


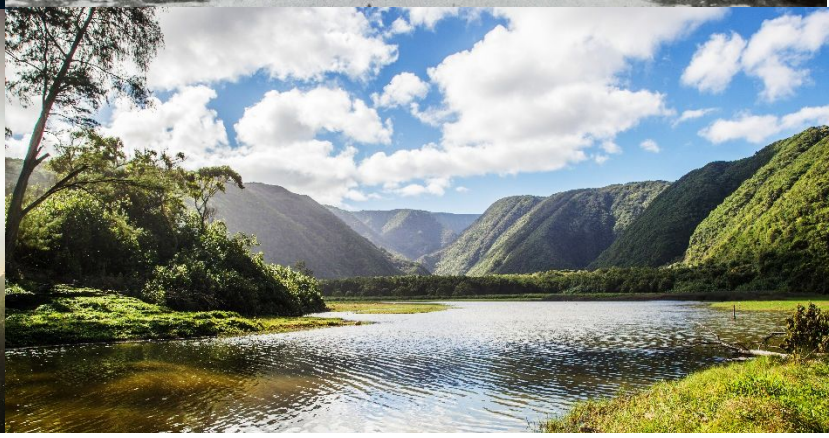

# One Water Roadmap:

## Integrating Water Resource Management on Hawai‘i Island
## Developing a Place-Based One Water Roadmap




Ke lepo ke kumu wai, e huaʻi ana ka lepo i kai
When the source of water is tainted, dirt is carried seaward

**Note to the reader:** The project team has adopted the ethos of not italicizing ʻōlelo Hawaiʻi—supposedly "foreign" words—or words that aren't used in the dominant culture. We've come to understand the practice of italicizing ʻōlelo Hawaiʻi (Hawaiian language) as a form of linguistic gatekeeping; a demarcation between which words are "exotic", "othered" or "not found in the English language," and those that have a rightful place in the writings of native speakers and the academic work of native scholars. Glossaries have been provided by the project team (*see final products folder*).

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# Preface

This work is designed to provide legible planning tools, framed within the One Water approach and strategies, for water management and planning within the context of Hawaiʻi Island. This report was conceived and developed by University of Hawaiʻi at Mānoa students, in the Department of Urban & Regional Planning Department (DURP). These students sought to work critically and consciously outside of comfort zones, to expand their capacity for learning, and leverage their lived experiences, skills and expertise while maintaining relationships with aloha ʻāina (love of land) and visions of ʻāina momona (fat or abundant lands). We (the authors) present this work in response to the long-range planning needs of Hawai'i County to work toward integrated water resource management. Bethany Morrison, Program Manager, Hawai'i County Long-Range Planning Division was our contact and liaison. It was noted, in her brief, that a lack of communication and collaboration was spurred on by siloed or sectoral management and may be caused by a failure to consider the diverse responsibilities across jurisdictional and geographic boundaries.

Formed in 2008, the US Water Alliance brings together diverse interests to identify and advance common-ground, achievable solutions to the US's most prevalent water challenges. One Water is an approach that was developed by the US Water Alliance to promote water stewardship that is innovative, inclusive, and integrated as it educates the nation about the true value of water and advances policies and programs that manage water resources to advance a better quality of life for everyone.

Hawai'i's water future is at a crossroads. We are experiencing increased droughts and storm frequencies not documented in recent history[1]. Furthermore, to accommodate growth and the desire for increased living space, local governments are pressed to fulfill water demands, expand and improve water delivery, stormwater and wastewater utilities, and water planning. Through all of this, there remains a requirement to be diligent and respectful when understanding the needs of the community, how to engage them, and ensure meaningful participation. Currently, the emergence of water champions and water championing speaks to the growing concern of how water is managed. Wai (water) protectors seek to assume their kuleana (responsibility) to steward water resources and make certain that people have access to it. And, so, Hawai'i can potentially lead the way by forging (k)new[2] solutions and implementing transformative, collaborative and holistic solutions.

[1] Keener, V. et al. (2018).

[2] (K)new, with the k in parentheses, is a method and a concept that entails gathering and revivifying inspiration from indigenous ancestral (ecological) knowledge systems or "old wisdom" for the integral development and redevelopment of contemporary problem solving

# Acknowledgements

Me ke aloha pumehana,

nā akua,
nā ʻaumākua,
nā kūpuna,
a me nāʻohana,

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and to
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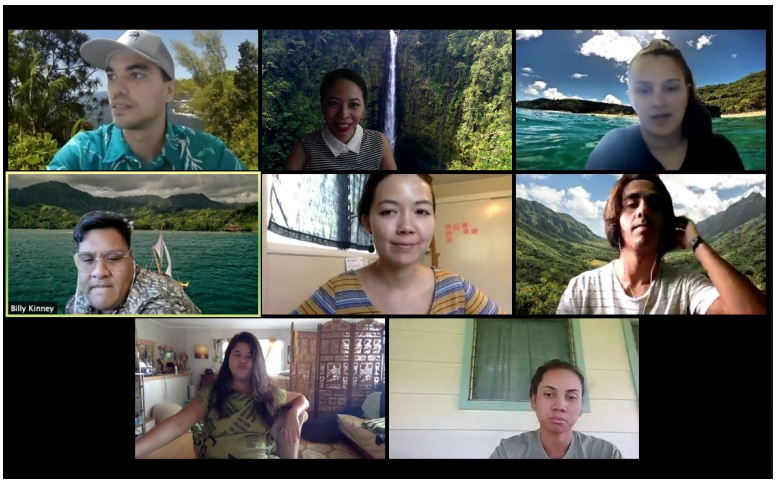
whose unwavering belief in our capabilities as today's leaders
remained encouraging and steadfast



# Contents

# Introduction

Wai, or freshwater, is the life blood of the land and the foundation from which society itself can spring forth into waiwai: abundance and worth. For kanaka ʻōiwi (native peoples), and the island communities in which we all live, both life and lifeways or the "close interaction of worldview and economy in small-scale societies" (Grim, 2006)[3] continue to be defined by wai[4].

The idea of an integrated systems approach to water is not new; in fact, the state of Hawaiʻi is mandated by law to maintain the purity and the flow of Hawaiʻi's water. The Hawaiʻi Supreme Court describes the Public Trust Doctrine as "the right of the people to have the waters protected for their use [which] demands adequate provision for traditional and customary Hawaiian rights, wildlife, maintenance of ecological balance and scenic beauty, and the preservation and enhancement of the waters..." for present and future generations. However, its full-scale implementation has yet to be actualized. There are many signs that water management in Hawaiʻi is entering another era of change and the drive to reignite lines of communication based on water abundance for all, and for future generations, seems promising through a lens of shared kuleana and public trust. All around the US, the management of water is seeing silo-busting examples of integrated and inclusive approaches to water resource management. These approaches exemplify the view that all water has value and should be managed in a sustainable, inclusive, integrated way. This perspective is called One Water. And, while we are guided by the national One Water strategies, the scope of this project is to develop a roadmap for Hawaiʻi island, and the promotion of robust local island economies, community and collective abundance, and thriving ecosystems.

Water Resources Management (WRM) systems include many institutional frameworks (legal, regulatory and organizational roles), management instruments (regulatory and financial), and the development, maintenance and operation of infrastructure (including water storage and conveyance, wastewater treatment, and watershed protection). Governments are normally organized in terms of specific functions and rigid hierarchies, the normal result of politics, inevitably leading to fragmentation and lack of coordination (Gil-Garcia, 2012). According to the US Water Alliance, the Nation should be proud of its systems and infrastructure to make water accessible and clean, but its systems, including the siloed actions, are insufficient for the challenges we are now facing. The regulatory, financial, and governance structures have put water into disjointed and separately managed silos for different forms of water: drinking water, wastewater, and stormwater.

An integrated approach considers scale, complexity, relationality, infrastructure, economies, varying worldviews, and parameters for measuring success. The One Water framework is a holistic and collaborative approach that can consider all of an island's water resources from surface water, groundwater, potable water, to wastewater, recycled water, and stormwater as "One Water." Silos are organizational units where there is a breakdown in communication, co-operation, and coordination with other parties[5]. Hawaiʻi County is faced with some unique, place-based, management challenges in regards to the silos which have created an environment of individual and disparate systems within larger organizational boundaries. Responsibilities of state and local governance often fall into complex management systems that are inefficient. Subsequently, sectoral or siloed actions often generate lag effects or inaction due to jurisdictional confusion and miscommunication. Given the changing and uncertain climate futures, research is needed to better inform and assist those who strive to create a more sustainable, equitable future in which freshwater resources are overflowing to meet domestic, economic and environmental needs. Recently, siloed approaches to land and water management have given way to more integrated approaches. Integrated approaches in

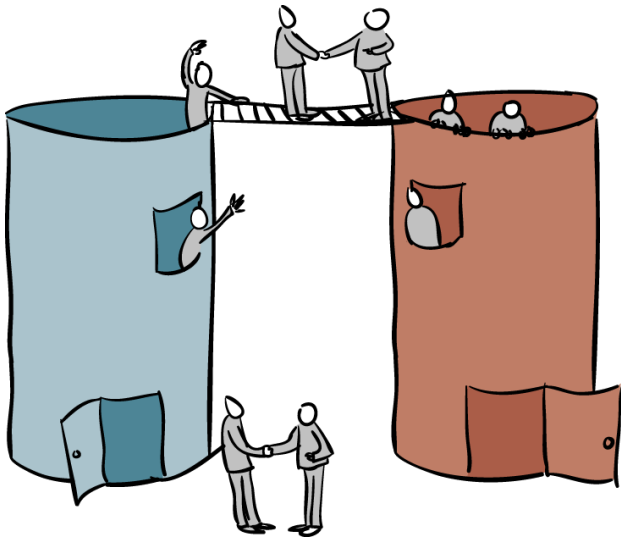
[3] Grim, John A. (2006).

[4] Wai: A general name for what is liquid; fresh water in distinction from kai, salt water: wai maka, tears; wai kahe, running water; wai u, milk; wai eleele, ink; wai hooluu, dye; wai puna, spring water, etc. (A dictionary of the Hawaiian language (revised by Henry H. Parker))

[5] Fenwick, et al. (2009).

water management necessitate processes of planning, developing and managing the world's most precious, life-giving resource - water - holistically and collaboratively.

The silos have been reinforced at every level of government—from the federal guidelines for clean and safe drinking water, to how water rights and regulation are managed at the state level, to the disjointed nature of how city & county agencies and local governments are organized. In addition, water resources are influenced by industries, agriculture, and ecosystem management in dissimilar ways that make decisions disparate from the decisions made by other water managers and communities within the same ahupuaʻa[6].



Solving today's water problems requires breaking down barriers not only within the uses of water, but also among all the stakeholders who influence, and are influenced by, the management of water resources. Stakeholder voices include community and business leaders, cultural practitioners, industries, traditional and non-traditional farmers[7], environmental advocates, conservationists, policymakers, academics, and many others. They all play important roles in the quest to secure a sustainable water future for all.

This report offers a framework attempting to approach water management, boldly, and to begin to formulate place-based solutions for leadership towards One Water management on Hawaiʻi island. We, the project team, were tasked to provide the following products / steps toward planning for One Water implementation[8]:

1. An overview of the current water resource management framework in Hawaiʻi County.
    a. Summarize existing State and County goals, objectives, policies, and guidelines related to water resource management.
        i. Review existing and proposed County strategies (relevant documents: Draft General Plan 2040, and the various CDPs).
    b. Identify agencies and organizations involved with water resource management, their missions, and their basic institutional framework (for example, regulatory jurisdiction, organizational structure in relation to resource management, etc.)
    c. Identify overlaps, connections, collaborations, and gaps among water resource management entities, and summarize the challenges to integrated water resource management (especially identify policies/functions that lead to siloed action):
    d. Clearly identify decision makers and the points at which they make decisions to establish policy and standards, allocate resources, approve permits, and otherwise determine the future of water resource management.
    e. Engage stakeholders in developing (a-d) above. Questions might include: How do these regulatory agencies see their role in water resource management? How do they see their agency counterparts' roles in resource management as complementary or contradictory?
2. One Water Framework: Develop a brief synopsis of the One Water approach which explains why integrating resource management is advantageous for Hawaiʻi; include at least one example of a successful One Water collaboration in a community similar to Hawai'i County, and summarize lessons learned and best practices.
    a. Cite case studies and other municipalities endeavors in integrating water resource management.

[6] An ahupuaʻa is a traditional socioeconomic, geologic, and climatic subdivision of land

[7] Traditional and non-traditional farming practices are distinct in some sense, but in terms of water law, traditional and customary practices of farming are protected

[8] Project objectives and deliverables were outlined in the project brief provided by the client, and the brief also included some identified issues and examples of organizational silos

3. Alternatives Analysis: Analyze the opportunities to collaborate in relation to water resource management in Hawaiʻi County, alternative approaches to improve collaboration, and the trade-offs of each alternative relative to One Water goals.
    a. Identify policies and functions of the above entities that create opportunities
    b. Engage stakeholders to explore the feasibility of alternatives. Questions might include: What would resource managers like to do differently? Where do they see room for improvement in collaborating to manage water resources better?
    c. Outline alternative approaches to moving the dial towards water resource management integration (such as opportunities to collaborate, policy creation/revision necessary for increased collaboration, public-private partnerships opportunities, MOUs between agencies, etc.).
    d. Evaluate and rank alternative approaches relative to One Water goals and other relevant criteria like cost, feasibility, etc.
4. Hawaiʻi County One Water Roadmap: Develop a roadmap of recommended actions for a progressive integration of Hawaiʻi Island's water resource management.
    a. Ensure that the roadmap addresses who would implement, what they would implement, and how they would implement. Priority should be placed on recommendations that result in 'silo-busting.' Include a proposed implementation time frame.
5. Slide Deck: Integrate the planning process and recommendations into a presentation (not to exceed 20 minutes)
    a. The intended audience of this report would be the Planning Director of the County of Hawaiʻi and the Hawaiʻi County Council.

<u>The report is organized into the following sections:</u>

1. **Process Design** summarizes the elements and functions of each portion of the project, and the internal processes for organizing team roles and duties.
2. **Ka Wai Ola** offers a beginning overview of wai's importance and Hawaiian perspectives of wai as a life-sustaining element (akua) and the context or implications of its use and management by humans prior to European contact and beyond.
3. **The Current Landscape of Wai** describes water management, jurisdictions, general water law and policies, governance, and issues relating to sectorally managed water and disjointed management.
4. **The One Water Approach and Arenas for Action** outlines the vision and core principles that guide One Water's framework and the Arenas for Action and outlines strategies for One Water management.
5. **(K)new One Water Framework** offers a synopsis of each One Water Arena for Action, while offering a "reframing" of those arenas to provide more place-based summaries for the types of implementable actions / strategies that each arena calls for in the context of Hawaiʻi island.
6. **Alternative Analysis / Recommendations** draws on findings from the stakeholder engagement to explore opportunities to move the dial toward integrated water resource management. Appendix C (Agency Flowchart) provides a visualization of the complexities within jurisdictional hierarchies and levels of government.
7. **Stakeholder Recommendation Tables** explore stakeholder dialogue and present recommendations for collaboration, policy creation/revision, and partnerships based on feasibility and priority.
8. **Moving Forward** concludes the written parts of this project by reinforcing the main message of the report; the rationale for integrated water resource management , One Water and (K)new One Water Approaches, and some important takeaways / illuminations.
9. **Appendices** contain (A) a list of stakeholders involved in this project, (B) the talk story guide used for stakeholder interviews, (C) a flowchart of agencies that comprise the landscape of water governance, (D) a matrix overview of federal, state, and county agencies, (E) a matrix of water management perspectives, (F) a diagram of (k)new arenas for action, and (G) a few maps of Hawaiʻi Island.

# Process Design

As the project was centered on designing a roadmap for collaborative and integrated water management, the project team developed a unique approach to process design grounded in Hawaiian knowledge, the lived experiences of each team member, and their relationships to water and to each other. This project was conducted over a four-month period and consisted of the following elements:

### Laying the Kahua (Foundation)

The first step in producing a One Water framework uniquely designed for Hawaiʻi Island was to familiarize ourselves with the area's history, landscape, and specific needs. Our goal was to create a framework that above all else focused on place-based design. To achieve this goal, preliminary place-based research was conducted to identify aspects of the One Water framework that would be most beneficial to serving the communities of Hawaiʻi Island. This research involved studying mele (songs) and moʻolelo (stories) documenting the different ecological regions and districts of Hawaiʻi Island, exploring the different types of wai, and acknowledging different issues regarding wai management on Hawaiʻi Island. The Hawaiian research methodology Papakū Makawalu[9], created and disseminated by the Edith Kanakaʻole Foundation, was also used to critically analyze and synthesize an understanding of the different perspectives of wai in mele (song and poetry) and pule (prayers or supplications). Furthermore, this method provided an on-going way for us to emphasize and utilize different senses, ways of categorizing and organizing our cultural / natural world to study and understand the issues and topics we were observing from multiple perspectives.

### Stakeholder Engagement Process

**Contact & Communication** -
We prioritized which agencies we believed we needed to engage; namely, starting with those that were provided by Bethany and the County of Hawai'i's Long Range Planning Division in a preliminary list within the project brief. We determined how we were going to connect with them; and team members contacted the identified stakeholders, scheduled for a kūkākūkā (talk story) session, and facilitated the session. We created an email template that included an introduction, a description of the project, and dates and times that we could all participate. We strove to accommodate stakeholders' schedules and, if they were unavailable, we requested that we be referred to another representative from their department.

**Scheduling & Preparation** -
We used a shared Google Calendar to schedule our kūkākūkā sessions, which allowed for easy reference and access for all team members. Due to the team members being situated across different islands and due to COVID-19, we conducted the talk story sessions via Zoom. We provided the talk story questions in advance to our stakeholders to make the valuable time we had with them most productive. The Talk Story guide can be found in Appendix B.

**Facilitation & Agenda** -
Our talk stories were conducted throughout the month of October. Every talk story was led by one facilitator and at least two team members as note takers. The time span ranged from 30 minutes to 1.5 hours depending on the stakeholder's availability. The agenda included a welina (welcome) with team member introductions, a brief description of our project, talk story, and a mahalo (thank you) closing. The stakeholder could answer our questions directly or share information in relation to our project more generally. After each talk story, the team debriefed and discussed all that we learned and how we could use it to complete our deliverables.

[9] http://edithkanakaolefoundation.org/papakuMakawalu.php

## Data Analysis

**Data Collection -**
We were respectful of any stakeholders who requested to remain anonymous and decided not to record interviews, opting to assign two notetakers and one facilitator for each kūkākūkā. This allowed the facilitator to focus on the flow of the conversation and obtain the necessary information. Although this resulted in some redundancies in note-taking, we found this method highly beneficial in capturing a greater wealth of information. We consolidated all of the talk story data we collected into a spreadsheet to assist us with the data analysis. Data collected from these stakeholder engagements included guided responses regarding an agency's role in water management, existing collaboration efforts and shortcomings, as well as relevant issues and recommendations indicated by the stakeholder.

**Reframing the One Water Arenas -**
An important step to assessing the One Water framework for the County was to review the US Water Alliance One Water Roadmap's six "Arenas for Action." We identified gaps or deficiencies in these arenas and strategies that made them less applicable to the project area. The next steps involved reframing these one water arenas to fit Hawaiʻi County specific issues. Updated arenas and strategy recommendations were made after analyzing and discussing the responses from the stakeholder engagement. A coding process was used to categorize stakeholder management activities into the six One Water arenas. Stakeholder responses were re-evaluated and assigned number(s) to correspond with the six One Water arenas (#1-6) along with documentation on how that stakeholder addressed themes corresponding to a given arena. After coding all stakeholder responses, common issues and themes among stakeholders operating under the same arenas for action were compiled for future use. These coded responses were instrumental in creating updated and place-based one water arenas for action well suited for Hawaiʻi County.

**Alternative Analysis/Recommendations Process -**
Our project brief asked us to identify, contextualize, and rank recommendations regarding water management and collaboration in Hawaiʻi County. To address this, we drew upon the recommendations we received from the stakeholders categorizing them into one of five themes: collaboration, infrastructure, research & data, policy & regulation, and planning process. Once categorized, each recommendation was assigned a number(s) 1-6, corresponding to a reframed One Water arena. The final step of this analysis involved ranking by priority and feasibility of each recommendation on a low-high scale. Low priority/low feasibility means the recommendation is not ready for immediate action/difficult to implement and high priority/high feasibility means it is ready for immediate action/easily implementable.

**Reporting and Presentation** -
The final deliverables for this project are a detailed written report and presentation slide deck as outlined in the project brief provided by the client. The intended audience for our project presentation is the Hawaiʻi County Planning Director and the Hawaiʻi County Council.

## Internal Processes

**Naʻau Check** -
During the first team meeting, the team conducted a naʻau check, an icebreaker exercise to develop relationships between team members. As the project progressed, the naʻau checks became an integral component of team meetings to check on the well-being of team members. Topics of these naʻau checks ranged from brainstorming project concepts to personal reflections. Naʻau checks strengthened team relationships while serving as a tool to allow team members to share personal stories, concerns, and experiences from school, work, and personal life.

**Team Communication -**
An important goal for the team for the duration of this project was avoiding internal silos. Team members worked together on project tasks through virtual work sessions, uploading active files to a team drive, and keeping lines of communication open via phone and email. This allowed the group to collaboratively work on project deliverables ensuring that the voice of each individual team member was included in the final product.

Another critical tool utilized throughout the project involved the completion of monthly evaluation surveys that allowed team members to discuss any personal successes, challenges, and/or feelings they were experiencing with the project. These evaluations were submitted anonymously for team members to feel more comfortable expressing their opinions openly and honestly. The survey responses were reviewed by the entire team and were used to guide the next steps of the project while also serving as a reminder of all the hard work that had successfully been completed up to that point.

**Respect, Navigating Disagreements, Playing to Strengths -**
With any team project, there are different views and opinions that come to light while completing the final product. In order to mitigate any challenges caused by differences, the team made it a point to respect and appreciate the individual strengths of the team members. The team leveraged the different skills and backgrounds of team members and allowed individuals to take the lead on components of the project that played to their strengths. When an issue did arise, the team consciously diagnosed the concern and created a plan of action to resolve the problem.

**Understanding That We Are Also Stakeholders -**
The team recognized that we, as individuals, are also seen as stakeholders in the future of wai and equitable management. As students and classmates, we also play a role in the overall well-being and growth of our peers. This realization, along with the many existing passions and planning interests of team members, ensured that this project was completed to the best of our abilities.

# Ka Wai Ola (The Living Waters)

**Life Giving Waters**[10]

Wai, or water, is the essential life force of all living things. Lines in the Kumulipo[11], a cosmogonic chant or inventory of the evolution of the living Hawaiian world, says “he wai ka ai a ka laau / o ke akua ke komo, aoe komo kanaka.” Plants thrive and survive on water. It is the element that exists where man cannot. Lāʻau (tree, plant, wood, forest) is also a poetic reference to the human body and its limbs. Wai is the essential element for humans, both, internally and externally.

Water in our environment is cyclical, and it is moved and transformed by various processes. The northeasterly trade winds provide Hawaiʻi with a majority of its rainfall. The windward (eastern) sides of the volcanic Hawaiian Islands, trade winds push moisture rapidly up the mountain slopes. Clouds form when moist air is cooled – condensation. The rising and cooling of this water-rich air leads to cloud formation and orographic rainfall, the origin of our fresh water, and provides recharge for the subterranean aquifers and deep reservoirs. In addition to above-ground water, Western science classifies three types of subterranean water: basal, perched, and dike-confined. Precipitation occurs when water drops, or ice particles, become large and heavy enough to fall from cloud masses. Rainwater recharges groundwater, rivers, streams, etc. Some of that water is used by plants. Established forests and healthy uplands return water back to the cycle through the creation mist, fog, vapor by way of transpiration and some is evaporated directly from saturated land, soil, and wet leaves. The sum of all the transpired and evaporated water then becomes available to form clouds and rain – this is what is called the evapotranspiration process.

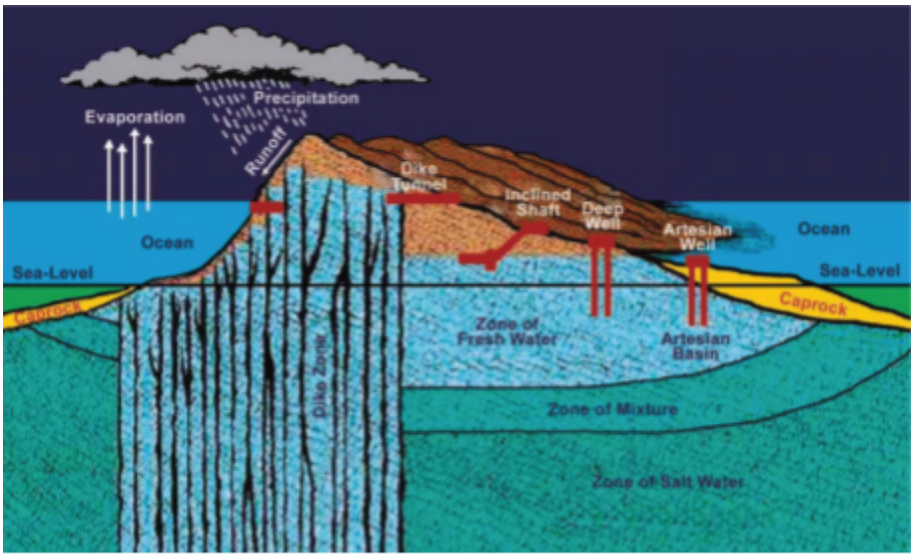



FIGURE 1. The hydrology of the Hawaiian Islands. *Hawaii Nature Guides.* Zimpfer and Toaspern, 2013.

For Native Hawaiians, akua are the natural processes and elements that are essential to life and akua are assigned to each part of the hydrological cycle. Kino lau akua are the earthly forms and representations of life-sustaining elements such as water in its various forms, plants, and natural phenomena that are the bare necessities of sustaining life within our island ecologies. Kāne is an akua of fresh water, juice, sap, bodily fluids (i.e. non-saltwater liquids) and in the form of Kānehoalani, heat and the sun, energy

[10] Much of this section is informed by and provided by the guidance and the work of Edith Kanakaʻole Foundation (Papaku Makawalu Workshops on wai) and “Ola I Ka Wai: A LEGAL PRIMER FOR WATER USE AND MANAGEMENT IN HAWAII” by D. Kapuaʻala Sproat, Ka Huli Ao Center for Excellence in Native Hawaiian Law, the William S. Richardson School of Law at the University of Hawaii at Manoa.

[11] Liliuokalani. The Kumulipo : an Hawaiian Creation Myth, 1979.

powering the water cycle. Kanaloa is the akua of the ocean, saltwater, breadth, depth, and expansiveness and therefore, the akua of subterranean water, aquifers, and deep-sea discharge. Laka represents the growth of the established forests and the moisture, ohu (mists), vapors, fogs, drip, and rain capture associated with it. Lono represents the elements of the rainy Makahiki (winter), one of harvest, abundance, and peace. Kū represents governance, law, and warfare, all of which are foundationally based in wai. Intricate respect, reverence, and understanding of these akua through reciprocal, life-giving relationships are how Native Hawaiians understand and care for their natural resources. Understanding and quantifying the movement of water in the hydrological cycle is necessary to manage our water resources, avoid environmental degradation, adapt to climate change, and ensure connection to land as well as an availability of water that meets domestic needs for future generations. Most importantly, the reverence for these physical manifestations of akua and spiritual connotations of water would disallow a commodifcation or ownership of water. Aliʻi and aliʻi nui (leaders and chiefs), instead, would manage water as a resource that benefits the entire ahupuaʻa, current and future kin.

Prior to the documented arrival of Westerners (1778), water was recognized as an akua or an essential element and process for life. The continuous flow of water from ma uka (in or toward the uplands) to ma kai (seaward) provided critical aquifer recharge, freshwater for forests, traditional agricultural systems, clean drinking water, loko iʻa (fishpond aquaculture), and supported productive estuaries and fisheries. In addition, streams and rivers provided necessary waterways for the life cycle, habitat, and migration or movement of native stream life from the uplands to the sea and vice versa – including ʻoʻopu, ʻōpae, hīhīwai, and hapawai. Managing mauka to makai connectivity was a kuleana, both a right and a responsibility.

Given the importance of water to Hawaiian society, naturally, traditional laws or kānāwai developed around the sharing, the use, and the management of freshwater. Appointed by aliʻi and aliʻi nui, konohiki stewarded resources, like fish and water, within an ahupuaʻa and smaller land divisions such as ʻili and ʻili kūpono[12]. Lunawai ("water boss" or water stewards) were also appointed, sometimes by the konohiki, and managed water distribution and was the overseer for waterway maintenance within various land divisions. The power of the konohiki and lunawai was predicated and relied on the cooperation of makaʻāinana (people that worked and tended to the land). Konohiki facilitated the relationship between makaʻāinana and the resource itself. To ensure productivity of the ahupuaʻa, then, would require the konohiki and lunawai to treat makaʻāinana fairly and avoid disputes or disruptions in the connectivity and management of water. If makaʻāinana felt mistreated or dissatisfied, they were free to leave, and thus, shame would fall on the konohiki or lunawai. Kānāwai can be translated, literally, as "relating to water" or "the rights of water" as it dictates all aspects of life. Thus, water was and is a public trust resource. In ancient times, no one could own water. Rather it was a resource to be managed for future and present generations.


FIGURE 2. A timeline of pertinent events in Hawaiian History regarding water management.

[12] Emma Metcalf Nakuina, Ancient Hawaiian Water Rights, in HAWAIIAN ALMANAC & ANNUAL FOR 1894 at 79 (Thomas G. Thrum ed., 1893)

The arrival of foreigners around 1778 affected life and society and the ways water was used and managed. The favorable climates allowed year-around growing seasons and sparked plantation agriculture (mainly sugar and pineapple). Ditch and irrigation systems were constructed on all major Hawaiian islands. Water was often transported away from Windward communities to feed Central and Leeward areas that were often too arid to support these agricultural industries. Water was becoming commodified, and while water was no longer revered as a physical manifestation of akua, the concept of public trust carried over into the Kingdom of Hawai‘i. These changes to water intensified many of the cultural harms to Kānaka Maoli and the lands / waters of Hawai‘i. The timeline above provides important events in the history of water use and management in Hawai‘i, from Western contact up to the landmark Interim Instream Flow Water Case of Nā Wai ‘Ēha.

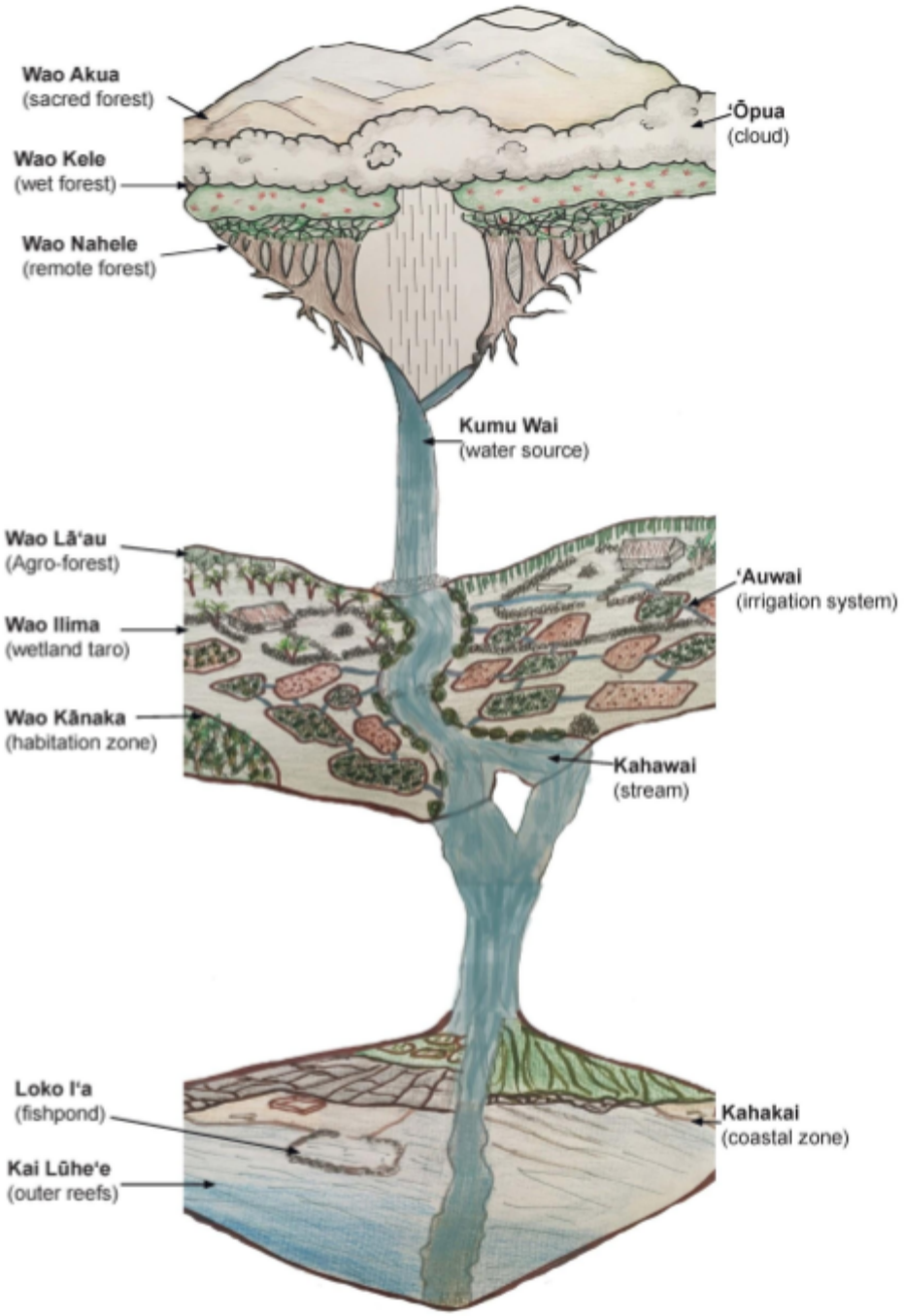



FIGURE 3. Visualization of land and water connectivity by wao.

# The Current Landscape of Water Management

For Hawai‘i County, water governance involves a network of federal, state, and county agencies that have specific legal responsibilities (see Figure 4). Although this multi-jurisdictional approach provides each county the flexibility to tailor water regulations to meet its own unique circumstances, the multiple layers of administration and governance presents challenges for responsible water management. Understanding how water resources are currently regulated can help stakeholders envision an integrated One Water framework for Hawai‘i County. A diagram of the various agencies that are involved in water management on Hawai‘i Island can be found in the Appendix C (Agency Flowchart).

At the federal level, the Environmental Protection Agency (EPA) is the primary agency that sets national standards through the Clean Water Act (CWA) and the Safe Drinking Water Act (SWDA) to protect water quality and monitor the implementation of these standards. The federal laws provide the foundational requirements that each state and county must adhere to in its regulation of water resources while allowing each state/county to establish more restrictive regulations where appropriate.

In Hawai‘i, several agencies are involved in water management. The Commission of Water Resource Management (CWRM) within the Department of Land and Natural Resources (DLNR) regulates groundwater, surface water, and water management areas (WMAs). Meanwhile, the Department of Health (DOH) monitors safe drinking water, wastewater, and groundwater. A description of agencies involved in water management can be found in Appendix D (Agency Overview).

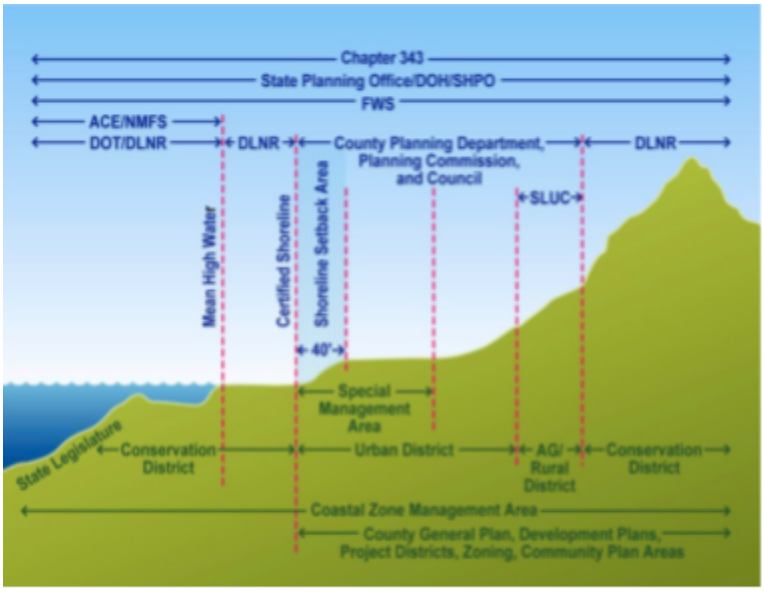



FIGURE 4. Ridge to Reef Management Jurisdictions. Source: Sichter, Lee (Belt Collins Hawaii), 2009

At the state level, water management is codified through the Hawai‘i State Constitution, the Hawai‘i Water Code (HRS Chapter 174C), Hawai‘i Administrative rules, and case laws[13]. The Public Trust Doctrine of the Hawai‘i State Constitution declares:

***“the State and its political subdivisions shall conserve and protect Hawai‘i’s natural beauty and all natural resources…all public natural resources are held in trust by the State for the benefit of the people.”[14]***

The Public Trust Doctrine codifies the State’s kuleana (responsibility) to protect all of Hawai‘i’s natural resources for the benefit of the people. The State’s kuleana to wai is articulated in Article XI, Section 7:

***“the State has an obligation to protect, control and regulate the use of Hawai’i’s water resources for the benefit of its people.”[15]***

The Public Trust Doctrine incorporates the dual mandate of protection and maximum reasonable and beneficial use[16]; therefore, the consideration and protection of the Public Trusts acts as the basis in allocating and planning *all* water resources for *all* state agencies.

[13] Sproat, Kapua, D., 2011.
[14] HAW. CONST. art. XI, § 1.
[15] HAW. CONST. art. XI, § 7.
[16] Waiahole I, 9 P.3d at 445; Sproat, Kapua, D., 2016..

At the federal, state, *and* county levels, there are agencies operating in silos when regulating water resources and developing or implementing policies that affect water use. A lack of inter-department collaboration between public agencies along with a lack of meaningful partnerships with private organizations sometimes results in ecosystem disruptions, inequitable access, unsustainable water allocation, and constraints on economic development. In the following section, we summarize some of the issues stemming from siloed action pertinent to Hawai‘i County.

Although the Hawai‘i County General Plan and the Community Development Plans (CDPs) stress the importance of effective water resource management, disjointed management persists. Despite the stated goal to effectively manage Hawai‘i Island's water resources and the need for a collaborative management approach, there are various jurisdictional and geographic disconnects that the County identified in their brief, including:

- Water supply, wastewater, and stormwater are managed by separate County agencies. These agencies do not actively collaborate with each other or operationalize integrated water system management.
- DWS is a semi-autonomous utility agency while the Wastewater Division is one of two divisions (the other being the Solid Waste Division) under the Department of Environmental Management. This perpetuates the concept that wastewater is a 'waste' product rather than a valuable water resource that requires careful management.
- State and Federal agencies regulate soil quality, stream quality, nearshore water quality, and individual wastewater systems; therefore, Hawai‘i County agencies generally defer to these agencies' jurisdiction rather than collaborate in planning for the management of these resources.
- The Department of Public Works treats stormwater as a waste product that must be quickly transported away from urban areas.
- There is no commitment from the County of Hawai‘i to participate in existing partnerships with watershed management entities around the island.

Through a synthesis of information from agency mandates, regulatory jurisdiction, community development plans, county general and water use plans, and stakeholder engagement we have summarized some of the issues faced by managers and communities in regards to the health and vitality of water and water systems.

**Disjointed management via siloed action, communication, and funding**

- There are *various disconnects between water and land use planning*. Land uses and development are designated in areas with insufficient water infrastructure and/or questionable water supplies. There is also a lack of consideration of the ecological impacts certain land uses may have on the health and quality of the water system. A few examples illustrating these disconnects include the following:
    - Land uses within the zone of influence on groundwater quality are not currently regulated. For instance, deep wells are often located downstream of agricultural and urban land uses which can impact the quality of these sources.
    - Hawai‘i County does not require verification of a long-term, reliable supply of water prior to the approval of development projects, such as subdivisions. There is also a lack of careful consideration of the ecological effects these communities will have on the water system.
    - Currently, Hawai‘i County Department of Water Supply looks for water based on what the land allocations are rather than having the water availability and ecological health be the basis of zoning and density/decision-making.

- There is a *lack of holistic understanding/approach for building water security and managing water as a Public Trust resource*. Treating water as a public trust resource should be ofthe highest consideration when making decisions that affect water resources, yet agencies still grapple with how to specifically fulfill their kuleana under the Public Trust. Fulfilling this kuleana requires adequate consideration of the interconnectedness of all water sources, including surface, ground, and coastal waters. Moreover, the system is currently set up in a way that rewards new development, including the development of new wells and diverting attention away from Public Trust considerations.

- There are inadequate *legislation, memorandums, and political water champions* to ensure sustained agency collaboration, project completion, and successful position turnover.

- ➢ *Limited funding and resources exacerbate disjointed management*. Agencies must "compete" for State funds and, with limited funding and resources, agencies must prioritize management actions. Collaboration opportunities are rarely highly prioritized.

**Infrastructure, Pollution, & Cesspool Closure**

- ➢ There are overall concerns regarding the *lack of, inefficiency of, and the aging of water infrastructure systems*. Furthermore, *complex island geology and sparse populations* constrain the physical and financial capabilities of infrastructure availability and expansion on Hawai'i Island.

- ➢ In recent decades, the County of Hawai'i has not adequately prioritized infrastructure to support development and population growth. This is often due to the *existing wastewater cost structure*. The county largely subsidizes wastewater service because the valuation for providing wastewater service is not based on the cost value for the service. This results in little to no financial incentive to significantly improve or expand the wastewater systems. Consequently, wastewater is the least addressed critical infrastructure asset within Hawai'i County, and often impedes thoughtful/responsible development.

- ➢ *Watershed, waterway, and (eco) system degradation is brought on by consumptive needs, industrial development, and climate change*. Water infrastructure, such as wastewater and stormwater systems, on Hawai'i island is inefficient and does not have the capacity to accommodate what users generate. This problem will be exacerbated by climate change hazards such as changes in precipitation and temperature patterns, extreme weather events, and sea level rise. Resulting flooding, erosion, and overwhelmed infrastructure and sewer overflows pose great risks of pollution and habitat destruction to Hawai'i Island.

- ➢ *Wastewater management and state-mandated cesspool closure* poses a major challenge for Hawai'i island. Fifty-seven percent of the State's cesspools are on Hawai'i Island, with many on highly permeable volcanic soil, lava tubes, near the coastline, or located at great distances from the nearest municipal system. Cesspool seepage has contributed to the pollution of coastal waters and also threatens underground sources of drinking water.

**Water Access & Equity**

- ➢ There are issues of *poor access to clean drinking water in certain Native Hawaiian, rural, and "off-the-grid"*[17] *communities*. Without access to easily accessible, clean drinking water, families and communities can be locked in poverty for generations. Lack of water services can also render properties unusable/unlivable. Figure 5 displays the water system and service areas for Hawai'i County overlaid with Hawaiian Homeland areas.

  In regards to "off-the-grid" communities it is important to better understand these communities on a contextual level. "Off-the-grid" communities are cheaper largely due to lack of services. Consideration must be given to the fact that some people may decide to live in these "off-the-grid" communities by choice whereas others may not be able to afford living elsewhere. These contextual understandings can come from conversations with these communities.

- ➢ There is a *lack of leadership from state and county entities/agencies to conduct meaningful community outreach and engagement that empowers community members* to be shared decision-makers and resource managers of *wai*. Currently, community involvement in water resource management is limited to the basic inclusionary processes: 1) Community Development Plan and General Plan updates; 2) public comment for Environmental Assessments; and 3) public notices and hearings.

**Funding Constraints**

*Lack of funding* is an overarching issue that limits an agency's ability to fulfill their responsibilities and thoughtfully address the issues outlined above. Financing requirements are increasing due to escalating infrastructure, maintenance, and water treatment costs, and are exacerbated by new demands from urbanization, population growth, and climate change threats. The development of innovative projects and initiatives, such as wastewater reuse projects,

[17] Quotation marks are used around the term 'off-the-grid' to imply that the term is misleading for no one is completely living off the grid. Whenever there is an emergency, the county must assist them.

are also impeded by limited funding and resources. In addition to the financing of infrastructure and services, more funding is needed to support in-agency functions, such as information gathering and capacity building. Finding cost-effective, long-term approaches to sustain infrastructure construction and operation costs, in-agency functions, and support the innovation of projects and initiatives is becoming ever more critical.

# The One Water Approach

The One Water approach envisions managing all water in an integrated, inclusive, and sustainable manner to secure a bright, prosperous future for generations to come. In contrast to typical integrated water resource plans (IWRP), One Water is more holistic in nature, primarily driven by triple-bottom-line (environmental, economic, and social) objectives and spearheaded by government officials.[18] One Water approaches are progressing in multiple arenas: from using advanced technologies to recover nutrients and energy from wastewater; to using green stormwater techniques to mitigate flooding while beautifying neighborhoods; to undertaking watershed-level planning and collaboration to address water quality issues; to implementing innovative financing and partnership models.


FIGURE 5. The One Water Cycle. US Water Alliance, 2010.

**CASE STUDIES**

One Water has experienced success on a national scale in a number of cities and locales of various sizes, each with varying management challenges and collaborative solutions:

- **Los Angeles, California -**
  - Led by the LA Department of Sanitation (LASAN) and LA Department of Water and Power (LADWP), LA focuses on reducing the dependence on imported water through wastewater reuse.
  - Memorandum of Agreements (MoAs) codify collaboration between LASAN and LADWP (water quality-supply nexus) regarding stormwater management.
  - Holistic lens identifies multi-purpose projects using a "trigger approach" and coordinates water management across all relevant city departments.
  - Developed master plans for wastewater and stormwater utilities, Water Conservation Potential Study, Water Reuse Master Plan, Stormwater Capture Master Plan.
- **Denver, Colorado -**
  - Recognizes negative impacts of siloed management and multi-benefit solutions of holistic water management
  - Denver One Water consists of a core planning team (six agencies) + a larger network of collaborative partnerships throughout the watershed.
  - Faces extreme wildfires, water shortfalls, projected population growth, demand, and climate pressures.
  - Promotes water reclamation and reuse for water conservation, resilience, urban livability, equity and social justice.[19]
- **Austin, Texas -**
  - Though finding One Water "intimidating" at first, severe drought catalyzed the implementation of One Water to diversify water systems, reuse, and management and reduce dependence on imported water.
  - Austin implements collaborative and adaptive management to model future water demand and supply projections.
  - Conducting 80 outreach events aided in developing outcomes for updating codes in water conservation, water

[18] One Water for Climate Resiliency: A White Paper. 2020.
[19] City of Denver, 2020.

loss control, diversifying landscape, stormwater and rainwater harvesting.

- **Miami-Dade, Florida -**
  - The Water and Sewer Department (WASD) utilizes One Water to address wastewater and sea-level rise concerns with 20-year, $13.5 billion Capital Improvement Plan (CIP).
  - Through an integrated utility management approach, understanding the integrated shocks and stressors of climate change within the sector better inform resiliency.
  - Recognizing that resiliency must be operationalized led to the establishment of the Resilient Utility Coalition (RUC), which aids in promoting leadership and education about climate resiliency.
- **San Francisco, California -**
  - Started small with an agency Working Group representing resource areas (Water, Wastewater, Power, Finance, and External Affairs) to focus on tangible implementation.
  - Comprehensive and transparent stakeholder involvement including but not limited to, a Citizens Advisory Committee, Rate Fairness Board, Revenue Board Oversight Committee, and Residential Users Appeals Board
  - Matches the "right water to the right use", such as using reclaimed and/or treated water for irrigation and saving potable groundwater for drinking.[20]
  - Fees to cover administrative costs of new ordinances, grants for those who implement non-mandatory projects.

A review of One Water case studies and the results of our stakeholder interviews support the conclusion that the framework has been successful in many communities, garnering support across jurisdictions. The One Water framework however is not a "one-size-fits-all" solution, and we identified the following as aspects that limit its usefulness.

**GAPS IN THE ONE WATER FRAMEWORK**

- **Opposes siloed management status quo -**
  - One Water relies heavily on collaboration and supports "out-of-the-box" thinking, which is difficult in siloed management
  - Public is largely risk-averse in nature, elevating the need for successful collaborative government efforts
  - Should not become a new reporting entity that usurps existing organizations
- **Top-down government approach** -
  - The framework has a tendency to be enforced on an agency-level (e.g. the Mayor's Office), trickling downwards to sub-agencies.
  - Can limit effectiveness depending on which agency is spearheading the effort.
  - Not often observed as a grassroots-level engagement strategy
- **Intention, not action based** -
  - Designed to be a guideline, not "a project unto itself"
  - One Water is often aspirational and intention-based. While this approach has the opportunity to bring diverse stakeholders together, its lack of an action-based approach makes effective implementation difficult.
- **Lack of place-based or indigenous knowledge** -
  - While water resources frequently have place-based and indigenous knowledge and methodology, the One Water leaving little to no room for community or indigenous knowledge or methodology. Meanwhile, indigenous and place-based knowledge is integral for water management initiatives, particularly in the Hawaiʻi County context.
- **Needs sufficient catalysts for implementation -**
  - ***Event*** **-** One Water often has a compelling need for implementation, for example, frequent flooding or climate change. Without a specific catalyst or event, the framework is difficult to implement, fund, or maintain.
  - ***Champions*** - Oftentimes, a One Water plan is initiated by a key champion in the form of an agency or individual, and relies on consistent, sustained efforts to accomplish the framework's goals. Thus, if agency management changes, or the key individual is no longer present, initiatives may not be completed.
- **Danger of being a "branding strategy"** -
  - With One Water's popularity as a tool for interconnected and integrated water management, it can run the risk of becoming a trend without substantial implementation or efforts. *"There are 3 words in the industry*

[20] San Francisco Public Utilities Commission, 2018.

*(sustainability, big data, and resiliency) that are very abused and have lost their impact. One Water risks being the fourth"*.

# Arenas for Action

This section of the report is organized into six arenas for action, offering concrete strategies that advance the One Water approach. The One Water arenas for action cover a range of issue areas, including: reliable and resilient water utilities; thriving cities; sustainable agriculture; competitive business and industry; social and economic inclusion; and healthy waterways. Taken together, these arenas for action can lead to tangible progress in how we manage water resources in America. Each arena begins with an overview of the issue, lays out strategies that are being deployed, and spotlights promising practices.


FIGURE 6. The Six Arenas of the One Water Approach. US Water Alliance, 2010.

We created a matrix of Traditional Resource Management / Public Trust / and One Water Frameworks and Perspectives *(see Appendix E*). It outlines the viewpoints of wai, ʻāina, water management, land tenure, law & governance, and community through each framework. This matrix assisted in the development of (k)new approaches that grounded our frameworks, rationales, and products / deliverables in a place-based narrative around water in relation to Hawaiʻi County and the illuminated gaps of each framework. From these illuminations, we have identified key aspects of an integrated, place-based, (k)new One Water framework that could guide managers toward a more equitable and abundant future of water management. The three main components of this framework are the Public Trust, Equity, and Pilina (relationships and interdependence).

It is important to note that while the report segments the major strategies into these six arenas, there is a natural interdependence. True to the One Water approach, water involves complex and interwoven solutions with many partners across jurisdictions. The six arenas are an imperfect but earnest attempt to structure the strategies in a logical fashion to support reflection and replication. The identified gaps or deficiencies in these arenas, as national and continental strategies, made them less applicable to the project area. The next steps involved reframing One Water arenas to fit Hawaiʻi County specific issues through analysis, discussion, and coding of the responses from the stakeholder engagement. In the following sections, coded responses were instrumental in creating the (K)new, place-based, One Water Arenas for Action better

suited for Hawai‘i County. One Water Arenas for Action is positioned, side-by-side, with the reframed (K)new One Water Arenas for Action starting on page 23.

# (K)new One Water Framework

**The Piko of Public Trust** -
Affirmative duty to take the Public Trust into account in planning and allocation of natural resources, and to protect Public Trust uses whenever feasible. Public trust applies to all water resources without exception or distinction, regardless of its immediate source (Waiahole, 94 Haw. 97 (2000)). Protected "trust purposes" include resource protection, Native Hawaiian rights and practices, appurtenant rights and domestic water. Presumption in favor of trust purposes; burden on state and commercial users to justify proposed uses.

**Streams of Equity -**
Social equity is creating, promoting, and incorporating equal and fair policies and opportunities for all to be healthy, happy, and prosperous. The Urban Sustainability Directors Network (USDN) defines equity through four components: distributional, procedural, structural, and transgenerational.[21]

**Landscapes of Pilina -**
Building and maintaining relationships and connections to one another is crucial for the implementation of integrated water management. By recognizing that relationships extend beyond the duration of a project or process (and often beyond social norms and boundaries), pilina transgresses temporary inclusion and produces genuine empowerment.

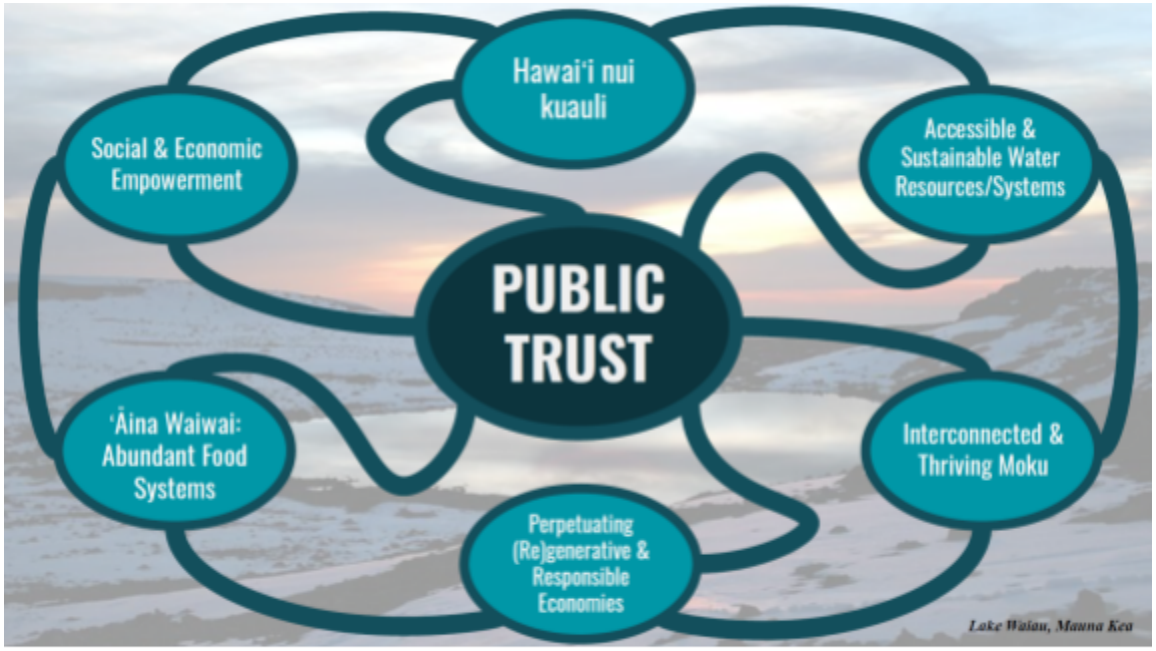



FIGURE 7. (K)new Arenas for Action— Piko of Public Trust, Streams of Equity, Landscapes of Pilina

[21] Components of Social Equity include: **Distributional Equity** - Programs and policies resulting in fair distributions of benefits and burdens across all segments of a community, prioritizing those with highest need; **Procedural Equity** - Inclusive, accessible, authentic engagement and representation in processes to develop or implement sustainability programs and policies; **Structural Equity** - Decisions are made with a recognition of the historical, cultural, and institutional dynamics and structures that have routinely advantaged privileged groups in society and resulted in chronic, cumulative disadvantage for subordinated groups; **Transgenerational Equity** - decisions consider generational impacts and do not result in unfair burdens on future generations.

The geographic piko (origin, center, navel) of Hawaiʻi island, and arguably the entire Hawaiian world, is Mauna Kea. Its geography and elemental inhabitants flourish to provide freshwater recharge to almost every region of Hawaiʻi island in different ways. Lake Waiau sits atop Mauna Kea, ka wai kamahao, a remarkable and sacred body of water. This imagery provides a place-based framework in which we have corroborated with the provided One Water narrative and literature to create an Integrated, Place-Based, (K)new One Water Framework and Arenas for Action, that are separate but also include and collaborate with the existing, national Arenas for Action as demonstrated by the One Water Roadmap.

| One Water Arena for Action | (K)new One Water Arena for Action |
|---|---|

## Arena for Action #1
### *Reliable and Resilient Water Utilities*

Beyond the historic mandates for utilities to comply with the Clean Water Act and the Safe Drinking Water Act, One Water and water utility innovation is transforming service delivery and improving water quality / environmental standards to stretch and diversify a community's water supply. One Water is designed to create responsible water managers, partnerships in local economic development, and proactive members of a watershed community that work toward delivering maximum benefits at affordable costs.

Additionally, through the notion that "there is no such thing as 'waste'" utilities of all types can be focused on resource recovery and natural processes wherever possible. When upgrades and/or repairs are required, the opportunities arise for making changes to modernize and make systems more resilient by increasing energy efficiency, reducing vulnerabilities, and improving management practices that also entail using the "right-sized" and optimal science and data for project-making purposes.

Some of the key strategies deployed by One Water include:

- Diversifying and stretching water supplies
- Utilizing green infrastructure to manage flooding and revitalize neighborhoods
- Transforming wastewater into a resource
- Forging new business models

## Arena for Action #1
### *Accessible and Sustainable Water Resources/Systems*

Standards for water delivery and accessibility are established by mandates such as the Clean Water Act and Safe Drinking Water Act, but when providing water to urban areas, outlier communities, various economies over the county's water delivery systems water managers should take into consideration sources and destinations of water in regards to Hawai'i's unique ecology and diverse socio-economic landscape. Hawai'i Island is expansive and vast; the volcanic and changing landscape can sometimes make the expansion of utilities to new communities challenging. Expanding land uses and growth can put pressure on existing water sources and delivery systems over time and illuminate underlying inequities. In Hawai'i, water exists as a natural feature or phenomenon and a public trust resource that enhances the quality of all human life - an important resource that should be accessible to all at affordable costs. Water infrastructure continues to be susceptible to time, climate change, changing political regimes and boundaries, and changes in value or use. Transforming stormwater and wastewater may be critical to extending the sustainability of water resources. Resort and agricultural industries may be able to utilize recycled water through reuse and reclamation in onsite and off-site systems. Water distribution and delivery, too, should stretch water resources through robust, reliant, and adaptive measures to be viewed through an integrated and shared lens of social and environmental justice - and an understanding of wai's importance sourced through a kanaka ʻōiwi worldview. Accessible and Sustainable Water Resources/Systems intends to assist Hawai'i County in forging new models for management, business, and climate resiliency of water systems and resources through a shared kuleana, promoting equity, and building pilina.

# Arena for Action #2
## *Thriving Cities*

As the urban population continues to grow and place additional stress on water resources, the social, economic, and environmental prosperity of these cities becomes increasingly dependent on the sustainable management of water. In recent years, the management of water has grown in strategic importance for local governments with sustainability becoming a unifying theme around the world. Integrated and inclusive management of water can create a multitude of benefits to help promote vibrant cities while also reducing the amount of negative impacts due to water emergencies.

Strategies for achieving Thriving Cities include:

- Integrated planning across the water cycle
- Utilizing onsite water systems
- Adopting a “dig once” approach
- Deploying advanced technologies to improve decision making
- Managing water to foster climate resilience

# Arena for Action #2
## *Interconnected & Thriving Moku*

Hawaiian land tenure systems contained the resources necessary for sustenance as well as the management mechanisms to ensure their sustainability and prosperity. Delineated by water boundaries and availability, land divisions such as moku (districts) were dependent on smaller ahupuaʻa (land divisions), which were in turn dependent on working, interconnected parts. The maintenance of this socio-ecological pilina (relationship) reduces vulnerability to external stressors and creates a multitude of social, economic, and ecological benefits.

In Hawai’i County, thriving growth has been hindered by siloed action and sectoral management. To achieve an interconnected and thriving future, emphasis should be placed on community and cross-jurisdictional collaboration as well as further developing these pilina. This interconnectivity will ensure that Hawai’i County is able to enhance the well-being of its residents while also creating an interconnected and thriving moku.

Strategies for achieving interconnected and thriving moku include:

- ➢ Upholding the integrity of the water cycle with ecological and human needs
- ➢ Focusing planning, efforts and initiatives at the watershed and moku levels
- ➢ Supporting localized, small-scale solutions to water reuse and onsite systems

# Arena for Action #3

## *Competitive Business & Industry*

Achieving a secure One Water future with both sustainable water resources and economic prosperity will require industries to operate within the framework that views the two outcomes as interconnected. Water is essential for all thriving industries, and water challenges (water availability and inadequate water quality) weaken business growth and opportunities. It is this codependent nature between business and water that necessitates the responsibility which industries have to be stewards that protect and restore the water resources they rely on. Competitive Business & Industry can be achieved through:

- Fully integrating water stewardship into company strategy
- Deploying water efficiency, stormwater management, and water reuse at industrial facilities
- Developing upstream and downstream partnerships in priority watersheds

# Arena for Action #3

## *Perpetuating (Re)Generative & Responsible Economics*

A critical component of Hawaiian cultural values involves understanding the kuleana that we as people have to mālama ʻaina (care for the land). In order to create a future of sustainable water use through the One Water framework, this value must be shared by all, especially by groups who are frequent users of natural resources such as water for commercial benefit.

Perpetuating (re)generative & responsible economies implies acknowledging and expanding upon the shared kuleana industries have to be stewards of the resources that drive their economies. To achieve a One Water future that decouples economic growth and ecological impacts, industries should work collaboratively to function as stewards of the land, protecting and preserving the resources that make their own growth and development possible.

- ➢ Encourage implementation of circular economies and aloha ʻāina economic futures process frameworks
- ➢ Ahupuaʻa scale industry water management collaborations
- ➢ Industrial site compliance with updated water management standards

# Arena for Action #4

## *Sustainable Agricultural Systems*

Freshwater is the lifeblood of agriculture—food production is responsible for 80 percent of all water consumed. The food, feed, fiber, and fuel on which we all rely is produced on 75 percent of the land [in America] where two percent of the population lives. Approximately 80 percent of the population lives in urban areas, and provides the labor force that processes and manufactures agricultural goods, contributing to local and regional economies. Changing weather patterns have a direct impact on farmers and their ability to adapt is key for managing crops and water in the face of present challenges. One Water leaders are implementing innovative ways to manage soil, water, and nutrients to achieve higher-performing systems that not only lead to more productive agriculture, but also minimize downstream and off-site impacts.

Strategies for sustainable agricultural systems include:

- Using on-farm strategies to reduce water consumption and manage nutrients
- Creating partnerships among upstream and downstream communities
- Using watershed-scale planning and monitoring

# Arena for Action #4

## *ʻĀina Waiwai: Abundant Food Systems*

ʻĀina waiwai, or abundant and productive water and land, are the main drivers of regenerative agriculture and food systems in Hawaiʻi. However, 90% of food in Hawaiʻi is imported and nearly 90% of locally-grown food is exclusively sold through the tourism industry.

Hawaiʻi Island holds a suitable landscape, rich history, and proud heritage of culturally-relevant food and agricultural cultivation. However, agricultural pollution, water distribution, reuse, and climate change are projected to be key issues in sustaining proper resource management and productive agricultural operations on Hawaiʻi Island.

Sustaining the ʻāina waiwai Hawaiʻi Island is known for, strategies include:

- ➢ On-farm strategies for the reuse and recycling of water
- ➢ Creating partnerships between upstream and downstream communities
- ➢ Moku-scale watershed management for planning

| One Water Arena for Action | (K)new One Water Arena for Action |
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# Arena for Action #5

## *Social & Economic Inclusion*

A sustainable water future requires that all people have access to clean, safe, and affordable water and wastewater service. There are vulnerable communities that struggle with water contamination, affordability, and inadequate infrastructure. Equitable and sustainable water management can increase social and economic inclusion. For example, utilities are deploying a range of approaches to contribute to a more equitable society—from low income assistance programs to workforce development and inclusive contracting to the leveraging of capital projects to foster neighborhood revitalization. Community-based organizations that have historically worked on issues such as affordable housing and transportation are turning their attention to local water concerns. A growing number of philanthropic organizations are incorporating water into their portfolio of investments to build a society and economy that works for everyone.

Social & Economic Inclusion can be achieved through:

- Building a water safety net
- Leveraging water investments to generate community benefits
- Fostering community resilience in the face of a changing climate
- Enhancing community capacity to engage in water planning and governance

# Arena for Action #5

## *Social & Economic Empowerment*

Social and economic inclusion implies efforts to engage communities in a passive or reactive manner. Moving beyond just inclusion, empowering communities means creating partnerships with communities, developing projects alongside communities, and creating pathways for their economic well-being. On Hawai‘i island, there are communities that have limited or no access to adequate water supply or sanitation systems. As many as 50,000 households use cesspools, which flows into drinking water wells, streams and the ocean, harming public health and the environment. Meanwhile, an estimated 30,000 to 60,000 households in Hawai‘i use water catchment systems, with most of them in the Puna, Ka‘ū, and Hāmākua districts. These unregulated systems are difficult to monitor for health and safety concerns. While there are efforts to improve or upgrade particular systems, such as cesspools, the costs to upgrade such systems are often out of reach. In addition, some communities have not been meaningfully engaged in issues regarding water access, management, and affordability for their communities.

Social & Economic Empowerment can be achieved through:

- ➢ Ensuring access to water to all communities
- ➢ Partnering with communities on projects to generate community benefits
- ➢ Facilitating community resilience projects in the face of a changing climate
- ➢ Working with communities to engage in water planning and governance

# Arena for Action #6
## *Healthy Waterways*

Healthy waterways are vital in sustaining life for human populations and natural ecosystems, providing benefits far beyond what we take from them. However, industrial development and human impacts continue to deal environmental and ecological damage to our nation's waterways. To remedy these issues, innovative solutions and partnerships aim to ensure purity and abundance for both natural and human-centric needs.

Strategies for achieving Healthy Waterways include:

- Maximizing natural infrastructure for healthy ecosystems mitigating the effects of drought, water flow and sediment discharge.
- Managing groundwater for the future. Recognize that groundwater isn't limitless, considering drought and climate change in pumping scenarios, investing in large-scale reuse and replenishment efforts
- Protecting forests to protect water to provide pollutant, sediment, and stormwater filtration, runoff reduction, improve water quality and protect stream health.
- Utilizing citizen science for ecosystem monitoring and watershed restoration. Citizens are "early warning systems," forge alliances and galvanize support.

# Arena for Action #6
## *Hawai ʻi nui kuauli*

Uli is the deep, dark color in the natural ecosystem representative of warmth, health, and abundance. Ranging from green to blue to red, uli thrives in the tangled growths of forests, in coursing waterways, in the depths of the sea, and in our bodies.

Hawaiʻi nui kuauli reaffirms health as the backbone of our wellbeing. Rooted in the reciprocal relationship of care between kānaka and akua, Hawaiʻi nui kuauli ensures the balance and perpetuity of health, stewardship, and waiwai for all living things. The stewardship of nature-nature, nature-human and human-human relationships are paramount to the perpetuation of uli for generations to come. Hawaiʻi nui kuauli is the optimal goal for our wai, our ʻāina, and our people.

Strategies for promoting and maintaining uli include:

- ➢ Respecting wai as akua; bearing in mind that water is for all and cannot be "owned".
- ➢ Incorporating/empowering kanaka ʻōiwi knowledge, understanding, and management of water
- ➢ Tying water management frameworks into land use and coastal zone planning
- ➢ Implementing water management practices at the ahupuaʻa-, moku-, and watershed-level
- ➢ Conducting comprehensive studies on the interconnectivity and availability of wai mauka-makai, above and below ground.

# Alternative Analysis / Recommendations

**Recommendation Themes -**
Stakeholder recommendations were reviewed and coded by the (K)new One Water Arenas for Action. The six themes that emerged are: *Collaboration, Funding, Infrastructure, Planning Process, Policy & Regulation,* and *Research & Data.* Tables were created for each theme and recommendations were ranked. The images of pewa (patch or wedge for repair) were chosen to represent the six themes. Pewa not only repair, but reinforce and strengthen the item they are repairing, much like we are achieving with One Water.

**Priority and Feasibility -**
Each recommendation was ranked based on priority and feasibility on a low-high scale. The feasibility of a recommendation was ranked given the cost, implementation time, and availability of technology and resources needed for implementation. The priority of a recommendation was ranked given the overall benefit in addressing the recommendation, level of desire/need, and who would be affected by the recommendation. An "overarching" rank was also given to recommendations identified as currently non-implementable but practical ideas that require continuous consideration.

For the purpose of this report it is important to note that these rankings are subjective relative to the scale we created as a team specifically for this project. Rankings have been created utilizing our group's knowledge of these issues given our research and data collection processes We would therefore recommend that the client complete a more detailed feasibility analysis to accurately identify which recommendations would be more implementable for the short- and long-term in Hawai'i County.


FIGURE 8. Recommendation themes and correlating pewa.

# Stakeholder Recommendation Tables

## COLLABORATION

| Priority | Feasibility | Stakeholder Recommendation | Accessible & Sustainable Water Resources/Systems | Interconnected & Thriving Moku | Perpetuating (Re)generative & Responsible Economies | ʻĀina Waiwai: Abundant Food Systems | Social & Economic Empowerment | Hawai'i nui kuauli | Total Arena(s) |
|---|---|---|---|---|---|---|---|---|---|
| Overarching | Overarching | *Don't be afraid to have hard conversations; do it with aloha* | | | | | | | 6 |
| Overarching | Overarching | *Bring kanaka back to land as there are folks wanting to do the work* | | | | | | | 6 |
| Overarching | Overarching | *Nurture relationships with other departments* | | | | | | | 6 |
| Overarching | Overarching | *Use catalyst projects to make connections between other ongoing projects* | | | | | | | 6 |
| High | High | *Reestablish Annual Water Conference and Quarterly CWRM meetings* | | | | | | | 6 |
| Medium | Medium | *Improve state efforts to educate the community about the existing problems and meet the community halfway in order to provide solutions* | | | | | | | 6 |
| High | Low | *Improve the language of the Hawaii Administrative Rules to create safe work environments in which public servants feel safe to think outside of the box and come up with creative and innovative solutions* | | | | | | | 6 |
| High | High | *Look further into watershed partnerships, DOFAW jurisdictions, and the restoration of native forests to recharge aquifers* | | | | | | | 6 |
| High | High | *Collaborate with those interested in getting involved* | | | | | | | 6 |
| High | High | *Use our economy and food systems to create true equity in how we live in Hawaii concerning housing, water, and land* | | | | | | | 6 |

| PRIORITY | FEASIBILITY |
|---|---|
| Overarching | Overarching |
| High | High |
| Medium | Medium |
| Low | Low |

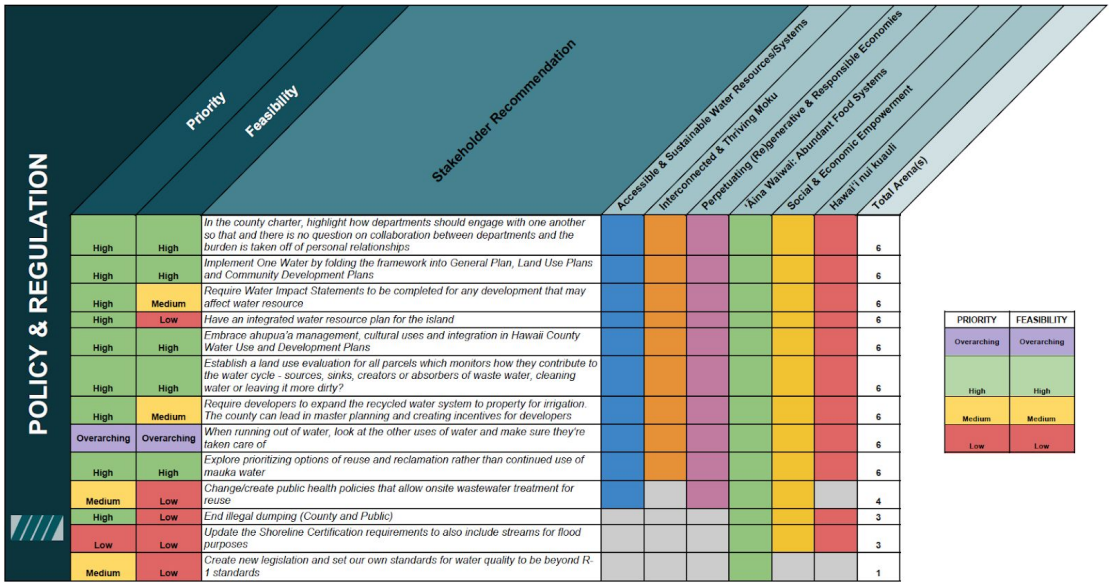
## FUNDING

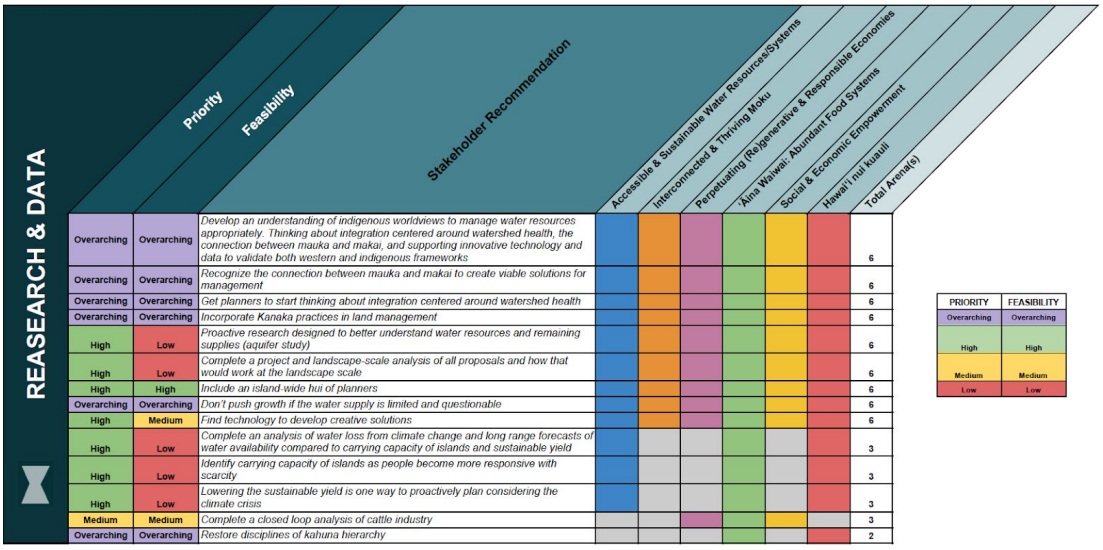
| Priority | Feasibility | Stakeholder Recommendation | Accessible & Sustainable Water Resources/Systems | Interconnected & Thriving Moku | Perpetuating (Re)generative & Responsible Economies | ʻĀina Waiwai: Abundant Food Systems | Social & Economic Empowerment | Hawai'i nui kuauli | Total Arena(s) |
|---|---|---|---|---|---|---|---|---|---|
| High | Medium | *Agency silos are a result of competition for the state's general funds. If funds were available to all for resource management, water management would be more effective* | | | | | | | 6 |
| High | High | *Seek out and take advantage of funding opportunities* | | | | | | | 6 |
| High | Medium | *Create public-private partnerships to leverage funding sources (CARES Act, USDA grants, leasing instead of buying)* | | | | | | | 4 |
| High | Medium | *Use cost-effective alternatives that promote recycling and cost recovery (i.e. containerized MBR systems)* | | | | | | | 2 |

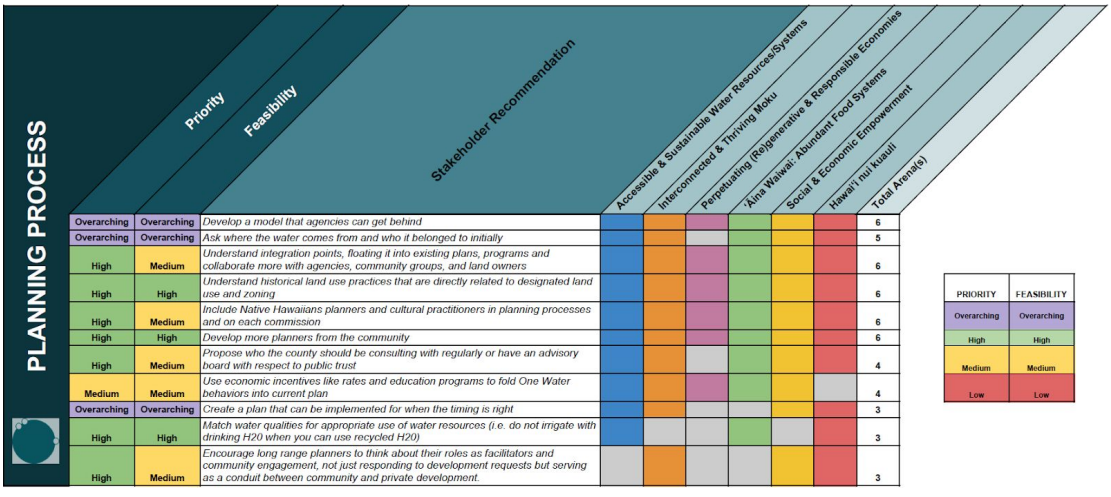
## INFRASTRUCTURE

| Priority | Feasibility | Stakeholder Recommendation | Accessible & Sustainable Water Resources/Systems | Interconnected & Thriving Moku | Perpetuating (Re)generative & Responsible Economies | ʻĀina Waiwai: Abundant Food Systems | Social & Economic Empowerment | Hawai'i nui kuauli | Total Arena(s) |
|---|---|---|---|---|---|---|---|---|---|
| Overarching | Overarching | *Improve infrastructure for water distribution* | | | | | | | 6 |
| Overarching | Overarching | *Open conversations regarding agricultural water use (possibly re-use)* | | | | | | | 6 |
| High | Medium | *Upgrade facilities to incorporate water recycling (particularly at Kealakehe, Mauna Lani Resort, Naalehu/Pahala)* | | | | | | | 6 |
| High | Medium | *Be creative with surface water resources instead of drilled water* | | | | | | | 4 |
| Medium | Medium | *Improve public outreach and education to reduce the amount of water used for emergencies* | | | | | | | 3 |

| PRIORITY | FEASIBILITY |
|---|---|
| Overarching | Overarching |
| High | High |
| Medium | Medium |
| Low | Low |


POLICY & REGULATION
Priority
Feasibility
Stakeholder Recommendation
Accessible & Sustainable Water Resources/Systems
Interconnected & Thriving Moku
Perpetuating (Re)generative & Responsible Economies
'Āina Waiwai: Abundant Food Systems
Social & Economic Empowerment
Hawai'i nui kuauli
Total Arena(s)
In the county charter, highlight how departments should engage with one another so that and there is no question on collaboration between departments and the burden is taken off of personal relationships
Implement One Water by folding the framework into General Plan, Land Use Plans and Community Development Plans
Require Water Impact Statements to be completed for any development that may affect water resource
Have an integrated water resource plan for the island
Embrace ahupua'a management, cultural uses and integration in Hawaii County Water Use and Development Plans
Establish a land use evaluation for all parcels which monitors how they contribute to the water cycle - sources, sinks, creators or absorbers of waste water, cleaning water or leaving it more dirty?
Require developers to expand the recycled water system to property for irrigation. The county can lead in master planning and creating incentives for developers
When running out of water, look at the other uses of water and make sure they're taken care of
Explore prioritizing options of reuse and reclamation rather than continued use of mauka water
Change/create public health policies that allow onsite wastewater treatment for reuse
End illegal dumping (County and Public)
Update the Shoreline Certification requirements to also include streams for flood purposes
Create new legislation and set our own standards for water quality to be beyond R-1 standards
PRIORITY
FEASIBILITY
Overarching
High
Medium
Low


REASEARCH & DATA
Priority
Feasibility
Stakeholder Recommendation
Accessible & Sustainable Water Resources/Systems
Interconnected & Thriving Moku
Perpetuating (Re)generative & Responsible Economies
'Āina Waiwai: Abundant Food Systems
Social & Economic Empowerment
Hawai'i nui kuauli
Total Arena(s)
Develop an understanding of indigenous worldviews to manage water resources appropriately. Thinking about integration centered around watershed health, the connection between mauka and makai, and supporting innovative technology and data to validate both western and indigenous frameworks
Recognize the connection between mauka and makai to create viable solutions for management
Get planners to start thinking about integration centered around watershed health
Incorporate Kanaka practices in land management
Proactive research designed to better understand water resources and remaining supplies (aquifer study)
Complete a project and landscape-scale analysis of all proposals and how that would work at the landscape scale
Include an island-wide hui of planners
Don't push growth if the water supply is limited and questionable
Find technology to develop creative solutions
Complete an analysis of water loss from climate change and long range forecasts of water availability compared to carrying capacity of islands and sustainable yield
Identify carrying capacity of islands as people become more responsive with scarcity
Lowering the sustainable yield is one way to proactively plan considering the climate crisis
Complete a closed loop analysis of cattle industry
Restore disciplines of kahuna hierarchy
PRIORITY
FEASIBILITY
Overarching
High
Medium
Low


PLANNING PROCESS
Priority
Feasibility
Stakeholder Recommendation
Accessible & Sustainable Water Resources/Systems
Interconnected & Thriving Moku
Perpetuating (Re)generative & Responsible Economies
'Āina Waiwai: Abundant Food Systems
Social & Economic Empowerment
Hawai'i nui kuauli
Total Arena(s)
Develop a model that agencies can get behind
Ask where the water comes from and who it belonged to initially
Understand integration points, floating it into existing plans, programs and collaborate more with agencies, community groups, and land owners
Understand historical land use practices that are directly related to designated land use and zoning
Include Native Hawaiians planners and cultural practitioners in planning processes and on each commission
Develop more planners from the community
Propose who the county should be consulting with regularly or have an advisory board with respect to public trust
Use economic incentives like rates and education programs to fold One Water behaviors into current plan
Create a plan that can be implemented for when the timing is right
Match water qualities for appropriate use of water resources (i.e. do not irrigate with drinking H20 when you can use recycled H20)
Encourage long range planners to think about their roles as facilitators and community engagement, not just responding to development requests but serving as a conduit between community and private development.
PRIORITY
FEASIBILITY
Overarching
High
Medium
Low

# Moving Forward

Through this collaborative undertaking, our team has reframed and catalyzed the One Water process to bridge indigenous, cultural, and place-based gaps in a nationally successful framework for integrated water management. In planning for the abundance, health, and wellbeing of Hawaiʻi, the following strategies look towards the building of a future steeped in waiwai.

Water resource management in Hawaiʻi County has a strong engineering focus, and, in order to manage water holistically, water resource management needs to include a justice/equity, Native Hawaiian, and environmental standpoints. This requires a management process that encourages the inclusion of indigenous and local knowledge, scientific or expert knowledge, and strategic knowledge as well as collaboration amongst diverse stakeholders.

Additional studies in understanding water resources are needed to implement a holistic approach for future water security. For instance, there is a dire need for more information to determine "safe" and accurate sustainable yields. This includes calculating groundwater withdrawals from small capacity wells and determining the impacts of climate change. There is a lack of information on the effects climate change has on the regularity of trade winds and their steady supply of rainfall to the Hawaiian Islands. Further studies to address these gaps in information would support holistic understandings and Best Management Practices (BMPs) for Hawaiʻi County.

One goal highlighted in the General Plan is to "protect and effectively manage Hawaiʻi's open space, watersheds, shoreline, and natural areas" through "a coordinated effort by County, State and private interests" (General Plan 11.2.2 f). Furthermore, various Community Development Plans mirror these goals of the General Plan. For instance, the Kaʻū CDP states a goal to "Protect, preserve, and effectively manage forests, watersheds, shoreline areas, natural areas, and rare or endangered species and their habitats" through collaborative efforts between federal, state, and county agencies as well as watershed partnerships. All of these initiatives align with the Public Trust, which is the piko of effective and equitable management for Hawaiʻi County.

- Continue stakeholder dialogue to seek additional input from private, watershed partners, and communities
- Develop comprehensive studies to accurately assess current water resources
- Acknowledge and incorporate collaborative/citizen science
- Incorporate Participatory and Indigenous Models for Planning
- Utilize "Catalyst Projects" by engaging with local initiatives
- Illuminate more "low-hanging fruit" (highly achievable/easily implementable actions)
- Develop a feasibility analysis for recommendations and ranking criteria for prioritization
- "Keep an eye" on Bill 65 (recently passed) which mandates One Water for the City and County of Honolulu (CCoH)
    - CCoH focuses on climate change and SLR. *What is Hawaiʻi County's focus for One Water?*
- Do not consider large shifts in mindset to be too idealistic. Instead, consider Public Trust and equity to be pillars for a future that we are collectively building

We offer this report and accompanying materials to be secondary to the main deliverable – the process. Our process and methodology constitute much of the work and consideration for relationships relating to akua, water, land, and community. We believe that this work should continue, and more time be dedicated to elevating the voices of water managers, water champions, stewards, and experts. Considerations for and implementation of participatory and indigenous models of planning, research, and Just Transitions[22] requires communication and engagement that go beyond what many agencies and managers are accustomed to. However, it is important if we expect to learn from each other, partner on just policy development, develop lasting advocacy positions, and work together to advance integrated water resource management for an uncertain climate future.

[22] https://climatejusticealliance.org/just-transition/

# Appendix A: List of Stakeholders

| STAKEHOLDER | SECTOR |
|---|---|
| Applied Life Sciences LLC | Private |
| Hawai‘i County Department of Water Supply | Public - County |
| Hawai‘i County Department of Environmental Management | Public - County |
| Hawai‘i County Fire Department | Public - County |
| Hawai‘i County Planning Department | Public - County |
| Honolulu Board of Water Supply | Public - County |
| Kamehameha Schools | Private |
| Ka Huli Ao Center for Excellence in Native Hawaiian Law | Public - Education |
| Kohala Watershed Partnership (+Kohala Institute) | Private |
| Lanihau Properties | Private |
| National Park Service: Hawai‘i Volcanoes National Park | Public - Federal |
| One World One Water LLC | Private |
| Sea Grant College Program (University of Hawai‘i) | Public - Education |
| State of Hawai‘i Department of Health - Safe Drinking Water Branch | Public - State |
| State of Hawai‘i DLNR: Commission of Water Resource Management | Public - State |
| State of Hawai‘i Land Use Commission | Public - State |
| State of Hawai‘i Office of Planning | Public - State |

# Appendix B: Talk Story Guide

| STAKEHOLDER TALK STORY GUIDE |
| --- |
| **Desired Outputs:** |
| 1. *Understand how agencies perceive their kuleana to the Public Trust, including how their agency honors/implements that kuleana* |
| 2. *Identify specific actions that would help build more collaborative efforts between their agencies and the other agencies* |
| **Questions:** |
| 1. *In regards to water management, what are the main goals and responsibilities of your agency? What laws/statutes dictate these goals/responsibilities?* |
| 2. *How does the agency engage in the process of fulfilling these responsibilities?* |
| 3. *What are the triggers that activate your jurisdiction ʻs/agency ʻs management response?* |
| 4. *How is your agency collaborating with other agencies in managing Hawai ʻi ʻs water resources?* |
| 5. *What are some of the primary challenges your agency/department faces in collaboration/managing water on Hawai ʻi island?* |
| 6. *Is there anything else you would like to share?* |
| 7. *Do you have any suggestions for who else we should contact?* |

# Appendix C: Agency Flowchart

*See attached PDF entitled "Appendix Additions" for higher resolution documentation*

# Appendix D: Agency Overview

*See attached PDF entitled "Appendix Additions" for higher resolution documentation*

# Appendix E: Matrix of Management Perspectives— Traditional, Public Trust, and One Water

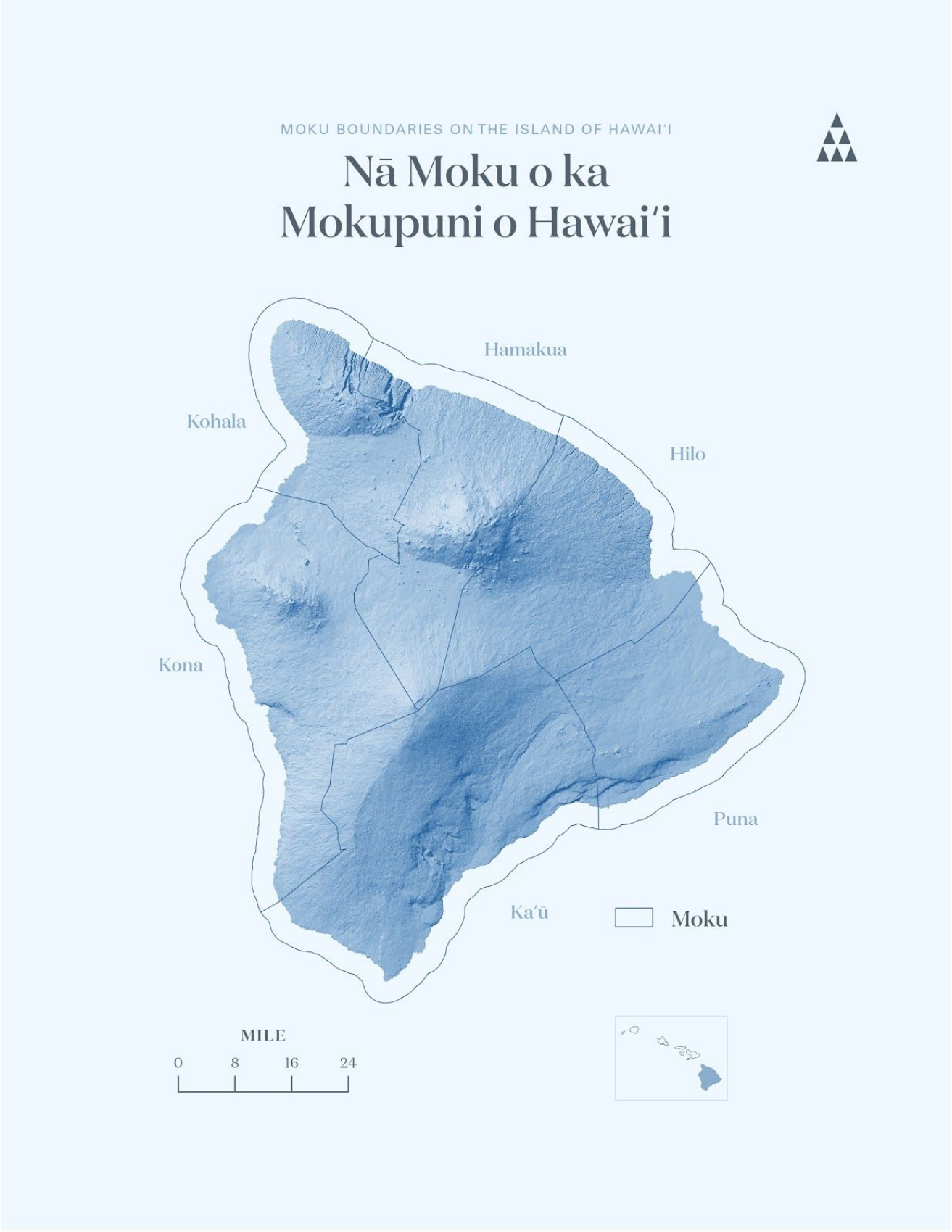
| Concept | Traditional Resource Management | Public Trust | One Water | Integrated Examples |
|---|---|---|---|---|
| **Wai** | *Is a public trust resource in which no one – not even aliʻi – could own. Water was a resource managed for present and future generations* | *Applies to all water resources. Dual mandate of 1) protection and 2) maximum reasonable and beneficial use* | *All water is one water. It is our world's most precious resource and essential to everything we do.* | ***Ola i ka wai! Water is life!***<br><br>Centering Public Trust in all water-related discussions & decisions |
| **ʻĀina** | *Native Hawaiians are genealogically connected to ʻāina as both the ancestral homeland and the elder sibling.* | *Applies to all natural resources of the State* | *Identifying and connecting important land-use policies and development to smart land use planning, flood protection, coastal protection, and strengthening water infrastructure.* | Proactive water & land management in the face of climate change<br><br>Determining water availability before determining land use |
| **Water Management** | *Native Hawaiians have physical, spiritual, genealogical, and sociopolitical/historical ties that define resources as something to be cared for* | *Affirmative duty to take the Public Trust into account in planning and allocation of natural resources, and to protect Public Trust uses whenever feasible.* | *Systems approach; scalable solutions; inclusion; watershed-scale action; partnerships; multiple benefits* | Ahupuaʻa, moku, & watershed-level stewardship<br><br>Encouraging new technology & innovative solutions |
| **Land Tenure** | *Land divisions (e.g. moku, okana, ahupuaʻa, wahi, ʻili ʻāina, kuleana, etc.) were often delineated by water and contained adequate resources necessary for sustenance* | | *Smart land use planning, flood and coastal protection, strengthening and diversifying water infrastructure* | Understand mauka-makai interconnectivity of wai<br><br>Encouraging development & use of accurate water data |
| **Law & Governance** | *Traditional Hawaiian law or kānāwai developed around the management and use of freshwater; makahiki and the contribution of abundance, kapu* | *Presumption in favor of trust purposes; burden on state and commercial parties to justify use.* | *Breaking down siloed and disjointed management structures that hinder effective integrated water management* | Codifying effective agency collaboration<br><br>Burden of Public Trust is on government agencies & developer<br><br>Develop public-private partnerships |
| **Community** | *Mauka-makai trade; mutual support; interdependence; moku system divided into social-ecological regions* | *Protected "trust purposes" include: resource protection, Native Hawaiian rights and practices, appurtenant, correlative and domestic rights* | *Engagement, Representation, Integration of community knowledge into planning process* | Equitable access for all under the Public Trust<br><br>Empower diverse communities in water governance |

# Appendix F: (K)new Arenas for Action— Piko of Public Trust, Streams of Equity, Landscapes of Pilina

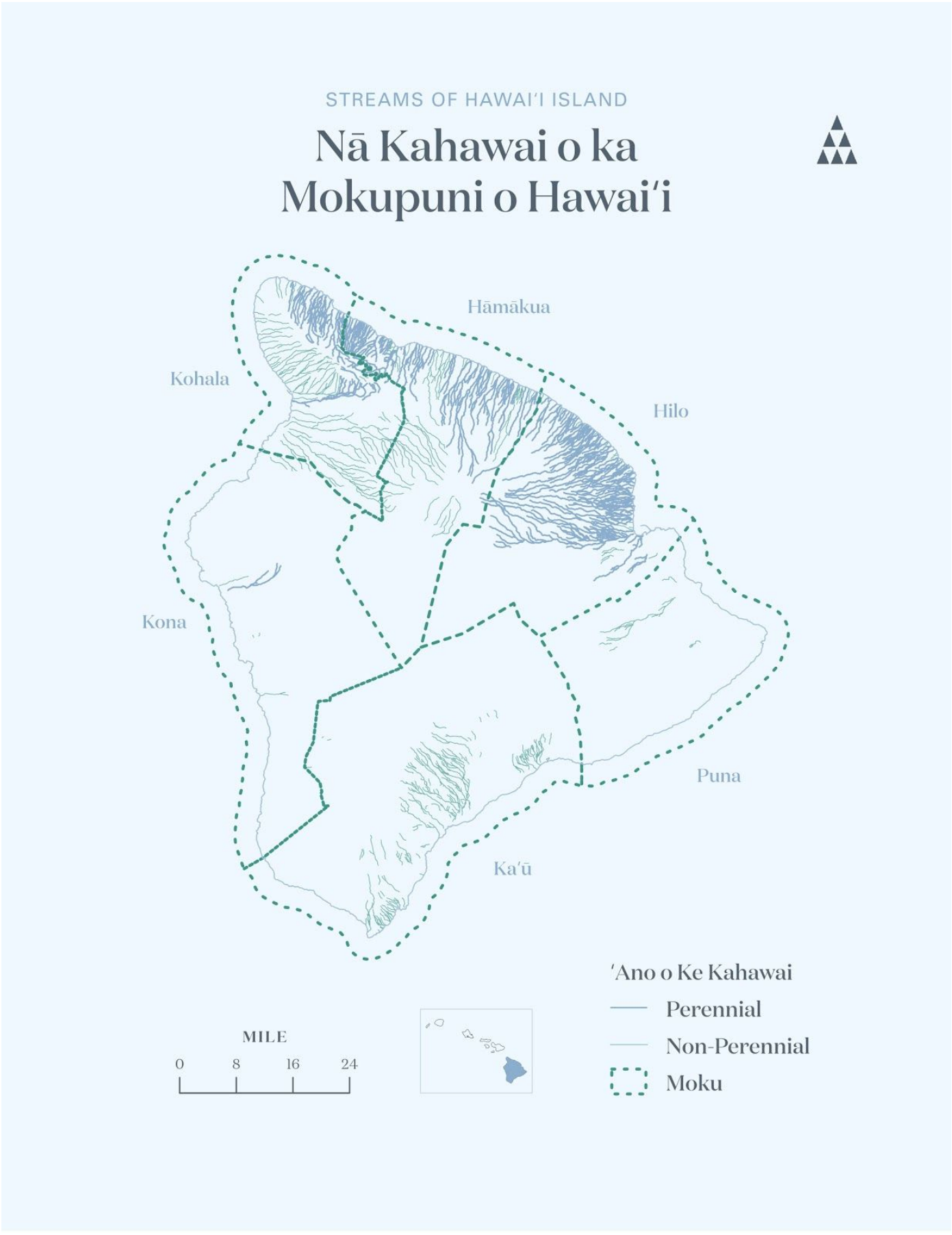
# Appendix G: Stakeholder Recommendation Tables

*See attached PDF entitled "Appendix Additions" for higher resolution documentation*

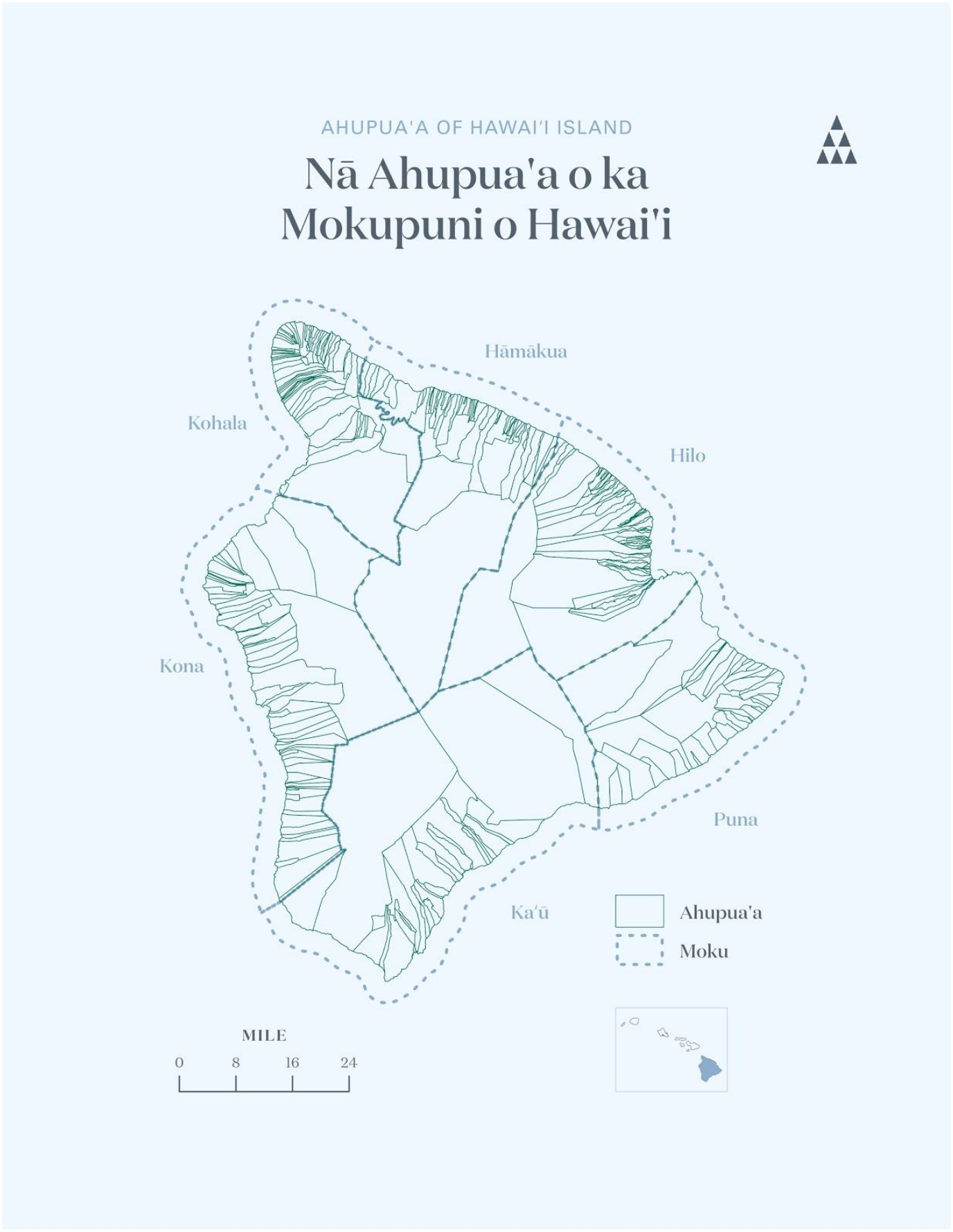
# Appendix H: Maps



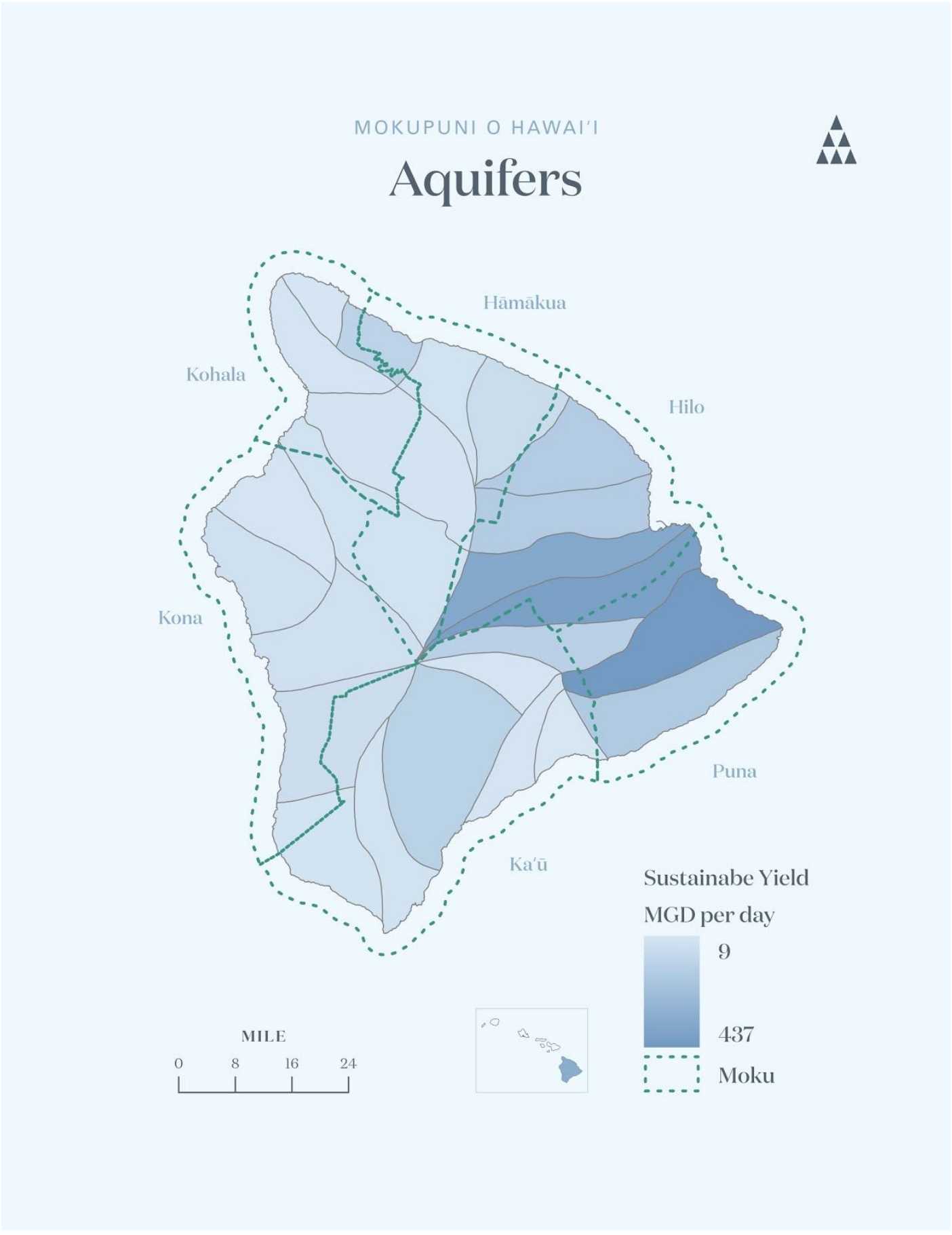

Map 1: Moku of Hawaiʻi Island with Digital Elevation.



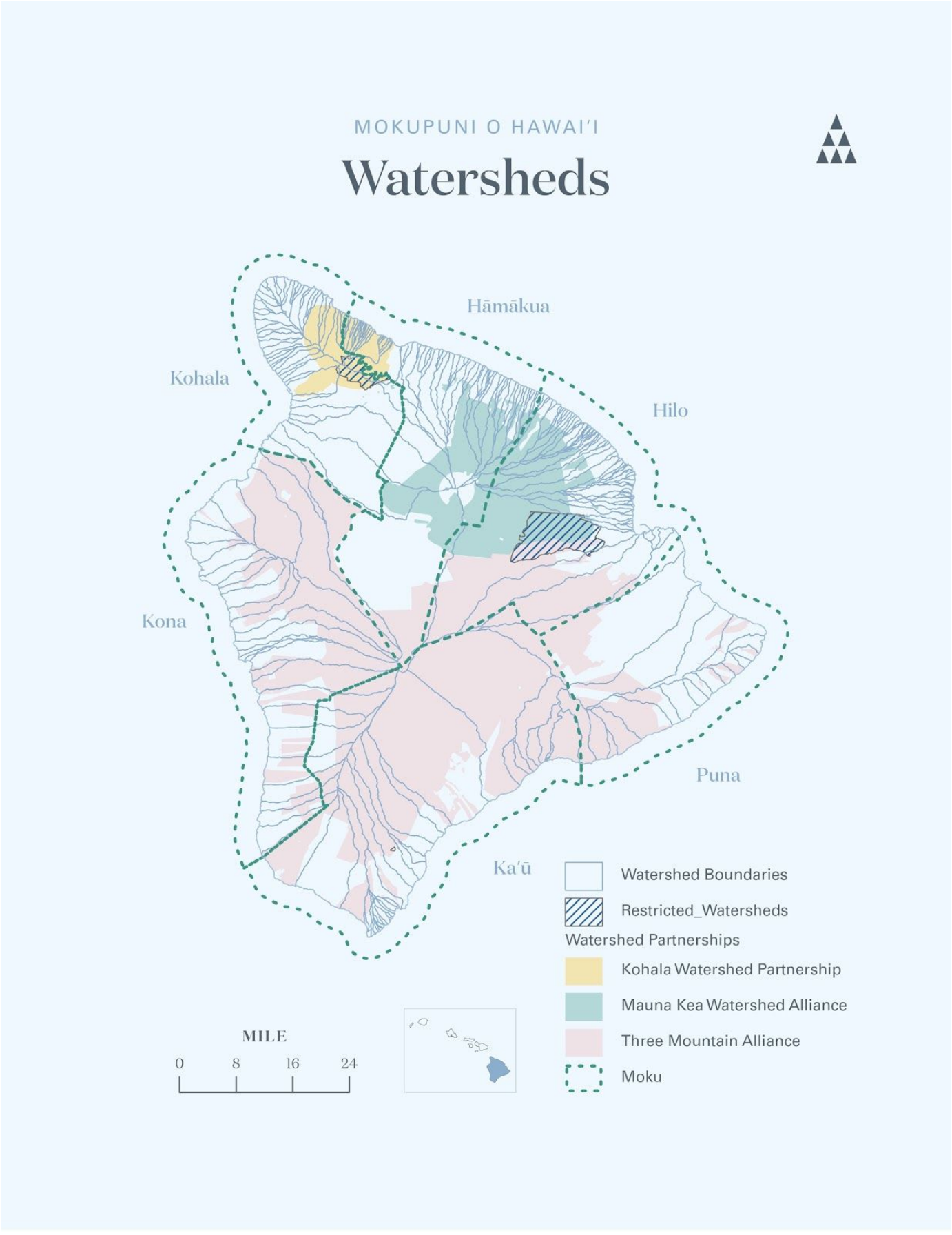

Map 2: Streams of Hawaiʻi Island



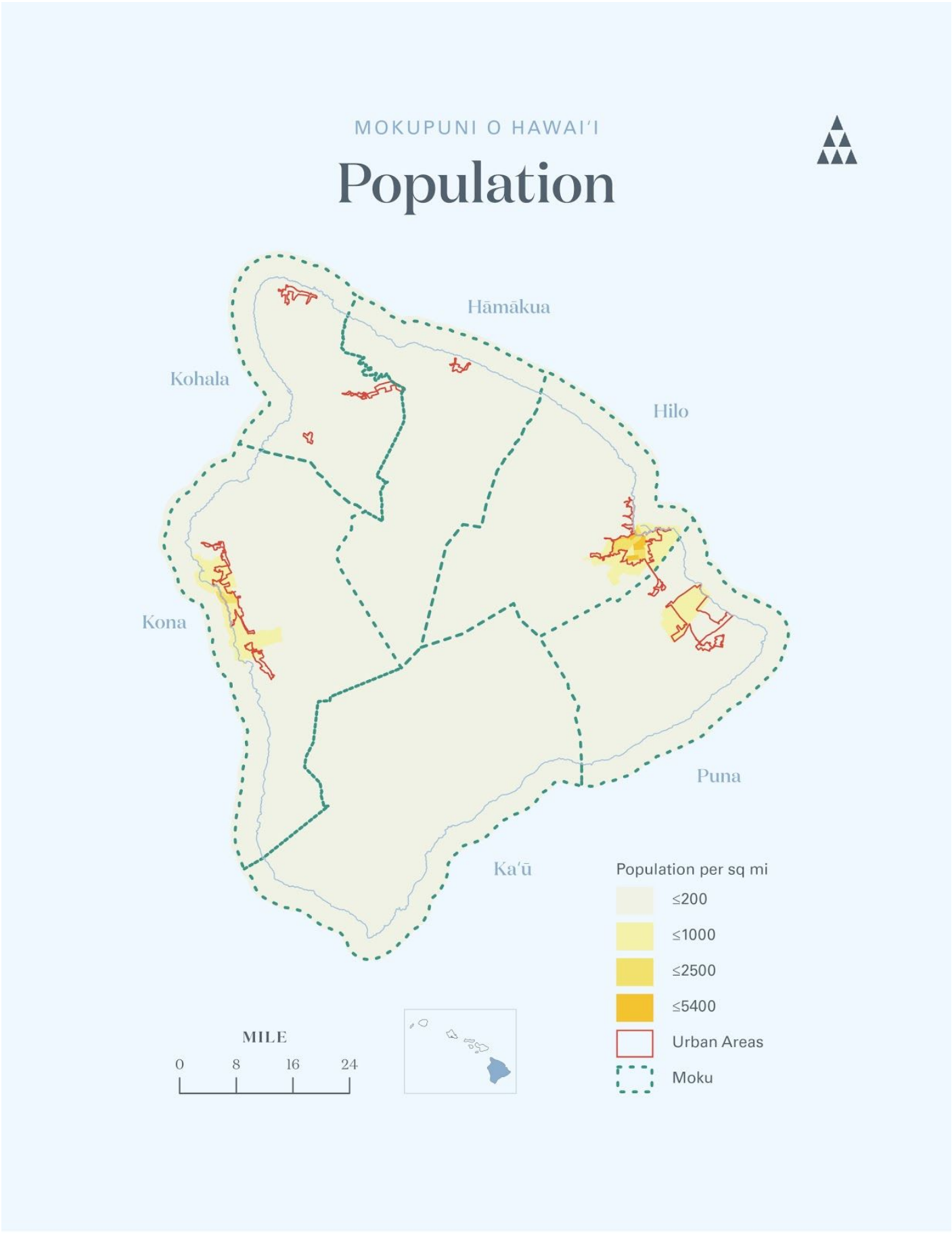

Map 3: Ahupuaʻa of Hawaiʻi Island



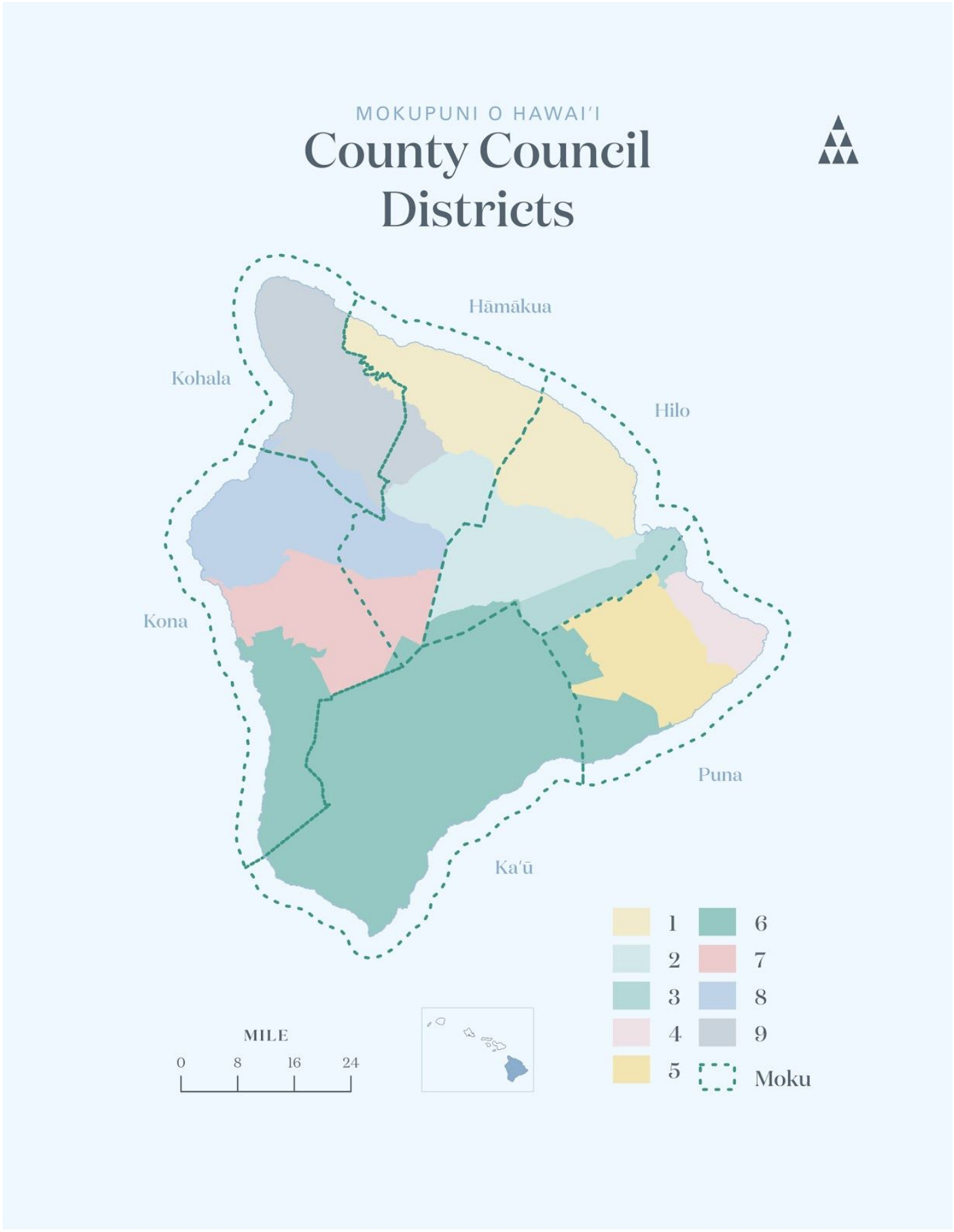

Map 4: Hawaiʻi Island Aquifers.



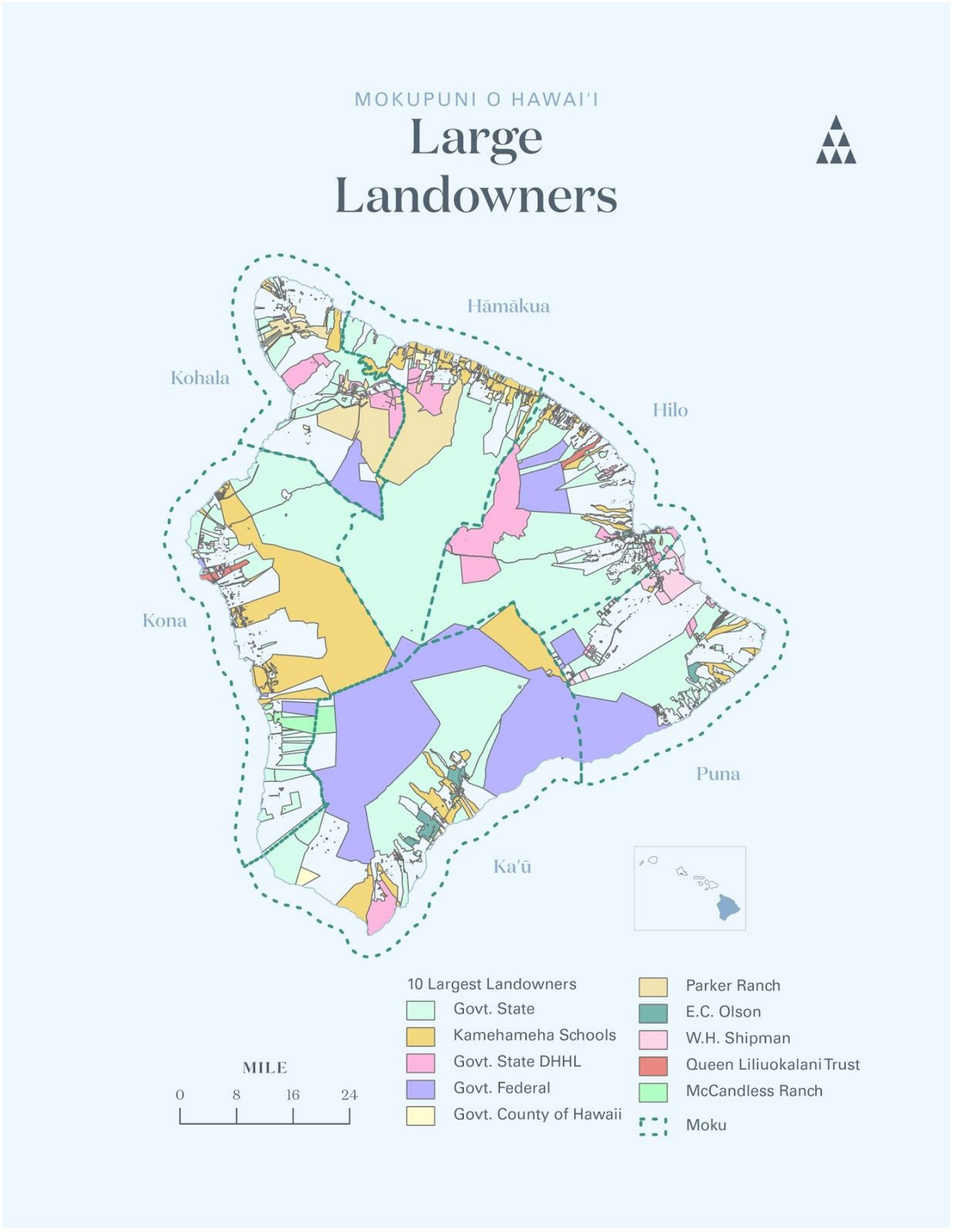

Map 5: Hawaiʻi Island Watershed Boundaries and Private Partnerships



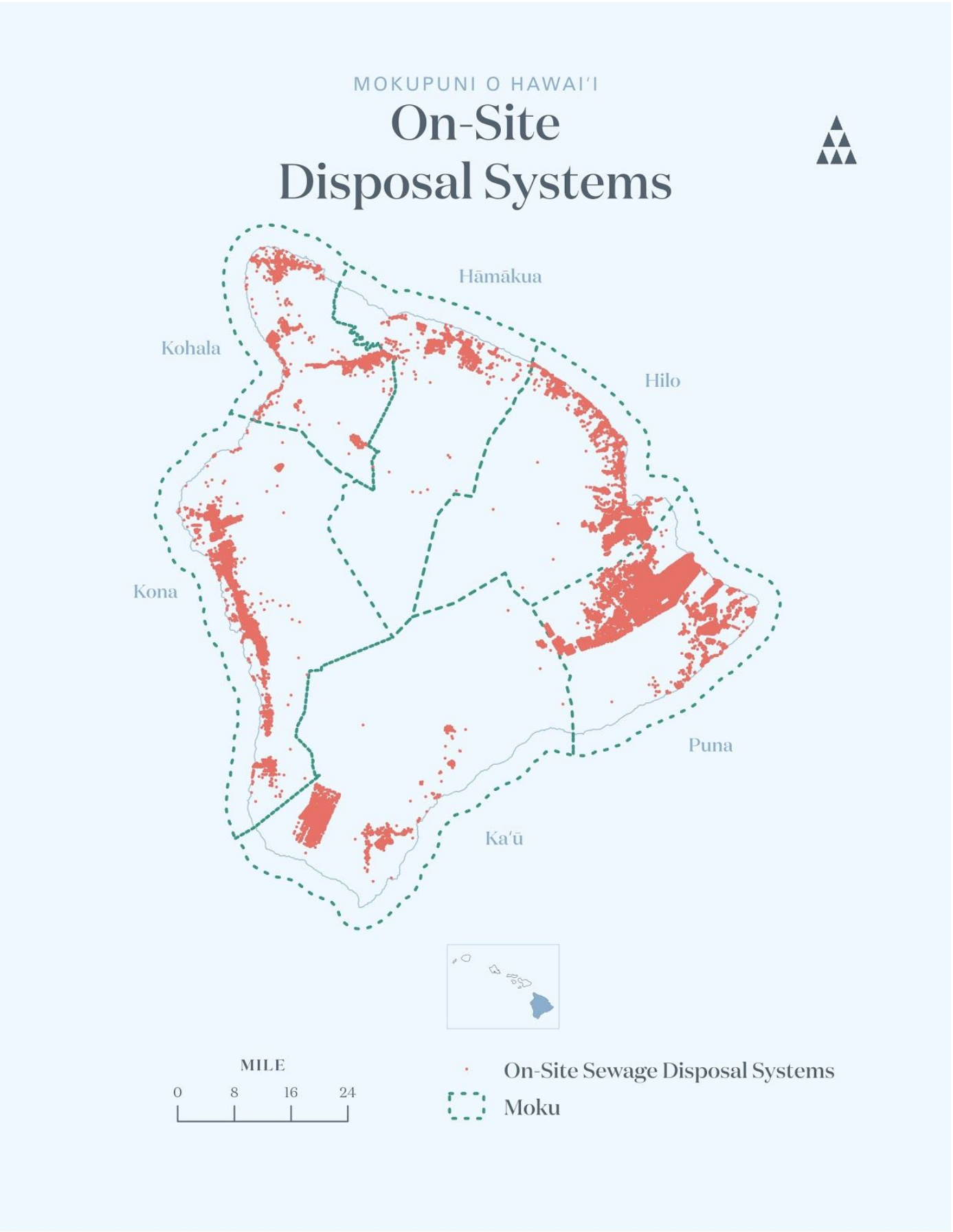

Map 6: Hawaiʻi Island Population



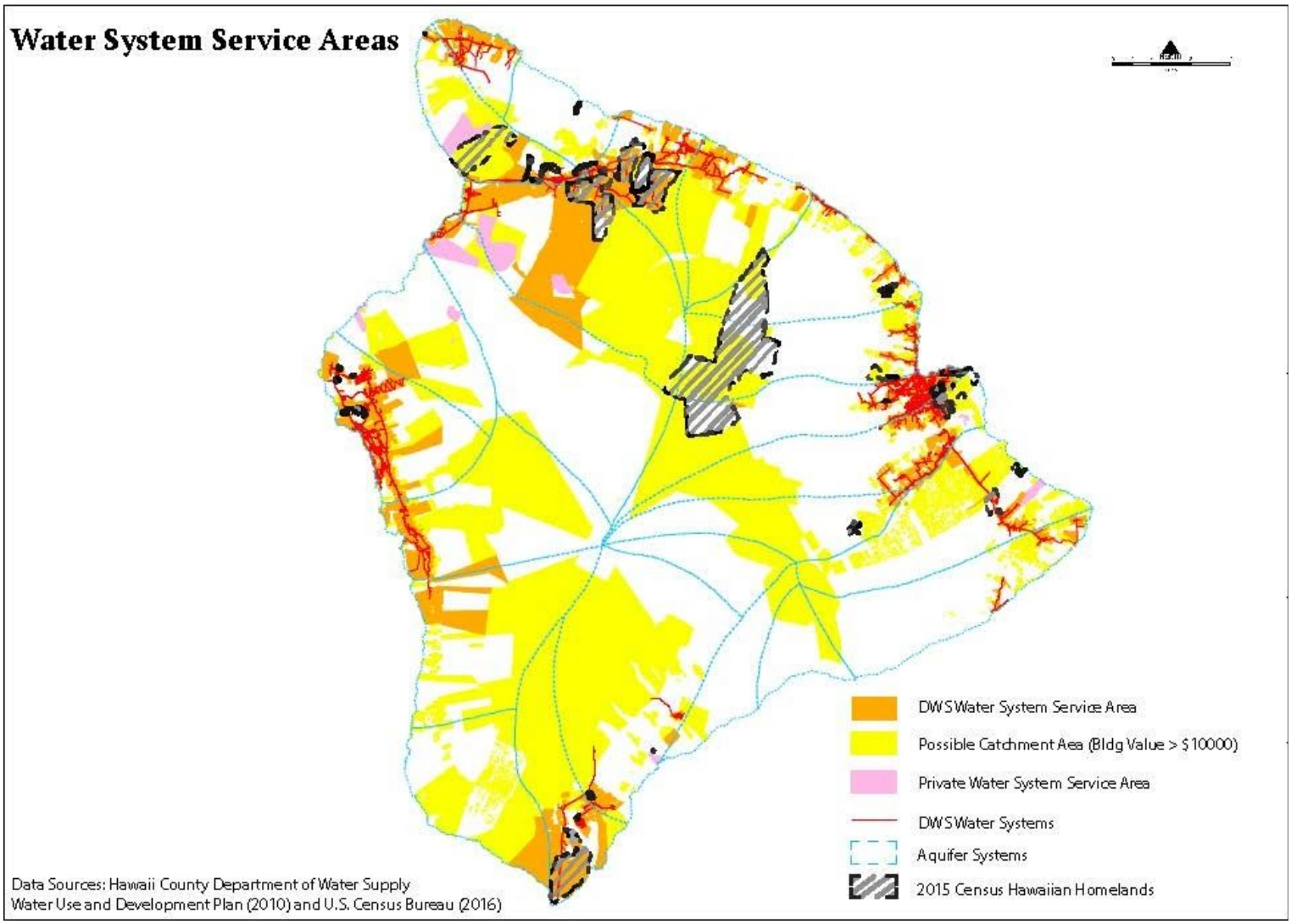

Map 7: Hawaiʻi Island County Council Districts




Map 8: Hawaiʻi Island Large Landowners




Map 9: Hawaiʻi Island On-Site Disposal Systems




Map 10: Hawai‘i County Water Systems and Service Areas Map. Water Use and Development Plan Update, 2010. Overlaid with Hawaiian Homeland areas. Census, 2015.

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