

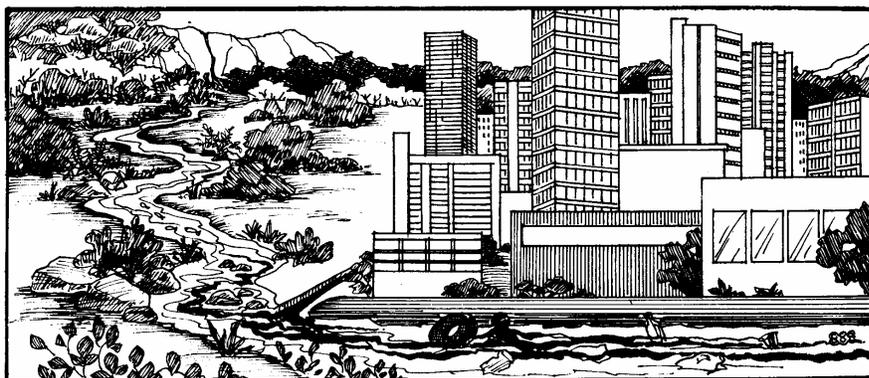
STREAMS IN HAWAI'I: YESTERDAY AND TODAY



Grades 6–8

Lesson at a Glance

Students explore a water rights issue and form a mock water commission to debate water rights policies. They write summaries describing the benefits and consequences of past agricultural practices on fresh water in Hawai'i and include suggestions for the State Commission on Water Resource Management.



Key Concepts

Freshwater resources provide habitat for stream life and supply the commercial, residential and agricultural water needs of a growing human population in the islands. Conflicts often arise when water supplies do not meet demands.

Hawai'i Content Performance Standards III, Language Arts

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|--|--|---|---|
| Grade 6 | | | |
| Strand | | Reading | |
| Standard 1: Reading: CONVENTION AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational texts for a variety of purposes. | | | |
| Topic | | Locating Sources/Gathering Information | |
| Benchmark LA.6.1.2 | | Use grade-appropriate online and print sources to research a topic). | |
| Sample Performance Assessment (SPA) | | The student: Finds and reads online (e.g., CD-ROM, internet, intranet, newsgroups) and traditional sources (e.g., encyclopedia, books, periodicals) to answer an inquiry arising from class or personal activities. | |
| Rubric | | | |
| Advanced | Proficient | Partially Proficient | Novice |
| Use substantive information from an extensive variety of grade-appropriate print and online resources to thoroughly research a topic. | Use relevant information from a variety of grade-appropriate print and online resources to research a topic. | Use some relevant information from a selection of grade-appropriate print and online resources to research a topic. | Use very little relevant information from grade-appropriate print and online resources to research a topic. |

| Grade 7 | | | |
|--|--|--|--|
| Strand | | Reading | |
| Standard 1: Reading: CONVENTION AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational texts for a variety of purposes. | | | |
| Topic | | Locating Sources/Gathering Information | |
| Benchmark LA.7.1.2 | | Use a variety of grade-appropriate print and online sources to research an inquiry question. | |
| Sample Performance Assessment (SPA) | | The student: Finds and reads online (e.g., CD-ROM, internet, intranet, newsgroups) and print sources (e.g., encyclopedia, books, periodicals) to answer a question or inquiry arising from class or personal activities. | |
| Rubric | | | |
| Advanced | Proficient | Partially Proficient | Novice |
| Use substantive information from an extensive variety of grade-appropriate print and online resources to thoroughly research an inquiry question. | Use relevant information from a variety of grade-appropriate print and online resources to research an inquiry question. | Use some relevant information from a selection of grade-appropriate print and online resources to research an inquiry question. | Use very little relevant information from grade-appropriate print or online resources to research an inquiry question. |

| Grade 8 | | | |
|--|---|--|---|
| Strand | | Reading | |
| Standard 1: Reading: CONVENTION AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational texts for a variety of purposes. | | | |
| Topic | | Locating Sources/Gathering Information | |
| Benchmark LA.8.1.2 | | Select appropriate information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis. | |
| Sample Performance Assessment (SPA) | | The student: Conducts research and evaluates information for validity, appropriateness, content, and use by asking questions (e.g., What makes the author an expert? Is the information found in multiple sources? What is the author saying and not saying?). | |
| Rubric | | | |
| Advanced | Proficient | Partially Proficient | Novice |
| Insightfully select highly effective and appropriate information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis. | Select appropriate information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis. | Select some trivial information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis. | Select irrelevant information after evaluating the usefulness of print and online resources that do not help to investigate a theme, answer a question, or test a hypothesis. |



Hawai'i Content Performance Standard III, Science, Grade 6

| | | | |
|--|--|--|---|
| Strand | | The Scientific Process | |
| Standard 2: The Scientific Process: NATURE OF SCIENCE—Understand that science, technology, and society are interrelated. | | | |
| Topic | | Science, Technology, and Society | |
| Benchmark SC.6.2.1 | | Explain how technology has an impact on society and science. | |
| Sample Performance Assessment (SPA) | | The student: Explains ways in which technology has changed our society and science. (<i>How the engineering and construction of water ditches impacted our economy, agriculture, and environment.</i>) | |
| Rubric | | | |
| Advanced | Proficient | Partially Proficient | Novice |
| Explain and provide examples of how technology has an impact on society and science. | Explain how technology has an impact on society and science. | Give a partial explanation of how technology has an impact on society and science. | Recognize that technology has an impact on society and science. |

Hawai'i Content Performance Standard III, Science, Grade 7

| | | | |
|--|--|---|---|
| Strand | | The Scientific Process | |
| Standard 2: The Scientific Process: NATURE OF SCIENCE—Understand that science, technology, and society are interrelated. | | | |
| Topic | | Science, Technology, and Society | |
| Benchmark SC.7.2.1 | | Explain the use of reliable print and electronic sources to provide scientific information and evidence. | |
| Sample Performance Assessment (SPA) | | The student: Explains how the evidence found in a wide variety of print and electronic sources (e.g., database programs, internet) can be used to develop conclusions (<i>e.g., based on evidence found in a wide variety of print and electronic sources, the student learns about environmental and water rights issues, develops conclusions as to how to take a stand on those issues.</i>) | |
| Rubric | | | |
| Advanced | Proficient | Partially Proficient | Novice |
| Explain how print and electronic sources can be used to provide scientific information and evaluate the sources used for validity and reliability. | Explain the use of reliable print and electronic sources to provide scientific information and evidence. | Explain that print and electronic sources can be used to provide scientific information and evidence. | Recognize that print and electronic sources can be used to provide scientific information and evidence. |



Hawai'i Content Performance Standard III, Science, Grade 8

| | | | |
|--|--|---|---|
| Strand | | The Scientific Process | |
| Standard 2: The Scientific Process: NATURE OF SCIENCE—Understand that science, technology, and society are interrelated. | | | |
| Topic | | Science, Technology, and Society | |
| Benchmark SC.8.2.1 | | Describe significant relationships among society, science, and technology and how one impacts the other. | |
| Sample Performance Assessment (SPA) | | The student: Provides earth and space examples of how science, technology, and society have impacted each other. <i>For example, the effects of land use on our surface water supplies, how knowledge of environmental science and technology (engineering of and construction of water ditches) are used to improve agriculture and the economy.</i> | |
| Rubric | | | |
| Advanced | Proficient | Partially Proficient | Novice |
| Evaluate and describe the relationships among society, science, and technology and how one impacts the other. | Describe significant relationships among society, science, and technology and how one impacts the other. | List a few relationships between society, science, or technology. | Recognize relationships among society, science, and technology. |

Time

two to four class periods

Subject Areas

social studies, Hawaiian studies, science, language arts

Materials

student reading (provided)
water rights scenarios (provided)
water commission task card (provided)

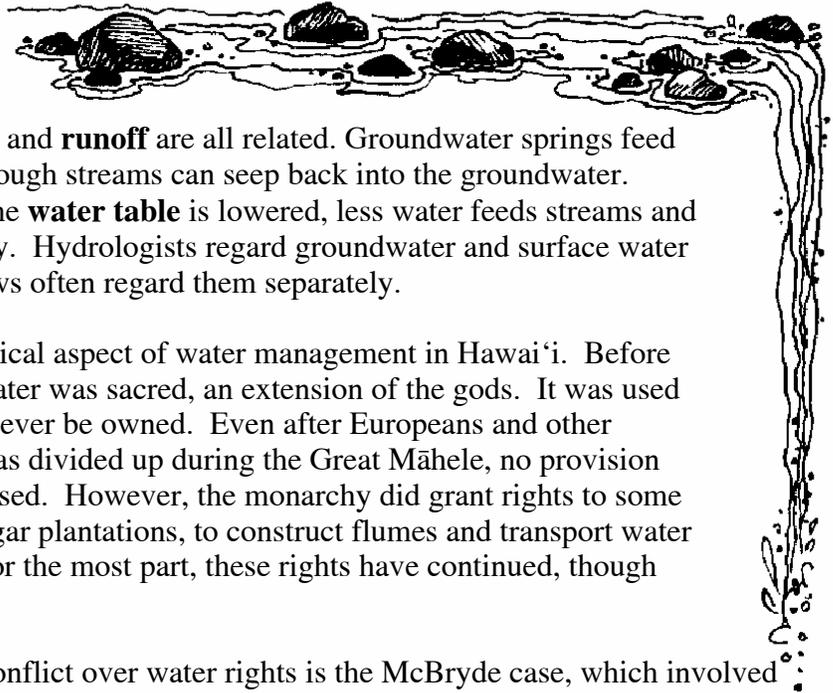
Preparation

Select an island water rights scenario from those provided and make a copy for each student. Also make copies of the water commission task card for one-fifth of your students.

Teacher Background

Precipitation in the form of rain, fog, and snow is the source of all fresh water in the Hawaiian Islands. Precipitation falling on the Islands may seep down into the soil or run off the land as **surface water**. Some of the surface water on the land may be lost to evaporation or to runoff into the sea. Water that seeps into the soil may be taken up by plants and transpired through their leaves and stems, and some of the water will drain through the soil beyond the reach of roots where it will **recharge** the **groundwater** lens.





Precipitation, transpiration, recharge and **runoff** are all related. Groundwater springs feed into streams, and water traveling through streams can seep back into the groundwater. When groundwater is pumped and the **water table** is lowered, less water feeds streams and springs, and they may dry up entirely. Hydrologists regard groundwater and surface water as part of the same system, while laws often regard them separately.

Adding to the confusion is the historical aspect of water management in Hawai'i. Before the arrival of Captain Cook, fresh water was sacred, an extension of the gods. It was used and respected by people, but could never be owned. Even after Europeans and other groups of people arrived and land was divided up during the Great Māhele, no provision for water ownership was ever discussed. However, the monarchy did grant rights to some individuals, especially owners of sugar plantations, to construct flumes and transport water from one land section to another. For the most part, these rights have continued, though not uncontested, until today.

One frequently cited example of a conflict over water rights is the McBryde case, which involved three major landowners in Hanapēpē Valley on Kaua'i: the McBryde Sugar Company, the Gay and Robinson Company, and the State of Hawai'i. The water dispute arose in the 1950s when the Gay and Robinson Company diverted water to an adjoining land area, reducing McBryde's flow of water downstream. In this case, McBryde wanted to know how much water it was entitled to. In 1959, after years of attempted negotiation, the Hawai'i Circuit Court ruled in favor of McBryde, awarding water rights to all landowners in the region. However, the case was appealed a number of times since. In 1973, using the traditional Hawaiian water view, the court majority opinion was that the state owned the excess surface water and that the right to use water on one's land could not be transferred to another watershed. This reestablished the pre-Māhele concept of public ownership of water. The court also ruled that the right to use the surface water flowing through or along one's land was limited to use that would not substantially diminish the natural flow of a stream.

For more than a decade, state policy makers have struggled with native Hawaiian rights, a changing economy, a growing population, and historical policies and assumptions, to develop a state water policy. A State Water Code was adopted by the legislature in 1987 (Chapter 174C) to address management of the state's water supplies. The code's Declaration of Policy opens with the following statement:

It is recognized that the waters of the state are held for the benefit of the citizens of the state. It is declared that the people of the state are beneficiaries and have a right to have the waters protected for their use.

A later paragraph in the same section continues:

The State Water Code shall be liberally interpreted to obtain maximum beneficial use of the waters of the state for purposes such as domestic uses, aquaculture uses, irrigation and other agricultural uses, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of water of the state for municipal

uses, public recreation, public water supply, agriculture, and navigation. Such objectives are declared to be in the public interest.

The code calls for:

- A Water Resources Protection Plan to be prepared by the state Commission on Water Resource Management
- Agricultural Water Use and Development Plan developed by each of the four counties
- A State Water Projects Plan prepared by various state agencies
- A Water Quality Plan prepared by the Department of Health

A landmark water rights issue that has led to intense scrutiny of the State Water Code is the dispute over the diversion of some windward O‘ahu streams to the Waiāhole Ditch for use by leeward farmers and developers. The debate over this issue has raged for a number of years and has not been fully resolved. For a summary of this issue leading up to the contested case hearing, see the water rights scenarios provided with this activity. An in-depth summary of the issue and various rulings is provided on the state Commission on Water Resource Management’s web site at <http://www.state.hi.us/dlnr/cwrm>.

The decisions by the Commission on Water Resource Management and a ruling by the Hawai‘i Supreme Court are not included in the students’ reading so that they can consider how *they* might resolve the issue. In December 1997, the Commission issued its original 250-page ruling on the Waiāhole diversion, dividing the water between the two groups. The Commission’s decision: 1) “amended the Interim Instream Flow Standards by adding 4 million gallons per day (mgd) to Waiāhole Stream and 2 mgd to Waianu Stream” from the ditch and tunnel system; 2) allowed that a “reasonable duty of water for diversified agriculture was 2,500 gallons per day” providing 10.64 mgd for certain leeward agricultural uses and proposed an additional 1.58 mgd reserve for agriculture; 3) “deferred formal rulemaking action on reservation petitions to a later date”; 4) approved 1.29 mgd for non-agricultural leeward use permits; 5) denied certain leeward agricultural and non-agricultural water use permits; and 6) “ordered that any portion of water subject to a water use permit or allowed for operational losses which were not being used, as well as the remaining ditch flows not subject to use permits, be released into windward streams.” One condition of the ruling was that the leeward parties receiving ditch water needed to “prepare, or contract for, a portion of the studies and monitoring activities.” In other words, to help determine how much water is needed in the windward streams.



The State Commission on Water Resource Management’s decision was appealed to the Supreme Court, which issued its ruling in August 2000. The Supreme Court responded to the manner in which both sides interpreted the State Water Code. Some leeward side proponents had argued that the “maximum beneficial use” of water promotes “consumptive uses such as agriculture” over instream uses. The Court found that the State Water Code “does not dictate maximum consumptive use, but instead requires maximum beneficial use for the range of purposes described, with the condition that ‘adequate provision shall be made’ for various protective purposes.” Some windward side proponents had argued that the code’s adequate provision mandate “grants an

absolute priority to resource protection.” The Court found that Water Code describes a “public trust...under which resource ‘protection,’ ‘maintenance,’ and ‘preservation and enhancement’ receive special consideration or scrutiny, but not a categorical priority.”

The Court ordered the State Commission on Water Resource Management to establish “interim instream flow standards” for the windward streams. These standards would establish how much water is needed in the streams for native stream life, for taro farming and other instream uses. The Court required that these standards be established before the Commission authorizes diversion of stream water for other uses.

In December 2001 the state Commission on Water Resource Management made its final decision in the Waiāhole case, effectively splitting the water between the two sides. The Commission ruled that an average of 13.3 million gallons a day out of the 27 mgd available, go to leeward agricultural and other uses. The Commission ordered 9.9 mgd to be added to the windward streams affected by the Waiāhole ditch. The balance of the water, including 1.58 mgd for a proposed agricultural reserve and 2.22 mgd non-permitted groundwater, was to remain in windward streams pending further action by the Commission. In addition, any of the 13.3 mgd not consumed or needed for day-to-day operations was to be released into windward streams.

The task of laying down specific guidelines for water use decisions in the state is a monumental challenge, and it is not surprising that the state is moving cautiously in developing its plan. In forming its own mock water commission, your class has the opportunity to address some of the thorny issues involved in determining equitable water use management in Hawai‘i.



Teaching Suggestions

1. Distribute copies of the student reading on the history of water rights. After students have read it, discuss the concept of private property, and compare water rights in ancient Hawai‘i with those of today. Discuss the questions presented at the end of the reading.
2. Divide the class into five groups. Appoint one group to be the student water commission. Distribute the water commission task card, and ask the group to consider guidelines for settling water use conflicts. Be sure they understand that there is no “correct” answer in this exercise.
3. Distribute copies of the water rights scenario to the remaining four groups. Ask each group to represent one of the interest groups identified, and outline its position and supporting arguments. Have students in each group select a spokesperson to present their case to the water commission.
4. Assemble the groups together, and ask a representative from the water commission to explain its role.

5. Ask each group's spokesperson to present a brief argument before the commission. Afterwards, provide a short recess for the commission members to reach a decision. Reconvene the class and have a commission spokesperson announce the decision. The commission must explain the rationale for the decision to the interest groups.
6. Discuss the commission's ruling and present the following questions for students to consider:

Discussion Questions

- Who should serve on the State Commission on Water Resource Management?
 - How should members of such a commission be appointed?
 - Should people be allowed to manage the water that is stored under their land? (termed correlative rights)
 - Should people be allowed to manage the water that flows over or through their land? (termed riparian rights)
 - If water flows between two properties, should the owners divide the water in half? What about the people who own property downstream?
 - Should the plants and animals that live in or next to streams and estuaries have rights?
 - Should people who live on the dry side of an island have equal access to the water that collects on the wetter side?
7. Explain that the actual State Commission on Water Resource Management has not yet resolved many of these questions. Ask students to write a short essay that a) organizes key events into a chronology showing how the current system of water rights evolved and b) comparing modern water rights with those in ancient Hawai'i. Students' essays should describe the benefits and consequences of past agricultural practices on fresh water in Hawai'i and include some suggestions for the State Commission on Water Resource Management.

Extended Activities

- Challenge students to examine water rights issues on other Hawaiian islands. See additional water rights scenarios provided.
- Have students research water distribution systems in other parts of the nation and the world, and compare them to water rights in Hawai'i.
- Ask students to describe how life might be today if community leaders 150 years ago had established different water rights. For example, what would our economy and landscape be like if sugar planters had not been permitted to capture water from distant sources?
- Have students research the daily newspapers for the latest developments in the water rights issue. Interested students may also want to visit the library and examine a copy of the State Water Code. An excellent summary and discussion of the State Water Plan is presented in *Environment Hawai'i*. See the website for this newsletter at www.environment-hawaii.org. All past issues are archived on the site and can be accessed by searching with key words. Search for state water plan to find the latest information. (Note that you may need to help your

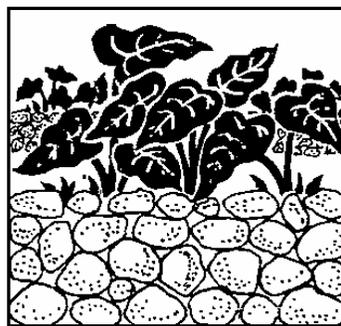
students understand the articles as the material may be above the reading level of most students.)

- The State Commission on Water Resource Management meetings to discuss water rights issues are usually held on the third Wednesday of each month at the DLNR board room in Honolulu. Check the commission's web site to learn more and find out when neighbor island meetings take place. If possible, plan to take your students to one of the meetings.

Water Rights in Early Hawai‘i

Hawaiians have historically placed a high value on fresh water. The Hawaiian word for fresh water is *wai*; the word for wealth or abundance is *waiwai*. Before the arrival of foreigners, water rights were governed by the *konohiki* as part of the *ahupua‘a*, or basic land holding system. Water was regarded as a gift from the gods. This precious resource was provided by *Kāne i ka wai ola* (Procreator in the water of life) and delivered by *Lono makua* (the Rain Provider). Neither land nor water was owned in the Western sense. Water was essential to grow taro, the principal food source. People worked together to build and maintain taro fields (*lo‘i*) and irrigation canals (*‘auwai*). Everyone could use the water as long as they used it in a way that benefited the whole community.

Sometimes people built a dam to force water into the *‘auwai*. But no more than half of the stream flow could be used, so that people downstream still had enough water for their needs. If one *‘auwai* served more than one area, the water was distributed according to how many men from each area worked to build and maintain the *‘auwai*. The Hawaiians believed that water was sacred, and took care not to pollute the streams. Activities such as bathing or washing utensils were carried out downstream from drinking areas, or away from the stream itself. The amount of fresh water that farmers could use depended upon the water available and the demands of the community. Water was used for different purposes during different times. Surplus water flowed to the sea, often providing nutrients to fishponds and nearshore marine life.



New Ideas from Foreigners

When foreigners first arrived in the Islands, they brought with them different customs and ideas. Hawai‘i had a feudalistic land system. Missionaries, business men, and others tried to persuade the Hawaiian rulers to legalize land ownership to help boost the economy. In 1845, the government presented an outline for a system of private land ownership. In 1848, the period of land division known as the Great Māhele began and the feudal land system ended. King Kamehameha III and his chiefs, who numbered more than 200, divided the land. Lands given to chiefs became known as *konohiki* lands. King Kamehameha III would further divide his portion into two. One portion reserved lands for his heirs and assigns and became known as crown lands. The other portion was reserved for the government and became known as government lands. All lands were subject to the rights of the native tenants, or commoners, who occupied and worked those lands. On July 10, 1850, it became legal for non-Hawaiians to purchase land, and many of the chiefs sold their lands for needed cash. In response to many land sales and the possible loss of rights of the commoners due to the sales of those lands, the *kuleana* act was passed on August 6, 1850. This act gave commoners that occupied and improved crown, government, and *konohiki* lands fee simple title to those lands. These lands were known as *kuleana* lands. By the end of the century, about 90 percent of the land in Hawai‘i (other than the crown lands, which could not be sold) was owned by

foreigners, who established large estates. Many Hawaiians easily lost their lands because the concept of private land ownership made no sense to them.

But the Hawaiian government did not give up water rights along with the land, and several efforts were made by King Kamehameha III to ensure that farmers and others continued to have their fair share of water. Not all landowners viewed the laws in the same way, and many believed that only free flowing streams and rivers were available to all, while water collected in ditches or wells belonged to whoever collected it.

At that time, the whaling industry in Hawai‘i was big with many whaling ships stopping over in Honolulu or Lahaina for supplies and ship repairs. Private land ownership meant that people could now raise cattle and other livestock, grow crops and firewood, and make money by selling them to whalers. Fresh water was also a necessary commodity sold to whaling ships as part of the ships’ supplies. During the 1860s, the American civil war decreased the number of ships to Hawai‘i, whale populations decreased, and petroleum replaced whale oil. Whaling declined only to be replaced by sugar.

Sugar did not take off right away. It was difficult selling sugar to the United States because the United States placed high tariffs on sugar from Hawai‘i. For years, the Hawaiian monarchy,

The Growth of Sugarcane

When sugarcane plantations replaced whaling as the biggest industry in Hawai‘i, water rights became a very important issue. At that time sugarcane used more water than anything else in the state. Some government leaders tried to help the sugar growers obtain land and water rights because they owed debts to the plantation owners. They also helped the growers because they believed that income from sugar would help the economy. In 1876, the legislature made water easily available to the sugar industry. Sugar companies then bought many acres of dry, unproductive land, with the understanding that they would be able to bring in water from wetter parts of the island. In some cases, the price growers paid for water depended upon the profits they made from sugar. When the sugar companies had a good year, the government earned more money. All profits were dependent upon a cheap and steady supply of water.



Over the next 50 years, ditches, tunnels and wells were built around the Islands to supply cane fields with irrigation water. There were often arguments over water rights, especially when neighboring sugar companies were competing for the same water. The courts tried to settle arguments using early Hawaiian water rights laws. But the Hawaiian attitude toward water could not easily be translated into Western law, and the courts often disagreed. Water rights decisions were sometimes reversed as the members of a court changed. A water dispute among two Kaua‘i sugarcane companies and the State of Hawai‘i led to a landmark court decision in 1973. At that time, the court determined that the State could decide who had rights to the water (just as the decision in old Hawai‘i would have rested with the *konoiki*).

In 1987, the State of Hawai‘i approved the State Water Code. This code established a State Commission on Water Resource Management. The Commission was given limited rights to

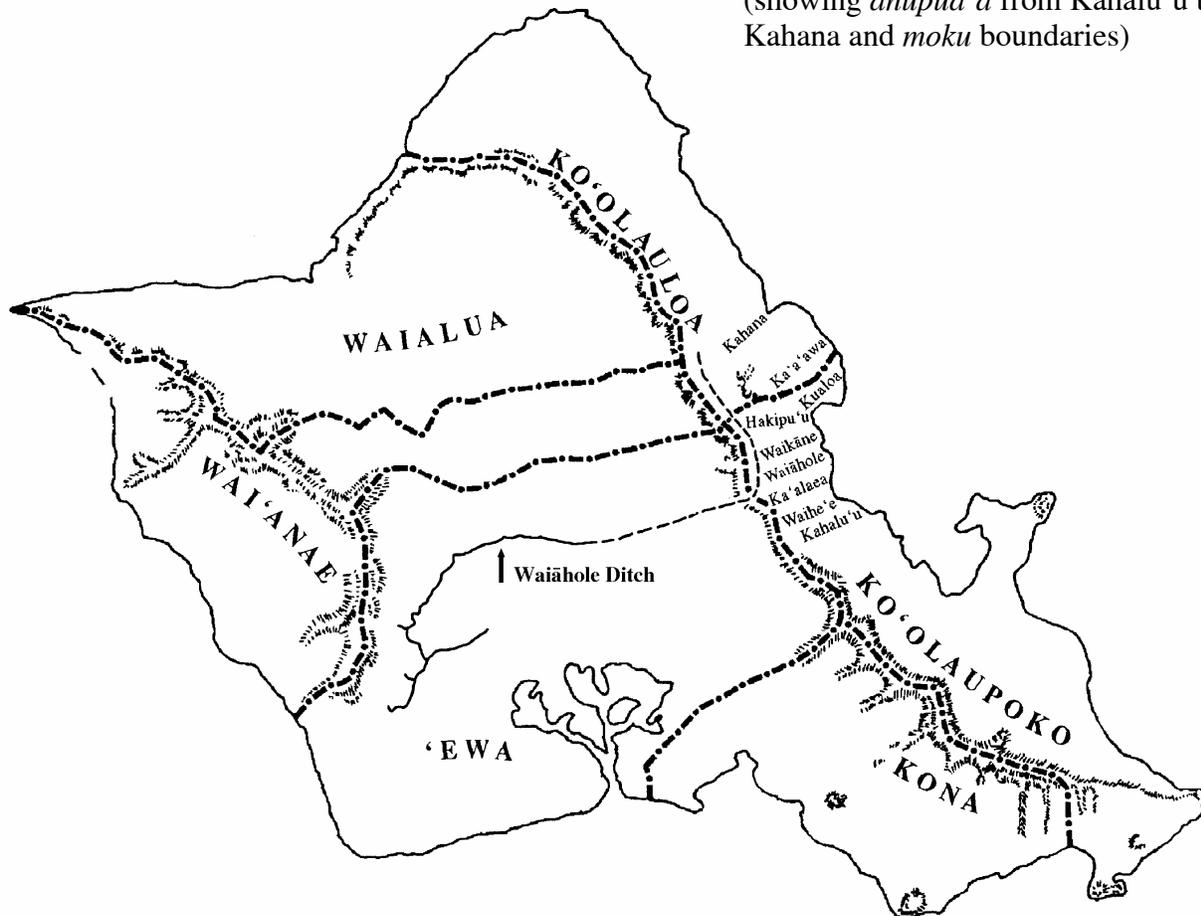
decide which water uses should be approved by the state. Unfortunately, the commission has no guidelines for choosing between two or more uses which are all “reasonable and beneficial.” For example, is stream habitat for an endangered fish more important than water for a hotel? Do the rights of small farmers outweigh those of larger agricultural businesses that rely on stream diversions for their water? How much water can someone pump from a well on their land, when their neighbors pump from the same underground water source? These kinds of issues are difficult to resolve and they are not yet settled.

Questions to consider:

- 1) How will disputes between groups competing for water be settled?
- 2) Are some water uses more important to the public than others? If so, which ones?
- 3) Should state law be changed so that water users pay a fee to ensure that future generations have adequate supplies of clean drinking water?
- 4) How can we protect our watersheds from pollution?

O'ahu: The Waiāhole Tunnel

Waiāhole Ditch, island of O'ahu
(showing *ahupua'a* from Kahalu'u to
Kahana and *moku* boundaries)



How did sugar growers manage to grow sugarcane on dry, leeward land when sugar needs so much water? This was a dilemma that O'ahu Sugar Company struggled with beginning in 1896 until the end of sugar on O'ahu in 1986. They got water to irrigate their leeward fields from wells engineered by James Campbell. Since it was too expensive to pump the groundwater from the wells upslope, they planted their crops below 200 m (650 ft). Still the company needed more water, so in 1912 they formed the Waiāhole Water Company. Their mission was to combine the water from Waiāhole, Waianu, Waikāne and Kahana streams on windward O'ahu and transport it across the central plain to the dry leeward sugar lands. The company had to obtain the rights to use the water from the landowners in the area, including the state government.

It took workers two years to complete the huge ditch system that diverts water from windward streams in the Ko'olau Mountains, and collects groundwater from four additional tunnels. One main tunnel collects the windward water and carries it through the mountain to ditches and reservoirs on the leeward side. The original ditch system was more than 34 km (21 mi) long; it has since been expanded by several more kilometers. This enormous project cost over \$2 million, not including the cost of the water rights. A bonus the engineers did not expect was the tremendous amount of water

within dikes in the mountains. This water had percolated down through the rocks from state-owned lands and become trapped behind dike rock within the mountain. Rights to the water were never formally purchased, but the flow allowed O‘ahu Sugar Company to begin irrigating their upland slopes much earlier with more water than ever expected. By the 1990s the ditch carried an average of 104 million liters per day (mld) (27 million gallons per day—mgd) to leeward O‘ahu.

On the windward side, the water diversion severely affected the flow of the three major streams, decreasing the water available to taro farmers, native stream life, and nearshore fisheries. In 1993, competing interests for the water erupted into a major dispute. On one side of the issue are the windward taro farmers, stream life advocates, and residents represented by the Kahalu‘u Neighborhood Board, Waiāhole-Waikāne Community Association, and the Hakipu‘u ‘Ohana who petitioned the Water Commission to restore flows in windward streams. This group wanted increased stream flows to support taro farming and fishponds, and to restore the value of Kāne‘ohe Bay as an estuary and fish nursery. They argued for increased stream flow to restore native stream animals to windward streams as well.

On the other side of the issue are those who want the water diverted to leeward areas for farming and urban development in central and leeward O‘ahu. This group included O‘ahu Sugar Company (which has since closed down and been taken over by Amfac/JMB-Hawai‘i), Waiāhole Irrigation Company (WIC) and the state of Hawai‘i (Dept. of Agriculture and Dept. of Land and Natural Resources). The original purpose of the ditch was to provide water for sugar. Since O‘ahu Sugar Company closed its operation in April 1995, the users for the water have expanded to include golf courses, small ranchers, pineapple growers and small truck farmers.

In October 1994 both sides entered into a mediation process, but they were unable to resolve the issue. However, an agreement was worked out to open the gate at the head of Waiāhole Stream and restore 58 mld (15 mgd) of water to this stream for six months. Stream biologists studied the impact of bringing water back into the stream. Once a month they set up overnight traps near the mouths of Waiāhole Stream and Waikāne Stream, which had no water returned. They found that all five native ‘o‘opu returned to Waiāhole as *hinana* (young fish in post-larvae stage). These fish were present in the stream in higher numbers than in Waikāne Stream. Surprisingly, even the young ‘o‘opu *alamo‘o*, a native goby that was thought to be extinct on O‘ahu, was found in Waiāhole Stream. The long-term survival of these fishes in the stream is still being studied.

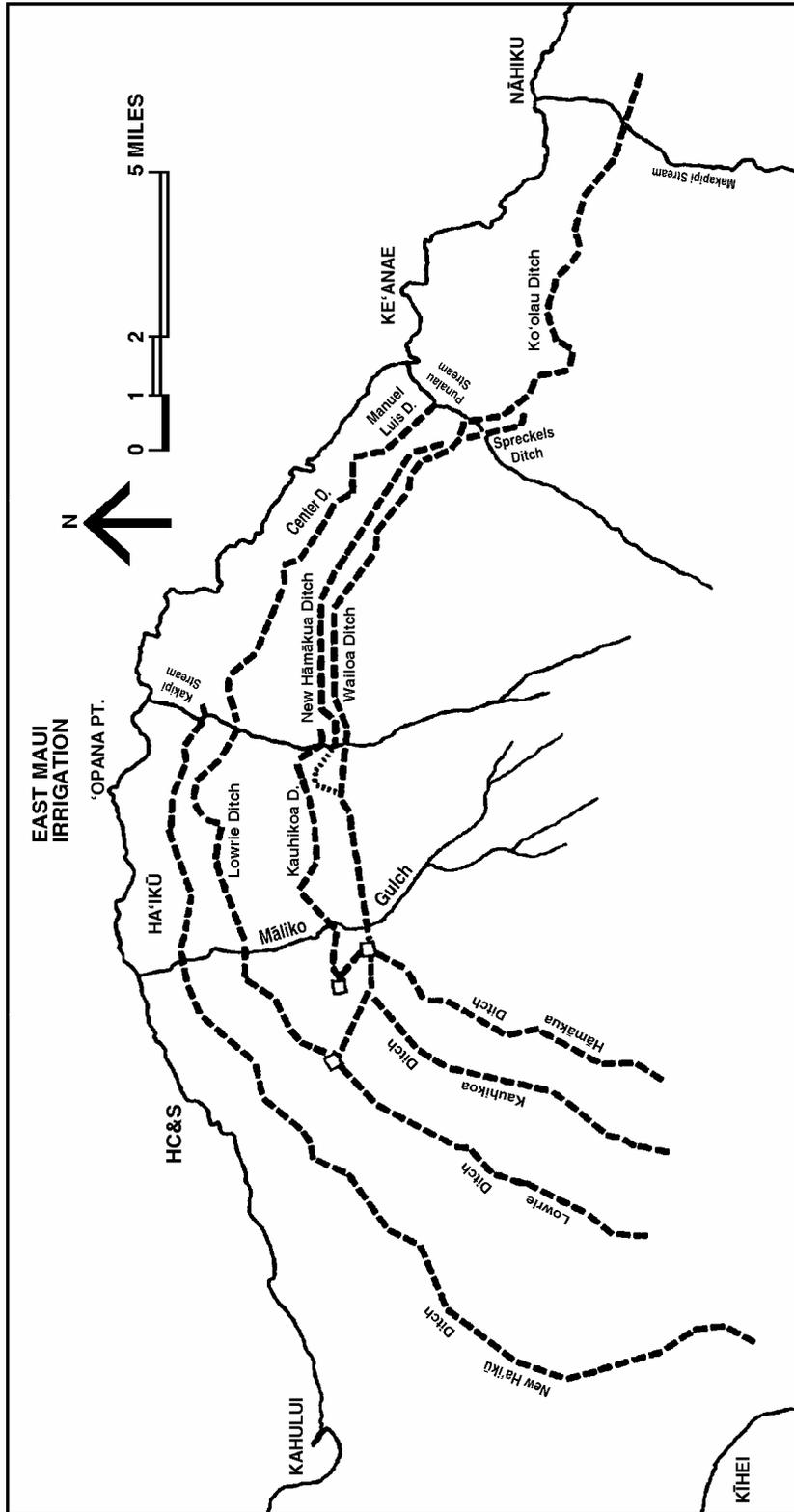
In November 1995 a contested case hearing opened before the State Commission on Water Resource Management. After 52 days and written testimony from 161 witnesses, the hearing finally came to a close.

Take a position on this issue, representing one of the interest groups and present your case to a mock water commission of your classmates.

Interest Groups

- real estate developers – seeking water for leeward housing
- farmers – leeward small farms
- farmers – windward taro farms
- biologists – seeking protection of windward stream and marine life

Maui: The Hāmākua Ditch



Ditches of East Maui. Only part of the original Hāmākua Ditch remains today. Adapted from Carol Wilcox, 1996, *Sugar Water: Hawaii's Plantation Ditches*, p. 120. A Kolowalu Book. Honolulu, Univ. Hawai'i Press.

If you owned hundreds of acres of land on the dry, leeward side of Maui and you needed water to grow sugarcane, what would you do? How would you collect water from the wet, windward side and carry it to your fields miles away? This is the problem that Samuel Alexander and Henry Baldwin solved in 1876 when they started building a ditch 27 km (17 mi) long to capture water from Nāhiku in East Maui, and transport it to the dry West Maui plains. At that time, many streams in East Maui flowed into the sea. Alexander and Baldwin were given two years to complete the ditch; if they didn't, the uncompleted ditch would be given to King Kalākaua. It took the men the full two years, \$80,000, and the help of many imported laborers to build the ditch on time. When completed, it carried 227 m³/d (60 mgd) to the sugar plantations. Each plantation used a share of water according to how much it had contributed to the ditch's construction. The Hāmākua Ditch is no longer used and little of it remains today.

The sugar companies added nine more ditches to the system: Hā'ikū, Spreckels, Center, Manuel Luis, Lowrie, New Hāmākua, Kauhikoa, Ko'olau, and Wailoa Ditch. Wailoa Ditch was completed in 1923. In 1938, the Territory of Hawai'i granted the East Maui Irrigation system (EMI) rights to use government land to collect and transport water through their ditch system. By 1948, most Maui plantations had become part of Hawaiian Commercial and Sugar Company, and all the water was controlled by EMI. EMI now operates 119 km (74 mi) of ditches and tunnels that deliver more than 1,725 m³/d (455 mgd) to drier areas of the island.

In 1961, Maui County asked the state to change its agreement with EMI. The county needed water for people's homes and other uses. The county though could not use the water within its own borders because of the agreement between the state and EMI. The county wanted to save a great deal of money by purchasing water directly from the state, rather than through EMI. In 1961, EMI paid the state \$9,000 for the right to collect water, and then sold just 11 percent of the right to Maui County for \$7,400! However, the state rejected Maui County's suggestion and entered into a 24-year agreement with EMI. That agreement has since expired, and the state now maintains a month-by-month agreement with EMI.

There is no question that the ditch built by Alexander and Baldwin more than 100 years ago benefited Maui's economy by making hundreds of acres productive. But some people, including ecologists, taro farmers, real estate developers and county government officials are now questioning whether EMI's control over water in Maui is best for everyone in the county. Taro farmers in Ke'anae are finding it very difficult to grow taro when water is diverted from streams that feed their *lo'i*. In addition to concerns over the cost of water rights, some people are concerned about stream life. The streams between Nāhiku and Huelo are among the best in the state for providing habitat for native stream animals such as gobies, prawns and snails. If water levels drop too low, introduced species become more dominant in the slow-moving waters. Alien species, such as tilapia, pass parasites onto native species and compete with them for habitat. When stream flows are restored, the alien species are reduced since they have no suction fins such as *'o'opu* to cling to rocks in fast-moving water.

Take a position on this issue, representing one of the interest groups and present your case to a mock water commission of your classmates.

Interest Groups:

- East Maui Irrigation Company
- real estate developers
- taro farmers
- ecologists concerned about stream and marine life

