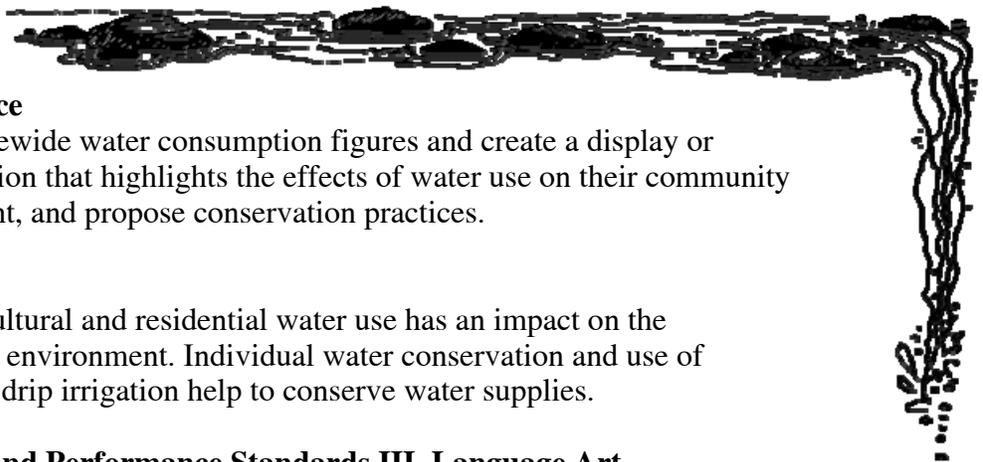


# WATER WE LOSING?



Grade 6–8



## Activity at a Glance

Students graph statewide water consumption figures and create a display or computer presentation that highlights the effects of water use on their community and the environment, and propose conservation practices.

## Key Concepts

Commercial, agricultural and residential water use has an impact on the community and the environment. Individual water conservation and use of recycled water and drip irrigation help to conserve water supplies.

## Hawai'i Content and Performance Standards III, Language Art

<b>Grade 6</b>			
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 (e.g., locate sources and gather information to determine how to manage our water resources, roles of special interest in watershed alliances, and location of watersheds in my neighborhood).	
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.

<b>Grade 7</b>			
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.		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

<b>Grade 8</b>			
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.		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 ( <i>e.g., to solve and improve environmental problems such as groundwater pollution</i> ).	
Sample Performance Assessment (SPA)		The student: Explains ways in which technology has changed our society and science.	
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.8.2.1		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 ( <i>e.g., database programs, internet</i> ) can be used to develop conclusions	
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.	
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.

### Subject Areas

social studies, science, language arts, art

### Time

four class periods

### Materials

student data sheet (provided)

water use graph (provided)

graph paper

marking pens

2 sheets of acetate and overhead projector (if computer projection not available)

### Prerequisite

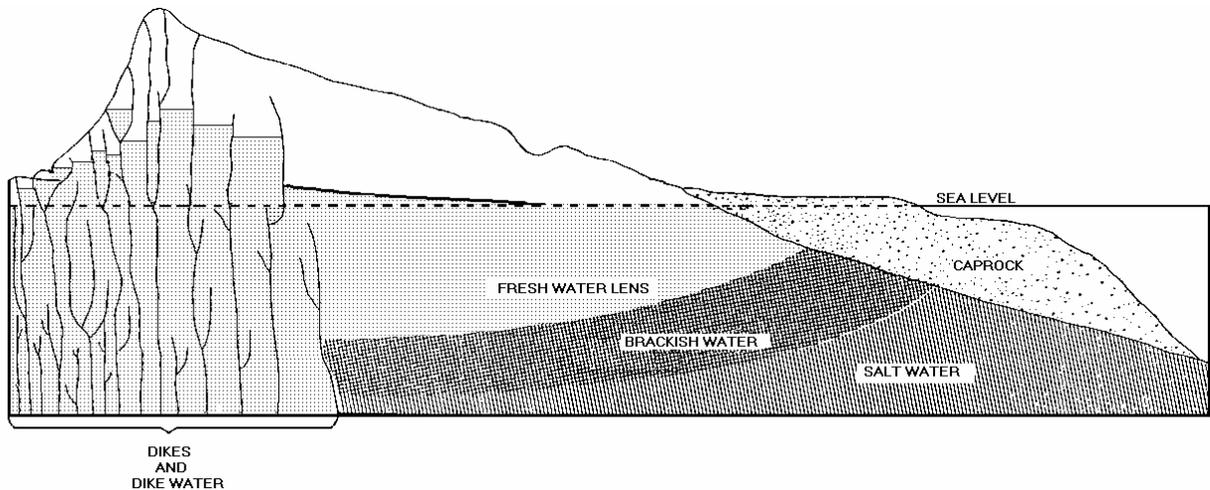
“Hold It!”, Geology, Grade 6 (describes how groundwater is naturally stored in the islands)

### Preparation

Copy the graph included in this lesson and the diagram from the student activity sheet in “Hold It!” onto acetate to use as overhead projector transparencies. Alternatively, if you have projection capability from your computer, project these documents during the class discussion.

### Teacher Background

**Surface water** (water from streams and springs) and **groundwater** (water trapped within the earth) supply most water needs in Hawai'i. People on O'ahu rely on groundwater as the major supply of residential water. On other islands, where groundwater sources are not as well developed, people also rely on surface water and rain catchment. (See the student data sheet.)



*diagram showing groundwater supply of an island*

Groundwater supplies more than 90 percent of the state's total daily residential water use. On O'ahu, groundwater supplies 100 percent of the drinking water. Groundwater also supplies water for agricultural and commercial uses. Surface water accounts for only a fraction of residential water use, but is a major source for agriculture. On the islands of Hawai'i, Maui and Kaua'i, surface water is also used to generate hydroelectric power.

The student data sheet summarizes the various uses of groundwater and surface water for individual islands. The categories for water use include:

Commercial and Government: water used for golf courses, highway irrigation, fire fighting, retail outlets, hotels, resorts, parks, laundries, pineapple canneries, military facilities and schools.

Residential: water used for human consumption and for household purposes.

Agricultural: water used for farms.

As the human population continues to grow, water conservation measures will become increasingly important. When sugarcane was extensively grown, most water in the state was used for agriculture. On O'ahu, municipal water has replaced agriculture as the largest user of groundwater. Much of the surface water used for agriculture is diverted from streams, causing a reduction in stream flow. This diversion generally occurs between 150–300 m (500–1,000 ft) above sea level. Under some conditions, pumping groundwater can also reduce stream flow. Pumping groundwater may reduce stream flow by lowering the water table and eliminating some springs that feed into streams. Pumping water from dikes in the mountains also lowers the water available to streams.

When stream water levels decline, small farm operations, particularly taro farms downstream may not have a continual source of flowing water to irrigate their crops. Loss of stream flow affects stream life as well since many streams that once flowed year-round become intermittent. This loss of habitat has contributed to the decline of native stream animals that

must return to the sea during part of their life cycles. (See “Swimming Upstream,” Humans and the Environment, Grade 4 for additional information.)

Water **conservation** is the primary means of reducing surface and groundwater demands. A number of hotels and residences have reduced groundwater demand through the installation of water-saving showerheads and toilets, as well as not serving water at meals unless requested. Agricultural water demands have been reduced through the use of drip **irrigation** on crops. Using this technique, farmers direct water to individual plants via tiny holes in hoses, rather than in ditches between rows where much water is lost to **evaporation** and infiltration. Recycling water is another means of conservation. Where feasible, reuse of treated sewage water from nonpotable sources may be available for watering crops, lawns, landscaped areas, and golf courses.

### Teaching Suggestions

1. Ask students to estimate how many liters or gallons of water they think they use each day. Write their estimates on the board.
2. List the average daily residential water use figures from the Board of Water Supply and have students add them up and compare to their original estimates.
3. Ask students to identify the source of their fresh water. Distinguish between groundwater, water catchment from roofs, and surface water sources. Review where groundwater is stored using the overhead transparency from the prerequisite activity.
4. Generate a list of nonresidential water uses and place them in two categories: commercial (including government uses) and agricultural. Ask students to estimate which of these is the biggest water user on their island.
5. Distribute the water use data sheet and graph paper. Discuss the concept of a million. Tell students that if they were to count to one million at the rate of one number each second, it would take 11.6 hours!
6. Ask students to use the data sheet to construct bar graphs of water uses on each island. Refer to the graph included in this activity. Compare the water use differences and discuss.

### Interpreting the Data

- Which islands use more surface water than groundwater? Why? (more agriculture, fewer wells, less developed groundwater supply on Hawai‘i and Maui)
- What is the most consumptive use of water in the state? (agriculture)
- Which island’s agriculture uses the most water? (Maui)
- What energy-related industry uses surface water? (i.e., hydroelectric power on Kaua‘i)
- What is the second most consumptive use of water in the state? (residential)
- In what ways could use of groundwater sources affect surface water supplies? (By lowering groundwater we can cause springs that feed into streams to dry up, thus reducing stream flow.)

### Discussion Questions

- Will there be enough water to meet projected water demands by the next generation?
  - What are some of the effects of human water consumption on the environment?
  - How might your individual water use reduce the flow of water in streams?
  - In what ways have individuals and other major water users reduced water use? (recycled water, drip irrigation, and conservation)
8. Have students do the Student Reading and Activity or “A Tale of Lāna‘i’s Water.”
  9. Challenge students to design a display or computer presentation about water use and potential water conservation practices on their island. Topics could be divided among groups of students. Potential topics are: groundwater uses, surface water uses, reduction of stream flow, meeting future needs, present conservation practices, and proposed conservation practices.
  9. Have students share their display or presentations with others in your school and/or community. To assess what students have learned, ask each student to write a summary. Their summaries should a) evaluate the effects of water use on the community and on the environment, b) evaluate present natural resources conservation practices, and c) propose additional practices relevant to the community.

### **Extended Activities**

- Adopt a stream! Have students select a stream that they would like to see preserved. Visit the stream, collect litter, observe organisms, and find out how the stream is used to meet human needs. Is water being diverted for other uses? See “Stream Sojourn,” Plants and Animals, Grade 4.
- Have students examine their family water bills. How much does water cost? How does the cost of a gallon of water compare to the cost of other liquids? Compare the water bills over a span of months. If usage went up or down, what were the probable causes?
- Students could design water conservation plans for their families. Have them observe the family's use of water for one week. Record the estimated water use and devise a plan to be discussed and possibly used by the family.



**1995 Water Use: State of Hawai'i**

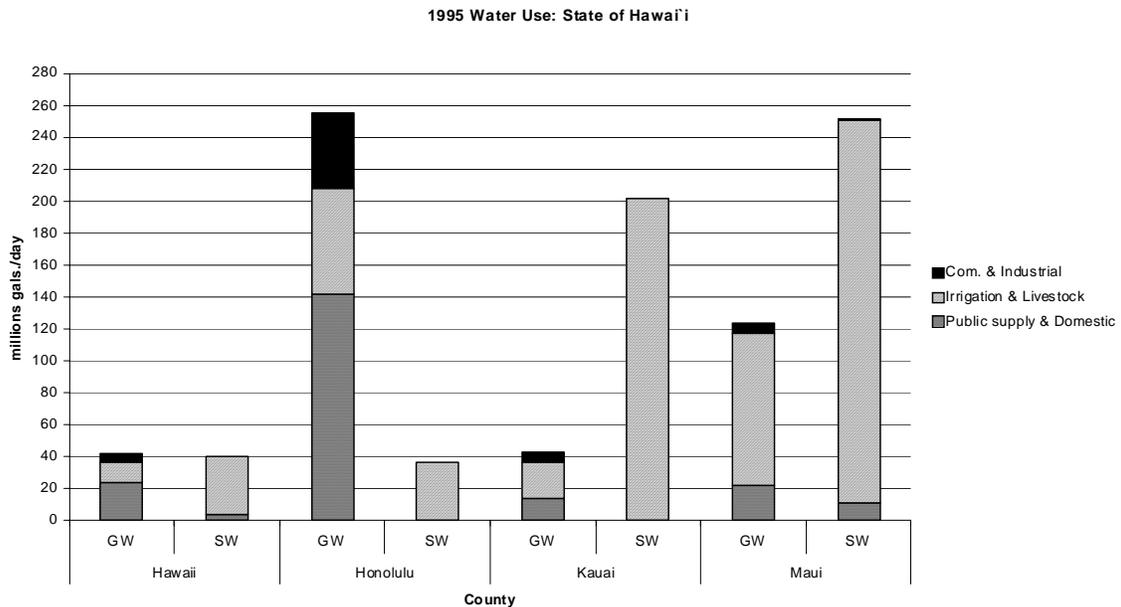
Note: Data in million gallons per day rounded off to whole numbers.

G = groundwater; S = surface water

County		Residential	Agricultural	Commercial & Government	Total
Honolulu	G	142	66	47	255
	S	0	36	0	36
Maui	G	22	95	7	124
	S	11	240	0	251
Kaua'i	G	14	22	6	42
	S	0	202	0	202
Hawai'i	G	24	13	5	42
	S	4	36	0	40

Source: U.S. Geological Survey

Replace chart when new data comes out later this year.



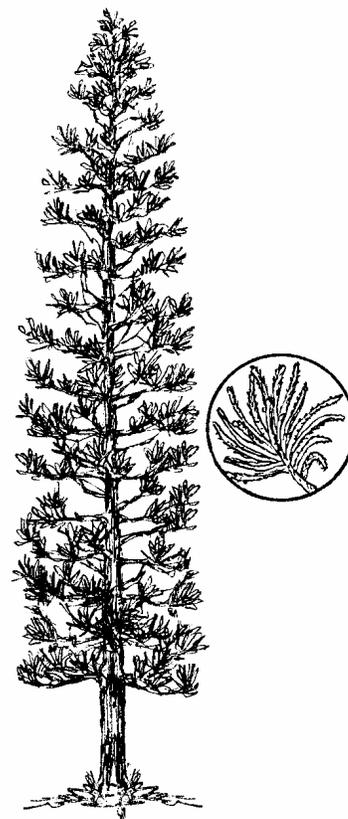
The island of Lāna‘i is located on the leeward side of Maui. It is said to be in Maui’s rain shadow because Lāna‘i is hidden behind its large neighbor, which blocks the trade winds and moisture. Consequently, the island receives little rainfall and is dry. Like Ni‘ihau and Kaho‘olawe, groundwater recharge is low. Most of the rainfall on Lāna‘i is at the summit of Lāna‘ihale (1,030 m in elevation, or 3,370 ft), the island’s highest peak and its watershed. Rainfall at Lāna‘ihale is merely 30–40 inches a year compared to 444 inches a year at the top of Wai‘ale‘ale on Kaua‘i, the wettest spot in the Hawaiian Islands.

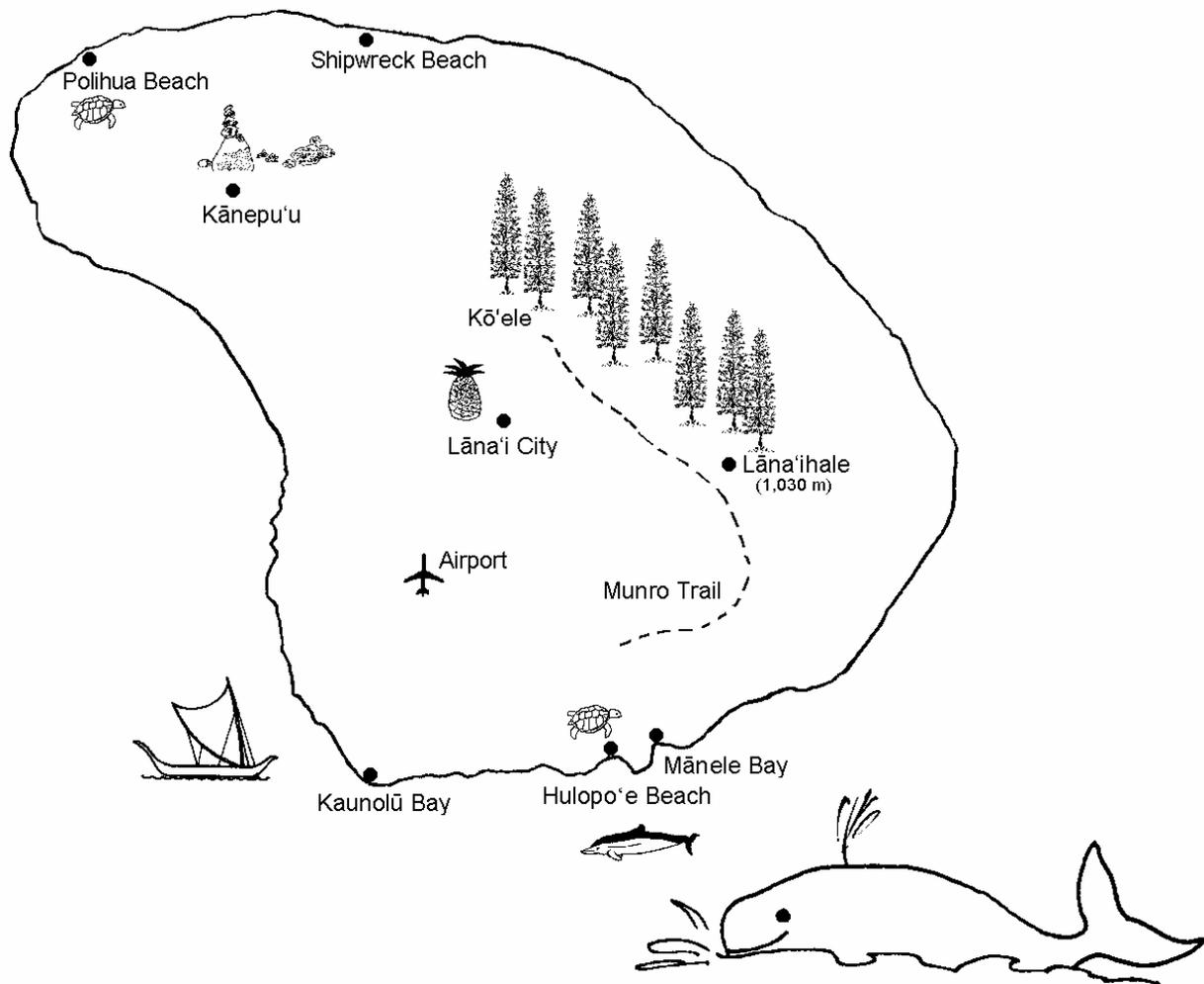
Water in the Hawaiian culture has always been regarded as a precious resource. In the days of old, Hawaiians would collect dew from the leaves of plants or the surface of oiled kapa spread out on the ground. At a Lāna‘i fishing village at Kaunolū, fresh water was scarce and valued. Hawaiians obtained their water from a well that tapped the brackish water aquifer below.

In the late 1700s, mouflon sheep and goats were introduced to Lāna‘i by passing sailors as a food supply for future sailing trips. In 1865, Walter Murray Gibson established Lanai Ranch, which raised goats and sheep. In 1867, he counted 10,000 sheep and 18,000 goats! Since the animals fed on the plants growing on the island, the explosive growth of sheep and goats resulted in the destruction of most of the vegetation on the island except the dryland forest at the top of Lāna‘ihale.

George Munro, a naturalist originally from New Zealand, came to Lāna‘i in 1920 to eradicate the sheep and goats for cattle ranching. That same year he also introduced 12 axis deer from Moloka‘i, something he later came to regret. The deer proliferated and destroyed more vegetation on the island. Mr. Munro built fences to keep grazing animals out of the remaining forest at Lāna‘ihale. He planted introduced Cook pine and eucalyptus trees, knowing a forest was needed to replenish the groundwater and to prevent erosion. Soil erosion caused by the animals’ overgrazing can still be seen today on the island at Kānepu‘u. The terrain is a windy desert of bare and hard soil. It is a devastated landscape. Recently, steps have been taken to restore Kānepu‘u’s native dryland forest. Native vegetation is being replanted and deer-proof fences have been erected. Mr. Munro was the first to erect fences at Kānepu‘u thereby saving a remnant of the original forest.

In 1922, James Dole and Hawaiian Pineapple Company removed the last of the cattle to grow pineapple. For decades, pineapple was the main industry on Lāna‘i, occupying 16,000 acres of land. During the early 1990s, pineapple production declined while new hotels and golf courses were developed at Mānele and Kō‘ele. Now pineapple is primarily grown on O‘ahu and Maui.

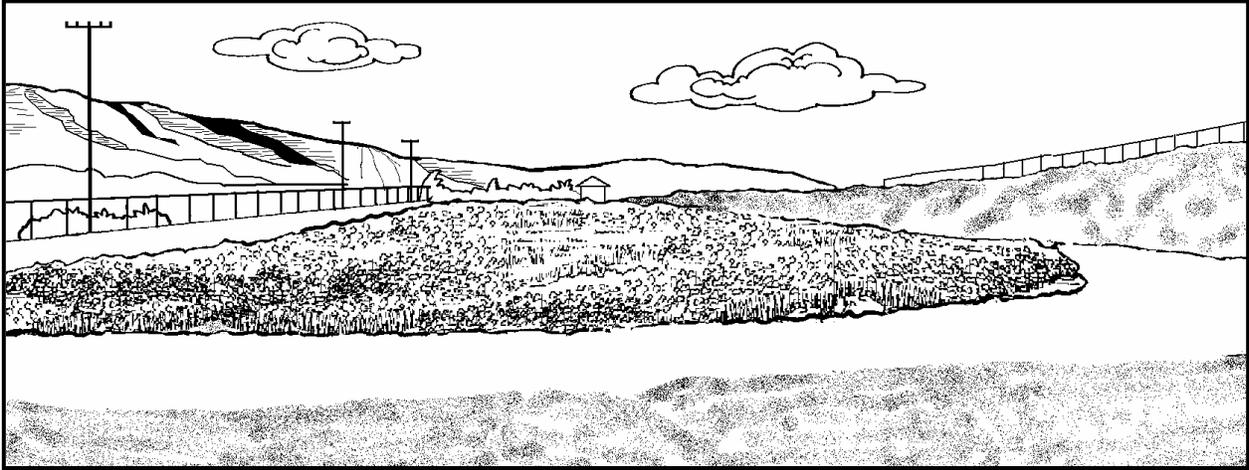




The top of Lānaʻi's watershed at Lānaʻihale is where the trees collect moisture from passing clouds. The moisture condenses into water drops and moves into the ground, recharging the groundwater below. This process is known as fog drip. The Cook pines planted by Mr. Munro are especially efficient in collecting fog drip. In fact tests have shown that a mature Cook pine can produce up to 20 inches of additional rainfall per year!

Although the island has an underground aquifer that shows no sign of depletion, Lānaʻi still works hard to maximize this important resource. Its groundwater comes from high-level dikes. Some of the water in the dike compartments is salty with the saltiness varying from one area to another. Although Lānaʻi has much fresh water, only a small amount is used for domestic use. The island depends primarily upon recycled water for many of its needs.

There are two types of water systems on Lānaʻi. One produces recycled wastewater, or reclaimed water for irrigation at golf courses, and the other produces both potable and nonpotable water. Potable water is suitable for drinking while nonpotable is not. Potable water is piped for residential and commercial uses. Reclaimed water, classified as R-1 by the State Department of Health, is nonpotable water. Koele Golf Course uses 100 percent reclaimed water for irrigation!



*Ponds with water hyacinth plants*

There are four water utility operations on Lānaʻi:

- Lanai Holdings, which produces water and sells irrigation water to hotels;
- Lanai Water Company, a public utilities commission that buys potable water;
- Manele Bay Wastewater Treatment Plant, which sells reclaimed water to Manele Golf Course; and
- Lanai City Auxiliary Wastewater Treatment Facility, which sells reclaimed water to Koele Golf Course.

Lanai City Auxiliary Wastewater Treatment Facility collects and filters wastewater in ponds filled with water hyacinth. In many parts of the world, people are spending a lot of money trying to get rid of this invasive weed from South America. However, it is useful at sewage treatment plants because it cleans the water by removing toxic metals, chemicals, and other harmful elements. After the wastewater is filtered through the water hyacinth beds, this reclaimed water is either stored used at Koele Lodge or stored in reservoirs until it is needed for future use.

Two different sources provide Manele Golf Course with the water it needs for its operations. The course is irrigated with nonpotable water from wells that have more salt than is allowable for drinking water (300 ppm vs. 250 ppm). Reclaimed water from Manele Bay Wastewater Treatment Plant provides the remaining water needed.

Lānaʻi's current water systems were developed in about 1994 when Maui County made it a requirement for the resorts that were being developed at Kōʻele and Mānele to use recycled water. Today, the island of Lānaʻi uses nearly 100 percent recycled water, although it costs two to three times more than potable water! By using reclaimed water and nonpotable irrigation water, it is now using much less potable water than it did when the island's major industry was pineapple agriculture. In the year 2003, Lānaʻi used less than 1,000,000 gallons per day of potable groundwater compared to the 3,000,000 gallons per day it used for pineapple cultivation.

The multiple efforts developed to conserve and maximize the water resources of Lānaʻi are impressive. Lānaʻi's wise use of its water resources can serve as an example to the rest of Hawaiʻi and the world.

## **A Tale of Water**

On Lāna‘i, we’ve learned how some businesses conserve and recycle water. How do other companies in Hawai‘i practice water conservation? Break into small groups and select a business on your island! Possible companies include hotels or resorts, landscaping, and golf courses. Answer the following about the business you are researching.

Name and location of business: \_\_\_\_\_

Nature of business: \_\_\_\_\_

1. How does this business use water? \_\_\_\_\_

\_\_\_\_\_

2. What is the company’s primary source of water? \_\_\_\_\_

\_\_\_\_\_

3. How does it conserve or recycle water? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. What is the history behind its water usage? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5. What are the costs of conserving and recycling water compared to fresh water? \_\_\_\_\_

\_\_\_\_\_

6. What are the environmental benefits for this business to conserve and recycle water?

\_\_\_\_\_

\_\_\_\_\_

7. What plans does this company have to modify its present water use? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_