TAKING CARE OF HAWAI‘I’S WATERS

A Guide for Getting Started in Volunteer Water Monitoring

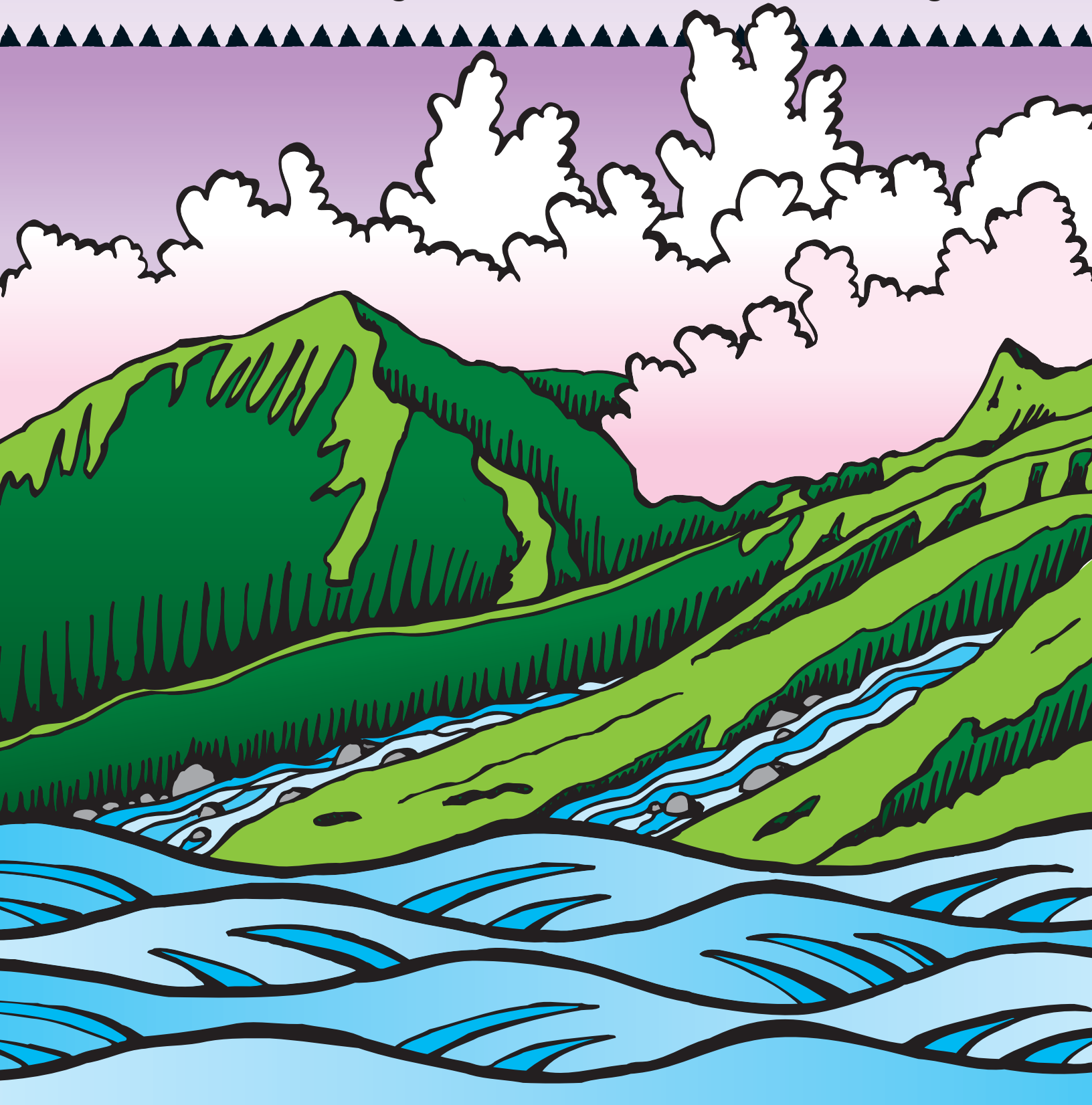

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TABLE OF CONTENTS

TABLE OF CONTENTS

HOW TO USE THE VOLUNTEER WATER MONITORING MANUAL

This manual is provided as a guidance tool for those interested in getting started in volunteer water monitoring; it is not intended to cover all aspects and protocols involved in volunteer monitoring. Each area/site provides its own challenges. While many of the protocols have been tested by volunteers, - your site, access to technical experts and equipment and abilities of your volunteers will differ. Please feel free to copy anything in this manual and adopt/change as needed for your particular area.

Section 1: Introduction to water quality
In this section you'll learn about the basics of water quality, what are water quality standards, why we should monitor water quality and why you should get involved.

Section 2: Watershed, estuarine and marine processes
This section gives an overview of watersheds, streams, estuaries, the hydrologic cycle and more.

Section 3: Water quality parameters
Learn about the various water quality parameters, why they are monitored, the various methods used and how changes can impact the health of the waterbody, humans and aquatic life.

Section 4: How to get started
This section outlines the basics of what you need to know in order to get started in volunteer water monitoring. By asking yourself the simple question of "what is your goal", you can determine what level of involvement you should be in. And if you aren't ready to get started, there is a list of some events organized by others.

Section 5: Three levels of volunteer monitoring
This section gives an overview of the different levels of monitoring, depending on your goals. It lists what might be involved at each level, and tells you how you might plan your monitoring program. At the end of each level, it references the various protocols you might consider as part of your program in sections 9-12.

Section 6: Volunteer management
Wondering how to recruit volunteers? This section gives an overview of how to recruit, train, manage and retain your volunteers, with tips from those who have developed programs elsewhere.

Section 7: Data management
What will you do with the data you collect? What's the best method to use? This section gives an overview of various ways to manage your data, which depends on the level of involvement you've selected in section 3.

Section 8: Transporting samples and safety issues
If you will not be analyzing your samples on site, or will be transporting the samples to a lab, here are some protocols to use. And safety, safety, safety! Remember these precautions to pass along to your volunteers.

Section 9: Field manual
This section lists some protocols that you can use for monitoring water quality, by code. It is meant to be a simple pullout section that you can make multiple copies of, or laminate.

Section 10: Stream measurements
Want to get involved in more than water quality monitoring? Monitoring the flow, recording visual observations during a stream walk, opala cleanup and recording and fish/invertebrate rapid assessments are all indicators of the health of the stream and its resulting impact on coastal areas.

Section 11: Watershed measurements
Watershed measurements are an important component of water quality monitoring. In this section, you'll learn about how to record rainfall, some tools for estimating runoff, how to identify areas of pollution "hotspots" (source of potential pollution), and how to conduct storm drain monitoring.

Section 12: Other coastal and ocean measurements
Other ocean related monitoring that can help in understanding the health of coastal resources is measuring ocean currents, tides, observing the weather, looking for aquatic invasive species and identifying coral bleaching and marine disease.

Appendix A: Other volunteer water monitoring manuals
Sources for other volunteer manuals.

Appendix B: Other organizational resources/Contacts
This is a list of additional resources to assist you in developing your program, including contact information.

Appendix C: Sample forms
Here you find a variety of forms and templates you can use, or modify for your own program.

Appendix D: Funding resources
Wondering how you can fund your program? Look here to locate an appropriate funding source.

Appendix E: Equipment and supply vendors
Here is a list of commonly used water quality supply vendors.

Appendix F: Applicable Federal, State and Local Laws
Know your laws! It is important that you understand the laws that government agencies, businesses, landowners and the community must comply with.

Appendix G: Glossary
What does that term mean? Here is a list of common water quality and other related terminology, including Hawaiian words.

Appendix H: Determining Latitude and Longitude
Don't have a GPS unit to determine your location? Here is a method using a topographic map, ruler and calculator to determine latitude and longitude.

ACRONYMS:

CWA: Clean Water Act
DAR: Division of Aquatic Resources
DLNR: Department of Land and Natural Resources
DO: Dissolved Oxygen
DOH: Department of Health
EPA: Environmental Protection Agency
GPS: Global positioning satellites
HAR: Hawaii Administrative Rule
HRS: Hawaii Revised Statute
MPN: Most probable number
NRCS: Natural Resources Conservation Service
QA: Quality Assurance
QC: Quality Control
QAPP: Quality Assurance Project Plan
SOP: Standard Operating Protocols
STORET: Storage and Retrieval (data management system by EPA)
TMDL: Total Maximum Daily Load
USACE: United States Army Corps of Engineers
USGS: United States Geological Survey

Photo by Liz Foote

▲ *Honolua Bay*

What is Water Quality?

Water quality measures the biological, chemical and physical attributes present in the water column. These attributes include oxygen content, temperature, salinity, turbidity, nutrient loading, amount of sediment and the presence of bacteria, metals, and other toxins. The sources of water pollution can be natural or anthropogenic (human induced), and are identified as either point sources or nonpoint sources. Natural sources of altered water quality include minerals worn from rocks or sediment from erosion. Point sources have a discrete discharge location, such as a pipe or culvert, and include wastewater treatment plants, power plants, and industrial facilities that discharge wastewater effluent. Nonpoint sources do not have discharges coming out of a defined point, but are difficult to identify and are typically conveyed as general runoff or groundwater seepage. Examples of nonpoint sources include surface runoff from agricultural land or urban areas.

Why Measure the Quality of Water?

The quality of water can affect the suitability of water for drinking, recreation, wildlife, agriculture, and other every day use. Anything that flows from yards, streets and gutters enters the storm drain and flows to the streams and ocean untreated. For example, fertilizer contains nitrates, which in disproportionate quantities can upset the ratio of nitrogen to phosphorus, nutrients that plants need for growth, but also cause the excessive production of algae. Too much algae can limit the amount of oxygen that other plants and fish need or crowd out native plants and algae. Other pollutants such as bacteria are carried by the stream to the ocean and can cause bacterial levels to exceed state standards for recreational contact. High levels of bacteria can indicate an increased risk of disease for people who swim, surf, snorkel, dive, fish or have other contact with the stream or ocean water. Metals such as lead and copper found in brake pads have been found in fish and can cause changes in reproductive behavior. Symptoms in humans can range from excessive headaches to kidney damage. These metals are found in significant quantities during storm water runoff. Researchers are even finding concentrations of the ingredients of sunscreen products in fish and other marine organisms. When streams are stripped of vegetation or buildings placed too close to the stream banks erosion can occur. The concrete streambeds facilitate the transfer of the sediment to the ocean, where it can smother corals.

What are the Laws to Protect Clean Water?

Federal Clean Water Act (CWA)

In 1972, the Clean Water Act, then the Federal Water Pollution Control Act, was created. Over the years it has had several amendments and modifications, as well as other acts passed to work in coordination with CWA. The statute was implemented to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USCA § 1251(a)) as its main goal. The Environmental Protection Agency (EPA) works with the state to set standards of acceptable levels of pollutants in water bodies in order to ensure a designated water quality standard. These standards consist of three components: 1) designated uses of water, 2) water quality criteria to protect the uses, and 3) an antidegradation policy directed at keeping healthy waters healthy.

The State of Hawai'i Department of Health (DOH) is required to designate uses for each waterbody. These uses include: swimming, drinking water and aquatic life. The designated use is a goal; that is, the waterbody may be designated for use of swimming, but perhaps not clean enough yet. DOH sets numeric and narrative water quality criteria to protect these uses. Numeric criteria define a maximum amount of a particular characteristic such as bacteria, metals or nitrates in the water. Narrative criteria (e.g "no sediment loading above natural conditions") may serve as a "catch-all" or a backup when numeric criteria have not (or can not) be developed. Antidegradation policies are developed to limit activities that will spoil existing water quality or improvements that have been achieved.

Every two years, the DOH must provide a Biennial Water Quality Report to Congress, also known as the 305(b) report. This report (required by Section 305(b) of the Clean Water Act) includes an assessment of the States' waters to determine if designated uses are being met. CWA Section 303(d) requires the DOH to prepare a list (every two years as well) of threatened and impaired waters and then develop cleanup plans for the waters on this list based on the total maximum daily load (TMDL) of pollutants that the waterbody can receive and still meet the water quality standards. A TMDL basically is a cap for every problem pollutant in the waterbody. It is divided into potential sources: 1) Background conditions, 2) Allocations for all point sources – also known as "wasteload allocations", 3) Allocations for all the nonpoint sources – also known as"load allocations", and 4) Margin of safety. But after developing these TMDLs, a strategic plan with a timeline is needed to achieve these TMDLs. Changes may be made to existing permits, which include improving or enacting "best management practices". (BMPs).

▲ *Point source example.*

Point source polluters must either have a permit to continue dumping, must meet the standards allowed for release, or must not discharge anything that will disrupt the integrity of the water body. Communities can intervene in the permitting process, can file administrative appeals if they feel a point source is not complying with the standards, or they can sue to enforce regulation and monitoring to be performed. Also, the EPA regularly holds public meetings to gather input on the adequacy of water quality standards set.

Under Section 404 of the Clean Water Act (CWA), the United States Army Corps of Engineers (USACE) and Environmental Protection Agency (EPA) jointly regulate the discharge of dredged and fill material into U.S. waters through a permit review process. Individual and general permits are granted by the USACE. Permit applicants must prove they have taken steps to avoid wetland impacts where practicable, minimized potential impacts to wetlands, and provided compensation for any remaining, unavoidable impacts. Section 401 of the CWA gives the state the authority to review and approve, condition, or deny all Federal permits that might result in discharge to State waters.

See www4.law.cornell.edu/uscode/33/ch26.html for full text of the Clean Water Act.

How Does Hawai'i Control Water Pollution?

Hawai'i Revised Statute HRS 342D directs the Director of the Department of Health to "prevent, control, and abate water pollution in the State". DOH "may control all management practices for domestic sewage, sewage sludge, and recycled water, whether or not the practices cause water pollution." In order to comply with this duty, the Director may enact rules under Chapter 91 in order to meet these duties.

With regards to civil penalties: If one violates this chapter, any rule, or any term or condition of a permit or variance issued, they shall be fined not more than $25,000 for each separate offense. Each day of each violation constitutes a separate offense. Administrative penalties may also be imposed.

Negligent violations can incur 1) a fine of not less than $2,500, but not more than $25,000 per day of violation, or 2) imprisonment for not more than one year, or 3) a fine and imprisonment. If a person has been convicted more than once under this chapter, punishment shall be 1) by a fine of not more than $50,000 per day of violation, or 2) imprisonment of not more than two years, or 3) a fine and imprisonment. Negligent violations include: 1) violations of this chapter, rule, condition in a permit or requirement imposed in a pretreatment program; or 2) negligence in introducing any water pollutant or hazardous substance which the person knew or reasonably should have known could cause personal injury or property damage into a sewerage system or into a publicly owned treatment; or 3) other than in compliance with all applicable federal, state, or local requirements or permits, which causes such treatment works to violate any effluent limitation or condition in any permit issued to the treatment works.

Specifically, HRS 342D-50 states that "No person, including any public body, shall discharge any water pollutant into state waters, or cause or allow any water pollutant to enter state waters except in compliance with this chapter, rules adopted pursuant to this chapter, or a permit or variance issued by the director."

What are Hawaii's Water Quality Standards?

(Hawaii's Water Quality Standards, Hawai'i Administrative Rule: HAR 11-54):

Hawai'i has a general policy of water quality anti-degradation: The overall policies include: 1) Protecting existing uses and the level of water quality; 2) Maintain and protect the quality of water in areas where the quality exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation., unless allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located…. ; and 3) High quality waters in national and state parks and wildlife refuge with exceptional recreational or ecological significance shall be maintained and protected.

▲ *Class AA waters: Hanauma Bay.*

These rules classify Hawai'i State waters as inland or marine waters. Inland waters can be fresh, brackish, or saline and are classified based on their ecological or natural characteristics. Fresh waters are classified as following: 1) Flowing waters (streams, flowing seeps and springs, ditches and other flumes that flow into receiving water bodies) 2) Standing waters (lakes and reservoirs) and 3) Wetlands. Brackish or saline waters are classified as the following: 1) Standing waters (anchialine pools or saline lakes) 2) Wetlands and 3) Estuaries. All marine waters are either embayments, open coastal, or oceanic waters. Embayments or open coastal waters are also classified according to the following bottom subtypes: 1) Sand beaches; 2) Lava rock shorelines and solution benches; 3) Marine pools and protected coves; 4) Artificial basins; 5) Reef flats; and 6) Soft bottoms.

Inland and marine waters, including marine bottom ecosystems are further classified according to their uses, and water quality standards for each parameter are developed for each type of use, by general or specific location. Inland waters are comprised of Class 1 and Class 2 waters. The objective of Class 1 waters is to remain in their most natural state possible, with the absolute minimal pollution from human sources. Waste discharge is prohibited in Class 1 waters. Class 1 waters are further divided into Class 1a and1b, where Class 1b uses are limited to scientific and educational purposes and protection of native breeding stock, baseline references from which human-caused changes can be measured. Other allowed uses include compatible recreation, aesthetic enjoyment, and other nondegrading uses. Class 1b water uses are designated for domestic water supplies, food processing, protection of native breeding stock, the support and propagation of aquatic life, baseline references from which human-caused changes can be measured, scientific and educational purposes, compatible recreation, and aesthetic enjoyment. Public access to these waters may be restricted to protect drinking water supplies. Class 2 waters objective is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. These uses must be compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. No discharge is allowed in these waters that has not received the best degree of treatment or control compatible with the criteria established for this class.

Marine waters are comprised of Class AA and A waters. The objective of class AA waters is to remain in their most natural state possible, with the absolute minimal pollution or alteration of water quality from human sources. Waste discharge is prohibited in Class AA waters. No zones of mixing are allowed in Class AA waters to include: 1) Within a defined reef area, in waters of a depth less than 18 meters (ten fathoms) or 2) Within a defined reef area, in waters of a depth less than 18 meters (ten fathoms). The uses to be protected in this class of waters are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and aesthetic

enjoyment. The objective of Class A waters is to protect their use for recreational purposes and aesthetic enjoyment. These uses must be compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters.

Marine bottom ecosystems are divided into Class I and Class II waters. The objective of Class I waters is to remain in their most natural state possible, with the absolute minimal pollution from human sources. Uses of marine bottom ecosystems in this class are passive human uses without intervention or alteration, to allow for the perpetuation and preservation of the marine bottom in a most natural state. This includes uses such as for nonconsumptive scientific research (demonstration, observation or monitoring only), nonconsumptive education, aesthetic enjoyment, passive activities, and preservation. Class II waters uses are such that the protection for propagation of fish, shellfish, and wildlife, and for recreational purposes not be limited in any way.

Basic water quality standards that are applicable to all waters states that "All waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants", including:

1. Materials that will settle to form objectionable sludge or bottom deposits;
2. Floating debris, oil, grease, scum, or other floating materials;
3. Substances that produce a distinguishable taste in the water or detectable off-flavor in the flesh of fish, or in visual observed changes in color, turbidity or other conditions in the receiving waters;
4. High or low temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, or other harmful substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use (see above use classifications) of the water;
5. Substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life (such as an increase in algae); and
6. Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands.

To comply with the above criteria, all state waters are subject to monitoring and standards for acute and chronic toxicity and the protection of human health.

Please read HAR 11-54 for more detail and information.

Why Get Involved?

Volunteer water quality monitoring programs help to build stewardship of local waters. Volunteers learn about the value of our water resources, the types of pollution impacting them and what they can do individually to protect our streams and coastal waters. A water quality monitoring program can help make the connection between watershed health and the health of our oceans, as well as build bridges among the community, businesses and various government agencies.

State agencies have limited funds for monitoring; thus many waterbodies are not monitored on a regular basis. Data volunteers obtain can be used to update the 303(b) list and potentially list a waterbody on the 303(d) list, paving the way for the State to develop TMDLs and an action plan to improve water quality in your area.

Photo by Liz Foote

Photo by Liz Foote

▲ *Westside Maui watershed, photo by Liz Foote*

What is a watershed?

Originally, a watershed was defined as a dividing line between two drainage basins. Presently, according to the United States Environmental Protection Agency, "A watershed is a geographic area in which all sources of water, including lakes, rivers, estuaries, wetlands, and streams, as well as ground water, drain to a common surface water body." In the case of Hawai'i, the watershed areas are all relatively small, and in almost all cases the drainage basins end up in the ocean.

Traditionally, the Hawaiians had a land division system known as the ahupua'a. These were areas that incorporated all the land from the sea to the tops of the mountains. They were developed so that each community would have access to the various resource needed to sustain life: from the sea where fish and seafood could be gathered, into the midlands where water and streams made agricultural pursuits bountiful, to the higher mountains where remaining native forests contained wood and resources for building.

It just so happens that these ahupua'a were often based on the geographical contours of a single valley, or what is now known as a watershed. In other words, here in Hawai'i, watershed areas at one time contained all the resources required to sustain life. While we no longer live in a system that requires sustainability in small areas, we can certainly benefit from keeping the ahupua'a concept alive and well by utilizing the knowledge of the Native Hawaiians.

What is the hydrologic cycle?

The hydrologic cycle is the never ending cycle which water goes through. Whatever water we have here on earth is here to stay; either in water or vapor form, or locked up in the form of ice. In the basic model, it consists of five states: evaporation, condensation, precipitation, infiltration and runoff.

Evaporation is the start of the cycle, where water is taken into the atmosphere in vapor form. When temperature and humidity levels reach a critical state, this causes condensation, usually in the form of clouds. When the clouds cool and can no longer hold the moisture, precipitation occurs. This is in the form of rain, snow, hail, etc.

As the precipitation reaches the ground, a portion of it infiltrates, or soaks, into the ground, while some flows on the surface and becomes runoff. All the while, as this occurs, evaporation and condensation are still taking place.

The water that infiltrates the ground usually goes to replenish the aquifer or water table. This is water that saturates the ground and is held in place by various factors. Meanwhile, the runoff water flows due to gravity in the watershed to streams, ponds, puddles and in Hawaii's case, eventually the ocean. Various models for different areas can calculate the amount water that infiltrates, evaporates and becomes runoff.

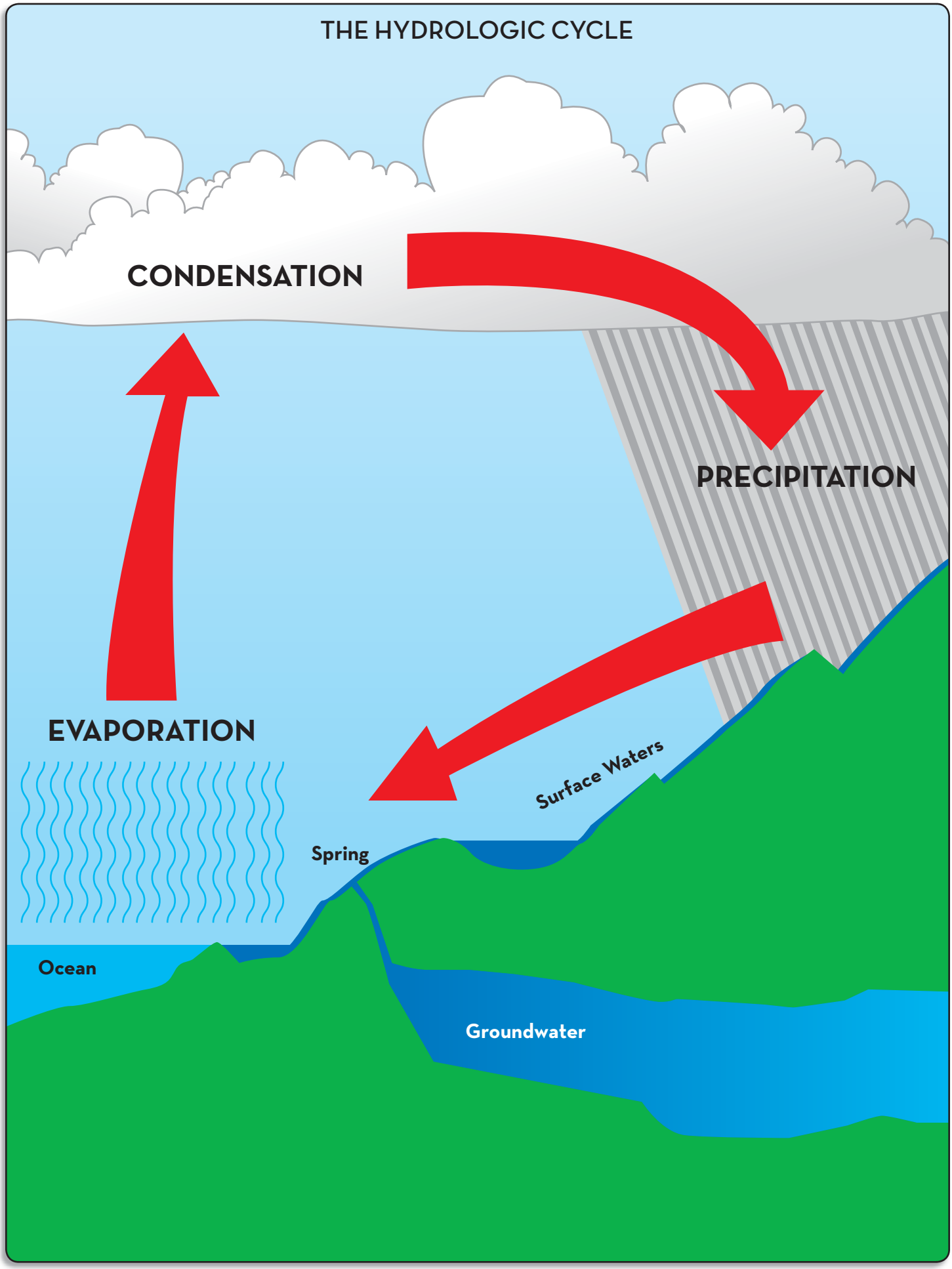
In more complex models, the cycle takes into consideration factors such as transpiration, which is the direct vapor loss from trees and vegetation into the atmosphere. Another variable to be considered is ice, which can temporarily take the water out of the cycle until it melts. For this reason, global warming, which would melt much of the polar ice and re-introduce the water it contains into the hydrologic cycle is a concern, although no one really knows what factor this excess water would have on the cycle. Some scientists feel that the excess water may exacerbate the warming while others believe that it may lessen its effect. In areas with high snowfall, the accumulated snow, also known as snowpack, generally stays throughout winter then gradually melts and, like rain, is taken in as groundwater as well as runoff. Many of the temperate regions of the world are very dependent on this as a source of their water; however, in Hawai'i there are few areas that receive much snowfall so it does not have much of an impact here.

What is groundwater and why is it important?

Groundwater is that water which has already infiltrated the water table. In Hawai'i, it usually forms into a lens shape, floating on the surrounding seawater. The edges of the freshwater lens are always draining into and mixing with the surrounding ocean water. In general, groundwater, due to the filtration process, is cleaner than surface runoff, however various factors come into play including how porous the surface is.

Areas with higher porosity, such as sand or volcanic basalt on the newer islands are very conducive to capturing groundwater, but that same porosity allows bacterial, viral and chemical infiltration as well. In east Hawai'i Island, an area of porous volcanic basalt where cesspools are the norm, high fecal coliform counts in the surrounding inshore waters are common. It is for that reason that septic tank systems, with a leach field (a surrounding area of lower porosity designed to filter out pollutants) have been mandated by law for any property of less than one acre on the Island of Hawai'i.

Areas with lower porosity, found on the more eroded older islands have had the accumulation of soil and eroded volcanic basalt fill in the porous bedrock thus making permeability much lower and percentage of runoff versus infiltrated water much higher. Luckily, the soils of the older islands are much more conducive towards the growth of vegetation than the lava fields of the newer islands.


THE HYDROLOGIC CYCLE
CONDENSATION
PRECIPITATION
EVAPORATION
Surface Waters
Spring
Ocean
Groundwater

SOURCES OF INPUTS INTO WATERSHEDS

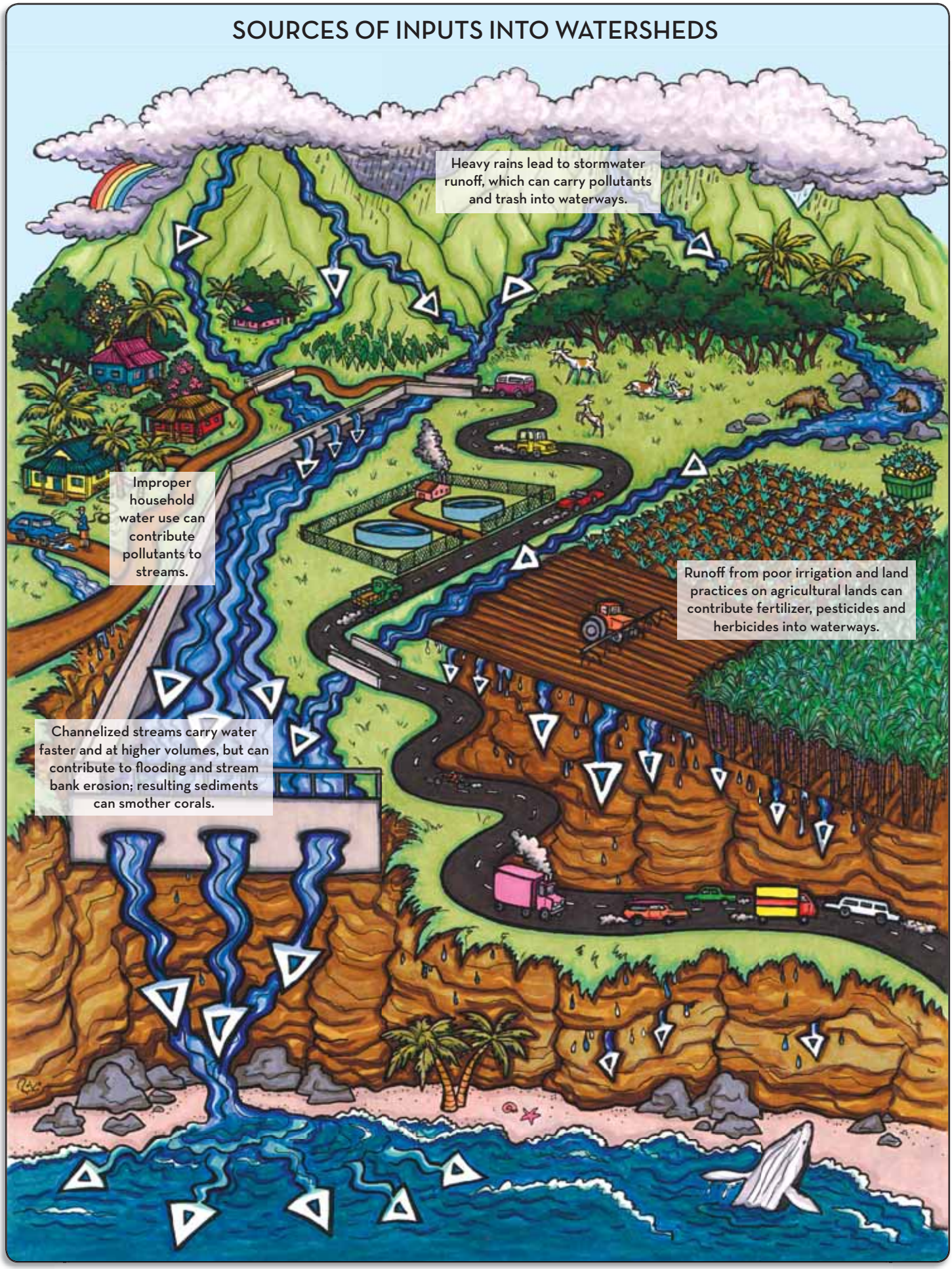


Illustration by Riki Inzano • artbyriki@yahoo.com

Hawai'i Streams

Streams can be classified by three types of general behavior: perennial, or streams that flow year round, nonperennial, or those that flow only intermittently, and ditches, which are man made diversions. These three genotypes of streams can be known by a number of terms including river, creek, crick, gulch, gully, canal, ravine, drainage basin etc.

Perennial streams continuously carry water from the mountains to the sea. Since this can contain pollutants, it is these streams, along with groundwater discharge, that create the base level of pollutants entering the estuaries and sea. In times of heavy rains or flooding, additional pollutants can enter through intermittent streams as well as ditches.

The latter two types of streams (nonperennial and ditches) can be problematic in times of heavy rains, because in the case of intermittent streams, pollutant levels can accumulate for a considerable time before being washed into the stream thus spiking pollutant levels to unacceptable high levels.

In the case of man made ditches, especially those designed just for overflow during floods, the natural features of a stream that slow down the flow of water such as curves and rocks, sand and gravel areas and riparian vegetation, are absent. This allows the polluted water to flow unhindered to the sea. There is one final defense, however, and that is an estuary.

Photo by Jill Komoto

▲ *Moloka'i*

Why is vegetation, like trees and shrubs important?

Generally, healthy ecosystems have a balance with a higher amount of infiltration than runoff. An excess of runoff can cause environmental damage in many ways. These include: direct erosion, transporting pollutants, and not allowing for infiltration, thereby not replenishing the water table.

Vegetation is an excellent way to counter all of the above negative impacts of excessive runoff. Trees, shrubs and grasses can slow down the rate at which water flows along the ground and their roots will also hold the soil in place to prevent direct erosion. They can also catch and trap pollutants before they enter critical areas, and the presence of live vegetation and its resultant organic material can create a sponge-like effect that holds the water and slowly lets it infiltrate the ground.

Photo by Jill Komoto

▲ *Waiulaula Stream, Hawai'i*

As with any generalization, there are instances where vegetation may not actually be the best solution for groundwater replenishment. In some areas with highly permeable surfaces such as sandy areas or volcanic basalt, even without vegetation the infiltration is very high, and the introduction of deep rooted non-native trees has been shown to decrease the water table.

What is an estuary and why is it important?

According to the US EPA, "An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meet and mix with salt water from the ocean. Estuaries and the lands surrounding them are places of transition from land to sea, and although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by such landforms as barrier islands or peninsulas."

Estuaries are an excellent habitat for all manner of flora and fauna: from freshwater plants in the upper regions to salt tolerant plants nearer to the sea, and from birds and animals on

Photo by John Replogle

▲ *Honu'apo Estuary*

land to fish hatcheries and shellfish in the water.

As fresh water flows through the plants in the estuaries some contaminants are trapped and filtered by the plants, the excess nutrients are taken up by the plants, and the slow intermixing of the runoff and seawater acts like a settling pond, where much of the sediments settle to the bottom and don't reach the sea itself.

One prime example of estuarine loss and its effect on the ocean is Waikiki on Oahu. In the past, much of that area was estuarial wetlands, but progress filled in the area and created the Ala Wai canal as the main outlet to the sea.

Coastal environments

Coastal environments include anchialine ponds, tidepools and coral reefs.

Anchialine ponds: Hawai'i is the only state in the USA to contain anchialine ponds. These are brackish ponds that form on lava flats near the sea, and are connected to the ocean by underground lava tubes. Seepage allows some seawater to enter the ponds, which then mixes with the groundwater from the freshwater lens. Due to their isolated nature, unique subspecies of aquatic life have formed over the millennium. Over the years many have been lost due to being filled in for construction projects, and further threatened by introduced exotic fish that throw the whole ecosystem out of balance and kill off the endemic species.

Tidepools: Tidepools differ from anchialine ponds in that they are connected by surface infiltration of seawater. This occurs as the tides rise and fall everyday. While not as ecologically unique as anchialine ponds, tidepools can form a sheltered habitat for many nearshore species as well as areas for people to explore, snorkel in etc.

Nearshore waters: As we see in the case of Waikiki, nearshore environments can be detrimentally affected by loss of the natural mountain to sea flow of the water. Polluted water not only has an effect on the whole nearshore ecosystem, but on the human use of the area. Since this area is heavily used by the public, and is one of the hallmark tourism areas, steps are being taken to lessen the pollution entering the sea.

Photo by Jill Komoto

▲ *Anchialine ponds, Ahihi Kina'u, Maui.*

Photo by Jill Komoto

▲ *Wai'opae Tidepools, Hawai'i*

One experiment being done right now in the Ala Wai is the planting of rafts of aquatic plants that take up the pollutants. While this may not be as effective as natural wetland restoration, it is at least a step in the right direction, and shows that technical solutions can help lessen our impact on the environment. Additional actions such as keeping pollutants off the streets and out of the storm drains, planting appropriate vegetation in denuded areas, taking pro-active steps to minimize sewage releases into the streams, etc. can be beneficial to the health of the nearshore waters.

Physical Parameters:

Physical parameters measure solids, plastics and debris in the water, as well as the color, taste, or heat of the water. This section describes the parameters of salinity (taste), temperature (heat), total dissolved solids (solids) and turbidity (solids- cloudiness). See section 10 for information on visual assessments and assessment of trash.

Conductivity/Salinity

What is salinity and why is it important?

Salts that dissolve in water break into positively and negatively charged ions. Conductivity is the ability of water to transmit an electrical current, and the dissolved ions are the conductors. Salinity measures the amount of salts in the water. Dissolved ions increase both conductivity and salinity, so the two are related. High salinity values can impact ecological value of surface waters and limit usage for recreation, agriculture and industries. Fresh and marine water organisms have very different tolerances to changes in salinity. One cause of increased salinity (in additional to tidal fluxes) is land management practices such as over-clearing of vegetation that increases the recharge of water to groundwater resources. The water table is brought closer to the surface and thus increases the amount of the salt-laden groundwater into the streams or introduces more salt into the stream from runoff. Increases in irrigation or domestic use can also cause the water table to rise and flow can decrease as a result. Corals tolerate a narrow range of salinity values between 30 to 40 parts per thousand.

▲ *Refractometer*

How is it measured and reported?

Conductivity meters: These electronic meters use a probe that applies voltage between two electrodes, spaced a known distance apart, and records the drop in voltage. These meters are best for measuring fresh or brackish waters.

Refractometer: A refractometer measures the ability of the water to refract light.

Hydrometer: The specific gravity, or density, of water is higher when the dissolved solids (salt and other substances) in the water are higher. A hydrometer measures specific gravity which can then be converted to salinity.

Conductivity and salinity results are usually expressed in grams/liter (g/l) or parts per thousand (ppt) for sea water (Pacific Ocean waters are around 32 g/l in winter). In freshwater the term "total dissolved solids" (TDS) is often used for the same thing instead of "salinity". Useful TDS units are milligrams/liter (mg/l) or parts per million (ppm).

What affects it in water?

Rain! In pristine environments, rainwater conductivity equals zero (i.e., the rain is essentially distilled water). Rain falling into a waterbody, or rain runoff flowing into it, will decrease conductivity/salinity.

Minerals: Soil and rocks release ions into the waters that flow through or over them. The geology of a certain area will determine the amount and type of ions. Spring water typically shows higher conductivity than inland rain water.

Ocean Spray: The salinity/conductivity of coastal rivers is influenced by sea spray that can carry salts into the air, which then fall back into the rivers with rainfall.

Tides and mixing zones: A mixing zone is an area where fresh and salt water merge together. In flat areas, water at the stream mouths are often salty because of salt water intrusion during high tides. The flow of streams into estuaries can greatly affect salinity as well as the location of the estuarine mixing zone. This is very important to the survival of estuarine organisms.

Evaporation: Evaporation and loss of fresh water will increase the conductivity and salinity of a waterbody. Warm weather can even increase ocean salinity.

Photo by Jill Komoto

▲ *Fresh and salt water mixing, Kiholo Bay, Hawai'i*

What can I expect to find?

Generally, DOH standards state that salinity shall not vary more than ten per cent from ambient conditions (wetlands, estuaries) or natural or seasonal changes considering hydrologic input and oceanographic factors (all other areas). DOH's website shows values ranging from 1.45 (in a river) to 35.4 g/L (ppt-parts per thousand) during a period in September. Hanalei Watershed Hui reported average salinity values of 1-4 ppt for monitored streams and 29-34 ppt in ocean waters.

Temperature

Why is temperature important?

Many aquatic organisms require clean, cool water for reproduction and growth. Temperature of a water body can vary due to seasonal and diurnal influences. Inflowing water, flow rate, wind speed, air temperature and riparian shade can

Photo by Jill Komoto

▲ *Concrete stream, O'ahu*

all affect water temperature. Concrete channelization of streams to provide for flood control can also increase water temperature and decrease recharge to groundwater due to the impervious surface and removal of a vegetative canopy cover which provides shade. Coral reef bleaching is associated with high temperatures, with concerns of impacts from global warming.

How is it measured and reported?

Temperature strips: These are quick and easy strips which change color to indicate the temperature.

Bulb Thermometers with colored alcohol (avoid mercury thermometers): The thermometer is lowered three inches in the water, and read after 2 minutes.

Temperature probes and meters: These usually come with other meters, such as pH or conductivity. The probe is placed in the water, and the temperature can be recorded separately, or some meters come with data loggers.

Hobo temperature loggers: These data loggers can be placed in the water for continuous measurements. The logger is removed and data is downloaded directly into a computer.

What can I expect to find?

DOH standards indicate generally that temperature shall not vary more than one degree Celsius from ambient conditions. In streams, the temperature shall not exceed 30 degrees Celsius, as a function of recent rainfall events and elevation at the sampling sites. Typical temperature ranges are: coastal waters- ~23° - 27°C (71° - 81°F); streams 16° - 21°C; (60° - 70°F); in streams that have been channelized, temperatures can be found up to 30°C or more (86°F +).

Total Solids

What are total solids and why is it important?

Total solids are elements that are suspended or dissolved in water; the residue that remains after a water sample is evaporated. Solids in water have different attributes and sizes. In stream water, dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other ions particles that will pass through a filter with pores of around 2 microns (0.002 cm) in size. Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter. These are particles that will not pass through a 2-micron filter. Along with turbidity, total solids can be an indicator of poor management practices in construction, agriculture, logging, wastewater discharges and other sources. Total solids can affect the water balance in the cells of aquatic organisms, and chemicals and other toxicants attach to solid particles.

How is it measured and reported?

Total solids are measured in milligrams per liter (mg/L). They are usually measured in a laboratory by weighing the amount of solids present in a known volume of sample. There are some electronic devices on the market, including several by the Onset Corporation.

What can I expect to find?

The State of Hawai'i HAR 11-54 includes water quality standards for total suspended solids: for inland waters there are two different standards, one for the dry season May 1 through October 31, and one for the wet season November 1 through April 30.

Turbidity

What is turbidity and why is it important?

Turbidity is a measure of water clarity. When a water body is cloudy it is often due to the runoff of sediment containing small clay particles or other organic particles and can also be associated with excessive algal growth or point source pollution. Turbidity varies naturally with the soil type, for example a clayey soil is dominated by very small sized clays which remain suspended and cause the water to be turbid for several days. Over clearing of vegetation can result in increased erosion and turbidity in the streams and nearshore waters. Sediment particles suspended in seawater can prevent light from reaching corals and as it settles, can smother them.

Photo by Judy Edwards

▲ *Erosion at Baldwin Beach, Maui*

How is it measured and reported?

Secchi Disk: The observer measures the depth at which the secchi disc is no longer visible. The results are measured in feet or meters. This method depends on the amount of sunlight, shadows and ripples that are in your sample area. Because of this, it can't be used in the surf zone or in short depths.

Transparency tube: The observer views an object or a Secchi pattern through the water in a tube, adding water gradually till the object is no longer visible. The results are measured in centimeters or inches. This can be used anywhere, including the surf zone and is a relative measure of turbidity.

Nepholometer or turbidimeter: This measures how much light is scattered when directed at a water sample. The units are reported in nephelometric turbidity units (NTUs) or Formazin turbidity Units (FTU) which, numerically, mean the same thing.

What affects it?

Natural Factors

- Algae and nutrient loading
- Suspended sediment from erosion and sediment transport
- Seasonal weather, storm events
- Local stream morphology will determine whether sediments are deposited or eroded

Human Factors

- Erosion due to removal of riparian vegetation, changes in stream morphology or stream flow patterns
- Excessive nutrient loading and algal growth

What can I expect to find?

DOH standards for turbidity are different depending on the area. DOH's website shows values ranging from 0 to 41 NTUs during a period in September. Typical values are shown below in table 3.1.

Chemical Parameters

Chemical parameters measure qualities such as how water looks, smells, and tastes. Chemical attributes of water can also affect its toxicity and whether or not it is safe to use.

Chemicals

What are chemical contaminants and why are they important?

Chemical contaminants, like pesticides, herbicides and hydrocarbons, can be extremely toxic to aquatic organisms. Detection of such chemicals could indicate misapplication, leakage or spillage upstream of the monitoring point.

How is it measured and reported?

Chemicals are generally measured and analyzed in contracted laboratory. There are some simple kits available; however these are for educational purposes and do not accurately measure the type and quantity. Values for chemicals refer to the dissolved fraction and are expressed in micrograms per liter. Numeric standards per HAR 11-54-4 are applicable for all Hawaiian waters, and vary by chemical, and category. Categories include: Freshwater (Acute and Chronic); Saltwater (Acute and Chronic); and Fish consumption. The freshwater standards apply where the dissolved inorganic ion concentration (salinity) is less than 0.5 parts per thousand; saltwater standards apply above 0.5 parts per thousand.

What can I expect to find?

A study by the USGS of water quality on Oahu during 1999-2001 found that insecticides used for termite control (dieldrin, aldrin (breaks down to dieldrin), chloradane and heptachlor) and phased out about 1988 were still found in samples that exceed guidelines. In Manoa Stream, dieldrin was detected (0.015 to 0.077 micrograms per liter) more often than other streams sampled and that concentrations were highest during base flow, and remained elevated during

WATER TYPE	TURBIDITY LEVEL
Water bodies with sparse plant and animal life	<0.1 NTU
Drinking water	<0.1 NTU
Typical groundwater	<1 NTU
Water bodies with moderate plant and animal life	1 - 10 NTU
Water bodies enriched with nutrients, supporting large plumes of planktonic life	10 – 50 NTU
Winter storm flows in streams and rivers	20 – 1000 NTU

▲ *Table 3.1: Typical turbidity values.*

storms. Concentrations were still one-half to one-third the concentration in base flow despite the dilution of base flow by storm runoff. This suggests more than one source in Manoa stream: flushed from the soil during runoff, supplied by groundwater inflow or dissolve into the water column from stream sediments.

Dissolved Oxygen

What is dissolved oxygen and why is it important?

All aquatic organisms need oxygen to live. Dissolved oxygen (DO) is the amount of oxygen dissolved in water and is measured in units of mg/L or percent saturation. Milligrams per liter is the amount of oxygen in a liter of water. Percent saturation is the amount of oxygen in a liter of water relative to the total amount of oxygen that the water can hold at that temperature. It varies inversely with temperature, as colder water contains a higher concentration of oxygen. Fluctuations in dissolved oxygen occur throughout the day due to changes in temperature, photosynthesis and respiration of aquatic organisms. Generally dissolved oxygen is highest at noon, due to photosynthesis from algae, and lowest in the evening or early morning hours due to uptake of oxygen through respiration of all organisms in the stream.

Photo by Division of Aquatic Resources

▲ *ʻōʻopu nopili*

How is it measured and reported? (from CWT 2004):

Colorimetric: This method uses a chemical reagent that reacts with oxygen to produce a colored product. The intensity of color is proportional to the concentration of oxygen in the sample and is compared to a series of color intensities that reflect known concentrations of dissolved oxygen. This method is found in most educational kits, is often used for screening low oxygen levels, and provides a quick and rough measurement of DO.

Titrimetric: In this method, samples are collected in a special bottle, with a specially-designed cap (or specially-designed mouth and glass stopper, often sold as "BOD bottle"), that allow for enclosure of liquids without contact with air. The Winkler method is the most common method, which involves fixing the sample with a series of reagents that form an acid compound that is titrated. Titration involves the drop by drop addition of a reagent that neutralizes the acid compound and changes the color of the sample solution. Titrimetric kits are useful for routine monitoring in streams and the sample can be fixed and titrated in the field or fixed and taken to a lab for titration. Most kits use an eyedropper and syringe type titration and is less precise than a digital titrator. If you need a high degree of accuracy and precision, obtain a digital titrator.

Polarographic: This method uses an electronic device that converts signals from a probe placed in the water into units of DO in mg/L. It is useful when many measurements are needed in a short time, or if you'd like to transfer the data directly to a computer. Results are read directly as mg/L, whereas with the titration method, the results must be converted to mg/L.

What can I expect to find?

With cool, fast flowing turbulent freshwater, you can expect to find DO at saturation levels of 9-10 mg/L depending on temperature. In the ocean, you can find a wide range of levels; the Department of Health's website shows values ranging from 4.3 to 7.3 during a period in September. Hawai'i administrative rules standards (HAR 11-54) require values ranging between 60 and 80 percent saturation (depending on the area) determined as a function of salinity and ambient water temperature.

Nutrients

What are nutrients and why are they important?

Plants require both nitrogen and phosphorus for growth; however excessive amounts of these nutrients that drain into surface water can stimulate the production of algae, which reduces the dissolved oxygen content in the water. Some algae can produce chemicals that are toxic to livestock and wildlife. Nitrogen and phosphorus are two of the most heavily applied nutrients in farming operations and the connection to water quality makes good management of fertilizer application crucial. Forms of nitrogen include ammonia, nitrates and nitrites. Excess nitrates can cause hypoxia (low levels of dissolved oxygen)

Photo by Jen Smith

▲ *Algae at Kahului Harbor.*

and become very toxic to aquatic animals at high concentrations (10 mg/L or higher) under certain conditions.

Organisms on coral reefs require nutrients; very low concentrations of nutrients occur in coastal waters. High concentrations can cause phytoplankton and algae blooms and may indicate contamination from bacteria, which sources include pollution from sewage, agriculture and industrial runoff.

How is nitrate-nitrogen measured and reported?

Cadmium reduction method: The cadmium reduction method is a colorimetric method that involves contact of the nitrate in the sample with cadmium particles, which cause nitrates to be converted to nitrites. The nitrites then react with another reagent to form a red color whose intensity is proportional to the original amount of nitrate. The red color is then measured by comparison to a color wheel with a scale in milligrams per liter that increases with the increase in color hue. The color wheel should be used only if nitrate concentrations are greater than 1mg/L. For concentrations below 1mg/L, a spectrophotometer should be used.

Nitrate electrode method: This method uses a probe with a sensor that measures nitrate activity in the water. Accuracy of this meter can be affected by high concentrations of chloride or bicarbonate ions, as well as fluctuating pH levels.

What can I expect to find?

DOH standards for Nitrate + nitrite nitrogen and total nitrogen vary depending on the area. Natural levels of nitrates or ammonia are low, less than 1 mg/L; however in the effluent of wastewater levels can be as high as 30 mg/L.

How is phosphorus measured and reported?

Monitoring for phosphorus is difficult because it involves measuring very low concentrations down to 0.01 mg/L or lower. But even low concentrations of phosphorus can have dramatic impacts on aquatic ecosystems. Less sensitive methods should be used only to identify serious problem areas.

Ascorbic acid method: In this method, a combined liquid or prepackaged powder reagent is added to either 50 or 25 mL of the water sample. This reagent colors the sample water blue in proportion to the concentration of orthophosphate in the sample. Absorbance or transmittance is measured after 10 minutes but before 30 minutes using a color comparator or an electric meter. Color comparators are useful for identifying heavily polluted sites with high concentrations (greater than 0.1 mg/L). Matching hues can be very subjective and lead to variable results. A field spectrophotometer or colorimeter is recommended for accurate determination of low concentrations (between 0.2 and 0.02 mg/L).

What can I expect to find?

DOH standards again vary depending on the area. In the UH study of the Waimanalo-Kailua area, researchers found phosphate levels ranging with geometric means of 2.75 to 27.97 ug/l (streams); 10.38 to 40.11 ug/l (estuaries); 2.75 to 9.86 ug/l (marine).

pH

What is pH and why is it important?

The pH measures acidity and alkalinity of water, with a pH below 7 indicating acidic conditions, and above 7 indicating alkaline conditions. Changes in pH could be due to erosion of some types of geological features or effluent from wastewater treatment plants. Low pH levels present a problem for most organisms with the exception of bacteria, which can survive pH levels as low as 2.0. Some species of fish and aquatic life are more sensitive to low pH levels than others.

While pH is unlikely to change much over time, a change in pH in coastal waters can indicate the presence of a new source of pollution or indicate an increase in pollution from an existing source.

How is it measured and reported?

Soluble indicator: These indicators are used in liquid indicator kits where some type of concentrate is added to the water and the color is compared to a pH scale. See method #1 for a description of its use. This method is also found in litmus strips that contain the liquid indicator and bleed out when dipped in the water solution. The litmus strips are good for a laboratory or in a class exercise and not recommended for environmental conditions.

Colorfast indicator strips: These are non-bleeding strips made of absorbent paper where the indicator molecule has been chemically linked to the paper and does not bleed out. These can be used in environmental conditions.

Colorimeter: This method uses a vial filled with the sample water, to which a reagent is added. The sample changes color and is compared to a color wheel or spectral standard. The colorimeter can be used for grab sample measuring, but not continuous measuring.

pH meter: A meter is recommended for precise and continuous measurement.

What can I expect to find?

DOH standards indicate that pH levels shall not vary more than 0.5 units from ambient conditions and be within a certain range, depending on the area. The pH usually varies in the ocean surface waters between 7.5 and 8.5 depending on the relative importance of photosynthesis versus respiration.

Trace elements

What are trace elements and why are they important?

Trace elements such as zinc, chromium lead etc. are natural elements used in industrial processes which can be toxic to aquatic life. Groundwater and wastewater treatment plants are required to monitor these elements regularly to indicate possible contamination in the watershed. Some metals such as mercury or lead can bioaccumulate (net accumulation

of contaminants from air, water and solids) in the fish that humans eat.

How is it measured and reported?

Trace elements are generally measured and analyzed in a contracted laboratory. There are some simple kits available; however these are for educational purposes and do not accurately measure the type and quantity. Values for trace elements refer to the dissolved fraction and are expressed in micrograms per liter. Numeric standards per HAR 11-54-4 are applicable for all Hawaiian waters, and vary by metal, and category. Categories include: Freshwater (Acute and Chronic); Saltwater (Acute and Chronic); and Fish consumption. The freshwater standards apply where the dissolved inorganic ion concentration (salinity) is less than 0.5 parts per thousand; saltwater standards apply above 0.5 parts per thousand.

What can I expect to find?

A study by the USGS of water quality on Oahu during 1999-2001 found that trace elements were elevated above background levels (the concentration found in the natural environment without human influences) in streambed sediments in urban and agricultural areas. For example, the elements of barium, cadmium lead, tin and zinc were found at urban sites (lead and zinc exceeded guidelines at 50 and 75 percent of urban sites, respectively); arsenic was greatest at agricultural sites (exceeded aquatic life guidelines 67% of agricultural sites). Urban sources include vehicular traffic (lead from leaded gas; barium, cadmium and zinc from tire wear). A potential source of arsenic is fertilizer. Even though leaded gasoline and lead-based paints were phased out in the 1970s, lead tends to accumulate in soils, stays around for a while and ends up entering streams and coastal areas during runoff.

Biological parameters

Biological parameters measure living organisms, including disease pathogens (i.e bacteria) and toxic organisms (dinoflagellates that cause algal blooms)

Bacteria

What are bacteria and why are they important?

Water contaminated with fecal matter may contain pathogens (bacteria and other micro-organisms that cause illness). Many pathogens are difficult measure in water samples. Certain bacteria, however, are relatively easy to measure in water samples and, if present, are used to measure the level of fecal contamination. These are called indicator bacteria. The State Department of Health uses *enterococci* (EPA approved) as an indicator of sanitary quality of water for drinking and recreational use like swimming or surfing. *Clostridium perfringens* is monitored as a secondary indicator. Both **enterococci** and *C. perfringens* are found in the intestinal tract of both humans and animals. Its presence is a good indicator of recent or past fecal contamination in water and spores survive well beyond the typical life-span of other fecal bacteria. Some organizations monitor for Eshcerichia coliform (E. Coli), fecal coliform or total coliform, especially in streams. Total coliform is a collection of microorganisms that aid in the decomposition of organic material. Where total coliform is found in water, testing is also conducted for E. Coli and fecal coliform. E. Coli is a type of fecal coliform that is associated with human or animal waste and can originate from the presence of large congregations of birds, livestock, dogs, septic systems or non-treated human waste.

How is it measured and reported?

Bacteria is reported in:

Colilert 18 method: This method tests for Total Coliform and Eshcerichia Coliform (E. Coli). EPA recommends testing for enterococci instead of Total coliform and E. Coli for salt water testing.

Enterolert testing: This method tests for enterococci using the Quanti-Tray sealer or 5 or 15 test tube method. The Enterolert reagent is used for the detection of enterococcus bacteria in fresh and marine water.

Millipore Test ("paddle test"): This is a test used by students but not by Surfrider chapters, as the results are unreliable. It can be used as a screening method to determine whether a problem exists at a site.

Quanti-Tray: IDEXX is a company that supplies water quality testing materials and has created the Quanti-Tray that improves the accuracy, reduces sample contamination and eliminates the need for the use of disposable test tubes. This is an EPA approved method.

What can I expect to find?

Department of Health (DOH) enterococcus standards are usually reported that a geometric mean should not exceed X amount per 100 per one hundred milliliters, where not less than five samples which shall be spaced to cover a period between 25 and 30 days. There is also a single sample limit. This depends on the location. You can find a wide range of levels; a look at the Department of Health's website (http://emdweb.doh.hawaii.gov/CleanWaterBranch/WaterQualityData/default.asp); a look at one period found samples ranging from .8 to 880.

Photos by Jill Komoto

▲ *Dogs and cows are some of the sources of E-coli.*

Define your goals

Before embarking on a volunteer monitoring program, you need to define your goals. Ask yourself- why, what, who, where, when and how. Write down these questions, and provide your answers. Use this list to determine what monitoring program level you should be in (See Section 5).

Why do you want to monitor?

- Do you have a question that needs answering?
- Do you want to educate people about water quality and make them more aware of how they can protect the areas they swim, fish, paddle or play in?
- Do you want to know whether water quality is improving or diminishing?
- Do you want to know whether land use activities are having an impact on the water you drink, surf, swim, fish or paddle in?
- Do you want to see what lives in the waterbody you are interested in?

What do you want to do with the monitoring results?

- Do you want to educate students and the local community about why clean streams and oceans are important to the health of the environment?
- Do you want to identify actual or potential sources of pollution?
- Do you want to provide high quality data to assist local agencies in monitoring the health of your waterbody?

Photo by Jill Komoto

▲ *Kamehameha Schools*

Who is going to use the data?

- Students and teachers.
- Local communities.
- Your watershed group for preparation of a management plan
- Landowners
- Local, State and Federal agencies.

Where are you going to monitor?

While you may be interested in the health of the water at a beach, you must also think about what other sources of water enter the area. See Section below.

This not only includes the waterbodies itself, but exact locations are where you are going to monitor.

Is this a public area? Will you need landowner permission?

Is it a culturally sensitive area?

When will you monitor?

This can depend on why you want to monitor. Do you want to see what the water quality is after a storm?

A restriction on when you will monitor can depend on the availability of both volunteers funding and equipment. If you have all readily available, then you can monitor more frequently.

How will you monitor?

This depends on why you want to monitor and who is going to use the data you provide. See section 5 for an introduction to the three types of programs/protocols you will use depending on the questions you want to answer.

Gather information about your water body

This can include pictures, research in the library or internet, contacting government agencies (like DLNR, Department of Health, EPA), or talking story with local residents. Take a walk along the stream or beach and take notes and pictures of what you are seeing. What problems have been identified in the water body? Find historical photos and compare with current photos. Is the waterbody listed as impaired by the DOH? Check out the Department of Health, Office of Environmental Planning list of impaired water bodies: http://www.hawaii.gov/health/environmental/env-planning/index.htm The information you gather can be used to develop a monitoring program that will the gaps with regards to knowledge about the waterbody or fill an agency/landowner need.

Some resources that are available include:

- State of Hawai'i Water Quality Studies database Environmental documents, such as Environmental Assessments, Environmental Impact Statements, watershed assessments. Check out the State library catalog.
- Another good source is the U.S Geological Survey (USGS) Pacific Islands Water Science Center which has conducted several studies in streams and marine waters around Hawai'i. http://hi.water.usgs.gov/
- Surf your watershed! EPA provides a website where you can find information about the watershed you are interested in. You can input your city, zip code, stream or county. From there you can find out about the causes of impairment, water use data and even use Enviromapper to map out your watershed! http://cfpub.epa.gov/surf/locate/index.cfm
- STORET (short for STOrage and RETrieval) is a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. http://www.epa.gov/storet/

- The Surfrider Foundation provides an annual State of the Beach report with regards to the health of our nation's beaches. This includes information on surf zone water quality, beach erosion, beach ecology and other indicators of beach health. http://www.surfrider.org/stateofthebeach/home.asp
- Talk to kupuna about the area. What do they remember?

How much funds do you have?

The amount of funds you have may limit the types of monitoring you can do. Try partnering with other organizations to obtain access to funding and/or equipment. EPA Region 9 has a volunteer equipment loan program; you can test out various types of equipment and pay for shipping. Other local organizations like the Surfrider Foundation, Digital Bus, Hawaiian Islands Humpback Whale National Marine Sanctuary and Department of Health may have equipment for loan as well. One tool developed by Boise State University assists organizations in determining their funding needs to meet the goals and objectives of their watershed program plan. http://efc.boisestate.edu/efc/Tools/Plan2Fund/tabid/104/Default.aspx

Where can I find funds?

Appendix D has list of some grant possibilities. It can depend on what and where you are monitoring or if there are endangered species present. Volunteer monitoring programs are best run when they are funded by a diverse range of funding types- private foundations, local, state and federal agencies, individual donors or through annual fundraisers.

How much experience do you have?

If you don't have any experience in water quality monitoring you'll want to seek technical assistance. Locate someone who has started a program that you are interested in. A good place to start is local schools, University of Hawai'i Sea Grant local offices, or DOH. Check with DOH to see if your island has a volunteer monitoring or other representative to help you.

Photo provided by Jeff Zimpfer

▲ *Obtaining help from the experts.*

What is your time commitment?

A more stringent monitoring program will require more time and energy from your volunteers. They may be asked to sample during storm events. You will also need time to develop data databases, input and analyze data, and write reports. Public outreach to the community, resource agencies and local media is critical for the success of your program, and it takes time to develop these relationships.

Photo by Signe Opheim

▲ *Alien Algae Cleanup Day*

Other events to protect water quality

The Great North American Secchi Dip In

The goal of the Secchi Dip-In is to increase the number and interest of volunteers in any type of volunteer monitoring. The Dip-In also demonstrates the ability of volunteers to collect environmentally important information on lakes, rivers and estuaries and gives a national perspective of water quality. The process is simple and is considered a snapshot of transparency of the particular water body for that date and time: individuals take a transparency measurement on one day during the weeks surrounding Canada Day and July Fourth. Individuals may be monitoring lakes, reservoirs, estuaries, rivers, or streams, using a secchi disk, transparency tube or turbidity meter. (See Section 9 for protocols and description). http://dipin.kent.edu/

Photo by Megan Webster

▲ *World Water Monitoring Day*

World Water Monitoring Day

World Water Monitoring Day (WWMD), held annually between September 18 and October 18, is an international outreach program that builds public awareness and involvement in protecting water resources around the world. Volunteers in communities worldwide monitor the condition of local rivers, streams, estuaries and other water bodies using simple kits that measure temperature, pH, turbidity and dissolved oxygen. http://www.worldwatermonitoringday.us/

International Coastal Cleanup

The Ocean Conservancy sponsors an International Coastal Cleanup day each year where trash is collected from streams, lakes, beaches and underwater. Each area has a local coordinator, who collects data such as number of people participating, pounds of trash collected and the type and category of marine debris. http://www.oceanconservancy.org/site/PageServer?pagename=press_icc

Alien Algae Cleanup

The University of Hawai'i- Manoa Marine Option program currently coordinates A'ohe Limu'e, utilizing dozens of volunteers, including SCUBA divers, snorkelers, boogie boarders, and a chain of volunteers on the beach to remove invasive algae, such as *Gracilaria salicornia* from reefs. Currently held in Waikiki, the program may be expanding.

Storm Drain stenciling

Storm drain stenciling uses a design with a fish, or other marine animal with a message that everything that is dumped in the drain, ends up in the ocean. The City and County of Honolulu offers storm drain stenciling kits with the clean water reminder, "Dump No Waste, Protect our Waters … For Life." The stencil also includes the City mascot, the o'opu, since it is recommended for use as a biological indicator of stream water quality. Check out: http://www.cleanwaterhonolulu.com/storm/hero/stenciling.html

The Maui chapter of the Surfrider Foundation offers a storm drain stenciling program for middle and high school students: http://www.surfrider.org/maui/

Marine debris cleanup

The Hawai'i Wildlife Fund, in partnership with several agencies and businesses, have been conducting a community marine debris cleanup since 2003 on the island of Hawai'i. Individuals and community groups come out to pick up trash, which includes fishing ropes, nets and buoys, thousands of pieces of plastic, rubber, styrofoam, aluminum cans, and even anchors. The nets and ropes are collected separately and shipped via a donated Matson container to Honolulu for burning in the H-waste plant. In 2003, over 50 tons of debris were collected by 150 people. Contact Bill Gilmartin of the Hawai'i Wildlife Fund at PO Box 70, Volcano, HI 96785.

Adopt-A-Stream/Reef/Highway

Clean Water Honolulu (CWH-City and County of Honolulu) sponsors a Clean-a-Reef program that coordinates with dive clubs and other volunteers to collect garbage from the reef throughout the year. CWH also sponsors an Adopt-a-Stream program to work with communities to keep their local streams free from garbage. Groups are required to conduct clean-ups four times a year and a sign is installed indicating their support. They receive training, materials and other resources to assist in the quarterly cleanups.

The State of Hawai'i Department of Transportation sponsors an Adopt-a-Highway program. See what you can do to reduce litter than can eventually end up in the ocean. http://www.state.hi.us/dot/highways/Adopt-Highway.htm

Snapshot day

In Fall 2008, the Malama Kai Foundation and the Hawaiian Islands Humpback Whale National Marine Sanctuary partnered together to develop a "Snapshot Day" program to get people involved in monitoring their local waters. Each island held a training session, the volunteers monitored basic parameters on one selected day, and then reported their results and what they learned to the community. See Appendix B for contact information.

Introduction

Now that you've thought about why you'd like to monitor, consider the three levels of monitoring that you can be involved with: Community Awareness, Community Involvement and Community Assessment. Each section below describes why you might want to consider monitoring at that level, a list of activities that may be involved, tasks for developing your monitoring program, and suggested protocols that you might want to consider from Section 9. See Table 5.1 for an overview of protocols.

COMMUNITY AWARENESS

In Section four, you defined your goals, and asked yourself why you want to monitor. If the main answer to the question "why" was to educate and build awareness of water quality issues, then you should select this level of volunteer monitoring. This level would be well suited to schools or individual classes to educate them about water quality, the importance of clean water, what are watersheds and the impacts we have on the ocean from our daily lives. You may also not have the time or monies available for regular monitoring, and perhaps would prefer to participate in annual events such as World Water Monitoring days as described in Section 4. Even if you want to learn about what lives in your water body, this program gives you some basic protocols to follow. You will help to build community awareness about water quality issues and how human impacts in the watershed will affect oceans and what they can do about it.

Photo by Megan Webster

▲ *Sample kit for World Water Monitoring Day.*

Here is what may be involved with this level:

- Utilization of simple kits to monitor water quality and teach people about what the different parameters indicate about the health of the water body or watershed.
- Select whatever water body is convenient and safe for access.
- Simple lettuce bioassay analysis (good exercise for students)
- Ways to spot pollution hot spots.
- Taking a dip net sample of fish and invertebrates in the stream and identifying them.
- Beach cleanups, and counting key types of marine debris.
- Tips on how to protect water quality in the household.

Planning for a one-time or annual educational event:

Whether for school or for the general community, planning for monitoring should still be done. Look at your checklist that you've created from Section four: who will use the data and who is your audience; how much funds you have; where you will monitor; when you will monitor; how you will monitor.

Photo by Liz Foote

▲ *REEF Survey and Water Quality Monitoring one day event.*

Tasks to consider:

- Develop a budget: you still need to figure out how much it will cost to conduct your awareness event or project. Some budget considerations include:
  - How will you obtain your equipment? Ask your local State Department of Health for possible connections. The Environmental Protection Agency, Region 9 has an equipment loan program for volunteer programs, but you must pay for shipping. Contact Amy Wagner at EPA Region 9 Laboratory: http://www.epa.gov/region09/lab/contact.html See below for suggestions on protocols/equipment in Section 9. If you are ordering equipment, order at least 2 weeks ahead of the event; shipping to Hawai'i can be expensive. See if you can coordinate your event with others on your island to share in shipping costs.
  - Will you need transportation? Is there enough parking for volunteers (encourage carpooling, cycling or walking) or if using a bus, is there room for a bus to turn around?
  - Outreach materials: There is a variety of outreach materials available for your use. See Appendix B for a list of materials.
  - Marketing your event: Many papers provide free listing for community events, (if your target group is the general public!)

- Where will you conduct your monitoring? Choose an area that has easy access to the waterway, with restroom facilities nearby. Find a public place if possible, like a State or County park.
- Recruit assistants! Recruit as many trainers as you can- especially if you have several people coming. Ensure that at least one of the trainers has first-aid/CPR training, or make sure that it is a park with lifeguards (if at the beach).
- Recruit your volunteers! Who is your target group?
- Select a date for both a presentation and in-the field training.
  - Locate a facility to give a presentation; many schools or local community centers offer their facilities free to community groups.
  - Give a presentation about water quality monitoring, including watershed basics, why we monitor, what the various parameters indicate. You may want to ask someone from the University, local nonprofit or resource agencies like USGS or NRCS to give the presentation.
  - Make sure you allow enough time to schedule the field trip (if for a school), and obtain all necessary permissions- including from parents/legal guardians.
  - Have a plan "B" in case of illness by the trainer(s), bad weather or natural disaster. This may include selecting alternate sites or postponement. Exchange cell phone numbers with key organizing personnel in case of the need to implement plan "B".

Photo by Megan Webster

▲ *Little things to bring.*

Little things that you should always remember to bring:

- Garbage bags
- First aid kit
- Buckets
- A folding table
- Paper towels
- Your sampling equipment/kits
- Drinking water
- Soap (bar, not liquid)
- Distilled water (if using kits)
- Sunscreen, hat
- Gloves
- Safety goggles
- Measuring beakers or small cups for pouring sample water

Protocols to consider:

Please read sections on safety (Section 8) and collecting samples (Section 9, M1-M6).

Protocols suitable for this level:

- **Section 9:**
  Conductivity/Salinity: P1, P2
  Temperature: P4, P5
  Turbidity: P8, P9, P10
  Chemicals: C1
  Dissolved Oxygen: C2, C3 (high school and higher)
  Nutrients: C5, C6 (high school and higher), C7, C8 (high school and higher), C9 (high school and higher)
  pH: C11, C12, C13 (high school and higher)
  Bacteria: B1, B2
- **Section 10:**
  Rapid assessment of fish and invertebrates in the stream: S6 (without taking a flow instrument. Identification of aquatic species only)
- **Section 11:**
  Rainfall: W1
  Pollution hotspots: W2
- **Section 12:**
  Ocean and currents observations: O1
  Identifying aquatic invasive species: O2

COMMUNITY INVOLVEMENT

If the answer to "why" in section 4 in defining your goals was to get people involved in stewardship of nearby waters, then you should select the protocols in this program. Use this method if you want to assist local agencies in monitoring the health of your water body, by alerting them of possible problems. The agency may send their technicians to conduct additional tests to determine the source of the problem. Data can also be used for providing information on what waters are or are not safe for recreation at any point in time. Even still, you may want to start with a few parameters and build your program as you gain experience. This level may include some more expensive monitoring kits, and individual sampling devices for in situ (in the field) monitoring. At this level you may want to extend your monitoring to looking at watershed health, looking for erosion hotspots, persistence of invasive plants and/or measuring rainfall.

Here is what may be involved with this level:

- Planning ahead- where when and how to monitor. Utilizing standard operating procedures. This may include the use of replicate samples to ensure reliability of the results and control samples. Control samples are usually used with distilled water to see if there are problems with the equipment, process/protocols or handling of the sample.
- Site selection required before going out in the field.
- Training can be informal.

- Calibration of equipment needed.
- Use of more expensive monitoring kits and electronic sampling equipment
- May use a contracted laboratory for analysis of samples.
- Data management and analysis skills- ability to store and analyze data
- Presenting your results to others

Planning your monitoring program

Here is a summary of steps to consider when planning your monitoring program:

- Establish relationships with local resources agencies
- Gather information about your water body.
- Determine where, how often, what you want to monitor and what protocols to use
- Identify landowners and obtain necessary permissions to monitor
- Determine data management needs
- Develop a budget
- Hire a project coordinator
- Develop standard operating protocols
- Develop team leaders and recruit volunteers
- Create a field kit with checklist

Getting started:

As you begin planning your monitoring program, start developing a relationship with the local resource agencies to find out what their needs are. Resource agencies such as DOH or DLNR can lend support, credibility, additional training, equipment and sometimes funding in collecting data. By including resources agencies at the start of your project, can help ensure that your data gets used. They can also help you fine tune the protocols listed in this manual to meet their standards so that your data is useful.

Additional information gathering

Look at your checklist that you've created from Section 4: who will use the data and who is your audience; how much funds you have; where you will monitor; when you will monitor; how you will monitor, and what you will monitor. You may need to do some additional research on the water body you are interested in monitoring. Is your water body listed as "impaired" by the State Department of Health under the Clean Water Action Section 303(d)? Are there any species of concern in your watershed or water body? This includes aquatic wildlife and insects, birds, marine mammals or sea turtles. Does the water body empty into a marine managed area? Check out the Division of Aquatic Resources website at: http://www.hawaii.gov/dlnr/dar/fish_regs/index.htm

Selecting your monitoring sites and establishing a schedule:

Identify the landowners, and obtain permission to access their property. Walk the stream length or coastal area to determine sampling/surveying locations. Some areas you might want to consider include: coastal confluences (where streams/rivers enter the ocean), main stem (the principal waterway of a river/stream, excluding its tributaries) sites, tributaries, paired studies of upstream and downstream sites, before and after monitoring on a single site tied to some event. You may want to establish sampling sites above and below areas of special interest, like storm drains, stream junctions, or effluent outlets. If you have a GPS unit, take coordinate readings for the site. Think about access and safety issues with regards to getting to the site, if high stream flows or tides might influence the site, and whether or not the site can easily be located years after your monitoring program is completed. Also write down a description of the area, with explicit directions on how to get there. Write down the altitude as well- you'll need this for calibrating the DO meter.

If sampling more than one stream, color-code the streams. All sampling/surveying material would be coded in that streams' color.

Establish a sampling schedule. Sampling reports should be handed in at a set time each month. A sample report includes a cover page, maps, survey forms, all types sampling forms, photographs and any other relevant information.

Data management plan

You'll need to create a plan on how you will record and archive your data. See Section 7 for more information on data management.

Develop a budget

After talking to resource agencies and doing some additional research on your water body, you have found out what you will be monitoring. Now you'll need to figure out a budget and obtain funding. The field manual includes some recommended equipment, with estimated costs (without shipping- shipping will vary depending on the company. Costs for equipment change frequently). Funding resources can be found in Appendix D. Think about the long-term sustainability of the program to develop a strategy for maintaining the program.

Some budget considerations, which depend on the monitoring protocols that you choose:

- Project coordinator
- Water quality monitoring equipment
- Safety supplies such as: first aid kit, gloves, safety goggles
- Monitoring extras such as: Buckets, tables, clipboards, pens, waterproof paper, scissors
- Facility to give presentations and demonstrations to the community (many will offer facilities for free for volunteer groups)
- Projector (check with your local resource agency or nonprofit

organization to see if you can borrow one)
- Screen (may be necessary)
- Extension cords
- Computer, with spreadsheet and word document software
- GPS unit
- Outreach and marketing materials- printing, website, graphic layout, database design
- Volunteer supplies, such as food, water, giveaways
- Project and volunteer coordinator time:
  - Giving presentations
  - Training
  - Overall coordination
  - Monitoring day
  - Data management
- Estimate value of volunteer time:
  - You'll need this when applying for grants, documentation of match (either cash or in-kind services). If a volunteer is providing specialized services, then use the charts provided by the Bureau of Labor Statistics at http://www.bls.gov/bls/blswage.htm. The website at http://www.independentsector.org/programs/research/volunteer_time.html provides the value of volunteer services- use the most current year value. Volunteer time can include: time to attend presentations, training and actual monitoring; experts providing technical support.
  - Estimate value of in-kind: This includes donating the use of equipment. You can use what it costs to rent the equipment, or what it would cost to purchase it. If someone is donating the equipment, include the fair market value as well.

If you need help in writing a grant, check out the resources provided in appendix D.

Hire a project coordinator.

A project coordinator is critical for managing volunteers, the budget, the data management system and maintaining relationships with agencies and other monitoring groups. While the project coordinator can be a full-time job, he/she will probably start part time as you build your program.

Good qualities for a coordinator to have: 1) Organized 2) Good computer skills, including documents, spreadsheets, presentations and use of the internet 3) Ability to work with a variety of people 4) Good public outreach and marketing skills 5) Ability to work under pressure 6) Grant writing ability and 7) Good sense of humor.

Develop standard operating protocols.

Start with the protocols listed in this manual. You may need to change some of the protocols depending on logistics of your monitoring program, location or use of different equipment. When using new equipment, read all instructions carefully prior to actual training and monitoring, including the safety instructions. Your standard operating protocols should include:

- General safety
- General sample collection
- Monitoring protocols, per parameter
- Custodial and handling procedures (including transportation and disposal of reagents, or hazardous materials)
- Basic data management

Develop Team Leaders and recruit volunteers.

Train leaders who can train volunteers. All Team Leaders must complete at least two hands-on-training sessions on monitoring. Topics include: general hydrology, ecology, safety, quality assurance and quality control measures, sampling procedures, field analytical techniques, and data recording. Leaders train the volunteers and must also participate in semi-annual quality control sessions, which allow for the groups to check the accuracy and precision of their equipment and testing techniques. See Section 6 on volunteer management.

Photo by Liz Foote

▲ *Water quality field kit.*

Fieldwork preparation

Create a field kit for your volunteer monitors:

Binder with:
- Ample supply of blank field data sheets
- Sheets for calibration records
- Copies of previous field data sheets
- Field manual for all protocols
- List of monitoring locations with GPS coordinates
- Checklist for supplies to bring
- Any other stuff that the group wants to have

Field Gear:
- Sampling apparatus
- Weight for apparatus
- Whirlpaks, Sample bottles or Bucket for getting sample water
- Pole, beaker, bucket, rope for deep water sampling.
- Yardstick or measuring tapes
- Measurement Instruments and kits
- Paper towels

- A jug of distilled or deionized water (DI)
- A spritz (squirt) bottle for DI
- Plastic cups (e.g., solo 9oz clear plastic) for temporary sample containers or for dilutions
- One 500-1000 ml container with WIDE MOUTH and tight cap (for garbage liquid that needs to be flushed into the sanitary sewer)
- Plastic bags for solid garbage
- Safety Goggles
- Gloves
- Permanent marker
- Spare batteries for pocket meters
- First Aid Kit
- Soap (bar, not liquid)
- Drinking water
- GPS unit
- See specific protocols for list of gear and create a specific field gear supply list for binder

Protocols to consider:

Please read sections on volunteer management (Section 6), data management (Section 7), Transportation and safety (Section 8) and collecting samples (Section 9, M1-M8).

Protocols suitable for this level:

- **Section 9:**
  Conductivity/Salinity: P2, P3
  Temperature: P5
  Total Dissolved Solids: P6
  Turbidity: P10, P11
  Chemicals: C2
  Sending samples to the lab: TDS (P7); Nutrients (C10); Bacteria (B4)
  Dissolved oxygen: C3, C4
  Nitrate: C6
  Phosphate: C8
  Nitrogen-Ammonia: C9
  pH: C13, C14
  Bacteria: B2, B3
- **Section10:**
  Stream flow: S1, S2, S3a, S3b
  Visual observations: S4
  ōpala: S5
  Rapid assessment of fish and invertebrates: S6
- **Section 11:**
  Rainfall: W1
  Pollution hotspots: W2
- **Section 12:**
  Ocean and weather measurements: O1
  Aquatic invasive species: O2
  Coral bleaching and marine disease: O3

COMMUNITY ASSESSMENT

If the answer to "why" in Section 4 in defining your goals is to provide data for a watershed management plan or other resource planning effort, then you will want to select the protocols in this level. This level may be used to monitor long term health of the waterhsed, or coastal area you have selected.

Here is what may be involved with this level:

- Planning ahead- where when and how to monitor. Development of standard operating procedures and a QAPP approved by the Department of Health.
- Fixed monitoring stations for long term monitoring of trends.
- Formal training required.
- Calibration of equipment needed with proper documentation
- Test kits with statement of accuracy on file with Quality Assurance Project Plan (QAPP)
- Annual equipment inspection with log.
- Use of a lab for analysis of samples.
- Data management and analysis skills- ability to store and analyze data

Planning your monitoring program

Here is a summary of steps to consider when planning your monitoring program:

- Establish relationships with local resources agencies
- Gather information about your water body.
- Determine where, how often, what you want to monitor and what protocols to use
- Identify landowners and obtain necessary permissions to monitor
- Determine data management needs
- Develop a budget
- Hire a project coordinator
- Develop Quality Assurance Procedures Plan (QAPP)
- Develop team leaders and recruit volunteers
- Create a field kit with checklist

Getting started:

As you begin planning your monitoring program, start developing a relationship with the local resource agencies to find out what their needs are. Resource agencies such as DOH or DLNR can lend support, credibility, additional training, equipment and sometimes funding in collecting data. By including resources agencies at the start of your project, can help ensure that your data gets used. They can also help you fine tune the protocols listed in this manual to meet their standards so that your data is useful.

Additional information gathering

Look at your checklist that you've created from Section 4: who will use the data and who is your audience; how much

funds you have; where you will monitor; when you will monitor; how you will monitor, and what you will monitor. You may need to do some additional research on the water body you are interested in monitoring. Is your water body listed as "impaired" by the State Department of Health under the Clean Water Action Section 303(d)? Are there any species of concern in your watershed or water body? This includes aquatic wildlife and insects, birds, marine mammals or sea turtles. Does the water body empty into a marine managed area? Check out the Division of Aquatic Resources website at: http://www.hawaii.gov/dlnr/dar/fish_regs/index.htm

Photo by Rayn Tabata

▲ *Maunalua Bay*

Selecting your monitoring sites and establishing a schedule:

Identify the landowners, and obtain permission to access their property. Walk the stream length or coastal area to determine sampling/surveying locations. Some areas you might want to consider include: coastal confluences (where streams/rivers enter the ocean), main stem (the principal waterway of a river/stream, excluding its tributaries) sites, tributaries, paired studies of upstream and downstream sites, before and after monitoring on a single site tied to some event. You may want to establish sampling sites above and below areas of special interest, like storm drains, stream junctions, or effluent outlets. If you have a GPS unit, take coordinate readings for the site. Think about access and safety issues with regards to getting to the site, if high stream flows or tides might influence the site, and whether or not the site can easily be located years after your monitoring program is completed. Also write down a description of the area, with explicit directions on how to get there. Write down the altitude as well- you'll need this for calibrating the DO meter.

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Establish a sampling schedule. Sampling reports should be handed in at a set time each month. A sample report includes a cover page, maps, survey forms, all types sampling forms, photographs and any other relevant information.

Data management plan

You'll need to create a plan on how you will record and archive your data. See Section 7 for more information on data management.

Develop a budget

After talking to resource agencies and doing some additional research on your water body, you have found out what you will be monitoring. Now you'll need to figure out a budget and obtain funding. The field manual includes some recommended equipment, with estimated costs (without shipping- shipping will vary depending on the company. Costs for equipment change frequently). Funding resources can be found in Appendix D. Think about the long-term sustainability of the program to develop a strategy for maintaining the program. Some budget considerations, which depend on the monitoring protocols that you choose:

- Project coordinator
- Water quality monitoring equipment
- Safety supplies such as: first aid kit, gloves, safety goggles
- Monitoring extras such as: Buckets, tables, clipboards, pens, waterproof paper, scissors
- Facility to give presentations and demonstrations to the community (many will offer facilities for free for volunteer groups)
- Projector (check with your local resource agency or nonprofit organization to see if you can borrow one)
- Screen (may be necessary)
- Extension cords
- Computer, with spreadsheet and word document software
- GPS unit
- Outreach and marketing materials- printing, website, graphic layout, database design
- Volunteer supplies, such as food, water, giveaways
- Project and volunteer coordinator time:
  - Giving presentations
  - Training
  - Overall coordination
  - Monitoring day
  - Data management
- Estimate value of volunteer time: You'll need this when applying for grants, documentation of match (either cash or in-kind services). If a volunteer is providing specialized services, then use the charts provided by the Bureau of Labor Statistics at http://www.bls.gov/bls/blswage.htm. The website at http://www.independentsector.org/programs/research/volunteer_time.html provides the value of volunteer

services- use the most current year value. Volunteer time can include: time to attend presentations, training and actual monitoring; experts providing technical support.
- Estimate value of in-kind: This includes donating the use of equipment. You can use what it costs to rent the equipment, or what it would cost to purchase it. If someone is donating the equipment, include the fair market value as well.

If you need help in writing a grant, check out the resources provided in appendix D.

Hire a project coordinator

A project coordinator is critical for managing volunteers, the budget, the data management system and maintaining relationships with agencies and other monitoring groups. While the project coordinator can be a full-time job, he/she will probably start part time as you build your program. Good qualities for a coordinator to have: 1) Organized 2) Good computer skills, including documents, spreadsheets, presentations and use of the internet 3) Ability to work with a variety of people 4) Good public outreach and marketing skills 5) Ability to work under pressure 6) Grant writing ability and 7) Good sense of humor.

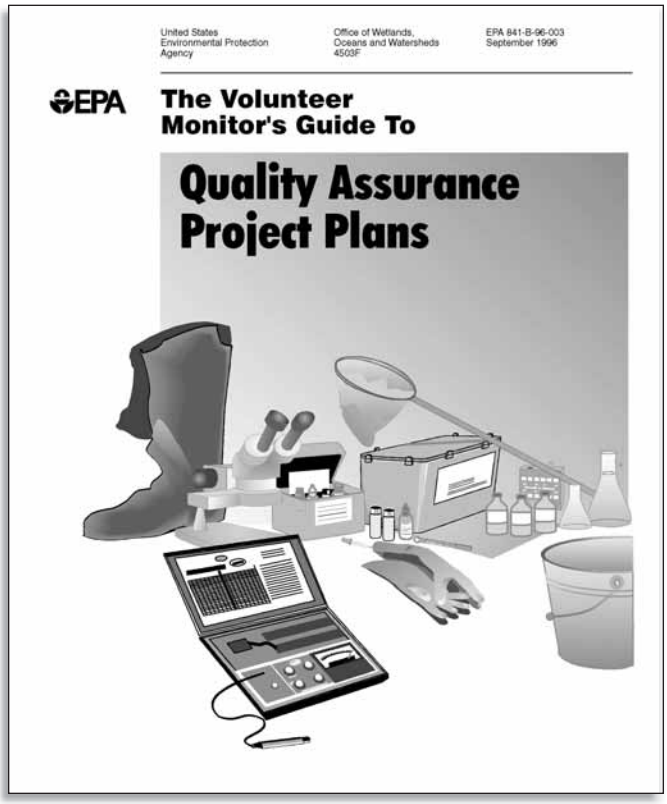
Develop a Quality Assurance Project Plan and Quality Assurance/Quality Control Plan

(adapted from EPA's Guide to Quality Assurance Project Plans)

Note: This will include standard operating protocols.

Overview

A Quality Assurance Project Plan (QAPP) is a document that outlines the procedures of a monitoring project to ensure that the data collected and analyzed meets the project requirements. If you are providing test results that provide more reliable data, you may want to look into creating a QAPP. A QAPP contains a definition of the problem, project organization, data quality objectives (i.e. accuracy, comparability, completeness, precision), training requirements, documentation and records, sampling method requirements, sampling handling and custody requirements, analytical methods requirements, technical requirements, quality control, testing, inspection and maintenance, instrument calibration and frequency, etc. As you can see, creating a QAPP may take time and money, but the results are more likely to be considered to be reliable. There are several templates available for you, see additional resources in Appendix B. If you are interested in providing data for DOH to use, they require the development of a QAPP, QA/QC and Standard Operating Procedures (SOP). Quality assurance refers to the overall management system as defined in a QAPP. QA provides the information you need to ascertain the quality of your data and if it meets the requirements of your project. Quality control refers to routine



▲ *EPA's QAPP Guide*

technical activities or in other words, control of errors in the field, laboratory or in the office. QA/QC together helps you provide credible data and in the end, saves time and money.

This section will give you an overview of a QAPP; see EPA's "The Volunteer Monitor's Guide To Quality Assurance Project Plans" and California's Citizen Monitoring Networks Standard Operating Procedures 7.1.1.1, Instructions for the use of Model Quality Assurance Project Plans.

What are the steps involved in developing a QAPP?

1. EPA suggests 11 steps in developing a proper QAPP, to ensure that it includes applicable information that is needed by organizations.
2. Establish a team of advisors that will help give you feedback. Collaborate with your regional EPA representative, other experience volunteer groups or those who have expertise in monitoring.
3. Determine the goals and objectives of the project- this should have done even before having to prepare a QAPP. (See Section 4)
4. Collect background information to help in the design of your project. (See Section 4)
5. Refine your goals when you have more information. This may be applicable if you've found out in your research that someone else is sampling in your location or sampling a particular parameter.
6. Design the sampling, analytical and data requirements- the

what, how, when and where you will be monitoring.

7. How will the project be implemented? Set out a task list with timeline for project logistics, with who is the leader and when to implement.
8. DRAFT your standard operating procedures (SOP) and QAPP. You can use the protocols here listed in this handbook as the basis for your SOPs and adapt as necessary for your particular project. You may need to add or change protocols, for example, how the samples will be delivered to a lab. The California Citizen Monitoring Network http://www.waterboards.ca.gov/ is a good resource and has SOPs that you can download.
9. Get feedback on your SOPs and QAPP from the State Department of Health or regional EPA staff. Contact the Clean Water Branch of DOH: (808) 586-4309, or EPA region 9: Amy Wagner (510) 412-2329, email: Wagner.Amy@epamail.epa.gov or Mark Kutnink: (415) 972-3801, email: Kutnink.Mark@epamail.epa.gov. Mark Kutnink has examples of QAPPs that he can share with you. Check out Appendix A for QAPP information.
10. Revise the QAPP based on feedback. Comments you receive may include being more specific about your methods, or modifying your procedures to adapt to agency requirements. The final review and approval can take at least a couple of months. Be persistent and always follow-up. Never wait for an agency to contact you back with comments.

YOUR QAPP HAS BEEN APPROVED! Get out and start monitoring!

Practice "adaptive management"- evaluate your project along with your QAPP and change it as needed.

QAPP concepts

You will hear these terms with regards to not only a QAPP, but for other statistical analysis. A QAPP will provide a description has to how your project will incorporate these terms.

Precision: Is there a degree of agreement when you have repeated measurements of the same characteristic? This can be measured using the standard deviation, or relative percent difference among replicate samples (two or more) taken from the same place at the same time. The standard deviation measures the spread of the data about the mean (average) value. It is useful in comparing sets of data which may have the same mean but a different range of values. Most standard calculators can perform the standard deviation function. The relative standard deviation (RSD), or coefficient of variation, expresses the standard deviation as a percentage. The smaller the RSD, the more precise your measurements. If you only have two replicate samples, then you can calculate the relative percent difference (RPD). The smaller the RPD, the more precise your measurements.

Accuracy: How close are your results are to a true or expected value? It is a measure of confidence in the measurement. This can be determined by comparing analysis of a standard, reference or control sample to its actual value. For example, the pH of a standard buffer solution is 7.0. The smaller the difference between the measurement and its "true" or expected value, the more reliable the result.

If you have concerns that other components of the sample may be interfering with the analysis of a parameter, one way to measure the accuracy is to add a known concentration of the parameter to a portion of the sample. This is called a "spiked sample". The difference between the original measurement and the measurement of the spiked sample should be close to the amount added to the spiked sample.

Many parameters (such as Secchi depth) do not have standard references or performance evaluation samples. In these cases use the trainers value or value that DOH samplers provide as your reference value.

Representativeness: Do the measurements represent the true environmental condition or population at the time the sample was collected? Are your sampling locations indicative of the entire water body? For example, sampling at a known outfall is not representative of the entire system.

Completeness: What is the comparison between the amount of valid (usable) data that you originally planned to collect versus how much you actually collected? You may not take as many samples as planned, so try to plan for more samples than you actually need. Completeness (%C) is calculated by dividing the number of measurements that have been judged valid (JV) by the total number of originally planned measurements (PM) and multiplied by 100. %C= (JV/PM) X 100

Comparability: Can the data be compared between sample locations or periods of time within a project or between projects?

Detection limit: A detection limit is the lowest concentration of a given constituent that a method or instrument can detect and report as a value greater than zero. Detection limits vary from parameter to parameter and change from time to time due to improvements in analytical procedures and equipment. This is important for several reasons, depending on the area you are monitoring. Some parameters have low concentrations to begin with especially in certain conditions. If you need to provide more precise data, you will need to use the methods/instruments with low detection limits.

Measurement range: The measurement range is the range of reliable measurements of an instrument or measuring device. Knowing the measurement range of the instrument is crucial if conditions in a waterbody are above or below the range of the device you want to use.

Quality control (QC) samples

One common source of error in both sampling and analytical procedures is contamination. A QC sample can help you identify when and how this might occur. While there is no set number of field or lab QC samples to be taken, a general rule is that 10% of the samples should be QC.

After the project is over, you can determine data quality by evaluating the results of QC samples and determining precision and accuracy. Here are the different types of QC samples:

Field blank: A "clean" sample, produced in the field used to analytical problems during the whole process (sampling, transport and lab analysis). Take a clean sampling container with clean water (i.e distilled water) to the sampling site. Handle all samples, including the field blank the same way. Since each sample will have an ID number, you will know which one is your field blank.

Equipment or rinsate blank: A "clean" sample used to check the cleanliness of sample collection equipment. This type of blank is used to determine if there is carryover contamination from reuse of the sample sampling equipment.

Split sample: One sample is divided equally into two or more sample containers and then analyzed by different analysts or labs. These are used to measure precision. The samples should be thoroughly mixed before splitting. The sample can be split in the field (field split) or in the laboratory (lab split). A sample split in the field and submitted to the lab without informing the lab is a blind sample.

Replicate sample: Two or more samples are taken from the same site, at the same time, using the same method and independently analyzed in the same manner. Replicate or duplicate (only two samples taken) samples can be used to detect both natural variability and that caused by field sampling methods.

Elements of a QAPP

The EPA document suggests that potentially 24 elements that can be included in a QAPP. Not all may be included in your QAPP, depending on your goals, objectives, scope, data uses, and DOH guidance. Please see the EPA document and sample templates for more information and tips.

Project Management
- Title and approval page
- Title and date of the QAPP
- Names of organizations involved
- Names, titles, signatures and document signatures of all appropriate approving officials, such as project manager, project QA officer, DOH.
- Table of contents

Distribution list
- List of organizations and individuals receiving a copy of QAPP and any subsequent revisions.

Project/Task organization
- Key personnel and organizations, as well as users of your data.
- List specific roles and responsibilities
- Organizational chart is good way to visualize roles and tasks

Problem identification/background
- Brief description of problem your monitoring program is designed to address.
- List background studies
- Why is the project needed?
- How will the data be used, and who will use it.
- What traditional knowledge could direct the focus, methodology, and interpretation of this research? Is this documented in surveys or interviews?

Project/Task description
- Work volunteers will perform and location
- What kinds of samples
- What conditions are being measured (which are critical, which are secondary)
- How will the results be evaluated
- Include project timetable with beginning and ending dates for entire project and for specific activities. Timetable should include sampling frequency, lab schedules and reporting cycles.

Data Quality objectives for measurement data
- Quantitative and qualitative terms to describe how good your data needs to be to meet your projects' objectives. This includes precision, accuracy, representativeness, completeness, comparability and measurement range.

Training requirements/certification
- Identify any specialized training or certification requirements that volunteers need to complete tasks.
- How will you provide the training?
- Who will conduct the training?
- How will the volunteers' performance be evaluated?

Documentation and records; what are the field and laboratory information and data you need?
- Raw data
- QC checks
- Field data sheets
- Lab forms
- How long and where will the records be maintained?
- Attach copies of all forms to be used in the project to the QAPP.
- Measurement/Data Acquisition
- Sampling process design
- Outline of the experimental design
- Types of samples required
- Sampling frequency
- Sampling period (e.g season)
- How sampling sites are selected and identified over time
- Identify constraints- weather, season variations, stream flow, site access, depth of water, closure of roads, that might affect scheduled activities and how these constraints will be handled.
- Site safety plan

- In place of the extensive discussion, you may cite sections of your SOPs which detail the sampling design of the project.

Sampling methods requirements
- Parameters sampled
- How samples will be taken
- Equipment and containers used
- Sample preservation methods used
- Holding times (time between taking samples and analyzing them).
- If the samples are mixed, describe how this will be done.
- Procedures for decontamination and equipment cleaning.
- Use a table to present the information or cite SOPs.

Sample handling and custody requirements
- Samples should be properly labeled in the field. Include sample location, sample number, date and time of sample, sample type, sampler's name and method used to preserve sample
- Procedures used to track samples being delivered or shipped to a lab
- Include chain of custody forms
- Include written procedures field crews and lab staff should follow when collecting, transferring, storing analyzing and disposing of samples.

Analytical methods requirements
- List analytical methods and equipment needed for analysis of each parameter, either in the field of the lab.

Quality control requirements
- Number and types of field lab quality control samples to be taken

Instrument/equipment testing, inspection, and maintenance requirements
- Plan for routine inspection and preventative maintenance of field and lab equipment and facilities.
- Which equipment is routinely inspected.
- What spare parts and replacement equipment on hand to keep operations running smoothly.
- Equipment maintenance schedule

Instrument calibration and frequency
- How will the sampling and analytical instruments be calibrated
- Frequency of calibration
- Types of standards or certified equipment that is used to calibrate
- How calibration records are maintained

Instrument/Acceptance requirements for supplies
- How will you determine if supplies such as sample bottles are adequate for your programs needs

Data acquisition requirements
- What types of data does your project utilize that is not obtained through your monitoring activities. This can include historical information, aerial photos, topo maps, Google Earth or reports from other monitoring groups.
- Discuss limits on use of this data resulting from uncertainty about its quality.

Data management
- From field collection, to lab analysis to data storage and use.
- How will you check for accuracy and completeness of field and lab forms
- How will errors be minimized and corrected in calculations, data entry to forms and databases and report writing.
- Examples of forms and checklists used
- Identify computer hardware and software used to manage data

Assessment and Oversight
- Assessment and response actions
- How will field, lab and data management activities, organizations and individuals be evaluated?
- How will problems be corrected that are identified through these assessments?

Reports
- Identify frequency, content, and distribution of reports to data users, sponsors, funders, and partnership organizations that detail project status, results of internal assessments and audits and how QA problems have been resolved.

Data Validation and Usability
- Data review, validation, and verification requirements (what will be done, and by whom)
- How will data be reviewed
- How will decisions be made regarding accepting, rejecting or qualifying the data

Validation and verification methods; procedures used to validate and verify data. For example:
- Comparing computer entries to field data sheets
- Looking for data gaps
- Re-checking calculations
- How will errors be corrected and be conveyed to data users

Reconciliation with data quality objectives
- What is the process for determining whether the data meet project objectives?
- Calculate and compare projects actual data quality indicators to those specified at start of project.

What will be done if these are not the same?
- Discard the data, set limits on use of data or revise the project's data quality objectives. See Section 7 for information on data management.

Develop Team Leaders and recruit volunteers

Train leaders who can train volunteers. All Team Leaders must complete at least two hands-on-training sessions on monitoring. Topics include: general hydrology, ecology, safety, quality assurance and quality control measures, sampling procedures, field analytical techniques, and data recording. Leaders train the volunteers and must also participate in semi-annual quality control sessions, which allow for the groups to check the accuracy and precision of their equipment and testing techniques. See Section 6 on volunteer management.

Fieldwork preparation

Create a field kit for your volunteer monitors:

Binder with:
- Ample supply of blank field data sheets
- Sheets for calibration records
- Copies of previous field data sheets
- Field manual for all protocols
- List of monitoring locations with GPS coordinates
- Checklist for supplies to bring
- Any other stuff that the group wants to have

Field Gear:
- Sampling apparatus
- Weight for apparatus
- Whirlpaks, Sample bottles or Bucket for getting sample water
- Pole, beaker, bucket, rope for deep water sampling.
- Yardstick or measuring tapes
- Measurement Instruments and kits
- Paper towels
- A jug of distilled or deionized water (DI)
- A spritz (squirt) bottle for DI
- Plastic cups (e.g., solo 9oz clear plastic) for temporary sample containers or for dilutions
- One 500-1000 ml container with WIDE MOUTH and tight cap (for garbage liquid that needs to be flushed into the sanitary sewer)
- Plastic bags for solid garbage
- Safety Goggles
- Gloves
- Permanent marker
- Spare batteries for pocket meters
- First Aid Kit
- Soap (bar, not liquid)
- Drinking water
- GPS unit
- See specific protocols for list of gear and create a specific field gear supply list for binder

Protocols to consider:

Please read sections on volunteer management (Section 6), data management (Section 7), Transportation and safety (Section 8) and collecting samples (Section 9, M1-M8).

Protocols suitable for this level:
- **Section 9:**
  Conductivity/Salinity: P3
  Temperature: P3 (temperature reading for meter)
  Total Dissolved Solids: P6
  Turbidity: P10, P11
  Chemicals: C2
  Sending samples to the lab: TDS (P7); Nutrients (C10);
  Bacteria (B4)
  Dissolved oxygen: C3, C4
  Nitrate: C6
  Phosphate: C8
  Nitrogen-Ammonia: C9
  pH: C13, C14
  Bacteria: B3
- **Section10:**
  Stream flow: S1, S2, S3a, S3b, S3c, S3d
  Visual observations: S4
  ōpala: S5
  Rapid assessment of fish and invertebrates: S6
- **Section 11:**
  Rainfall: W1
  Pollution hotspots: W2
- **Section 12:**
  Ocean and weather measurements: O1
  Aquatic invasive species: O2
  Coral bleaching and marine disease: O3

VOLUNTEER MONITORING PROTOCOLS SUMMARY MATRIX

CODE	PARAMETER	EQUIPMENT TYPE
P1	Salinity	Hydrometer
P2	Salinity	Refractometer
P3	Conductivity/Temperature	Cole Parmer Con 400 meter
P4	Temperature	Lamotte GREEN Water monitoring kit: Lamotte temperature strip
P5	Temperature	Field thermometer
P6	Total Dissolved Solids	"Oakton Waterproof TDSTestr 2,3"
P7	Total Dissolved Solids	Send sample to the lab
P8	Turbidity	Lamotte GREEN Water monitoring kit
P9	Turbidity	Secchi disk
P10	Turbidity	Transparency tube
P11	Turbidity	"Lamotte Portable Turbidimeter, model 2020"
C1	Chemicals	Lettuce seed bio-assay
C2	Chemicals-detergents	Hach Model DE-2
C3	Dissolved Oxygen	Lamotte GREEN Water monitoring kit
C4	Dissolved Oxygen	Chemetrics DO kit
C5	Dissolved Oxygen	YSI 55 Dissolved Oxygen Meter
C6	Nitrate	Lamotte water monitoring kit
C7	Nitrate	Chemetrics Nitrate Kit 6904D
C8	Phosphate	Lamotte GREEN Water monitoring kit
C9	Phosphate	Chemetrics Chemets 0-1 and 1-10 ppm stannous chloride
C10	Nitrogen-ammonia	Chemetrics Chemets ammonia-salicylate
C11	Nutrients	Send sample to the lab
C12	pH	Lamotte GREEN Water monitoring kit
C13	pH	pH strips
C14	pH	Hach 17-N wide range (4-10) pH test kit
C15	pH	Oakton Waterproof pH 300 meter
B1	Bacteria	Lamotte GREEN Water monitoring kit
B2	Bacteria	Coliscan Easygel
B3	Bacteria	IDEXX Quanti-Tray Enterolert
S1	Stream flow	Observations
S2	Stream flow	Estimates
S3a	Stream flow	Fill container and timepiece
S3b	Stream flow	Float method
S3c	Stream flow	Marsh McBirney Portable Current Analag or Digital Meter (model 201) and a 4' topsetting wading rod
S3d	Stream flow	"Bucket Wheel Meter, Mini Current Meter or AA Current Meter"
S4	Visual observations	N/A
S5	ʻŌpala	N/A
S6	Fish and invertebrates-stream	ʻŌpae net
W1	Rainfall	Manual rain gauge
W2	Pollution hotspots	N/A
W3	Storm drain	Lamotte Storm Drain Monitoring kit
O1	Ocean and weather measurements	N/A
O2	Aquatic invasive species	N/A
O3	Coral bleaching and marine disease	N/A

Recruiting, training and retaining volunteers (Adapted from "Volunteer Management" by the Volunteer Water Quality Monitoring National Facilitation Project)

The success of any volunteer program depends on active and committed volunteers. It takes time, effort and skill to recruit, train and retain good volunteers. It is more than just training people to take a few samples. There are five R's of volunteer monitoring: rights, responsibilities, recruitment, recognition and retention.

Rights and responsibilities

One essential element of a successful volunteer program is ensuring that volunteers have a good experience. By helping the volunteers know what is expected from the start and what they can expect from your program improves the satisfaction and results for both the volunteers and program staff.

Typical volunteer rights:

- To be provide appropriate orientation and training.
- To have clear, appropriate assignments.
- To have fulfilling work
- To have informed involvement with program supervision and support.
- To be recognized for their contribution.
- To be respected as a volunteer
- To have time put to best use
- To be provided safe, healthy and appropriate working conditions.

Typical program rights:

- To expect support for the program and its personnel
- To screen volunteers
- To request references
- To require volunteers to be responsible
- To reassign volunteers if needed
- To receive notice of leaving

Typical volunteer responsibilities

- To understand their role as a volunteer
- To be honest about their goals, skills, limitations and motivations
- To fulfill their commitment
- To cooperate with staff
- To be flexible and open-minded
- To stay informed
- To ask for help

By describing your expectations of the volunteer or their responsibilities, allows the potential volunteer to better understand what they are committing to- time, interest, resources and schedule are compatible with your program. Provide your volunteers with a job description, to let them know what is expected of them. This should include a liability waiver (See Appendix C)

Recruiting volunteers

As you start to recruit volunteers for your program, think about what motivates volunteers to monitor. Some are interested in learning new skills, while others are interested in a specific resource and may only participate if they can only monitor that specific site. Others are simply interested in meeting others with similar interests. There are some volunteers who may feel disgusted with government action and want to take charge over a particular area. Beware of these individuals, as their goals may not mesh with your groups and may act out individually, harming the program.

Understand your volunteers and their needs, and provide opportunities that accommodate them and their schedules, such as including social or advanced training activities or not scheduling training sessions during school vacations. In addition, knowing the "why, what and who" of your monitoring efforts will help you to target potential volunteers. The first step for more effective volunteer recruitment is documenting roles and responsibilities of volunteers.

How do you find volunteers? You may want to accept volunteers as they come forward, or screen them when they apply. Think about the needs of your program- do you need a statistical expert or someone that loves numbers and charts? This type of person will be very useful for analyzing the data. Are there people with database skills? Databases (to be discussed in Section 7) may be needed, and someone skilled with database development would be able to set up a database so that data collected by volunteers is easily entered.

Here are some tips to locating volunteers:

Established groups: Work with established groups (i.e Sierra Club, Surfrider Foundation) near your proposed monitoring site and target their membership

Photo by Liz Foote

▲ *Recruiting volunteers*

Newspapers/newsletters: Send press releases to newspapers- include not only dailies, but smaller weekly or bi-monthly papers.

Community organizations: Attend local groups meetings to talk about your project

Photo by Liz Foote

▲ *Certificates of appreciate is a good way to recognize volunteer service.*

Shoreline residents: Usually those closest to the waterbody have the most direct interest in the resources, not to mention ease of access. Contact these residents through neighborhood boards or watershed groups.

Sporting organizations: Local fishing, outrigger canoe, surfing- all have an interest in the waterbody because they usually are in and/or on the water every day.

Special events, fairs and festivals: Having a booth at a local event not only gives you an opportunity to recruit volunteers but give people a chance to learn about problems and try out equipment at your table.

Brochure: Brochures, if written and created creatively, help to get the word out about your program and gives basic contact information

Word of mouth: After you find volunteers, use existing volunteers to help recruit new people.

Television and radio: Send press releases to have your program listed on the station's community event listing.

Internet: A website can communicate information about your program, and about the waterbody itself.

Retaining volunteers

Retaining volunteers is one of the keys to any successful volunteer based program. The better you target your volunteers, provide them with a good description of what is expected of them, good training and communication, regular feedback can help retain volunteers for a long time. Why do people leave a program? Some reasons are beyond the control of a program, such as moving for a new job, a new baby, or new spouse. Some of the things you can control include frustration of the volunteer due to no changes in water quality conditions or the health of the watershed, lack of feedback, and lack of use from data gathered.

Some tips for retaining volunteers:

Some people lose interest because there are no challenges; it has gotten easy and repetitious. Monitoring by its nature must be repetitious in order for conditions or changes to become discernible. Let people know up front what monitoring entails, and the need for consistent monitoring.

Offer workshops in new techniques that you may utilize in the future. This may get a volunteer so excited that they may help you obtain funding!

Get people involved in other aspects of the program- like fundraising, giving presentations to others on the results of their efforts.

Within your program, offer the volunteers who have vested a lot of time and effort in the process to become monitoring leaders or trainers.

Make sure you have regular feedback about what the program and volunteers are accomplishing- get the word out through newsletters, email lists, media and a website.

Recognition of volunteers

One way to retain volunteers and instill satisfaction in their work is to show volunteers that you appreciate their work. There are many ways to show how much you appreciate volunteers, here are some examples:

- T-shirts, hats, stickers, tote bags with your program logo
- BBQs, picnics, potlucks at the end of each season's monitoring. Provide giveaways from local vendors
- Have special treats at workshops or when monitoring- find goodies at your local farmer's market!
- Provide special workshops on topics of interest or new monitoring techniques
- Articles in local papers. Get a monthly column that allows you to report your group's results or to highlight "volunteer of the month"
- Offer scholarships to state or national conservation or monitoring conferences
- Certificates of recognition after completing various monitoring milestones
- Get your program listed in the national Volunteer Monitor newsletter!

Training volunteers:

Training volunteers depends on the program level you choose. Basic information that should be included in all training workshops:

- Purpose, goals and objectives of the program
- Water quality terms, for example runoff (urban, point and nonpoint, agriculture).
- Basic water quality parameters and why they are important
- Basic ecosystem ecology and watershed processes
- Current information about the water body being tested
- Role of the volunteer
- Parameters being tested in this program, with protocols
- Demonstrate how to calibrate equipment (which is usually

done before going out into the field)
- Data use- how and by whom
- Reporting results

After an overview of water quality basics, the water body/ watershed being monitored, field training is conducted. A hands-on training at one of the sites is the best way to expose volunteers to show them the process involved. When selecting a training site, consider the following:

Accessibility: is parking and bathrooms available?

Size: too large of an area allows people to wander off

Safety: no steep slopes, large boulders in the way to access the water; not a known area with a lot of criminal activity.

Features: enough diversity/necessary habitats available?

Vulnerability: will it be damaged by having volunteers testing at various sites or will animals/bird be disturbed? Is it the time when birds or turtles are nesting, or is it a beach where Hawaiian monk seals are known to haul out?

Permission: Do you need permission from the landowner to conduct a training?

Distance: is the site close to where most volunteers live?

Useage: is it a popular area for residents and/or visitors? If so, it may be difficult to keep people's attention or find an appropriate place to conduct monitoring.

Time of day: while regular monitoring may be conducted at all times of the day, you may want to select at time when it is cooler, either earlier in the morning or later in the afternoon, depending on the place. If the place is shaded, this may not make a difference.

Place to set up a tent, with table and chairs: to provide shade and a place to rest for volunteers.

What should be involved in field training?

If you have a large group (more than 6), consider breaking the instruction into several stations if you have enough trainers.

Give a brief overview of why we're monitoring and basic safety instructions.

Demonstrate how to take a water sample. Have each person try this out, using various pieces of containers, such as Whirl-pak, bottle or bottle on a pole. (if you have these types)

Demonstrate use of the equipment or other stream, watershed or coastal protocols you are following. This should include taking a reading, recording data and cleaning up. Then have each person become familiar with each step.

Photo by Jill Komoto

▲ *Volunteeer training*

Adapted from "Considerations for Planning Your Program's Data Management System, by the Volunteer Water Quality Monitoring National Facilitation Project.

Overview

Even if you are planning a once a year event, such as a Snapshot day or participating in World Water Monitoring Day, you will want to maintain some type of data management system. A data management system includes not only the storage of the monitoring data you collect, but a method for collecting/ recording, entering and retrieval of data for future analysis.

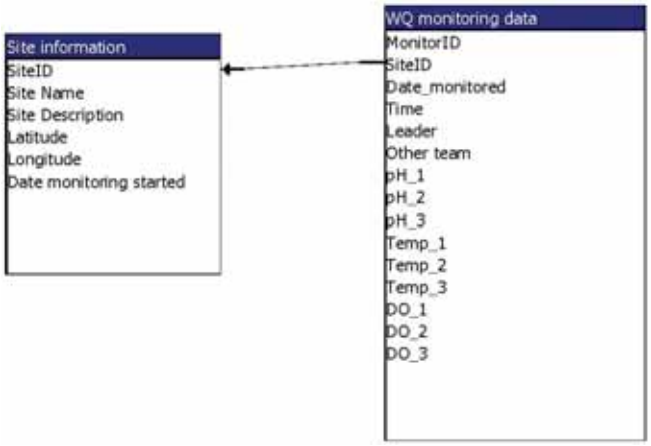
There are a variety of data management systems; the type you choose depends on you and your volunteer abilities, funding available and how you plan to use the data. Table 7.1 gives an overview of some methods with strengths and weaknesses. For collecting or recording of data, most people will use the manual method, recording results on the data sheet. There are some pieces of equipment that have software recording the data; you connect it to a computer to download the data. Some examples of this type of monitoring equipment include a GPS unit (e.g Trimble) or the Onset Water Temperature Data Loggers.

	PAPER FILES	SPREADSHEETS	DESKTOP DATABASES (e.g. Access, Filemaker Pro)	ONLINE DATABASES (e.g Access, MySQL, Oracle)
Set-up and Costs	Very inexpensive Good to keep even with electronic data management system	Inexpensive - Familiar to many and easy for most to use	Inexpensive - Fairly easy to use (after setup). Good for small datasets. May need to hire someone to develop database. Need to train users	Costs vary- free to tens of thousands of dollars. Need a programmer to set up. Need to train users
Maintenance, Security, Backup, and Data Quality	Lowest percent chance of error in data reported on data sheets. Save copies of field and lab datasets. Maintenance, security and file backup dependant on amount of data collected and room to store it. Depending on amount of data collected, may require a large amount of storage space.	Electronic file back up simple. Can be programmed to meet individual program needs, but easier to use a database with built-in backup capabilities.	Electronic file backup simple. Can be programmed to meet individual program needs (e.g allow for data entry templates, recognize data entry mistakes, provide template reports, create special data dumps for data sharing with other databases and STORET	Need a programmer to maintain database code over time. Electronic file backup simple. Can be programmed to meet individual program needs (e.g allow for data entry templates, recognize data entry mistakes, provide template reports, create special data dumps for data sharing with other databases and STORET
Entering and Storing Data	Similar amount of time as with spreadsheets, but depends on amount of data being stored.	Only one user can enter/ modify data at a time. Good for storing small datasets.	Generally only one user can enter/modify data at a time (unless used in a networked mode, during which data integrity may be jeopardized if more than one person uploads data at once, thus overwriting the others' data). Data entry from a single computer. Can store large volumes of data. Training needed for data entry at a single location, and often for only a few individuals.	Multiple users can modify data at one time. Data entry can be done from any computer with internet access (password protected). Can store large volumes of data. Training required for many users; likely needed at multiple locations.
Searching and Sharing Data	Depends on amount of data to be shared and how well organized your files are.	Not as query friendly as a relational database. Good at simple statistical and mathematical analyses. Graphing friend	Good for searching and retrieving data (query friendly). Queries can be tricky in trying to obtain accurate answers. Data on web usually static (e.g a person has to upload information to the web manually, it is not uploaded to the web automatically as a user enters data into the database)	Good for searching and retrieving data (query friendly). Queries can be tricky in trying to obtain accurate answers. Web posting of data is dynamic (e.g. as data is entered into the database, the website is updated automatically. Training may be required to teach people to use.

▲ *Table 7.1 Issues to consider when developing a data management system*

Spreadsheets are easier to use but….

While many people are familiar with spreadsheets, they are limited in the ways it stores data. It is possible to create spreadsheets that limit data entry errors. But once you start entering a lot of data, you may realize that you are creating duplicates of some fields, such as the site location. That's where a database is helpful; you only have to enter certain items like site location once. This is called a relational database; it has multiple tables that are related to each other by values that are common between the tables. For example, you might have a table with basic site information: site number, description of site, latitude and longitude, date monitoring started. Another table might have all of the monitoring data for all sites. Rather than enter the basic site information each time in a spreadsheet, you can list it just once in a database and link it with other types of data, using the site number. With many databases, you can still export to Excel and create charts and graphs or other tables.



▲ *Example of a relational database*

Still not sure whether to use a spreadsheet or database?

If the answer is yes to any of the following questions, you should consider using a database:

- Do the data need to be stored long-term?
- Do multiple people need access to the data?
- Do I need to safeguard against erroneous entries? (Keep in mind that Excel does have the capability to provide checks against erroneous entries as well, but you may need an advanced Excel user/programmer to set it up)
- Do the data need to be protected against inadvertent corruption?
- Is a large part of the information redundant?

What information do I need to know when planning my database?

The most important thing you need to know before starting out is "what do I want to get out of this database? What will I be using it for?"

Other questions to ask yourself:

What resources do I have available?

Funds - what funds do I have available?

Software: does someone have the software I need, or will I need to purchase it?

Is there someone in my group who might volunteer to create a database? This person should be familiar not only with creating a database, but have the ability to work and communicate well with others. It is helpful if this person understands all phases of your monitoring work- from data collection, recording, entering and analyzing. (if she/he can participate, that is even better) The programmer will understand the technical capabilities of the software; but may need guidance from you (the project manager) on how user friendly to make the entry process, what types of reports, charts or statistical analyses you need.

Who will use the data?

You've asked this question in stage one, when determining what type of monitoring program you want to be involved in. If you are planning on being in level 2 or 3, work with the agency staff to determine what type of information, and in what format that they would be most interested in. But don't forget that those with little experience with computers may want to access the data.

How will the data be used, and what type of output will best serve these purposes?

This question will be answered in conjunction with "who" will use the data, but with more detail:

- What parameters do you want to be able to search by? (i.e. waterbody name, county, etc.)
- What type of searching options do you want?
  - Simple: Searching on a unique identifier such as site name or county. From this, you can not narrow your search.
  - Dynamic: A search in which options change based on the first selection you make. For example, you might select your waterbody, then narrow it to the site or date, and selecting the type of data.
  - Multi-variable: A search in which multiple parameters can be chosen at one time, without narrowing the options down.
- Are you going to store the raw data, calculated results, or both?
- What reports will you want to get out of the system?
- Do you want to graph the data, view it in a tabular format, or use it as part of a GIS system, with maps?
  - Graphs are good at viewing basic data, but you may want to develop an interactive GIS map system. For example, users can click on specific sites, and obtain a variety of information about the site.
- Will you want to upload the data to a specific organization or other database such as STORET? If so, how would the data need to be compiled in order to do that?
  - STORET is EPA's national database into which states and organizations report their water quality data. An example of State and volunteer database using STORET

is IOWATER. Each site in IOWATER is assigned a STORET number; and when the State of Iowa uploads its information, the citizen monitoring data is entered as well. http://www.iowater.net/database/viewdata/asp.

- Do you want to email the data or alerts about the data to other organizations, the newspaper or individuals?
- How many significant figures should be entered to the database and reported in output for each parameter?
- How do you want the data to be stored within the database? Do you want to store the data as a numeric or a character value? Some data that you collect may be above or below the detection limit and recorded with the less than or more than sign ("<" or ">").
- Do you want the database to report statistical output? What type of statistics do you want?
  - This will help to determine the structure of the data; most databases are limited in their statistical output, limited to averages or standard deviation. You may need to export the data to specialized statistical software, or consider purchasing Excel Statistic software add-ins, such as Analyze-it.

How will you control the reliability (also known as data integrity) of the data?

The programmer you select should be familiar with various methods to limit or enhance the accuracy of the data being input. This may include: authorized users only (password protected), using drop down boxes (limiting entry to the list), or setting range restrictions for parameters.

All people who will be entering the data should be trained and provided with a user manual. You should also develop a plan on how you will double-check the accuracy of the entered data.

What sort of security do you want the database to have? How will you control that security?

Most databases, as mentioned previously will have internal security, or the use of usernames and passwords in order to enter the data. If you are developing an web-based database, you will need to consider external security, to prevent hackers from hijacking or messing up your data.

You'll also need to consider who will be the database administrator; this person will have the ability to assign users, and edit the data. Users, or data entry personnel can enter the data, but not edit the data.

Online, or web-based databases:

Many companies, like Google are providing free online web space for sharing documents, presentations, scheduling meetings, and databases. Most free online databases have some level of secured access, but some are limited in terms of amount of storage. Some on-line databases are easier to use than others. Here are a few to check out:

Google documents: www.docs.google.com

Zoho online: http://zoho.com/

Gnumeric (Free spreadsheet, with statistical software): http://www.gnome.org/projects/gnumeric/

There are many examples of online volunteer monitoring databases; you may want to check these out if you plan on developing one.

Alabama Water Watch
http://frontpage.auburn.edu/icaae/index.aspx
Colorado River Watch
http://wildlife.state.co.us/riverwatch Click "Data"
Colorado Data Sharing Network
http://coloradowatershed.org/CWQMC/
Earthforce
http://www.earthforce.org/section/programs/green
Great North American Secchi Dip-in
http://dipin.kent.edu/DipInData.htm)
Illinois' Volunteer Lake Monitoring Program
http://www.epa.state.il.us/water/conservation-2000/volunteer-lake-monitoring/
Indiana's Hoosier Riverwatch
http://www.HoosierRiverwatch.com
IOWATER
http://www.iowater.net/database/viewdata.asp
Lake Michigan Federation's Adopt-A-Beach
http://www.lakemichigan.org/adopt/search.asp
Maine Healthy Beaches Program
http://www.mainecoastdata.org/public/
Maine's PEARL (Public Educational Access to Environmental Information) database
http://pearl.maine.edu/
Massachusetts' Waquoit Bay National Estuarine Research Reserve Bay Watchers
http://cdmo.baruch.sc.edu/
Minnesota's St. Louis River - River Watch
http://www.slriverwatch.org
Missouri Stream Teams
http://www.mostreamteam.org/1stpage.asp
New Jersey's Watershed Watch Partnership
http://www.state.nj.us/dep/wms/bfbm/vm/index.html
New York's Hudson Basin River Watch
http://www.hudsonbasin.org/dataxchange.html
New York's Westchester County's Citizen Volunteer Monitoring Program
http://cvmp.westchestergov.com/cvmp/
Ohio's Greenacres Foundation/Little Miami Watershed Monitoring Program
http://lmr-mc-database.daap.uc.edu/lmr/home-main.htm
Pathfinder Science's online mapping system
http://pathfinderscience.net/about/index.cfm
Pennsylvania Environmental Alliance for Senior Involvement
http://www.easi.org/monitor/index.php?module=MonitorAnything
South Carolina Oyster Restoration and Enhancement
http://score.dnr.sc.gov/deep.php?subject=5&topic=25
Washington's Nature Mapping
http://www.cbr.washington.edu/naturemapping/
West Virginia Save Our Streams
http://www.wvdep.org/dwwm/wvsos/vad/index.htm
Wisconsin's Citizen Lake Monitoring Network
http://www.dnr.state.wi.us/org/water/fhp/lakes/lakesdatabase.asp
Wisconsin Discovery Farms-Trained Local Samplers
http://www1.uwex.edu/ces/erc/discovery
Wisconsin's Water Action Volunteers
http://watermonitoring.uwex.edu/wav/monitoring/database.html
World Water Monitoring Day
http://www.worldwatermonitoringday.org/sitereg/database.html

TS1. Shipping And Custody (Adapted from California's Citizen Monitoring Protocols, 2004)

To prevent contamination and allow for more accurate results, you should follow standard procedures for shipping and custody of samples. Make sure you have the written procedures for sample handling available and that they are followed whenever samples are collected, transferred, stored, analyzed or destroyed. This includes a written record to trace the possession and handling of samples from collection through reporting. Here are some procedures you can start with, and revise to fit your specific needs (i.e allowing enough time for sample transport if your lab is at a distance)

A sample is in someone's "custody" if:

- It is in one's actual physical possession;
- It is in one's view, after being in one's physical possession;
- It is one's physical possession and then locked up so that no one can tamper with it;
- It is kept in a secured area, restricted to authorized personnel only.

Sample Collection, Handling and Identification

It is important that a minimum number of persons be involved in sample collection and handling. Use guidelines established in standard manuals for sample collection preservation and handling (e.g., EPA NPDES Compliance Sampling Inspection Manual, MCD 51, Standard Methods for Examination of Water and Wastewater). Complete the field records at the time the sample is collected and sign or initial it, including the date and time, by the sample collector(s). Field records should contain the following information:

- Unique sample or log number
- Date and time;
- Source of sample (including name, location and sample type)
- Preservative used
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, DO, Cl residual, etc.)
- Serial number on seals and transportation cases
- Comments

Identify each sample by affixing a pressure sensitive gummed label or standardized tag on the container(s). Where a label is not available, write the sample information on the sample container with an indelible marking pen. This label should contain:

- Sample number
- Source of sample
- Preservative used
- Collector(s') initials.
- The analysis required should be identified.

Place the closed sample container in a transportation case along with the chain-of-custody record form, pertinent field records, and analysis request form. Seal and label the transportation case. Fill out all records legibly in waterproof pen. The use of locked or sealed chests will eliminate the need for close control of individual sample containers. When the use of a chest will be inconvenient, the sampler should place a seal around the cap of the individual sample container which would indicate tampering if removed.

TS2. Transfer of Custody and Shipment

When the samples are transferred, the transferee must sign and record the date and time on the chain-of-custody record. Custody transfers, if made to a sample custodian in the field, should account for each individual sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record.

The field custodian (or field sampler if a custodian has not been assigned) is responsible for properly packaging and dispatching samples to the designated laboratory for analysis. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record. A recommended chain-of-custody format is illustrated in the forms Appendix C.

The chain-of-custody record and other pertinent forms are sent with the package to the laboratory. The field custodian retains a copy of these forms.

If you are mailing packages through the U.S Post Office, register it with return receipt requested. If packages are sent by common carrier, receipts should be retained as part of the permanent chain-of-custody documentation.

Samples that are being transported must be packed to prevent breakage. If samples are shipped by mail or by other common carrier, the shipper must comply with any applicable Department of Transportation regulations. Seal or lock the package to prevent tampering. Any evidence of tampering can be readily detected if adequate sealing devices are used.

If the field sampler delivers samples directly to the laboratory, custody may be relinquished to laboratory personnel. If appropriate personnel are not present to receive the samples, they should be locked in a designated area of the laboratory to prevent tampering. The person delivering the samples records a log entry stating where and how the samples were delivered and secured. Laboratory personnel may then receive custody by noting in a logbook, the absence of evidence of tampering, unlocking the secured area, and signing the custody sheet.

TS3. Laboratory Sample Control Procedures

Sample control procedures are necessary in the laboratory from the time of sample receipt to the time the sample is discarded. The following procedures are recommended for the laboratory (which can include your own lab that you set up as well as a state or commercial lab facility):

Designate a specific person as custodian and an alternate designated to act as custodian in the custodian's absence. All incoming samples must be received by the custodian, who must indicate receipt by signing the accompanying custody/control forms and who must retain the signed forms as permanent records.

The custodian maintains a permanent logbook to record, for each sample:

- The person delivering the sample
- The person receiving the sample
- Date and time received
- Source of sample
- Date the sample was taken
- Sample identification log number
- How transmitted to the laboratory, and
- The condition received (sealed, unsealed, broken container, or other pertinent remarks)

This log should also show the movement of each sample within the laboratory; i.e., who removed the sample from the custody area, when it was removed, when it was returned, and when it was destroyed. Establish a standardized format for logbook entries.

Designate a "custody room"; which should be a clean, dry, isolated room, building, and/or refrigerated space that can be securely locked from the outside.

The custodian must ensure that heat-sensitive samples, light-sensitive samples, radioactive samples, or other sample materials having unusual physical characteristics, or requiring special handling, are properly stored and maintained prior to analysis.

Distribution of samples to the analyst performing the analysis must be made by the custodian.

The laboratory area must be maintained as a secured area, restricted to authorized personnel only.

Laboratory personnel are responsible for the care and custody of the sample once it is received by them and must be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the custodian until the time that the analyses are completed.

Photo by Amy Wagner

▲ *Laboratory sample control procedures.*

Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, must be returned to the custodian. The returned tagged sample must be retained in the custody room until permission to destroy the sample is received by the custodian.

Samples will be destroyed only upon the order of the responsible laboratory official when it is certain that the information is no longer required or the samples have deteriorated. (For example, standard procedures should include discarding samples after the maximum holding time has elapsed.) The same procedure is true for sample tags. The logbook should show when each sample was discarded or if any sample tag was destroyed.

Procedures should be established for internal audits of sample control information. Records should be examined to determine traceability, completeness, and accuracy.

TS4. Safety

The health and safety of your volunteers should not be taken lightly. The duty of care is a general and legal duty on all individuals and organizations to avoid carelessly causing injury to persons. This obligation exists regardless of the organizations size, its income or whether the organization has paid staff.

If your organization asks a volunteer to do a task, which results in them injuring themselves or anyone else the organization, at a minimum, may be liable. No matter what activities your organization is involved in, from entering data, running a small laboratory, to organizing field collection trips on the seaside, you will have to consider the duty of care owed to your volunteers. Liability depends on establishing that the organization failed to take reasonable care.

The health and safety law lays down your duties to your employees. The law also imposes further responsibilities on you as an employer with regard to people not in your employment, such as volunteers and other members of the public, who may be affected by your work activities. Please refer to the Hawaii and Federal offices of Occupational Heath and Safety Administration for guidance. Hawaii office (808-586-9100): http://hawaii.gov/labor/hiosh/index.shtml Federal office (800-321-OSHA [6742]): http://www.osha.gov/

Conducting a risk assessment

You may want to conduct a risk assessment that will help your group identify and control potential hazards conducted with your activities. This is includes identifying all the hazards, assessing the risk and putting in places measures to control unacceptable risks. A hazard is anything that has the potential to cause harm, e.g. a faulty electrical socket. Risk is the likelihood of the hazard causing harm and the degree of harm it could cause (e.g. an electrical shock, which could lead to a fatality).

How do you conduct a risk assessment?

Here is one method:

- Identify the organization's personnel (by name not just position), their responsibilities, training received, experience level, qualifications to perform such work and contact information.

- Make a list of the tasks and duties to be performed and identify potential hazards and how to avoid/minimize the potential for those hazards.
- Provide a list of personal protection equipment that will be used and provide.
- List the work location(s) and the potential hazards associated with those locations (e.g. large slippery rocks, mosquitoes).
- Do the same for all of the equipment and include Material Safety Data Sheets (MSDS) for chemicals that may be used.
- Include your emergency procedures plan on who (person and place) and how (radio, phone...) to communicate health and safety issues.
- Address standard health and safety issues (e.g. no horse play, work in teams of at least two…). Your organization may also need to address their responsibility for buildings and premises.

Do I need insurance coverage?

At the very least, each volunteer should sign a liability waiver, but even this doesn't provide much assurance against potential lawsuits. Every organization should also have insurance coverage(s), but this can be expensive. There are several insurance options and policies to consider. Review this insurance coverage at least once a year as well as your volunteer liability waivers.

Safety tips

General Safety

- Ensure that proper evacuation and emergency response protocols are established and in place in the event of an accident or injury. Consider requiring a number of participants to complete first aid and CPR training, and provide a first aid kit for activities.
- Never send volunteers into the field without some type of communications equipment, especially if they are alone.
- Always let someone else know where you are, when you intend to return, and what to do if you don't come back at the appointed time.
- Always obtain permission from the landowner before crossing private property.
- Watch for hostile dogs and pests such as centipedes, wasps and scorpions.
- Carry a first aid kit and make sure someone knows how to use it.
- Watch for vegetation that may cause rashes, irritation or scratches and stinging jellyfish.
- Team leaders should inspect and restock safety equipment including first aid kit, gloves and eye wash. They should keep a record of all injuries and report them to the project coordinator

Water monitoring safety

- If you'll be working in the ocean, take extra precautions to avoid problems. Ask people who are certified in CPR and first aid such as local lifeguards to assist. Have one or two kayaks or canoes in the water to provide extra support.
- Always monitor with at least one partner.
- Never drink the water in the stream. Bring your own water from home.
- Please don't walk on unstable streambanks. Disturbing these banks can accelerate erosion and may prove dangerous if a bank collapses.
- Be very careful not to disturb streamside vegetation.
- Be very careful when monitoring swiftly flowing streams, do NOT attempt to wade into or across them when the water is swift or above knee height.
- If at any time you feel uncomfortable about the condition of the stream or your surroundings, stop monitoring and leave the site.

YOUR SAFETY IS THE MOST IMPORTANT THING.

Safe work habits

To ensure that the project is safe, make sure you and your volunteers are aware of the following procedures:

- Volunteer should be well supervised and thoroughly trained in proper work methods and safety procedures.
- Ensure that all volunteers are capable of performing the assigned work.
- If tools are used, ensure that they are in proper working condition, that they are handled properly, and that volunteers are briefed on proper use.
- Stop work during bad weather or when unsafe conditions arise.

Safe work clothes

- Volunteers should wear appropriate clothing such as covered shoes, protective clothing, gloves, and eye protection.

Photo by Liz Foote

▲ *Be prepared when working in the ocean.*

- Rubber gloves should be worn when handling hazardous materials, including water quality testing materials.
- Wear a hat and sunscreen (waterproof) for protection from the sun. Drink plenty of water while working in the heat or the sun.
- Wear brightly colored clothes or safety vests when working

along roadways or near traffic.
- Wear gloves, especially if you have open cuts or wounds and safety glasses when working with chemicals.
- Be aware of pathogenic microorganisms such as Giardia and Leptospira, and try to avoid direct contact with the stream water. Avoid eating food or snacks during sampling to minimize hand to mouth contamination.
- Wash hands after every sampling event and after every experiment.

Using chemicals
- Wear safety glasses and gloves when handling chemicals.
- Know your equipment, sampling instructions, and procedures before beginning.
- Know the chemicals you are using and their hazards (see Material Safety Data Sheets for each chemical in you will use).
- Avoid contact between chemical reagents and skin, eye, nose, and mouth. Never use your fingers to stopper a sample bottle when shaking a solution.
- Do not eat or drink while monitoring. Wash hands thoroughly before contact with eyes, food, or mouth.
- Rinse test vials with deionized or distilled water after each test; dry hands and outside of vial.
- Tightly close all reagent containers after use; check for correct cap.
- Wipe up spills when they occur.

Photo by Jill Komoto

▲ *Wear safety glasses and gloves when handling chemicals.*

Disposal of chemicals
- Chemical waste disposal: In the field, collect all chemical wastes in a clearly labeled plastic container. You may wish to use a separate container for wastes from nitrate and ammonia tests, since the reagents used in these include cadmium and mercury, both heavy metals. Do not dispose of wastes in the stream or on the streambank. Proper disposal of chemical reagents and solutions is necessary since many of them are toxic. Follow your school's recommended procedure for storage and disposal of chemical wastes.

COLLECTING A WATER SAMPLE

M1. Before setting out to monitor:

1. Make a list of all of your monitoring needs. Don't forget the little items! This might include:
   - Designated bucket for disposing of used reagents, used kit items
   - Garbage bags
   - Paper towels
   - Pens/pencils
   - Notebook for additional notes
   - Distilled water
   - Test tube brush.
   - Drinking water (Stay hydrated!)
   - Gloves
   - Safety goggles
   - Tables/tents/chairs
   - Monitoring forms
   - Clipboards
   - Stopwatch, or watch with second hand
   - Copies of monitoring protocols (copy on waterproof paper or laminate)
2. At least two weeks prior to starting your monitoring program, check to make sure that any reagents or other products have not expired.
3. Read all instructions for your equipment before going out to monitor.
4. Calibrate equipment according to instructions provided with the equipment.
5. Prepare for various weather conditions. You may need to bring tents, raingear, sunscreen or rocks to hold materials down during windy conditions. During windy conditions, make sure everything is secure: have a closed plastic box to hold materials not being used and/or assign a volunteer to keep an eye on all equipment.

M2. Preparing the collection container

General preparations

- Label bag or bottle with site number, date and time.
- Tear off the top of the bag or remove the cap just prior to sampling. Try to avoid touching the inside of the container.
- Never touch inside of a sterile whirl-pak or bottle.

Preparing reusable sampling container:

- Wash each sample bottle or glassware piece with a brush and phosphate free detergent.
- Rinse three times with cold tap water.
- Rinse with 10 percent hydrochloric acid.
- Rinse three times with deionized water.

M3. Where to sample

In a **stream**, sample away from the stream bank in the main channel- avoid stagnant water. If shallow, wade carefully out into the center current, disturbing as little of the bottom sediment as possible. Collect the water in an area that is fast flowing, without whitecaps and is at least 6-8" deep.

In **coastal waters**, take the sample approximately six inches below the surface of the water in ankle to knee deep water from an area where waves are breaking or water is agitated. Take the sample during an incoming surge of water. Try to avoid taking the sample from an area where the water is not moving. (Surfrider Blue Water Task Force)

M4. Collecting standard samples in shallow water

A standard sample is used to collect measurements on site including turbidity, pH, conductivity, nitrates, and phosphates. Standard samples are rinsed in the water body three times before being filled to insure that any contaminants that may have been in the sample container are removed prior taking the actual sample.

Taking a standard sample using a Whirl-pak bag

1. Fill and rinse out the bag with water from your waterbody three times. Make sure that the rinse water is thrown out downstream or downcurrent of where you will be taking your actual sample.
2. Hold the two white pull tabs in each hand, lowering the bag into the water with the opening facing upstream or towards the incoming surge of water. The bag should fill with water, if not scoop the water in, by drawing the bag upstream and away from you. Fill no more than three quarter full.

Photos by Randy Bartlett

▲ *Taking a sample using a Whirlpak bag.*

3. Take the bag out of the water, pour out any excess water.
4. Pull on the wire tabs to close the bag. Hold onto the wire tables and flip the bag 4-5 times quickly to seal the bag- there is no need to squeeze the air out of the top of the bag.
5. Fold the end of the wire tabs together at the top, twist them together forming a loop.
6. Place sample standing straight up in the cooler supported with ice or ice packs.

Taking a standard sample using a bottle

1. Fill and rinse out the bottle and cap with water from your waterbody three times. Make sure that the rinse water is thrown out downstream or downcurrent of where you will be taking your actual sample.
2. Hold the bottle near its base and plunge it below the water surface. Collect a water sample 8 to 12 inches beneath the surface or mid-way between the surface and the bottom if the stream reach is shallow.
3. For the bottle, leave a 1-inch air space (except for DO and BOD samples) so that the sample can be shaken right before analysis. Recap the bottle carefully.
4. Place sample standing straight up in the cooler supported with ice or ice packs.

M5. Collecting samples in deep water

You may want to collect ocean samples from boats or off piers/bridges, or in a deep stream. Some people use a special sampling device called a Niskin sampler (cost ~ $360). The Niskin sampler is attached to a rope or cable and is lowered into the waterbody being sampled. This device is equipped with a messenger (weight) that triggers the Niskin sampler to close at a specific depth.

A much cheaper alternative is to get a bucket and rope ($5) or attach a bottle to a pole. In each case, make sure you rinse out the container three times with the sample water before taking a sample. Toss the bucket off the boat/bridge; let it sink and fill. Haul it up; swirl it around; spill it out; toss the bucket back again. Now you can take a sample with your prepared bottle. When you rinse the sample bottle with water from a bucket it's important to keep swirling the water in the bucket so that particles do not settle to the bottom and you have a representative sample. Again, rinse the bottle three times first.

▲ *Niskin deep water sampler*

If you are transporting your samples, make sure that the sample is placed in a cooler with ice. The bacteria samples should be tested within six hours of taking the sample.

M6. Collecting preserved samples

Preserved samples are water samples requiring some type of chemical additive to prevent the sample from undergoing unwanted chemical reactions. Never place the preserved sample container direction into the waterbody. Use the specifically designated "filling container" to fill the sample bottles containing the preservative.

M7. Cleaning sampling containers

Make sure you rinse out all sampling containers (this includes re-usable sampling bottles, test tubes, sample cups, etc) with fresh water, scrubbing bottles and tubes with a brush, followed with a distilled water rinse.

Any kit using cadmium, such as the Chemetrics Nitrate kits should store used waste in a separate cadmium waste container for special disposal at a designated toxic waste disposal site. Dispose of all other used chemicals into your designated waste bucket. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool.

M8. Equipment storage and maintenance

Read the safety instructions carefully that should come with each piece of equipment. In general, all equipment should be kept in a safe and cool place, out of sunlight, areas that could potentially be flooded and out of the reach of keiki. It is recommended that you maintain records for checking out and in the equipment, inspection of equipment, maintenance records and when the equipment is calibrated. Borrowing information should include the person's name, signature, date/time out, date/time in, type of equipment, borrower's phone number. If you are required to prepare a QAPP, details on how equipment is stored and maintained is required.

WATER MONITORING PROTOCOLS

Physical Parameters

Conductivity/Salinity

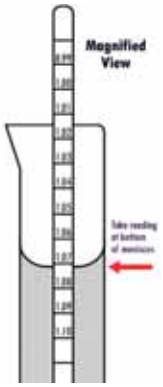
P1. HYDROMETER

(cost ~ hydrometer and jar-$36; thermometer-$6-$15)

Read all safety cards and familiarize yourself with all procedures before using equipment. Be careful when using a hydrometer; it is fragile and creates toxic waste when broken. Because of its fragility, it is not as portable as other methods, and you will need to use a table to convert specific gravity to salinity.

What you'll need:
- Hydrometer
- Hydrometer jar
- Thermometer
- Hydrometer conversion table
- Distilled water

Fill a graduated cylinder (3/4 full) with your sample water and insert the thermometer so it is completely submerged. Record the temperature reading. Remove the thermometer and place the hydrometer in the cylinder. Wait until the hydrometer has stopped bobbing around. Be sure that your eye is even with the water level in the graduated cylinder, at the bottom of the meniscus. (See figure 9-1) Viewing at an angle can give an inaccurate reading. Read and record the number on the hydrometer that best matches up with water level. This is the specific gravity of the sample.



Follow along the top row of table to the column with the temperature (C) of the water sample. Then, follow down the right side of the table, the Observed Reading row, to the reading obtained from the hydrometer. Where the column and the row intersect on the table is the salinity reading for the water sample. It is expressed in parts per thousand (ppt). The range of this method is limited to 16-40 ppt, with an extent of error +/- 10%.

Make sure you rinse out your equipment with distilled water.

▲ *Figure 9-1: How to read a hydrometer*

P2. REFRACTOMETER: AQUATIC ECO-SYSTEMS SALINITY REFRACTOMETER (cost-$42 to $109)

Read all safety cards and familiarize yourself with all procedures before using equipment.

What you'll need:
- Refractometer
- Kimwipes
- Distilled water

Calibrate refractometer: see instrument manual for calibration instructions.

Testing procedure:
1. Because this test is temperature sensitive, try to keep the refractometer as close as possible to room temperature. Keep the refractometer out of the sun, and do not hold it in your hand when not in use.
2. Close the daylight plate gently.
3. Open the daylight plate and apply 1 or 2 drops of the water sample onto the prism surface.
4. The water sample solution will spread into a thin film between the daylight plate and prism. The sample should be spread completely over the prism surface with no bubbles. If not, repeat steps 2 and 3 with more of the water sample.
5. Stand with your back to the sun. Hold the refractometer with the daylight plate upwards and observe the field of view through the eyepiece. If the field of view is not clear, adjust it by turning the cross strip portion on the eyepiece either clockwise or counterclockwise.
6. Read the scale where the boundary line of the blue and white fields cross the scale.
7. The value of the scale to the right of the field of view is the salinity in parts per thousand.
8. Record your value on your data sheet.
9. Open the daylight plate and rinse the prism with deionized water.
10. Lightly dab (not wipe) the prism with a Kimwipe to dry.

Photo by Jeff Zimpfer

▲ *Using a refractometer.*

P3. WATER TEMPERATURE & CONDUCTIVITY COLE PARMER CON 400 METER (cost ~ $515)

This meter can be used with fresh and salt water. (From Heal the Bay Fresh and Marine Water Team)

What you'll need:
- Conductivity meter
- Distilled water

Read all equipment instructions to familiarize yourself with all parts of the equipment before continuing. Calibrate equipment according to instructions included by the manufacturer.
1. Connect the probe to the conductivity meter by aligning the slots at the top of meter and end of probe.
2. Take a water sample using the same procedure as in "Collecting Water Samples" at the beginning of this section or take measurements directly in the water body.
3. Note: Temperature results are only recorded from measurements taken directly in the waterbody.
4. Press and release the ON/OFF button to turn the meter on.
5. Hit the ENTER/RANGE button slowly and deliberately

three times. Once the ENTER/RANGE button is pressed the Meas light should start to flash. The first time you hit the enter button, the LCD should display two decimal places 0.00 uS. Each time the ENTER/RANGE button is pressed the meter will drop a decimal place. The second time you should see 0.0 uS and the third time 0 uS.

▲ *Conductivity meter*

6. Dip the probe into the sample container making sure that the second metal band on the probe is submerged in the water sample or waterbody. If the meter says OR (Over Range) hit the ENTER/RANGE button again. The LCD will then display in mS.
7. Use the probe to stir the sample and allow time for the meter to correct the readings for solution temperature changes. The temperature must remain stable for at least one minute before you record the result.
8. When the temperature has been stable for longer than one minute note the conductivity reading on the LCD. * Note: If your reading is below 300 uS remove the probe from the sample and turn the meter off by pressing the ON/OFF button. Repeat steps 3-10. If the results are still below 300 uS record the result and make your monitoring program leader aware of this measurement.
9. Record results under the appropriate column (uS/cm or mS/cm) on your Field Sheet under conductivity. Record water temperature results and the time.
10. Pour the sample back into the waterbody, and take a new sample with the same container. If you are sampling directly in the waterbody move to a slightly different location.
11. Repeat steps 2-10.
12. Press and release the ON/OFF button when finished to turn the meter off.
13. Always rinse the probe and electrode with distilled water and shake dry.
14. Disconnect the probe from the meter.

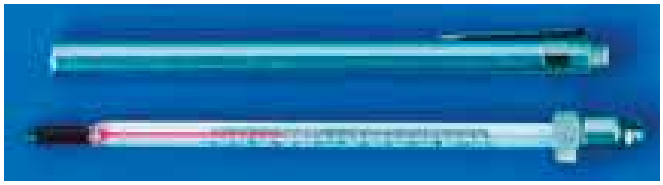
Temperature

P4. LAMOTTE GREEN WATER MONITORING KIT (total kit cost ~ $200):

Read all safety cards and familiarize yourself with all procedures before using equipment.

Submerge the temperature strip on the white container four inches under water (if possible) for one minute. The water temperature will be indicated in green.

P5. FISHERBRAND 15-021B POCKET FIELD THERMOMETER OR OTHER THERMOMETER; (cost ~$6-$15)


▲ *Thermometer*

Read all safety cards and familiarize yourself with all procedures before using equipment. Wear safety goggles and gloves, especially if using a mercury thermometer!

1. Read all instructions before use.
2. Lower thermometer three inches below the water surface. Pick a site out of direct sunlight.
3. Keep the thermometer below the water surface for about 2 minutes to ensure a constant reading.
4. Read the thermometer while it is still in the water.
5. To measure air temperature, pick a site out of direct sunlight, hold the thermometer by the top (not the bulb end) and read the air temperature after 3 minutes.
6. Be careful not to break the thermometer. If a mercury thermometer breaks, collect all spilled mercury and the pieces of the thermometer into a sampling container for special disposal at the University of Hawai'i or a designated toxic waste disposal site.

Total Dissolved Solids

There are several different models of TDS testers to use; below are instructions for Oakton Waterproof TDSTestr and ECTestr series. Use the chart below provided by Oakton to determine which model to use.

P6. OAKTON WATERPROOF TDS TESTER 2, 3 (cost ~$70)

Read all equipment instructions to familiarize yourself with all parts of the equipment before continuing.

What you'll need:

- TDSTestr
- Rubbing alcohol
- Distilled water
- Container to soak electrode in alcohol
- Three containers for calibration

Before you get started:

Remove electrode cap. Switch unit on for 15 minutes to stabilize the batteries. Soak electrodes for a few minutes in alcohol to remove oils. Caution: Never immerse the electrode above color band! This will damage instrument electronics!

Calibration:

Select a calibration standard appropriate for your waterproof TDSTestr:

TDSTestr 2: between 3 ppt and 10.00 ppt

TDSTestr 3: between 300 µS and 1990 µS

Select a standard calibration solution close to the test solution value, and one that has a similar chemical make-up to the test solution. To determine the chemical makeup of your test solution, go back to your research on the waterbody (a task from Section 4) to see what information has been collected on your waterbody previously. Generally, NaCl is used for brines and the 442 formulation is used for general water and waste water, rinse water, boilers and cooling towers, lakes, streams and wells. If you don't do this, there will be significant discrepancies between the ppm or ppt reading and the actual ppm or ppt of TDS in the test solution. Use a ready-made standard solution that has the same types of dissolved solids as the solution to be tested.

Choose a ready-made calibration solution according to the following guidelines:

1. Choose a TDS standard calibration solution that contains the same types of dissolved solids to be tested.
2. Choose a TDS standard calibration solution that has a ppm or ppt value as close as possible to the value of the solution to be tested. If this is not reasonable because of the variations in the test solution, it is best to calibrate the TDS indicator with a TDS standard that has a ppm or ppt value in the upper one-third of the TDS indicator's measurement range.
3. The following (Table P6) is a list of ppm TDS standard calibration solutions available from Oakton for Oakton Instruments, with their contents and applications described. Standardization values of the calibration solutions are based on conditions of 25°C.

▲ *Oakton TDS tester*

*442 is a formulation of 40% sodium sulfate, 40% bicarbonate and 20% sodium chloride that is used as a TDS Standard for testing natural waters (i.e. lakes and streams) and boiler and cooling tower waters.

If this list does not contain a conductivity standard calibration solution required by application, it is possible to have "tailor made" conductivity calibration solutions produced at a local testing laboratory. Consult your OAKTON Distributor for alternatives.

Instructions for calibration

1. Pour calibration standard into two separate containers and tap or deionized water into a third.
2. Rinse electrode in the deionized water, then rinse it in first container of standard, then dip it into the second container of standard.
3. Switch unit on (ON/OFF button). Wait several minutes to allow display to stabilize.
4. Using a small screwdriver, adjust the trimpot (located inside the Testr's battery compartment) until the display reads the same value as the standard.
5. Rinse the electrode in the tap or deionized water and proceed with testing.

TDS or Conductivity Testing

1. Remove electrode cap. Switch unit on (ON/OFF key).
2. Dip electrode into test solution. Make sure sensor is fully covered.
3. Wait for reading to stabilize (Automatic Temperature Compensation corrects for temperature changes). Note reading.
4. Press ON/OFF to turn off Tester. Replace electrode cap. Note: Tester automatically shuts off after 8.5 minutes of nonuse.

HOLD function

Press HOLD key to freeze display. Press HOLD again to release.

Setting TDS Factor (TDSTestrs only)

The TDSTestrs let you select a TDS factor of 0.4 to 1.0.

APPLICATION	CALIBRATING STANDARD	USE WITH:	ADJUST INSTRUMENT DISPLAY TO:
TDS of lake, stream, well waters, boiler and cooling tower waters, general water treatment, waste water and brines	WD-00653-89	TDSTestr 2	7.61 ppt (442*) 7.23 ppt (NaCl) 1 pt.
General	WD-00653-18	TDSTestr 3	1410 uS

▲ *Table P6: Oakton standard calibration solutions.*

1. Open battery compartment. With meter on, press the HOLD key, then press the INC key (INC key is inside battery compartment; see diagram at left).
2. Press the INC or DEC keys to adjust the TDS factor.
3. After 3 seconds without a key press, the display flashes 3 times, then shows "ENT". Tester accepts TDS factor and returns to measurement mode.
4. Replace battery cap.

P7. SEND SAMPLE TO THE LAB

If total dissolved solids or total suspended sediment is a problem in your waterbody, you'll want to send your water sample to a lab. Here they will be able to measure the solids more accurately, by drying and weighing the solids.

Turbidity

P8. LAMOTTE GREEN WATER MONITORING KIT (total kit cost ~ $200):

Read all safety cards and familiarize yourself with all procedures before using equipment.

Fill the white container included in the Lamotte kit to the fill line (being careful not to stir up the bottom sediment). Look for the secchi disk on the bottom of the container. Compare the visibility of the secchi disk to your color card.

▲ *Lamotte kit, viewing the secchi disk.*

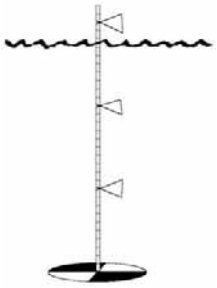
P9. SECCHI DISK (cost ~ $43 or make your own)

Read all safety cards and familiarize yourself with all procedures before using equipment. Wear safety goggles!

What you'll need:

- Secchi disk, with measuring line. Use a white disk for measuring the clarity of the water in saltwater and the black/white disk for freshwater.
- Clothespin

1. Check to make sure that the Secchi disk is securely attached to the measured line.
2. Lean over the side of the boat/bridge (be careful!) and lower the Secchi disk into the water, keeping your back toward the sun to block glare.
3. Lower the disk until it disappears from view. Lower it one third of a meter and then slowly raise the disk until it just reappears. Move the disk up and down until the exact vanishing point is found.
4. Attach a clothespin to the line at the point where the line enters the water. Record the measurement on your data sheet. Repeating the measurement will provide you with a quality control check.



▲ *Secchi disk*

P10. TRANSPARENCY TUBE (cost ~ $40-$50):

Read all safety cards and familiarize yourself with all procedures before using equipment.

1. Collect water sample as directed in instructions. Remove any large objects from the water sample.
2. Stir sample for 15 seconds to suspend all materials.
3. Stand out of direct sunlight, or use your body to cast a shadow on the tube.
4. Slowly pour a small amount of sample into the tube. Look for target disk on the bottom of the tube. If disk is visible, add water until it just disappears.
5. If target is not visible, pour water off water a little at a time (or use release valve) until disk is just visible.
6. Record nearest NTU mark, or use a tape measure to measure from disk at bottom of tube to top of water level.
7. Record measurement on data sheet. Make sure you indicate centimeter or inches if you used a tape measure. Dump contents of tube.
8. Repeat steps 2 through 7.
9. Record the second measurement on the data sheet. Indicate if you measured in cm. (centimeters) or in. (inches).
10. Add both of the readings and divide by two and record this number on the data sheet.

Photos by Jill Komoto

▲ *Using a transparency tube.*

11. Use the turbidity value conversion chart (See Table 9.1) to determine the turbidity value from the average measurement (step 12) if you measured with a tape measure. If you used the NTU measurements written on the tube, record this information.*
    *If disk is still visible after being filled to the top mark, please record as <10 NTUs
12. Rinse out the tube with distilled water prior to storage.

P11. NEPHOLOMETER/TURBIDIMETER: LAMOTTE PORTABLE TURBIDIMETER, MODEL 2020; (cost ~$800)

Read all equipment instructions to familiarize yourself with all parts of the equipment before continuing.

What you'll need:
- Turbidimeter
- Paper towels

Calibration: Calibrate the turbidimeter according to equipment instructions.

Testing Procedure (Adapted from the Heal the Bay Freshwater and Marine Team Guide)

▲ *Turbidimeter*

1. Rinse the two empty turbidity tubes and caps (comes with the kit) with sample water three times. Shake out excess water.
2. Fill both turbidity tubes to the neck so that there are no air bubbles. Make sure to take the "cleanest" sample you can, by going upstream or upcurrent of any other team members that might be clouding the water.
3. Cap the tubes and wipe them dry. Make sure they are dry and clean- no fingerprints!
4. Hold one tube upside-down before inserting it into the meter. Be careful not to create bubbles.
5. Open the meter lid. Align the indexing arrow on the tube with the indexing arrow on the meter. Insert the turbidity tube into the chamber.
6. Close the lid. Push the READ button. The turbidity in NTU units will be displayed within 5 seconds.
7. Repeat steps 4-6 two more times with the first tube. Then repeat steps 4-6 three times with the second tube. In the end, you should have a total of 6 turbidity readings (3 for each tube).
8. To turn the meter off, hold the READ button down for several seconds until the display says "off".
9. Rinse all tubes with distilled water.

Centimeters	Inches	Turbidity Value
6.4 to 7.0	2.5 to 2.75	240
7.1 to 8.2	2.76 to 3.25	185
8.3 to 9.5	3.26 to 3.75	150
9.6 to 10.8	3.76 to 4.25	120
10.9 to 12.0	4.26 to 4.75	100
12.1 to 14.0	4.76 to 5.5	90
14.1 to 16.5	5.6 to 6.5	65
16.6 to 19.1	6.6 to 7.5	50
19.2 to 21.6	7.6 to 8.5	40
21.7 to 24.1	8.6 to 9.5	35
24.2 to 26.7	9.6 to 10.5	30
26.8 to 29.2	10.6 to 11.5	27
29.3 to 31.8	11.6 to 12.5	24
31.9 to 34.3	12.6 to 13.5	21
34.4 to 36.8	13.6 to 14.5	19
36.9 to 39.4	14.6 to 15.5	17
39.5 to 41.9	15.6 to 16.5	15
42.0 to 44.5	16.6 to 17.5	14
44.6 to 47.0	17.6 to 18.6	13
47.1 to 49.5	18.7 to 19.5	12
49.6 to 52.1	19.6 to 20.5	11
52.2 to 54.6	20.6 to 21.5	10
>54.7	>21.6	<10

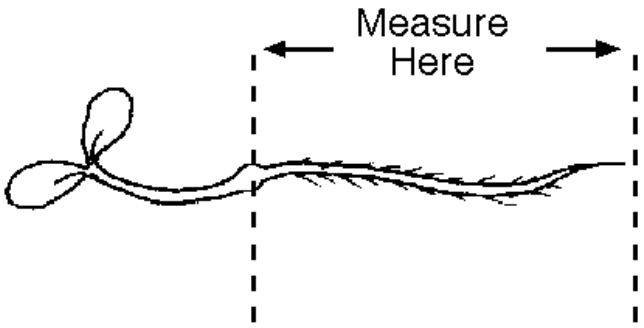
▲ *Table 9.1 Turbidity chart*

Chemical parameters

Chemicals

C1. LETTUCE SEED BIO-ASSAY (cost ~ Petri dishes-20 for $7; seeds- $3; whirlpak-100 for $17)

While chemical analysis of water samples can be costly, here is a simple method to determine presence of chemicals, especially herbicides. Plant seeds, such as lettuce seeds are excellent test organisms as they remain dormant and may be stored in a refrigerator for months. Once hydrated, they undergo rapid physiological changes and become highly sensitive to environmental stress. Lettuce seed germination/root elongation bioassay has two endpoints: seed germination and root length. Each endpoint is sensitive to different pollutants to different degrees. With presence of these toxicants, there will be a noticeable reduction in seed germination and root length. The most common lettuce seed varieties used are "Buttercrunch" and "Black-Seeded Simpson".



▲ *Figure 9-2: Measuring root length*

What you'll need:

- Lettuce seeds- Buttercrunch or Black-Seeded Simpson
- Whirlpak or bottle
- Gloves
- Safety glasses
- Bleach, such as Clorox
- Distilled water
- Measuring cup or tube
- Petri dishes (6)
- Sharpie pen (waterproof)
- 9-cm Whatman #1 filter paper
- Pipette or dropper
- Calculator or computer with spreadsheet

To avoid collecting surface film which is usually more contaminated than the underlying water, submerge the bottle or Whirpak bag about 6 inches and the water bubble in. See protocols M2-M5 on how to collect samples. Use gloves and eyewear when preparing the assay.

Performing the assay:

1. Prepare a solution comprised of 1 part Clorox to 10 parts distilled water.
2. Soak the seeds for 20 minutes in the 10% solution of Clorox in distilled water, then rinse 5 times with distilled water. The Clorox will kill any fungi that may interfere with seed germination.
3. Label three10 cm plastic Petri dishes per sample with: date/time; sample water ID and seed type.
4. Place 9-cm Whatman #1 filter paper into the labeled Petri dishes. Three replicate dishes per sample are recommended.
5. Pipette 5 to 7 ml of undiluted sample onto the filter paper (enough to saturate the paper). Use the same volume in all tests. Also prepare 3 control dishes, using distilled water instead of the sample.
6. Place 10 seeds on the paper, spaced evenly.
7. Incubate dishes at room temperature, in the dark, for 5 days. You can check the dishes briefly during incubation. If the paper seems dry, pipette a few ml of distilled water onto the paper.

Interpreting the results

1. For each dish, record the following
   a. The percent of seeds that germinated
   b. The individual root length, to the nearest mm (Figure 9-2)
2. If fewer than 80% of the sees in the control sample germinate, this indicates a problem with the assay (e.g. bad seeds, poor incubation conditions) and the test should be re-run.
3. For each sample (including the control) calculate the mean and standard deviation for each endpoint. Comparisons can be made by using the Student's t-test. Another less quantitative method is to compare the mean +/- 1 standard deviation of each sample to the control. If a sample's mean +/- 1 standard deviation does not overlap with that of the control, there is a strong likelihood that the sample is significantly more toxic than the control.
4. Tip: If your control sample using the distilled water has a lower seed germination than in the test water samples, there may be a lack of dissolved salts in the distilled water that stresses the seeds and roots. One solution is to use dechlorinated tap water as your control source.

If you find that the water body you are testing does not cause a noticeable reduction in seed germination or root growth, then try one of the following methods: test the sediment or use a positive control. Silty sediments usually contain higher concentrations of most contaminants than does water.

Testing sediments using the lettuce seed assay:

1. After labeling the Petri dishes, cover the bottom with sediment, smooth the surface, place the filter paper on top, and add the seeds. If the sediment does not adequately saturate the filter paper, add distilled water.
2. If you have a soil sample, you first need to prepare a liquid solution called an elutriate. To do this, combine 1 part sample with 4 parts distilled water in a clean jar, shake vigorously for 3 minutes, let settle overnight, and draw off the overlying water (elutriate) to use in the assay. Follow procedures in the previous step and with the water sample to germinate and analyze the results.

Using a positive control:

Also known as a "reference toxicant", a positive control is an artificial sample containing a sufficient concentration of a toxicant to cause a measurable toxic effect. The most common reference toxicant used is non-iodized sodium chloride (table salt: NaCl). Prepare the sample using 2 g NaCl per liter of distilled water. This will cause some seed mortality and reduce root growth by about 50% compared to the negative control.

'C2: OTHER- DETERGENTS HACH MODEL DE-2 (cost ~ $230)

This test responds to synthetic detergents such as laundry detergents, dish detergents, and car wash detergents. It does not respond to soaps. Soaps are salts of fatty acids, whereas detergents are salts of sulfonic acids. The Hach test responds primarily to LAS detergents (linear alkylate sulfonate) and ABS (alkyl benzene sulfonate) detergents.

WARNING: The chemicals in this kit may be hazardous to the health and safety of the user if inappropriately handled. Read all warnings carefully before performing the test and use appropriate safety equipment.

What you'll need:

- Hach Model DE-2 Test kit
- Demineralized water
- Distilled water

Instructions:

1. Fill one of the test tubes to the upper mark (20 mL) with the water to be tested.
2. Add 12 drops of Detergent Test Solution and shake to mix.
3. Add chloroform to the lowest mark (5 mL) on the test tube. (Chloroform is heavier than water and will sink.) Place the stopper on the test tube, shake vigorously for 30 seconds and allow to stand for one minute to allow the chloroform to separate.
4. Using the draw-off pipet, remove the water from the tube and discard.
5. Refill the test tube to the upper mark with the Wash Water Buffer and, using the draw-off pipet, remove the Wash Water Buffer and discard. This step washes away the remaining water sample.
6. Refill the test tube to the upper mark with the Wash Water ™Hach Company trademark Buffer, place the stopper on the test tube and shake vigorously for 30 seconds. Allow the tube to stand for one minute to allow the chloroform to separate.
7. Insert the test tube containing the prepared sample in the right opening of the color comparator.
8. Fill the other test tube with demineralized water and place it in the left opening of the comparator.
9. Hold the comparator up to a light, such as the sky, a window or a lamp, and view through the two openings in the front. Rotate the Detergents Color Disc until a color match is obtained. Read the ppm Detergents (LAS and/ or ABS) from the scale window.
10. If the color is darker than the highest reading on the color disc, the original sample may be diluted 20-to-1 by adding 1 mL of sample to the test tube (using the plastic dropper filled to the top, or 1-mL mark) and filling the test tube to the upper mark (20 mL) with demineralized water. Repeat Steps 2 through 9 and multiply the results by 20.

Notes:

If the water sample is turbid, the chloroform layer must be filtered after Step 6, using the procedure given below.

a. Place a small ball (about the size of a large pea) of glass wool in the filter thimble.
b. Using the draw-off pipet to remove the chloroform, filter the chloroform through the glass wool and into the extra test tube.
c. Proceed with Step 7.
d. Enough Wash Water Buffer is included for 32 tests. Enough Detergent Test Solution and Chloroform are included for approximately 90 tests.

Dispose of used chemicals into your designated waste bucket. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool.

Prior to storing of the kit, clean all test tubes by scrubbing them with a test tube brush using only tap water. Don't use soap or detergent. Rinse tubes and any equipment with distilled water before putting the kit away.

Dissolved Oxygen (DO)

C3. LAMOTTE GREEN WATER MONITORING KIT (total kit cost ~ $200):

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

Fill the small glass tube until it is overflowing. Add two DO test tabs to the glass tube. Cap the tube and shake it until the tablets have disintegrated (about four minutes). Wait an additional five minutes. Compare the color of the sample to the color card and record the results as ppm dissolved oxygen.

C4. DISSOLVED OXYGEN TEST KIT CHEMETRICS DO KIT, 1-12 PPM; (cost ~ $35)

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

What you'll need:

- Dissolved oxygen kit
- Eyedropper
- Paper towels
- Distilled water
- Bucket for disposal of used ampoule
- Stopwatch or watch with second hand

Using test kits to obtain accurate dissolved oxygen is difficult; exposure to the air will cause the sample to reach saturation. Biological activity can cause oxygen to deplete. With the following instructions, try to use a steady hand to reduce shaking the sample too much when dipping and pouring.

▲ *Eyedropper*

▲ *Ampoule*

▲ *Snapper cup* ▲ *DO color comparator*

Test Procedure

1. Fill the sample cup to the 25 mL mark (middle of arrow) with your sample water. Use an eyedropper to add or remove sample water. (fig. 1)
2. Place the CHEMet ampoule in the sample cup. Snap the tip by pressing the ampoule against the side of the cup. Don't break the tip off completely. The ampoule will fill, leaving a small bubble to facilitate mixing (fig. 2).
3. Take the ampoule out of the cup. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end each time. Wipe all liquid from the exterior of the ampoule. Wait 2 minutes for color development. (fig 3)
4. Hold the comparator in a nearly horizontal position while standing directly beneath a bright source of light. Place the CHEMet ampoule between the color standards moving it from left to right along the comparator until the best color match is found (fig 4). If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made.

Dispose of ampoules in a small trash bag. Dispose of used chemicals into your designated waste bucket. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool. Make sure you rinse and scrub all containers that held chemicals with tap water; rinse with distilled water prior to storage.

▲ *Fig 1*

▲ *Fig 2*

▲ *Fig 3*

▲ *Fig 4*

C5. POLAROGRAPHIC METHOD, DO METER: YSI 55 DISSOLVED OXYGEN METER (cost ~ $665-$759 depending on cable length)

▲ *YSI Dissolved Oxygen meter*

Read all equipment instructions to familiarize yourself with all parts of the equipment before continuing.

Calibrating the DO Meter: If you are sampling in a lagoon or in the ocean, take a salinity measure first. You will need this value to calibrate the DO meter. Because DO can be affected by altitude, you must calibrate the DO meter to reflect the altitude of each site. See the meter manual for detailed calibration instructions.

Testing Procedure

1. Remove the probe from the calibration chamber. Lower the probe in the water halfway between the surface and the bottom of the water column. Be careful not to let the probe hit the bottom.
2. If the water is fairly still, move the probe tip through the water at a rate of one foot per second by creating circles in the water (try to keep your circles the same size and move your probe at a consistent speed).
3. Once the meter stabilizes, you will record three things:
   a. Dissolved oxygen measured in mg/l
   b. Dissolved oxygen measured in % saturation
   c. Temperature measured in °C
4. Use the "mode" button to switch between % saturation and mg/l.
5. Repeat steps 1-3 two more times, in two different areas of the stream or coastal area. In the end, you should have

Temperature (°C)	Do (mg/L)	Temperature (°C)	Do (mg/L)	Temperature (°c)	Do (mg/L)
0	14.6	16	9.85	32	7.28
1	14.19	17	9.65	33	7.16
2	13.81	18	9.45	34	7.16
3	13.44	19	9.26	35	6.93
4	13.09	20	9.07	36	6.82
5	12.75	21	8.9	37	6.71
6	12.43	22	8.72	38	6.61
7	12.12	23	8.56	39	6.51
8	11.83	24	8.4	40	6.41
9	11.55	25	8.24	41	6.41
10	11.27	26	8.09	42	6.22
11	11.01	27	7.95	43	6.13
12	10.76	28	7.81	44	6.04
13	10.52	29	7.67	45	5.95
14	10.29	30	7.54		
15	10.07	31	7.41		

▲ *Table 9.2: Maximum DO Concentration at Temperature Reading*

taken 3 different readings 3 times. To calculate percent saturation of the sample:

6. Find the temperature of your water sample as measured in the field.
7. Find the maximum concentration of your sample at that temperature as given in Table 9.2.
8. Calculate the percent saturation, by dividing your actual dissolved oxygen by the maximum concentration at the sample temperature.

Nutrients

Monitoring for nutrients can be costly, especially if you send the samples out to a commercial lab. But for better results and if you are adhering to EPA standards, you should send samples to a lab. The manual method listed below is a good teaching instrument and can alert officials to potential problems if the area is sampled on a regular basis. UH researchers found that the Nitrate-nitrite method using the low cost kits provided a reasonable low resolution estimate for nitrate nitrogen.

Check to see whether other organizations such as the University of Hawai'i, US Geological Survey, or EPA are conducting monitoring in the area.

Nitrates

C6. LAMOTTE GREEN WATER MONITORING KIT (total kit cost ~ $200): Nutrients, #5971

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

Test Procedure

1. Fill the test tube (0106) to the 5 mL line with the water sample.
2. Add one *Nitrate #1 TesTab (2799).
3. Cap the tube and mix until the tablet has disintegrated.
4. Add one *Nitrate #2 TesTab (NN-3703).
5. Cap the tube and mix until the tablet has disintegrated.
6. Wait 5 minutes.
7. Hold the tube against the white part of the Nitrate Color Chart (5891-CC). Match the color of the solution in the tube to a color on the Nitrate Color Chart.
8. Record the Nitrate test result.

C7. CADMIUM REDUCTION METHOD: Chemetrics Nitrate Kit 6904D (cost ~ $60)

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

What you'll need:

- Nitrate kit
- Eyedropper
- Distilled water
- Bucket for disposal of used ampoule
- Stopwatch or watch with second hand
- Paper towels

The Nitrate VACUettes®1 test method employs the cadmium reduction method. Results are expressed in ppm (mg/Liter) NO3-N. Samples containing nitrite will give erroneous, high test results. Samples containing in excess of 2000 ppm chloride will give low test results. Certain metals, chlorine, oil and grease will also give low test results.

▲ *Snapper cup*

▲ *Eyedropper*

▲ *Ampoule*

▲ *Sample cup*

▲ *Nitrate color comparator*

Test Procedure

1. Fill the 25 mL dilutor snapper cup to the top edge with distilled water (fig 1).
2. Fill the 5 mL sample cup to the 5 mL mark (middle of arrow) with your sample water (fig 1). Use an eye dropper to add or remove sample water.
3. Empty the contents of one Cadmium Foil Pack into the sample cup. Cap the cup and shake it vigorously for exactly 3 minutes. Allow the sample to sit undisturbed for 2 minutes.
2. Make sure that the VACUette tip is firmly attached to the ampoule tip.
3. Holding the VACUette almost horizontally, touch the tip to the contents of the sample cup (fig 2). NOTE: The capillary tip will fill completely with sample.
4. Put the VACUette into a vertical position. A small portion of the collected sample (shaded area) should fall into the sleeve of the VACUette tip (fig 3). NOTE: If none of the sample falls, a light tap near the shoulder of the ampoule will accomplish this.
5. Place the VACUette in the dilutor snapper cup and snap the tip (fig 4). Don't break the tip off completely. The ampoule will fill leaving a bubble to facilitate mixing.
6. Take the ampoule out of the cup. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end. (fig 5) Dry the exterior of the ampoule and wait 10 minutes for color development.
7. Hold the comparator in a nearly horizontal position while standing directly beneath a bright source of light. Place the VACUette ampoule between the color standards moving it from left to right along the comparator until the best color match is found (fig 6). If the color of the VACUette ampoule is between two color standards, a concentration estimate can be made.
8. Any kit using cadmium, such as the Chemetrics Nitrate kits should store used waste in a separate cadmium waste container for special disposal at a designated toxic waste disposal site. Make sure you rinse and scrub all containers that held chemicals with tap water; rinse with distilled water prior to storage.
9. The CHEMets Nitrate 0-1 and 1-5 ppm using the Zinc reduction method can be used with seawater; however as of October 2007 the product is not yet available and is expected to be out in 2008. Nitrate is reduced to nitrite in the presence of zinc. This test method is applicable to industrial wastewater, drinking water, surface water and seawater. It can also be used to measure nitrate in the presence of up to 0.4 ppm (mg/Liter) nitrite-nitrogen (NO2-N) by difference.

▲ *Fig 1*

▲ *Fig 2*

▲ *Fig 3*

▲ *Fig 4*

▲ *Fig 5*

▲ *Fig 6*

Phosphate

C8. LAMOTTE GREEN WATER MONITORING KIT (total kit cost ~ $200): Nutrients #5971

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

Test Procedure

1. Fill the test tube (0106) to the 5 mL line with the water sample.
2. Add one * Phosphorus TesTab (5422).
3. Cap the tube and mix until the tablet has disintegrated.
4. Wait 5 minutes.
5. Hold the tube against the white part Phosphate Color Chart (5892-CC). Match the color of the solution in the tube to a color on the Phosphate Color Chart.
6. Record the Phosphate test result.

C9. CHEMETRICS CHEMETS 0-1 AND 1-10 PPM STANNOUS CHLORIDE CHEMISTRY METHOD (cost ~ $55)

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

▲ *Eyedropper*

▲ *Ampoule*

▲ *Snapper cup* ▲ *Sample cup* ▲ *Activator solution* ▲ *Phosphate color comparator, low range*

▲ *Phosphate color comparator, high range*

What you'll need:

- Phosphate kit
- Eyedropper
- Distilled water
- Bucket for disposal of used ampoule
- Stopwatch or watch with second hand
- Paper towels

Test procedure:

1. Fill the sample cup to the 25 mL mark (middle of the arrow) with your sample water. Use an eye dropper to add or remove sample water. (fig 1)
2. Add 2 drops of A-8500 Activator Solution (fig 2). Cap the sample cup and shake it to mix the contents well.
3. Place the CHEMet ampoule in the sample cup. Snap the tip by pressing the ampoule against the side of the cup. Don't break the tip off completely. The ampoule will fill leaving a small bubble to facilitate mixing (fig 3).
4. Take the ampoule out of the cup. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end each time. (fig 4) Wipe all liquid from the exterior of the ampoule. Wait 2 minutes for color development.
5. Use the appropriate comparator to determine the level of ortho-phosphate in the sample. If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made. If the ampoule appears to be lighter tan the lowest standard on the high range comparator, then use the low range comparator.
   a. Using the low range comparator: Place the CHEMet ampoule, flat end downward into the center tube of the low range comparator. Direct the top of the comparator up toward a source of bright light while viewing from the bottom. Rotate the comparator until the color standard below the CHEMet ampoule shows the closest match (fig 5).
   b. Using the high range compartor: Hold the high range comparator in a nearly horizontal position while standing directly beneath a bright source of light. Place the CHEMet ampoule between the color standards moving it from left to right along the comparator until the best color match is found (fig 5).

Dispose of ampoules in a small trash bag. Dispose of used chemicals into your designated waste bucket. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool. Make sure you rinse and scrub all containers that held chemicals with tap water; rinse with distilled water prior to storage.

▲ *Fig 1*

▲ *Fig 2*

▲ *Fig 3*

▲ *Fig 4*

▲ *Fig 5*

Nitrogen-Ammonia

C10. CHEMETS AMMONIA-SALICYLATE CHEMISTRY METHOD 0-2, 0-20 PPM #11410 (cost ~ $22)

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

What you'll need:

- Ammonia-Salicylate kit
- Eyedropper

- Bucket for disposal of used ampoule
- Stopwatch or watch with second hand
- Paper towels
- Distilled water

This test method measures free ammonia and monochloramine in drinking water, clean surface water and good quality nitrified wastewater effluent. Results are expressed in ppm (mg/Liter) ammonia nitrogen, NH3-N. High levels of ammonia can reduce the intensity of the developed color from this reagent and give false low test results. Samples suspected to contain ammonia at greater than 10 times the test range (20 ppm if performing the 0 - 2 ppm procedure; 200 ppm if performing the 0 - 20 ppm procedure) must be further diluted to ensure that this phenomenon has not occurred.

▲ *Eyedropper*

▲ *Ampoule*

▲ *Snapper cup*

0 - 2 ppm Test Procedure:

1. Fill the sample cup to the 25 mL mark (middle of arrow) with your sample water (fig 1). Use an eyedropper to add or remove sample water.
2. Add 2 drops of A-1401 Catalyzer Solution (fig 2). Stir briefly with the tip of the ampoule.
3. Add 2 drops of A-1400 Activator Solution (fig 2). Stir briefly with the tip of the ampoule.
4. Immediately snap the tip by pressing the ampoule against the side of the cup. Don't break the tip off completely. The ampoule will fill leaving a small bubble to facilitate mixing (fig 3).
5. Take the ampoule out of the cup. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end each time. (fig 4) Wipe all liquid from the exterior of the ampoule.
6. Wait 15 minutes for color development.
7. Hold the high range comparator in a nearly horizontal position while standing directly beneath a bright source of light. Place the CHEMet ampoule between the color standards moving it from left to right along the comparator until the best color match is found (fig 5). If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made.

▲ *Fig 1*

▲ *Fig 2*

▲ *Fig 3*

▲ *Fig 4*

▲ *Fig 5*

0 - 20 ppm Test Procedure:

1. Using the syringe, dispense 2.5 mL of sample into the sample cup. Then, using ammonia free water, dilute to the 25 mL mark (fig 1).
2. Using this diluted sample, perform Steps 2 through 7 of the 0 - 2 ppm Test Procedure listed above.
3. For final test results, multiply the value obtained from the comparator in Step 7 by a factor of 10.

Dispose of ampoules in a small trash bag. Dispose of used chemicals into your designated waste bucket. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool. Make sure you rinse and scrub all containers that held chemicals with tap water; rinse with distilled water prior to storage.

C11. SEND SAMPLES TO A CERTIFIED LABORATORY

If funding is available, find a certified laboratory. Cost ranges between $25 - 70 per sample, depending on the number of samples submitted (quantity discounts offered), form of parameter (i.e. nitrite + nitrogen, total nitrogen) and/or method used. Contact laboratories for up to date information. Utilize the sample bottles provided by the laboratory you've contracted with and follow the how to take a sample from the first part of this section.

pH

C12. LAMOTTE GREEN WATER MONITORING KIT (total kit cost ~ $200): Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

Fill a large test tube to the 10 mL line. Add one pH test tab. Shake the tube until the test tab has disintegrated. Compare the color of the sample to the color card and record the results as pH (you can take the reading immediately after the test tab has dissolved-you do not have to wait).

C13. PH STRIPS (cost ~ $7):

Find pH strips with a wide range, and with smaller increments, such as pH Hydrion.

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

What you'll need:

- pH Strips

▲ *pH strips*

▲ *Reading the pH strips*

- Gloves
- Sample bottle
- Deionized water
- pH tube

Procedure

1. Rinse the pH tube with sample water and refill.
2. Tear off a piece of indicator paper that is 1 to 2 centimeters longer than the tube. Leave 1-2 cms of paper sticking out the top and recap the tube. This avoids contamination from skin acids on fingers.
3. Wait for five minutes for the full color to develop.
4. Place the tube on the black strip running through the middle of the pH color chart.
5. Match the color of the solution with the colors on the chart to find the pH reading.
6. Have a second person confirm your color match before recording the reading your data sheet.
7. Pour the water into the liquid waste bottle and place the pH paper in the solid waste container.

Maintenance

1. Rinse the tube with deionized water and dry it before returning it to the kit.
2. Minimize damage or staining of the color chart, store in dark.
3. Avoid storing the pH paper in damp conditions as water reacts with dyes in the paper.

C14. COLORIMETER: HACH 17-N WIDE RANGE (4-10) PH TEST KIT (cost ~ $65 for 100 tests):

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

▲ *Hach kit*

1. Fill a viewing tube to the first (5-mL) line with sample water. This is the blank.
2. Place this tube in the top left opening of the color comparator.
3. Fill another viewing tube to the first (5-mL) line with sample water.
4. Add six drops of Wide Range 4 pH Indicator Solution to the second tube. Swirl to mix.
5. Place the second tube in the top right opening of the color comparator.
6. Hold comparator up to a light source such as the sky, a window or a lamp. Look through the openings in front.
7. Rotate the color disc until the color matches in the two openings. Read the pH in the scale window.
8. Dispose of used chemicals into your designated waste bucket. Make sure you rinse all containers with distilled water after use. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool.
9. Rinse out and scrub test tubes using tap water; rinse with distilled water prior to storing the kit.

C15. PH METER: OAKTON WATERPROOF PH 300 METER (COST ~$540):

Read all equipment instructions to familiarize yourself with all parts of the equipment before continuing.

▲ *pH meter*

What you'll need:

- pH meter
- Distilled water

Calibrating the pH meter: Check that the pH meter is calibrated correctly before each use according to equipment instructions.

Testing Procedure

1. Turn the pH Tester 2 meter on by pressing the ON/OFF button.
2. Dip the pH meter directly into the stream, and let the meter stabilize.
3. Record the pH reading on the field sheet.
4. Repeat steps 2-3 two more times in different parts of the waterbody. In the end, you should have 3 separate pH readings.
5. Turn off the meter by pressing the ON/OFF button.
6. Rinse the electrode with distilled water.

Protocols for Biological Parameters

Bacteria

B1. LAMOTTE GREEN WATER MONITORING KIT (cost ~ $200)

Read all safety cards and familiarize yourself with all procedures before using kits. Wear safety goggles!

The coliform test in this kit will show if you have above or below 20 coliform colonies per 100 mL of stream water. Even if the result of this test shows that the test for coliform is negative, this is not proof that the water is safe to drink. The tablet enclosed with the kit contains nutrients to support the grown of coliform bacteria, and a pH indicator. If coliform organisms are present, gas will be generated as a result of the bacteria metabolizing the nutrients in the tablet. The gas is trapped in the gelling substance and cuase the gel to rise in the tube. The pH indicator may change color from red to yellow as further evidence of coliform activity.

What you'll need:
- Coliform kit equipment
- Other whirlpak bag or sample bottle.
- Bleach
- Goggles
- Gloves

Procedure:
Dechlorination of water sample:

If you are using tap water or other water that may contain chlorine to measure coliforms, you will need to dechlorinate your water sample. Water with chlorine tends to suppress the growth of coliform bacteria when used with this kit.

1. Tear off top of a Water Sampling Bag (included with kit) at the scored line.
2. Pull the tabs outward to open the bag.
3. Fill the bag to the 100ml fill line with the tap (or chlorinated sample) water.
4. Pull wire ends to close the bag.
5. Hold tape wire and whirl the bag 3 complete revolutions.
6. Unwhirl bag and pull tabs to open. Fold one tape wire inward to form a pouring spout.

If you do not need to dechlorinate the sample, then collect the sample per instructions at the beginning of this section.

To avoid any contamination, do not remove the tablet from the tube or touch the inner surface of the cap or tube!

If you want to run a *quick screening test* to see if coliform bacteria are present in numbers greater or less than 20 colonies/100mL of water, then run a single tube test.

1. Fill the tube to the 10mL line.
2. Replace the cap.
3. Stand the tube upright, with the tablet flat on the bottom of the tube.
4. Incubate the tube upright at room temperature, for 48 hours. Store out of direct sunlight. Record the date and time you began the incubation.
5. Compare the contents of the tube to the coliform bacteria color chart. Record results on data sheet.

TEST RESULTS	SCORE
Negative	3 (good)
Positive	1 (poor)

If you want to *determine the coliform population density* in terms of the Most Probable Number (MPN), which is the term the water quality standards refer to, then use the five tube test.

1. Follow the single tube incubation procedure to test 5 tubes at one time.
2. Compare the appearance of the tubes to the picture on the coliform color chart. Record the results for each tube as positive or negative. Count the number of positive tests.

# POSITIVE TUBES	MPN INDEX/100 ML	SCORE
0-2	0-5	3 (good)
3-4	9-18	2 (fair)
5	>18	1 (poor)

Dispose of tubes in a small trash bag. Dispose of used chemicals into your designated waste bucket. Make sure you rinse all containers with distilled water after use. All wastewater, including the tube rinse water should be flushed with flowing water, into a sewer system connected wastewater treatment plant and not a cesspool.

B2. E-COLI; COLISCAN EASYGEL FOR E. COLI (cost ~ $20- 20 tests per set)

There are several options for testing for the presence of bacteria. While not EPA approved, for Level 2, the Coliscan Easygel for E. Coli is recommended due to its ease of use and lower cost. The method is not recommended for very low counts as even with the largest sample volume the detection limit is 20 E. coli/100ml. You'll also need a homemade incubator or a simple chick-egg incubator.

How does it work?

The Easygel contains a sugar linked to a dye which, when acted on by the enzyme ß-galactosidase (produced by coliforms including E. coli), turns the colony a pink color. Similarly, there is a second sugar linked to a different dye which produces a blue-green color when acted on by the enzyme ß-glucuronidase. Because E. coli produces both ß-galactosidase and ß-glucuronidase, E. coli colonies grow with a purple color (pink + blue). The combination of these two dyes makes possible the unique ability to use one test to differentiate and quantify coliforms and E. coli. (Because E. coli is a member of the coliform group, add the number of purple colonies to the number of pink colonies when counting total coliforms.) When incubating the Easygel, Micrology Laboratories has these comments:

Coliscan can effectively differentiate general coliforms from E. coli when incubated at either room temperatures or at elevated temperatures (such as 90-98° F).

However, there is no one standard to define room temperature. Most would consider normal room temperature to vary from 68-74° F, but even within this range the growth of bacteria will be varied. Members of the bacterial family Enterobacteriaceae (which includes coliforms and E. coli*) are generally hardy growers that prefer higher than room temperatures, but which will grow at those temperatures. They tend to grow at a faster rate than most other bacterial types when conditions are favorable. Thus, try to place inoculated

dishes in a "warm" place in a room for incubation if a controlled temperature incubator is not available.

What you'll need:
- Micrology Lab's Coliscan Easygel
- Petri dishes
- Permanent marker or waxpencil
- Homemade incubator (see end of this section) or simple chick-egg incubator
- Gloves
- Safety goggles
- Water tight bags (for disposal)

Procedures:

Label the petri dishes with sample information: Date and time, site ID, sampler, using a permanent marker or wax pencil.

Inoculation of Coliscan Easygel

1. Sterilely transfer water from the sample containers into the bottles of Coliscan Easygel (Consult the following table for rough guidelines for inoculum amount). Swirl the bottles to distribute the inoculum and then pour the medium/inoculum mixtures into the correctly labeled petri dishes. Place the lids back on to the petri dishes. Gently swirl the poured dish until the entire dish is covered with liquid (but be careful not to splash over the side or on the lid).

WATER SOURCES	INCOLUMN AMOUNT
Environmental: River, lake, pond, stream, ditch	1.0 to 5.0 mL
Drinking water: well, municipal, bottled	5.0 mL

2. Place the dishes right-side-up directly into a level incubator or on a warm level spot in the room while still liquid. Solidification will occur in approximately 40 minutes.
3. Incubate at 35° C (95° F) for 24 hours, or at room temperature for 48 hours. Micrology Labs gives some comments on incubation:
   - At elevated temperatures, no counts should be made after 48 hours as any coliforms present will be quite evident by that time and if new colonies form after 48 hours they are most likely not coliforms, but some other type of slow growing organisms that should not be included in your data.
   - At room temperatures, the best procedure is to watch the plates by checking them at 10-12 hour intervals until you observe some pink or purple colonies starting to form and then allowing another 24-30 hours for the maturation of those colonies. Since the coliforms (including E. coli) are generally the faster growing organisms, these will be the first to grow and be counted. Colonies that may show up at a later time are likely to not be coliforms.

Inspect the dishes

1. Count all the purple colonies on the Coliscan dish (disregard any light blue, blue-green or white colonies), and report the results in terms of E. coli per ml of water. NOTE: To report in terms of E. coli per 100 ml of water, first find the number to multiply by. To do this: first, divide 100 by the number of ml that you used for your sample. Then, multiply the count in your plate by the result obtained from #1. For example, a 3 ml sample, 100 / 3 = 33.3. So, 4 E. coli colonies multiplied by 33.3 will equal 133.2 E. coli per 100 ml of water.
2. Count all the pink and purple colonies on the Coliscan dish (disregard any light blue, blue-green or white colonies) and report the results in terms of coliforms per ml of water.

Disposal:

1. Place dishes and Coliscan bottles in a pressure cooker and cook at 15 lbs. for 15 minutes. This is the best method.
2. Place dishes and Coliscan bottles in an ovenproof bag, seal it, and heat in an oven at 300° F for 45 minutes.
3. Places dishes and Coliscan bottles in a large pan, cover with water and boil for 45 minutes. Place 5 ml (about 1 teaspoon) of straight bleach onto the surface of the medium of each plate. Allow to sit at least 5 minutes.
4. Place in a watertight bag and discard in trash.

How to make your own incubator (from "The Amateur Scientist", Scientific American, June 1994 pp 108-111, by John Iovine):

What you'll need:
- 20 gallon aquarium (doesn't need to air/water tight)
- Heavyweight clear plastic
- Strong tape
- Small lamp that can use up to 75-watt bulb
- Thermometer (0-100 C) preferably in a clear plastic case

Instructions:

1. Turn the opening so it faces the front instead of the top.
2. Cut the plastic slightly wider than the opening and about 2 inches longer than the height of the opening.
3. Tape the plastic to the top of the aquarium, so the plastic falls over the opening at the front. This is your "door".
4. Place the lamp in the aquarium, letting the cord come out the front under the plastic covering
5. Place the thermometer in the aquarium so that you can read it without opening the plastic "door".
6. Try different bulbs until you find one that gives you the temperature you need for your incubator.

If you need to regulate the temperature, you can add a dimmer switch to the lamp.

B3. IDEXX Quanti-Tray, (cost, including supplies ~ $6,300)

Colilert-18 and Enterolert are approved methods for the bacteriological analysis of marine and estuarine waters. The purpose

of this analysis is to give an estimation of the bacteriological density of coliform, E. Coli and/or enterococcus bacteria within the water in question. The quality of any analysis is highly dependent upon the integrity of the sample and the methods of testing. Enterolert, as its name suggests, is the method to monitor for Enterococci, which is the indicator bacteria that DOH uses for saltwater, and is EPA-approved for ambient waters. Colilert-18 is used for monitoring E. Coli. Since DOH uses Enterococci as its indicator bacteria, only the Enterolert method will be described here.

Additional safety measures

Because you may be sampling in potentially contaminated waters, precautions should be taken in addition to those listed in Section 8.

- Prevent coming into contact with the contaminated water. Use gloves when sampling and wash with soap following sampling and analysis.
- If there has been a known sewage spill or the beach has been closed by DOH, do not enter the waters!
- Never sample from bridges or roads where there is the potential for being at risk from automobile traffic.
- Never sample when river, surf or beach/shore conditions are hazardous.
- Always wash down all surfaces used in the processing of samples with anti-bacterial solutions (e.g., Lysol, etc.) once the Quanti-trays are in the incubator or after a spill of a sample.

Setting up your own lab:

In order to analyze your samples, you'll need space to set up your equipment. A garage or other covered area works well. Make sure you have a good, stable power source, a running water supply, and space to work and store materials. Some equipment should be stored in a climate-controlled environment. Keep the lab space clean!

Laboratory steps:

There are two methods, one using test tubes, the other using the IDEXX Quanti-Tray. Only the Quanti-tray method is described here. If interested in the test tube method, refer to Surfrider's "Standard Operating Procedure for Bacteriological Analysis of Marine Waters Most Probable Number Method Utilizing Colilert – 18 and Enterolert Media". Check it out on Surfrider's website: http://www.surfrider.org/bwtf/BWTF_manual_June2003.pdf The Quanti-tray method is easier to use, but is more expensive, due to the purchase of the Quanti-Tray equipment.

The cost for the equipment used below is around $6,300. Here is what you'll need:

Quanti-tray Sealer Method Lab Materials:

- ❑ 35 degree Celsius Incubator
- ❑ UV Lamp
- ❑ Sterile pipettes
- ❑ Pipette Pump
- ❑ Sterile plastic bottles
- ❑ Sterile deionized or distilled water
- ❑ Enterolert reagent
- ❑ Quanti-tray sealer trays
- ❑ 115V Model 2X Quanti-tray Sealer
- ❑ 97-well rubber insert for Sealer
- ❑ Antibacterial Hand Soap
- ❑ Laboratory Notebook
- ❑ Disinfectant spray for counter tops

Sampling Materials (needed for all testing methods):

- ❑ Cooler
- ❑ Blue ice
- ❑ Whirlpak sample bags
- ❑ Sharpie pen for writing site location
- ❑ Name on sample bottle/whirl-pack
- ❑ Sample sheet and pen
- ❑ Tide Book
- ❑ Calculator

Lab procedures-preventing contamination in the lab

1. Take special care not to contaminate the samples once they are analyzed in your lab.
2. All laboratory personnel will wash their hands prior to beginning tests and will wash hands thereafter whenever their hands become soiled with samples, etc.
3. Use tight fitting sterile latex gloves when working with samples in the lab.
4. All counters must be cleaned with a bactericide prior to performing tests.
5. Sample bottles or Whirl-paks must be inverted (to mix) prior to opening in the lab.
6. After opening the samples, sub samples for dilutions must be performed as soon as possible to minimize the potential for contamination. Only sterile pipettes must be used for sub sampling.
7. Use sterile dilution water. The water used to prepare culture media and reagents will be sterile distilled water stored out of direct sunlight to prevent growth of algae. All marine water samples must be diluted by at least 1:10 with distilled sterile water.
8. False Positives: These are wells in which a different bacteria (other than enterococci) has grown and caused a biochemical reaction resulting in fluorescence. Even when all of the above precautions are followed there may still be false positive wells in the incubated quanti-trays. Do not record false positives as positive wells. However, you should make a note in your lab book or lab data sheet regarding the presence of the false positives for future reference.

Preparation of samples

Depending on the water sample, you'll need to prepare each sample differently.

With a black magic marker label the Quanti-tray Label the back of a Quanti-tray pouch with:

- Sampler's name
- Tester's name

- Date and time of sampling
- Location of sampling
- Time in incubator
- Dilution used
- Time out*
- Large wells*
- Small wells*
- MPN*
- MPN x 10*

*to be filled in later>>

Photos by Alastair Hebard

◀ *Preperation of Samples*

1. For sterile (blank) water or relatively clean fresh water pour 100 ml of sterile water or sample directly into the sterile 100 ml mixing bottle (by filling to the 100 ml line) and add one package of the reagent. Cap and shake until dissolved.
2. For fresh water that is suspected to contain contamination, pour 50 ml of sterile distilled water into the mixing bottle and add one package of the reagent. Cap and shake until dissolved. Then, after the foam subsides, using a sterile pipette add 10 ml of sample and top off with 40 ml (to the 100 ml line). Cap and shake again. This is a 1:10 dilution.
3. For all marine or estuarine water samples (salinity greater than 5 ppt), pour 50 ml of sterile distilled water into the mixing bottle and add one package of the reagent. Cap and shake until dissolved. Then, using a sterile pipette add 10 ml of sample and top off with 40 ml (to the 100 ml line). Cap and shake again. This is a 1:10 dilution.
4. Holding the Quanti-tray upright, squeeze slightly and pull on the tab to open the tray. Pour in the contents of the sterile bottle. Tap the small wells of the tray until all the bubbles have risen to the top. Set tray face down on the red rubber mat with small wells going in first. If the indicator light on the sealer is green, slowly push the mat into the sealer, lifting the metal guide if necessary. As the tray comes out of the back of the sealer, allow it to fully seal then pick up the sealed tray once movement ceases. Examine the tray to make sure that there is water in every cell and that the tray is completely sealed.
5. Place the sealed tray in a 41° ± 0.5° C incubator for a minimum of 24 hours and a maximum of 28 hours (includes warming time) and make sure you record the "time in" on your sheet. This is the incubation period. Make sure to include any control samples (see quality contrl section) with these samples.

Photos by Alastair Hebard

▲ *Quality control*

Quality control for bacteria samples:

1. Run duplicates: A minimum of 5 % of the samples on a given day should be sub sampled and run in duplicate. At least one duplicate should be run on every day in which the analyses are run. Attempt to select samples that yield positive results (i.e., suspected of contamination) for the duplicate analyses.
2. Negative Blanks: One blank (sterile) water sample will be analyzed per batch of samples processed.
3. External Reference Samples: A positive control is a sample prepared in the lab to contain a known approximate concentration of enterococcus bacteria. An external reference sample is a positive control prepared and provided by a professional laboratory. The external reference sample is split. You should analyze the split external reference and compare your results to the professional lab. At least two external reference samples must be run per year.

How to calculate the Most Probable Number of Enterococci Cells Per 100ml of Sample

Turn the incubator off and remove all the trays, recording the time on each.

1. After the incubation period observe and count the number of positive (fluorescent) wells. For enterococci look for blue fluorescence with a 6 watt, 365nm, UV light within 5 inches of the sample. Face light away from your eyes and towards the sample. The fluorescence intensity of positive wells may vary.
2. Wells that fluoresce yellow or yellow-green are false positives.
3. Refer to the MPN table (provided by IDEXX) specific to the type of quanti-tray used (51 well or 97 well type of quanti-tray) to obtain a Most Probable Number per 100 ml of sample.
4. If a dilution was performed, after obtaining the initial MPN result from the table, multiply that result by the dilution level to obtain the final result (e.g., if a 1:10 dilution was employed, multiply the result from the MPN table by 10 to get the final result in MPN/100 ml).
5. If the sample is inadvertently incubated over 28 hours without observation, the following guidelines apply: Lack of fluorescence after 28 hours is a valid negative test. Fluorescence after 28 hours is an invalid result. In other words, only positive results obtained using the proper incubation period (24-28 hours) are valid.

Disposal

Quanti-trays may be disposed of in the regular trash. Any samples, reference materials or equipment that are known or suspected to have been contaminated with bacteria via your samples must be sterilized prior to disposal.

B4. SEND SAMPLES TO A CERTIFIED LABORATORY

If you have the funds, you may also send your samples to a professional lab. Make sure that the lab has been approved by the state and follows established quality assurance and control protocols. Cost ranges between $45-110 per sample, depending on the number of samples submitted (quantity discounts offered), form of parameter (i.e. Total coliforms, Enterococcus), and/or method used. Contact laboratories for up to date information.

Photo by Jill Komoto

▲ *Waiulaula Stream, Hawai'i*

In this section, you'll learn about conducting measurements in the stream: stream flow, visual observations (i.e general observations on odor, color, oil, etc), ʻōpala (counting the type and amount) and rapid bioassessments (presence or absence of freshwater organisms).

Stream Flow

What is stream flow?

Stream flow or discharge is the volume of water that moves over a set point over a fixed point in time. It is usually expressed in cubic feet per second (ft3/sec) and is directly related to the amount of water moving off the watershed. It is affected by weather, such as during storms as well as by seasons. Summer months' flow is typically slower than winter months. It is a function of water volume and velocity. Water withdrawals for irrigation and dams can also impact stream flow. Stream velocity increases as volume increases and can affect the type of organisms that live in the stream. It can also impact how much sediment and silt is carried by the stream and where it settles. Smaller streams may have less capacity than larger, faster moving streams to dilute and degrade pollutants. If you are measuring turbidity and/or are conducting a rapid stream bioassessment, you will need to measure stream flow as well.

Why measure stream flow?

In Hawai'i, native stream animals rely not only on clean water, but uninterrupted flow from the stream to the ocean. These stream animals evolved from marine forms, so they live a life both in the stream and ocean. The adults live and breed in freshwater streams and their larvae drift out to the ocean via stream flow to feed for several months before returning to their birth stream. This is know as amphidromy. Some of the native species rely on freshets, or periods of high rainfall in a short time, to cue the time to spawn. For more information about native and alien freshwater species, please see "Hawaii's Native and Exotic Freshwater Animals" by Mike Yamamoto and Annette Tagawa.

Summary of methods

Measuring stream flow involves two steps, summarized below:

1. Select your sampling reach and cross section. A sampling reach is the area along the stream where you will be taking flow measurements. The cross section is from stream bank to stream bank, across the stream or channel.
2. Select your methods for monitoring stream flow. Methods for measuring stream flow vary, and can depend not only on your resources, but the physical features area you select. See flow chart and pros/cons of each method

METHOD	TYPICAL ERROR AS +/- PERCENT OF PARAMETER VALUE	EQUIPMENT COST FACTOR (C)	LABOR (TIME) FACTOR (D)	PREPARATION
Float (velocity)	10 to 25	$	++	training
Bucket meter (velocity)	2 to 5 (a)	$$$ to $$$$	+ (a)(e)	training
Electronic meter (velocity)	2 to 5?	$$$$	+ (e)	training
Fill container (volume per unit time)	10-30	$	+	low
Imaginary container (volume per unit time)	500-1000 or more	none	+	low
Automated flow meter (volume per unit time at preset intervals)	varies with method of calibration (b)	$$$$ risk of loss or vandalism	Very low (maintenance interval - 1-2 months)	Set-up, calibration
Apron, flume or weir (accessory forvelocity-area or fill container methods	Used to reduce errors due to channel shape	$-$$	+	depends on primary measurement method

a) calibration effort level ++ on each field day
b) range of observation is precalibrated to site;requires professional oversight
"c) cost codes: $: <$50, $$: $50-$200, $$$: $200-$1000, $$$$:>$1000"
d) time factor codes reflect relative error on meter can increase to 100% with improper calibration or use; time required for one measurement, including replication where recommended
e) number of readings taken with meter is usually greater than with floats for one discharge measurement

▲ *Table 10.1 Major ways to observe, estimate and measure flow*

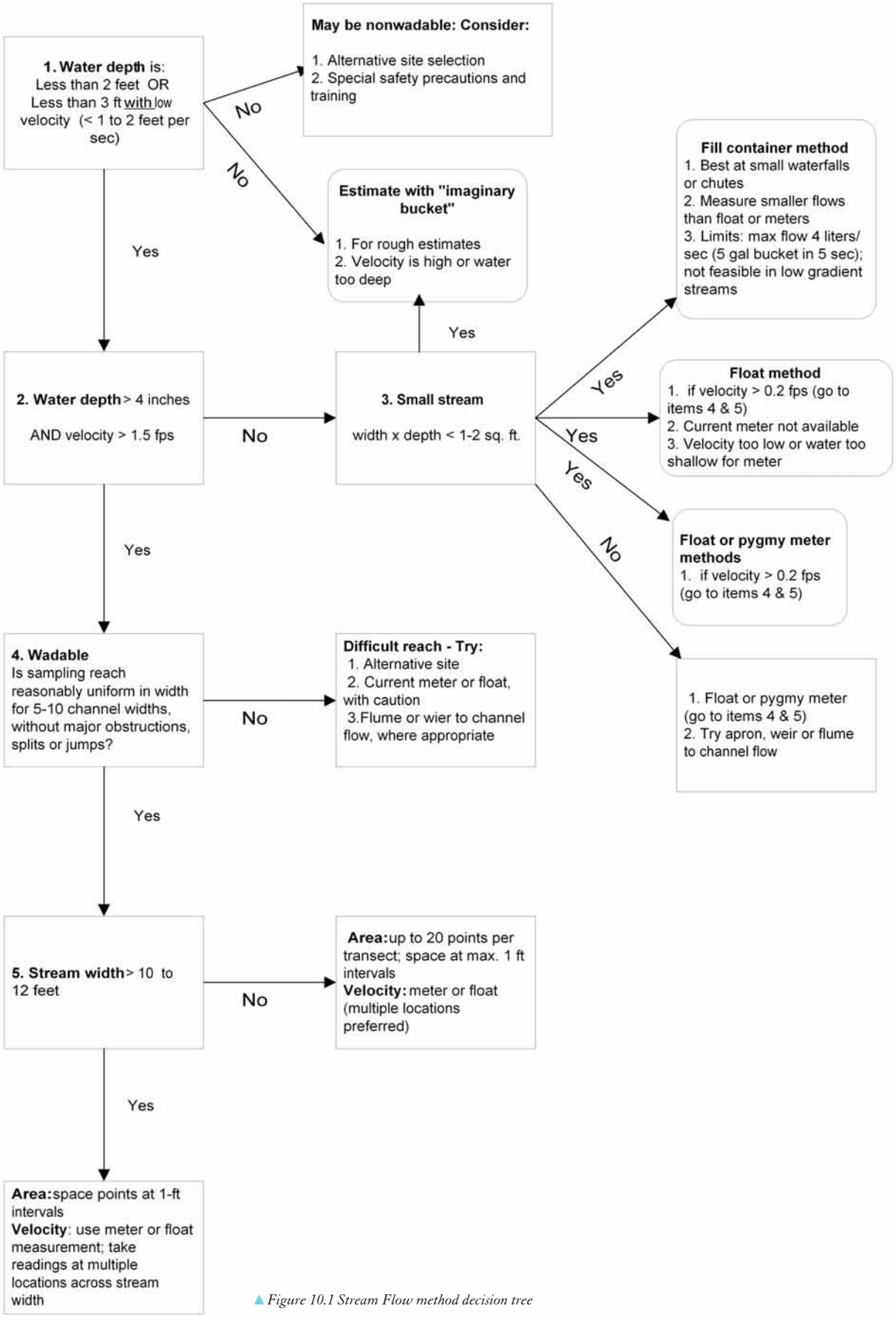
a. There are at least three options for capturing flow information. The method you use depends not on the operator's skill, time availability and funding, but there are additional factors that may be out of your control. Three options include: observations, estimates and measurements.
   i. Observations: With the observation method you visually observe the stream and choose the verbal category that describes it best.
   ii. Estimates: The second option estimates the volume that passes through per unit time, either by visualizing the water going into a container and estimating the time it would take to fill it, or by estimating the average velocity of objects moving with the water.
   iii. Measurements: Taking a measurement includes the volume, velocity, channel dimensions, stage or any other of the characteristics required to compute the volume that passes through per unit time.

b. Which method should you use? Table 10.1 lists the major ways to observe, estimate and measure flow. Figure 10.1 is a decision tree to use when deciding which method to use.

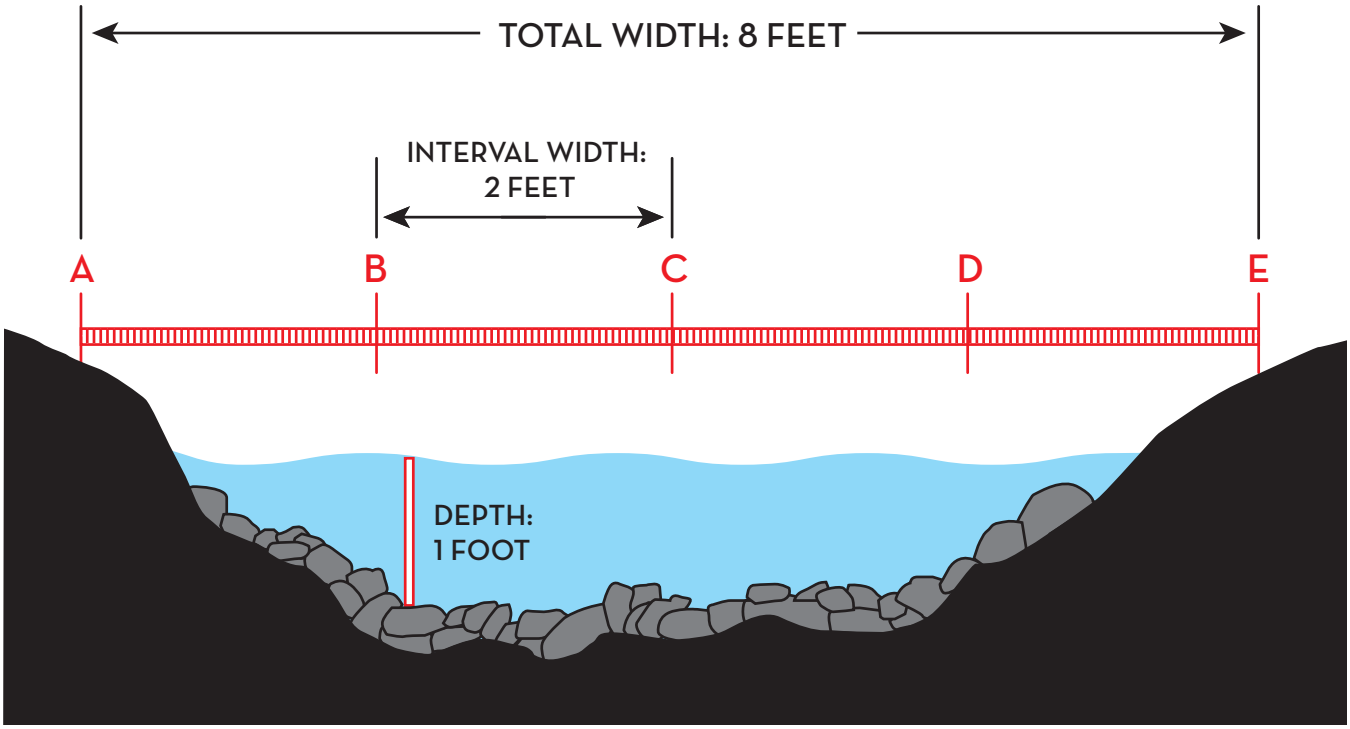
Selecting your sampling reach and cross section

A primary goal when selecting a sampling reach and measurement cross section is finding a location with representative flow, with the following characteristics:

1. The water moves uniformly and smoothly in a direction perpendicular to the transect. If possible, try to avoid back flowing eddies (area of a circular counter current) or split streams.
2. The reach length ideally should extend for at least 5 channel widths above the measurement section and at least 2 channel widths below the measurement section and be straight, with a stable streambed and bank.
3. An area of the channel that has obstructions which creates turbulence, either vertically or horizontally, should be avoided. This includes scattered boulders, weeds, logs or bridge piers or abutments.
4. If you are using a float, find a reach with slower velocities and greater depths. One good cross-section location is near the outlet of a pool where velocities don't vary drastically across the channel (USDA 1996; USDI 1992).
5. If measurements will be made by wading, such as with a



▲ *Figure 10.1 Stream Flow method decision tree*



▲ *Figure 10.2: Measuring cross sectional area.*

current meter, use this rule for safety and quality results: The product of the stream depth (expressed in feet) times the water velocity (in feet per second) should always be less than 10.

6. Ideal cross section locations are hard to find and one must make compromises. For example, if you can't find a long enough reach with water flowing in a uniform matter, then find one that has at least 20 feet in reach length.

If you plan on repeating flow measurements, then you need to be able to find the cross section later. Use permanent benchmarks or reference points at the site that visually locate the cross section on each side of the channel. You can mark the spot with rebar driven into the ground surface, spikes at the base of trees, or marked boulders, number the spike and take GPS coordinates. Make sure the landowners or land managers are consulted before selecting and placing permanent benchmarks.

Methods for Monitoring Flow

S1. Using observations to measure flow

This option may be first used to analyze different reaches of the stream to determine its feasibility for measuring flow. In this method, you observe the flow and choose a verbal category that describes it best. 1) Dry streambed; 2) isolated pools 3) Trickle (<1 quart per second); 4) 1 to 20 quarts/sec 5) > 20 quarts per second; 6) stream full but with no observed flow 7) Small waterfalls.

S2. Using estimates to measure flow

In this method you have two options: 1) Visualize all the water going into a container and estimate the time it would take to fill it (using the "virtual bucket method"), or 2) Estimate the average velocity of objects moving with the water and the average dimensions of the channel section (width and depth) and then compute the estimated volume.

Flow discharge estimates are reported in one of two ways:

1) as a number, in volume per unit time; 2) as a numeric range category. This takes practice, with a good eye at estimating length and depth. When reporting estimates using reporting option one (volume per unit time), make sure you distinguish it clearly, naming the parameter as a "Flow Estimate".

Using measurements to measure flow

Measuring flow can be conducted using five different approaches; two are described below as they are the methods used by most volunteer groups.

Volume per Unit Time (Direct measure)

S3a: Fill Container and timepiece method:

If you are measuring flow through a pipe or in an area with small waterfalls or chutes, you may want to use this method. In this method you simply measure the volume of water that collects in a container during a period of time. Measurement units are quarts per second; quart/minute or gallon/minute (GPM); cubic meter per hour, etc. If the flow is in an order of

magnitude of 20 quarts/second, then you may want to use the "apron" method described later to help channel the water.

What you'll need:
- The container size: can be filled in about 15-20 seconds.
- Watch with second hand

Procedures (without an apron)
- Get materials ready; the person with the watch will tell the container holder when to place the bucket under the flow. Make sure you have good footing.
- At the timers signal, the bucket holder places the bucket under the flow and takes it out when filled.
- Convert the capacity and time to XX/minute.

CURRENT VELOCITY AND CROSS SECTION (VELOCITY-AREA)

S3b: Float method
(from EPA's guide to volunteer monitoring in streams):

This method, commonly used by volunteer groups "floats" an object like an orange or tennis ball for a specified distance. It is generally less accurate than using current meters (see below), but is much less expensive. The float method is better in streams that are too shallow for these meters (<0.2 feet) or those with a flow rate below the level of detection of the meter. Oranges are usually used because they are easy to see, float partially submerged, and are biodegradable if lost.

What you'll need:
- Ball of heavy-duty string, four stakes and a hammer to drive the stakes into the ground (for a transect line)
- Tape measure (100')
- Waterproof yardstick of other implement to measure depth
- Twist ties (to mark off intervals on the string of the transect line)
- Orange, large lemon or tennis ball ("your float")
- Dip net to scoop your float out of the stream
- Stopwatch
- Calculator

Selecting a stretch of the stream
- Straight (no bends)
- 6 inches deep
- No areas of slow water such as a pool.
- Length, around 20 feet

Measuring the length

Mark the upper and lower end by running a transect line across the stream perpendicular to the shore using the string and stakes. The upstream transect in transect #1, and the downstream transect is #2.

Calculate the average cross-sectional area
- The cross sectional area is the product of stream width multiplied by average water depth. To calculate the cross sectional area, determine the cross sectional area for each transect, add the results together and then divide by 2 to determine the average cross-sectional area for the stream reach.

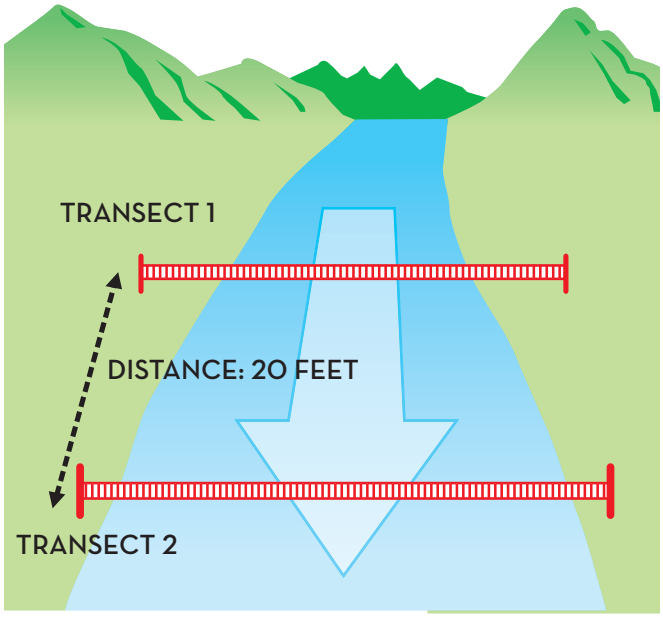


Illustration by Geoff Moore

▲ *Setting up a transect*

Measuring the cross sectional area:
- Determine the average depth along the transect by marking off equal intervals along the string with the twist ties. The intervals can be one-fourth, one-half and three-fourths of the distance across the stream. Measure the water's depth at each interval point (Fig. 10.2).
- To calculate average depth for each transect, divide the total for the three depth measurements by 4. (You divide by 4 instead of 3 because you need to account for the 0 depths that occur at the shores).
- Determine the width of each transect by measuring the distance from shoreline to shoreline. Add together all the interval widths for each transect to determine its width.
- Calculate the cross-sectional area of each transect by multiplying width times average depth.
- To determine the average cross-sectional area of the entire stream reach (A in the flow formula), add together the average cross-sectional area of each transect and then divide by 2.

Measure travel time
- Have one volunteer go to the upstream transect. The float should be positioned so that it floats in the fastest current.
- As the float is positioned and let go, the volunteer should yell "start" and the timer should begin timing. The clock stops when the float passes fully under the downstream transect.
- After the float travels under the transect line, it can be scooped out with the net.
- Conduct this test at least three times. Try to float the object

at different distances from the bank to get various velocity estimates. Discard any float trials if the object gets hung up in the stream (by rocks, roots, debris, etc)

Calculate flow

Flow can be calculated using this equation: Flow = ALC / T

Where

A = Average cross-sectional area of the stream
L = Length of the stream reach measured
C = A coefficient of correction factor (0.8 for rocky-bottom streams or 0.9 for muddy bottom streams)
T = Time, in seconds, for the float to travel the length of L

Record the flow on the data form.

Using an electromagnetic current meter:

There are several types of flow meters that can be used. One less expensive (~$1,000) meter is the bucket wheel or "pygmy meter". While it produces accurate data, it requires a lot of maintenance and can be more difficult for volunteers to use. The other type of meter (current meter) is more expensive and easier to use ($2,000-$3,000) but is not necessarily more accurate than the bucket wheel. One advantage of the current meter is that has the capability to download data directly to your computer.

The two methods below describe the Six-Tenths Monitoring Method and are conducted when water depths are 2 feet or less; the reading is taken in the water column six tenths from the surface, or four-tenths from the stream bottom.

S3c: Marsh McBirney Portable Current Analag or Digital Meter (model 201) and a 4' topsetting wading rod

What you'll need:

- 4' top setting rod
- Flow meter
- Thermometer
- Watch/stopwatch
- D size batteries
- 100' tape measure that reads in tenths
- Data sheets/clip board/pencil
- Flathead screwdriver
- Rubber boots or tabis
- 2-3 people (Top-setting rodperson; timer; data recorder)

Select a point on the stream to monitor:

- Wadable (less than 2 feet)
- Has a depth greater than .2 feet
- Lacks obstructions (such as logs, rocks, human structures or anything else that significantly affects flow) within 15 feet up or downstream of the site
- At least 10 feet in width (if not possible, take more readings)

Procedures:

Photo from Marsh Birney website

▲ *Marsh Birney Portable Meter*

1. Attach the flow meter to the topsetting rod. Loosen the screw on the end of the meter and fit in onto the base of the rod. The meter should fit flush with the rod. Tighten the screw.
2. Extend the tape measure across the section of stream to be measured. Make sure you use the side of the tape that measures feet in tenths, not inches. The tape must be held in place firmly during all measurements and not moved. Measure the total width of the stream. If the stream width is 20' or greater, take measurements at 1' intervals. If the stream is less than 20' wide, take measurements at 0.5' increments. Make sure to take at least 20 measurements.
3. Calibrate the meter by turning it from "Off" to "Cal". The meter needle should hit the black "Cal" box. If it does not, insert new 6 "D" batteries by unscrewing the back plate of the meter with a flathead screwdriver.
4. After calibrating, switch the setting to "2.5" to read streamflow measurements. "2.5" refers to 2.5 feet per second, indicating that you are estimating the flow within that range. If the meter is maxed out when you set it to the 2.5 setting you will have to change the setting to the 5 or 10 feet per second scale, depending on the streamflow. Read all measurements from the appropriate setting. The Time Con. should be set at "2."
5. Place the top-setting rod in the water so that the meter bulb faces upstream. Make sure the rod sits flat, stands upright, and there are no rocks, sticks, etc. obstructing the meter bulb. Hold the cord straight up from the meter bulb so that there is no slack in the cord.
6. Begin on the right bank (when facing downstream) of the stream and measure across to the left bank. You may be unable to obtain a reading at depths <0.2'.
7. Take at least 20 readings.
8. To set the top setting rod, visually measure the depth of the stream using the graduation lines on the hexagonal rod. One line = 0.1', Two lines = 0.5', Three lines = 1.0'.
9. Once you've determined the depth, set the rod to the 6/10 reading. To do this, press the trigger (see diagram) to slide

the smaller rod up or down. This will change the setting within the "vernier" located at the top of the rod. The smaller rod has graduations marked in feet starting with "0" for depths less than 1 foot. For example, if the stream depth at a certain point is 1 foot, move the rod so that the 1 foot graduation lines up with the "0" on the vernier. If the stream depth is 1.4 feet, raise the rod to the 1 foot graduation and align it with the "4" on the vernier.

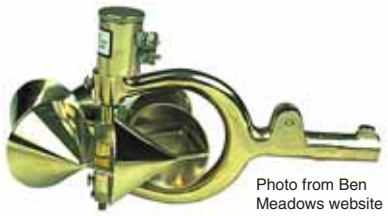
10. To measure the stream flow, have one person holding the rod. This person should stand downstream and to the side of the top-setting rod. Once the rod is set for the proper depth, let the flow meter equilibrate for 20 seconds in the stream. After 20 seconds, average the meter reading for 40 seconds and record on the data sheet provided. The data recorder should repeat the information back to the rod person to ensure correct data recording.
11. Repeat this process for all points.

S3d: Bucket Wheel Meter, Mini Current Meter or AA Current Meter, Ben Meadows (cost ~ $680 - $939)

The meter you select depends on the velocity of water.

What you'll need:

- 4' top setting rod
- Flow meter
- Headphones
- Thermometer
- Watch/stopwatch
- D size batteries
- 100' tape measure that reads in tenths
- Data sheets/clip board/pencil
- Calculator
- Flathead screwdriver
- Rubber boots or tabis
- 2-3 people (Top-setting rodperson and "click counter; timer; data recorder)



▲ *Bucket wheel meter*

Select a point on the stream to monitor:

- Wadable (less than 2 feet)
- Lacks obstructions (such as logs, rocks, human structures or anything else that significantly affects flow) within 15 feet up or downstream of the site
- At least 10 feet in width (if not possible, take more readings)

Procedures:

1. Attach the flow meter to the topsetting rod. Loosen the screw on the end of the meter and fit it onto the base of the rod. The meter should fit flush with the rod. Tighten the screw.
2. Attach the connecting wire from the top setting rod onto the meter by loosening the screw above the bucket wheel. Slide the connecting wire into the base of this screw and tighten.
3. Plug the headphones into the connection at the top of the top setting rod. The meter is now ready to collect readings.
4. Extend the tape measure across the section of stream to be measured. Make sure you use the side of the tape that measures feet in tenths not inches. The tape must be held in place firmly during all measurements and not moved. Measure the total width of the stream. If the stream width is 20' or greater, take measurements at 1' intervals. If the stream is less than 20' wide, take measurements at 0.5' increments.
5. Begin on the right bank of the stream and measure across to the left bank (right and left banks when facing downstream). You may be unable to obtain a reading at depths <0.4'.
6. Take at least 20 readings.
7. To set the top setting rod, visually measure the depth of the stream using the graduation lines on the hexagonal rod. One line = 0.1', Two lines = 0.5', Three lines = 1.0'.
8. Once you've determined the depth, set the rod to the 6/10 reading. To do this, press the trigger on top of the rod to slide the smaller rod up or down. This will change the setting within the "vernier" located at the top of the rod. The smaller rod has graduations marked in feet starting with "0" for depths less than 1 foot. For example, if the stream depth at a certain point is 1 foot, move the rod so that the 1 foot graduation lines up with the "0" on the vernier. If the stream depth is 1.4 feet, raise the rod to the 1 foot graduation and align it with the "4" on the vernier.
9. To measure the stream flow, have one person holding the rod and wearing the headphones. Once the rod is set for the proper depth, let the flow meter calibrate for 20 seconds in the stream. After 20 seconds, count the number of "clicks" or revolutions (these will sound like static blips in the headphones) for 40 seconds in the headphones and record on the data sheet provided. You can determine the velocity by consulting a rating table for your meter that determines velocity (one should be provided in your meter's manual).
10. Repeat this process for all points.

Option for facilitating flow measurements:

1. When the ideal stream reach is unavailable, you might want to change the configuration of a channel with special devices to aid flow measurements. It costs a little more and takes time to set up, but this extra cost may be justified in some cases.
2. When the flow through a channel is no more than 2 liter/second, the water can be channeled into a flexible "apron" that discharges into a bucket, and the rate at which the bucket is filled is measured. (see "Container and timepiece method" under Volume per Unit Time). To be successful with this method, you must get all the water in the channel to flow into the apron, and to have a sufficient "step" under the apron discharge that would accommodate a bucket. Cloths, clay, or other materials can temporarily seal cracks;

some people have used Plumber's Putty to create a spout in "waterfalls".
3. Another option is to use a flatter tray and transfer the water into a bucket later, for volume measurement.
4. In higher gradient streams, a small weir or barrier can be used to channel flow into a container.

S4: Visual observations

What is a visual assessment?

A visual assessment can provide first level of information about a waterbody. This can also include taste and odor. It doesn't use measurement tools, but a good eye for determining distances, color irregularities, and water pollution, or your nose to determine peculiar odors.

Why use visual observations?

These observations are useful as screening tools for a more detailed investigation. They allow us to obtain general information for large areas within a short period of time relative to more expensive and detailed methods.

The following characteristics can be observed:

Algae:

Excessive algal growth may be an indication of insufficient flow, high water temperatures, lack of riparian cover, excessive nutrients or other factors. The presence of some algae is natural and important because it forms the base for the food chain. An imbalance in the amount of algae can decrease water clarity and alter the color of the water.

Foam:

The presence of foam may be an indication of detergents, excessive nutrients or other unnatural inputs to the waterway. While foam may be an undesirable result of pollution, it can also result from the presence of natural protein sources (for example, natural organic matter whipped into a frothy foam due to wave action along a beach.)

Turbidity:

In a general sense, this is also referred to as a lack of transparency or clarity. It is most commonly associated with rainfall events but can also be associated with excessive algal growth or point source pollution. In addition to visual observations of turbidity, this parameter can also be measured by empirical procedures.

Color:

Color can be assessed for both flowing water (e.g. in streams) or in lakes, estuaries or bays. Poor color (e.g. brown or yellowish) can indicate turbidity caused by sediment, pollution, or excessive algae blooms.

Oil:

Oil on the surface of water may be a result of naturally occurring lipids, but more commonly is an indicator of petroleum. Most of the hydrocarbon molecules found in petroleum are lighter than water and therefore float at its surface. Even very small amounts of oil can cause large rainbow colored "sheens," which result from the fact that hydrocarbon molecules are repelled by water molecules. When weathered oil winds up on a shoreline, the lighter molecules evaporate or degrade, and the remaining tar is left behind. While petroleum is biodegradable, it is also toxic.

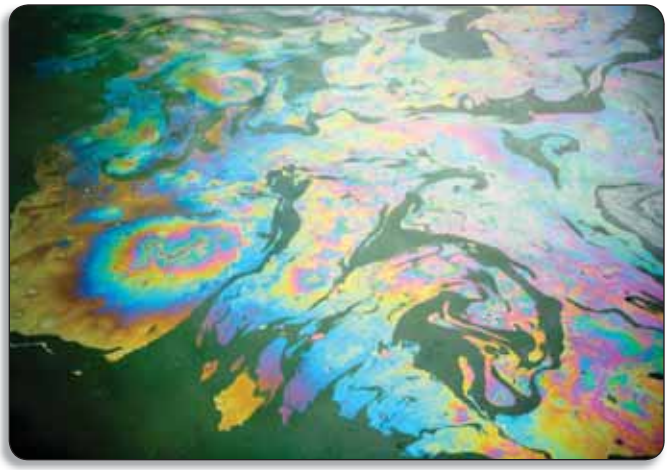


Photo from Istockphoto.com

▲ *Oil sheen on water*

ʻōpala:

ʻōpala (litter) degrades the aesthetic quality of a water body, but is often detrimental to wildlife due to entanglement or even ingestion. Litter can also increase nutrient loading.

Odor:

Certain odors, such as chemical, petroleum, decay, fecal matter, and "rotten egg" smells can indicate water quality problems.

Recommended protocols (adapted from the Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment)

These procedures utilize minimal equipment and training. It will take about 2-3 hours for a team of volunteers to survey a stream or shoreline. Survey reach lengths should be approximately ¼ to ½ mile in length, depending on the terrain and accessibility.

How often should I survey the area? This depends on your monitoring goals. Two types of goals are provided below:

a. Gross problem identification. In this situation, it is assumed that, based on the results of an initial Stream or Shore Walk, a more in-depth monitoring program will be designed

to evaluate specific non-point or point source pollution problems.

b. Baseline monitoring. For baseline monitoring, it is recommended that volunteers survey the same reach 2-3 times per year, specifically during early spring (before trees or shrubs are in full leaf and water levels are generally high), late summer (when water levels are low), or late fall (US EPA 1997).

What you'll need:
- Team (minimum of 2) of volunteers: Note-taker, Observer and/or Observer/Photographer
- Data sheets and clipboard
- Pencil/pen
- Topographic Map
- Road map
- Camera
- Ruler (for scale)
- Waterproof boots or waders or tabis for streams
- Optional:
- Plant communities guide for your region
- Additional water testing equipment
- Transparent cup for evaluating the color of the water
- GPS unit

Safety reminders:
- Make sure the area you are surveying is either accessible to the public or that you have obtained permission from the landowner prior to the survey.
- Inclement weather
- Flood conditions, fast flowing water, or very cold water
- Dangerous insects and animals (e.g.: centipedes, scorpions, bees, dogs, feral pigs)
- Harmful or hazardous trash (e.g.: broken glass, hypodermic needles, human feces)

Instructions for completing the Hawaii Volunteer Monitoring Visual Assessment Form:

Body of Water:
Write in the name of the stream, tributary or gulch you are surveying. If you are surveying a lake, reservoir, estuarine or coastal environment write in the name of that water body.

Watershed Name:
Write in the name of the watershed or ahupua'a you are surveying in. This information can be found on the State of Hawaii's GIS website – Historic Land Divisions (http://www.state.hi.us/dbedt/gis/histlanddiv.htm) by creating your own maps using ESRI Corporation's free ArcExplorer Mapping software at http://www.esri.com/software/arcexplorer/download.html

Island:
Name of the Island your survey reach is located in.

Volunteers:
Names of all volunteers present during the survey

Date:
The date when the survey was actually conducted.

Reach Length:
Indicate the distance of stream or shore surveyed. The protocol recommends surveying ¼ to ½ mile. If a different survey length was surveyed please explain why in the notes section. To determine the length of the reach use your maps or the odometer of your car. There may be cases when physical landmarks such as bridges, roads, or tributaries will bracket the reach. In such cases these starting and ending landmarks may dictate the length of the reach. You can also use a GPS unit to determine the reach length.

Start Time:
Include the start time of the survey (when you began to collect information). Be sure to include "a.m." or "p.m."

End Time:
The time you finished collecting information. Be sure to include "a.m." or "p.m."

Weather in past 24 hours:
Record any applicable weather codes using the codes provided on the right side of the datasheet. Of special importance is any precipitation information (see below).
- Precipitation in past 24 hours:
- If any rainfall has occurred within the last 24 hours, circle "yes."
- If no rain has occurred during the last 24 hours, circle "no."
- If you know how much precipitation occurred during the last 24 hours, please record the amount in inches. If you record the inches of precipitation, reference your source for that information (e.g., newspaper, rain gauge, weather service website, television, etc.) here or in the comments section.

Current weather conditions:
Record all applicable weather codes at the start of the survey. For instance, if the weather is sunny and windy, record a "0" and a "2" in the box.

Starting point:
Where possible, begin your survey at a prominent landmark (e.g. a bridge, or some other feature that will be easy to find again on subsequent surveys). If no prominent landmark is present, describe the starting point in detail. In some cases, you can use surveyor's flagging, stakes or some other type of reference mark for subsequent visits. Provide enough details

and instructions so that someone who had never been to the site could locate it. On streams, if possible, try to plan your observations so that the starting point is downstream of the ending point (i.e., you then proceed upstream.)

Station ID:
Give the starting and ending point a unique station identifier for database use. An example for the lower reach of Waiulaula Stream would be "WAI-LWR-001."

Latitude:
Determine latitude from a topographic map, GPS unit, software program, or other means and record it in the box. See Appendix H for a way to calculate latitude and longitude without a GPS unit.

Longitude:
Determine longitude from a topographic map, GPS unit, software program, or other means and record it in the box. See Appendix H for a way to calculate latitude and longitude without a GPS unit.

Starting Point Observations:
The following eight parameters should be assessed using the codes provided on the right side of the datasheet.

Odor:
An odor, of natural or human-induced origin, may be present at a specific point of your survey reach that you can detect. If so, record the number of odor type from the "Terms and Descriptions" page. If "other" is chosen, describe the type of smell present.

Algae:
Any type of algal growth present in the stream or waterway should be classified by the percentages listed on the "Terms and Descriptions" page.

Foam:
If foam is present at a particular site, assess whether the foam appears as:
- None-no sign of foam or bubbles.
- Separated bubbles-floating bubbles or groups of small bubbles on the surface of the water that do not form a contiguous layer on the surface; bubbles do not form patches greater than 3 inches in diameter.
- Moderate foam- contiguous bubbles (bubbles attached together) forming foam patches with a diameter of more than 3 inches but having a height of less than 1 inch.
- High foam-large frothy accumulations of foam, approximately 1 inch or more in height and with a diameter greater than 1 foot.

The presence of foam may be an indication of detergents, excessive nutrients or other unnatural inputs to the waterway. While foam may be an undesirable result of water pollution, it sometimes can result from natural causes (for example, natural organic matter whipped into a frothy foam due to wave action along a beach).

Turbidity:
Turbidity can be described in 3 ways:
- Clear-the water is clear and the observer can easily see the bottom.
- Cloudy- the water is somewhat cloudy but the observer can see greater than 4 inches below the surface of the water, or the bottom of the waterway can be seen in greater than 4 inches of water.
- Murky- the water is very turbid and the observer cannot see any more than 4 inches below the surface of the water, or the observer cannot see the bottom of the waterway in 4 inches or less of water.

If your group has sampled and measured for turbidity at time of your survey, then in addition to the narrative turbidity observation, also give the measured result along with its units (e.g., 5.5 NTU).

Flow:
Estimate the amount of water present in the channel, or the flow status. The flow categories for streams are described below:
- None- dry (no water is present in the channel.)
- Low- water fills 25-50% of the channel.
- Medium- water fills 50-75% of the channel.
- High- water fills 75-100% of the channel and reaches the base of both lower banks.
- Flooding- water level exceeds channel and bankfull.

If you are aware of a measured flow rate (e.g., provided by an agency), or if your group has measured the flow at the time of your survey, then in addition to the narrative flow observation, also give the measured flow rate along with its units (e.g., 10 cubic feet per second). If agency flow data is used give its source (e.g., USGS, DWR, etc.). You may need to use the comment section if this information does not fit in the flow box.

If you are surveying the shoreline of a lake or reservoir then mark the flow box NA. If you are surveying a tidally influenced shore, record whether or not the tide is low or high as follows:
- HT: High tide
- ET: Ebb tide, between high and low tide when the tide is falling
- LT: Low tide
- FT: Flood Tide, between low and high tide when the tide is rising

Oil:

The visual presence of petroleum or other oily substances can be described in 3 ways:

- None- no oily sheen present.
- Light sheen-a thin accumulation of oil (<1/8 inch) at the surface of the water with the appearance of rainbow colors or metallic appearing patches.
- Slick-a thick accumulation of oil (>1/8 inch) floating at the surface.
- Tar on banks/bed-Solid or semi-solid accumulations of oil on the shore (e.g. adhering to the sediment or rocks above the water line).

ʻōpala:

(See section onʻōpala for a more intensive survey) Include all litter observed within the waterway, along the banks or shore within a 20 meter diameter area (10 meter radius of your position.) Banks or shoreline should be surveyed away from the water for 10 meters.

Color:

Color can be assessed for both flowing water (e.g. in streams) or in lakes, reservoirs, estuaries or bays. Poor water color (e.g. brown or yellowish) can indicate turbidity caused by sediment, excessive algal growth and/or a point source pollution problem.

Flowing water

To determine water color in flowing streams where little canopy cover is present, determine the color by just looking at the stream. If it is difficult to determine the water color due to extensive canopy cover, shallow water (substrate visible) or light reflection, use the "cup method:"

Use a transparent plastic cup to collect a sample of water from the stream. Be sure to minimize the bottom sediments in the sample. Place a piece of white paper behind the cup and with the sun at your back observe the color of the water.

Lakes, reservoirs, estuaries and bays

Observe the color at the water surface, and record the narrative results (blue, blue-green, etc.).

The Forel-Ule color scale is traditionally used in estuarine or marine environments. If you have a Secchi Disc and a Forel-Ule color scale, use the following method: With the sun at your back, and the Secchi disc near its extinction (where you can last see the disk) depth, determine the best match with the Forel-Ule scale. In cases where wave action, current flow, or boat movement make Secchi observations difficult, raise the disc to the depth which minimizes the interference caused by movement but still allows for adequate color. When recording the Forel-Ule color always label the result starting with FU, then give the Roman Numeral, with the corresponding Arabic number in parentheses. For example, FU IV (4). Even if you use the Forel-Ule scale also record the narrative color (e.g., blue-green).

List land uses and activities:

Based on your observations, record the primary land uses and/or activities occurring within ¼ mile of the waterway you are surveying. You may also be able to obtain a copy of a land use map for the area through your county or city planning department, or utilize ESRI's free ArcExplorer to create your own maps. The State of Hawaii maintains GIS layers at its website at: http://www.state.hi.us/dbedt/gis/.

Photo by Matt Rosener

▲ *Agricultural land use, Hanalei, Kauaʻi*

Discharges, seeps or leaks:

If you come across any obvious discharge points during the survey, fill out the "discharges" section with the discharge(s) observed. If you have a GPS unit, record the coordinates of the location on the form. A discharge point may not necessarily be a pipe or drain but could also be a dumping location for trash, etc. If no discharge points were observed, write zero or "none" in this section. You may also use the "Notes" section if you need additional room.

- Briefly describe the location (you may need to use additional space provided in the "Notes" section).
- Using the codes provided on the bottom of the datasheet, list the "discharge point" (e.g., pipe, open concrete storm drains, earthen drains) and the "discharge type" observed (if there are any). Also fill out the information regarding flow, odor, foam, turbidity, color, oil and litter in the same manner described above.

Dominant stream or shore-side vegetation: *Note: this section is for observers who have some knowledge of the local flora. If you do not know primary plant species or native vs. nonnative plants, put a slash through this section.

- % Native- Estimate the percentage of native vegetation present throughout the reach surveyed. Optional: If you can identify the primary species, list them or describe them (common names are acceptable).
- % Non-native- Estimate the percentage of non-native vegetation present throughout the reach. If you can identify

the primary species, list them or describe them (common names are acceptable).
- Natural vegetation zone width- Estimate the overall width of the natural vegetation on both sides of the stream or along the shoreline. If there is little or no natural vegetation present, please describe what is present (e.g., golf course, cement path, etc.).

Ending point:

Where possible, end your survey at a prominent landmark (e.g. a bridge), something that will be easy to find again on subsequent surveys. If no prominent landmark is present, describe the ending point in detail. In some cases, you can use surveyor's flagging, stakes or some other type of reference mark for subsequent visits. Provide enough details and instructions so that someone who had never been to the site could locate it. Record the Station ID, Latitude and Longitude in the same manner as described above for the Starting point.

Ending point observations:

Fill this section out the same way the "Starting point observations" section was filled out.

Notes, special problems, comments:

Use this section to describe any of the above parameters in further detail. This section can also be used to identify any special problems, illegal activities, or interesting observations (e.g. wildlife, fish, etc.).

Photos taken:

If time allows, include photo documentation with this survey. Briefly include photo information on the stream and shore walk form so that any photos taken during the survey can be tracked.

Draw a map of the reach or shoreline:

After you have walked the reach, draw a map or sketch of the reach that depicts the key features including: start and stop points; vegetation features; discharges; stream or shoreline modifications; stream diversions; possible fish barriers; erosion, photo point locations, direction of flow, and a "north arrow" (approximate direction of north).

Possible barriers to fish passage, such as perched culverts (making it difficult for 'o'opu to make its way upstream), waterfalls (either natural or manmade) or lack of water; and stream/shore modifications, such as diversions, stream channelization, or armoring (e.g., rip rap): If you encounter any of the above problems, use this section to describe each location where a barrier, diversion, modification or channelization was observed. Make sure you include it in your map or site sketch as well. With regard to possible fish barriers, take into consideration flow levels throughout the year, i.e., will an object or structure be a barrier to fish passage at the time of the year in which fish migration occurs.

Erosion, unstable banks, bed conditions (sedimentation): If you encounter any areas of erosion, bank instability or excessive bed sedimentation during the survey, describe each location and, using the codes provided on the Terms sheet, list the code that corresponds to the observed problem.

Special problems:

Using the codes provided on the Terms sheet, list any special problems observed.

Comments:

Use this section for any other pertinent comments or information regarding survey observations.

S5: ʻōpala

What is ʻōpala and/or marine debris?

Marine debris is any type of manufactured or manmade material that enters the coastal or marine environment via a stream, outfalls, tossed by beachgoers, or lost by boats at sea. There are four types of marine debris: derelict fishing gear, plastics, derelict vessels and glass, metal and rubber materials. Sources of debris include fishing vessels, offshore oil and gas platforms, cargo ships and vessels, littering and dumping, storm water discharges, and natural events such as floods, hurricanes and tsunamis. Large marine debris removal from coral reefs utilizes trained divers to carefully remove fishing gear and other hazardous items from the reef.

Photo by Jill Komoto

▲ *Marine debris*

Why use ʻōpala/marine debris surveys?

Derelict gear can severely damage a reef and entangle whales, dolphins, Hawaiian monk seals and sea turtles. Humans swimming, snorkeling or diving can also become entangled in the gear. Many marine species including birds, turtles and seals mistake litter for food, and end up starving due to lack of proper nutrition. Some litter such as syringes or broken glass pose as a human health hazard if stepped on. Surveys can be conducted both on the beach and in the streams.

A rapid trash assessment can be used for many purposes: as part of a regular monitoring program, evaluation of management actions, determining trash accumulation rates, comparing sites with and without public access, or for targeting outreach to the community by identification of the type of ʻōpala. Regular monitoring of ʻōpala can also help document how trash may accumulate at certain times of the year or during events such as storms.

Recommended protocols:

You'll need to adapt these protocols to your individual area. Depending on the amount of trash in your selected area, it should take about 1-2 hours. Re-visit the site at various times of the year to characterize the type and amount of trash for water quality purposes.

If you are interested in participating in the Ocean Conservancy's International Coastal Cleanup day, see http://www.oceanconservancy.org/ for more information on how to get involved or organize the event in your area. Some counties also have an Adopt-A-Stream program; see Honolulu County's program http://www.cleanwaterhonolulu.com/storm/hero/adopt.html

What you'll need for a rapid trash assessment:

- At least one team of two people
- Measuring tape
- GPS unit or identifiable landmarks for upper and lower boundaries of survey area
- Trash bag
- Gloves
- Clipboard, with pen and form for recording trash

Selecting the site:

Find a 100 foot section of the stream or shoreline to survey. If possible, select an area with easily identifiable starting and ending landmarks, or document it with a GPS unit. Measuring the length should cover all the curves of the shoreline or stream and not in just a straight line. Determine where the high water mark boundary should be, based on whether the ʻōpala could be carried by wind or water.

Surveying the site:

If you plan on revisiting and reassessing the site for trash accumulation and usage patterns, pick up the trash as you record it.

If you have just one team of two people, use this surveying protocol:

- Surveyor #1, who also serves as the recorder, walks along the bank or in the water at the edge of the stream or shore, and looks for trash on the bank to the upper bank boundary. Surveyor #2 walks in the streambed, and up and down the opposite bank.
- Each person picks up the trash and surveyor #1 records each item using tally marks on the trash form, in the appropriate box- above or below the high water line.
- Don't forget to look under logs, rocks or bushes. Try not to uproot vegetation.
- Look for small pieces of ʻōpala, such as cigarette butts, glass or styrofoam.
- Be careful when picking up sharp objects.
- Make a note at the bottom of the tally sheet if it looks like the items have been littered, dumped or accumulated though transportation downstream.
- Record specific descriptions of items found if not fully described in the tally sheet.

Photo by Jill Komoto

▲ *Surveying the shore*

Tallying the trash totals on the form:

- Count up two totals per trash item: one for items found above the high water line and one for items found below the high water line.
- Sum the two totals per trash line.

Trash assessment parameters:

1. In general, determine a score for each parameter. Use a score of "0" only in extreme conditions. Think about the following when scoring:
   a. What are the possible sources or factors contributing to the amount and types of trash?
   b. Has there been a recent storm?
   c. Level of trash: Score this based on your "first impression"
   d. Actual number of trash items found: Many times trash is broken up into several pieces.
      - If the piece has a greater threat to aquatic life (such as plastics), then count this individually; otherwise count the pieces as part of its "parent".
      - If broken glass is scattered, then count these up individually.
2. Threat to aquatic life: Some types of trash pose more of a threat to aquatic life as well as birds. On the beach, some seabirds have been found to pick out red colored pieces of plastic and weathered glass as it reminds them of their

favorite food. Other items like fishing gear, 6-pack plastic tops can entangle animals.
3. Threat to human health: Some pieces of trash, such as discarded diapers, medical, pet and human waste contain bacteria or other viruses which can make people ill.
4. Illegal dumping and littering: Some people deliberately dump items in an area which is easily accessible or not noticeable by the general public or in dry gulches. Other areas may be near a trash collection facility. Leaf litter, grass clippings, cut trees are trash when it is evident that it has been dumped.
5. Accumulation of trash: Trash dumped vs. accumulated can be determined by its age or where it ends up. For example trash that has been transported downstream may be faded, be wrapped around vegetation or show signs of decay.
6. Sum up the scores.
7. Dispose of trash in proper container!

S6: Fish and Invertebrates-rapid assessment

What is a rapid assessment of fish and invertebrates (in the stream)?

A rapid assessment is just that; looking for presence or absence of species in streams. The part that takes the longest is finding appropriate areas where you can measure flow.

Why conduct a rapid assessment?

Local biologists can not be everywhere; the distribution of freshwater species around the state is unknown. This information assists biologists in further understanding the life history and other characteristics of freshwater species, including their requirements/tolerances for various water quality parameters.

Recommended protocols:

This method is adapted from DLNR-DAR's rapid assessment method.

What you need:

- Stream reach with at least 20 feet of one type of habitat (riffle, run or pond)
- Tennis ball or orange
- Measuring tape (100ft+)
- Watch with timer that has tenths of seconds.
- Clipboard with pencil
- ID Form
- ID book
- Clear plastic bag- 1 gallon size
- Tabis (for better footing)
- ʻōpae net or two scoop nets. Electrical plastic ties. Because the fabric ties are easily destroyed, replace them with the electrical plastic ties. Mark on the handles where the ties are; then drill a hole at your marked spot. You may also want to cut down the poles and tie up any side pockets in the net.
- WQ meter(s) or other equipment to measure pH, DO, temperature, turbidity. OR use a transparency tube for measuring clarity.
- Hat, sunscreen, rain gear if appropriate. Quick dry shorts or pants.
- GPS unit
- Camera

Taking flow measurements:

An important component of this method is taking flow measurements. See the Flow measurement section for instructions as well as how to determine which method to use. Read through this section thoroughly before conducting this survey. In addition, to conduct this bioassessment, it is recommended that you find a variety of sites with stream reaches containing different stream types, such as one with a pool, cascades/waterfalls, riffles, and even-flowing sections.

Making a list of monitoring sites:

After determining the sections of the stream to take flow measurements, create a list of your monitoring sites with the following information to expedite monitoring at future assessments:

1. Site ID#
2. Site name.
3. Longitude and latitude
4. Waypoint number
5. Stream type:
6. Site Type
   a. Stream: Natural or Modified
   b. Ditch: Earthen or Concrete
   c. Spring: Spring or Seep
   d. Lake: Natural or Artificial
   e. Wetland: Natural or Artificial

Conducting the assessment:

1. Fill out the general information from the site list create earlier.
   a. Enter the date, and time (a.m. or p.m), moon phase. Check a calendar to determine the moon phase.
   b. Enter collector(s) names.
   c. If taking water quality samples, circle Y. Fill in the temperature, specific Conductivity, pH, Dissolved oxygen, clarity.
   d. Circle general observation for flow- low, medium or high.
2. Take five flow measurements for each site, at evenly spaced sections along your transect, from bank to bank. On the backside of the form, create a brief sketch of the area. Record the following information:
   a. Width: width of the cross section
   b. Distance from bank: For each trial, take a reading from a different distance from the bank. Record the distance here.

c. Depth: Depth of water at each trial section.
d. Flow reading (in time T, to be used for calculations below): Record the time (T) in seconds it takes for the float to move from the upstream transect to the downstream transect.
e. Velocity (optional): Average Stream Velocity (meters per second or m/s) Average stream velocity is calculated by dividing total flow by the cross-sectional area of your transect. The cross-sectional area is determined by calculating a cross-sectional area for the box at each spot of your transect and then summing the cross-sectional areas.

   Average Stream Velocity = Total Flow / [(W1*SD1) + (W2*SD2) + (Wn*SDn)]

   Where
   Total Flow= (W1*SD1*SV1) + (W2*SD2*SV2) + (Wn*SDn*SVn)
   SD = stream depth (meters; SD1 is the stream depth at spot 1)
   1, 2, etc = spots along the stream transect
   n = number of spots along the transect
   W = width of box at each spot; 1 meter is used
   SV = stream velocity (1 meter divided by seconds measured; meters per second)
f. Discharge (optional): Stream discharge is a measure of the amount of water that flows by a certain point in a particular period of time. It is the volume per unit time.

   D = (W * Z * L * A)/T

   Where
   * = Multiply
   D = Discharge (cubic meters per second)
   W = Mean stream width (m)
   Z = Mean stream depth (m)
   L = Length of stream section measured (m)
   T = Time to float length L
   A = Bottom correction constant
   A = .9 for sandy/muddy bottom
   A = .8 for gravel/rock bottom

EXAMPLE (Adapted from Iowater: Iowa volunteer water quality monitoring): Sally and Bill measure stream width, depth, and velocity for Waiulaula Stream. Waiulaula Stream is 4.2 meters wide.

	STREAM DEPTH (meters)	STREAM VELOCITY (meters/second)
Spot 1	0.21	1 meter/8 seconds (0.125)
Spot 2	0.45	1 meter/4 seconds (0.25)
Spot 3	0.62	1 meter/3 seconds (0.33)
Spot 4	0.35	1 meter/7 seconds (0.143)

Average Stream Depth = (0.21 m + 0.45 m + 0.62 m + 0.35 m) / 4 = 0.41 m

Total Flow = (1 m * 0.21 m * 0.125 m/s) + (1 m * 0.45 m * 0.25 m/s) + (1 m * 0.62 m * 0.33 m/s) + (1 m * 0.35 m * 0.143 m/s) = 0.39 m3/second

Average Stream Velocity = Total Flow / Cross-Sectional Area

Average Stream Velocity = 0.39 m3/second / [(1 m * 0.21 m) + (1 m * 0.45 m) + (1 m * 0.62 m) + (1 m * 0.35 m)] = 0.24 m/s

f. Substrate: Indicate what the substrate (stream bottom) is primarily comprised of: sand, cobble, boulder, other.

2. In the flow transect area, carefully place your ōpae net with the opening facing upstream, crossing the handles at the top. You may need to use your other hand to "chase" aquatic organisms into the net, or use your partner to herd them towards the net. Scoop the net up, and identify the critters using your book or hand reference card. If you're feeling adventurous, you may want to use a snorkel and mask to survey the entire area underwater.
3. Mark with numbers (indicating how many you've found) in the appropriate line: 1) Sex (if known); 2) size class; 3) sampling method; and 4) life stage. If you have additional notes, then use the note section at the bottom of the page and number it.
   - Example: If you've first found a female, 'O'opu nōpili, size 2-4, adult, place a number "1" in each corresponding. column. And wow! You've found another 'O'opu nōpili, but this time male, size <2, juvenile, place a number "2" in each corresponding column.
4. When you are done with this site, go on to your next site. Turn in your sheet to your team leader. If you are conducting this survey individually, turn in your sheet to your local DLNR-DAR office.

Rainfall and runoff

What is stormwater runoff?

Stormwater runoff includes rain and irrigation water flowing over impervious surfaces such as roofs, driveways, and roads. If the soil has become soaked due to previous storms, then runoff can also occur over lawns and agricultural land. Pollutant loads in stormwater are usually highest during the "first flush" of the first major storm of the season, or after a long dry spell. Land use has a big impact on whether pollutants are filtered before entering storm drains, into streams and the ocean. Sidewalks, roads and parking lots plastered with concrete and asphalt cover the bare soil and prevent pesticides, fertilizers, and other pollutants from infiltrating or dispersing into the ground.

Everyday household activities can also contribute to runoff; washing the car, watering the lawn and garden, and washing driveways, parking lots and sidewalks. The fertilizer and pesticides that are applied to lawns and gardens, use of soaps when washing the car that contain phosphorus find their way to our waterways.

Photo by Liz Foote

▲ *Stormwater runoff, Maui*

Why measure rainfall?

The amount and rate of rainfall can affect the amount of runoff into streams and the ocean. Combined with other factors, rainfall can affect erosion, groundwater recharge, and water chemistry, as well as nonpoint sources pollution into waterways. Rainfall data is used in mathematical equations to calculate the rate of runoff. "Official" rain gauges are usually maintained by the U.S. Geological Survey, but are scattered around. Rainfall data collected by citizens can assist in knowledge about relationships between rainfall and stream flow, hydrology and geomorphology.

W1: Measuring rainfall

What you'll need:

- Rain gauge with 0.1 inch or 2 mm increments (or finer)
  Cost ~ $35.00
- Post
- Clipboard
- Data sheets
- Pencil

▲ *Rain gauge*

Recommended protocols:

Rainfall is measured with a rain gauge, which can be electronic, or a simple collection tube that is read manually at the same time each day.

How and where to set up the rain gauge: The rain gauge should be placed where it can be easily read, and in an area that is clear of obstructions within a 90-degree cone. Attach the gauge to a post, making sure it isn't tilted in any direction, with at least four feet of clearance from the ground. If you have a GPS instrument, record the location on your datasheet. If not, then record the general physical address.

Recording rainfall data:

1. Select a specific time of the day that you can monitor the gauge every day. The gauge must be monitored every day when there has been any rain. The best time of the day is in the morning, as the captured water will evaporate quickly once the weather clears. If you plan on being way, make sure you have one or more "backup monitors".
2. Read the amount of captured precipitation at eye level; water in the gauge will appear to be rounded. This is due to water tension, and is called a meniscus. The gauge is read at the middle of the meniscus.
3. Record the level of rainfall on your datasheet, and before dumping out the water, double-check your reading. Empty the gauge and reset it.
4. You may want to take additional readings during the day, especially during large storms. Record the time and reading on your datasheet. Don't record anything in the 24-hour total when taking these additional readings; only record the 24 cumulative total.
5. The Comments column is used to record observations when there is no discernible precipitation in the gauge, but there were conditions such as light rain, or rain blowing sideways.

Other potential uses of rainfall data:

NOAA's National Weather Service maintains a volunteer Cooperative Observation Program, which includes rainfall monitoring. Created in 1890, more than 11,000 volunteers take observations on farms, in urban and suburban areas, National Parks, seashores, and mountain tops. If you are interested in becoming an NWS Cooperative observer, contact the NWS

representative in the WFO supervising your location. In Hawaii, the address is: NWS, Cooperative Program Manager, Grosvenor Center, Mauka Tower, 737 Bishop Street, Suite #2200, Honolulu, HI 96813. If you are selected to become an official NWS Cooperative station, NWS will provide you with the training and supervision you will need to perform your duties.

Tools for estimating runoff rates: The Local Government Assistance Network provides resources and tools to assist local governments with environmental management, planning, funding, and regulatory information. This includes a tool for estimating changes in runoff due to land use changes. http://www.ecn.purdue.edu/runoff/lthianew/

Pollution hotspots

What are pollution hotspots?

Pollution hotspots are areas where pollutants such as chemicals, bacteria, sediment or nutrients are in close proximity to waterways, or can easily make its way to storm drains and eventually into streams or the ocean. Hotspots can include both point and nonpoint sources of pollution:

- Pipe outfalls into streams or the ocean
- Agricultural operations
- Automotive businesses
- Medical facilities
- Other commercial businesses like beauty salons, dry cleaners, paint shops or printing/photographic processors
- Golf courses;
- Nurseries.
- Large trash bins where people throw all sorts of garbage into can leak and end up in our waters, especially if near a storm drain.
- Person washing their car, with hose running
- Eroding roads

Other areas may not be as obvious, such as a sloped parking lot near a stream that has a small gully developing on the stream bank. This can not only facilitate runoff into the stream, but increase the amount of sediment that enters into the water, by eroding the stream bank.

Phot by Jill Komoto

▲ *Trash bin hot spot located next to a stream.*

Why look for pollution hotspots?

Commercial businesses use a variety of chemicals and other hazardous waste. If disposed of improperly, this waste can end up in our water and can be toxic to both human health and aquatic life. Agriculture and golf courses both use pesticides and fertilizer that can also end up in our streams. By identifying these "hotspots", we can better understand why our streams and nearshore waters are impaired and flag the area for further monitoring to determine the extent of the impairment, if any. This can lead to projects restoring the area or "best management practices". These methods can include: better fertilizer/pesticide application or alternative methods of controlling pests; vegetated areas where runoff can be stored and then filtered before entering the ground or the stream; use of pervious materials which help to filter the water directly into the ground instead of running directly into the streams; catchments to capture water before it ends up on the ground, which can be used for watering during times of drought; or re-directing runoff and re-vegetating stream banks to prevent future erosion.

Photo by Liz Foote

▲ *Erosion at construction site*

W2: Identifying Pollution Hotspots

What you'll need:

- Clipboard or Notebook
- Pencil
- Color pencils if you want to highlight areas

Recommended protocols:

1. To start with, if you haven't already, you may want to conduct a literature search to find reports, management/ strategic plans or other documents that may identify various uses in your watershed that may be a pollution hotspot. Another method might be to use Google Earth or even a tool like Mapquest which can identify various businesses in the area.
2. If you have the time, you may want to conduct a visual

assessment of your area. See Section 10.
3. Make a map of the area you want to assess for pollution hotspots (adapted from UH-CTAHR's "Mapping Your House and Yard to Identify Pollution Risks")

To draw your map, you will be creating an aerial view- the way the area would look like if you took a photo of it from the air. The amount of detail you put in your map will depend on the map(s) you already have and the time and resources you have available, but be sure to include the following features:
- property boundaries (if in a neighborhood)
- garden areas and flower beds
- roads-paved
- roads-unpaved
- Sidewalks-paved
- Sidewalks-unpaved
- Parking lots
- ponds, streams and drainage ditches
- any paved areas like driveways and patios

Just start walking around your neighborhood (careful not to trespass!). Record the following:
- Date
- Address or provide GPS coordinates if you have a GPS meter
- Take pictures

Try to include as much information as possible on your map. Show the approximate size of flower beds, gardens, driveways and patios and their distances from each other. A sketch will be adequate for beginning the planning process. Having a more accurate map will allow you to calculate the areas of gardens, lawns, and other features, which can later be useful in planning the best ways to reduce pollution hazards.

Look for these potential pollution hotspots and draw them on your map:
- Trash bins, leaking fluids
- Storm drains
- Auto repair shops
- Car washes
- Construction areas- note places where dirt is not covered up, "rivlets" or eroded spots in hills, where dirt is tending to congregate (such as after rainfall)
- Nurseries
- Dry cleaners

Discuss your results with your group and your team leader; are there problem areas that need immediate attention? See Table 11.1 for contact information.

Storm drain monitoring

Introduction

Storm drains, which channel urban runoff, provide endpoints at which some parameters can be measured. Some examples of urban runoff sources are: motor oil, coolant, copper from brake pads, paints, soaps, fertilizers and trash. This can come from overland runoff from roads and parking lots (i.e copper from brake pads, motor oil), permeate through farming and ranching lands (fertilizers), and improper or illegal connections to the storm drain system.

These protocols are based on the Central Coast Regional Citizen Monitoring Guide (California), which utilize Texas Watch protocols developed with the cooperation of the U.S. EPA. The Lamotte "Storm Drain Monitoring" kit (Model SSDK, cost ~ $378, reagent refill ~$110) was developed according to National Pollutant Discharge Elimination (NPDES) Phase I dry weather monitoring requirements and is designed to detect illegal stormdrain connections and discharges.

Volunteers are trained one day, and asked to conduct sampling once to twice a month. They are divided into several teams with three to four members each. Sampling is conducted twice within a 24-hour period with at least 4 hours between each sampling event. The parameters monitored include: detergents, phenols, ammonia nitrogen, chlorine, turbidity, pH, water and air temperature, odor, and color. Volunteers also note if they see oil sheen, sewage, trash, and surface scum present.

W3: Monitoring storm drains
What you'll need:
- Maps of your area, working with the County's Public Works

PROBLEM:	CONTACT:
Water pollution or improper discharges	Department of Health, Clean Water: Branch (808) 586-4309
Oil spills or hazardous materials	US Coast Guard: (800) 552-6458 or VHF channel 16
Chemical spills	Department of Health, Hazard Evaluation & Emergency Response (808) 586-4249
Solid wastes or littering	Department of Health, Solid and Hazardous Waste Branch: (808) 586-4226 Statewide Litter Hotline managed by Community Work Day: (888) 592-2522

▲ *Table 11.1: Contact information for pollution hotspot problems.*

department to obtain these maps and insights on storm drains to focus on. You may need to map out the physical location of the storm drains, using a GPS unit.
- Select storm drains located downstream of different land uses.
- Equipment needed:
  1. Data sheets/data binder
  2. Thermometer
  3. Whirl-pak bags
  4. Permanent marker
  5. Rubber gloves and eye protection
  6. LaMotte Storm drain monitoring kit
  7. Ruler (in centimeters)
  8. Distilled/deionized water
  9. Wastewater container
  10. Storm drain monitoring information display
  11. Paper Towels
  12. Sponge
  13. Trash bags
  14. Cooler with ice

Getting started:

- Conduct about 1-2 training sessions to familiarize yourself with the Lamotte stormdrain kit; follow the instructions for each chemical test.
- Calibrate the pH meter within 24 hours of usage.

Safety first!

Always practice safety tips as provided at the beginning of section 8. Many of the chemicals used in the Lamotte kit are toxic or caustic. As a reminder:

- Avoid contact between reagent chemicals and skin, eyes, nose and mouth.
- Gloves and safety goggles are a must!
- When rinsing test tubes or mixing chemicals, cap the tubes with the covers, never with your gloved finger.
- When you are dispensing a reagent from a plastic squeeze bottle, hold the bottle vertically upside-down (not at an angle) and gently squeeze it. If this does not work, then the dispensing cap or plug may be clogged.
- Wipe up any reagent spills, liquid or powder as soon as they happen.
- Close all reagent containers tightly, making sure you do not interchange caps from different containers. Return containers to the kit directly after using.
- Avoid prolonged exposure of equipment and reagents to sunlight.
- Check expiration dates of reagents, and replace any that are out of date.

Sample collection protocol:

- If it has rained more than 1/10th of an inch in the last 48 hours, DO NOT SAMPLE!!
- Never sample when conditions are dangerous- high water, high tide, obvious toxins (e.g raw sewage), unstable or slippery slopes, biohazards (e.g needles, etc)
- Use the buddy system; at least two people should be conducting the monitoring.
- Fill out the data sheet:
  - Date and time
  - Samplers' names
  - Record any notes on anything surround the site that could affect your data. Note anything that may be directly affecting the data or conditions that have been affected by the stormdrain flow. This may include:
    - Land use changes- upstream and downstream
    - Vegetation changes (including algae)
    - Signs of recent higher flows coming out of the storm drain (ie watermarks, erosion at the bottom of the stormdrain)
    - Signs of life in the water
    - Possible discharge sources
    - Information from passerbys
  - Record photo numbers and description of what is in the photo.
- Write the sample location and date on the bag prior to sampling. Collect the sample using gloves and a Whirlpak bag.
- Take the sample from the mid-part of the flow without disturbing the bottom of the stormdrain.
- If the water is at a very low flow, then you might need to use another Whirlpak bag to create a ledge to divert the water into the first Whirlpak bag for the sample.
- Take photos if you can not accurately describe an event happening at the time of sampling that can not be adequately described in words. Record your photo number on your data sheet. Things that you might want to take a picture of – unusual water color or flows; unusual amount or types of trash; pollution sources.

Using the storm drain kit:

General protocols:

- Rinse the test tube you are using for your chemical reaction out three times with distilled water before putting the sample water into the tube. Cap the tube after filling with distilled water, shake and empty the water into your designated wastewater container.
- To determine the color comparison:
  - One person does the detergent testing for all sites. For each dropper full of the detergent, make a tick mark on the data sheet. This shows how much reagent has been used.
  - One person does all the phenols testing
  - Split up the rest of the remaining parameters.
  - Use the Borger Color System and compare the sample side

by side to the color examples. The Borger Color System is an inexpensive portable reference for shades typically found in natural waters, originally developed for color insects and larvae found in streams and lakes. Also allows for recording the color algae and bacteria found on stream beds.

Individual kit instructions:

Note: Reagents marked with a * are considered to be toxic and potential health hazards.

Total residual chlorine

- Fill test tube (0106) to 5 mL line with water sample.
- Add one *Chlorine DPD #4R Tablet (6899). Cap and shake until dissolved.
- Insert test tube into Octa-Slide Viewer (1100). Match color with a standard on the Chlorine OctaSlide Bar (3401). Record as ppm Total Residual Chlorine.

Total copper

- Fill two test tubes (0106) to 10 mL line with sample water.
- Add 5 drops of *Copper 1 (6446) to one test tube. Cap and invert to mix. If more yellow than second test tube, copper is present.
- Insert each test tube into Octa-Slide Viewer (1100). Match color with a standard in Copper Octa-Slide Bar (3435).
- Subtract the unreacted sample result from the reacted sample result. Record result as ppm Copper.

Phenols

- Fill Sample Reaction Tube (0837) to line with sample water.
- Use 0.1 g spoon (0699) to add 1 measure of Aminoantipyrine Reagent (7825). Cap and mix.
- Use the unmarked pipet (0344) to add 4 drops of *Ammonium Hydroxide Solution (7826). Cap and mix.
- Use the 1.0 mL pipet (0330) to add 2 mL (2 measures) of *Potassium Ferricyanide Solution (7827). Cap and mix. Solution will turn orange/pink if phenols are present.
- Fill test tube (0106) to 10 mL line with solution. Insert test tube into Octa-Slide Viewer (1100). Match sample color to a color standard on Phenols Octa-Slide Bar(3434). Record as ppm Phenols.

Detergents

- Fill Bottle (0800) to 65 mL line with sample water.
- Use the 1.0 g spoon (0697) to add 2 measures of *Detergent Reagent #1 (7444). Shake until dissolved.
- Fill to 75 mL line with Detergent Reagent #2 (6037).
- Use pipet (0335) to add 0.5 mL Detergent Reagent #3 (7445). Shake vigorously for 15 seconds.
- Wait until layers separate (20-30 seconds). If the top layer is light blue, less than 0.1 ppm detergent is present and no further testing is necessary. If the top layer is colorless, continue adding Detergent Reagent #3 (7445), 0.5 mL at a time, shaking vigorously for 15 seconds after each addition, allowing the layers to separate until the top layer is light blue. Count the number of additions of 0.5 mL additions of Detergent Reagent #3 (7445) required to change the top layer in the Bottle from colorless to light blue.
- Detergent concentrations in ppm = (Number of pipets Detergent #3 (7445) - 1) x 0.1. EXAMPLE: It takes 9 pipets to turn top layer light blue. (9-1) x 0.1 = 0.8. The amount of detergent is greater than 0.7 ppm but less than 0.9 ppm detergent.

Turbidity

- Fill one (0107) test tube to the 10 mL line with sample water.
- Insert tube (with black lines to the rear) into Octa-Slide Viewer (1100). Insert Turbidity Standard Slide Bar (3436) into Octa-Slide Viewer. Compare the degree to which the black lines are obscured by the turbidity of sample. Disregard any differences in color between the sample and the standards; test is based on turbidity, not color.
- Record results as Low-Medium-High. NOTE: The standards were produced by comparing Formazin Turbidity standards and matching appropriate chips. The results may be expressed as a range of turbidity in FTU's.

pH Electronic Pocketester

Read basic operation manual prior to using Pocketester.

Front Panel Description

1. Battery compartment cap
2. LCD Display
3. MODE/HOLD button
4. CAL/RECALL button
5. ON/OFF button
6. Electrode Collar
7. Electrode

pH Electronic Pocketester

Automatic Calibration

When the TRACER is turned on, it will enter the Automatic Calibration mode. SELF and CAL will appear while calibration is in progress. After the calibration is completed, the SELF and CAL display icons will extinguish and both the main display and the bar graph will read in pH units. The readings will flash on the display until they have stabilized.

Getting Started

1. Remove the cap from the bottom of the TRACER to expose the electrode glass surface and reference junction.
2. Before first use or after storage, soak the electrode (with cap removed) in a pH 4 buffer for about 10 minutes.
3. White KCl crystals may be present in the cap. These crystals will dissolve in the soak or they can be rinsed off with tap water.
4. Always calibrate close to the expected measurement value.

Preparation of Buffers

1. Fill a sample cup with 20 mL of distilled or deionized water.
2. The buffer tablet you choose depends on whether you are calibrating with 1, 2 or 3 points. Calibrating with one point means you are conducting a reading over one range; two points, readings over two ranges, and three points, readings over the entire range. If you have only one sample cup, make sure you rinse out the cup three times with distilled water after previous use. Dump buffer into your wastewater container. Start with the pH 7.0 buffer tablet first.
   pH 4.0 Code 3983
   pH 7.0 Code 3984
   pH 10.0 Code 3985
3. Use the tablet crusher (0175) to crush the tablet. Stir until the tablet has disintegrated.

NOTE: Buffers should be prepared fresh daily.

pH Calibration

The TRACER can be calibrated at 1, 2 or 3 points. For the most accurate results with a two point calibration, calibrate the TRACER with a pH 7 buffer first, then calibrate with either a pH 4 or pH 10 buffer whichever is closest to the pH value of the sample to be tested. When performing a three-point calibration, calibrate with the pH 7 buffer first, followed with the pH 4 buffer and then the pH 10 buffer.

1. Place the electrode into a buffer solution (4, 7, or 10 pH) and press the CAL/RECALL button. Typically, pH 7 is calibrated first, then 4 or 10, depending on the measurement range. If readings are going to be made over the entire range, calibrate with 4, 7 and 10 buffers.
2. The TRACER will automatically recognize the solution and calibrate itself to that value. The circled number on the display will match the pH of the buffer. Note that if the buffer is more than 1 pH unit off from the 4, 7, or 10 pH buffer, the TRACER will assume an error and abort the calibration. CAL and END will be displayed.
3. During calibration, the pH reading will flash on the main display.
4. When calibration is complete, the TRACER will automatically display END and return to the pH measurement mode.
5. Rinse the electrode with distilled water.
6. The appropriate circled indicator (4, 7, or 10) will appear on the display when a calibration has been completed. The calibration will be stored until a new calibration is performed.
7. For a two- or three-point calibration, repeat Steps 1-5. Create new buffer solution if you have only one cup. See section above for preparation of buffer.
8. The meter should be calibrated before each use to obtain the most accurate results.
9. Always turn the meter off and then on before calibrating to allow sufficient time to complete the calibrations during one power cycle.

If the meter auto powers off during calibration the calibrations remain valid, but new calibrations will turn the circled indicators off.

pH Measurement

1. Place the electrode in the test sample. Do not submerge the pH meter below the line on the meter.
2. Record the pH after the reading becomes stable and the display stops flashing. The main display will indicate the pH in numeric units from 0.00 to 14.00. The bar graph will also display the pH value. The center of the bar graph is 7.00. As the pH increases, the bar graph will move from the center to the right. If the pH is less than 7.00, the bar graph will move from the center to the left.
3. Press the ON/OFF button to turn the meter off. Rinse the electrode with distilled water. Replace cap.

Cleaning the kit:

1. Clean the kit immediately after use.
2. IMPORTANT! Rinse test tubes with deionized water, 3 times in succession, after each test procedure is completed.
3. At the end of each day, all sampling and test glassware should be brushed with the test tube brush (0514) and detergent and rinsed 3 times in succession with deionized water.
4. To avoid possible detergent test interference, do not use detergent (soap) to clean Detergent Bottle (0800), rinse 3 times in succession with deionized water only.
5. Dispose of rinsing water in wastewater container.
6. Be sure to note broken equipment or chemicals that need to be replaced.

Phone numbers in case of emergency with kit:

In case of an accident or suspected poisoning, immediately call the Poison Control Center at 1-800-662-9886 or call your doctor. Be prepared to give them the name of the possible reagent in question, and its LaMotte code number. Note that code numbers for each reagent are listed in the kit instructions and the above section.

LaMotte reagents are registered with POISINDEX, a computerized poison control information system available to all local poison control centers. Keep hazardous material safety data sheets for each reagent and chemical (supplied by LaMotte with each reagent, and also available on their website) in the kit at all times. The sheets include important safety precautions and emergency first aid proce

For other monitoring protocols in the coastal area, check out "Getting Involved in Caring for Hawaii's Coastal Resources: A Community Guidebook", which can be obtained through your local Division of Aquatics office or online at the Community Conservation Network website: www.conservationpractice.org. Protocols include: Tidepool monitoring, human use surveys, coral reef surveys and marine mammal observation.

If you are interested in "Beach Mapping", which includes mapping erosion hotspots, surfing areas, beach access, shoreline structures and wildlife, check out Surfrider Foundation's "Beachscape: A community-based coastal mapping program".

Current and other weather observations in marine and estuarine conditions

What are current, ocean and weather observations in the coastal area?

When it is not feasible to enter the water such as at beaches or in estuaries, visual observations can be recorded. These include wind conditions, surf height, sea state conditions, and tidal flows. Most of the major surface currents in the world are wind-driven. Since the Earth has an eastward rotation, this changes the direction of currents in each hemisphere. Thus, in the Northern Hemisphere, currents are deflected to the right and in the Southern Hemisphere; currents are deflected to the left.

Waves are the main source of energy which causes a beach to change its size, shape and sediment type. Measurements of wave characteristics include: wave height, wave period and wave direction. Sea state conditions consider the overall area of observation, which are impacted by a combination of wind, currents and tidal conditions.

Why measure currents in the coastal area?

The direction and velocity of currents in your area are important for larval transport as well as sediments and other pollutants. When currents meet and mix, meet land areas or major rivers, travel over shallower depths, vertical circulation patterns are changed which affect the availability of nutrients to phytoplankton. Phytoplankton form the basis of the oceans' food chain, from small fish to whales.

Tidal conditions, with currents and wind can impact beach conditions, transport of sediment and larvae and types of critters that live in tidepool areas and sandy beaches.

Wind conditions not only affect the conditions in the sea, but can transport toxic air particles which can eventually settle on land and on the sea surface, potentially impacting aquatic resources.

O1: Ocean and weather measurements:

Heal the Bay's Freshwater and Marine Team Field Guide and UNESCO's Sandwatch program gives some protocols to follow when determining flow conditions in marine and estuarine waters.

Photo by Jill Komoto

▲ *Estimating current direction*

What you'll need:

- Orange(s), lemon, or tennis ball.
- Watch with second hand or stopwatch.
- Net with long handle to capture the orange, lemon, tennis ball
- Compass
- GPS or general location of your monitoring site
- Clipboard and pencil
- Form for recording current and weather observations

Prior to taking measurements, note on your form the location using either a GPS unit or the physical location.

Measuring Current Direction

Current is determined by watching what direction a floating object moves in relation to the beach.

1. Stand on the beach or shoreline facing the waterbody. Draw a line perpendicular in the sand or dirt to mark your starting position. You will use this line to determine the direction of the orange (upcoast or downcoast)
2. Throw the orange (or other object) into the water. You may use peels, but small peels are difficult to see.
3. Stand on the start line that was drawn on the shoreline. Watch the orange to determine the direction it is moving. Wait at least two minutes to determine the direction of the current by observing the orange.
4. If possible, find and retrieve the orange.
5. Record the direction of the current on your field sheet by circling the correct direction. Choices are: upcoast, downcoast, or None if the peel does not appear to move in either direction.

Wave characteristics

If you are measuring currents, you should measure take wave measurements since both can give a picture of sand and

larval transport. Wave measurements include wave height, wave period and wave direction.

Illustration by Jill Komoto

▲ *Estimating wave height*

Wave height is a visual estimate of the wave height from the bottom of the wave (trough) to the peak. Use the following instructions to visually estimate the surf height at your monitoring site.

1. Stand on the beach or shoreline facing the waterbody. Have at least two people take independent visual height estimations.
2. Take your wave height measurements in the area where you conduct other water sampling. Visually estimate the height of surf from the bottom (trough) of the wave to its peak.
3. Circle the answer on the field sheet that best describes the surf height. Flat = 0-1 ft, Low = 1-3 ft, Medium = 3-7 ft, and High is 7 ft or larger.

Wave period is the time in seconds for eleven wave crests to pass a fixed object, or if there is no fixed object available, then the time for eleven waves to break on the beach. Using a stopwatch, start timing when the first wave passes the object or breaks on the beach, and stop it on the eleventh. Divide the total number of seconds by ten to get the wave period.

The *wave direction* is the direction from which the waves approach and is measured in degrees. Using a compass, stand higher up on the beach and sight the compass along the direction from which the waves are coming. Waves will be coming at right angles to the wave crests.

Sea State Conditions

Select the answer that best describes the sea state conditions and circle it on your field sheet. Choose one of the following: Calm, Swell, Choppy, or White Caps.

Determining Tidal Conditions

It is critical to know what the tidal conditions are at the time you are sampling. Use a tide chart to determine the tidal conditions. Tide charts show the two high tides and two low tides that occur every 24 hours. You'll need to adjust the basic tides according to where you are in the islands. Record the tidal conditions on the field sheet by circling the answer of the correct condition.

Wind Conditions

Wind plays an important role in determining wave height and sea state conditions in the ocean, and currents in estuaries. A scale known as the Beaufort Scale was created to quantify wind strength (Figure 12.1). Use the Beaufort Scale to quantify the wind strength at your location.

1. Select the Beaufort Scale Number that best represents the wind conditions at your site.
2. Look up the Beaufort Scale in the chart provided below.
3. Select the appropriate Beaufort Scale number from the "Number" column that best reflects the wind conditions at the monitoring site using the "Description" column, "Wind Speed" column, and "Sea Surface" column.
4. Record the appropriate Beaufort scale "Number" on the field sheet. Also make other observations at the site about the wind conditions. Note if there are gusty conditions, whether you are in a bay, whether there are large trees or buildings that could influence wind conditions at your site.

Photo by Jill Komoto

▲ *Estimating wind conditions*

O2: Aquatic Invasive Species

As of June 2008, the Malama Kai Foundation, UH Sea Grant and DLNR-DAR have been working on a pilot project on Hawaii Island to hold workshops targeting oceans users on identifying and reporting potentially new aquatic invasive species. At least two community members will be identified and trained as first responders; the ones who will first confirm new sitings of AIS before reporting to DLNR-DAR. A watch list of key AIS is created for Hawai'i Island with the AIS Steering committee input and others with specialized knowledge. Identification cards are made up and laminated. At the same time, workshops are held around the island with ocean users.

NUMBER	DESCRIPTION	WIND SPEED (MPH)	SEA SURFACE
0	Calm	0	Like a mirror, smoke rises vertically
1	Light air	3-Jan	Ripples, smoke drifts slightly
2	Light breeze	7-Apr	Small wavelets, not breaking, leaves on trees rustle, wind felt on face
3	Gentle breeze	12-Aug	Larger wavelets, scattered white caps, flags extended
4	Moderate breeze	13-18	Small waves, numerous whitecaps, loose leaves, litter and dust raised up
5	Fresh breeze	19-24	Moderate waves, many whitecaps, some spray
6	Strong breeze	25-31	Large waves, whitecaps everywhere, more spray, large tree branches sway, wind whistling in wires
7	Moderate gale	32-38	Foam from breaking waves blown in streaks, whole trees move, resistance felt when walking against wind
8	Fresh gale	39-46	Moderate high waves of greater length, twigs and small branches broken off trees, progress impeded when walking
9	Strong gale	47-54	High waves, sea begins to roll, spray reduce visibility, roof tiles blown off
10	Whole gale	55-63	Very high waves with overhanging crests, heavy rolling, poor visibility, trees broken or uprooted

▲ *Figure 12.1: Beaufort Scale*

O3: Coral Bleaching and Marine Disease (CCMD)

The CCMD Local Action Strategy is working with Reef Check Hawaii to develop an "Eyes on the Reef" program which will train ocean users to identify and report potential bleaching and marine disease. Reef Check will serve as the first response area and determine whether a report is valid or not. They will house all reports and send information on to the Rapid Response Team if the report is valid. For more information, check out Reef Check's website: www.reefcheckhawaii.org. When the response network is in place, responders will be asked to call the Reef Check hotline (808) 953-4044. On Hawaii Island, the AIS workshops will include a presentation on bleaching and disease. Hawaii Island will test out the "train the trainers" concept and utilize the trained community members to first confirm reports before sending off to Reef Check or the Rapid Response Team. Contact the Mālama Kai Foundation for more information.

REFERENCES

Central Coast Monitoring Guide (California):
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The Clean Water Team: Guidance Compendium for Watershed Monitoring and Assessment.
Great resource for protocols, general information.
http://www.swrcb.ca.gov/nps/cwtguidance.html

Environmental Protection Agency, The Volunteer Monitor's Guide To Quality Assurance Project Plans:
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Thiel, T. University of Missouri-St. Louis. Department of Biology. Make your own incubator.
http://www.umsl.edu/~microbes/pdf/Incubator.pdf

Webster, M. and J. Zimper. University of Hawai'i, Sea Grant:
Nonpoint Education for Municipal Officials (NEMO) fact sheets on polluted runoff; recycling posters; managing boat waste.
http://www.soest.hawaii.edu/seagrant/communication/publications.php#CNR

University of Hawai'i, Water Quality Extension Program:
Includes presentations about water quality and watersheds; HAPPI (Hawaii's Pollution Prevention Information) Home Series, a set of 16 informational worksheets developed to address water-pollution issues in and around your home.
http://www.ctahr.hawaii.edu/wq/publications/publications.htm

APPENDIX A: VOLUNTEER WATER QUALITY MANUALS

Central Coast Monitoring Guide (California):
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Citizens Monitoring Bacteria: A training manual for monitoring E. Coli. 2005.
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The Clean Water Team: Guidance Compendium for Watershed Monitoring and Assessment.
Great resource for protocols, general information.
http://www.waterboards.ca.gov/nps/cwtguidance.html#10

Environmental Protection Agency, quality assurance project plan:
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EPA Volunteer Stream monitoring manual:
http://www.epa.gov/owow/monitoring/volunteer/stream/

EPA Volunteer Estuary monitoring manual:
http://www.epa.gov/owow/estuaries/monitor/

Heal the Bay, The Freshwater and Marine Team Field Guide:
http://www.healthebay.org/assets/pdfdocs/st_fieldguide.pdf

Missouri Stream Team Fact sheets:
http://www.mostreamteam.org/mostreamfacts.asp

Project SEARCH, Water Quality Monitoring for Secondary Schools, includes a manual, presentations, forms and a QAPP.
http://www.projectsearch.org/download.htm#manual

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http://www.uri.edu/ce/wq/ww/Manuals.htm

Virginia Department of Environmental Quality:
http://www.deq.state.va.us/cmonitor/guidance.html

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Clark County, State of Washington, Volunteer QAPP:
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Native American Fish & Wildlife Society, Alaska:
http://www.alaska.net/~aknafws/qapp.html

New Jersey Department of Environmental Protection, Volunteer Monitoring program:
http://www.state.nj.us/dep/wms/bfbm/vm/quality_assurance.html

APPENDIX B: CONTACTS/OTHER WATER QUALITY RESOURCES

NONPROFIT ORGANIZATIONS:

Ala Wai Watershed Association
Contact: Karen Ah Mai
1314 South King Street, #521
Honolulu, HI 96814
Phone: (808) 955-7882
Fax: (808) 732-7329
Email: awwa@alawai.org
http://alawai.org/index.htm

Malama Kai Foundation
P.O. Box 6882
Kamuela, HI 96743 USA
Phone: (808) 885-6354
Fax: (808) 885-6474
Email: info@malama-kai.org
http://www.malama-kai.org/

Community Conservation Network
PO Box 4674
Honolulu, HI 96812
Phone: (808) 528-3700
Fax: (808)528-3701
Email: info@conservationpractice.org
http://conservationpractice.org/

Malama Maunalua
Malama Hawaii
c/o The Nature Conservancy of Hawai'i
923 Nu'uanu Avenue
Honolulu, HI 96817
Email: greenwaveproductions@gmail.com

The Digital Bus
Ellen Federoff
Educational Outreach Coordinator
Phone: (808) 442-7152
Fax: (808) 442-7140
Email: ellen@digitalbus.org
http://www.digitalbus.org/index.htm

APPENDIX B: CONTACTS/OTHER WATER QUALITY RESOURCES

The Nature Conservancy
923 Nu'uanu Avenue
Honolulu, HI 96817
Phone: (808) 537-4508
Fax: (808) 545-2019
E-mail: hawaii@tnc.org
http://www.nature.org/wherewework/northamerica/states/hawaii/

Hanalei Watershed Hui
Post Office Box 1285
Hanalei, HI 96714
Phone: (808) 826-1985
Fax: (808) 826-1012
Email: hanaleiriver@hawaiian.net
http://www.hanaleiwatershedhui.org/

Project S.E.A.-Link
Contact: Liz Foote
160 Kinohi Loa Loop
Wailuku, HI 96793
Phone: (808) 669-9062
Email: lfoote@hawaii.rr.com
http://www.projectsealink.org

The Hawai'i Wildlife Fund
Contact: Hannah Bernard
PO Box 790637
Paia, HI 96779
Phone: (808) 579-9138
Email: wild@aloha.net
http://www.wildhawaii.org/

Sierra Club, Hawaii Chapter
P.O. Box 2577
Honolulu, HI 96803
Phone: (808) 538-6616
Email: jeff.mikulina@sierraclub.org
http://www.hi.sierraclub.org/

Kai Makana
P.O. Box 22719
Honolulu HI 96823
Phone: (808) 261-8939
Email: info@kaimakana.org
http://www.kaimakana.org/

Surfrider Foundation
Oahu: Scott Werny
Clearwater@hawaii.rr.com
http://www.surfrider.org/oahu/default.htm
Kauai: Paul Tannebaum
paultannenbaum@gmail.com
http://www.surfrider.org/kauai/SR_Kauai/Home.html
Maui: maui.surfrider@hawaiiantel.net
http://www.surfrider.org/maui/

LOCAL AGENCIES

City and County of Honolulu
Board of Water Supply
630 S. Beretania St.,
Honolulu, HI 96843
Phone: (808) 748-5000
Email: contactus@hbws.org
http://www.hbws.org/cssweb/display.cfm?sid=1059

City and County of Honolulu
Department of Environmental Services
Contact: Iwalani Sato
Phone: (808) 768-3300
Email: isato@honolulu.gov
http://www.cleanwaterhonolulu.com/storm/index.php

Coastal Zone Management Program
Contact: Melissa Iwamoto
Office of Planning
P.O. Box 2359
Honolulu, HI 96804
Phone: (808) 587-2845
Fax: (808) 587-2899
Email: miwamoto@dbedt.hawaii.gov
http://hawaii.gov/dbedt/czm/initiative/nonpoint.php

Department of Health,
Clean Water Branch
Environmental Management Division
State Department of Health
P.O. Box 3378
Honolulu, HI 96801-3378
Phone: (808) 586-4309
Fax: (808) 586-4352
Email: CleanWaterBranch@eha.health.state.hi.us
http://www.hawaii.gov/health/environmental/water/cleanwater/index.html

Department of Health, Environmental Planning Office
19 Ala Moana Blvd., Room 312
Honolulu, HI 96814
Phone (808) 586-4337
http://hawaii.gov/health/environmental/env-planning/index.html/

Department of Land
and Natural Resources:
Division of Aquatics
1151 Punchbowl Street #330,
Honolulu, HI 96813
Phone: (808) 587-0100
Fax: (808) 587-0115
http://hawaii.gov/dlnr/dar/

University of Hawai'i Sea Grant:
Link to University of Hawai'i
Sea Grant Staff Directory: http://www.soest.hawaii.edu/seagrant/directory/directory.php#ext
O'ahu Sea Grant:
2525 Correa Road, HIG 238
Honolulu, HI 96822
Phone: (808) 956-7031
Fax: (808) 956-2858

Kaua'i Sea Grant
Adam Asquith, Ph.D.
Kaua'i Agricultural Research Station
7370-A Kuamo'o Road
Kapa'a, HI 96766
Phone: (808) 822-4984 ext. 235
Fax: (808) 822-2190
Email: adam_asquith@yahoo.com

West Hawai'i Sea Grant
Sara Peck
Natural Energy Laboratory of Hawai'i
P.O. Box 489
Kailua-Kona, HI 96745
Phone: (808) 329-2861
Fax: (808) 329-6998
Email: peck@hawaii.edu

Hawaii Association
of Conservation Districts
99-193 'Aiea Heights Drive, Suite 110
'Aiea, HI 96701
Phone: (808) 483-8600 ext. 120
Fax: (808) 483-8619
http://www.hacdhawaii.org/index.html

APPENDIX B: CONTACTS/OTHER WATER QUALITY RESOURCES

Hawaii Association of Watershed Partnerships
http://www.hawp.org/index.php

Hilo Bay Watershed Advisory Group
Susan O'Neill, HBWAG Co-Spokesperson
Phone: (808) 345-5900
Email: susandan@aloha.net
http://www.numerologyreadings.com/hilobaywatershed/index.htm

Kailua Bay Advisory Council
Contact: Todd Cullison
45-1055 Kamehameha Highway, Suite 204
K?ne'ohe, HI, 96744
Phone: (808) 277-5611
Fax: (808) 988-0096
Email: tcullison@hawaii.rr.com
http://www.kbac-hi.org/index.html

LOCAL MARINE EDUCATION PROGRAMS:

Hanauma Bay Education Program
100 Hanauma Bay Road
Honolulu, HI 96825
Phone: (808) 397-5840
E-mail: hanauma@hawaii.edu
http://www2.hawaii.edu/~hanauma/about.htm

Ocean Science Discovery Center
300 Maalaea Drive, Suite 211
Wailuku, HI 96793
Phone: 1-800-942-5311
Email: info@osdcmaui.org
http://www.osdcmaui.org/

Mau'i Ocean Center
Contact: Education Director
192 Ma'alaea Road
Ma'alaea, HI 96793
Phone: (808) 270-7085
Fax (808) 270-7070
www.mauioceancenter.com

Waikiki Aquarium
Contact: Mark Heckman
2777 Kalakaua Ave
Honolulu, HI 96815-4027
Phone: (808) 923-9741
FAX (808) 923-1771
Email: mheckman@waquarium.org
http://www.waquarium.org/

FEDERAL AGENCIES:

Environmental Protection Agency
Contact: Wendy Wiltse
300 Ala Moana Blvd.
Box 50003
Room 5-152
Honolulu, HI 96850
Phone: (808) 541-2752
FAX: (808) 541-2712
http://www.epa.gov/Region9/index.html

Hawaiian Islands Humpback Whale National Marine Sanctuary
http://hawaiihumpbackwhale.noaa.gov/Welcome.html
Email: hihumpbackwhale@noaa.gov
Kaua'i Office

Kukui Grove Executive Center
4370 Kukui Grove Street, Suite 206
Lihu'e, HI 96766
Phone (808) 246-2860
Fax (808) 246-2862
Mau'i Office
726 Kihei Road
Kihei, HI 96753
Phone: (808) 879-2818, (800) 831-4888
Fax: (808) 874-3815
O'ahu Office
Contact: Naomi McIntosh
6600 Kalaniana'ole Highway, Suite 301
Honolulu, HI 96825
Phone: (808) 397-2651
Fax: (808) 397-2650

Natural Resources Conservation Service (NRCS)
USDA NRCS Hawai'i State Office
P.O. Box 50004
Honolulu, Hawai'i 96850-0050
Phone: (808) 541-2600
Fax: (808) 541-1335 or 541-2652
http://www.hi.nrcs.usda.gov/
US Geological Services,

Pacific Islands Water Science Center
677 Ala Moana Blvd., Suite 415
Honolulu, HI 96813
Phone: (808) 587-2400
Fax: (808) 587-2401
http://hi.water.usgs.gov/

LOCAL BUSINESSES:

Maui, Land and Pineapple
P.O. Box 187
Kahului, Hawai'i 96733-6687
Phone: (808) 877-3351
Fax: (808) 871-0953
Email:
http://www.mauiland.com/

EDUCATION/PRINTED MATERIALS

City and County of Honolulu, storm water runoff outreach materials, targeting different stakeholders. http://www.cleanwaterhonolulu.com/storm/learning_center/learning_center.html

County of Maui, water conservation information: http://mauiwater.org/conservation.html

Department of Health, State of Hawai'i. Information brochure on water quality standards. http://hawaii.gov/health/environmental/env-planning/wqm/wqsbrochure.pdf

Department of Health, State of Hawai'i. Information brochure on leptospirosis. http://hawaii.gov/health/about/reports/leptobrochure.pdf

EPA's Polluted Runoff Outreach materials, including a toolbox for creating an outreach campaign. http://www.epa.gov/owow/nps/outreach.html

EPA World Water Monitoring outreach materials. http://www.epa.gov/owow/monitoring/volunteer/monitoringmonth.html

EPA's fact sheets on coastal watersheds: http://www.epa.gov/owow/oceans/factsheets/

Hawai'i Networked Learning Communities: An online resource for educators in improving science, math and technology education in Hawaii's schools. http://www.hnlc.org/home/index.php

APPENDIX B: CONTACTS/OTHER WATER QUALITY RESOURCES

Island Stewardship: Guide to Preventing Water Pollution for Maui's Homes and Businesses. Maui Watershed Management Advisory Committee and Hawai'i Department of Health.

Kailua Bay Advisory Council, website with good information on water quality http://www.kbac-hi.org/resources.htm

Surfrider's Respect the Beach program for K-12 grade levels: http://www.surfrider.org/programs/respectthebeach.asp

University of Hawai'i, Sea Grant: Nonpoint Education for Municipal Officials (NEMO) fact sheets on polluted runoff; recycling posters; managing boat waste. http://www.soest.hawaii.edu/seagrant/communication/publications.php#CNR

University of Hawai'i, Water Quality Extension Program: Includes presentations about water quality and watersheds; HAPPI (Hawaii's Pollution Prevention Information) Home Series, a set of 16 informational worksheets developed to address water-pollution issues in and around your home. http://www.ctahr.hawaii.edu/wq/publications/publications.htm

Water words that work: Words to use, words to avoid when conducting outreach to the public http://waterwordsthatwork.com/

Hawaiian Cultural Resources: Craighill-Handy, E.S., E Green-Handy, with the collaboration of M. Kawena Pukui. Revised 1991. Native Planters in Old Hawai'i: their life, lore and environment. Bishop Museum, 1525 Bernice Street, Honolulu, HI 96817. 676p.

Titcomb, M. 1972. Native use of fish in Hawai'i. University of Hawai'i Press, Honolulu, HI. 188p.

Hawaiian Islands natural history, geology: Hazlett, R.W. and D.W Hyndman. 1996. Roadside Geology of Hawai'i. Mountain Press Publishing Company. 304p.

Kay, Alison (ed). 1994. A Natural History of the Hawaiian Islands. Selected Readings II. University of Hawai'i Press. 520p.
Rauzon, M. 2001. Isles of Refuge:

Wildlife and History of the Northwestern Hawaiian Islands. University of Hawai'i Press, Honolulu, HI 205p.

Russo, Ron. 1994. Hawaiian reefs: A natural history guide. Wavecrest Publications, San Leandro, CA. 174p.

INVASIVE SPECIES:

Alien marine algae in the Hawaiian Islands: http://www.botany.hawaii.edu/GradStud/smith/invasive/BROCHURE.htm

Alien and Invasive Algae in Hawai'i (Hawai'i Coral Reef Initiative):http://www.botany.hawaii.edu/GradStud/smith/websites/ALIEN-HOME.htm

Bishop Museum and the University of Hawai'i, Guide to introduced marine species of Hawai'i: http://www2.bishopmuseum.org/HBS/invertguide/index.htm
Cox, G. 1999. Alien Species in North

America and Hawai'i: Impacts on Natural Ecosystems. Island Press, 1718 Connecticut Ave, NW, Suite 300, Washington DC 20009. 172-187pp. 387 p.

Hawai'i Ecosystems at Risk (HEAR) project: http://www.hear.org/AlienSpeciesInHawaii/

National Aquatic Nuisance Task Force: http://www.anstaskforce.gov/

National Biological Information Infrastructure Invasive species: http://invasivespecies.nbii.gov/

State of Hawai'i Aquatic Invasive Species Management Plan: http://www.hawaii.gov/dlnr/dar/pubs/ais_mgmt_plan_final.pdf

University of Hawai'i, Department of Botany, Invasive algae of Hawai'i: http://www.hawaii.edu/reefalgae/invasive_algae/INDEX.HTM

LIMU RESTORATION:

Abbot, Isabella Aiona, Limu An Ethnobotanical Study of some Hawaiian Seaweeds, Pacific Tropical Botanical Garden, 1996. 39 p.

Aliomanu limu restoration, Kapa'a Elementary School: http://www.kauaiworld.com/articles/2005/05/17/news/news01.txt

Ewa Beach limu restoration and proposed Fishery management Area: http://www.hawaii.gov/dlnr/dar/regs/ch60.6dr.pdf

Fortner, Heather. The Limu Eater, a cookbook of Hawaiian seaweed. UH Sea Grant, 1985. 102 p.

Magruder, W.H. and J.W Hunt. 1979. Seaweeds of Hawai'i: A photographic identification guide. Oriental Publishing Co. Honolulu, HI.

Project Ho'olokahi, Kaiser High School: http://pikoi.hawaii.edu/pikoi4/overview.html

MARINE DEBRIS:

Asia Pacific Economic Cooperation, Derelict Fishing Gear and Related Marine Debris Seminar, January 13 - 16, 2004, East-West Center - University of Hawai'i, Manoa: Documents from the seminar: http://www.wpcouncil.org/documents/APECSeminar/index.html

EPA site on marine debris: http://www.epa.gov/owow/oceans/debris/

NOAA's marine debris program, with general information on marine debris: http://marinedebris.noaa.gov/

Ocean Conservancy, National Marine Debris Monitoring Program, 5 year program analysis: http://www.oceanconservancy.org/site/PageServer?pagename=mdm_debris

Marine Resource information: Hawai'i Ocean User's Guide: http://hawaiihumpbackwhale.noaa.gov/special_offerings/sp_off/publication_pdfs/

HawaiiOceanUsersGuide_2004.pdf Ocean Atlas of Hawai'i: Description of the ocean around Hawai'i - marine climate, water properties, currents, tides, waves. http://radlab.soest.hawaii.edu/atlas/

RECYCLING/TRASH:

Adopt-a-beach Hawai'i: http://www.adoptabeachhawaii.com/

Hawai'i Island recycling: http://www.recyclehawaii.org/where.htm

Honolulu recycling and waste disposal: http://www.opala.org/

Kaua'i county recycling program: http://www.kauai.gov/Default.aspx?tabid=68

Kaua'i recycling for the arts, transforming glass into art: http://www.kauaiglass.org/

Maui recycling service: http://www.mauirecycles.com/

O'ahu community recycling: http://www.ocr2000.com/index.html

STREAMS:

Natural Resources Conservation Service. 2001. Hawai'i Stream Visual Assessment Protocol: http://hawaii.gov/health/environmental/env-planning/wqm/nrcsvaprotocol.pdf

Yamamoto, M, A. Tagawa and L. Shimizu-Ide. 2000. "Hawaii's Native and Exotic Freshwater Animals". Mutual Publishing. 200pp.

TRADITIONAL KNOWLEDGE:

Smith, M.K. and M. Pai. 1992. The ahupua'a concept: Relearning coastal resource management from ancient Hawaiians. NAGA: The ICLARM Quarterly. 15 (2): 11-13.

Titcomb, M and Mary Kawena Pukui. 1972. Native use of fish in Hawai'i. University Press of Hawai'i. 175p.

VOLUNTEER MONITORING PROGRAM INFORMATION:

Designing your monitoring strategy: Basic questions and resources to help guide you: http://www.usawaterquality.org/volunteer/outreach/designingyourstrategy.pdf

Global Rivers Environmental Education Network (Good resource for educational based programs): http://www.green.org/

Santa Barbara ChannelKeeper Volunteer Citizen Monitoring Groups: http://www.stream-team.org/

Volunteer Water Quality Monitoring National Facilitation Project: http://www.usawaterquality.org/volunteer/

Waterkeeper Alliance (national organization with local chapters dedicated to protecting the waters from pollution): http://www.waterkeeper.org/

WATER QUALITY DATA AND INFORMATION:

EPA Better Assessment Science Integrating point and Nonpoint Sources (BASINS) software system BASINS is a multipurpose environmental analysis system designed for use by regional, state, and local agencies in performing watershed and water quality-based studies. This system makes it possible to quickly assess large amounts of point source and non-point source data in a format that is easy to use and understand. Installed on a personal computer, BASINS allows the user to assess water quality at selected stream sites or throughout an entire watershed. This invaluable tool integrates environmental data, analytical tools, and modeling programs to support development of cost-effective approaches to watershed management and environmental protection, including TMDLs. http://www.epa.gov/waterscience/basins/

EPA STORET. STORET (short for STOrage and RETrieval) is a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. http://www.epa.gov/storet/

EPA Environmental Technology Verification Program. This program verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. Check out the Monitoring systems and Water Quality Protection areas. http://www.epa.gov/etv/index.html

EPA Water Quality Assessment and Total Maximum Daily Loads Information. This site provides information reported by the states to EPA about the conditions in their surface waters. http://www.epa.gov/waters/ir/ EPA Water Quality Standards Academy. This website provides

classroom-based courses and occasional satellite broadcasts of instruction. http://www.epa.gov/waterscience/standards/academy/

National Environmental Monitoring Index. NEMI is a free, searchable clearinghouse of methods and procedures for both regulatory and non-regulatory monitoring purposes for water, sediment, air and tissues. At this time, there is not a lot of methods that are used by volunteer groups, but is a good website to check out. http://www.nemi.gov/

NOAA N-SPECT tool (Nonpoint Source Pollution and Erosion Comparison) is a complex yet user-friendly geographic information system (GIS) extension that helps coastal managers and local decision makers predict potential water-quality impacts from nonpoint source pollution and erosion. http://www.csc.noaa.gov/crs/cwq/nspect.html

State of Hawai'i, Department of Health, Clean Water Branch: http://www.hawaii.gov/health/environmental/water/cleanwater/index.html

State of Hawai'i Water Quality studies database: http://www.aecos.com/CORAL/CZM_WQ.html

Surfrider Foundation: Hawai'i water quality and beach status reports conducted annually (Check out the State of the Beach): http://www.surfrider.org/

Hawai'i USGS, Pacific Islands Water Science Center. The Pacific Islands Water Science Center collects hydrologic information and studies water-resource issues in support of the USGS mission. http://hi.water.usgs.gov/office/mission.html

Watershed restoration:
Center for Watershed Protection: http://www.cwp.org/

Department of Land and Natural Resources, Conservation Hawai'i (information on Hawaii's natural resources) http://www.state.hi.us/dlnr/consrvhi/intro.html

Department of Land and Natural Resources, Division of Forestry and Wildlife: http://www.dofaw.net/

Hawaiian streams information, DLNR, Division of Aquatic Resources, see also the bibliography section for additional references: http://www.hawaii.gov/dlnr/dar/streams/index.htm

Hawai'i Association of Watershed Partnerships, information on watershed, partnerships and how to help: http://www.hawp.org/

Hawai'i streams information, Hawai'i Stream Research Center: http://www.hawaii.edu/hsrc/home/
Kido, M. 2002. The Hawai'i Stream Bioassessment Protocol, version 3.01. The Hawai'i Stream Research Center, Center for Conservation Research and Training, University of Hawai'i. 48p. http://www.hawaii.gov/health/environmental/env-planning/wqm/hsbp301.pdf

National River Restoration Science Synthesis (NRRSS) River Restoration in our Nation: A Scientific Synthesis to Inform Policy, Grassroots Actions, and Future Research: http://www.nrrss.umd.edu/NRRSS_Proj_Descr.htm

Native plants to control stream bank erosion: http://www.ctahr.hawaii.edu/rnre/Downloads/Plants%202%20Control.pdf

Natural Resources Conservation Service, Hawai'i office, information for communities, farmers on soils, plants, stream restoration, water quality: http://www.hi.nrcs.usda.gov/

Natural Resources Conservation Service. 2001. Hawai'i Stream visual assessment protocol. http://www.hawaii.gov/health/environmental/env-planning/wqm/nrcsvaprotocol.pdf

Online training in watershed management, EPA: http://www.epa.gov/watertrain/

Riley, A. 1998. Restoring Streams in Cities: A guide for planners, policymakers and citizens. Island Press, Washington D.C. 423p.

Riparian Restoration Plant Database: http://www.ctahr.hawaii.edu/rnre/Riparian_Restoration_Plant_Database.asp

Stormwater magazine: Storm water management tools, techniques and case studies. Free magazine subscription: http://www.stormh2o.com/sw.html

Stream corridor restoration: Principles, Processes and Practices: The document encourages locally led, public involvement in restoration planning and implementation. Click on Table of Contents for the entire document: http://www.nrcs.usda.gov/technical/stream_restoration/newgra.html

Waipi'o Valley Stream Restoration Study, a research collaboration of scientists and students. http://www.bishopmuseum.org/research/natsci/waipiostudy/students/intro.html

VOLUNTEER RESPONSIBILITIES CONSENT FORM

(Please initial each item and sign at the bottom of the form)

____ 1. Fulfill the given assignments or notify the program coordinator of any change in plans.

____ 2. Each monitoring team leader and member will fulfill roles and responsibilities as established by the program.

____ 3. Always obtain permission from landowner before entering private property.

4. Follow the safety guidelines for sampling and surveying, including the following:

____ Wear rubber boots, hiking boots, tabis, or similar protective footwear when conducting stream survey and sampling work.

____ Do not survey or take samples in or close to the stream during flooding.

____ Always conduct surveying or sampling field work with a partner.

____ Do not enter the ocean at high surf for sampling or surveying purposes.

____ Always wear safety glasses and protective gloves during sampling and water quality analysis.

____ Always carry a first aid kit while on a field survey or sampling trip.

NAME (Please print) _____

SIGNATURE _____DATE _____

Chain of Custody Form

Survey				Samplers:	*Signature*				
Station Number	Station Location	Date	Time	Sample Type			Seq. No.	No. Of Containers	Analysis required
				Water		Air			
				Comp	Grab				
Relinquished by:	*Signature*		Received by:	*Signature*				Date/Time	
Relinquished by:	*Signature*		Received by:	*Signature*				Date/Time	
Relinquished by:	*Signature*		Received by:	*Signature*				Date/Time	
Relinquished by:	*Signature*		Received by Mobile Laboratory for Field analysis:	*Signature*				Date/Time	
Dispatched by:	*Signature*		Date/Time		Received for Laboratory by:	*Signature*		Date/Time	
Method of Shipment:									

Data Sheet for Water Quality Monitoring

Page/of Total _____

Date _____ Lunar phase _____

Site ID _____ Site Name _____

Latitude/Longitude coordinates _____

Waterbody name _____ Watershed Name _____

Project name and/or ID _____ Organization name and/or ID _____

Team Name _____ Name of recorder _____

Team members _____

Measurements

Equipment Type	Parameter	circle Unit	Result #1	Result #2	Result #3	Measurement Depth*	Notes
	Salinity	ppt					
	Specific Conductivity	*M/cm*					
	Water Temp	C or F					
	pH	pH					
	Dissolved oxygen	Mg/L or % satur.					
	Turbidity	NTU					
	Transparancy	cm					
	Phosphate	ppm					
	Nitrate	ppm					

*** Measurement Depth** (select one) Surface; Mid Column; Near Bottom
OR provide measured depth and unit of measurement

Bacteria Sample Sheet

Site Number & Name:		Waterbody & Watershed Name		Latitude/Longitude	
Sample Date:	Sample Time:	Sampler Name:		Today's Date:	Tide (H or L):
Lab Tech Name:		Score Date:	Score Time:		

Login #	Sample	Temp (C or F) Water	Air	Time	Depth	Observations	Bacteria Level: MPN Number/ (Number of Tubes or wells)
						Surf: Weather: Rain (Yor N):	*E Coli (Fecal)* *Enterococcus*
						Surf: Weather: Rain (Yor N):	*E Coli (Fecal)* *Enterococcus*
						Surf: Weather: Rain (Yor N):	*E Coli (Fecal)* *Enterococcus*
						Surf: Weather: Rain (Yor N):	*E Coli (Fecal)* *Enterococcus*

Tide: Time of nearest High or Low tide (indicate which)
Surf: Wave height or N/A
Weather: Sunny, partly cloudy, overcast, fog, light rain, heavy rain
Rain: circle Y if it has rained in the past 3 days; otherwise N
Total: MPN number of # tubes or wells that are yellow
E coli or enterococcus:MPN number of # tubes that flouresce
E coli: number of coliforms per ml of water

Dissolved Oxygen Calibrate to site elevation: _____

Reading	Mg/L	% Saturation	Time	Comments
1				
2				
3				

Collect Sample for Nutrient Testing Bottle # _____ Time collected: _____

Time put on ice: _____ Relinquished by: _____ Time: _____

Collect Sample for Bacteria Bottle # _____ Time collected: _____

Time put on ice: Relinquished by: _____ Time: _____

Sample Bottles received by: _____ Time: _____

Comments: _____

_____

_____

Storm Drain Data Form

Sampling Site:

pH Meter Calibration (Circle pH calibration) 4.0 **7.0** 10.0	Date	Time	Initial Reading

	First Visit		Second Visit	
Date				
Time				
Precipitation in last 48 hrs?	Y or N		Y or N	
Flow Depth (cm)				
Flow Width (cm)				
Air Temp				
Water Temp				
Trash (list types in notes)	Y or N		Y or N	
Sewage (sighted or smelled)	Y or N		Y or N	
Oil Sheen	Y or N		Y or N	
Surface scum	Y or N		Y or N	
	First try	Repeat	First try	Repeat
Detergent (ppm)				
Chlorine (ppm)				
Phenosis (ppm)				
Copper (ppm)				
Ammonia Nitrogen (ppm)				
pH (standard units)				
Turbidity				
Others (state)				
Others (state)				
Odor number				
Color Number				

Other Observations:	Other Observations:

Team Members:	What test(s) they did	Team Members:	What test(s) they did

Note: Circle either Y or N in all boxes to indicate yes or no

INTERNATIONAL COASTAL CLEANUP™ DATA CARD

Data collected during the International Coastal Cleanup™ is used to educate the public and develop solutions to solid waste management practices. Through cooperative efforts among government agencies, private industries, community associations, environmental organizations and local citizens, changes in behavior and practices result which help to conserve and protect the environment. The annual cleanup is how we measure our continued success. Thank you for being a very important part of this process.

Type of Cleanup: ❑ Shoreline/Beach ❑ Underwater

Country Where Cleanup Was Conducted:_____

Zone or County Cleaned:_____

Beach Site Name:_____

Today's Date: Month_____ Day_____ Year_____

Name of Coordinator:_____

Number of People Working on This Card:_____

Distance Cleaned:_____

Number of Trash Bags Filled:_____

Total Estimated Weight Collected:_____

NAMES OF PARTICIPANTS IN YOUR GROUP

If you are interested in learning more about **The Ocean Conservancy's** efforts to protect our oceans and waterways and if you would like to receive *Action Alerts* on critical marine conservation issues from The Ocean Conservancy's free Ocean Action Network (OAN), please check the box below with your name and address.

1. Name:_____ Age:_____
Address:_____
City:_____ State:_____
Country:_____ Zip Code:_____
Phone: (_____) _____
Email:_____
I would like information on: ❑ The Ocean Conservancy ❑ The OAN

2. Name:_____ Age:_____
Address:_____
City:_____ State:_____
Country:_____ Zip Code:_____
Phone: (_____) _____
Email:_____
I would like information on: ❑ The Ocean Conservancy ❑ The OAN

3. Name:_____ Age:_____
Address:_____
City:_____ State:_____
Country:_____ Zip Code:_____
Phone: (_____) _____
Email:_____
I would like information on: ❑ The Ocean Conservancy ❑ The OAN

4. Name:_____ Age:_____
Address:_____
City:_____ State:_____
Country:_____ Zip Code:_____
Phone: (_____) _____
Email:_____
I would like information on: ❑ The Ocean Conservancy ❑ The OAN

ENTANGLED ANIMALS: (❑ Dead or ❑ Alive). Type of Animal(s) and What Entangled the Animal:_____

WHAT WAS THE MOST PECULIAR ITEM YOU COLLECTED?_____

The following national and international organizations endorse and/or support the International Coastal Cleanup:

- U.S. Environmental Protection Agency
- IUCN – The World Conservation Union
- Intergovernmental Oceanographic Commission (IOC) of the United Nations' Educational, Scientific, and Cultural Organization (UNESCO)

Please return this card to your area coordinator or mail it to:

The Ocean Conservancy
Pollution Prevention and Monitoring Office
1432 N. Great Neck Road, Suite 103
Virginia Beach, VA 23454 USA
Phone (757) 496-0920
Fax (757) 496-3207

The Ocean Conservancy
Formerly the Center for Marine Conservation

Appendix A: Sample Data Forms

ITEMS COLLECTED

The debris forms listed on this data card should be considered as indicator items based on their known uses (related activities) and impacts in the marine/aquatic environment (animal entanglement and ingestion, habitat destruction, human health and safety, vessel disablement, and economics and aesthetics).

Volunteers should clean up all debris found on the beach but only record information on the items listed below.

Keep a count of your items using tick marks and enter the item total in the box.

Example: [8] Bags/Food Wrappers 𝍸 |||

SHORELINE AND RECREATIONAL ACTIVITIES

(Debris from beach-goers, sports/games, festivals, litter from streets/storm drains, etc.)

- ☐ Bags/Food Wrappers
- ☐ Balloons
- ☐ Beverage Bottles (plastic) 2 liters or less
- ☐ Beverage Bottles (glass)
- ☐ Beverage Cans
- ☐ Caps, Lids
- ☐ Clothing, Cloth
- ☐ Cups, Plates, Forks, Knives, Spoons
- ☐ Diapers
- ☐ Fast-food Containers
- ☐ 6-Pack Holders
- ☐ Pull Tabs
- ☐ Shotgun Shells/Wadding
- ☐ Straws, Stirrers
- ☐ Toys

OCEAN/WATERWAY ACTIVITIES

(Debris from recreational/commercial fishing and boat/vessel operations)

- ☐ Bait Containers/Packaging
- ☐ Bleach/Cleaner Bottles
- ☐ Buoys/Floats
- ☐ Crab/Lobster/Fish Traps
- ☐ Crates
- ☐ Fishing Line
- ☐ Fishing Lures
- ☐ Fishing Nets
- ☐ Light Bulbs/Tubes
- ☐ Oil/Lube Bottles
- ☐ Pallets
- ☐ Plastic Sheeting/Tarps
- ☐ Rope
- ☐ Strapping Bands

SMOKING-RELATED ACTIVITIES

(Debris associated with smoking-related waste)

- ☐ Cigarettes/Cigarette Filters
- ☐ Cigarette Lighters
- ☐ Cigar Tips
- ☐ Tobacco Packaging/Wrappers

MEDICAL/PERSONAL HYGIENE

- ☐ Syringes
- ☐ Condoms
- ☐ Tampons/Tampon Applicators

DUMPING ACTIVITIES

- ☐ Appliances (refrigerators, washers, etc.)
- ☐ Batteries
- ☐ Cars/Car Parts
- ☐ Construction Materials
- ☐ 55-Gal. Drums
- ☐ Tires

DEBRIS ITEMS OF LOCAL CONCERN

(Items listed determined by local ICC Coordinator)

- ☐
- ☐
- ☐

National Marine Debris Monitoring Program
Data Card

Thank you for completing this data card. Please answer the questions and return to your survey director. This information will be used in The Ocean Conservancy's National Marine Debris Monitoring Program's data base to determine trends and sources of specific debris items.

Name_____ Affiliation _____

NMDMP Region _____ Survey Site _____

Survey Number _____ Today's date: _____ /_____ /_____

Air Temperature _____ Wind Direction _____

Wind Speed _____ (1=no wind, 2=slight, 3=moderate, 4=heavy, 5=gale)

Brief Description of Weather _____

Weather Conditions from previous week: _____

_____

Time (Beginning of Survey) _____ Time (End of Survey) _____

Other Remarks _____

_____

Safety Tips

1. Wear gloves and closed-toed shoes.
2. Be careful with sharp objects and syringes.
3. Stay out of dunes.
4. Watch out for wildlife.
5. Don't lift heavy objects.
6. Do not go near any large drums.

Dead, Live and/or Entangled Animals:

_____

_____

Foreign Labels: _____

_____

_____

Survey Director: _____

_____

Please return this card to your survey director or mail it to:

The Ocean Conservancy
1432 N. Great Neck Road, Suite 103
Virginia Beach, VA 23454

The Ocean Conservancy

Printed on recycled paper

Appendix A: *Sample Data Forms*

Items Collected

You may find it helpful to work with a buddy as you clean the area, one of you picking up trash and the other taking notes. An easy way to keep track of the items you find is by making tick marks. The box is for total items; see sample below.

Example:

Balloons 𝍸 𝍸 𝍸 || 17

Ocean-Based

Gloves
Pl. sheets ≥ 1 meter
Light bulbs/tubes
Oil/gas containers (> 1 quart)
Pipe-thread protectors
Nets ≥ 5 meshes
Traps/pots
Fishing line
Light sticks
Rope ≥ 1 meter
Salt bags
Fish baskets
Cruiseline logo items
Floats/Buoys

Land-Based

Syringes
Condoms
Metal beverage cans
Motor oil containers (1 quart)
Balloons
Six-pack rings
Straws
Tampon applicators
Cotton swabs

General Sources

Plastic bags with seam < 1 meter
≥ 1 meter
Straps Open
Closed
Plastic bottles: beverage
food
bleach/cleaner
other pl. bottles

Comments:

LAND ACCESS PERMISSION LETTER

From:

To:

Re: Permission to access stream as part of the _____ Volunteer Water Quality Monitoring Program

Aloha,

The accompanying brochure explains the _____ Volunteer Water Quality Monitoring Program. I am writing to inform you about the program, and to ask for your cooperation (and assistance if you care to join the Water Monitoring Team) in carrying out the program.

As you own property near one of the streams, I am sure you are interested in keeping the water in the stream as clean as possible. We feel that though a collaborative program with the community, private landowners and government, we can achieve our goal toward a healthy watershed. The program is designed to assess the quality of the water in the stream and, if any source of pollution is detected, we will seek to solve the problem cooperatively.

As the volunteers begin to characterize portions of the stream and take water samples, they may require access to a part of your property in order to get to our up streams. It is our policy never to allow our volunteers to cross private land unless we have written permission from the landowner.

We only need limited access to and along the stream. All reasonable care will be taken to limit any impact on your property. In most cases, the access will be a one-time event as the volunteers walk up the stream to verify their maps showing the course of the stream. After verifying the course of the stream, the team will select ____ water monitoring stations. We foresee a group of ___ volunteers requiring access possibly ___ times a month to obtain water samples at these stations. All volunteers are registered and trained and have been extensive safety briefings.

The enclosed form is provided to make it easy for you to allow the team members access to your property under any limitation you feel necessary to impose. If you would like further information, you may contact me at XXX-XXXX.

Please return the form in the enclosed envelope by _____ as we have as ambitious schedule to accomplish the task we have outlined for ourselves. We are looking forward to working with you on this important project.

LANDOWNER ACCESS CONSENT FORM

Last Name _____First Name _____ Plot Number _____

Address _____City _____ State _____ Zip _____

CONTACT

Day Phone _____ Evening _____

Email _____

☐ I give team members permission to cross my property to access the stream with the following conditions: (Check any condition(s) you wish to impose.)

___ That the team leader contact me before the first instance of access.

___ That I know at least one day in advance of each access.

___ I also would like to add the following restriction(s) and/or comment(s)

_____

_____

_____

_____

_____

If permission is granted, we request that any dangerous dogs be restrained by the owner. All reasonable care will be taken by the volunteers to ensure that damage is done to the property.

☐ I will not allow access to my property under any circumstances.

Print name _____

Signature _____Date _____

Hawai'i Rapid Bioassessment Form

Site #:		Site Type	Describe type			Water quality sampled:	Collector name(s)
Site Name:		Stream:	Natural	or	Modified	Y / N	
Date:	Time:	Ditch:	Earthen	or	Concrete	Bottle/pak #:	
Moon phase:		Spring:	Spring	or	Seep	Temp:	
Waypoint:		Lake:	Natural	or	Artificial	Sp_Conductivity:	
Latitude (DD):		Wetland:	Natural	or	Artificial	pH: DO:	
Longitude (DD):		Photo #s:				Clarity:	Flow: Low Med High

			Sex			Size Classes					Sampling Method								Life Stage					
	Species	Species code	Male	Female	Unknown	Small	Medium	Large	Abundance	Reproduction	Visual	Hook and line	Trap	Scoop net	Throw net	Aerial net	Surber	Seine	Adult	Juvenile	Postlarvae	Larvae	Egg	Notes #
Native Fishes	'O'opu naniha	4				<2	2-3.5	>3.5																
	'O'opu 'akupa	5				<2	2-6	>6																
	'O'opu nākea	3				<2	2-6	>6																
	'O'opu nōpili	2				<2	2-4	>4																
	'O'opu 'alamo'o	1				<2	2-3.5	>3.5																
	Āholehole (Zebra head flagtail)	973				<2	2-5	>5																
	Āholehole (Hawaiian flagtail)	6				<2	2-5	>5																
	Ama'ama	7				<3	3-8	>8																
Topminnows	Mosquitofish	220				<0.5	0.5-1	>1																
	Guppy, rainbow fish	210				<0.5	0.5-0.75	>0.75																
	Sailfin molly, tabai	214				<1	1-2	>2																
	Liberty/Mexican molly	215				<1	1-2	>2																
	Cuban Molly	212				<1	1-2	>2																
	Green swordtail	200				<1	1-3	>3																
	Moon fish	205				<1	1-2	>2																
Cichlid &Cichlid-like fishes	Tilapia sp1					<2	2-5	>5																
	Tilapia sp2					<2	2-5	>5																
	Midas cichlid/red devil	231				<2	2-5	>5																
	Convict cichlid	230				<1	1-3	>3																
	Nicaragua cichlid	6083				<2	2-5	>5																
	Jaguar cichlid	234				<2	2-6	>6																
	Firemouth	233				<2	2-4	>4																
	Johanni cichlid	235				<1	1-3	>3																
	Banded jewel/Five spot	6045				<2	2-5	>5																
	Oscar	250				<3	3-8	>8																
	Peacock bass	260				<4	4-12	>12																
	Smallmouth bass	256				<4	4-10	>10																
	Largemouth bass	255				<4	4-12	>12																
	Bluegill	265				<2	2-5	>5																
Miscellaneous Introduced Fishes	Rainbow trout	300				<4	4-10	>10																
	Dojo	305				<2	2-5	>5																
	Chinese catfish	310				<4	4-9	>9																
	Channel catfish	993				<4	4-12	>12																
	Carp/Koi	280				<4	4-12	>12																
	Goldfish	281				<2	2-6	>6																
	Chevron snakehead	995				<4	4-12	>12																
	Rice paddy eel	340				<6	6-15	>15																
	Suckermouth catfish	325				<2	2-6	>6																
	Bristlenose/bearded catfish	320				<2	2-4	>4																
	Long-fin armored catfish					<4	4-10	>10																
	Bronze catfish	315				<0.75	0.75-1.5	>1.5																
	Stickfish/Silver needlefish	996				<4	4-9	>9																
	Threadfin shad	225				<1	1-3	>3																
	Mangrove goby	17				<0.5	0.5-1	>1																
	Fang-toothed blenny	44				<1	1-2	>2																
Other																								

	Species	Species code	Sex: Male	Sex: Female	Sex: Unknown	Size Classes: Small	Size Classes: Medium	Size Classes: Large	Abundance	Reproduction	Sampling Method: Visual	Sampling Method: Hook and line	Sampling Method: Trap	Sampling Method: Scoop net	Sampling Method: Throw net	Sampling Method: Aerial net	Sampling Method: Surber	Sampling Method: Seine	Life Stage: Adult	Life Stage: Juvenile	Life Stage: Postlarvae	Life Stage: Larvae	Life Stage: Egg	Notes #
Native Invertebrates	ʻŌpaekala'ole/Mountain ʻōpae	10																						
	ʻŌpae ʻoeha'a	11																						
	ʻŌpae ʻula	4789																						
	Hīhīwai	8																						
	Hapawai	9																						
	Pīpīwai																							
	Pond snails																							
	Freshwater sponge	989																						
Introduced invertebrates	Crayfish	802																						
	Tahitian prawn	12																						
	Grass shrimp	803																						
	Chinese mystery snail	507																						
	Apple snail	502																						
	Ramshorn snail																							
	Thiarid snails	57																						
	Pouch snails	511																						
	Asiatic freshwater clam	501																						
Frog	Cane toad	400																						
	Bullfrog	405																						
	Wrinkled frog	403																						
Turtle	Red-eared slider	11169																						
	Wattle-necked softshell turtle	452																						
	Chinese softshell turtle	451																						
Others																								
#	Notes																							

Trial number:

Discharge	1	2	3	4	5
Width:					
Distance from bank:					
Depth:					
Flow reading:					
Velocity:					
Discharge:					
Substrate:					

Calculations

$$\text{Flow} = \frac{A \; L \; C}{T}$$

A = Average cross-sectional area of the stream

L = Length of the stream reach measured (usually 20 ft.).

C = A coefficient or correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams).

T = Time, in seconds, for the float to travel the length of L

Site sketch

Hawai'i Volunteer Monitoring Visual Assessment Form

Site # / Island:	Start time:		**Weather in past 24 hours**	**Weather:**
Site Name:	End time:		Precipitation in past 24 hours:	0. Clear/sunny
Watershed Name:	Reach length:		Rainfall within last 24 hours? Y N	1. Calm
Date:	Photo #s:	Brief description	Amount of rainfall (if known):	2. Lt. Breeze
Moon phase:			Source of information:	3. Windy
Volunteer name(s)				4. Very windy
			Current weather conditions:	5. Overcast/cloudy
				6. Partly cloudy
				7. Foggy
				8. Drizzle
				9. Rain
				10. Snow
				11. Hail
				12. Other

STARTING POINT OBSERVATIONS:

Starting point description

Latitude:

Longitude:

Odor	Algae	Foam	Turbidity	Flow	Oil	Opala	Color

Dominant stream or shore side vegatation:

% Native: % Non-native Natural vegetation zone width:

Land uses and activities:

Discharges, seeps or leaks:

ENDING POINT OBSERVATIONS:

Ending point description

Latitude:

Longitude:

Odor	Algae	Foam	Turbidity	Flow	Oil	Opala	Color

Dominant stream or shore side vegatation:

% Native: % Non-native Natural vegetation zone width:

Land uses and activities:

Discharges, seeps or leaks:

Comments

Odor:
0. None
1. Feces
2. Fishy
3. Musty
4. Decay
5. Ammonia
6. Petroleum
7. Sulfide
8. Chlorine
9. Other

Algae:
0. None
1. Light (<5%)
2. Mod. (5-25%)
3. High (26-50%)
4. Dense (>50%)

Foam:
0. None
1. Separated bubbles
2. Moderate (<1/2 in high)
3. High (>1/2 in high)

Turbidity:
0. Clear
1. Cloudy
2. Murky

Land Uses	**Discharge Points:**	**Flow:**	**Oil:**
0. undeveloped	0. none	0. None	0. None
1. residential	1. pipes	1. Low	1. Light sheen
2. rural residential	2. concrete drain channel	2. Med.	2. Slick
3. commercial/offices	3. earth drainage ditches	3. High	3. Tar on banks/bed
4. auto repair/gas station	4. other (describe)	4. Flood	
5. industrial	**Types of Discharges:**	**Opala:**	
6. sewage treatment	0. none (no flow)	0. None	
7. institution/school	1. seep/spring	1. Light (< 5 pcs)	
8. landfill	2. pond drainage	2. Mod. (6-10 pcs)	
9. agriculture	3. industrial	3. High (11-25 pcs)	
10. grazing	4. sewage discharge	4. Somewhat dense (26-50 pcs)	
11. animal feedlot/dairy	5. storm water runoff	5. Dense (> 50 pcs)	
13. construction	6. agricultural	**Color:**	
14. logging	7. feedlot/dairy/grazing	0. None	4. Green
15. golf course	8. leaking pipeline	1. Blue	5. Red
15. mining	9. illegal dump site	2. Brown	6. Yellow
16. park/recreation facilities	10. other (describe)	3. Olive brown	7. Other
17. Strip mines, quarries, gravel pits			
18. open space (describe)			
19. other (describe)			

Draw a map of the stream reach or shoreline.
Show start and stop points, important vegetation features, discharges or trash dumps, stream or shoreline modifications, stream diversions, possible barriers to fish passage, erosion and sedimentation, and locations of any photos taken:

Possible barriers to fish passage; diversions; stream/shore modifications; or stream channelization		**Possible Barriers to Fish Passage:**
Location:	Type:	0. natural waterfall
		1. man-made waterfall or dam
		2. Culverts
		3. Other
Location:	Type:	
		Stream channeling, straightening, modification:
Location:	Type:	(If only one bank, describe by R for right and L for left.
		The banks are described as you look downstream.)
		1. stream diversion
Location:	Type:	2. channelization
		3. concrete channel
		4. rip-rap
		5. other (describe in comments)
Location:	Type:	**Sedimentation, Bed Conditions:**
		1. mud
		2. sand
		3. rocks/riffles
Erosion, unstable stream banks, bed conditions (sedimentation):		4. other (describe)

Location:	Bank conditions:	Bed conditions:	**Erosion/Unstable Stream Banks:**
			0. none
			1. loss of vegetative cover
Location:	Bank conditions:	Bed conditions:	2. collapsing vegetation
			3. stream bank collapsed
			4. stream banks eroding
Location:	Bank conditions:	Bed conditions:	5. other (describe)

Special problems:	Comments:	**Special Problems**:
		0. none
		1. fish kills
		2. animal carcas
		3. flooding
		4. no flow
		5. Large pieces of debris
		6. other

Rapid Ōpala Assessment Worksheet

ŌPALA ITEM TALLY

	Tally Above	#	Tally Below	#	Total		Tally Above	#	Tally Below	#	Total
PLASTIC						**METAL**					
Plastic bags						Aluminum Foil					
Plastic bottles						Aluminum or Steel Cans					
Plastic bottle caps						Bottle Caps					
Plastic cup lid/straw						Metal Pipe Segments					
Plastic pipe segments						Auto Parts (specify below)					
Plastic Six-Pack Rings						Wire					
Plastic Wrapper						Metal Object					
Soft Plastic Pieces						**LARGE**					
Hard Plastic Pieces						Appliances					
Styrofoam cups pieces						Furniture					
Styrofoam Pellets						Garbage Bags of Trash					
Fishing Line						Tires					
Oyster sticks						Shopping Carts					
Lobster trap						Cars					
Tarp						Other (write-in)					
Buoys						**TOXIC**					
Other (write-in)						Chemical Containers					
BIOHAZARD						Oil/Surfactant on Water					
Human Waste/Diapers						Spray Paint Cans					
Pet Waste						Lighters					
Syringes or Pipettes						Small Batteries					
Dead Animals						Vehicle Batteries					
Other (write-in)						Other (write-in)					
CONSTRUCTION DEBRIS						**BIODEGRADABLE**					
Concrete (not placed)						Paper					
Rebar						Cardboard					
Bricks						Food Waste					
Wood Debris						Yard Waste (incl. trees)					
Other (write-in)						Leaf Litter Piles					
MISCELLANEOUS						Other (write-in)					
Synthetic Rubber						**GLASS**					
Foam Rubber						Glass bottles					
Gill net floats						Glass pieces					
Balloons						**FABRIC AND CLOTH**					
Ceramic pots/shards						Synthetic Fabric					
Hose Pieces						Natural Fabric (cotton, wool)					
Cigarette Butts						Other (write-in)					
Golf Balls											
Tennis Balls											
Other (write-in)											
Total pieces Above:			**Below:**			**Grand total**					
Tally all trash in above rows; make notes below as needed to facilitate scoring											
Littered:											
Dumped:											
Downstream accumulation:											
Specific description of items found:											

Grant writing:
Hawai'i Community Foundation- Grant opportunities and assistance

City and County of Honolulu, Community Revitalization Unit: http://www.honolulu.gov/dcs/communityrevit.htm

Hawai'i Alliance of Nonprofit Organizations:
http://www.hano-hawaii.org/

Hawai'i County Resource Center:
http://www.hcrc.info/grant-resources

In addition to the sources of grant funding below, think about some simple or creative ways of fundraising:

- Bake sales, car washes, garage/yard sales.
- Using collection boxes at your booth during events.
- Fundraising events, like dinners, concerts. Find someone "famous" in your local community that will attract people to your event.
- Use videos, cartoonlets, newsletters (See awareness/outreach) as a way to solicit contributions for your activities.

LOCAL:

Alexander and Baldwin Foundation Grants:
The A&B Foundation works to improve its communities through a responsive, broad-based program of giving in the following categories: health & human services, education, community, culture and arts, maritime and the environment.
Eligible Applicants & Types of Support: Nonprofit organizations with 501c3 are eligible. The Foundation will consider support for startup, general operating, and special project needs, as well as major and minor capital requests.
Amount of funds awarded: Usually $1,000 to $25,000, but may award more.
Information: http://alexanderbaldwinfoundation.org/

The Atherton Family Foundation Grants:
Supports programs and projects within a broad spectrum of activities which in some way benefit the people of the state of Hawai'i.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations. Grant making fields in order of preference are education, human services, youth development, arts, culture and humanities, health, community development, environment, religion, and others.
Amount of funds awarded: Varies, usually $1,000 to $35,000 but can be more.
Information: http://www.athertonfamilyfoundation.org/

Board of Water Supply, City & County of Honolulu Watershed Management Partnership Program:
For assistance to watershed partnerships, agencies, and organizations for the management, protection, and enhancement of watershed areas on O'ahu, Hawai'i.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations; Subject areas of interest include: Watershed studies, watershed resource protection, educational outreach for watershed management and protection, invasive species control, forest protection, water conservation activities.
Amount of funds awarded: N/A
Information: http://www.hbws.org/cssweb/display.cfm?sid=1364

Cooke Foundation Ltd, grants:
Supports worthy endeavors in the community that the family feels will make a significant difference in the betterment and welfare of the people of Hawai'i.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations; Demonstration and pilot programs, and time-limited projects; Strengthening activities that help stabilize or grow an organization or improve its performance; Joint project requests from two or more nonprofit organizations seeking to explore and resolve community problems that are of interest to the Trustees
Amount of funds awarded: Maximum of $25,000
Information: http://www.cookefdn.org/

Department of Health, Clean Water Branch, Polluted Runoff Control Program, Clean Water Act Section 319 grants for controlling polluted runoff:
Eligible Applicants & Types of Support: Private schools, local governments, nonprofit organizations, environmental organizations. Project types include: Demonstrates new and innovative best management practices (BMPs) in urban, forested areas, agricultural areas, marina and recreational boating areas, or hydro-modified areas. Develops a Watershed-Based Plan (WBP) that includes all of EPA's Components for Watershed-Based Plans. Protects waters (Natural Area Reserves, wetlands, et. al.) that are at risk of being impaired from residential, commercial, industrial and/or agricultural developments
Amount of funds awarded: Maximum $300,000
Information: http://www.hawaii.gov/health/environmental/water/cleanwater/prc/index.html

Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW), Watershed management and Wildlife urban interface grants.
Information: http://www.dofaw.net/

APPENDIX D: FUNDING RESOURCES

Hagadone Printing Company:
Eligible Applicants & Types of Support: Nonprofit organizations. Emphasis is on those communities choosing to deliver their message through printed means.
Information: http://www.hagadoneprinting.com/pages/aboutUs/communitySupport.html

The Harold K.L Castle Foundation:
Eligible Applicants & Types of Support: 501c3 nonprofit organizations, Proposals are usually not considered for: Ongoing operating expenses, vehicles, endowments, annual fund drives, sponsorships or special events.
Amount of funds awarded: varies
Information: http://www.castlefoundation.org/

Hawai'i Coastal Zone Management program, section 309 grants.
Section 309 of the federal Coastal Zone Management Act establishes a voluntary coastal zone enhancement grants program to encourage states and territories to develop programs in one or more of nine coastal zone enhancement areas. The nine enhancement objectives are wetlands, public access, coastal hazards, CSI, energy and government facility siting, marine debris, ocean resources, special area management plans, and aquaculture.
Information: http://www.hawaii.gov/dbedt/czm/program_documents/section_309.html

Hawai'i Community Foundation – Nonprofit grants:
Has recently launched major programs focusing on the protection of natural resources, building community leadership and social capital, and broad-based public health initiatives.
Eligible Applicants & Types of Support: Hawai'i nonprofit organizations. Funds are not given to support: Endowments, loans, Individuals (with the exception of the Scholarships program), large capital projects (with rare exceptions), funding after an event has occurred.
Amount of funds awarded: Varies
Information: http://www.hawaiicommunityfoundation.org/grants/grantmaking.php

Hawai'i Invasive Species Council:
Various grants, including education outreach on invasive species in Hawai'i. Signup on various Invasive Species Council listserves to obtain announcements:
http://www.hear.org/hearlists/index.html
Information: http://www.state.hi.us/dlnr/dofaw/HISC/

Hawai'i Tourism Authority:
Offers a variety of grants throughout the year
Information: http://www.hawaii.gov/tourism/

State of Hawai'i Legislature- Grants-in-aid
Eligible Applicants & Types of Support: Any nongovernmental unit. Requests for aid submitted directly to the Legislature for approval.
Information: http://www.capitol.hawaii.gov/site1/info/grant/grant.asp

Maui County, Department of Housing and Human Concerns, Grants administration:
Information: http://www.co.maui.hi.us/departments/Housing/grants.htm.
Email: grants.hhc@co.maui.hi.us Phone: (808) 270-7807

Office of Hawaiian Affairs:
To help communities make a difference for Hawaiians, in the areas of education, health, human services and culture.
Eligible Applicants & Types of Support: Hawai'i nonprofit organization; must have clear potential to improve the socio-economic well-being of the community; include the community in membership, decision-making and project development; and demonstrate outreach and organizing activities.
Amount of funds awarded: up to $50,000
Information: http://www.oha.org/cat_content.asp?contentid=59&catid=57

Patagonia Enviro Action Grants:
Fund activists who take radical and strategic steps to protect habitat, wilderness and biodiversity.
Eligible Applicants & Types of Support: Small 501c3 nonprofit organizations. They fund work that: is action-oriented, builds public involvement and support ,is strategic, focuses on root causes, accomplishes specific goals and objective, takes place in communities in which we do business. Areas of interest include: Alternative Energy, Biodiversity, Forests, International, Media/Publications, Resource Extraction, Social Activism, Sustainable Agriculture, Toxics/Nuclear, Water/Marine
Amount of funds awarded: small, generally under $10,000
Information: http://www.patagonia.com/enviro/enviro_grants.shtml

Young Brothers:
Eligible Applicants & Types of Support: 501(c)3 nonprofit organizations. Projects eligible for grants are in the categories of health, education, civic and community services, youth activities, cultural enrichment, environment and special community projects.
Amount of funds awarded: up to $1,000
Information: http://www.htbyb.com/yb/communitygiftgiving.php

FEDERAL:

Environmental Protection Agency (EPA)
Environmental Education Grants:
Provides financial support for projects that increase public awareness about environmental issues and provide the public with skills to make informed decisions and take responsible actions.
Eligible Applicants & Types of Support: Educational agencies, colleges, universities, state educational or environmental agencies, not-for-profit organizations and noncommercial educational broadcasting entities are eligible.

Award Amounts/Project Examples:
Up to $50,000 awarded per project. It is a competitive program; matching funds of 25% of the total grant are required. The likelihood of funding increases with more modest requests; a significant amount of the regional allocation is targeted for requests of $10,000 or less.
Information: http://epa.gov/region09/enviroed/grants.html

Environmental Protection Agency (EPA),
Environmental Justice Grants:
Provides financial assistance to eligible community groups with projects that address environmental justice issues.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations and other located in locally affected area
Amount of funds awarded: $25,000 per project; max $50,000 per region
Information: http://www.epa.gov/compliance/environmentaljustice/grants/index.html

Environmental Protection Agency (EPA)
Environmental Research Grants:
Information: http://es.epa.gov/ncer/rfa/

Environmental Protection Agency (EPA),
Region 9 (includes Hawai'i) grant opportunities:
http://www.epa.gov/region09/funding/index.html

Environmental Protection Agency (EPA),
Smart Growth Funding:
To encourage community groups, businesses, and government agencies to work together on sustainable developmental efforts that protect the local environment and conserve natural resources while supporting a healthy economy and an improved quality of life. NOAA Coastal Services Center Program offers several grant programs, including in Hawai'i, the Bay Watershed Education and Training Program. The program supports existing environmental education programs, fosters the growth of new programs, and encourages the development of partnerships among environmental education programs throughout the Hawai'i. Funded projects provide meaningful outdoor experiences for students and professional development opportunities for teachers in the area of environmental education.
Eligible Applicants & Types of Support: K-through-12 public and independent schools and school systems, institutions of higher education, commercial and nonprofit organizations, state or local government agencies, and Indian tribal governments. Proposals must address one or both of the two areas of interest: (1) Meaningful Outdoor Experiences for Students; or (2) Professional Development in the Area of Environmental Education for Teachers.
Amount of funds awarded: Typically $10,000 to $50,000
Information: http://www.epa.gov/dced/topics/funding.htm

Environmental Protection Agency (EPA),
Wetland Program Development Grants:
These grants provide eligible applicants an opportunity to conduct projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. While WPDGs can continue to be used by recipients to build and refine any element of a comprehensive wetland program, priority will be given to funding projects that address the three priority areas identified by EPA: Developing a comprehensive monitoring and assessment program; improving the effectiveness of compensatory mitigation; and refining the protection of vulnerable wetlands and aquatic resources.
Eligible Applicants & Types of Support: States, Tribes, local governments (S/T/LGs), interstate associations, intertribal consortia, and national non-profit, non-governmental organizations. $50,000 to $300,000 typically available
Information: http://www.epa.gov/owow/wetlands/grantguidelines/

NOAA Coral Reef Conservation Program Grants:
Eligible Applicants & Types of Support: State and Territory Coral Reef Management (Applicants: State and Territory Management Agencies); State and Territory Coral Reef Ecosystem Monitoring (Applicants: State and Territory Management Agencies);
Coral Reef Ecosystem Research (Applicants: Academia, NGO's, etc.); Projects to Improve or Amend Coral Reef Fishery Management Plans (Applicants: South Atlantic, Caribbean, Gulf of Mexico, and Western Pacific Fishery Management Councils); General Coral Reef Conservation (Applicants: Academia, NGOs, Local and Tribal governments, community organizations, etc.); and International Coral Reef Conservation (Applicants: International governments, NGOs).
Amount of funds awarded: Varies
Information: http://www.coralreef.noaa.gov/grants.html

NOAA Restoration Center:
Various funding opportunities, including Habitat Restoration, American Rivers, 5-Star program, Marine debris, etc: The Community-based Restoration Program's objective is to bring together citizen groups, public and nonprofit organizations,

industry, corporations and businesses, youth conservation corps, students, landowners, and local government, state and Federal agencies to restore fishery habitat around the coastal U.S.
General Information:
http://www.nmfs.noaa.gov/habitat/restoration/funding_opportunities/funding.html
Five-star restoration: The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects. Funding levels are modest, from $5,000 to $20,000, with $10,000 as the average amount awarded per project. http://www.epa.gov/owow/wetlands/restore/5star/

NOAA, National Marine Sanctuaries Foundation, Ernest F. Hollings Ocean Awareness Trust Fund:
New for 2006. The Foundation seeks to fund projects that educate and engage the public to increase their awareness of ocean issues and understanding of their relevance to future health and well-being. Key areas include marine debris, human interaction with marine mammals, or public health issues like red tide or marine pharmaceuticals.
Eligible Applicants & Types of Support: Formal or informal education institutions, nonprofits, commercial organizations, and state, local and Indian tribal governments.
Amount of funds awarded: Total funding for 2006: $150,000; awards typically $10,000 to $25,000.
Information: http://www.nmsfocean.org/docs/oatf_rfp.doc

NOAA Bay Watershed Education and Training (BWET):
B-WET Hawai'i provides support and technical assistance to existing environmental education programs, fosters the growth of new programs, and encourages the development of partnerships among environmental educators and programs.
Eligible Applicants and Types of Support: Primary recipients include community groups, schools, teachers, nonprofit organizations, and state and local governments. Funds projects that provide meaningful outdoor experiences for K-12 students and professional development opportunities for teachers in the area of environmental education.
Information: http://www.csc.noaa.gov/psc/bwet.html

National Park Service (NPS), Rivers, Trails and Conservation Assistance Program:
To provide technical assistance to citizen groups, local communities, and governments working to conserve river corridors and watersheds and to establish trails and greenways.
Information: http://www.nps.gov/rtca

National Resources Conservation Service (NRCS), Wildlife Habitat Incentive Program (WHIP):
This is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. NRCS provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat.
Eligible Applicants & Types of Support: Eligible lands under the program are: Privately owned land; Federal land when the primary benefit is on private or Tribal land; State and local government land on a limited basis; and Tribal land.
Information: http://www.nrcs.usda.gov/programs/whip/

National Resources Conservation Service (NRCS), Environmental Quality Incentive Program (EQIP):
This program provides a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land.
Information: http://www.nrcs.usda.gov/programs/eqip/

National Resources Conservation Service (NRCS), Conservation Innovation Grants:
This is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production.
Information: http://www.nrcs.usda.gov/programs/cig/

National Science Foundation, various grants:
The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.
Information: http://www.nsf.gov/funding/

U.S. Department of Agriculture, Sustainable Agriculture Research and Education Grants:
SARE grants are used to increase knowledge about sustainable agricultural practices and to help farmers and ranchers adopt those practices.
Eligible Applicants & Types of Support: There are four types of grants: 1) Research & Education 2) Farmer/Rancher 3) Professional + Producer 4) Professional development program and 5) Graduate Fellow. Eligible applicants depend on the type of grant.
Information: http://wsare.usu.edu/grants/

U.S. Fish and Wildlife Service, Coastal Restoration Program:
Eligible Applicants & Types of Support: The Coastal Program provides funding and technical assistance to private landowners, private non-profit organizations, government agencies and others to protect and restore coastal and marine habitats and the native species that live there. Coastal Program focus areas include: Offshore islet restoration, community-based marine conservation, biological surveys and mapping of important marine and coastal habitats and species, conservation of coral reefs, native plants, birds, seals, invertebrates, and sea turtles, applied research on management and restoration techniques and environmental education.
Information: http://www.fws.gov/pacificislands/worg/orghc_coastal.html

U.S. Fish and Wildlife Service, Division of Bird Habitat Conservation North American Wetlands Conservation Act (NAWCA) Grants Program:
Eligible Applicants & Types of Support: Provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico.
Amount of funds awarded: Small grants less than 25,000; larger grants in Standard grants program.
Information: http://www.fws.gov/birdhabitat/NAWCA/grants.htm

U.S Fish and Wildlife Endangered Species, Private Stewardship Program:
Eligible Applicants & Types of Support: The Private Stewardship program provides grants and other assistance to individuals and groups involved in local, private and voluntary conservation efforts that benefit federally listed, proposed or candidate species or other at-risk species. A ten percent match of cash or through in-kind contribution is required. Private landowners are eligible, and in Fiscal Year 2004, more than $7 million was awarded.
Information: http://www.fws.gov/endangered/grants/index.html

Water & Watersheds Research; U. S. Dept. of Agriculture (USDA), U.S. EPA, & the National Science Foundation (NSF):
The goal of this competition is to develop an improved understanding of the natural and anthropogenic processes that govern the quality, and availability of water resources in natural and human-dominated systems.
Eligible Applicants & Types of Support: Areas of interest include: Biological and Ecological Research, Hydrologic, Geochemical, and Engineering Research, Social Science Research. Proposals on the following will not be considered in this competition: industrial accidents, spills, routine monitoring projects, routine application of well-established models, projects involving site-specific remediation practices, drinking water treatment and distribution, point-source waste-water treatment and sanitary sewerage infrastructure, and research on human health effects.
Amount of funds awarded: $75,000 to $500,000
Information: http://es.epa.gov/ncer/rfa/archive/grants/96/96wwsann.html

NATIONAL FUNDING ORGANIZATIONS:

Ben and Jerry's Foundation:
Offers competitive grants to not-for-profit, grassroots organizations throughout the United States which facilitate progressive social change by addressing the underlying conditions of societal and environmental problems.
Eligible Applicants & Types of Support: The Ben & Jerry's Foundation does not fund: Discretionary or emergency requests, colleges or universities, individuals or scholarship, programs, research projects, capital campaigns, state agencies, religious programs, international or foreign-based programs, social service programs.
Amount of funds awarded: Up to $15,000
Information: http://www.benjerry.com/foundation/guidelines.html

Boat US Foundation:
To support education & hands on efforts to clean up the boating environment.
Eligible Applicants & Types of Support: Local community organizations focusing on promoting safe boating practices, clean boating education.
Amount of funds awarded: Up to $4,000
Information: http://www.boatus.com/foundation/#

Environmental Support Center:
Programs include Leadership and Enhanced Training Program (work with other organizations across the country in building your organization); Training and Organizational Assistance (capacity building for the organization); Fundraising for Sustainable Organizations (FUNDS)
Eligible Applicants & Types of Support: FUNDS: In the past have supported organizations working on water issues in selected geographic areas, and who want to make fundamental changes in their approach to fundraising.
Information: http://www.envsc.org/about-us

ESRI, Inc: GIS based system grants:
Eligible Applicants & Types of Support: Nonprofit organizations with 501c3 are eligible. Schools. Provides ESRI GIS software, training, accessories.
http://www.esri.com/grants/index.html

Home Depot – Environmental Grants:
To promote the most effective environmental effect, such as by supporting sustainable and green building practices, forestry & ecology, recycling & clean-up, lead poisoning prevention, and consumer education.
Information: http://www.homedepotfoundation.org/

Ludwick Family Foundation:
To support environmental organizations.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations. New vehicles or equipment, equipment replacement and modernization, improvements to facilities, and educational materials.
Amount of funds awarded: Grants range from $5,000 to $50,000
Information: http://www.ludwick.org

Merck Family Foundation:
The two goals of the Foundation are: 1) "To restore and protect the natural environment and ensure a healthy planet for generations to come." And 2) "To strengthen the social fabric and the physical landscape of the urban community." A current focus in the environment is climate change.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations. The Fund strongly prefers applications printed double-sided on non-chlorine bleached 100% recycled or alternative paper, and organizations that have a commitment to recycled and reused products throughout their work.
Information: http://www.merckff.org/index.html

National Fish and Wildlife Foundation (NFWF):
NFWF conserves healthy populations of fish, wildlife and plants, on land and in the sea, through creative and respectful partnerships, sustainable solutions, and better education.
Information: http://www.nfwf.org/

The Ocean Fund, founded by Royal Caribbean International and Celebrity Cruises:
To support marine conservation organizations in their efforts to preserve the world's oceans.
Eligible Applicants & Types of Support: Non-profit groups and institutions conducting activities directly related to marine conservation, including research, education and innovative technologies.
Amount of funds awarded: averages $25,000-$50,000, but no maximum
Information: http://www.royalcaribbean.com/ourCompany/environment/oceanFund.do

The David and Lucile Packard Foundation Conservation and Science Program:
The Conservation and Science Program is focused on the challenge of sustainability, finding paths for human progress that protect and restore the ecological systems upon which all life depends.
Eligible Applicants & Types of Support: 501c3 nonprofit organizations in areas of oceans and coasts and atmosphere. Coastal systems program for Western pacific islands only.
Amount of funds awarded: Varies.
Information: http://www.packard.org/categoryList.aspx?RootCatID=3&CategoryID=61

PADI Foundation grants:
To encourage the understanding & preservation of the aquatic environment, and to encourage sensitivity to and protection of underwater life. National Fish and Wildlife Foundation, has a variety of grant programs:
Eligible Applicants & Types of Support: All applicants, Projects should enrich mankind's understanding of the aquatic environment and encourage sensitivity to and protection of the delicate ecological balance of underwater life.
Amount of funds awarded: Up to $20,000, typical award $5,000 to $10,000
Information: http://www.padifoundation.org/

Project AWARE Foundation grants:
Project AWARE is committed to conserving and preserving the aquatic environment and its resources.
Eligible Applicants & Types of Support: All applicants. Public education (formal and informal), grass roots conservation and enhancement projects, environmentally focused research that leads to conservation measures, public awareness initiatives, Environmental assessment and monitoring projects, volunteer-supported community activism.
Amount of funds awarded: $1,000-$10,000
Information: http://www.projectaware.org/americas/english/grants.asp

Sea World and Busch Gardens Conservation Fund:
Eligible Applicants & Types of Support: All applicants.
The primary focus is to support conservation efforts directly benefiting wildlife in their native ranges (in-situ).
Project areas include: Species Research – Aquatic, Species Research – Terrestrial, Habitat Protection, Animal Rescue & Rehabilitation, Conservation Education
Amount of funds awarded: Usually between $5,000 and $25,000.
Information: http://www.swbg-conservationfund.org/

Switzer Foundation Environmental Fellowship Award Program; Switzer Foundation:
To support projects that have direct, early, & measurable results in improving the quality of the natural environment.
Eligible Applicants & Types of Support: Graduate students in environmental fields
Amount of funds awarded: A one year $13,000 cash award.
Information: http://www.switzernetwork.org/

Tiffany & Company Foundation:
Eligible Applicants & Types of Support: The Foundation supports research as well as community-based work promoting the conservation of coral reefs. 501c3 nonprofit organizations.
Information: http://www.tiffanyandcofoundation.org/

The Tom's of Maine Grant Program:
Eligible Applicants & Types of Support: 501c3 nonprofit organizations. Funded projects must integrate two areas of

giving which the Tom's of Maine support; such as environment and education; environment and the arts, or environment and human needs of youth, disabled people, and indigenous people. They are moving towards grants funding core missions and leadership development programs.
Amount of funds awarded: Grants range from $1,000 to $10,000.
Information: http://www.tomsofmaine.com/toms/community/grants.asp

The Tool Factory:
Eligible Applicants & Types of Support: Provides education grants for cameras and educational software at the Tool Factory. K-12 and special education schools in the US, its territories, and Canada are eligible to apply. Private, public, and charter schools are equally considered.
Information: http://www.toolfactory.com/olympus_contest/

Toyota TAPESTRY:
Eligible Applicants & Types of Support: Toyota TAPESTRY is open to K-12 teachers of science. The program is open to all middle and high school science teachers who teach at least two science classes per day. The program is open to elementary teachers who teach some science in the classroom or as teaching specialists. All applicants must have at least two years of science teaching experience in a K-12 school not including the current school year. Only the Project Director has to meet the above criteria. The project staff may consist of educators of any discipline or administrators.
Amount of funds awarded: 50 grants awarded up to $10,000. A minimum of 20 "mini-grants" of up to $2,500 each will be awarded as well.
Information: http://www.nsta.org/pd/tapestry/index.htm

Walmart, State Giving Program:
Eligible Applicants & Types of Support: 501c3 nonprofit organizations. Initiatives supported includes projects that are designed to help people become more personably sustainable or to help support the environment. Examples are parks, recycling programs, outdoor classrooms, and environmental educational initiatives.
Information: http://walmartstores.com/CommunityGiving/8169.aspx

OTHER RESOURCES FOR FUNDING SOURCES:

Coastal Listserve is a coastal engineering list, and members post job listings and grant opportunities related to the coastal zone. www.switzernetwork.org/fellowship-overview.htmlhttp://udel.edu/mailman/listinfo/coastal_list

EPA's Catalog of Federal Funding Sources for Watershed Protection: http://cfpub.epa.gov/fedfund/

EPA Watershed Funding Website:
Provides tools, databases, and information about sources of funding to practitioners and funders that serve to protect watersheds.
http://www.epa.gov/owow/funding.html

EPA Sustainable Financing Tools:
http://www.epa.gov/owow/funding/tools.html

The Foundation Center, Grantmaker Websites:
http://fdncenter.org/funders/grantmaker/

The Foundation Center, request for proposals announcements:
http://fdncenter.org/pnd/rfp/cat_environment.jhtml

Grants Alerts, search engine for education grants:
http://www.grantsalert.com/

Invasive Species Manager's Tool Kit - Grants & Funding:
http://www.invasivespeciesinfo.gov/toolkit/grantsrequests.shtml

Kauai Planning and Action Alliance, resources for Kauai organizations:
http://www.kauainetwork.org/section.php?sub_cat_id=1

NAPCOR, The National Association for PET C ontainer Resources:
Vision statement: To be the credible voice and champion of the PET (polyethylene terephthalate) packaging industry; to facilitate solutions to the introduction and use of PET packaging; and to provide education on the benefits of PET packaging. The NAPCOR Store is a one-stop shop for tools and resources to promote and increase PET plastic recycling in your community. http://www.napcor.com/plastic/bottles/store.html

NOAA's Coral Listserve also provides a forum for discussion of coral reef health and monitoring; members post job listings and grant opportunities related to coral reefs:
http://coral.aoml.noaa.gov/mailman/listinfo/coral-list/

NOAA's FishNews provides weekly updates with regards to the nation's fisheries; includes public notices about research reports, draft rules impacting fisheries as well as grant opportunities announcements. http://www.nmfs.noaa.gov/fishnews.htm

APPENDIX E: WATER QUALITY EQUIPMENT AND SUPPLY VENDORS

WATER QUALITY LABORATORIES:

The AECOS Laboratory
45-939 Kamehameha Hwy., Suite 104
Kane'ohe, HI 96744
Laboratory Director: Jacqueline "Snookie" Mello
Phone: (808) 234-7770
Fax: (808) 234-7775
Email: SMello@aecos.com
http://www.aecos.com/aecoslab.html

University of Washington Oceanography Lab:
The Marine Chemistry Lab at the School of Oceanography provides seawater and freshwater analytical services to the University and Oceanographic communities. The lab specializes in the analysis of salinity, oxygen, nutrients, and DOC in aqueous samples and CHN analysis in particulate samples.

School of Oceanography
Box 357940
University of Washington
Seattle, WA 98195-7940
Facility manager: Katherine Krogslund
Email: kkrog@u.washington.edu
http://www.ocean.washington.edu/2004/services/tech/marinechem.html

WATER QUALITY SUPPLIES:

Aquatic Ecosystems, Inc
2395 Apopka Blvd
Apopka, FL 32703
Phone: (877) 347-4788
http://www.aquaticeco.com/index.cfm

Fisher Scientific
Phone: (800) 766-7000
Fax: (800) 926-1166
https://www1.fishersci.com/index.jsp

Ben Meadows Company
PO Box 5277
Janesville WI USA 53547-5277
Phone: (800) 241-6401
Fax: (800)628-2068
http://www.benmeadows.com/

Extech Instruments
285 Bear Hill Road
Waltham, MA 02451
Phone: (781) 890-7440 ext. 220
Fax: (781) 890-7864
Email: sales@extech.com
http://www.extech.com/instrument/index.html

Chemetrics, Inc.
4295 Catlett Rd.
Calverton, VA 20138
Phone: (800) 356-3072 (540) 788-9026
Fax: (540) 788-4856
Email: orders@chemetrics.com
http://www.chemetrics.com/

Forestry Supplies, Inc
205 West Rankin Street
P.O. Box 8397
Jackson, MS 39284-8397
Phone: 800-647-5368
http://www.forestry-suppliers.com/

Cole-Parmer Instrument Company
625 East Bunker Court
Vernon Hills, Illinois 60061-1844, USA
Phone: (800) 323-4340
Fax: (847) 247-2929
Email: sales@coleparmer.com
www.coleparmer.com

Hawaii Rainwater Catchment test kits:
Hawaii Rainwater Catchment Systems Association
c/o UH CTAHR NREM Cooperative Extension Service
875 Komohana Road
Hilo, HI 96720
Phone: (808) 981-5199
Fax: (808) 981-5211
http://www.hawaiirain.org/resources/kits.php

Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389
Phone: (800) 227-4224
Fax: (970) 669-2932
http://www.hach.com/

IDEXX Laboratories
One IDEXX Drive
Westbrook Maine 04092
Phone: (800) 321-0207
Fax: (207) 556-4630
Email: water@idexx.com
http://www.idexx.com/

Science Kit & Boreal Laboratories
777 E Park Dr
Tonawanda, NY 14150
Phone: (800) 828-7777
Fax: (800) 828-3299
http://sciencekit.com/

LaMotte Company
PO Box 329
802 Washington Avenue
Chestertown, MD 21620
Phone: (800) 344-3100
Fax: (410) 778-6394
Sales email: mkt@lamotte.com
www.lamotte.com

Vernier Software
13979 SW Millikan Way
Beaverton, OR 97005-2886
Phone: (503) 277-2299 or (888) 837-6437
Fax: (503) 277-2440
Email: orders@vernier.com
http://www.vernier.com/

Micrology Laboratories
PO Box 340
Goshen, IN 46526-5360
Phone: (574) 533-3351
(888) EAS-YGEL
Fax: (574) 533-3370
E-mail: info@micrologylabs.com
http://www.micrologylabs.com/

YSI, Inc
1700/1725 Brannum Lane
Yellow Springs, OH 45387-1107
Phone: (800) 765-4974; (937) 767-7241
Fax: (937) 767-9353
Email: environmental@ysi.com
https://www.ysi.com/

APPENDIX E: WATER QUALITY EQUIPMENT AND SUPPLY VENDORS

Oakton Instruments
P.O. Box 5136
Vernon Hills, IL 60061
Phone: (888)-4OAKTON (1-888-462-5866)
Fax: (847) 247-2984
E-mail: info@4oakton.com
http://www.4oakton.com/

Onset Company (data loggers)
PO Box 3450
Pocasset, MA 02559-3450
Phone: 1-800-564-4377
Fax: 508-759-9100
Email: sales@onsetcomp.com
http://www.onsetcomp.com/

Project W.E.T
1001 West Oak, Suite 210
Bozeman, MT 59715 U.S.A.
Phone: (406) 585-2236; (866) 337-5486
Fax: (406) 522-0394
Email: info@projectwet.org
http://store.projectwet.org/
Includes manuals and kits for use with students

APPENDIX F: OTHER APPLICABLE FEDERAL, STATE AND LOCAL LAWS

LOCAL/STATE REGULATIONS:

Hawai'i Coastal Zone Management:
Hawai'i revised statute Chapter 205A: This statute sets up Hawaii's coastal zone management program and provides objectives, policies and guidelines for all agencies charged with adhering to these policies.
http://www.capitol.hawaii.gov/hrscurrent/Vol04_Ch02010257/HRS0205A/HRS_0205A-.htm

FEDERAL LAWS:

Coastal Zone Management Act (CZMA):
The CZMA established a voluntary national program within the Department of Commerce to encourage coastal States to develop and implement their own coastal zone management plans, consistent with the federal law and its goals. The goals of the act are "to preserve, protect, develop, enhance and restore, where possible, the coastal resources." The National Estuarine Research Reserves system was created in 1972 with the passage of CZMA. The Act also provided funds for states to assist in the management of the coastal zone. In 1990, a section was added to reduce nonpoint source pollution of coastal waters, requiring states that have a CZM program to develop and implement coastal nonpoint pollution control programs. Check out the Department of Health's Clean Water Branch, Polluted Runoff Control Program:
http://www.hawaii.gov/health/environmental/water/cleanwater/prc/index.html

Endangered Species Act (ESA):
The ESA is key legislation for community stewards who may be dealing with an issue involving an endangered or threatened species. It is helpful to understand the basics of this statute even if your issue is not directly affected by ESA, because recommendations given by your group may not be feasible for implementation due to extenuating circumstances. In 1973 the ESA achieved approval by Congress as a means to conserve, restore, and protect endangered and threatened species and their habitats. The ESA consists of five key regulations addressing: how a species gets listed, the process for consulting federal actions, a prohibition of "taking" a listed species, the process for getting a permit to "take", and enforcement mandates of the act. A species is listed based on scientific and commercial data proving its immediate danger of extinction or likelihood to become endangered. The second step simply determines whether a listed species may be present on federal land, like a national forest, and - if it is in jeopardy -what actions should be taken to avoid species harm. The third and fourth components define what it means to "take" (kill, injure, or harm) a species and the process rules for determining whether a permit to incidentally "take" it is reasonable under certain circumstances. Finally, enforcement of ESA is the responsibility of the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration (NOAA), but citizens also have standing to stop an agency violation of the mandate. Although ESA allows for citizen standing, overall the act is not really open to public participation, with the exception of aiding in developing and implementing a recovery plan for a species.

Migratory Bird Treaty Act:
The Migratory Bird Treat Act implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful. Thus it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product, manufactured or not.

National Environmental Policy Act (NEPA):
This act was passed in 1969 as a formal environmental policy mandate. Any federal action that may have a significant effect on the environment must undergo what's commonly referred to as the "NEPA process," as a means of ensuring consideration for environmental protection. Agencies must prepare an Environmental Analysis, which covers potential environmental effects of the proposed federal action. If it

APPENDIX F: OTHER APPLICABLE FEDERAL, STATE AND LOCAL LAWS

reveals that significant changes will occur in environmental quality due to the proposed action, the agency must then provide an environmental impact statement. This "EIS," as it is known, includes a description of what the significant environmental impacts will be for a given action, and some reasonable alternatives to the proposed action. NEPA is also an important law to consider because it actually promotes collaboration between agencies and the public throughout the process. The public can help scope the significant issues to include in the EIS, and then the public can comment on the draft EIS – to which the agency must respond – before a final one is produced. Collaboration among stakeholders is a great way to influence a particular NEPA process. However, some stakeholders feel that any "collaboration" through NEPA is merely advisory, since the agency is still the ultimate decision making authority and must only "consider" the public's opinion. The best way to get the most out of a NEPA collaboration is by creating a group of local stakeholders that addresses the scope of the EIS early on and can pull together what could be widely different opinions of the general public.

APPENDIX G: DETERMINING LATITUDE AND LONGITUDE (Adapted From EPA)

What is latitude?

Latitude (lat) is the angular distance of a particular location north or south from the equator. Latitude lines are called parallels.

What is longitude?

Longitude (long) is the angular distance of a particular location east or west of some prime meridian (usually Greenwich, England). Longitude lines are called meridians.

How is it measured?

Latitude and longitude are defined and measured in degrees (°), minutes (‘), and seconds (“). There are 60 seconds in a minute and 60 minutes in a degree of latitude and longitude.

Why measure latitude and longitude of your area when monitoring?

There are many ways that monitoring groups identify and describe the location of sampling sites. In many cases, monitoring sites are described by the stream or coastal area name and geographic location, such as Volunteer Creek at Oak Road or Volunteer Creek behind the picnic area in Volunteer Park. Make sure you assign a station number to these descriptions (i.e. VC001, VC002).

Maps, in many forms, are also typically used to help identify sites. These include road maps, state/county maps, aerial maps, hand-drawn site maps, and topographic maps.

The most accurate way to identify sampling locations is by determining their latitude and longitude. Most groups use a global positioning system (GPS) to determine latitude and longitude. This hand-held tool is used in the field and receives signals from orbiting satellites to calculate the lat/long coordinates of the user.

Use EPA's Surf Your Watershed website to utilize the U.S. Geological Survey's (USGS) Names Information System to provide latitude and longitude information for locations throughout the U.S. These locations include bridges, schools, rivers, parks, and more. Check it out at: www.epa.gov/surf/surf_search.html for more information.

Calculating Latitude and Longitude manually:

What you'll need:

- Topographic map
- Metric ruler
- Calculator

To Determine Latitude:

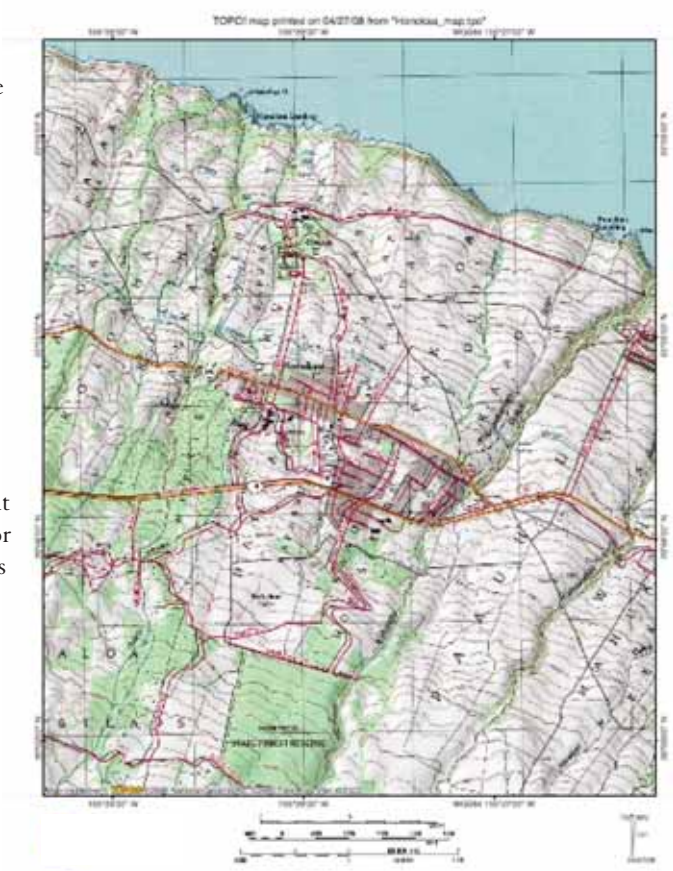
1. Look at the right side (upper or lower corner) under the map name, or the second of two numbers separated by “x” to find the height scale (latitude) of the topo map.
   If “7.5 Minute Series,” enter 450
   If “15 Minute Series,” enter 900
   If “7.5 x 15 Minute Series,” enter 450
2. Using the ruler, measure the length of your map (exclude the map borders) north to south in centimeters.
3. Divide #1 by #2 to the nearest whole number.
4. Enter the latitude located in the map's edge closest to your site.
5. Using the ruler, measure from your site straight down, to the bottom of the map (in centimeters).
6. Multiply #5 by #3 to the nearest whole number.
7. Determine how many times 60 goes into #6 completely and what 60 goes into 216 is left as the remainder (don't use a calculator for this). These completely 3 times answers will become the minutes and seconds of the latitude.
8. Convert these numbers to minutes and seconds. Minutes are equal to the whole number determined in #7, or the number of times 60 goes into #6 completely. In other words, your whole number after the division in the previous step is the number of 3 minutes and minutes. Seconds are equal to what is left (remainder) after the 36 seconds = division in #7.
9. Determine the latitude of your site by adding #4 to #8.

APPENDIX G: DETERMINING LATITUDE AND LONGITUDE (Adapted From EPA)

To Determine Longitude:

1. Look at the right side (upper or lower corner) under the map name, or the second of two numbers separated by "x" to find the width scale (longitude) of the topo map.
   If "7.5 Minute Series," enter 450
   If "15 Minute Series," enter 900
   If "7.5 x 15 Minute Series," enter 900
2. Using the ruler, measure the width of your map (exclude the map borders) east to west in centimeters (cm).
3. Divide #1 by #2 to the nearest whole number.
4. Enter the longitude located in the map's lower right hand corner.
5. Using the ruler, measure from your site straight across, to the right hand side of the map (in centimeters).
6. Multiply #5 by #3 to the nearest whole number.
7. Determine how many times 60 goes into #6 completely and what 60 goes into 333 is left as the remainder (don't use a calculator for this). These completely 5 times answers will become the minutes and seconds of the longitude. (The longitude degrees are #4.)

8. Convert to these numbers to minutes and seconds. Minutes are equal to the whole number determined in #7, or the number of times 60 goes into #6 completely. In other words, your whole number after the division in the previous step is the number of 5 minutes and minutes. Seconds are equal to what is left (remainder) after the 33 seconds division in #7.
9. Determine the longitude of your site by adding #4 to #8.



▲ *Example: 7.5 Minute Topo Map of Honoka'a, HI*

2. Using the ruler, measure the width of your map (exclude the map borders) east to west in centimeters (cm).
3. Divide #1 by #2 to the nearest whole number.
4. Enter the longitude located in the map's lower right hand corner.
5. Using the ruler, measure from your site straight across, to the right hand side of the map (in centimeters).
6. Multiply #5 by #3 to the nearest whole number.
7. Determine how many times 60 goes into #6 completely and what 60 goes into 333 is left as the remainder (don't use a calculator for this). These completely 5 times answers will become the minutes and seconds of the longitude. (The longitude degrees are #4.)

8. Convert to these numbers to minutes and seconds. Minutes are equal to the whole number determined in #7, or the number of times 60 goes into #6 completely. In other words, your whole number after the division in the previous step is the number of 5 minutes and minutes. Seconds are equal to what is left (remainder) after the 33 seconds division in #7.

APPENDIX H: GLOSSARY

Ahupua'a: Land division from the mountains to the sea– is the basic unit of Hawaiian natural and cultural resource management.

'āina: Ocean, that which nourishes.

Alien or Introduced Species: Organisms that were not brought to that location naturally, but by man, such as the Polynesian. The common guava and feral pigs are examples.

Aloha 'āina: Love of the land, people do not posses or own land and its resources but maintain stewardship over it.

Ambient: Environmental conditions, such as temperature that are normal for a given location.

Anthropogenic: Human-induced or resulting from human activities; often used to refer to environmental changes, global or local in scale.

Background concentration: Concentration of a substance in a particular environment that is indicative of minimal influence by human sources.

Benthic (zone): Occurring at the bottom of a body of water, usually in the depths of the ocean.

Biocide: A chemical with the capacity to kill organisms. Examples include pesticide, antimicrobial pesticides, herbicides, fungicides and insecticides.

Biodiversity: The variety and variability of life forms, including genetic and ecosystem diversity, in a defined area at and over time.

Biomass: The quantity of living matter (living organisms) expressed as unit of weight per unit are or unit volume.

Biotechnical: Combination of a structural or mechanical element and vegetative elements working together to stabilize a site-specific condition. Structural components are employed to allow the establishment of vegetative elements, while at the same time providing a level of protection for stability. Vegetative components serve as a natural erosion and stabilization measure.

Carrying capacity (humans in an area): Number of individuals that the resources of an area can support.
Deforestation: The permanent destruction of indigenous forests and woodlands.

Diurnal: Occurring or active during the daytime rather than at night.

Ecosystem: A community of plants, animals, and microorganisms that are linked by energy and nutrient flows and that interact with each other and with the physical environment.

Effluent: Wastewater- treated or untreated- that flows out of a treatment plant, sewer, or industrial outfall.

Endemic: Organisms that are native and can be found only in that location. Examples of organisms that are endemic to Hawai'i are the spectacled parrotfish, fantail filefish, and Hawaiian Monk Seal.

Erosion: The wearing away and removal of materials of the Earth's crust by natural means, including running water, waves, moving ice, wind currents, and chemical solution.

Fluorescence: The absorption of light at one wavelength and its re-emission at a longer wavelength. Fluorescence plays an important role in the perceived color of many objects.

Forel-Ule Scale: The Forel-Ule Scale is a method to approximately determine the color of bodies of water, used in limnology and oceanography. By means of different inorganic compounds (ammonia, copper sulfate, neutral potassium chromate) a color palette is produced in a series of numerically designated vials (00-21), which is compared with the color of the water body. The result is a color index for the water body, which gives an indication of the transparency of the water and thus helps to classify gross biological activity. The color graduations correspond to open sea and lake water colors, as they appear to an observer ashore or on board a vessel. The method is used in conjunction with the Secchi_disk.

Geometric Mean: A measure of central tendency calculated by multiplying a series of numbers and taking the nth root of the product, where n is the number of items in the series. The geometric mean is often used when finding an average for numbers presented as percentages.

Global Positioning System (GPS): A system of satellites and receiving devices used to compute positions on the Earth.

Goal: A general summary of the desired state that a project is working to achieve.

Gradient: Gradient is the slope of the stream and is measured by the difference in elevation between two points on a stream divided by the distance between the two points that the water actually flows. Gradient is usually expressed in feet per mile of meters per kilometer. Gradient looks at how far the water drops over the distance the water actually flows. The gradient influences the velocity of the stream. The steeper the gradient, the higher will be the velocity if all other factors are held constant.

APPENDIX H: GLOSSARY

Groundwater: The supply of freshwater found beneath the Earth's surface, usually in aquifers, which is often used to supply wells and springs.

Habitat: The environment in which an animal or plant can normally be found or normally grows.

Heterotroph: Any living organism that obtains its energy from organic substances produced by other organisms. All animals and fungi are heterotrophs, and they include herbivores (plant eaters), carnivores (eats other animals), and saprotrophs (those that feed on dead animal and plant material).

Hydrology: The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hydrometer: A device used to compare the densities of liquids.

Impervious (surface): Impervious surfaces are mainly constructed surfaces - rooftops, sidewalks, roads, and parking lots - covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water and prevent precipitation and meltwater from infiltrating soils. Soils compacted by urban development are also highly impervious.

Indigenous: Organisms that are native but can be found elsewhere. An example of this is the Hawaiian Green Sea Turtle.

Intrusion (saltwater): This occurs when a lowered water table encourages the seawater to flow into the ground and mix with the groundwater.

Invasive Species: Plants, animals, and microbes not native to a region which, when introduced either accidentally or intentionally, out-compete native species for available resources, reproduce prolifically, and dominate regions and ecosystems. Because they often arrive in new areas unaccompanied by their native predators, invasive species can be difficult to control.

Invertebrate: An animal without a backbone, such as an urchin or crab.

Kapu: The set of regulations that guided people's behavior reflecting natural cycles, following spawning and tides of local areas. Failure to comply with these rules met with strict punishment, in order to keep a necessary balance.

Lagoon: A shallow sound or body of water, connected to a larger body of water.

Marine debris: Marine debris is any type of manufactured or manmade material that enters the coastal or marine environment via a stream, outfalls, tossed by beachgoers, or lost by boats at sea.

Meniscus: The curved top of a column of liquid in a small tube.

Monitoring: The periodic collection and evaluation of data relative to stated project goals, objectives and activities.

Native: Organisms brought to a location without the help of man, such as by wind, wave and or birds.

Nephelometric turbidity units (NTU): A measure of the clarity of water. Turbidity is measured with an instrument called a nephelometer, which measures the intensity of light scatted by suspended matter in the water. Turbidity in excess of 5 NTU is just noticeable to the average person.

Nonpoint source: Sources of pollution discharged over a wide land area, not from one specific location. These sources include urban runoff, agricultural runoff, erosion, construction, and mining.

Nutrient loading: The introduction of excessive amounts of nutrients such as nitrogen or phosphorus from fertilizers into the soil or water, usually via non-point source runoff and sewage effluent. Nutrient loading often leads to algal blooms.

Objective: A specific statement detailing the desired accomplishments or outcomes of a project.

Pathogenic microorganisms: Microorganisms that can cause disease in other organisms or in humans, animals, and plants.

Photosynthesis: The process by which plants use light energy trapped by chlorophyll to convert water and carbon dioxide into stored energy or food.

Point source: A stationary location or fixed facility from which pollutants are discharged or emitted (e.g. pipe, ditch, ship)

Pollutant: A substance that adversely alters the physical, chemical or biological properties of the environment.

Presence/absence: A monitoring technique that determines simply if an organism is present or not in the sample area.

Reagent: A substance used in a chemical reaction to detect, analyze, or produce a characteristic reaction in order to determine the presence of another compound.

Recharge: Water that drains through the soil and reaches the water table.

Refractometer: An instrument which measures the bending (refraction) of light through a liquid. It can be used to measure the salinity of water.

Respiration: The metabolic process by which plants and animals convert food to energy.

Restoration: Repair or reconstruction of a damaged ecosystem or habitat.

Runoff: Water from precipitation or irrigation that flows over the ground and into bodies of water. It can contribute to soil erosion and carry harmful pollutants.

Secchi disk: The Secchi disk is used to measure how deep a person can see into the water. To obtain a measurement, the disk is lowered into the water while observing the depth at which it disappears. The disk is then raised until it reappears. The depth of the water where the disk vanishes and reappears is the Secchi disk reading. The depth level reading on the tape at the surface level of the water body is recorded to the nearest foot.

Sedimentation: Settling of particulate matter in water related to particle size, water velocity, and water flow.

Spectrophotometer: A photometer (a device for measuring light intensity) that can measure intensity as a function of the color, or more specifically, the wavelength of light.

Stewardship: Care or management of land or waters and passing healthy ecosystems to future generations.

Stream velocity: The speed at which water flows through a stream. The higher the velocity, the greater the erosive force of the stream.

Sustainable: Referring to an activity that is able to be carried out without damaging the long-term health and integrity of natural and cultural environments.

Tidepool: A tidepool is a rocky pool by the ocean that is filled with seawater, which forms when the ocean covers the beach twice a day during the tides.

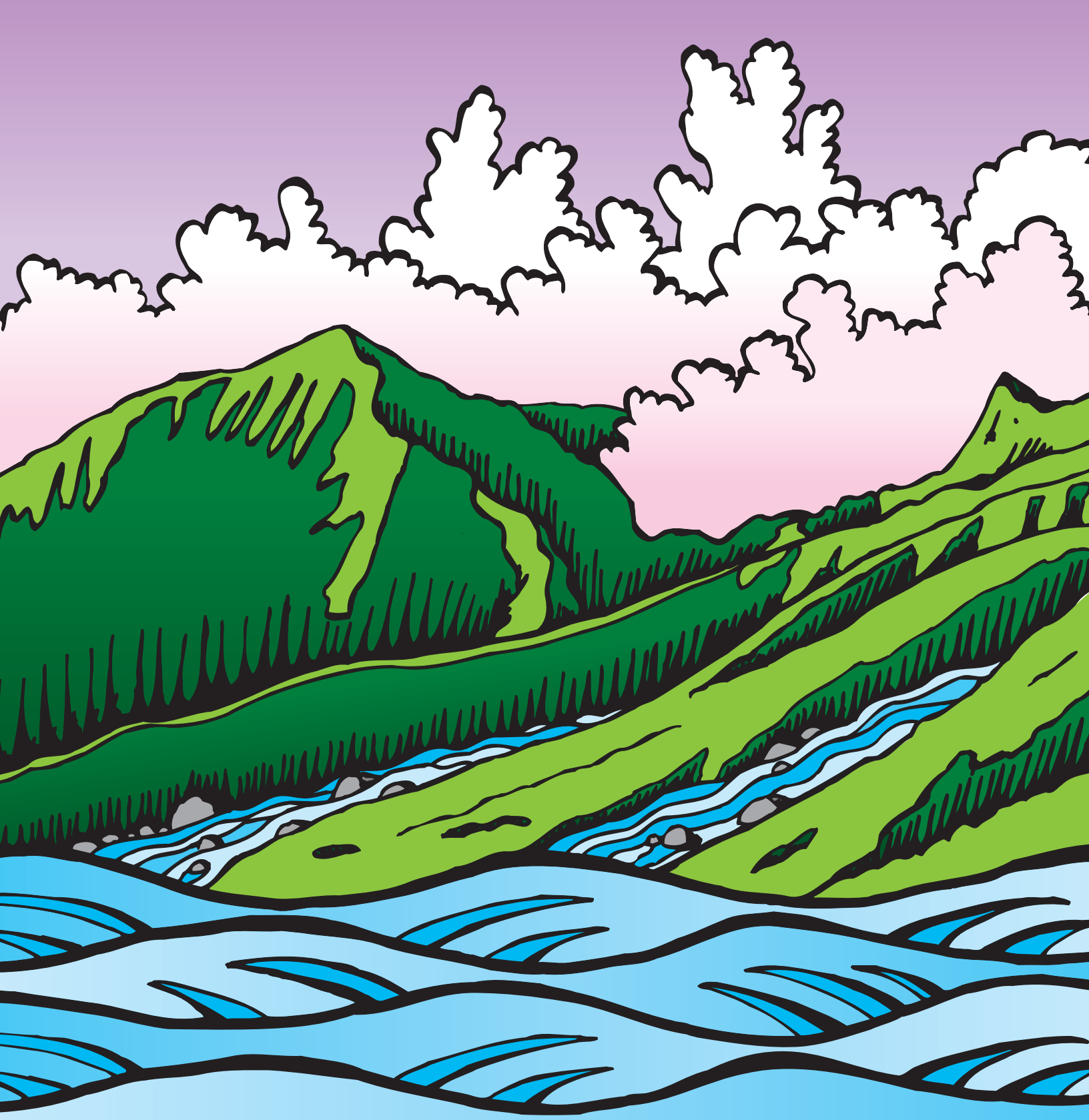
Toxin: A toxin is a substance that is capable of inducing adverse effects (i.e. illness, organ dysfunction, or death) to living organisms.

Transect: An area of land or seafloor sectioned off, usually in the form of a long, continuous strip and used to survey the distribution of organisms or substrate across a given area. Sample plots or points are established along the transect for collecting data.

Water table: The upper limit of saturated ground in an aquifer.

Watershed: A geographic area in which water, sediments, and dissolved materials drain to a common outlet- to a point on a larger stream, lake underlying aquifer, estuary, or ocean.

Zone of mixing: The area where treated wastewater is authorized by DOH/EPA to mix with a water body is called a mixing zone



TAKING CARE OF HAWAI'I'S WATERS

A Guide for Getting Started in Volunteer Water Monitoring