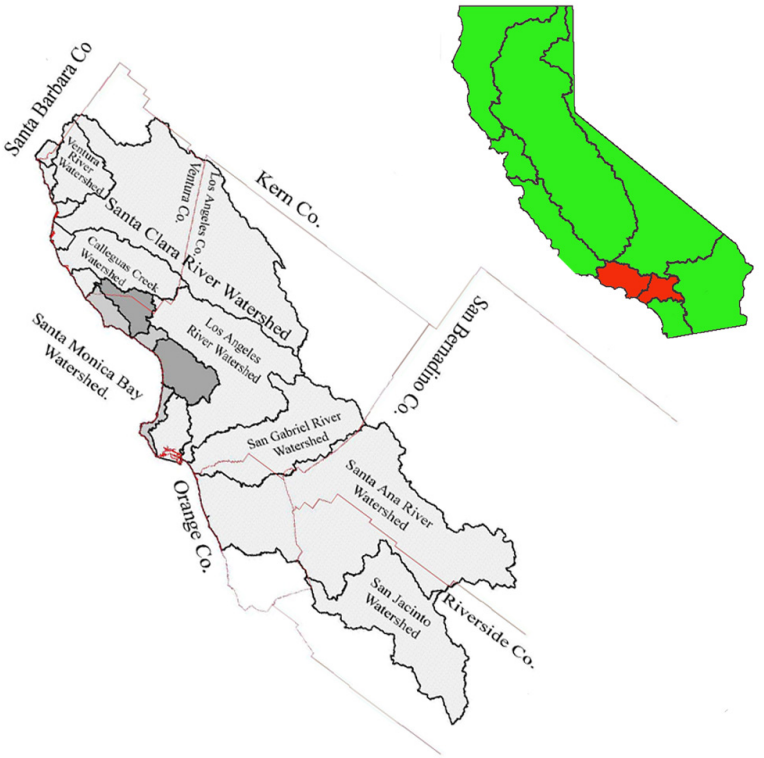
The Freshwater and Marine Team Field Guide



The Freshwater and Marine Team Field Guide

Revision Produced by:

Adapted from:
T*he Malibu Creek Watershed Stream Team Field* Guide

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Section 1
Introduction to the Freshwater and Marine Team

Welcome to the Freshwater and Marine Team!

You are about to become part of a very special and rewarding effort. The Freshwater and Marine Team is a coalition of volunteer monitoring organizations and citizen volunteers dedicated to collecting high quality accurate data. The data we collect must be usable by resource managers, decision makers, environmental organizations, and citizens to protect and enhance the water quality in our freshwater and marine environments. This effort partners the information needs of local, state, and federal government agencies with the needs of environmentally aware citizens who wish to actively work to protect and enhance the environment in our rivers, streams, estuaries, and ocean.

The Freshwater and Marine Team program is made up of several environmental groups who collect water quality information on local rivers, streams, lakes, estuaries and ocean. These groups are members of the Los Angeles Regional Citizen Monitoring Steering Team (LARCMST).This team was formed to help volunteer programs collect high quality data for use by local groups and regulatory agencies that monitor and protect water quality. The team is comprised of representatives from the Los Angeles Regional Water Quality Control Board (Regional Board), the State Water Resources Control Board (State Board), and members of organizations currently monitoring in the region. In 2001, LARCMST received Environmental Protection Agency (EPA) Section 319 grant funds to purchase water chemistry testing equipment, conduct training and quality control seminars, and produce a field guide for use by its member groups. This grant insures that all the organizations within the LARCMST are collecting accurate and consistent water quality data. The field guide, and recommended water monitoring equipment, are modified from Heal the Bay's *Malibu Creek Watershed Stream Team Field Kit and Field Guide*, which have been used successfully since 1998. Training, quality control seminars, and grant management are conducted by the Southern California Marine Institute (SCMI). The combined efforts of the LARCMST member groups and their volunteers wil help make southern California's coastal waters safe and healthy for people and aquatic life.

As a team member, you will join hundreds of other volunteers throughout southern California in the pursuit of clean water. By joining the Freshwater and Marine Team program, you, along with many other concerned citizens, can rise to the challenge of becoming care takers of the rivers, streams, lakes, estuaries, and ocean where you

live and play. In the following pages, you can learn how this is possible. This Field Guide is designed to give you an understanding of watersheds and the important role they play in the aquatic ecosystem, then lead you through the specific steps necessary to become a successful volunteer monitor. Get to know your Field Guide. It's yours to refer to again and again. Make this guide your own personal clean water tool!

Why Water Quality Monitoring is Important

Poor water quality is a health concern for humans and wildlife, including birds and aquatic life. Pollutants like sediments, nutrients, pesticides, and heavy metals originate upstream, somewhere within the watershed. Urban runoff carries these pollutants into streams and rivers, which ultimately flow into the ocean. Urbanization of watershed areas has altered the natural hydrology of southern California. The main purpose of this program is to determine to what extent upstream development is contributing to poor water quality in our rivers, streams, lakes, harbors, estuaries, and ocean.

This volunteer monitoring program will address the sources and causes of degradation to water quality. It is the program designer's hope that all volunteers understand how poor land use practices can negatively impact natural watershed processes, water quality, and environmental health.

Goals and Objectives of the Freshwater & Marine Team

Each local monitoring group will have specific goals and objectives that address the issues of concern in the area they are monitoring. The Freshwater and Marine Team program is a coordinated effort to help these local monitoring groups collect accurate and useful water quality information. The standardized equipment kit and field guide, expert training and frequent instrument testing insure that local monitoring groups collect accurate and consistent data. Each piece of equipment in the field kit has been specially selected for ease of use, durability, accuracy, precision, and reliability. Both the equipment and data collection methods have been rigorously researched and tested to insure the highest data quality. The information collected will be used to develop strategies to improve ecological health and water quality throughout southern California.

The overall goal of the monitoring program is to collect information that facilitates:

- Consistent and accurate water quality data collection by all volunteer monitoring groups within the Los Angeles Region.
- The identification of waters that do not meet current water quality standards.
- The use of data by regulators and decision makers to set appropriate and protective water quality standards.

Involvement by citizen volunteers in the monitoring program will allow the Freshwater and Marine Team to meet the following objectives:

- To determine the current water quality conditions (baseline data) in the region.
- To increase the amount of data collected by providing no-cost collection of water samples for analysis by specialized laboratories.
- To assess the effectiveness of restoration efforts and/or Best Management Practices (BMP's) that are implemented to protect against negative impacts to water quality.

The Inspiration Behind the Program

Influenced by the consistently poor water quality throughout southern California, SCMI has contracted Heal the Bay to adapt their highly sucessful *Malibu Creek Watershed Stream Team Field Guide* for use by volunteer monitoring groups throughout the southern California. There is an urgent need to collect useable data for developing more protective water quality standards. In fact, the U.S. Federal Clean Water Act requires the Environmental Protection Agency to establish nationwide water quality standards that protect the designated beneficial uses of water bodies. The Clean Water Act (CWA) was created in 1972, and is the cornerstone of surface water quality protection in the United States. The overarching goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters to support "the protection and propagation of fish, shellfish, and wildlife."(http://www.epa.gov/watertrain/cwa/).

Each state is obligated to adopt a list of designated beneficial uses and water quality standards for both marine and inland surface waters within their jurisdiction that are at least as strong as those created by the EPA. In California, The State Water Resources Control Board (State Board) is responsible for making sure this occurs. The State Board assigns water quality standards for marine waters within 3 miles of the coast. These water quality standards for the marine environment are contained in the California Ocean Plan. The California Ocean Plan can be viewed at http://www.swrcb.ca.gov/plnspols/. For inland waters the State Board allocates this responsibility to the nine Regional Boards (Figure 1-1). Every surface water body is considered to have some use or uses that benefit the general public, wildlife, or aquatic life. Some examples of beneficial uses are: Commercial and Sport Fishing, Recreational Body Contact, Wildlife Habitat, Marine Habitat, and Agricultural Water Supply. Each Regional Board creates a document known as a Basin Plan that specifically designates beneficial uses and water quality standards for all surface water bodies in the region. The Basin Plan also incorporates the water quality standards created in the California Ocean Plan. In the Los Angeles/Ventura Area (Region 4)

Figure 1-1 The 9 Regional Board Areas in California. Region 4 includes Los Angeles and Ventura Counties and Region 8 includes Orange and Riverside Counties. Image adapted from Basin Plan.

there are 24 beneficial uses and in the Santa Ana Area (Region 8) there are 19 designated beneficial uses. You can view a copy of the Basin Plan for the Los Angeles/ Ventura Region on line at http://www.swrcb.ca.gov/rwqcb4/html/meetings/tmdl/Basin_plan/basin_plan.html. and for the Orange County/Santa Ana Region the Basin Plan can be viewed at http://www.swrcb.ca.gov/~rwqcb8/pdf/R8BPlan.pdf

Once the beneficial uses for a water body are stated, we then need to determine if the water body is clean enough to support these uses. We accomplish this by testing the water and comparing the results to the water quality standards listed in the Basin Plan. This is one of the critical uses of Freshwater and Marine Team data. Your data will be compared to official standards to determine if your water body is supporting the designated beneficial uses. If the water body does not meet the standard it is considered impaired (unable to support its designated beneficial use). Water bodies that do not meet the minimum water quality standards are placed on a list of impaired water bodies known as 303 (d) list. Throughout California more than 509 individual water bodies currently do not support their beneficial uses. One-third or 155 of these

impaired water bodies, and more than 700 individual reaches are in the Los Angeles/ Ventura Counties region.

What Happens if your Water body is Impaired?

If your water body is impaired and is on the 303 (d) list , the CWA requires that a plan be created to reduce the pollution that is causing the impairment to a safe level. This plan is called a Total Maximum Daily Load or TMDL . A TMDL is the amount of a particular pollutant that a water body can handle and still support its designated beneficial uses.

How Does Volunteer Monitoring Help Protect the Water?

With more than 700 impairments in our region, an incredible amount of water quality data needs to be collected to insure that TMDLs are developed in a way that will restore and protect beneficial uses. Your data will help show where water quality is poor, and what water quality in your water body should be. The best way to determine what the water quality should be is to find a section of stream, or ocean that has not been impacted by development . This is known as a reference condition. This reference area tells us what pollution levels are without man-made input. This reference condition should be used to help set new water quality standards that will restore the beneficial uses of the impaired water body. In other words, you will help collect the data needed to create an appropriate TMDL.

Once a TMDL has been created, we will know the amount of a pollutant that can safely enter the water body. The Regional Board will then assign an allowable limit to all entities that contribute the specific pollutant into the water body. For example, if only five pounds a day of dirt can enter the stream before it starts to hurt aquatic life and we have two businesses that make and sell topsoil, neither business will be allowed to discharge more than 2.5 pounds into the stream. A large amount of data needs to be collected to determine if the TMDLs are being met.

How you can Benefit from the Program?

By participating in the monitoring program, you will be rewarded in many ways. You will learn new skills and receive expert training, such as how to conduct water chemistry tests. The information you gather will be used by the Regional Board and other organizations interested in protecting and enhancing the water quality in southern California. By participating, you can be a part of the history of successful projects conducted by local organizations dedicated to improving water quality for people and marine life in southern California. Get to know your watershed including its beauty and its problem areas. In the Malibu Creek Watershed, Stream Team volunteers have found and reported two sewage spills. Because these volunteers quickly reported the incident, raw sewage was prevented from reaching our streams and ocean. Join us and become a steward for clean water.

How to use the Field Guide

The Freshwater and Marine Team Field Guide is designed for use by citizen monitors who have been trained to conduct monitoring for their specific program. The field guide is a companion to field training, and is not intended to be used on its own.

Note to program leaders about the Field Guide

The Freshwater and Marine Team program is specially designed to collect accurate and reliable data. Heal the Bay and SCMI recommend that citizen monitoring programs adhere to the following protocols:

1. Calibrate all instruments in a laboratory setting **(not in the field)**.

2. Calibrations should be done by the program leader or specially trained representative of the program leader.

3. Calibrate instruments just prior to each monitoring event.

4. Test all instrument calibrations directly after they are used in the field to ensure the validity of field measurements. If the post collection calibration exceeds the criteria stated in the Quality Assurance Project Plan (QAPP) for that instrument, the data collected with that instrument must be discarded or measured again.

5. Program leaders must maintain a calibration log that details the date, time and person who calibrates each instrument and the date, time and person who tests the instruments when they return from the field.

6. Use only the appropriate NIST certified standards for each instrument calibration.

7. Conduct every field measurement at least twice. Take a third field measurement if the first two measurements vary significantly.

8. Conduct one split sample and one replicate sample for nutrients and bacteria on every sampling day.

9. On each day of nutrient testing the program leader must test a NIST certified standard (solution with a known value) for each nutrient being measured.

10. Remove all equipment references from this field guide that will not be used in your monitoring program, to avoid confusion among the volunteers.

Section 2
Watershed, Estuarine, and Marine Processes

Defining a Watershed

Everyone lives in a watershed. A watershed, or drainage basin, is defined as the land area from which water, sediments, and dissolved materials are drained by a series of tributaries, streams, and creeks into a common outlet (Napa County Resource Conservation District 1998, pg.7). You can delineate a watershed by connecting all the high points surrounding a given water body (Figure 2-1). Any precipitation falling inside this boundary stays in the watershed, whereas precipitation falling outside this boundary flows into another watershed. Watersheds can vary greatly in size and shape.

The Los Angeles region contains seven large watersheds (Figure 2-2).

The **Santa Clara River Watershed** is approximately 1,200 square miles in area. It is the largest river system in southern California that remains in a relatively undisturbed state. The Santa Clara River flows nearly 100 miles. The river originates in the northern slopes of the San Gabriel Mountains and flows westward towards Ventura County. It eventually empties into the Pacific Ocean at the Santa Clara River Estuary between the cities of Oxnard and Ventura (http://dpw.co.la.ca.us/wmd/watershed/sc/).

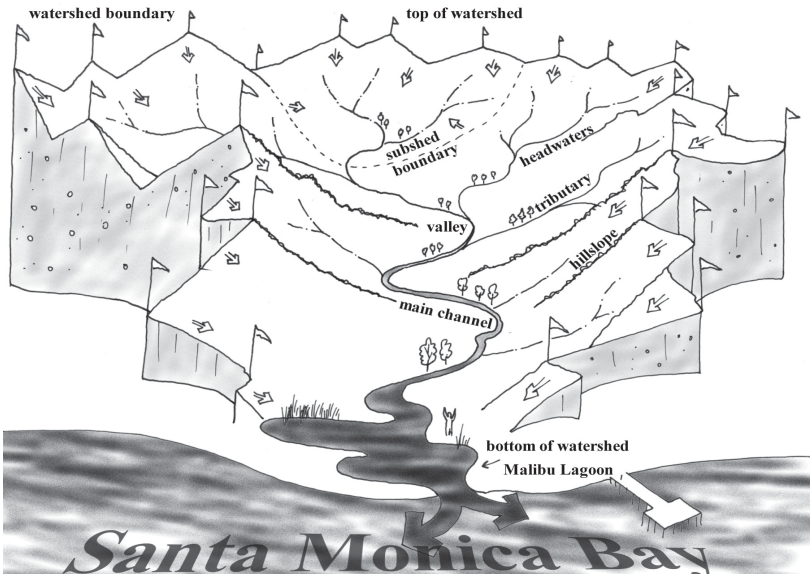


Figure 2-1: Delineating watersheds

The **Ventura River Watershed** drains an area of 235 square miles. The 31-mile river flows south forming an estuary at its outlet with the Pacific Ocean near the city of Ventura. In 2000 the Ventura River was named the third most endangered river in the United States. (http://www.americanrivers.org/mostendangered/ventura2000.htm).

The **Calleguas Creek Watershed** is 343 square miles in area, comprised of 25% agricultural land use, 25% urban and residential land uses, and 50% open space. Calleguas Creek begins in the Santa Suzana mountains in the north and the Santa Monica Mountains in the southeast and flows 36 miles to its outlet at Mugu Lagoon. (Calleguas Creek Watershed Management Plan, http://www.calleguas.com/ccbrochure/introld.html). Mugu Lagoon is one of the few remaining salt water wetland habitats in southern California.

The **Los Angeles River Watershed** covers a land area of 834 square miles from the eastern portions of the Santa Monica Mountains, Simi Hills, and Santa Suzana Mountains to the San Gabriel Mountains in the west. Forty-eight miles of the 51- mile river are lined with concrete. The river empties into San Pedro Bay near Long Beach at the Pacific Ocean. Approximately 475 square miles of the watershed are highly developed by commercial, industrial or residential land uses. Over 80% of the river's flow is made up of discharge from industrial uses and waste water treatment plants. (http://dpw.co.la.ca.us/wmd/watershed/LA/).

The **San Gabriel River Watershed** is 640 square miles with approximately 26% of its total area developed. The San Gabriel River flows south from the San Gabriel Mountains, in the Angeles National Forest, until it enters the Pacific Ocean in Long Beach. The San Gabriel River may connect with the Los Angeles River during extremely strong winter storms at the Whittier Narrows Dam and Reservoir (Common Ground from the Mountains to the Sea, pg. 20).

The **Dominguez Channel Watershed** is 110 square miles in area. Ninety-six percent of the total area has been developed. The channel starts at the Los Angeles International Airport and receives runoff from the cities Inglewood, Hawthorne, El Segundo, Gardena, Lawndale, Redondo Beach, Torrance, Carson and Los Angeles. The Dominguez Channel empties into Los Angeles and Long Beach Harbors. The harbor was once a series of mudflats and wetlands fed by the Los Angeles River. In the early 1900's marshes and wetlands were filled to accommodate large ships. The river was diverted and a breakwater was constructed to allow ships to easily unload their cargo. The entire Dominguez channel is lined with concrete (http://dpw.co.la.ca.us/wmd/watershed/dc/current_cond.cfm/).

The **Santa Monica Bay Watershed** drains an area of 414 square miles. Twenty-eight separate smaller watershed all drain into Santa Monica Bay, the two largest being the 126-square mile Ballona Creek Watershed and the 110-square mile Malibu Creek Watershed. Santa Monica Bay's natural boundaries extend from Point Dume to Palos

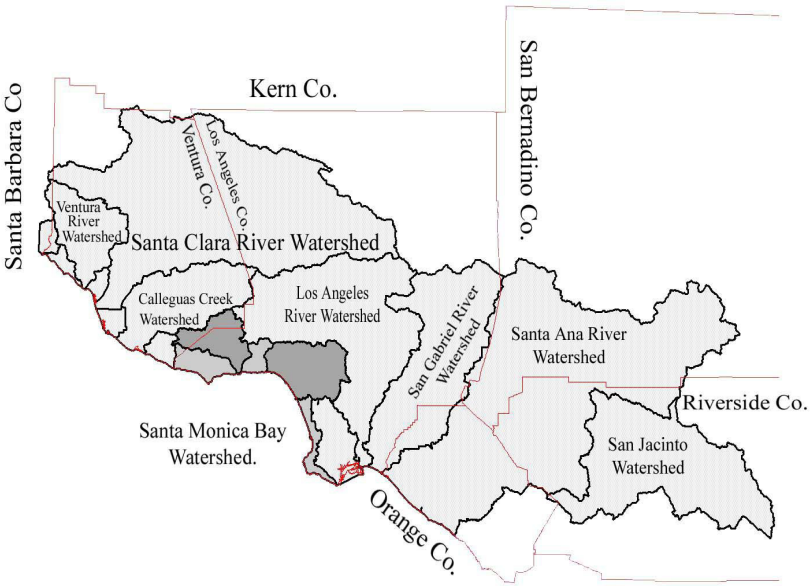


Figure 2-2: Major Watersheds of the Los Angeles and Santa Ana Regions (Region 4 and Region 8).

Verdes Point. It has 50 miles of coastline with 22 separate public beaches that provide recreational opportunities for an estimated 45 million visitors each year (http://www.smbay.org/10.htm).

The Santa Ana region is made up of portions of two distinct watersheds that drain a combined area of 2,800 square miles (Figure 2-2).

The **Santa Ana River Watershed** covers 2,650 square miles of wildly varying terrain, which includes parts of San Bernardino, Riverside, and Orange Counties. Over 4.8 million people live in the watershed. The mainstem of the Santa Ana River is over 100 miles long and is the largest river system in southern California. The headwaters of the Santa Ana River and its tributaries are in the San Gabriel and San Bernardino Mountains to the north and the San Gorgonio and San Jacinto Mountains to the east. Peaks in these ranges are over 10,000 feet high. The Santa Ana River flows in a southwesterly direction to its mouth at the Pacific Ocean located on the boundary between Newport Beach and Huntington Beach. (http://eureka.regis.berkeley.edu/wrpinfo/).

The **San Jacinto Watershed** covers approximately 760 square miles with elevations that range from 1,260 to 10,805 feet at San Jacinto Peak. The watershed is located within Riverside County with a small portion extending into Orange County. The

watershed is bounded on the north by the San Timoteo Badlands and on the east by the San Jacinto Mountains. The watershed contains three reservoirs: Lake Hemet, Perris Reservoir, and Railroad Canyon Reservoir, which are used for municipal, industrial, and agricultural use. (http://eureka.regis.berkeley.edu/wrpinfo/).

The Hydrologic Cycle

The hydrologic cycle is the earth's process of water recycling. It is critical for understanding watersheds. The hydrologic cycle is a closed loop system driven by the energy of the sun, that continually transports water between the atmosphere and the earth's surface water. The three main processes of the hydrologic cycle are precipitation, evaporation,

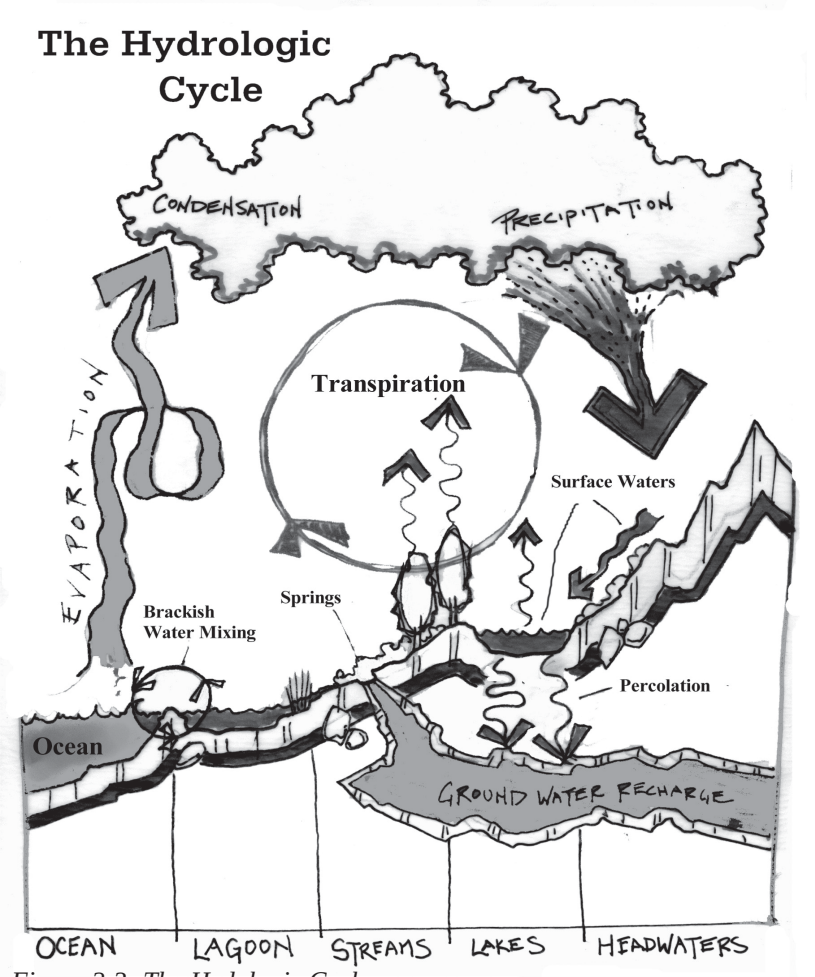


Figure 2-3: The Hydologic Cycle

and transpiration. Once precipitation falls on to land, approximately two-thirds is evaporated back into the atmosphere. The remainder is either absorbed into the ground or flows over the land as surface water. Transpiration occurs when energy from the sun draws water from the leaves of plants back into the atmosphere in the form of water vapor (Figure 2-3).

The hydrologic cycle can be best explained by beginning with a discussion of surface water. Surface water in lakes, streams, lagoons, oceans and on the ground, is heated by the sun's energy and turned into vapor through the process of evaporation. Transpiration occurs when plant roots absorb water stored in the soil. The water migrates up the stem or trunk until it eventually comes out from thousands of tiny holes on each leaf. The process of transpiration may produce more water vapor in the atmosphere than evaporation. A large oak tree transpires approximately 39,578 gallons per year (Leopold 1997, p.5). Warm air can hold more water vapor than cold air. When air cools down, the water vapor exceeds the carrying capacity of the air. The water vapor turns back into its heavier liquid form, and falls to earth as precipitation. The rain is again absorbed into the soil, or flows over the land and into the streams and eventually into wetlands, lakes, and the ocean.

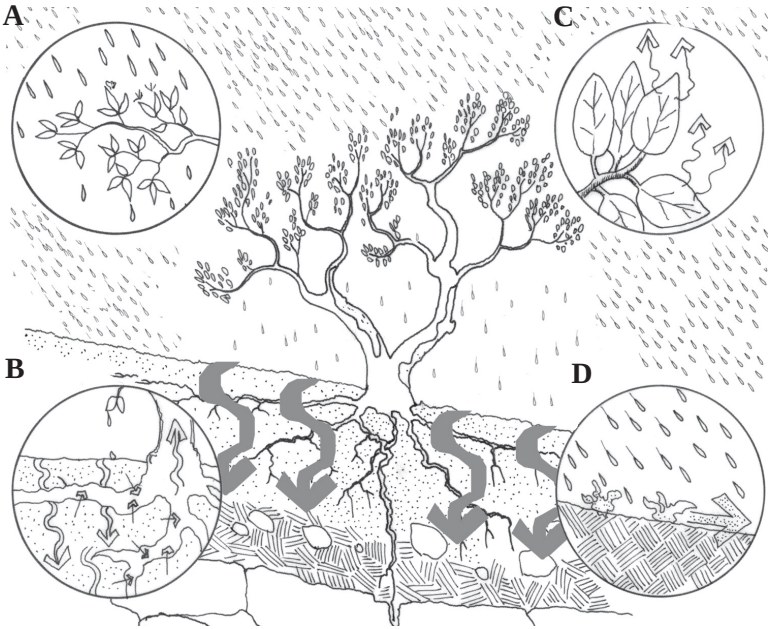


Figure 2-4: Vegetation helps infiltration and prevents erosion by: A) intercepting the rain and slowing down water flows, B) roots break up soils creating pore space for water to infiltrate, and C) water absorbed by roots can be transpired from the leaves. D) Rain loosening exposed soils and transporting sediments into reciving waters.

The hydrologic cycle is continually repeated. The sun evaporates surface waters, and plants transpire water into vapor, which eventually falls back to earth as rain. The total amount of water on the earth's surface is finite, and in essence, it is the same water cycling over and over again. Therefore it is critical to maintain non-polluted, high quality water.

One important aspect of the hydrologic cycle, in terms of watersheds, is the process of infiltration. The rate at which water is absorbed into the ground (infiltration) is influenced by two main factors: the characteristics of the soil material and the type and density of the vegetation growing or lying on the ground (Leopold 1997, p.10). Soil is composed of millions of tiny particles that have air spaces or pores separating each particle. Precipitation that falls onto the land is absorbed or infiltrated through these pores. Soils with bigger pores, like sand, allow precipitation to infiltrate more quickly. Conversely, soils with smaller pores, like clay, absorb water more slowly. When the rain falls faster than the pores can absorb, or when soil becomes saturated, the excess rain flows across the surface of the land. This surface runoff flows down the mountains into waterbodies.

Vegetation plays an important role in the infiltration of rain by reducing the velocity of water flow over the landscape (Figure 2-4 previous page). This is important for minimizing rapid sheet flows of water into the streams and creeks. Studies conducted on plots of land with varying amounts of vegetation reveal the benefits of vegetation on the infiltration process. On one plot, a third of the land had grass or other vegetation growing on it, and the other plot was bare ground. The land with vegetative cover infiltrated water at six times the rate of bare ground (Leopold 1997, p.12).

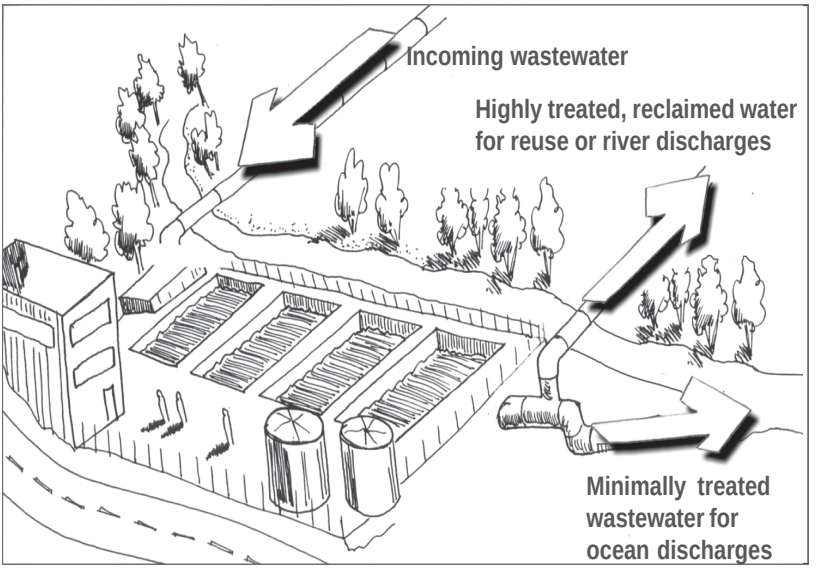


Figure 2-5: The discharge of treated wastewater from sewage treatment facilities contributes nutrients and increases flows to rivers.

As watersheds in southern California become more urban, two major changes to the hydrologic cycle generally occur. The quantity of water circulating within the watershed increases. The increase is caused by the need to import water and the inability of the landscape to absorb rain and storm runoff because of the increasing amount of paved surfaces. The quality of water decreases due to the pollutants in urban runoff. The resulting increase in water quantity and decrease in water quality is altering the chemical, biological, and physical characteristics of our rivers and oceans.

In order to accommodate our growing population, and the demands of domestic, commercial and industrial water users within watersheds, it has become necessary to import water. This water is supplied primarily from the California State Water Project, which collects and transports water from northern California rivers and the Colorado River. Imported water, storm runoff, and pollutants enter waterbodies in three ways. The first is by way of sewage treatment plants and/or industrial dischargers, second, by surface runoff via the storm drain network, and lastly through groundwater.

Sewage treatment plants receive wastewater from households and businesses (Figure 2-5). Sewage treatment plants that discharge into freshwater are required by law to filter and treat wastewater to a cleaner level than facilities that discharge to the ocean. Generally, treatment plants are located near rivers or the ocean because it is cheaper to discharge directly to a waterbody than to pipe the treated water long distances for disposal. Some freshwater treatment facilities reclaim wastewater by treating it until it is clean enough to be safely reused for irrigation. The reclaimed water is sold to cities for watering parks, public gardens, and highway medians. When freshwater treatment plants have more reclaimed water than they can sell, surplus water is discharged into our rivers. Most treatment facilities that have ocean discharges do not reclaim treated wastewater. They discharge poorer quality water at higher quantities than freshwater facilities.

Treated wastewater generally has high levels of nutrients (food for plants). When nutrient rich wastewater is discharged into rivers the food supply for aquatic plants, such as algae, is increased. Algae is an important source of food for many aquatic animals, but when excess nutrients cause too much algae, it degrades water quality. This is because algae use up oxygen from the water. The effect is most severe at night when algae do not photosynthesize so oxygen in the water is not replaced. Too much algae can cause low levels of dissolved oxygen at night. When algae dies it decomposes in the water and this uses up even more oxygen. Without enough available oxygen in the water, other plants and animals can not survive.

The treated water discharged to streams and the ocean is called a point source because it comes out of a single pipe. Other point sources include industrial users. For example, numerous power plants generate electricity in our region. These plants use clean water to cool the generating equipment, then discharge the water at a higher temperature back into the water body. Numerous manufacturing plants and other industries also generate

Sources of Water Inputs into Watersheds

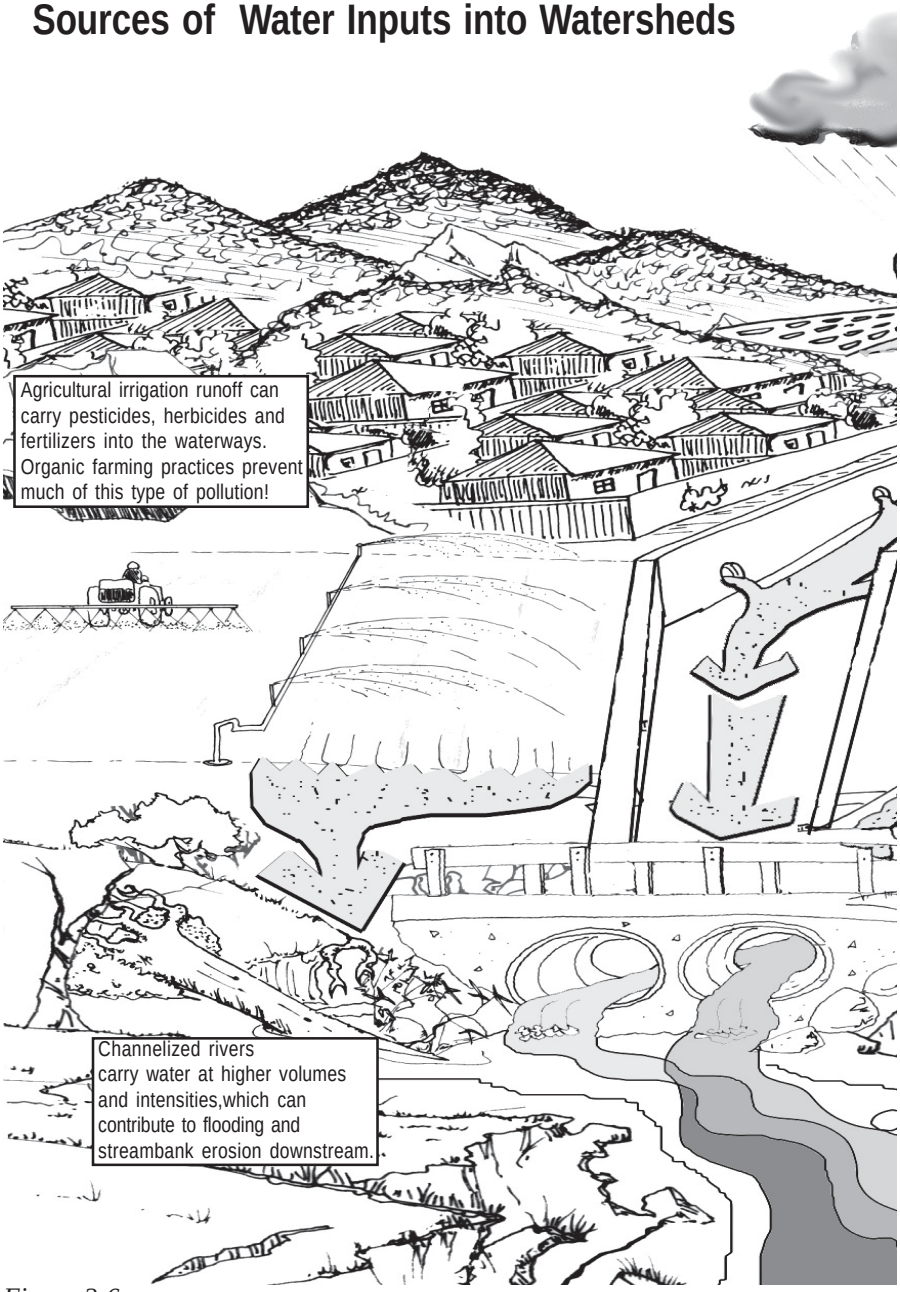
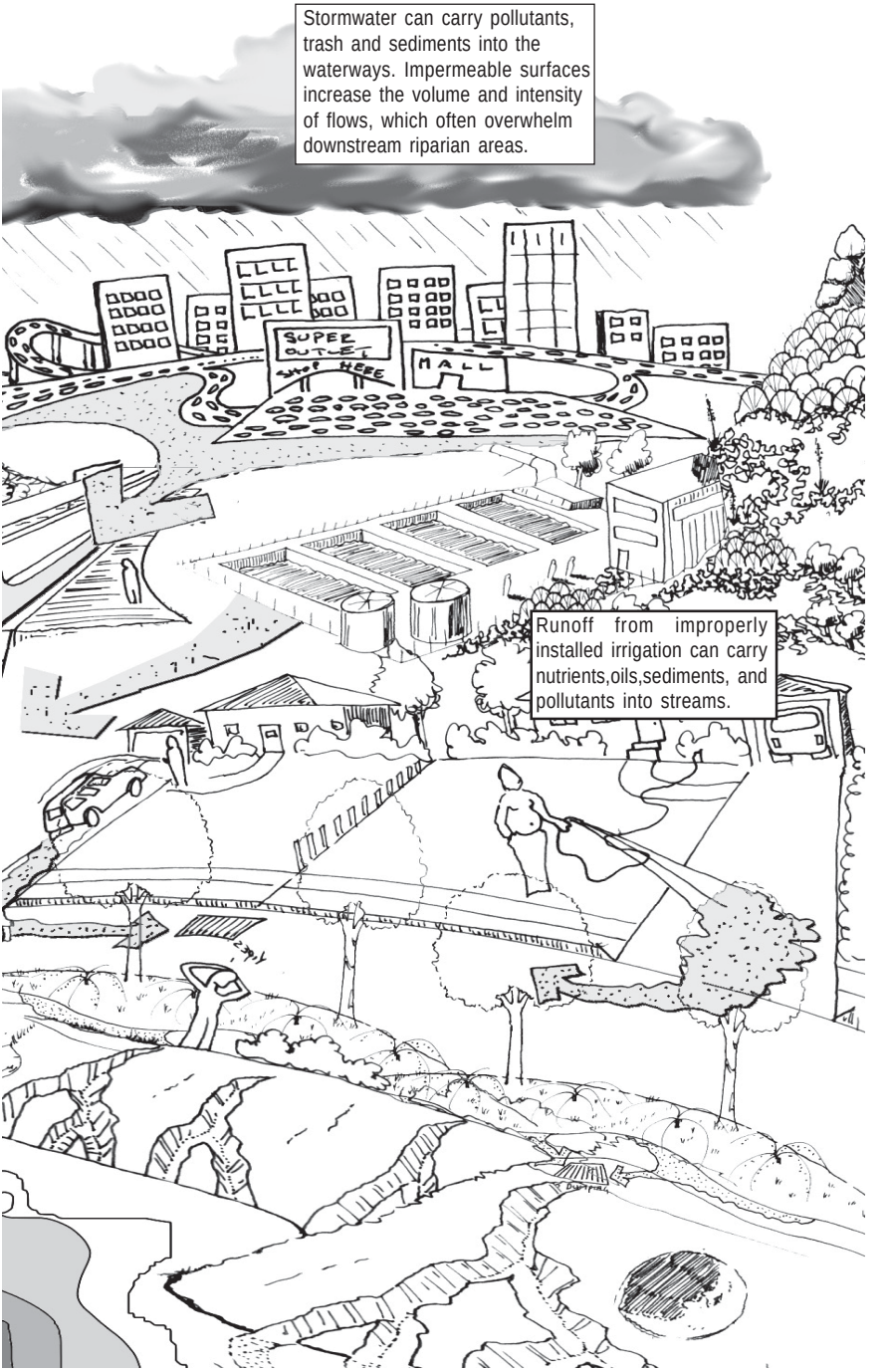


Figure 2-6


Stormwater can carry pollutants, trash and sediments into the waterways. Impermeable surfaces increase the volume and intensity of flows, which often overwhelm downstream riparian areas.
SUPER OUTLET
MALL
Runoff from improperly installed irrigation can carry nutrients,oils,sediments, and pollutants into streams.

liquid wastes and discharge them to surface waters. The Clean Water Act dictates that point source dischargers are regulated by the Regional Board through discharge permits. These permits limit both the concentration and total amount of pollutants that can be released.

Imported water, rainwater, and pollutants also enter the streams through surface runoff via the storm drain network. Surface runoff is that water which is not evaporated, transpired, or infiltrated. The storm drain network captures water that flows over land from irrigation, rain, or any source that contributes water to the street. As surface water flows over the land, it washes nutrients, sediments, trash, and other pollutants from the land into storm drains and then to the rivers and ocean (Figure 2-6 previous page).

Paved surfaces and rooftops are impervious surfaces. They replace vegetation and soils, thereby affecting the landscape's ability to infiltrate and clean surface runoff. An impervious surface is one that prevents the penetration of water, resulting in stormwater rushing off of the surface, into the storm drain network, and eventually into a channel or waterbody. The increased quantity and intensity of surface water created by impervious surfaces often overwhelms plants growing along the sides of waterbodies and causes severe erosion of the streambanks. Further, impervious surfaces capture pollutants leaking from poorly maintained cars, settling air pollution, and litter. Each year, the first

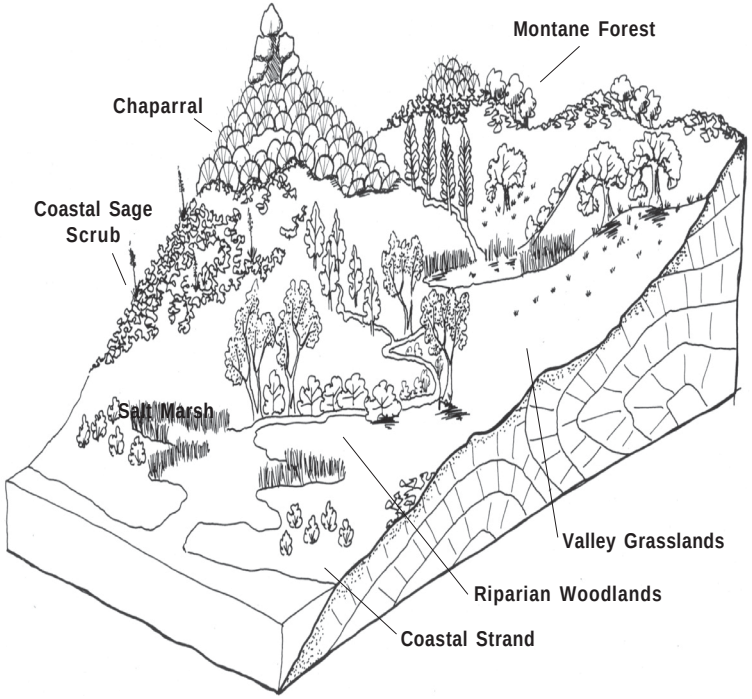


Figure 2-7: The image above represents the various plant communities found in the region.

rainfall of the season carries several months worth of urban pollutants, trash, sediments, and nutrients that are washed off the impervious surfaces directly into waterbodies, in what is known as the "first flush". The first flush washes these pollutants directly into lakes, rivers, streams, and ultimately the ocean.

Once, our nation's beaches were littered only with the likes of seaweed, shells, driftwood, and stranded jellyfish. These days, the litter is more likely to include cigarette butts, grocery bags, scraps of fishing nets, pieces of foam coffee cups, fast food containers, and soda bottles. Rarely can a person visit a stream, lake, river, estuary, or ocean and fail to observe some form of trash. Trash and debris that are carried into waterbodies and ultimately the ocean impact human health and safety; pose an entanglement or ingestion threat to wildlife; and degrade critical habitats. Plastic debris such as, nets, fishing lines, and trash bags can snare boat propellers or clog cooling water intakes, damaging the motor. A disabled motor can not only be costly to fix, but can leave boaters stranded in the water. Wildlife often fare even worse than humans. Marine debris can mean death to aquatic animals. One common cause of death by marine debris is **entanglement**. Many animals are caught in discarded fishing nets and lines, rope, six-pack rings, balloon ribbons, grocery bags, and other floating debris. Some animals die from marine debris **ingestion**, mistakenly eating the human-made materials. Endangered sea turtles, for example, consume floating trash bags and balloons, probably mistaking them for jellyfish. Several seabird species have been found to swallow plastic pieces and cigarette butts. These materials can damage the animals' digestive systems. Ironically, since the debris in their stomachs offers no nutritional value, these animals can eventually starve to death while feeling full.

Imported water also reaches waterbodies through groundwater. Water from landscape irrigation or from septic systems infiltrates into the soils. Eventually, it can flow through underground channels and into streams. That water may carry excess nutrients from lawn and agriculture fertilizers, and improperly functioning septic systems.

Vegetation

This area of southern California is covered with plant communities that have evolved to fit the unique soils and climate of the region (Figure 2-7). Chaparral and Coastal Sage Scrub vegetative communities dominate in most areas. Both plant communities are adapted to the dry conditions of the summer months. For example, they have small glossy leaves to retain moisture, as well as the ability to drop their leaves in times of drought.

Chaparral plants such as Manzanita or Chamise, and Coastal Sage Scrub plants such as Black Sage and California Sagebrush are fire-adapted and depend on regular burning to remove old growth and rejuvenate the plants (figure 2-8 on the next page). Many of these plants have seeds that need fire to stimulate them to germinate and grow. Others have the ability to "crown sprout" directly from their roots after a fire. Fire suppression near developed areas has allowed plant communities to age unnaturally, thereby increasing

the amount of wood available to fuel a fire, and decreasing wildlife habitat value. Older Chaparral and Coastal Sage Scrub stands result in more intense fires and increased soil erosion after the fire.

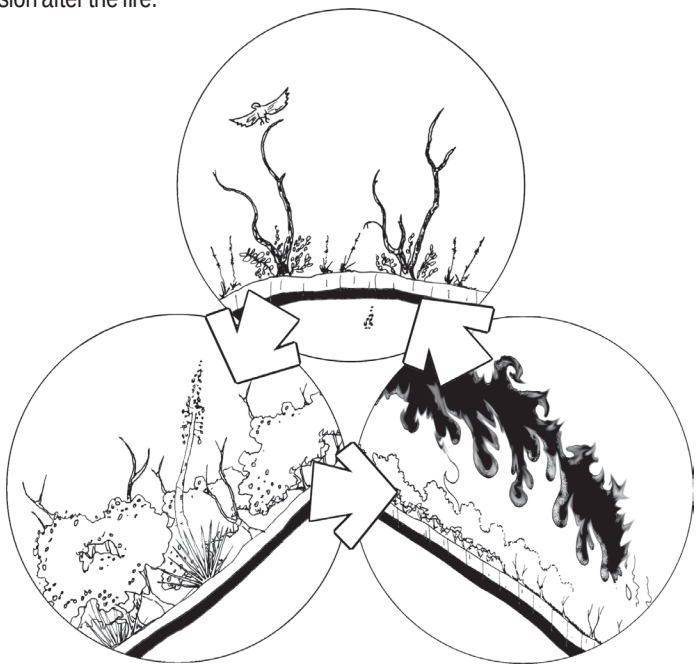


Figure 2-8: Fire plays an important role in the health of many plant communities. In this repeating cycle, fire burns an old stand of chaparral, the area quickly crown sprouts and grows back within a few years.

In areas that are above 4,000 feet elevation, such as the Angeles National Forest and San Gabriel Mountains, the Montane Forest vegetation begins to appear. The Montane Forest vegetative community generally has tall, closely spaced trees. Trees of this community are usually cone-bearing, pyramid in shape, and have needle-type leaves. The indicator species are bigcone spruce, Canyon oak, Jeffrey pine, Coulter pine, and incense cedar.

Riparian Zone

The riparian zone is the vegetated area on either side of a body of water (US EPA 841-B-97-003 1997, p. 203) (Figure 2-9). Riparian zones or corridors are important vegetation communities that help maintain water quality and stream health. Riparian vegetation generally has a higher need for water, and grows in areas with a high water table. The plants of a healthy riparian corridor are diverse and include shrubs, groundcover and trees such as oaks, sycamores, alders, cottonwoods, and willows. This area is unique because it is where the land-based (terrestrial) and aquatic ecosystems interface (Murdoch, Cheo, and O'Laughin, 1996, p. 60).

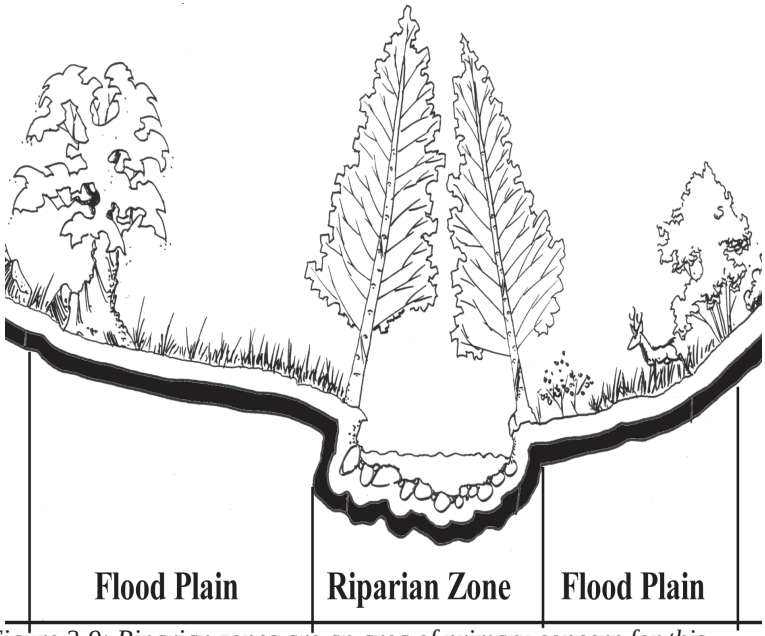


Figure 2-9: Riparian zones are an area of primary concern for this program. This cross section helps define the boundaries of a riparian area, here in relationship to the flood plain.

A healthy riparian zone supports diverse wildlife, birds, and aquatic life. According to the Washington State Department of Wildlife, more than 85% of wildlife inhabit riparian areas at some time during their life cycles to find water, shelter, and food. Riparian trees are important because they provide shade that helps cools water temperatures. Certain fish species like the endangered steelhead trout require cold water temperatures to survive and reproduce. Shade also minimizes evaporation, so more water remains in streams, providing flow later in the hot summer season. Trees and other vegetation drop leaves, twigs, and branches that provide food for the aquatic organisms at the base of the food chain. This debris accumulates in the streams, providing both habitat and shelter for fish and other aquatic life.

Removing riparian plants has adverse effects on the physical, chemical, and biological characteristics of streams and rivers. Without riparian vegetation streams and rivers have increased water temperatures, making them too warm for some aquatic organisms. Without plants and their root systems, soil is less stable, and more prone to erosion. Streamside vegetation helps slow down the large flows associated with flood events, and provides areas for water storage. When a river overflows its banks, the water is slowed down by trees, shrubs, and rocks that the water encounters on the banks. Consider a smooth parking lot with no obstructions as compared to a natural landscape with ground cover, shrubs, rocks, trees, and depressions. Imagine the difference in the speed that water travels over each of these surfaces. In addition, plant roots and burrowing animals make

holes in the earth that increase the ability of the soil to absorb water. As water moves slowly down through the soil, a myriad of pollutants are removed. Depressions in the landscape and the obstacles created by fallen trees and their branches allow water to be stored until it evaporates or infiltrates into the soil. Most importantly, vegetation utilizes water and nutrients to feed and grow. When vegetation is replaced with concrete, there are no plants and therefore no uptake of water or pollutants can occur.

The Stream Continuum

Streams and rivers are dynamic forces, both reflecting and changing the character of the surrounding landscape. There are three types of streams in the watershed. The first type of stream is ephemeral, flowing only during storms. Many of the upper watershed or headwater streams are ephemeral. The second stream type is intermittent, a type of stream which flows only during the wet season and dries up during the summer season. Intermittent streams are common in southern California. Intermittent streams converge and flow into perennial streams or rivers. Water runs year-round in the perennial streams, which are generally lower in a watershed (Figure 2-10).

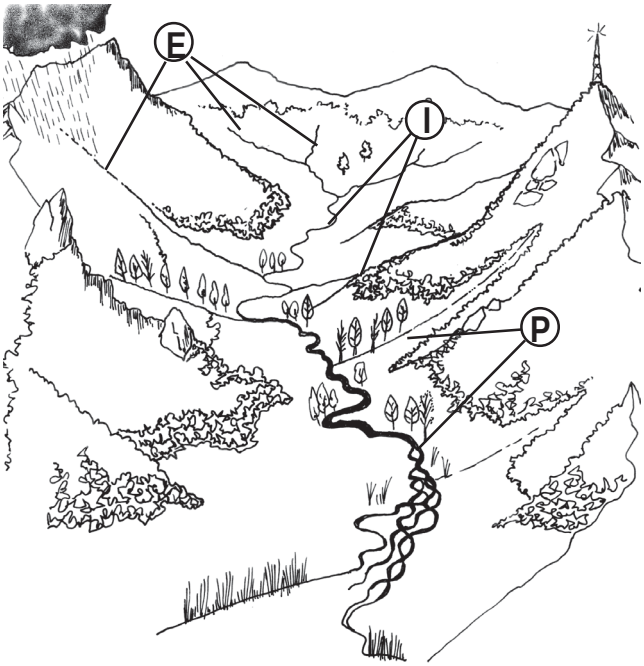


Figure 2-10: The Stream Continuum. The top of the watershed is characterized by ephemeral headwater streams (E) with steep gradients and large substrates. These are followed by intermittent (I) and perennial (P) streams with a lower gradient and a finer substrate. If the gradient becomes shallow enough, the stream can become braided with silty substrates.(adapted from figure 1, USDA report rm-245)

Materials such as sand, gravel, cobbles, or boulders line each stream and are called the substrate. The type of substrate is a direct result of many factors including elevation, soils, geology, and slope. Substrate materials are generally larger in the upper reaches of a stream. The headwater streams are steep and narrow with substrates consisting of large cobble, boulders or bedrock that are hard to move. In middle stream sections, as stream gradient decreases and water velocity slows, the substrate is generally composed of medium-sized cobbles and gravel. As the river continues to flow downstream towards the ocean, the amount of water continues to increase while the stream gradient flattens out. This results in slower-flowing, wider stream channels. The water is too slow to transport even the smallest particles of gravel, sand and silt. These particles settle out and deposit along the stream channel. These deposits create large sandbars that give the river channels a braided appearance as they approach the ocean. The small particles eventually make their way to the beach to replenish sand washed away by the ocean waves.

A natural watershed drainage network changes continuously but maintains a balance between the shape of its stream channels and the amount and force of water running off the hillsides into the channels (Murdoch, Cheo, O'Laughin. 1996, p.63). Healthy streams are in a state of equilibrium, where the amount of sediments and water that enter the stream are the same amount that leave the stream. When a stream is in equilibrium, sand and gravel are scoured from the outside bend of one curve, and then are deposited on the inside of another curve. Stream currents are strongest on the outside parts of the curves. As a result, sand and gravel are eroded from the outside banks, creating pools. Conversely, this material is transported downstream to the inside bends and deposited where current is slowest, often creating gravel bars and sandbars (Figure 2-11). A meandering stream pattern forces water to travel over a longer distance and dissipates the erosive power of the water. The balance of erosion and sedimentation is part of the stream continuum concept, which explains how climate, geology, and topography interact

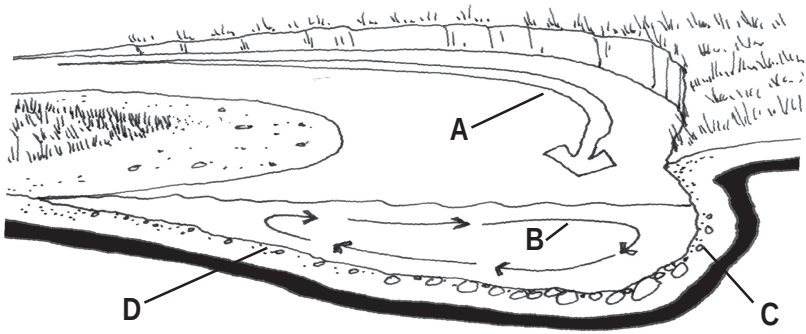


Figure 2-11:Erosion and deposition along stream curves: A) path of current around curve, B) circulatory current in water flowing around curve, C) area of erosion and D) area of deposition (from figure 28, Leopold"Water,Rivers and Creeks"1997)

to form healthy, natural streams. Unusual natural events, or permanent alterations in the stream continuum caused by development, can upset the balance of erosion and deposition of stream sediments.

Development has significantly influenced the hydrologic functions within watersheds. Of primary concern to the hydrology of the watershed are the influences of imported water and channelization of the waterways. The effects of imported water are manifold. Runoff from irrigation and the discharge of treated wastewater increases the overall volume of surface flows and introduces excess nutrients into the waterways. The increase of nutrients in water can trigger algal blooms. When the algal blooms die off, decomposition depletes the water of oxygen needed by other organisms for survival.

Channelization is another alteration with major impacts that affects a watershed's hydrologic function. Channelized streams are artificially lined with concrete for flood control purposes. They are designed to move water quickly out of the area. The result is a waterway that has few if any plants, and little wildlife habitat value (Figure 2-12). The channelization of a creek diminishes other benefits of riparian corridors such as water purification and slowing down the water flow. With no cobbles, boulders, plants, or streambank irregularities to slow down the rushing water, very fast flows result, which can overwhelm the slowing capacities of downstream riparian areas. Pollutants in storm water runoff are carried directly into the ocean.

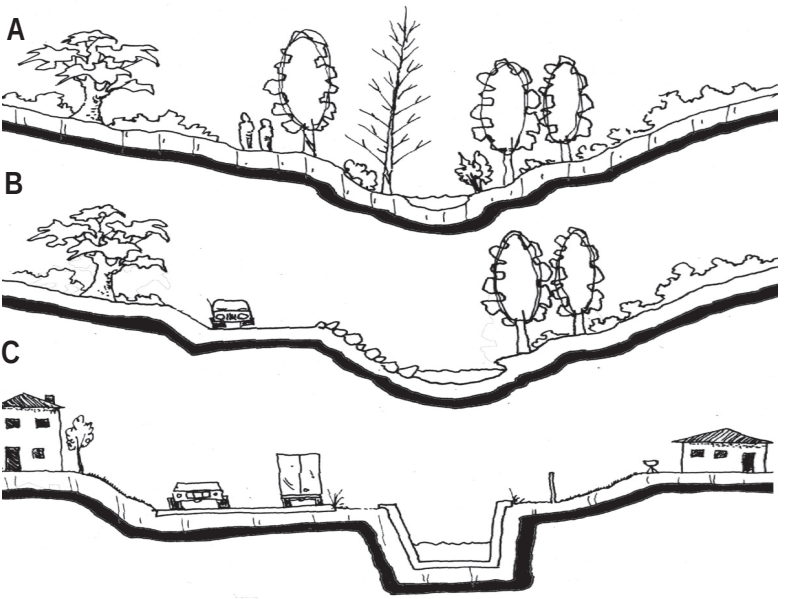


Figure 2-12: The transformation of the Riparian Corridor: A) pristine riparian zone, B) impacted riparian zone and C) channelization.

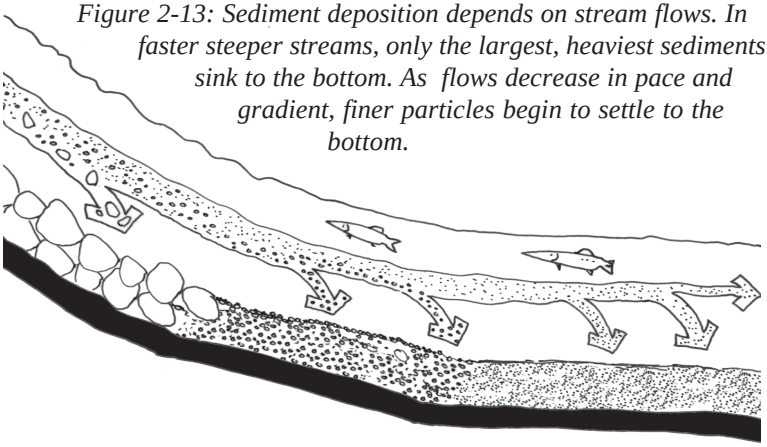


Figure 2-13: Sediment deposition depends on stream flows. In faster steeper streams, only the largest, heaviest sediments sink to the bottom. As flows decrease in pace and gradient, finer particles begin to settle to the bottom.

Erosion and Sedimentation

Erosion and sedimentation are also important issues in our region. Erosion occurs when precipitation and surface runoff wash loose soils into waterways. Sedimentation is the process of eroded soils entering a waterway for downstream transport. Sedimentation is the downstream result of erosion. The insoluble particles carried by streams, such as sand, silts, and clays, are called sediments.

The mountains in this region consist of many soil types that are considered highly erodible. An area's erodibility is dependent on the type of soils, slope, vegetative cover and amount of rain. Erosion is a natural process that happens frequently within watersheds. Erosion adds sediments and nutrients to the streams. Erosion is also part of the natural cycle of wildfires. However, in developed areas, fire suppression measures have resulted in older, unburned plants. This has increased the fuel loads, and therefore the intensity of a potential fire. The resulting erosion from these more intense fire events can lead to unnaturally high sediment loading in streams.

When eroded soil is carried into waterways, it then becomes part of the sedimentation process. The insoluble clay, sand, and silt particles are carried in the water as suspended solids. Suspended solids remain in the water as long as the flow has the velocity and force to transport these particles downstream. Pollutants attach to these suspended particles. As the water slows, the suspended solids begin to sink to the bottom (Figure 2-13). Slow moving stream and river sections, lakes, wetlands, lagoons, and near shore shallows, collect sediments on the bottom, which forms the substrate. The pollutants attached to these sediments may either resuspend back into the water column or stay attached to the substrate. Whether in the water column or attached to sediments these pollutants can impact aquatic life. In the natural process, much of the sediment washes into waterways during intense storm events. As a result, much of the sediment from our region is carried out to sea by high storm flows. It is deposited on the ocean floor or becomes beach sand.

Increased sedimentation in streams and rivers can have a significant effect on habitat quality. Several factors have caused an increase in the sedimentation of streams and rivers, altering this natural process. Construction sites have exposed soils that erode, increasing sedimentation. These sediments can cover the stream bottoms altering the habitat for aquatic life. The local steelhead trout is particularly sensitive, since they need gravelly stream bottoms (not sand or silt) for reproduction. The construction of dams and reservoirs also disrupts sediment transport. Dams slow the water to the point that it will drop all the suspended sediments. The dams then become sediment traps that quickly fill (Figure 2-14). Many reservoirs and man-made lakes need regular dredging to remove accumulated sediments.

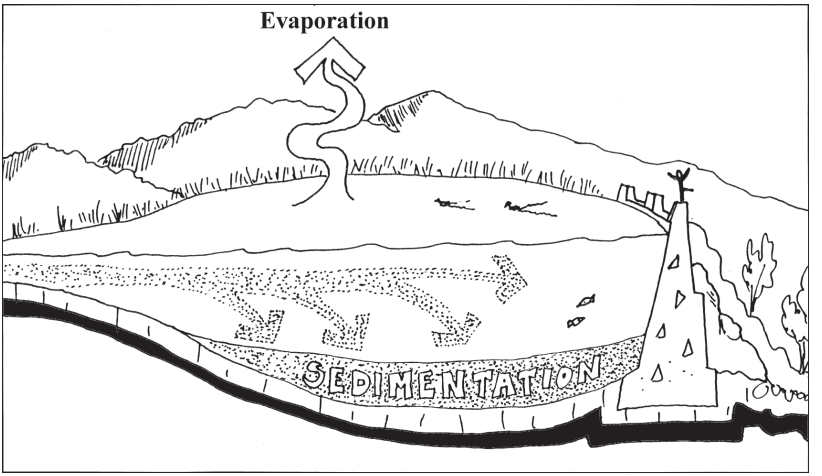


Figure 2-14: Sedimentation quickly fills in constructed lakes and reservoirs.

Estuaries and Lagoons

At the bottom of every watershed is an outlet, either into another watershed, or into a large body of water such as a lake, lagoon, or the ocean. Estuaries are where the river meets the sea. An estuary is defined as a partially enclosed body of water where the freshwater in rivers, streams, or creeks mixes with the salt water in the ocean. In estuaries fresh water from rivers and salt water from the ocean mix to create brackish water. For example, the Malibu Creek and Calleguas Creek Watersheds flow into Malibu Lagoon and Mugu Lagoon, respectively. Estuaries are influenced by the tides, like the ocean, but are sheltered from the full force of waves and wind. In general, estuaries are protected by marshes and wetlands from the land side and reefs, sand and mud flats on the ocean side. Estuaries are among the most biologically productive and economically important ecosystems on the planet. "More than two thirds of all the fish and shellfish we eat spend some part of their live in estuaries." (http://estuaries.gov/about.html). Some examples of estuaries are bays, lagoons, sloughs, and harbors.

Lagoons and wetlands are two critical types of estuarine habitat. One of the major functions of lagoon and wetland habitats is to act as large natural filters of water, cleaning out pollutants and debris before surface water makes its final journey out to sea. The maze of channels, the wetland plants, the tidal action, and the aquatic life contribute to the filtering and cleansing of water. Wetlands also offer protection from flooding. They provide areas that can capture and store floodwaters during large storm events. Migrating birds use wetland habitats as rest stops on their long journeys. Coastal lagoons supply critical rearing habitat for the endangered southern steelhead trout. Adult steelhead use lagoons to make the transition from saltwater to fresh water before they begin their spawning runs up river. Young steelhead use the brackish waters of lagoons to adjust to saline conditions as they leave freshwater streams and migrate into the ocean.

A sandbar is a key feature of functioning lagoon ecosystems. During the dry summer months, the closed sandbar separates the lagoon from the ocean. This is because less water reaches the lagoon due to the drying up of ephemeral or intermittent streams, and lower volumes of reclaimed water discharged into the stream from wastewater treatment facilities during the dry season. As the water flows diminish, sediments close the lagoon off from the ocean. This creates a less saline wetland condition that supports a large diversity of terrestrial and aquatic life. In the wet winter months, the increasing quantity of water flowing into the lagoon eventually breaches or breaks open the sandbar. Following the breach, water is flushed into the ocean, and the lagoon ecosystem becomes more saline as it is once again subject to the ocean tides.

Development throughout the watershed has also had a significant effect on estuarine ecosystems. Pollutants from urban runoff, sediments, nutrients, and debris collect in estuaries, which become a sink, or point of deposition. Although lagoons and wetlands are excellent water purifiers, the additional quantity and lower quality of water has reduced their capacity to effectively filter the water. Further, according to historical records, most

Figure 2-15: Summer lagoon breeching upsets the lagoon ecosystem. The lagoon is an important habitat for many endangered species.

lagoons and wetlands today are much smaller than they once were. In essence, these smaller lagoons are being asked to treat more and dirtier water. Excess flows of wastewater discharged into streams and rivers can cause unseasonable breaching of the sandbar during the dry season (Figure 2-15). This may suddenly change the lagoon's salinity, which upsets the natural processes and causes stress to plants and animals.

In many locations streams and rivers do not flow into lagoons or wetlands but instead empty directly into the ocean. Channelized rivers and storm drains often bypass wetlands and even natural streams can empty directly into the nearshore estuaries and harbors. For example, the Domiguez Channel and the Los Angeles River have been channelized and now flow into Los Angeles and Long Beach Harbors instead of the wetlands that formerly existed. The Ventura and Santa Clara Rivers flow directly into sheltered ocean areas or estuaries. When a river drains directly to the ocean without the benefit of filtration from wetlands or lagoons, polluted storm water runoff can have dramatic effects. The pollutants and debris carried in the river can affect the nearshore marine environments.

Near Shore Marine Environments

As water exits lagoons, wetlands, and estuaries or is channeled directly into the ocean it is dumped either into sandy/muddy shallows or rocky intertidal regions that descend into kelp forests. Runoff from industrial uses such as waste water treatment plants and manufacturing facilities as well as storm water runoff from housing and urban areas can greatly impact these coastal communities. Runoff can also impact the plankton populations that occur within near shore environments.

Muddy/Sandy Shallows

Muddy and sandy shallows are made up of mud, clay, or sand transported down rivers and streams and deposited near the shore. Because sediments are continually deposited, plants can not take root and stabilize these shallow bottom areas. Near shore shallows experience large movements of water from tidal flow. Tidal action disturbs the sediment, causing it to mix with the ocean water. This tidal mixing allows attached pollutants to become suspended in the water column where they are picked up by plankton and passed on through the food web. Pollutants can also be passed through the food web by fish who feed on decaying matter that settles in the shallows, ingesting sediment particles and attached pollutants along with their food.

Rocky Intertidal

Some coastline areas have rocky habitat, between the high and low tides, referred to as the rocky intertidal zone. Rocky intertidal habitat consists of four zones: 1) Splash, 2) high tide, 3) middle intertidal, and 4) subtidal. These zones are based on how much water covers the rocks at a given time.The splash zone is closest to the shore and only receives sprays of water from crashing waves or wind. The splash zone is highly exposed to sun

and heat in the summer and cold temperatures in the winter. Marine organisms in this zone have adapted to these harsh and extreme conditions. For example, barnacle species can close their shells to protect their soft bodies from drying out , and then open up again when food is delivered in the sea spray. The high and middle intertidal zones are most influenced by the tidal regime and wave action. Every 24-hour period we have two high tides and two low tides. During low tides the water level decreases exposing the algae and animals attached to the rocky substrate to the drying influences of the sun. Mussels, limpets, and other animals that live in the high and middle intertidal zones generally cling to rocks, have low profiles which help minimize the stress caused by wave action, and are protected by hard shells to help defend against drying out and predation. The corraline algae in this zone have a dense structure made of calcium carbonate, enabling it to survive after losing as much as 90% of its daily water. The subtidal zone is covered with water most of the time and is only exposed during extreme low tides. This consistent water level allows for a greater diversity of plant and animal life. Red algae is the most dominant plant species in the subtidal zone. As the water gets deeper and colder, red algae is displaced by brown algae. These algae provide shelter and food for animals such as the purple sea urchin, various types of crabs, and marine snails.

Kelp Forests

Kelp forests are among the most productive of all coastal communities. Kelps are large brown algae that require light for photosynthesis, rocky substrate to anchor, and cold water with high nutrient content. Kelp usually occurs at depths of 10-30 meters (30-95 feet). Kelp is very sensitive to changes in water temperature and water quality. If water temperature rises above 20 degrees celsius (70 degrees farenheit) for sustained periods, kelp begins to die off. Discharge of heated water from energy generation facilities can harm kelp forests. In addition, energy facility discharges can cause plankton blooms and the plankton then competes with the kelp for nutrients in the water. This stress causes the stems and/ or the portion of the plant that anchors it to the rocky substrate (holdfast) to weaken and break loose. In southern California the dominant kelp species is Giant Kelp (*Macrocystis pyrifera*). Giant kelp can grow up to 14 inches a day, making it one of the fastest growing plants on Earth. Giant Kelp provides food and shelter for a large number of plant and animal species. In addition to a large variety of invertebrates, giant kelp forests are home to a diverse assortment of fish species such as calico bass, sheepshead, rock fish, and garabaldi, the California State Fish. Kelp is primarily eaten by purple sea urchins (*Strongylocentrotus purpuratus*) which are in turn eaten by sea otters. During the 1800's widespread hunting of sea otters allowed urchin populations to grow unchecked. Freed from predation, purple sea uchins have had a profound impact on the abundance of kelp in southern California. The recent recovery of sea otters, commercial urchin harvesting, and restoration efforts by groups such as the Santa Monica Bay Keeper have helped kelp forests to begin to recover.

Plankton

Plankton is an animal or a plant that lives within the water column of lakes, large rivers, and oceans. The name is derived from a Greek root that means "wanderer." These organisms range in size from microscopic bacteria and plants to larger animals (http://www.chesapeakebay.net/info/plankton.cfm). These small animals and plants have limited or no swimming ability and are at the mercy of the currents and tides for transport.

Phytoplankton (plant plankton) are the ocean's producers and are believed to generate as much as 80% of the world's oxygen supply. Phytoplankton are a type of algae and are dependent on photosynthesis for food production. Like other algae, phytoplankton absorb nutrients (primarily phosphates and nitrates) and carbon dioxide from the water and produce oxygen. The two most prevalent types of marine phytoplankton are diatoms and dinoflagellates. When excess nutrients are carried to the sea by rivers and streams and ocean temperatures warm, phytoplankton can undergo rapid growth or "algal blooms". During these blooms, most of the phytoplankton die and sink to the bottom, where they are decomposed by bacteria. This process depletes the dissolved oxygen necessary for the survival of bottom dwelling fish and other organisms. Dinoflagellate algal booms create a special condition known as red tides. The tides are named for the reddish appearance that is created by a sudden bloom of millions of dinoflagellates. Red tides not only contribute to oxygen depletion, they are also known to release strong neurotoxins that can cause massive fish kills. These toxins can be ingested by shellfish and passed on to humans who eat the infected shellfish, causing illness and even death.

Zooplankton (animal plankton) are the ocean's consumers. The zooplankton community is composed of both primary consumers (herbivores), which ingest phytoplankton, and secondary consumers (carnivores), which eat other zooplankton. Dominating the zooplankton community are the copepods, tiny crustaceans one millimeter long. Zooplankton also include the tiny larvae of invertebrates and fish, which will eventually grow into larger animals, such as sea stars, snails, and hermit crabs. Other types of zooplankton include krill, shrimp, and sea jellies (jellyfish). Plankton, regardless if it is plant or animal, are crucial to the food web. From the smallest zooplankton, eating phytoplankton, to the blue whale, the largest mammal on earth, who dines primarily on krill, life on this planet would cease to exist without a healthy plankton community.

As you have completed our journey from the mountains at the top of the watershed to the ocean at the bottom, it is the hope of the authors that you have gained a better understanding of the ecological processes and the interconnectedness of aquatic environments. We all live in a watershed, we all contribute to and can fix the pollution problems that threaten our streams, rivers, lakes, estuaries, and oceans.

Section 3
Water Quality Testing

Purpose

Numerous rivers, streams, and stretches of ocean in the southern California region consistently have poor water quality, which is a concern for the health of humans and the wildlife that frequent these areas. Your mission is to analyze the waters for a variety of parameters, which include some pollutants. In doing so, you may help locate areas that are contributing to the poor water quality.

Water pollution is the chemical and physical alteration of surface waters that were once of good water quality. Good water quality can be defined as waters that support abundant native aquatic plant and animal species in a balanced ecosystem. In areas where people come in contact with the water for recreation, excellent water quality is needed. Channelized streams such as the Los Angeles River, Ballona Creek, and portions of most streams in urban areas cannot support plants and animals.

Agencies like the Regional Board and the EPA are charged with maintaining safe levels of water quality for both humans and wildlife. In many instances, these agencies have set certain water quality thresholds that may not be exceeded. To learn what the water quality thresholds are for your water body consult the Basin Plan. As a member of the Water Quality Team, you will collect the data to determine if these thresholds or safe levels are exceeded. You are the first line of defense. Your tools will be a specially designed water chemistry field kit and a keen sense of observation. The information you collect will be distributed to the appropriate agencies, so that actions can be taken to correct the problem. Good luck!

Why Water Quality Testing is Important

If the overall goal of the monitoring program is to improve water quality, then water testing provides us with the springboard of data from which further action can be taken. Specifically, the objectives are:

- To establish current baseline conditions within the various streams, rivers, estuaries, and stretches of ocean in southern California.
- To locate areas that are not meeting the water quality thresholds established by regulatory agencies.
- To collect data necessary for regulatory agencies to establish more protective water quality thresholds.

Water quality that is good for aquatic life is often good for humans as well. The overall goal of this program is to ultimately improve water quality throughout southern California.

What to Expect When Water Quality testing

Water testing requires some visual observation skills and a lot of patience. It is best if you familiarize yourself with the first half of this section, up to the "Procedures", before you arrive at the monitoring event site. Please read the following sections in the field guide so that you are familiar with the water quality testing issues: "What to Monitor," "When to Monitor," and "How the Data Can Be Used."

The components of these chemical tests are self-contained in the field kit that will be provided. Each test is to be conducted twice. If the second result does not closely coincide with the first result, a third test must be performed. Double-checking results in this way will ensure higher quality data. The equipment that you will be using has been rigorously tested to insure it is easy to use and provides accurate data.

What to Monitor

The parameters you will be monitoring have been selected by the local organization heading up the monitoring effort in your area. Each local group has its own goals and objectives and also has specialized monitoring needs. The parameters listed below are common to most monitoring whether it is in streams, rivers, lakes, estuaries, or the ocean. Detecting the presence of pollutants and their potential sources should lead to actions that improve the water quality throughout the region.

As a Marine and Stream Team volunteer, you will be measuring and testing the following parameters:

Physical Parameters

1. Site Conditions (weather conditions, debris, visual properties of water like color, clarity, and odor)
2. Air Temperature
3. Water Temperature
4. Turbidity/Transparency and Color measurements

Chemical Parameters

5. Dissolved Oxygen
6. pH
7. Conductivity/Salinity
8. Nutrients (Nitrate-Nitrogen, Phosphorous, and Ammonia-Nitrogen)

Biological Parameters

9. Bacteria (Total coliform, E.coli, and Enterococcus)
10. Algae

This list is not exhaustive, some citizen groups may sample other pollutants that are of interest in their area. Other commonly tested pollutants are: detergents, chlorine, herbicides and pesticides, and metals. These chemical parameters may require very expensive equipment to analyze, which is beyond the means of citizen groups. For many of these tests, citizen groups collect the field samples, which are then transported to a state certified laboratory for the analysis. Utilizing citizen groups to collect the field samples provides a substantial cost savings.

For purposes of the program, Site Conditions are visual observations that do not require quantitative measurements, but do require a general agreement on observation conclusions. Items three through seven are either measured chemically or with meters, and require patience and acute attention to detail. Water chemistry teams will collect water samples for items eight and nine, but will not perform the actual tests. Measuring nutrients and bacteria are complicated procedures. To ensure high quality information these measurements will be performed by the Program Coordinator of the group conducting monitoring in your local area. Item ten is quantified byusing a tape measure and calculating the amount and types of algae. Your training and future monitoring events should further reinforce the steps involved. The best results are achieved when these parameters are sampled and tested in this order.

1. Site Conditions

Brief, but careful, observations should be noted on the "Site Conditions" Field Sheets. Included among these are *Weather* conditions, presence of *Debris*, and *Water Properties* like water color, appearance, and odors. Special attention should be paid to trash. Numerous streams in urban areas are considered impaired by trash and will have to be cleaned up. Your observations and measurements can help locate drains that contribute large amounts of trash to receiving waters. Site conditions can be noted at any time during the monitoring event.

2. Air Temperature

Air temperature is an important determinant of water temperature. Take an air temperature measurement at the beginning and end of the monitoring event.

3. Water Temperature

Temperature of the water directly affects biological and chemical processes. Some fish species prefer colder waters than other species. Larval insects in the stream will move to find their optimal temperature. You will take the water temperature twice, once at the beginning of the monitoring event, and once at the end. Water temperatures are taken with the dissolved oxygen meter and with the conductivity/salinity meter.

4. Turbidity/Transparency and Color Measurements

Turbidity and transparency are measures of water clarity. Insoluble solids or suspended particles such as clay, silt, sand, algae, plankton, and other substances affect the clarity of the water. High levels of turbidity affect the ability of steelhead trout and other aquatic organisms to survive. Water temperature is increased because suspended particles absorb more heat. Also, when turbidity is high, photosynthesis is reduced due to the decrease in the amount of light traveling through the water. Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding streambanks, large numbers of bottom feeders that stir up sediments, churning of sediments through wave action, and excessive algal growth. The Freshwater and Marine Team measure turbidity by using a turbidity meter or a Secchi disk. Turbidity meters shine a light through the particles contained within the water column and then calculate how much that light scatters using a unit known as Nephelometric Turbidity Units (NTUs). In southern California, turbidity in reference streams is almost always less than 0.2 NTUs. Secchi disks are 20 centimeter disks that are lowered into the water by a rope until they are no longer visible. The length of rope at the point where the Secchi disk dissapears is the measured transparency of the water. To detect brown and /or red tides a number of monitoring programs measure water color. Citizen monitors look through a specially made viewer and compare the color of the water against a standardized color scale called the Forel-Ule scale.

5. Dissolved Oxygen

Aquatic organisms rely on the presence of oxygen in streams. In water, oxygen is in a dissolved form. Water temperature, altitude, time of day, and season can all affect the amount of dissolved oxygen. Oxygen is both produced and consumed in a stream. Because of constant churning, running water, especially in riffles, dissolves more oxygen than the still water often found in a lake or stream pool (US EPA 841-B-97-003 1997, p.139). The presence of aquatic plants also affects dissolved oxygen concentrations. Green plants release oxygen underwater during photosynthesis. Maximum amounts of DO are produced with the energy of the late afternoon sun. By early morning, the same plants may have taken up the oxygen, making levels of DO lowest at this time. Because DO is lowest in the morning hours, it is one of the first tests you will perform when you arrive at the sampling station. When levels drop to 3-5 mg/l many aquatic organisms become stressed. If levels fall below 3 mg/l (a condition known as **hypoxia)** mobile species tend to migrate elsewhere while the remaining immobile species will probably die. When the water becomes totally depleted of oxygen (below 0.5 mg/l) a second condition known as **anoxia** occurs and results in the death of any organism that requires oxygen for survival (USEPA 842-B-93-004 199, p 9-4). The Basin Plan states that water bodies with cold water fish species must maintain a minimum dissolved oxygen level of 7.0 mg/L and those that have warm water fish species must maintain a minimum DO level of 5.0 mg/L.

6. pH

pH is a measure of how acidic or alkaline the water is at the time of testing. The pH of a waterbody affects the ability of plants and wildlife to function and live. pH is measured on a scale from 1.0 to 14.0. Neutral pH is 7.0 (pure water). Acidic pH is less than 7.0, and alkaline is greater than 7.0. A wide variety of aquatic animals prefer a range of 6.5-8.5 pH. Low pH could be due to acid rain, runoff from acidic soils, or contamination by agricultural chemicals. Rapid changes in pH are stressful to aquatic life. The ability of water to maintain a stable pH as acids or bases are added to it is called buffering capacity. Think of a buffer as a large sponge that can absorb excess acid or base. In natural systems, freshwater has minimal buffering capacity and is more susceptible to rapid fluctuations in pH. As minerals such as sodium, carbonates, and bicarbonates are dissolved in water the buffering capacity is increased. Therefore, saltwater has a higher buffering capacity and a more stable pH than freshwater. For example, when hard water comes out of your shower it leaves a residue on the glass shower door. This is caused by calcium carbonate in the tap water. Cleaners used to remove this residue contain an acid such as lime juice or vinegar. pH increases as plants in the water remove carbon dioxide from the water during photsynthesis. pH is usually highest or most alkaline in the late afternoon, and will decline at night when carbon dioxide in the water increases and is converted to carbonic acid. A pH meter measures the electric potential of water in millivolts or pH units. Many species have trouble surviving if pH levels drop under 5.0 or rise above 9.0 (http://www.epa.gov/owow/estuaries/monitor/chptr11.html#ph).

7. Conductivity/Salinity

Conductivity measures the ability of water to pass an electrical current. The concentration of dissolved solids or the conductivity of water is directly affected by the geology in the area that the stream or river flows through and the substrate or stream bottom material. In general, conductivity is higher in areas with clay soils or limestone geology because these materials tend to easily dissolve in water. In contrast, areas with granite dominated geology usually have lower conductivity because granite does not easily dissolve when washed into streams or rivers. Conductivity indirectly measures the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum (Murdoch, Cheo, and O'Laughin. 1996, p. 181). These minerals and salts enhance the ability of water to conduct electricity. Failing septic tanks, sewage spills, and agricultural runoff are indicated by high conductivity measurements. Conversely, organic substances like oil, alcohol, and grease are poor conductors of electricity and will yield low conductivity measurements. Excessive amounts of dissolved solids leads to poor tasting drinking water with laxative effects (Murdoch, Cheo, and O'Laughin. 1996, p. 181). Temperature plays an important role in water's ability to pass electrical current. The warmer the water, the easier it is to pass electrical current, and the higher the conductivity. The Freshwater and Marine Team uses meters that compensate for temperature and standardize all readings as if they were measured at 25 degrees celsius.

In estuarine (brackish) and marine waters, salinity is measured to determine the amount of total salts in the water. Dissolved salts increase the salinity and conductivity of the water. The most common salt found in the ocean is sodium chloride (NaCl) or common table salt. Salinity of sea water is usually between 33 and 36 parts per thousand (ppt).

8. Nutrients (Nitrate-Nitrogen, Phosphorus, and Ammonia-Nitrogen)
Phosphorus and nitrogen are nutrients occurring naturally in water bodies and are essential for plants and animals in an aquatic ecosystem. These nutrients originate from both naturally occurring sources and from areas of human development. Naturally occurring sources include soils, eroding rocks, and terrestrial animal and plant waste washing into the water ways. Sources of nutrients from human development include wastewater treatment plants; runoff from fertilized agriculture, lawns, and golf courses; runoff from grazing animals; and commercial cleaning activities. Problems occur when large amounts of phosphorous and nitrogen are introduced into the ecosystem. As a result, there can be excessive algal growth depleting the available oxygen that fish and other aquatic organisms depend upon. The Regional Board and EPA are developing nutrient TMDLs for the Los Angeles River Watershed, the Calleguas Creek Watershed, and the Malibu Creek Watershed. Citizen monitoring data are being used to develop all three.

Dissolved phosphorous, or phosphate (PO_4^{2-}), is a useful indicator of potential problems associated with excessive plant growth. Phosphate is a required nutrient for plants. High amounts of phosphates may indicate a pollution source such as chemical fertilizers or leaky septic systems. Phosphorous may come from excessive erosion, animal waste, or sewage (Murdoch, Cheo, and O'Laughin 1996, p.180). The EPA water quality criteria state that phosphates should not exceed 0.025 mg/l within a lake or reservoir, 0.05 mg/l in streams that discharge into lakes or reservoirs, and 0.1 mg/l in streams flowing into the ocean, to control algal growth (USEPA, 1986).

Nitrogen (N_2) is the gas that composes 80% of the air we breath. Most plants can not use nitrogen in this form. Bacteria and other natural processes convert nitrogen into a form that can be used by plants. Plants take in nitrogen as nitrates (NO_3^{-2}), nitrites ($N0_2^-$), and ammonia (NH_3). Nitrates are the most stable form of nitrogen and will usually occur at the highest concentration in your water samples. Two field tests are used to measure the different forms of nitrogen in waterbodies: nitrate-nitrogen (NO_3^{-2} + $N0_2^-$-N) , and ammonia-nitrogen (NH_3-N). Sources of nitrates include wastewater treatment plants, runoff from animal manure storage areas, runoff from fertilized lawns and croplands, failing or improperly maintained septic systems, and industrial discharges containing corrosion inhibitors.Though nitrates are essential plant nutrients, when present in excessive amounts they can cause explosive plant and algal growth. Such an increase in aquatic plant growth affects dissolved oxygen concentrations and water temperature. In water that has low levels of dissolved oxygen, nitrogen will be found in the form of ammonia. Ammonia is extremely toxic to aquatic life. Ammonia

is also a naturally occurring by-product of animal excretions and organic decomposition. In reference streams, nitrate-nitrogen and ammonia-nitrogen concentrations are generally below 0.10 mg/l. Check the Basin Plan for the limits in your waterbody.

9. Bacteria (*Total coliform, Escherichia coli (E.coli) and Enterococcus*)
Bacteria are microscopic single-celled organisms that function as decomposers by breaking down plant and animal remains. This releases nutrients previously locked up in the organic matter. Certain bacteria convert ammonia to nitrite, which is then converted by other bacteria into the nitrate form that can be used by plants. Bacteria can live in surface water, in the sediments at the bottom of a stream, estuary, or ocean, on dead organic material, and in or on the bodies of plants and animals (http://www.epa.gov/owow/estuaries/monitor/chptr17.html).

Human activities often transport disease-causing bacteria or pathogens into the ecosystem. The fecal waste from humans or warm-blooded animals is the largest concern for human health. Sources of fecal bacterial contamination include livestock areas, landfills, faulty septic systems, fecal waste from pets, sewage sludge, sewage discharge that has not been disinfected, leaky sewage pipes, and stormwater runoff. Wildlife also add bacteria to water bodies through feces. Direct testing for pathogens is very expensive and impractical, because pathogens are hard to find in waterbodies. We monitor for Total coliform, *E.coli*, and *Enterococcus* bacteria because their presence indicates the existence of other pathogens that do pose a health risk to humans. Illnesses typically associated with swimming or surfing in water contaminated with these bacteria include stomach flu, ear infection, upper respiratory infection, and skin rash.(http://www.healthebay.org/brc/warningsigns.asp). In addition, tests for these bacteria can be done quickly and cheaply.

Total coliform, which means coliform bacteria of all types, originates from many sources, including soil, plants, animals, and humans. *E.coli* (a type of fecal coliform bacteria) and *Enterococcus* bacteria are found in the fecal matter of mammals and birds. Studies by the Santa Monica Bay Restoration Project (SMBRP) demonstrated that there is a significant possibility of sewage contamination in Santa Monica Bay storm drain runoff at any given time (http://www.healthebay.org/brc/gradingsystem.asp). In 1986, EPA revised its bacteriological ambient water quality criteria recommendations to include *E. coli* and *Enterococcus*, as they are better indicators of the risks of swimmers getting sick than fecal coliforms (http://www.epa.gov/owow/estuaries/monitor/chptr17.html).

The state of California has passed Assembly Bill 411, which requires summer time bacteria testing of every beach that is adjacent to a flowing storm drain and receives in excess of 50,000 visitors per year. In addition, if these tests do not meet the bathing water standards, the beach must be posted as unsafe to swim. You can check the water quality at your favorite beach by visiting Heal the Bay's Beach Report Card™ at www.healthebay.org. The Report Card grades local beaches on an A-F scale based

on daily and weekly water quality monitoring data collected by County and City public agencies throughout the State. Sample locations include most public beaches from Sonoma to San Diego County, specifically targeting popular beaches. Heal the Bay grades over 450 beaches throughout the state of California. Heal the Bay also provides beach water quality data to the Los Angeles Times, which is published every Saturday in the Los Angeles and Orange County editions in the weather section.

The bacteria water quality standards as stated in AB-411 are defined as MPN, or most probable number of bacteria per 100 ml. The standards for a single sample and the 30-day geometric mean are:

AB-411 Standards for single sample

Indicator	Marine Water	Fresh Water
Total coliforms	<10,000 MPN	No standard
Fecal coliforms	< 400 MPN	No standard
Enterococcus	< 104 MPN	< 61 MPN
E.coli	No standard	< 235 MPN
Ratio of Total to Fecal	< 10	

(Ratio is applicable only if Total coliforms are greater than or equal to 1000 MPN per 100 ml of Sample).

AB-411 Standards for 30-day geometric mean

Indicator	Marine Water	Fresh Water
Total coliforms	< 1,000 MPN	No standard
Fecal coliforms	< 200 MPN	No standard
Enterococcus	< 35 MPN	< 33 MPN
E.coli	No standard	< 126 MPN

Shellfish such as mussels, clams, and oysters may contain bacteria that can cause health problems when they are consumed by people. According to the California Ocean Plan 2001: “At all areas where shellfish may be harvested for human consumption, as determined by the Regional Board, the following bacterial objectives shall be maintained throughout the water column: The median Total coliform density shall not exceed 70 MPN per 100 ml of sample, and not more than 10 percent of the samples shall exceed 230 MPN per 100 ml”.

10. Algae, diatoms, and red tides

A certain amount of algae is present in all natural freshwater, brackish water, and marine environments. Increased levels of nutrients that result from polluted discharges of urbanized areas, agricultural lands, animal grazing lands, and wastewater treatment

plants can cause excessive amounts of algae to grow. These algal blooms may result in low dissolved oxygen levels. As algae dies and decomposes, oxygen is consumed. Moreover, at night when photosynthesis stops, algae and other aquatic plants produce carbon dioxide and consume oxygen. When oxygen levels fall below a certain point, fish suffocate. In streams, rivers, lagoons, and estuaries, algae is considered to be a problem or an impairment, when more than 30% of a waterbody is covered in algae. When increased nutrients combine with marine waters and increased temperatures, it creates the perfect environment for red tide algal blooms. Off the California coast, we experience algal blooms of dinoflagellates called red tide (due to the reddish appearance of the water). These red tides not only lower dissolved oxygen levels, they can release strong neurotoxins, such as saxitoxin, that can cause massive fish kills. The Freshwater and Marine Team has two different methods for measuring algae: One is designed for shallow streams, rivers, and estuaries and one is designed for the rocky intertidal zone.

Where to Monitor

The long term goal of the program is to have monitoring locations in each of the watersheds within the Los Angeles, Ventura, and Orange County, regions.

Comparing the results from these sampling sites should help determine the effects of land uses and paved surfaces on water quality, and to what extent a given watershed is contributing to pollution. Based on the results of your work, your local monitoring group and other agencies should be able to determine which watersheds require immediate attention and future action. Because each watershed has its own unique natural features and land uses, the impacts to water quality differ between them. You can choose monitoring locations based on the natural and man-made features of your watershed.

When to Monitor

To accurately sample for trends over time, each monitoring event must take place at the same location, and at the same time of day. This is because concentrations of the substances you'll be testing may vary according to season, time of day, and temperature. Each group should create a schedule of water chemistry testing events, including the dates and times. If for some reason you cannot attend an event(s), call the program coordinator so alternative arrangements can be made.

How The Data Can Be Used

The data you collect will be very useful to local government agencies and organizations such as the Regional Water Quality Control Board, the California Department of Fish

and Game, the Environmental Protection Agency, and other stakeholder agencies working to protect the natural environment. They are very interested in using the data to track trends in water quality. For example, in some of the upper watershed monitoring stations, the data you collect may demonstrate the natural conditions of water quality for that watershed. This information can assist in developing future water quality standards, determining if current water quality standards are being met, and setting appropriateTMDLs, which will ultimately result in clean water.

Water Chemistry Testing Procedures

Safety

General Safety Guidelines (adapted from LaMotte's instruction cards)

- Never put yourself or your teamates at risk to collect a water sample! Your safety is the first priority.
- Wear proper clothing and attire. Your program leader will instruct you on the proper protective clothing to wear when sampling your waterbody. Many waterbodies are highly polluted and will require that you wear protective gloves and boots. Follow your program mangers instructions.
- Store reagents in a secure cool, dry place to prolong shelf life and prevent accidents.
- Read all instructions to familiarize yourself with the test procedure before you begin. Note any precautions in the instructions.
- Read the label on each container prior to use. Some containers include precautionary notices and first aid information.
- Keep all equipment and reagent chemicals out of the reach of young children.
- Properly dispose of chemicals and hazardous waste. If your monitoring program uses chemicals or reagents that produce hazardous waste you will receive a special container to store the waste generated in the field. This hazardous waste will be given to your monitoring program leader when you return from the field. **Never pour chemicals into the water at your sampling site or onto the ground nearby.**

In the event of an accident or suspected poisoning, immediately call the American Association of Poison Control Centers at **800-222-1222** or call your physician. Be prepared to give the name of the reagent in question, and its LaMotte code number. LaMotte reagents are registered with POISINDEX, a computerized poison control information system available to all local poison control centers.

Protect Yourself & Your Equipment (adapted from LaMotte's instruction cards included in the testing kit)

- Avoid contact between reagent chemicals and skin, eyes, nose, and mouth.
- Wear safety goggles or glasses and gloves when handling reagent chemicals.
- Use the test tube caps or stoppers, not your fingers, to cover test tubes during shaking or mixing.
- When dispensing a reagent from a plastic squeeze bottle, hold the bottle vertically upside-down (not at an angle) and gently squeeze it (if a gentle squeeze is not sufficient, the dispensing cap or plug may be clogged).
- Wipe up any reagent chemical spills, liquid or powder, as soon as they occur. Rinse area with wet sponge, then dry.
- Tightly close all reagent containers immediately after use. Do not interchange caps from different containers.
- Thoroughly rinse test tubes before and after each test. Dry your hands and the outside of the tube.

Equipment Care

You will be provided with a Freshwater and Marine Team Field Kit, specially designed for this monitoring program. Each parameter you will be testing for has its corresponding equipment contained within the test kit. Please familiarize yourself with the equipment care guidelines, as well as the safety measures in the following section.

- Tighten the equipment caps immediately after use. Do not interchange caps.
- Avoid prolonged exposure of equipment and reagents to direct sunlight. Protect them from extremely high temperatures, and from freezing.
- Report any reagents that are running low to the monitoring program leader.
- Report any malfunctioning of electronic equipment (error messages, etc.) to the monitoring program leader.

Field Sheets

Please record your data onto the Field Sheets immediately after each procedure. To insure that testing procedures are done properly and the quality of the data collected is good, each procedure will be conducted two or three times, depending on the results. Each result will be recorded, then averaged on the data sheet. Please turn in field notes and field sheets to the designated person at the end of each monitoring session.

How To Conduct Water Chemistry Testings

When you first arrive at the monitoring site **PLEASE TURN ON THE DISSOLVED OXYGEN METER and let it stabilize for 15 minutes before testing the dissolved oxygen!** Refer to the meter used by your program on pgs. 3-12 thru 3-26 to measure dissolved oxygen and water temperature.

1. Site Conditions

Site Conditions are general observations that will be recorded when your team first arrives at the monitoring site. The following general observations should be recorded on the Site Conditions Field Sheet: the color of the water, the weather conditions, the air temperature, the general flow conditions of the water, appearance of the water, the odor of the water, and if there is trash or debris at your monitoring site. These different conditions should provide clues regarding sources of pollutants at the monitoring location.

Field Sheet:

When your team first arrives at the monitoring site please fill out the Site Conditions Field Sheet. Circle the answers that best describe the conditions at your monitoring site. A sample of the Site Conditions Field Sheet is provided at the end of section 3-3, Water Chemistry Testing.

2. Air Temperature

Air Temperature is taken twice at each sampling station and recorded on the Site Conditions Field Sheet.

Pull from the test kit the following item that you will need:

1. Armored thermometer (Figure 3-1).

Air Temperature Sampling Procedure

1. Hang the thermometer in the shade on tree limb or other object by its lanyard. (Thermometer must be elevated and out of direct sunlight).

2. Record the air temperature twice, once at the beginning of the testing period, and once at the end. **(Wait 5 minutes after the thermometer is hung to take your first reading)**

3. Record both readings and the time they were taken on the Site Conditions Field Sheet.

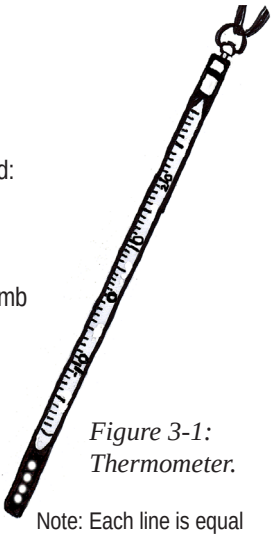


Figure 3-1: Thermometer.

Note: Each line is equal to 1 degree Celsius.

4. Turbidity LaMotte 2020 Turbidimeter

Pull from the test kit the following items that you will need:

1 2020 Turbidimeter
2 Turbidity tubes (Kit contains 6).

Turbidity Testing Procedure is adapted from the LaMotte 2020 Turbidimeter Instruction Manual.

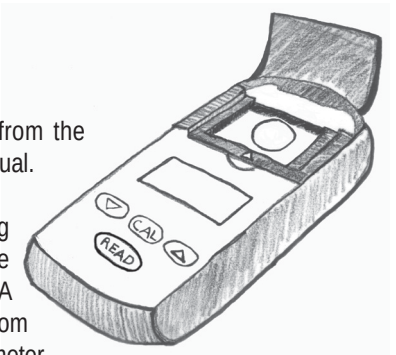


Figure 3-2: LaMotte 2020 Turbidity meter

Note: the turbidity meter has two operating modes, the standard operation mode and the EPA mode. We will be operating in the EPA mode. The meter can only be switched from one mode to the other while turning the meter on, from the **OFF** state. The meter will remain in which ever mode it was last used in, even if it has been turned off.

Switching to the EPA mode (In EPA mode, a triangle is displayed on the LCD).

1. When the meter is first turned on make sure that a small black triangle is displayed in the lower left corner of the LCD. If the triangle is not visible proceed to step 2 below to switch to the EPA mode.
2. Turn off the meter.
3. Simultaneously press the **CAL** and **READ** buttons to turn the meter on.

Each time this procedure is done the meter will switch between modes.

Turbidity Testing Procedure

1. Thoroughly rinse the container and cap of the two turbidity tubes 3 times with the water you intend to measure. If you are in a wadeable stream, river, or estuary submerge both turbidity tubes and caps directly in the waterbody. If you are sampling from deep water collect your sample using one of the methods described in the Sample Collection section on pgs. 3-43-48.

2. Face upstream or against the current and wait until any sediments that were disturbed by entering the water float past you. With the turbidity tubes submerged remove the cap. Fill the tubes until they stop bubbling and replace the caps with the tubes still submerged.

3. Make sure that both tubes are filled only to the neck (there should be a small air bubble when tubes are inverted).

4. If the turbidity tubes are filled above the neck, carefully remove the excess by pouring a little bit of the sample into the cap until the tube is full only to the neck. This will insure that you don't pour out too much sample.

5. Wipe the turbidity tube clean and dry with the lint-free tissue provided in your field kit.

6. Carefully invert the first tube (tube A) twice just before inserting the tube into the meter. Align the indexing arrow on the tube with the indexing arrow on the meter (Figure 3-3).

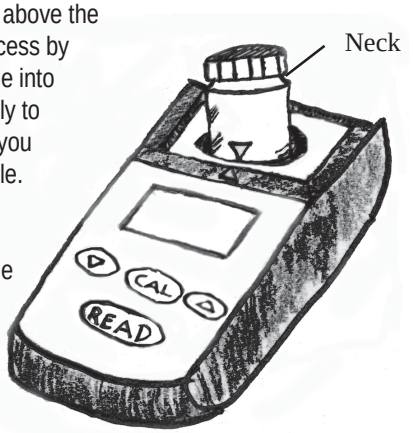


Figure 3-3: Turbidity meter with proper alignment of indexing arrows.

7. Close the lid. Push the **READ** button. The turbidity in NTU units will be displayed within 5 seconds.

8. Record the first result for ***Bottle A*** on the field sheet. Take two additional measurements on ***Bottle A*** by repeating steps 5-8. ***Bottle A*** should have three results.

9. Repeat steps 5-8 using the second bottle ***(Bottle B)*** .

Note: The Turbidimeter is an extremely sensitve instrument. Minor misalignment of the indexing arrows, finger prints, and lint on the turbidity tube can dramatically change the results. **Readings below 1.0 NTU must not vary by more than 0.10 between readings on a single bottle or between *bottle A and bottle B* or by more than 10% if the sample is 1.0 NTU or greater.** If these criteria are exceeded collect and test new water samples by repeating steps 1-9

10. The meter will turn off automatically one minute after the last button pushing. To turn the meter **OFF** manually, hold the **READ** button down for at least 2 seconds. Release the button when **OFF** is displayed.

Note: If the sample is higher than 1100 NTU, it must be diluted and retested.

4. Transparency Secchi Disk

The Secchi Disk is a white (salt water) or half black and half white (fresh water) 20 centimeter (cm) diameter plastic disk. The Secchi disk is used to determine the clarity or visibility of waterbodies. A measured line is attached with tick marks at every 10 cm and thicker tick marks to denote every meter. We recommend taking measurements in the early morning or late afternoon, when the sun is at a lower angle in the sky and there is less glare on the water.

Note: Always take Secchi disk measurments on the side of the boat, pier, or dock that is sheltered from the wind and sun.

Secchi Disk Testing Procedure

1. Lower the Secchi Disk into the water until it just disappears.

2. Record the depth at the point where the Secchi disk dissapears by counting the tick marks on the measured line. Each small tick mark is 10 cm and the large tick marks are meters (Figure 3-4).

3. Slowly raise the Secchi disk until it just reappears.

4. Record the depth where the Secchi disk just reappears using the measured line.

5. Average the two depth readings (depth in step 2+ depth on step 4, then divide by two).

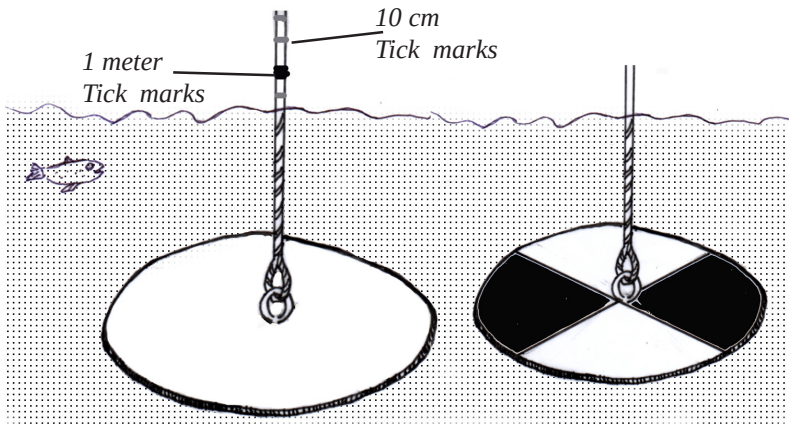


Figure 3-4: Secchi disks (White: salt water, Black and white: fresh water).

6. Record the result as Transparency on your field sheet (Figure 3-5).

The deeper the Secchi disk can be lowered into the water and is still visible, the clearer or less turbid the water.

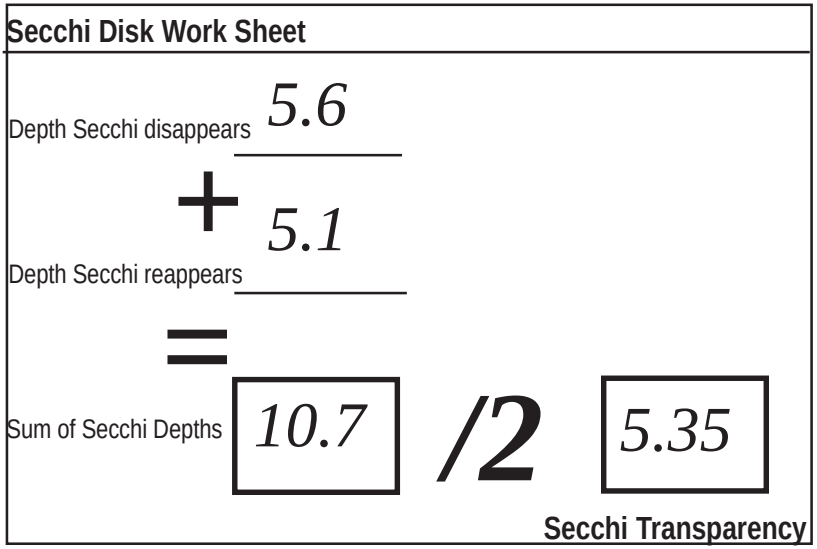


Figure 3-5: Secchi disk Work Sheet

4. Measuring Color using the Forel-Ule Color Comparator Kit

The Forel-Ule Scale uses specially developed color standards to provide a relative measure of color in waterbodies. Freshwater and Marine Team volunteers will visually compare the color in the waterbody to the Forel-Ule color scale by looking through the color comparator viewing windows. Each color is identified by a roman numeral. The blue-to-green of the Low Range Comparator are used for off-shore ocean waters. The green-to-brown colors of the High Range Comparator are used for coastal and inland waters.The Forel-Ule Color Test is done in conjunction with the Secchi Disk.

Pull from the test kit the following items that you will need:

QTY	CONTENTS	CODE
1	Forel-Ule Comparator, Low Range	5908
1	Forel-Ule Comparator, High Range	5909
4	Distilled Water Ampoules. (5 ml each)	2748

Measuring Water Color Using the Forel- Color Comparator Kit

1. Insert distilled water ampoules (2748) into the viewing windows of the appropriate comparator. Use the Low Range comparator (5908) for off-shore ocean waters and the High Range comparator (5909) for near coastal and inland waters.

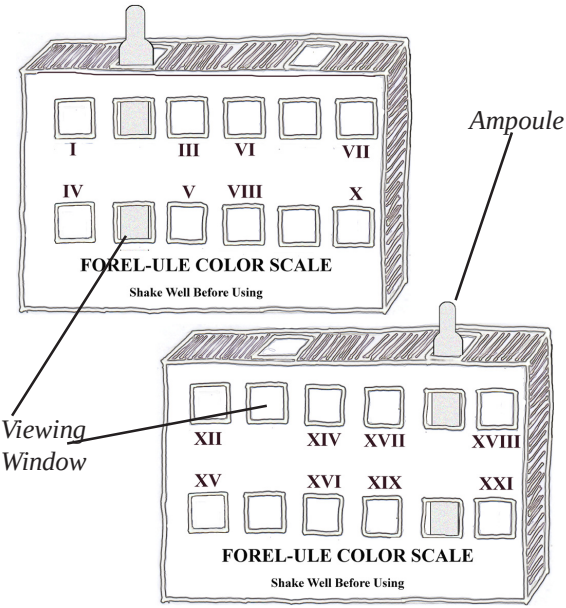


Figure 3-6: Forel-Ule Test

2. Lower the Secchi disk into the water until just before it disappears.

3. Hold the comparator at arm's length and view the submerged Secchi disk through the comparator viewing windows with the inserted ampoules.

4. Using the submerged Secchi disk as the background, find the color standard that is closest to the color of the water by looking through the viewing window.

5. Note the roman numeral value in front of the Forel-Ule color that most closely matches the water color when looking through the view window.

6. Record the Forel-Ule value on your field sheet.

3 & 5. Water Temperature & Dissolved Oxygen LaMotte D.O.4000

Oxygen is measured in its dissolved form as either milligrams per liter (mg/l), or percent saturation. You will be using the LaMotte 4000 dissolved oxygen meter (DO Meter) to take both DO measurements and water temperature(Figure 3-7).

The first part of testing for dissolved oxygen is calibrating the meter. The calibration must be done every time you use the meter. **The D.O. meter must be turned on and left to stabilize for 15 minutes prior to calibration.**

1. Turn the DO meter on by depressing the percent saturation button adjacent to the slope knob on the face of the meter.The liquid crystal display (LCD) should come on. Allow meter to stabilize for 15 minutes.

2. After the probe has stabilized for 15 minutes depress the unmarked black polarization button located on top of the meter so that the button extends in a position slightly raised from the surface of the meter. This unmarked black button is immediately adjacent to the location of the probe's connection to the meter (Figure 3-7).

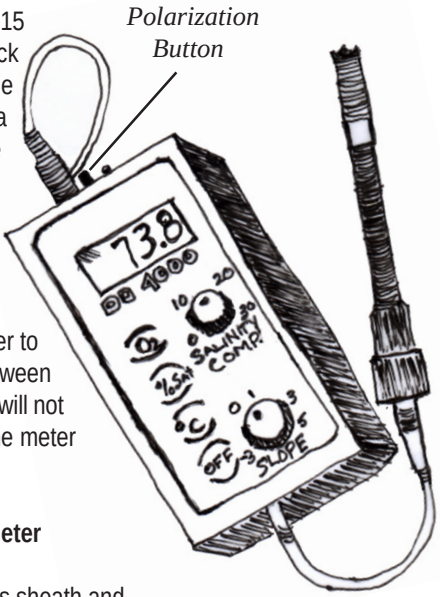


Figure 3-7 D.O. 4000

The polarization feature allows the user to turn the meter off when traveling between sampling sites. At the second site you will not have to wait another 15 minutes for the meter to stabilize before calibrating.

Calibrating the dissolved oxygen meter

1. Remove the probe from its sheath and shake it dry; the probe must be completely dry to properly calibrate the meter.
2. Use a sample bottle or beaker to retrieve and reserve a sample of water to calibrate the probe with. **DO NOT SUBMERGE THE PROBE IN THE CONTAINER OF WATER.**
3. Turn the salinity and slope knobs to zero (Figure 3-7).
4. Hold the probe approximately 2-3 inches above the container of water. The meter must be calibrated while dry, and in a humid environment.
5. If necessary, turn the slope knob until the meter display reads 100.

***The meter is ready to use when the display reads 100 percent saturation with the probe held above the water sample at the site to be measured.** Repeat this procedure each time you visit a new site.

Measuring Dissolved Oxygen Using theLaMotte 4000 DO Meter

1. Set the "Salinity Comp" knob to the salinity of the sample water. (If sampling fresh water salinity is assumed to be zero). If you are sampling a lagoon or the ocean use a salinity measurement that was taken separately (see Conductivity/Salinity section on pgs. 3-37-42). Press the " % SAT" button to turn the meter on (Figure 3-7)**.**

2. Lower the probe in the water halfway between the surface and the bottom of the water you are sampling (at least 3.5 inches below the surface water). **Be careful not to let the probe hit the bottom**.

3. Swirl the probe tip in the water until the display stabilizes. In deep water raise and lower the probe until the display stabilizes.

4. Record the dissolved oxygen reading in the % sat column on the Chemical Parameters Field Sheet.

5. Press the " O_2" button to switch the meter into the mg/l mode.

6. Repeat steps 2-4 in the mg/l mode.

7. With the probe still in the water press the " C" button to switch the meter into the temperature mode.

8. Swirl the probe tip in the water until the temperature on the display stabilizes. In deep water raise and lower the probe until the display stabilizes.

9. Record the temperature reading and the time that the temperature was measured on the Chemical Paramters Field Sheet.

10. Move to a slightly different location at your site for your second measurement and repeat steps 2-9 above.

11. Press the "OFF" button to turn the meter off.

12. Rinse the probe with the distilled water provided in the field kit.

After you have completed the last dissolved oxygen measurement at the last monitoring site DEPRESS the "POLARIZATION" button).

3. & 5. Water Temperature & Dissolved Oxygen YSI Model 55 DO Meter
(Make sure the DO meter has been on for 15 minutes)

Calibrating the YSI 55 DO Meter. (The meter must be calibrated at every site).

1. Turn the DO meter on by pressing and releasing the **ON/OFF** button. The liquid crystal display (LCD) should come on. Make sure the probe is in the calibration chamber and allow the meter to stabilize for 15 minutes before step 2.

2. Press and release the mode button until the display reads in % (Figure 3-8).

3. With the probe in the calibration chamber simultaneously press and release the two arrow keys (Figure 3-8).

4. The LCD will prompt you to enter the altitude in hundreds of feet for your monitoring station. The altitude for each monitoring station will be given to you.

5. Use the arrow keys to enter the altitude of the monitoring station. The up arrow will increase the altitude and vice versa. Entering 12 indicates 1200 feet.

6. When you are satisfied that the number on the DO meter's LCD is the correct altitude of the monitoring station, hit the **ENTER** button.

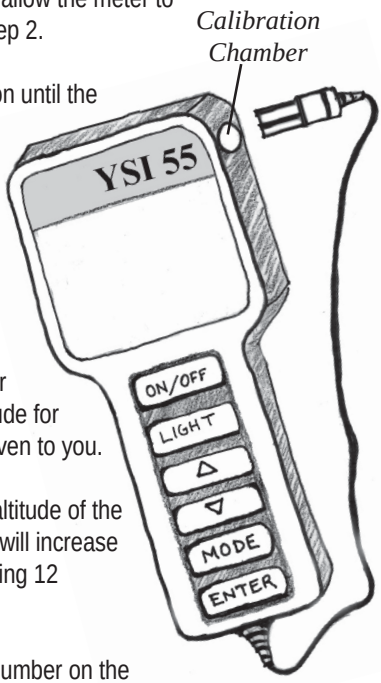


Figure 3-8: YSI 55 D.O.Meter

7. Wait for the main display to stabilize and hit the **ENTER** button again.

8. The LCD will prompt you to enter the approximate salinity of the water you will be sampling. Fresh water is assumed to be zero. If you are sampling a lagoon or the ocean use a salinity measurement that was taken separately (see Conductivity/Salinity section on pgs. 3-37-42). Use the arrow keys to enter the salinity at your sampling location. When the LCD shows the correct salinity hit the **ENTER** key.

9. Repeat this process each time you sample a new monitoring site.

Measuring Dissolved Oxygen Using the YSI 55 DO Meter

1. Remove the probe from the calibration chamber (Figure 3-8).

2. Lower the probe in the water halfway between the surface and the bottom of the water you are sampling (at least 3.5 inches below the surface water). **Do not to let the probe hit the bottom** (Figure 3-9).

3. Slowly move the probe tip through the water at a rate of one foot per second. This can be accomplished by gently bobbing the probe tip up and down in deep water or moving it back and forth through the water.

Again, be careful not to let the probe hit the bottom of the stream, this may cause damage to the meter.

4. Wait for the reading on the meter stabilize then record the temperature and dissolved oxygen measurement in the % saturation column on the Chemical Parameters Field Sheet. **Do not stop moving the probe tip through the water.**

5. Press the **MODE** button to switch the meter into the **mg/l** mode.

6. Wait for the reading on the meter stabilize then record the temperature and dissolved oxygen measurement in the mg/l column on the field sheet.

7. Move to a slightly different location at your site for your second measurement and repeat steps 1-6, and record the results on the field sheet.

8. If this is your last sampling site turn the meter off by pressing and releasing the **ON/OFF** button otherwise leave the meter on.

Note: Rinse the probe with the distilled water provided in the Field Kit and replace the probe in the calibration chamber.

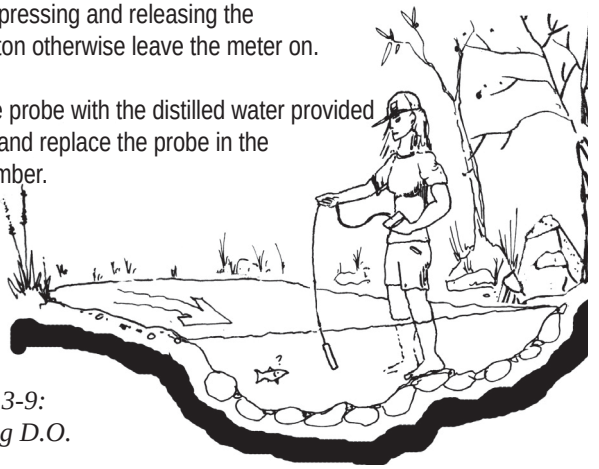


Figure 3-9: Measuring D.O.

3 & 5. Water Temperature & Dissolved Oxygen YSI Model 550 DO Meter
(Make sure the DO meter has been on for 15minutes)

Calibrating theYSI 550 DO Meter (The meter must be calibrated at every site).

1. Turn the DO meter on by pressing and releasing the **ON/OFF** button. The liquid crystal display (LCD) should come on. Make sure the probe is in the calibration chamber and allow the meter to stabilize for 15 minutes before step 2.

2. Press and release the mode button (Figure 3-10) until the display reads in %.

3. With the probe in the calibration chamber simultaneously press and release the two arrow keys.

4. The LCD will prompt you to enter the altitude in hundreds of feet for your monitoring station. The altitude for each monitoring station will be given to you.

5. Use the arrow keys to enter the altitude of the monitoring station. The up arrow will increase the altitude and vice versa. Entering 12 indicates 1200 feet.

6. When you are satisfied that the number on the DO meter's LCD is the correct altitude of the monitoring station, hit the **ENTER** button.

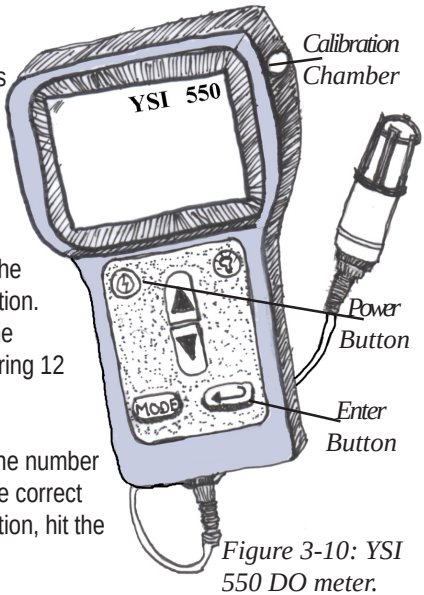


Figure 3-10: YSI 550 DO meter.

7. Wait for the main display to stabilize and hit the **ENTER** button again.

8. The LCD will prompt you to enter the approximate salinity of the water you will be sampling. Fresh water is assumed to be zero. If you are sampling a lagoon or the ocean use a salinity measurement that was taken separately (see Conductivity/Salinity section on pgs. 3-37-42). Use the arrow keys to enter the salinity at your sampling location. When the LCD is correct hit the **ENTER** key.

9. Repeat this process each time you sample a new monitoring site.

Measuring Dissolved Oxygen Using the YSI 550 DO Meter

1. Remove the probe from the calibration chamber.

2. Lower the probe in the water halfway between the surface and the bottom of the water you are sampling (at least 3.5 inches below the surface water). **Do not to let the probe hit the bottom** (Figure 3-11).

3. Slowly move the probe tip through the water at a rate of one foot per second. This can be accomplished by gently bobbing the probe tip up and down in deep water or moving it back and forth through the water.

Again, be careful not to let the probe hit the bottom of the stream, this may cause damage to the meter.

4. Wait for the reading on the meter stabilize then record the temperature and dissolved oxygen measurement in the % saturation column on the Chemical Parameters Field Sheet. **Do not stop moving the probe tip through the water.**

5. Press the **MODE** button to switch the meter into the **mg/l** mode.

6. Wait for the reading on the meter stabilize then record the temperature and dissolved oxygen measurement in the mg/l column on the field sheet.

7. Move to a slightly different location at your site for your second measurement and repeat steps 1-6, and record the results on the field sheet.

8. If this is your last sampling site turn the meter off by pressing and releasing the **ON/OFF** button otherwise leave the meter on.

Note: Rinse the probe with the distilled water provided in the Field Kit and replace the probe in the calibration chamber.

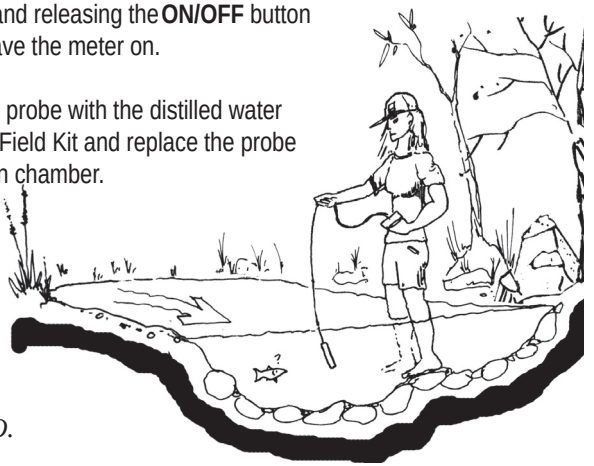


Figure 3-11: Measuring D.O.

3.& 5.Water Temperature & Dissolved Oxygen YSI Model 85 DO Meter
(Make sure meter is on for 15minutes)

Calibrating the YSI 85 DO Meter (The meter must be calibrated at every site).

1. Turn the DO meter on by pressing and releasing the **ON/OFF** button. The liquid crystal display (LCD) should come on. Make sure the probe is in the calibration chamber and allow the meter to stabilize for 15 minutes before step 2.

2. Press and release the mode button (Figure 3-12) until the display reads in %.

3. With the probe in the calibration chamber simultaneously press and release the two arrow keys.

4. The LCD will prompt you to enter the altitude in hundreds of feet for your monitoring station. The altitude for each monitoring station will be given to you.

5. Use the arrow keys to enter the altitude of the monitoring station. The up arrow will increase the altitude and vice versa. Entering 12 indicates 1200 feet.

6. When you are satisfied that the number on the DO meter's LCD is the correct altitude of the monitoring station, hit the **ENTER** button.

7. Wait for the main display to stabilize and hit the **ENTER** button again.

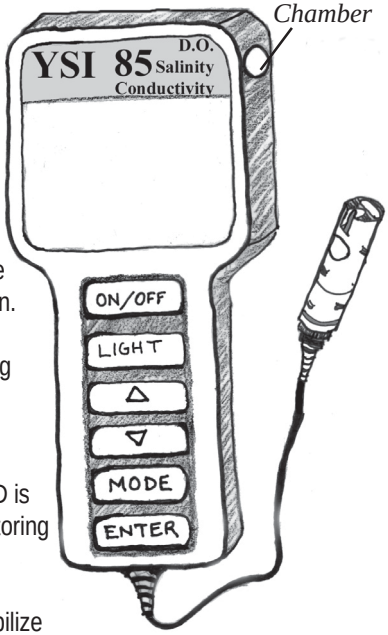


Figure 3-12: YSI 85 D.O.,Conductivity, Salinity

8. The LCD will prompt you to enter the approximate salinity of the water you will be sampling. Fresh water is assumed to be zero. If you are sampling a lagoon or the ocean use a salinity measurement that was taken separately (see Conductivity/ Salinity section on pgs 3-37-42). Use the arrow keys to enter the salinity at your sampling location. When the LCD is correct hit the **ENTER** key.

9. Repeat this process each time you sample a new monitoring site.

Measuring Dissolved Oxygen Using the YSI 85 D O & Conductivity Meter

1. Press and release the mode button (Figure 3-12) until the display reads in mg/l.

2. Remove the probe from the calibration chamber.

3. Lower the probe in the water halfway between the surface and the bottom of the water you are sampling (at least 3.5 inches below the surface water). **Do not to let the probe hit the bottom** (Figure 3-13).

4. Slowly move the probe tip through the water at a rate of one foot per second. This can be accomplished by gently bobbing the probe tip up and down in deep water or moving it back and forth through the water.

Again, be careful not to let the probe hit the bottom of the stream, this may cause damage to the meter.

5. Wait for the reading on the meter stabilize then record the temperature and dissolved oxygen measurement in the mg/l column on the Chemical Parameters Field Sheet.

6. Move to a slightly different location for your second measurement and repeat steps 1-4, and record the results on the field sheet.

7. If this is your last sampling site turn themeter off by pressing and releasing the **ON/OFF** button otherwise leave the meter on.

Note: Rinse the probe with the distilled water provided in the Field Kit and replace the probe in the calibration chamber.

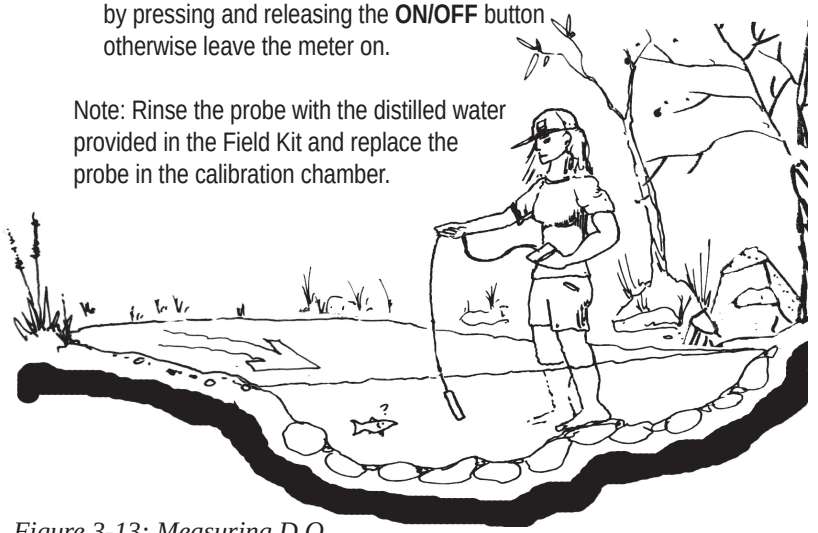


Figure 3-13: Measuring D.O.

5. Measuring Dissolved Oxygen using the Winkler Method

The method you will be using, the Winkler method, involves filling a sample bottle with water. Dissolved oxygen is then "fixed" using a series of reagents that form an acid compound that is titrated. Titration is the drop-by-drop addition of a reagent that neutralizes the acid compound and causes a change in the color of the solution.

Pull from the test kit the following items that you will need:

QTY	CONTENTS	CODE
30 mL	*Manganous Sulfate Solution	*4167-G
30 mL	*Alkaline Potassium Iodide Azide	*7166-G
30 mL	*Sulfuric Acid, 1:1	*6141WT-G
60 mL	*Sodium Thiosulfate, 0.025N	*4169-H
30 mL	Starch Indicator Solution	4170WT-G
1	Direct Reading Titrator, 0 – 10	0377
1	Titration Tube, 20 mL, w/cap	0299
1	Bottle, Water Sampling, 60 mL, glass	0688-DO

*WARNING: Reagents marked with an * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read the label and accompanying MSDS before using.

Collecting Samples

Sample collection varies depending on the type of water body that you will be measuring. For example, you may be able to wade into a shallow stream, river, or estuary to collect a water sample. However, in deep rivers, lakes and the ocean wading is not an option. You will be instructed by the monitoring leader on proper sample collection for the specific conditions of your waterbody. Please see the section on *Collecting Water Samples* on pgs. 3-43-48.

1. To avoid contamination, thoroughly rinse the Water Sampling Bottle (0688-DO) with sample water **three times**.
2. Tightly cap the bottle and submerge to the desired depth. Remove the cap and allow the bottle to fill.
3. Tap the sides of the submerged bottle to dislodge any air bubbles clinging to the inside. Replace cap while the bottle is still submerged.

Retrieve the bottle and examine it carefully to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately to "fix" the sample.

Fixing the Water Sample for Winkler Dissolved Oxygen Test

The water sample must be "fixed," which is a procedure that ensures it will not be affected by exposure to air. If an unfixed sample is exposed to air, the results may be skewed.

Note: Be careful not to introduce air into the sample while adding the reagents. Simply drop the reagents into sample. Cap carefully, and mix gently.

1. Add 8 drops of *Manganous Sulfate Solution (4167) and 8 drops of *Alkaline Potassium Iodide Azide (7166). Cap and mix by inverting several times. A precipitate (dark or light flakes) will form. Allow the precipitate to settle below the shoulder of the bottle before proceeding (Figure 3-14).

2. Add 8 drops of *Sulfuric Acid, 1:1 (6141WT).

3. Cap and gently invert the bottle until the reagent and the precipitate have dissolved. A clear yellow to brown-orange color will develop, depending on the oxygen content of the sample.

Figure 3-14: Settling Precipitate.

Testing For Dissolved Oxygen Using the Winkler Method

To measure the dissolved oxygen of water, this test kit uses the azide modification of the Winkler Method and employs a LaMotte Direct Reading Titrator in the final titration.

Note: You need the fixed sample to be faint yellow in color, if it is already faint yellow you do not need to complete Steps 2 and 3. If the fixed sample is dark yellow or brown you must follow the procedures in step three until the sample changes to a faint yellow color.

1. Fill the titration tube (0299) to the 20 mL line with the "fixed" sample and cap.

2. Fill the Direct Reading Titrator (syringe 0377) with *Sodium Thiosulfate, 0.025N (4169). Insert the titrator into the center hole of the titration tube cap (Figure 3-10). While gently swirling the tube, slowly press the plunger to titrate until the yellow-brown color is reduced to a very faint yellow. *See following section on How to Use and Fill Titrator pg 3-29 and 3-30).*

3. Remove the titrator and cap, placing them to the side. Be very careful not to disturb the titrator. *This is only pertinent if you had to complete step 2*.

4. Add 8 drops of Starch Indicator Solution (4170WT). The sample should turn blue.

5. Replace the cap and reinsert the titrator (syringe Figure 3-15), again be very careful not to disturb the titrator. With the tip of the titrator inserted into the opening of the titrator tube cap, slowly depress the plunger to dispense the Sodium Thiosulfate titrating solution (4169) one drop at a time. Gently swirl the tube to mix the solution.

6. Continue adding the Sodium Thiosulfate titrating solution (4169) one drop at a time until the color changes from blue to clear. If the plunger tip on the syringe reaches the bottom line on the titrator scale (10 ppm) before the endpoint color change occurs, refill the titrator and continue the titration. When recording the test result, be sure to include the value of the original amount of reagent dispensed (10 ppm).

7. Read the test result directly from the scale opposite the bottom of the plunger tip (Figure 3-16a).

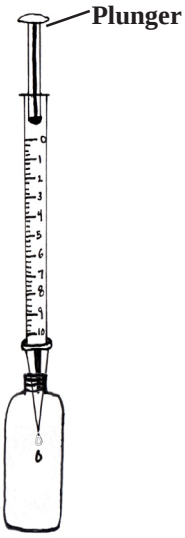


Figure 3-15: Insert Titrator.

Figure 3-16a: Reading the Titrator.

Note: Each minor division on the titrator scale equals 0.2 ppm.

8. If no additional tests are to be made, discard the titrating solution in the waste container provided in the field kit. Thoroughly rinse the Titrator (syringe) and the titration tube with distilled water and discard that water into the same waste container.

How to Use and Fill the Titrator

1. Depress the plunger of the titrator to expel air.

2. Insert the titrator (syringe) into the plastic fitting of the Sodium Thiosulfate titrating solution bottle (4169) (Figure 3-15).

3. To fill the titrator invert the bottle and slowly withdraw the plunger until the bottom of the plastic part of the plunger is opposite the zero mark on the scale of the titrator (Figure 3-16).

4. Note: A small air bubble may appear in the titrator barrel. Expel the bubble by partially filling the barrel and pumping the titrating solution back into the inverted reagent container. Repeat this pumping action until the bubble disappears.

5. Turn the bottle right side up and remove the titrator.

Figure 3-16: Filling the Titrator.

Chemicals used in the Winkler Titration Method are hazardous! Citizen monitors should wear gloves when performing this test. In addition, citizen monitors should be trained to properly dispose of hazardous wastes. Citizen monitors must be supplied with a secure container for the hazardous waste created during this test. All waste must be poured into this safe container and returned to the citizen monitoring program leader for safe and proper disposal.

*** Heal the Bay's testing of the Winkler Titration method has shown that reagents frequently go bad and yield inaccurate results. We strongly recommend that the citizen monitoring leader of any program using Winkler Titration standardize the Sodium Thiosulfate Solution 0.025 N (4169) just prior to being used in the field and the Sodium Thiosulfate Solution should be standardized again immediately when the field kit is returned to the citizen monitoring program leader.**

6. pH Testing

Pull from the test kit the following items that you will need:

1 pH Testr 2 meter (Figure 3-17)

pH Testing Procedure

1. Turn the Testr 2 on by pressing the **ON/OFF** button and remove the cap.

2. Collect a water sample or place the meter directly into the water at the sampling site (see Collecting Water Samples pgs. 3-43-48).

3. Dip 1/2 to 1 inch of the electrode into the Field Sample Bottle that contains the water sample, or measure pH directly from the waterbody. Make sure that you stir the meter so that samples are well mixed. Let the reading stabilize.

   Note: It may take up to two minutes for the meter to stabilize.

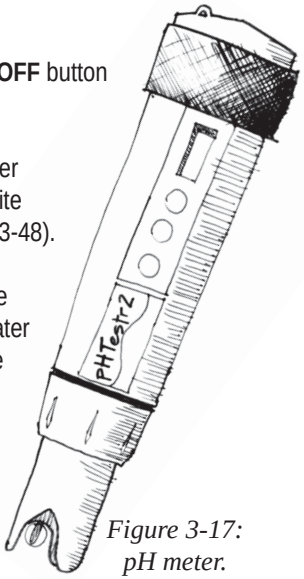


Figure 3-17: pH meter.

4. Note the pH measurement displayed on the meter and record it on the field sheet.

5. Pour the sample back into the water body, and take a new sample with the same container, or slightly vary the location of measurements if taken directly from the waterbody.

6. Repeat steps 1-5 and record your second measurement.

7. Turn off the meter by pressing the **ON/OFF** button.

8. Rinse the electrode with distilled or tap water and and shake off the excess water .

9. Replace the cap.

Note: Keep a small piece of sponge moistened with clean tap water (not distilled) in the cap to keep the electrode from drying out.

3. & 7. Water Temperature & Conductivity Cole Parmer Con 400 Meter (This meter can be used in fresh or salt water).

Pull from the test kit the following items that you will need:

1 Cole-Parmer Waterproof Conductivity Meter (Figure 3-18).
1 Conductivity probe

Conductivity Testing Procedure Cole Parmer Con 400 Waterproof Meter

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" section on pgs. 3-43-48 or take measurements directly in the water body.

Note: Temperature results are only recorded from measurements taken directly in the waterbody.

3. Press and release the **ON/OFF** button to turn the meter on (Figure 3-18).

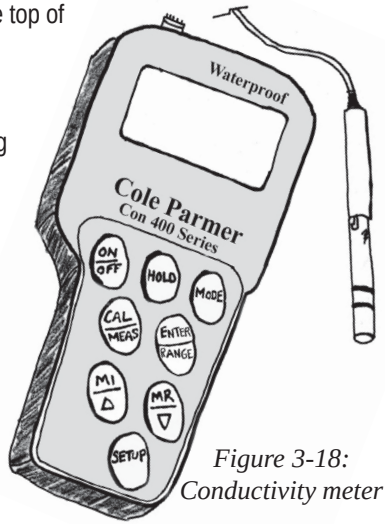


Figure 3-18: Conductivity meter

4. Hit the **ENTER/RANGE** button slowly and deliberately three times (Figure 3-18). 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**.

4. 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 (Figure 3-18). If the meter says **OR (Over Range)** hit the **ENTER/RANGE** button again. The LCD will then display in **mS**.

5. 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.**

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 3-6 on pg 3-33 and 3-34. If the results are still below 300 uS record the result and make your monitoring program leader aware of this measurement.

6. Record results under the appropriate column (uS/cm or mS/cm) on the Chemical Parameters Field Sheet under conductivity. Record water temperature results and the time in the third and fourth columns under Conductivity.

7. 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.

8. Repeat steps 2-6.

9. Press and release the **ON/OFF** button when finished to turn the meter off. Always rinse the probe and electrode with distilled water and shake dry. Disconnect the probe from the meter.

3. & 7.Water Temperature & Conductivity LaMotte Con 5 Meter (This meter is not recommended for use in salt water).

Pull from the test kit the following items that you will need:

1 Con 5 Conductivity Meter (Figure 3-19).
1 Conductivity probe

Conductivity & Water Temperature Testing Procedures LaMotte Con 5 Meter

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"section on pgs. 3-43-48 or take measurements directly in the waterbody.

Note: At your first monitoring site, place the Con 5 meter's probe in sample water and allow the probe to soak for at least 10 minutes.

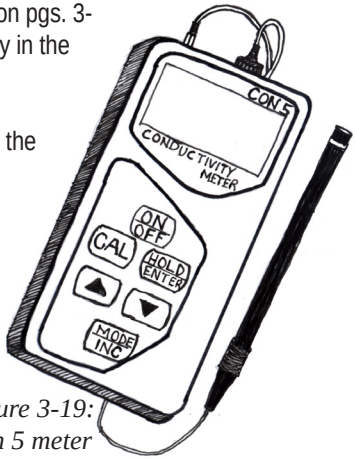


Figure 3-19: Con 5 meter

3. Press and release the **ON/OFF** button to turn the meter on (Figure 3-19).

4. Dip the probe into the sample container making sure that the tip of the probe is completely submerged in the water sample or waterbody.

5. Use the probe to stir the sample and allow time for the meter to correct the readings for temperature changes. Read the result once the display is stable.

6. Record the conductivity result under the appropriate column (uS/cm or mS/cm) on the Chemical Parameters Field Sheet.

7. With the probe in the waterbody press and release the **MODE/INC** button to select " ^{0}**C** " temperature function.

8. Let the display stabilize and read the result.

9. Record water temperature results and the time in the third and fourth columns in the conductivity section of the Chemical Parameters Field Sheet.

Note: Temperature results are only recorded from measurements taken directly in the waterbody.

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 2-9.

12. When finished, press and release the **ON/OFF** button to turn the meter off. Always rinse the probe and electrode with distilled water and shake dry. Disconnect the probe from the meter.

3. & 7. Water Temperature, Conductivity, & Salinity YSI Model 30 Meter (This meter can be used in fresh or salt water).

The YSI Model 30 conductivity/salinity and temperature meter is ideal for marine water and brackish water sampling.

Pull from the test kit the following items that you will need:

1 YSI Model 30 Conductivity, Salinity, & Temeperature Meter (Figure 3-20).

Conductivity and Water Temperature Testing Procedure YSI Model 30

1. Press and release the **ON/OFF** button to turn the meter on (Figure 3-20).

2. Take a water sample using the same procedure as in "Collecting Water Samples"section on pgs. 3-43-48 or take measurements directly in the waterbody.

Note: Temperature results are only recorded from measurements taken directly in the waterbody.

3. Dip the probe into the sample container making sure that the large oval opening on the probe is completely submerged in the water sample or waterbody (Figure 3-20).

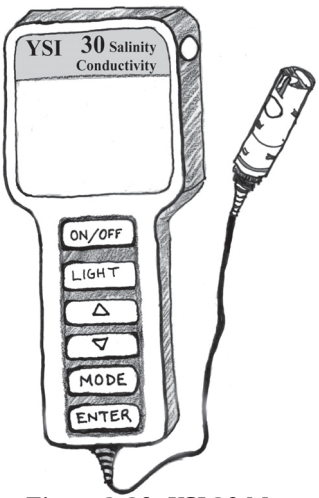


Figure 3-20: YSI 30 Meter

4. With the probe in the sample or waterbody press and release the **MODE** button slowly and deliberately until the LCD display shows the ***"uS** or **mS"*** symbol next to the main display and the flashing "**^{0} C** " symbol in the lower right hand corner of the LCD (Figure 3-21).

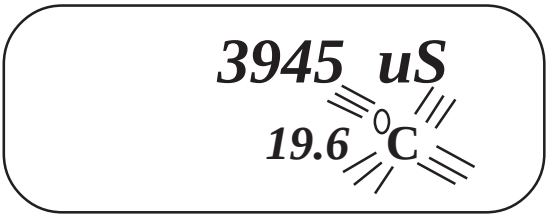


Figure 3-21:LCD Display YSI 30

5. Use the probe to stir the sample and allow time for the meter to correct the readings for temperature changes. Read the result once the display is stable.

6. Record the conductivity result and the water temperature under the appropriate column (uS/cm or mS/cm) on the Chemical Parameters Field Sheet.

Salinity and Water Temperature Testing Procedure YSI Model 30

7. With the probe in the sample or waterbody press and release the **MODE** button slowly and deliberately until the LCD display shows the ***"ppt"*** (parts per thousand) symbol next to the main display (Figure 3-22).

Figure 3-22: LCD Display YSI 30

8. When the display stabilizes record the salinity and the water temperature results in the appropriate column (ppt) on the Chemical Parameters Field Sheet.

9. Press and release the **ON/OFF** button when finished to turn the meter off. Always rinse the probe and electrode with distilled water and shake dry.

*** BE CAREFUL! The YSI 30 meter has two different conductivity modes. Pay special attention to whether or not the " ^{0} C " symbol is flashing. Flashing "^{0}C " means that the conductivity measurement is temperature corrected. The Freshwater and Marine team only measures temperature corrected conductivity. Salinity measurements are done for brackish and marine water unless specifically required by the monitoring program leader.**

3. & 7. Water Temperature, Conductivity, & Salinity YSI Model 85 Meter (This meter can be used in fresh or salt water).

The YSI Model 85 dissolved oxygen, conductivit, salinity and water temperature meter is ideal for marine and brackish water sampling.

Pull from the test kit the following items that you will need:

1 YSI Model 85 DO, Conductivity, Salinity, & Temperature Meter (Figure 3-23).

Conductivity and Water Temperature Testing Procedure YSI Model 85

1. Press and release the **ON/OFF** button to turn the meter on (Figure 3-23).

2. Take a water sample using the same procedure as in "Collecting Water Samples" section on pgs.3-43-48 or take measurements directly in the waterbody.

Note: Temperature results are only recorded from measurements taken directly in the waterbody.

3. Dip the probe into the sample container be sure that the large oval opening on the probe is completely submerged in the water sample or waterbody (Figure 3-23).

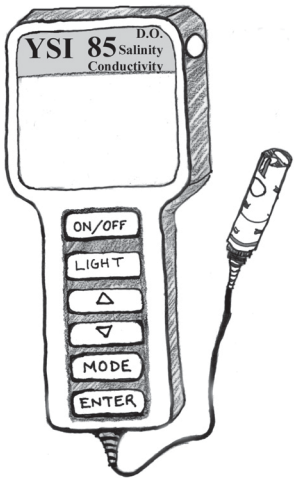


Figure 3-23: YSI 85 Meter

4. With the probe in the sample or waterbody press and release the **MODE** button slowly and deliberately until the LCD display shows the ***"uS** or **mS"*** symbol next t o the main display and the flashing " **°C** " symbol in the lower right hand corner of the LCD (Figure 3-24).

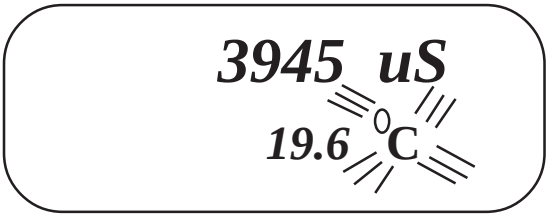


Figure 3-24: LCD Display YSI 85

5. Use the probe to stir the sample and allow time for the meter to correct the readings for temperature changes. Read the result once the display is stable.

6. Record the conductivity result and the water temperature under the appropriate column (uS/cm or mS/cm) on the Chemical Parameters Field Sheet.

Salinity and Water Temperature Testing Procedure YSI Model 85

7. With the probe in the sample or waterbody press and release the **MODE** button slowly and deliberately until the LCD display shows the ***"ppt"*** (parts per thousand) symbol next to the main display (Figure 3-25).

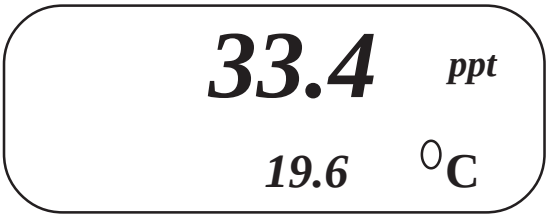


Figure 3-25: LCD Display YSI 85

8. Record the salinity result and the water temperature under the appropriate column (ppt) on the Chemical Parameters Field Sheet.

9. Press and release the **ON/OFF** button when finished to turn the meter off. Always rinse the probe and electrode with distilled water and shake dry.

*** BE CAREFUL! The YSI 85 meter has two different conductivity modes. Pay special attention to whether or not the "°C " symbol is flashing. Flashing "°C " means that the conductivity measurement is temperature corrected. The Freshwater and Marine team only measures temperature corrected conductivity. Salinity measurements are done for brackish and marine water unless specifically required by the monitoring program leader.**

7. Salinity Salt Refractometer Automatic Temperature Compensation (This meter can be used in fresh or salt water).

The portable refractometer is a precision optical instrument used to measure the salt concentration of liquids. The refractometer provides salinity measurements in parts per thousand (ppt).

Pull from the test kit the following items that you will need:

1 Salt Refractometerr (Figure 3-26).

Calibrating the Salt Refractometer

1. Aim the angled end of the refractometer (the prism) toward a light source and rotate the eye piece until the boundary line between the light and dark halves is clearly in focus.

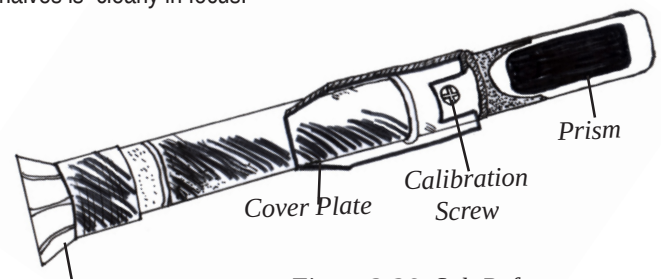


Figure 3-26: Salt Refractometer

2. Open the cover plate and clean the prism with the cloth provided in your field kit..

3. Apply a few drops of distilled water on prism. Distilled water is provided in your field kit.

4. Close the cover plate.

5. Remove the rubber cap from the calibration screw.

6. While looking through the eye piece, rotate the calibration screw so the dark and light boundary line (like the focus of a camera) lines up exactly with the "**0**" line on the ppt scale (Figure 3-27 pg.3-42).

7. Use the cloth provided to carefully dry the prism.

Salinity Measuring Procedure using the Salt Refractometer

1. Apply a few drops of sample water on prism.

2. Close the cover plate.

3. Aim the angled end of the refractometer toward a light source and rotate the eye piece until the boundary line between the light and dark halves is clearly in focus (Figure 3-27).

4. The number adjacent to the boundary line between the light and dark halves on the right side of the scale is the salinity of the water in parts per thousand (ppt) (Figure 3-27).

5. Clean the prism with the cloth provided in the field kit.

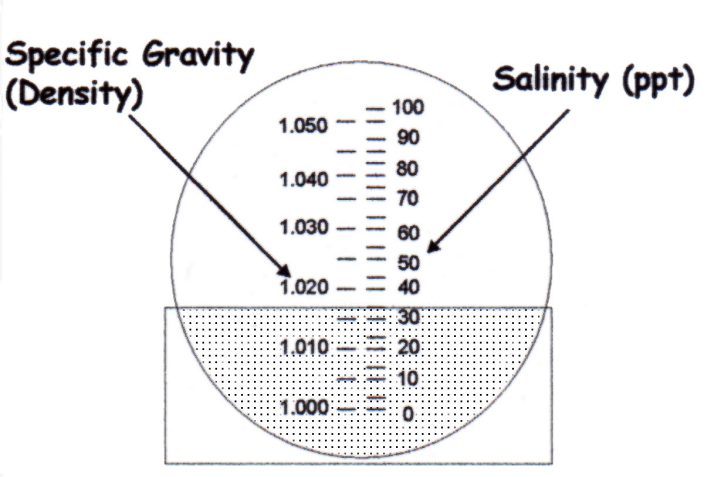


Figure 3-27: Reading the salt refractometer scale

8. Nutrients

The Freshwater and Marine Team collects water samples and transports them to a laboratory for nutrient and bacteria testing. These tests require expensive equipment, strong chemicals, and incubation at specific temperatures and can not be done in the field. Instructions for properly collecting and transporting water samples are provide in the "Collecting Water Samples" section. Nutrients are measured using an instrument called a colorimeter. Special chemicals called reagents are added to the water samples collected in the field to measure nitrate-nitrogen, ammonia-nitrogen, and phosphate. These reagents cause the sample water to change color. The higher the concentration of the nutrient being measured the darker the color change. The amount that the color changes is measured by the colorimeter.

***Note: Freshwater samples of ammonia-nitrogen must be preserved with sulfuric acid to prevent decay of the sample during transport.**

9. Bacteria

Bacteria are measured using the IDEXX system. Special reagents to measure coliforms, *E.coli,* and *Enterococcus* are added to 100 ml (milliliter) water samples. The water samples with the reagents are then placed in a special tray with pre-measured compartments or wells. The trays are then placed in an incubator at a specific temperature to grow any bacteria that might be in the water sample. After the incubation process, the number of wells that have grown bacteria are counted. This provides us with the amount of bacteria in the sample. The result of the bacteria tests are reported as the Most Probable Number (MPN) of bacteria per 100 ml of sample. **Bacteria samples must be transported to the lab and analyzed with in six hours of the time they were first collected.**

Collecting Water Samples

One of the critical skills needed to conduct water quality testing is the ability to properly collect samples. Your monitoring program leader will provide specific instructions on proper sample collection. **All water samples should be collected and transported to the lab in strict accordance with these instructions.**The Freshwater and Marine Team is composed of various groups that collect water samples in different environments. Some monitoring programs work in shallow streams, rivers, and estuaries, and other programs work in deep rivers, lakes, estuaries, and the ocean. The Collecting Water Samples section is divided into two components: sampling wadeable (shallow) streams, rivers, and estuaries and deep water sampling from boats, piers, and bridges. Please select the section that is appropriate for your monitoring group.

Collecting Water Samples General Information

Often, the Freshwater and Marine Team will be asked to collect additional samples

for other groups or agencies so that they can run additional tests. Citizen monitoring groups have limited laboratory space and do not have the facilities or equipment to conduct certain tests. This partnership between public agencies and citizen monitoring groups benefits both parties. Public agencies save a great deal of money by having field samples collected for free. Citizen groups benefit from the public agencies ability to run additional tests that that are often too costly for the citizen group.

Figure 3-28: Bacteria Sample Containers

The Freshwater and Marine Team collects three types of samples: **Bacteria samples** are collected in sterile containers. The critical issue is that these containers have been specially cleaned so that they contain no bacteria that might contaminate our water samples. *** When collecting bacteria samples, never rinse the sample container.** The Freshwater and Marine Team collects bacteria samples in a 120 ml sterile bottle or a sterile sample bag known as a Whirl-Pak (Figure 3-28). **Preserved Samples** are water samples that require some type of chemical additive (usually acid) to prevent the water samples from undergoing unwanted chemical reactions. **Never place preserved sample containers into a waterbody. Always use the specially designated "filling container" to fill sample bottles containing preservative.**

Standard samples are used to collect any measurements on site such as turbidity, pH, and conductivity. In addition, nitrates, phosphates, pesticides, and toxicity water samples are all collected in this manner. Standard samples are rinsed in the waterbody or with the sample water three times before being filled. This insures that any contaminants that may have been in the sample container are removed prior to taking an actual water sample.

Collecting Water Samples in wadeable (shallow) water

The best place to collect samples from shallow streams and rivers is in the center, away from the banks. Collect water in an area that is fast flowing but does not have turbulence or white water and is at least 6-8" deep. Do not collect water in stagnant water or in rapids, for the results may not represent the average concentration of the parameter being measured.

Figure 3-29: Collecting stream samples

1. Slowly wade to the center of your shallow stream or river, being careful not to kick up sediments, and face upstream (Figure 3-29).

Note: If your group collects beach samples from the ocean or in shallow estuaries, slowly wade out to the sample location, being careful not to disturb the sediments, and face into the current.

2. Allow sufficient time for any sediments to settle out or drift past you before collecting your sample.

Collecting Bacteria samples (using 120 mL sterile bottles):

Note: Do not touch the inside of a sterile bottle or Whirl-pak.

1. Pull the 120 mL sterile bottle labeled with the appropriate site # from the ice chest and remove the plastic seal from the outside of the bottle.

2. Facing into the current submerge the 120 mL sample container. With the bottle submerged remove the cap until the container stops bubbling and replace the cap with the container still submerged.

3. Place the bottle upright into the ice chest. Be sure the sample is thoroughly surrounded with ice.

Figure 3-30
Filling Whirl-Paks

4. Record the site name, the sample bottle numbers, the time the samples were collected, and the time the samples were put into the ice chest on your field sheet.

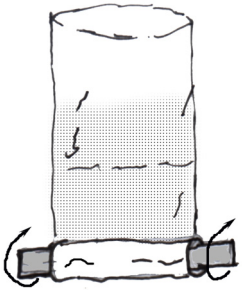


Figure 3-31
Sealing Whirl-Paks

Collecting Bacteria samples (using the Whirl-Pak):

1. Pull the Whirl-Pak labeled with the appropriate site # from the ice chest. If your Whirl-Pak is not labeled, label the Whirl-Pak with the site number, date and the time the samples were collected.

2. Remove the perforation seal from the top of the Whirl-Pak (Figure 3-28).

3. Submerge the Whirl-Pak. With the Whirl-Pak submerged pull out on the side tabs to open the bag until it fills with water (Figure 3-30). With the Whirl-Pak underwater, close the bag and remove the sample.

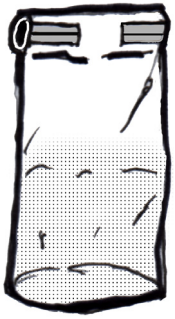


Figure 3-32
Closing Whirl-Paks

4. Hold the Whirl-Pak from the ends, and flip the bag away from your body two to three times to ensure a water tight seal (Figure 3-31).

5. Secure the closure by snugly twisting the metal ties together and folding the metal-reinforced ends around the Whirl-Pak (Figure 3-32).

6. Hold the Whirl-Pak upside down and carefully check for leaks and/or punctures. Repeat the above steps until the sample is water tight.

7. Place the Whirl-Pak in the ice chest and gently surround the Whirl-Pak with ice, being careful not to puncture it.

8. Record the information labeled on the Whirl-Pak and the time the samples were put on ice on your field sheet.

Collecting Preserved and Standard Water samples: ***(****Always use a designated filling container to fill a sample bottle containing preservative and labeled "****preserved"****).* Please follow the instructions below for any sample labeled preserved.

1. Pull the **Designated filling container** labeled with the appropriate site # from your field kit. Each container will have a site number labeled on the side; use only the container with the appropriate site numbers.

2. Acclimate the large filling container marked for your site by filling and rinsing it out with water from your waterbody three times. Don't forget the cap.

3. Submerge the large container with the cap on below the surface of the water.

4. With the container submerged remove the cap until the container stops bubbling and replace the cap with the container still submerged.

5. Use the designated filling container to carefully fill **all** the smaller sample bottles labeled **"preserved"** with the appropriate site #. **DO NOT ALLOW PRESERVED SAMPLE CONTAINERS TO OVERFLOW**.

6. Place the samples in the cooler **standing straight up surrounded and supported by the ice.**

7. Record the number of each sample written on the sample bottle, the time the samples were collected, and the time the samples were put on ice on the Field Sheet.

If your group does not use preserved sample containers you will collect a a **Standard Sample** by following steps 2-4 and 6-7 above using the designated sampling bottles for your sampling site.

Collecting Water Samples in Deep Water

The Freshwater and Marine Team have monitoring locations where the water is too deep to safely enter the waterbody. Some groups collect ocean samples from boats or off piers, and other groups collect samples in deep lakes and rivers, which requires a special sampling device called a Niskin sampler (Figure 3-32). 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. Figure 3-33 shows a vertical Niskin Sampler, which is used for lakes, estuaries, and the ocean. In deep streams and rivers a horizontal version of the Niskin sampler is used to capture flow coming downstream.

1. Pull the **Niskin Sampler** from the field kit (Figure 3-33)**.**
2. Ready the Niskin Sampler by folding the top closure down and the bottom closure up.
3. Connect the lanyards attached to the top and bottom closures to the "Mounting block" (see steps 4-6).
4. Press down on the plunger to open the "Release Pins" (Figure 3-34).
5. Place the "Top Lanyard Loop" under the left "Release Pin" (Figure 3-34). Once the top lanyard loop is securely around the release pin let go of the plunger. The release pin should close and lock the top closure in the open position.

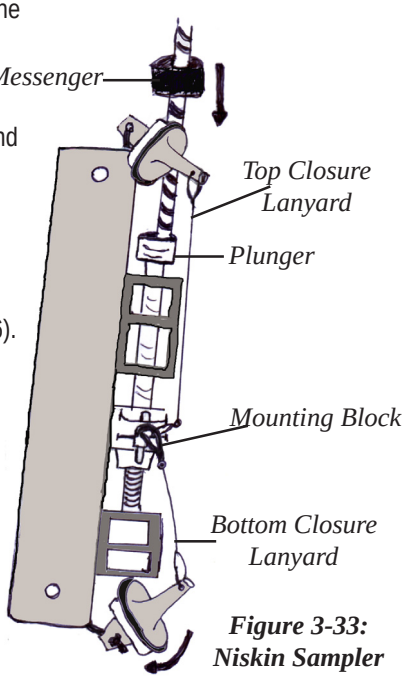


Figure 3-33: Niskin Sampler

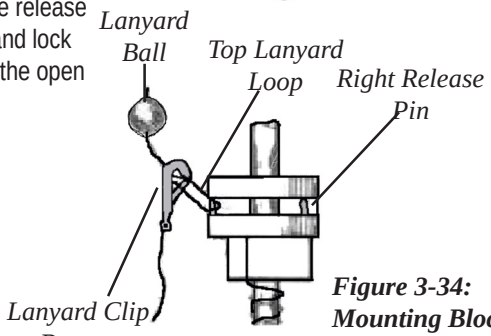


Figure 3-34: Mounting Block.

6. Attach the “Bottom Lanyard Clip” onto the top closure lanyard above the top lanyard loop and below the “Lanyard Ball” (Figure 3-34). This should lock the bottom closure into the open position (Figure 3-33).

7. Lower the open Niskin sampler into the waterbody to the depth that you wish to collect your sample. Your monitoring program leader will specify the sampling depth. If you do not receive explicit instructions, lower the Niskin sampler to a depth of one meter.

8. Acclimate the Niskin sampler by holding it stationary at the sampling depth for at least one minute.

9. Release the messenger (weight) that is attached to the lowering rope. When the messenger hits the plunger it will trigger the release pins and allow the top and bottom lanyards to escape. This will close the Niskin sampler at the desired sampling depth.

10. Slowly retrieve the sampler by pulling up on the rope. **The Niskin sampler can then be used to fill “ Bacteria Samples”, “preserved Samples”, and “Standard Samples”.** Follow the instructions for Collecting Bacteria Samples or Collecting Preserved and Standard Samples on pgs. 3-45-46.

Stream Flow

Adapted from *Streamkeeper's Field Guide* (Murdoch, Cheo, and O'Laughin 1996, p. 108)

Stream flow is measured by calculating the volume of water that passes a particular point in a stream within a specified amount of time. To calculate flow you must know two things: how much water a section of stream holds (volume), and how fast that water is moving (velocity). Stream flow can be determined by measuring the velocity of water and the cross sectional area of the stream. The formula to use when calculating stream flow is:

stream flow = velocity x **cross sectional area**

To measure velocity, a float (orange peel) will be used to determine how fast the water is flowing. To calculate the cross sectional area of the stream, a stadia rod (vertical measuring stick) will be used to measure water depth at 1-foot intervals across the width of the stream (Figure 3-35).

Procedures for determining stream flow:

1. Pick a 20-foot long section of the stream that is straight and of uniform width. Water should be flowing evenly within this section without turbulence, obstacles or other disturbances. This section of the stream should be shallow enough for you to safely wade across and conduct the stream flow test. *In narrow headwater streams it may be necessary to choose a 10- foot long stream section.*

2. Securely hammer in two stakes directly across from each other on the wetted edge of each stream bank. The wetted edge is where the land and water meet. Stretch the string line across the stream and securely attach it to the two stakes. The string line should be stretched across the stream at a 90 degree angle. (Figure 3-35).

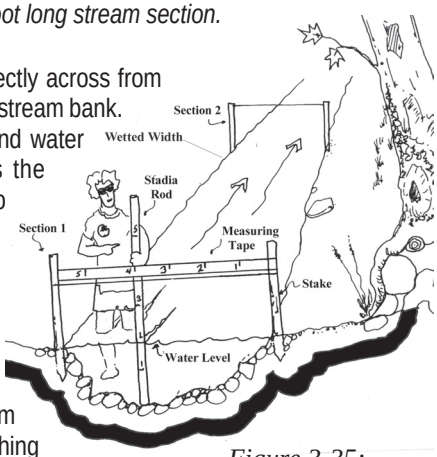


Figure 3-35: Wetted Width

3. Have a teammate hold the loose end of the tape measure against the stake on the left stream bank. Walk downstream along the left stream bank while stretching out the tape measure until it reads 20-feet. Hammer in another stake.

4. Repeat step 2 on the right stream bank and attach the string line on the downstream stakes. You should have 2 sets of stakes and string lines stretched across the stream, 20 feet apart (Figure 3-35).

5. Using the string line as your guide, measure the wetted stream channel across the upstream set of stakes. Hold the tape measure as close to the surface of the stream as possible and make sure the tape is stretched tightly (Figure 3-36). *The wetted channel is the width of the stream where the water just touches the land.* Record this information at the top of the Stream Flow Field Sheet (Figure 3-37 on pg. 3-53).

6. Attach the loose end of the tape measure to one of the stakes using the spring clamp provided in the field kit. Have one of your teammates stretch and attach the tape measure to the stake on the opposite streambank with the second spring clamp. The tape measure should be placed directly beside the string line and stretched tightly.

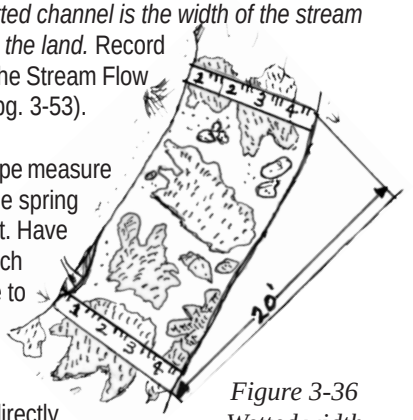


Figure 3-36
Wetted width

This will be the starting line for the stream flow velocity trials.

7. Have one person take the stadia rod to measure the depth of the water at 1-foot intervals across the stream, use the tape measure to establish these points. Continue to measure at 1-foot intervals until you reach the edge of the water on the opposite side of the stream bank. Call out the depth measurements at every 1-foot interval so it can be recorded on the Stream Flow Field Sheet. The upstream string line is Cross section and wetted width # 1.

Reading the Stadia Rod

Hold the stadia rod plumb (straight up and down) and on the stream bottom. You are taking measurements at every foot along the horizontal tape measure that is stretched across the stream. The team is measuring at the four foot mark on the tape measure in (Figure 3-35). The stadia rod touches the top of the stream water at the 2.75 inch mark (Figure 3-36). Record 2.75 inches on the Stream Flow Field Sheet in the box directly beside the # 4 box.

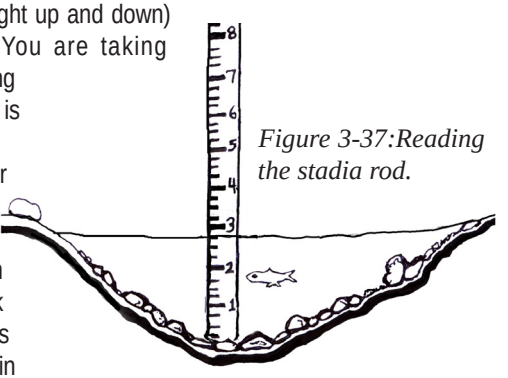


Figure 3-37:Reading the stadia rod.

Note: Each line on the stadia rod is equal to .25 inches.

7. Repeat steps 4-6 at the second set of stakes located 20- feet downstream.

This is the finish line for your stream flow velocity trials. Do not remove the string line until after velocity trials.

8. Add up the columns for cross section 1 and 2 and place your result in the boxes labeled “Sum of section1 and 2” on the Stream Flow Field Sheet. In the example on page 3-53 the “Sum of section 1 and 2 “ are 69 and 110.

9. If your stadia rod is in feet and inches divide the sum of each section by 12 to convert to decimal feet. 69/12= 5.75 and 110/12=9.1667

10. Add the converted Sum of each cross section and divide by 2 to calculate the “Average Cross Sectional Area.” In the example 5.75 + 9.1667=14.9167. 14.9167/2= 7.45835

Now you are ready for the velocity float trial part of the stream flow test.

1. Peel the orange provided in your Field Kit into pieces the size of a quarter. It is suggested that you peel at least 10 quarter size pieces.

Note: Be sure to eat the delicious orange that was lovingly selected by your monitoring program leader. Please share the orange with your team.

2. Record the distance between the start line and the finish line on the Stream Flow Velocity Trials Field Sheet (Figure 3-39 on pg. 3-54). This distance should be 20 feet.

3. One team member stands in the stream at the starting line with an orange peel. Another team member stands downstream at the finish line waiting to retrieve the orange peel as it crosses the finish line. A third team member is standing on the bank next to the start line with a stopwatch and clipboard.

4. The team member at the starting line drops an orange peel and as it passes the starting line, the person on the bank starts the stopwatch. The person with the stop watch walks ahead to the finish line and stops the watch as the orange peel passes it. The orange peel is retrieved, and the time is recorded on the Stream Flow Field Sheet.

5. Repeat this test five times moving from left to right across the entire stream channel. The first velocity trial should be along the slow moving left edge of the stream. The last velocity trial shouldbe along the slow moving right edge of the stream. It is critical that we calculate velocity on

the slower stream edges and the fast moving middle. Doing this will give you a more representative depiction of stream flow.

6. Add up the times for each of the velocity float trials and divide by the number of trials (5) to get an “Average Velocity” (Figure 3-39 pg. 3-54). Record the results on the Stream Flow Field Sheet.

7. Use the Stream Flow Field Sheet to calculate surface velocity (Figure 3-38). Divide “distance” (20- feet) by “Average Velocity” to get “Average Surface Velocity” in feet per second. Next, multiply this result by the velocity correction factor of 0.8 to get “Average Corrected Velocity”. The velocity correction factor has been added to adjust for the fact that water velocity at the surface is faster than water velocity closer to the bottom of a stream.

8. Finally, calculate stream flow by multiplying “Average Corrected Velocity” by “Average Cross Sectional Area”. Your result will be in CFS (cubic feet per second). Record this number on the Stream Flow Field Sheet (Figure 3-39).

Cross Sectional Area:

Record depths at 1-foot intervals. Depth in inches = D

wetted width 6' 9"

Cross Section 1 Upstream

#	D	#	D
1	6.25	11	
2	11.75	12	
3	18.50	13	
4	15.00	14	
5	11.50	15	
6	6.00	16	
7		17	
8		18	
9		19	
10		20	

sum of section 1= 69

wetted width 8' 4"

Cross Section 2 Downstream

#	D	#	D
1	8.75	11	
2	14.50	12	
3	19.25	13	
4	20.50	14	
5	16.00	15	
6	12.50	16	
7	10.25	17	
8	8.25	18	
9		19	
10		20	

sum of section 2= 110

Convert inches to decimal feet

section 1: (69)/12 = 5.75 ft²

section 2: (110)/12 = 9.1667 ft²

Average Cross Sectional Area = (sum 1)+(sum 2) /2

$$\frac{(5.75) + (9.1667)}{2} = 7.45835 \text{ ft}^2$$

Average Surface Velocity = 20 / 50.2 = .39841 X (0.8) = .318725 ft/sec

distance/ avg. time | feet/sec. | Avg. Corrected Velocity

Stream Flow = .318725 ft./sec. X 7.45835 ft² = 2.38 CFS

avg. corrected velocity | avg. cross sectional area | (cubic ft/second)

Figure 3-38: Stream Flow Field Sheet

STREAM TEAM
MALIBU CREEK • HEAL THE BAY

Malibu Creek Watershed Stream Team

Chemical Testing
Stream Flow

Use this form to calculate stream flow. Velocity and cross sectional area of the stream need to be determined. The result will be stream flow in CFS (cubic feet per second). The information you gather will be helpful in understanding the relationship between stream flow, sedimentation, dissolved oxygen, and concentration of pollutants.

Date: 07/04/2000 **Stream Name:** LAS VIRGENES SITE5
Time: 10:30 AM **Recorder:** Aquaticus

Velocity Float Trials:

Record time in seconds 1 minute 11.5 seconds = 71.5 seconds

Trial #	Time
1	49.7
2	62.3
3	48.0
4	41.0
5	50.0
Total	251.00

Distance
20 Ft.

251 / 5 = 50.2

total time / # of trials — average time

Figure 3-39: Stream Flow Velocity Float Trials Field Sheet

Flow Observations in Marine and Estuarine Environments

In estuaries and beaches, or areas where it is not feasible to enter the water, we can make visual observations that describe the flow and current. Wind conditions, surf height, sea state conditions, and tidal flows are useful to describe flow.

Measuring Current Direction

Current is determined by watching what direction a floating object moves in relation to the beach. Use the following instructions to measure the direction of the current at your monitoring site.

1. Peel the orange provided in your Field Kit into pieces the size of a quarter. It is suggested that you peel at least 3 quarter size pieces.

2. Stand on the beach or shoreline facing the waterbody. Draw a line in the sand or dirt to mark your starting position.

3. Throw each of the three orange peels into the water, waiting fifteen seconds in between each peel.

4. Stand on the start line that was drawn on the shoreline. Watch the orange peels to determine which direction they are moving. Wait at least two minutes to determine the direction of the current by observing the orange peels.

5. If possible, find and retrieve the orange peels.

6. Record the direction of the current on your field sheet by circling the correct direction. Choices are : upcoast (North), Downcoast (South), or None if the orange peel does not appear to move in either direction.

Estimating Surf Height

Surf 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 the surf height at your monitoring site.

1. Stand on the beach or shoreline facing the waterbody.

2. 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.

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. The monitoring leader will train you to identify the different "Sea State" conditions.

Determining Tidal Conditions
It is critical to know what the tidal conditions are at the time you are sampling. Use the Tide Chart provided in your field kit to determine the tidal conditions. Tide charts show the two high tides and two low tides that occur every 24 hours.

Reading the Tide Chart
Tide charts show the time and height of low and high tides for a given area. Imagine you are collecting your sample at 8:56 am on Saturday August 2nd. Using the tide chart below, find the high or low tide that most closely approximates 8:56 am. In this example, the high tide occurred at 2:54 am and low tide will occur at 9:08 am. The tide is moving from high to low. The result would be recorded on the field sheet as low tide because it is within 15 minutes of the posted time. Choose the answer on the field sheet that best describes the tide at the time you are sampling. High tides on August 2nd would occur between 2:39-3:09 am and 3:12-3:42 pm. Low tides would occur between 8:53-9:23 am and 9:21-9:51 pm. Ebb tides occur when the tide is changing from high to low. For example, from 3:09 am - 9:23 am would be an ebb tide. Flood tides occur when the tide is going from low to high, for example, from 9:21 pm-2:39 am.

Date		High				Low			
August		hgt (ft)	AM	hgt (ft.)	PM	hgt (ft.)	AM	hgt (ft.)	PM
Friday	1	2:08	10.3	2:42	9.5	8:31	-.5	8:47	.3
Sat	**2**	**2:54**	**10.2**	**3:27**	**9.7**	**9:08**	**-.4**	**9:36**	**.1**

Figure 3-40: Tide Chart

1. Look up the date and time of the sampling on the tide chart.

2. 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 3-41). Freshwater And Marine Team volunteers will use the Beaufort Scale to quantify the wind strength at their marine and estuary sampling locations.

Number	Description	Wind Speed (MPH)	Sea Surface
0	Calm	0	Like a mirror, smoke rises vertically
1	Light Air	1-3	Ripples, smoke drifts slightly
2	Light Breeze	4-7	Small wavelets, not breaking, leaves on trees rustle, wind felt on face
3	Gentle Breeze	8-12	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 3-41: Beaufort Scale for Wind Conditions

Measuring Wind Conditions (Beaufort Scale)

Select the Beaufort Scale Number that best represents the wind conditions at your site.

1. Look up the Beaufort Scale on pg. 3-57 in the Freshwater and Marine Team Field Guide.

2. 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.

3. Record the appropriate Beaufort scale “Number” on the field sheet.

Freshwater Algae Protocol

1. Find an area at your monitoring site that is a long glide (slow, steady flowing, relatively shallow area) or a combination of glide and riffle (fast flowing shallow area with some turbulence).

2. Make sure the area you select is represents what algal coverage is like throughout the entire stream reach. *Do not select areas that have unusually high or low amounts of algae when compared to the rest of the stream reach.*

3. Choose the starting location where you will begin your algae measurement and hammer one of the stakes contained in the field kit into the ground at the wetted edge (where the land and water meet) This is Transect 1.

4. Extend the stadia rod (stick used to measure stream depth) or a tape measure at a 90 degree angle across the stream. The stadia rod or tape measure should be inline with the upstream stake (Figure 3-42).

5. While standing directly above the stadia rod or tape measure, calculate the amount and types of algae the stadia rod or tape measure passes through for transect 1 (Figure 3-42). Note: Use the Algae picture identification cards and descriptions to identify algae types.

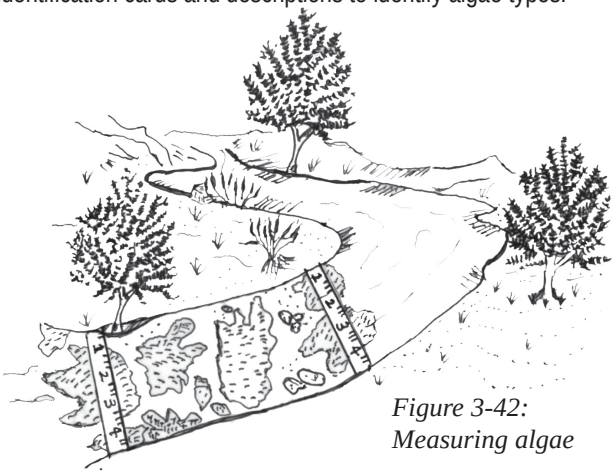


Figure 3-42: Measuring algae

6. Record the result(s) of transect 1 on the *Freshwater Floating Algae and Mat Algae* Field Sheets (pgs. 3-60 and 3-61)

7. Place a second stake at a representative location downstream for transect 2. For example, if your stream reach has sections with algae and without algae select a transect from each of those conditions.This will ensure that algae measurement represent the conditions at the site.

8. Repeat steps 4-6 on transect 2 and record the data on the Algae Field sheets.

9. Calculate the percentage of total floating and mat algae cover on the Freshwater algae field sheets (Fiigure 3-43 and 3-44).

For example, the wetted width of the stream along the first transect is 10 ft. wide with no floating algae (pg. 3-60). The first 3 ft. is solid Cladophora (CL/RZ) mat algae, and then there is no algae for 1 ft., followed by 4 ft. of thick diatoms (DT) mat algae, and 2 ft of no algae. Transect 2 has a wetted width of 6 ft. with no floating algae. The first

Freshwater Floating (FLT.) Algae

Date: July 4, 03 Site Name/#: Malibu Creek #1
Time: 3:30 Am Recorder(s): Lucy (Pretty girl) Van P.
TRANSECT 1 (T-1)
% Canopy Cover (CC-1) 70% Wetted Width (WW-1) 10.0

Distance on tape as a range i.e. 0-.7 ft.	Algae Type	Algae in Feet
0 - 10.0 ft	NONE	0
	Sum Impaired T-1	0

TRANSECT 2 (T-2)
% Canopy Cover (CC-2) 80% Wetted Width (WW-2) 6.0 ft

Distance on tape	Algae Type	Algae in Feet
		0
	Sum T-2	0

Sum T-1 0 + Sum T-2 0 = Total FLT. 0
WW-1 10.0 + WW-2 6.0 = Total WW 16.0

Figure 3-43: Floating Algae Field Sheet

3 ft. has no algae, followed by 2 ft of Cladophora (CL/RZ), and 1 ft of no algae. The algae sheets and calculations can be seen on pgs. 3-60 and 3-61.

10. Record the total percent cover of floating and mat algae on the *Biological floatables* section of the *Site Conditions* field sheet. **You can have more than 100% coverage if you add both floating and mat algae together.**

Your program manager will calculate the floating *algae types and %* and *mat algae types and %* of the *Site Conditions* field sheet.

Freshwater Attached (Mat) Algae

TRANSECT 1 (T-1)

Distance on tape as a range i.e. 0-.7 ft.	Algae Type	Algae in Feet
0 - 3.0 ft	CL/RZ	3.0
3 - 4.0 ft	NONE	—
4.0 - 8.0 ft	Dt	4.0
8.0 - 10.0 ft	NONE	—
TRANSECT 2 (T-2)	**Sum Impaired T-1**	7.0

Distance on tape as a range i.e. 0-.7 ft.	Algae Type	Algae in Feet
0 - 3.0 ft	NONE	—
3.0 - 5.0 ft	CL/RZ	2.0
5.0 - 6.0 ft	NONE	0.0
	Sum T-2	2.0

Sum MAT T-1 7.0 **+ Sum T-2** 2.0 **=Total MAT** 9.0

Divide the total Mat & Floating Algae by Total WW to calculate % Covers.

Total MAT = 9.0 (Divide) 16.0 **Total WW** **(100) =** 56 **% Mat Cover**

Total FLT = 0 (Divide) 16 **Total WW** **(100) =** 0 **% FLT Cover**

Figure 3-44: Mat Algae Field Sheet

Algae Decriptions

Floating algae is almost always one of two types:

***Enteromorpha* (EN)** is lime green to dark green in color and when examined closely has a hollow tube shape that resembles an intestine or sausage casing.

Diatoms can be green or brownish in color and generally have small bubbles throughout. Diatoms will easily break up when rubbed between your fingers. Diatoms that are thicker than 3 millimeters (slightly thicker than a nickel) are recorded as ***DT.***

Mat algae is attched to the bottow of the stream and can be one of 6 types:

Diatoms may also be attached as mats. They are brown and may be a thin film on rocks and sandy bottoms. Diatoms appear as a fuzzy coating on rocks, plants or sandy bottoms, or they may be long strands streaming in the water. They break apart easily if you disturb them. Diatoms that are thicker than 3 millimeters (slightly thicker than a nickel) are recorded as ***DT.***

***Chara* (CH)** has a stalk with thin "branches" along it in rings. It could be mistaken for a vascular plant. It attaches to the bottom and grows up toward the surface.

***Cladophora* (CL/RZ)** is fine and stringy, or filamentous. It may float on the surface, attached by a stalk to the substrate (the dark green "hair" algae), or it may grow more like a mat on a shallow rock. Cladophora is generally found in shallow, well oxygenated riffle parts of the stream. Either way it is recorded as mat algae.

***Rhizoclonium* (CL/RZ)** is usually attached to the bottom or rocks, and grows like a turf or mat. It has a similar appearance as Cladophora, but we generally find it in the deeper, slower flowing water of glides and pools.

***Spyrogyra* (SP)** is similar to *Cladophora* but is very slimy and usually lighter green. It often looks whispy or cloudy in the water column.

***Enteromorpha* (EN)** is a bright green bladder filled with air, and floats on the surface. It may also be attached to the bottom instead of free floating. Often, Enteromorpha is mixed with other algae, when it is attached to the bottom.

Unidentified macroalgae is what we call algae that we can see but cannot identify.

Marine Algae

1. Pull the Marine Algae Identification Cards from your field kit.

2. Record the presence or absence of any marine algae at your monitoring site on your field sheet using the Marine Algae Identification Cards and the descriptions below.

Marine AlgaeTypes

Red tide is a bloom of dinoflagellates that give the water a reddish or muddy appearance.
Green algae is found erect or higher in profile above the rock surfaces in the rocky intertidal zone.
Coralline red algae can be red or pinkish gray patches that appear to be painted onto rock surfaces in the rocky intertidal zone. Coralline red algae include both the encrusting and erect forms.

Brown Algae

Feathery boa kelp *(Egregia laevigata*) is one of the largest types of rocky intertidal brown kelps. Feather boa kelp was named because of its strong resemblance to the popular scarfs of the 19th and 20th centuries.
Grape bladder kelp (*Sargassum muticum)* is an invasive kelp or brown algae that is believed to have been introduced when japanese oysters were imported for farming in the early 1900's. The impacts of grape bladder kelp are unknown.
Giant kelp *(Macrocystis pyrifera)* is the largest and most dominant species off the California Coast.

Brown and red algal turfs are any combination of low growth brown and red algae. This category is used when both brown and red algae are growing together in a dense mat or turf.

SCMI has created a very detailed algae survey for the Rocky Intertidal Zone. The survey involves detailed measurments to quantify the amounts and types of algae present at specific sites. SCMI conducts separate trainings for the Rocky Intertidal Algae Survey.

SUMMARY

Congratulations! You have successfully completed the important task of Water Chemistry Testing. Your data will be compiled and analyzed by SCMI. This information will be made available to all interested agencies working in your watershed. Further, the information will be loaded on a regional water monitoring database maintained by the Regional Board. This database can be accessed by interested public and private organizations throughout the country. Ultimately, water quality problems can be traced to their sources and the problems corrected. In other words, your efforts are going to be rewarded with action towards improving water quality throughout southern California.

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STREAM TEAM
MALIBU CREEK • HEAL THE BAY

Freshwater Testing
CHEMICAL PARAMETERS FIELD SHEET

Date: _____ **Site Name/#:** _____
Time: _____ **Recorder(s):** _____

Weather Conditions
Clear ☐ Overcast ☐ Showers ☐ Rain ☐
Air Temperature/Time: _____/_____ (@ start of testing)
Air Temperature/Time: _____/_____ (@ end of testing)

Type of Flow:
none ☐ intermittent ☐ trickle ☐ steady ☐ heavy ☐

PROPERTIES OF WATERBODY
Water Clarity:
clear ☐ cloudy ☐ milky ☐ muddy ☐ other: _____
Water Color: clear ☐ red ☐ yellow ☐
brown ☐ green ☐ gray ☐ other: _____
Odors: none ☐ rotten eggs ☐ sewage ☐ chlorine ☐
musty ☐ ammonia ☐ other: _____
Floatables: none ☐ oily sheen(rainbow colored) ☐
garbage ☐ sewage ☐ other: _____
Biological Floatables: mosquito larvae ☐

Total Floating Algae Cover % (from Algae sheet) _____
Floating Algae Types & % (s) (from Algae sheet) _____

Total Mat Algae Cover % (from Algae sheet) _____
Mat Algae Types & % (s) (from Algae sheet) _____

DEBRIS
Density of Trash: **None** ☐ **Light** (1-10) ☐ **Moderate** (10-50) ☐
High (50 +) ☐ **Appr. # of Items** _____

Type of Trash: (% type of item)
_____ % **Organics** (food items)
_____ % **Non-recyclable trash** (food wrappers)
_____ **% Plastics**
_____ **% Recyclables** -not plastic
_____ **% Large items** (cars, appliances...)

(Adapted from the "Standard Field Observation Sheet, RWQCB)

STREAM TEAM
MALIBU CREEK • HEAL THE BAY

Freshwater Testing
SITE CONDITIONS FIELD SHEET

Date: _____ **Site Name/#:** _____
Time: _____ **Recorder(s):** _____

5. Dissolved Oxygen
(meters must be on for 15 minutes before calibrating).

Mg/L	% Saturation	Water Temp.	Time
a. _____	a. _____	a._____	a._____
b. _____	b. _____	b._____	b._____
c.* _____	c.* _____		
** _____	** _____		

6. pH
_____ (1st reading)
_____ (2nd reading)
_____ (3rd reading*)
_____ Average of 2 readings**

* Optional - Take a third reading only if first two readings differ significantly
** Discard reading that is significantly different .

7. Turbidity **(Measure samples 3 times and average results).**

Bottle 1. **Bottle 1.**
a. _____ NTU b. _____ NTU c. _____ NTU **mean** _____ NTU
Bottle 2 **Bottle 2.**
a. _____NTU b. _____ NTU c. _____ NTU **mean** _____ NTU
Bottle 3* **Bottle 3.**
a._____ NTU b. _____ NTU c._____ NTU **mean** _____ NTU

Average the mean for bottles 1+2 _____ NTU
(Bottle 3 is only used when necessary**)

8. Conductivity

		Water Temp.	Time
a._____ µS/cm	a._____ mS/cm	a._____	a._____
b._____ µS/cm	b._____ mS/cm	b._____	b._____
c._____ µS/cm*	c._____ mS/cm*		

_____ µS /cm or mS/cm - mean**

8 & 9: Nutrient and Bacteria Testing

Sampler's Name & Signature _____

Sample bottle #'s _____ _____ _____ _____

Time of Samples _____ _____ _____ _____

Time put on ice _____ _____ _____ _____

Freshwater Attached (Mat) Algae

Date: _____ **Site Name/#:** _____

Time: _____ **Recorder(s):** _____

TRANSECT 1 (T-1)

% Canopy Cover (CC -1) _____ **Wetted Width (WW-1)** _____

Distance on tape as a range i.e. 0-.7 ft.	Algae Type	Algae in Feet
	Sum Impaired T-1	

TRANSECT 2 (T-2)

% Canopy Cover (CC -2) _____ **Wetted Width (WW-2)** _____

Distance on tape	Algae Type	Algae in Feet
	Sum T-2	

Sum T-1 _____ **+ Sum T-2** _____ **= Total FLT.** _____

WW-1 _____ **+ WW-2** _____ **= Total WW** _____

Freshwater Floating (FLT.) Algae

TRANSECT 1 (T-1)

Distance on tape as a range i.e. 0-.7 ft.	**Algae Type**	**Algae in Feet**
	Sum Impaired T-1	

TRANSECT 2 (T-2)

Distance on tape as a range i.e. 0-.7 ft.	**Algae Type**	**Algae in Feet**
	Sum T-2	

Sum MAT T-1 _____ + **Sum T-2** _____ = **Total MAT** _____

Divide the total Mat & Floating Algae by Total WW to calculate % Covers.

Total MAT = (Divide) _____ **(100) =** ☐ **Total FLT =** (Divide) _____ **(100) =** ☐

Total WW = **% Mat Cover** **Total WW =** **% FLT Cover**

STREAM TEAM
MALIBU CREEK • HEAL THE BAY

Freshwater Testing

STREAM FLOW FIELD SHEET

Use this form to calculate stream flow. Velocity and cross sectional area of the stream need to be determined. The result will be stream flow in CFS (cubic feet per second). The information you gather will be helpful in understanding the relationship between stream flow, sedimentation, dissolved oxygen, and concentration of pollutants.

Date: _____ **Site Name/#:** _____

Time: _____ **Recorder:** _____

Velocity Float Trials:

Record the time in seconds i.e. 1 minute 11.5 seconds =71.5 seconds

Trial #	Time
1	
2	
3	
4	
5	
Total	

Distance

[/] = [ ]

total time / # of trials — average time

Cross Sectional Area:

Record depths at 1-foot intervals. Depth in inches = D

wetted width _____ **wetted width** _____

Cross Section 1 Upstream

#	D	#	D
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

sum of section 1= ☐

Cross Section 2 Downstream

#	D	#	D
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

sum of section 2= ☐

Convert inches to decimal feet

section 1: ( )/12 = _____ ft.$_2$

section 2: ( )/12 = _____ ft.$_2$

Average Cross Sectional Area converted (sum 1)+(sum 2) /2 =

$$\frac{(\quad) + (\quad)}{2}$$

☐ **ft²**

Average Surface Velocity = ☐ / ☐ = distance/ avg. time / feet/sec.

X (0.8) = ☐ ft/sec

Avg. Corrected Velocity

Stream Flow = ☐ ft./sec. **X** ☐ **ft²** = ☐ **CFS**

avg. corrected velocity | avg. cross sectional area | (cubic ft/second)