Appendix 7-K: Upper Malibu Creek Watershed Restoration Supporting Documents

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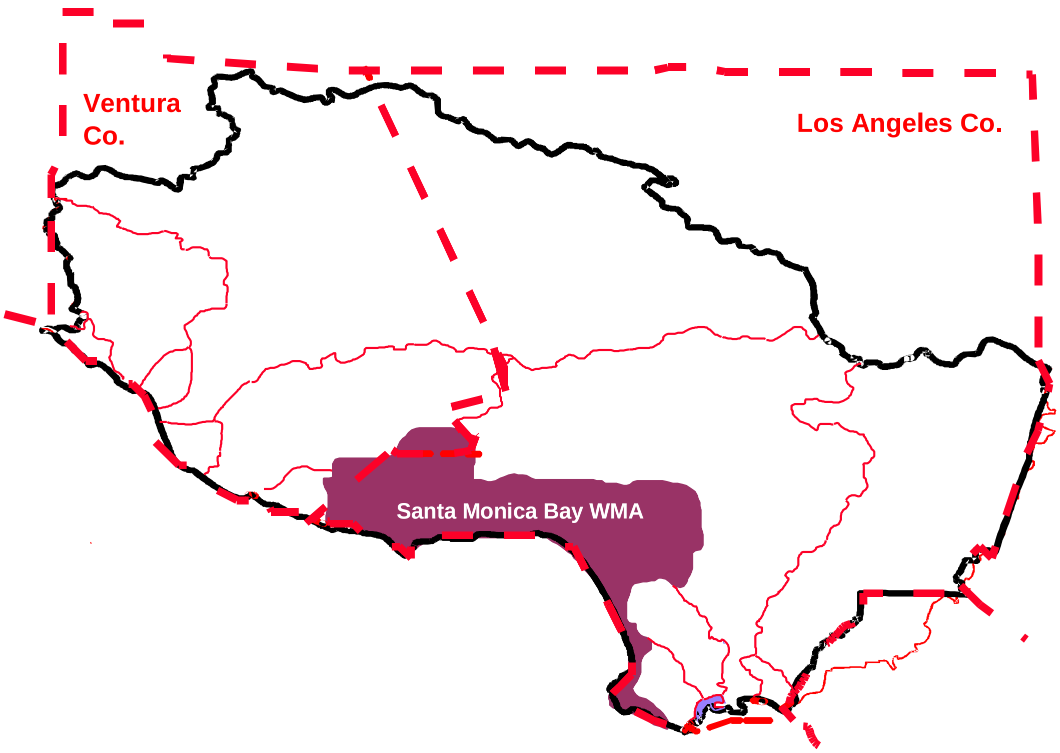
STATE OF THE WATERSHED – Report on Water Quality

The Santa Monica Bay Watershed Management Area
2nd edition



November 2011

California Regional Water Quality Control Board – Los Angeles Region
Shirley Birosik, Watershed Coordinator

PREFACE

This report is one in a series written by the Regional Board's watershed coordinator which summarizes and characterizes surface water or sediment quality data for the Region's watersheds; no policy or regulation is either expressed or intended. The Regional Board is often asked very basic questions about its watersheds and water quality and, in many instances, State of Watershed reports answer these questions. The reports are also helpful in showing how effectively or ineffectively we are all collectively doing monitoring and sharing data/information by going through the process of acquiring and merging data from different sources and making these data/information accessible.

There is some discussion of the watershed's biological resources due to their widespread occurrence and since there are many aquatic life-related beneficial uses sensitive to water and sediment quality problems; however, this report is not meant to be a complete documentation of these resources and instead the reader is encouraged to consult the references cited.

This report is the first in the watershed series to be an update of the original report produced in 1997 (hence, 2nd edition). The first edition was built upon the 1993 *Santa Monica Bay State of the Bay* report produced by the Santa Monica Bay Restoration Project with an emphasis on information available that related to the Santa Monica Bay watershed (land area) as opposed to the Bay alone. In 1997, a team approach was utilized when producing watershed reports whereas now it is primarily the responsibility of the watershed coordinator to complete. The format of these watershed reports has changed considerably since 1997 but there is every intention to both provide new data and reference findings from the previous report for comparison purposes. Use of the Internet was minimal to non-existent in 1997 whereas now virtually every reference is readily available through hyperlinks with the Internet; as a result, often reports cited are only briefly summarized and the reader can consult the full report at his/her leisure.

It became apparent during preparation of this report that tremendous changes have occurred in this Watershed Management Area since the first edition was produced. While much data are available, the amount and extent of research that has occurred is also considerable. A multitude of activities to improve habitat and water quality are ongoing; some are strictly voluntary while others are the direct result of regulatory requirements. The cooperative nature of the work being done among such a diverse groups of stakeholders is to be commended.

Photos embedded in the report were taken by the author; maps were generated in ArcGIS 9.3 by the author.

Prior to release of the public draft, in-house comments were provided by Regional Board staff. An announcement of the public draft report's availability for review and comment was made to the Email lists of interested stakeholders and on the Regional Board's website. Major comments were submitted by Las Virgenes Municipal Water District and Los Angeles County Department of Public Works. The document was revised as appropriate.

November 2011

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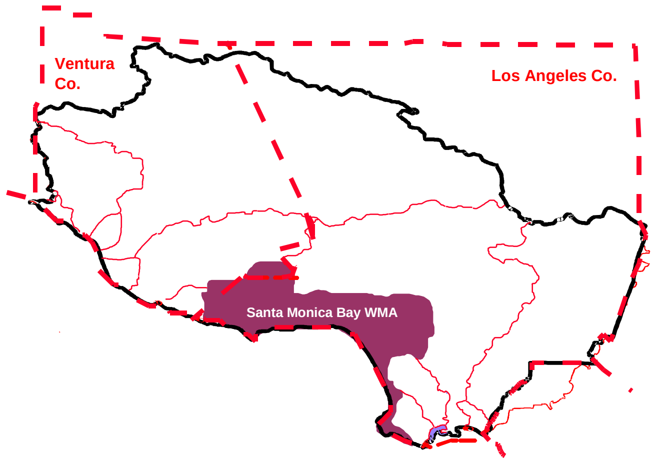
EXECUTIVE SUMMARY



The Santa Monica Bay Watershed Management Area (WMA), which encompasses an area of 414 square miles, is quite diverse. Its borders reach from the crest of the Santa Monica Mountains on the north and from the Ventura-Los Angeles County line to downtown Los Angeles. From there it extends south and west across the Los Angeles plain to include the area east of Ballona Creek and north of the Baldwin Hills. A narrow strip of land between Playa del Rey and Palos Verdes drains to the Bay south of Ballona Creek. The WMA includes several watersheds, the two largest being Malibu Creek to the north (west) and Ballona Creek to the south. The Malibu Creek area contains mostly undeveloped mountain areas, large acreage residential properties and many natural stream reaches while Ballona Creek is predominantly channelized, and highly developed with both residential and commercial properties (CRWQCB, 2007).

As a nationally significant water body, Santa Monica Bay was included in the National Estuary Program in 1988. It has been extensively studied by the Santa Monica Bay Restoration Project, formed in 1989, (now the Santa Monica Bay Restoration Commission or SMBRC) and the Bay Restoration Plan was approved by US EPA and the State of California in 1995. The SMBRC was established in 2004 to oversee implementation of the Plan (CRWQCB, 2007).

The Santa Monica Bay WMA embraces a high diversity in geological and hydrological characteristics, habitat features, and human activities. Almost every beneficial use defined in the Basin Plan is identified in water bodies somewhere in the WMA; however, many of these beneficial uses are impaired. While some of the impaired areas are showing signs of recovery, beneficial uses that are in relatively good condition still face the threat of degradation. Beneficial use impairment problems in the watershed fall into two major categories: human health risk and natural habitat degradation (CRWQCB, 2007).

Permitted discharges:

- MS4 permittees (84 cities, LA County, and LA County Flood Control District)
- 193 traditional NPDES discharges including: seven major NPDES permit discharges, three POTWs (two direct ocean discharges), one refinery, and three generating stations; 18 are minor discharges
- 175 dischargers covered under general permits
- 87 dischargers covered by an industrial storm water permit
- 401 dischargers covered by the construction storm water permit

Of the major non-stormwater NPDES dischargers in the Santa Monica Bay WMA, the three Publicly-Owned Treatment Works (POTWs), particularly the two direct ocean discharges, are the largest point sources of pollutants to Santa Monica Bay. Pollutants from the minor discharges have been estimated to contribute less than two percent of the total pollutants being discharged to the Bay (CRWQCB, 2007).

State of the Watershed

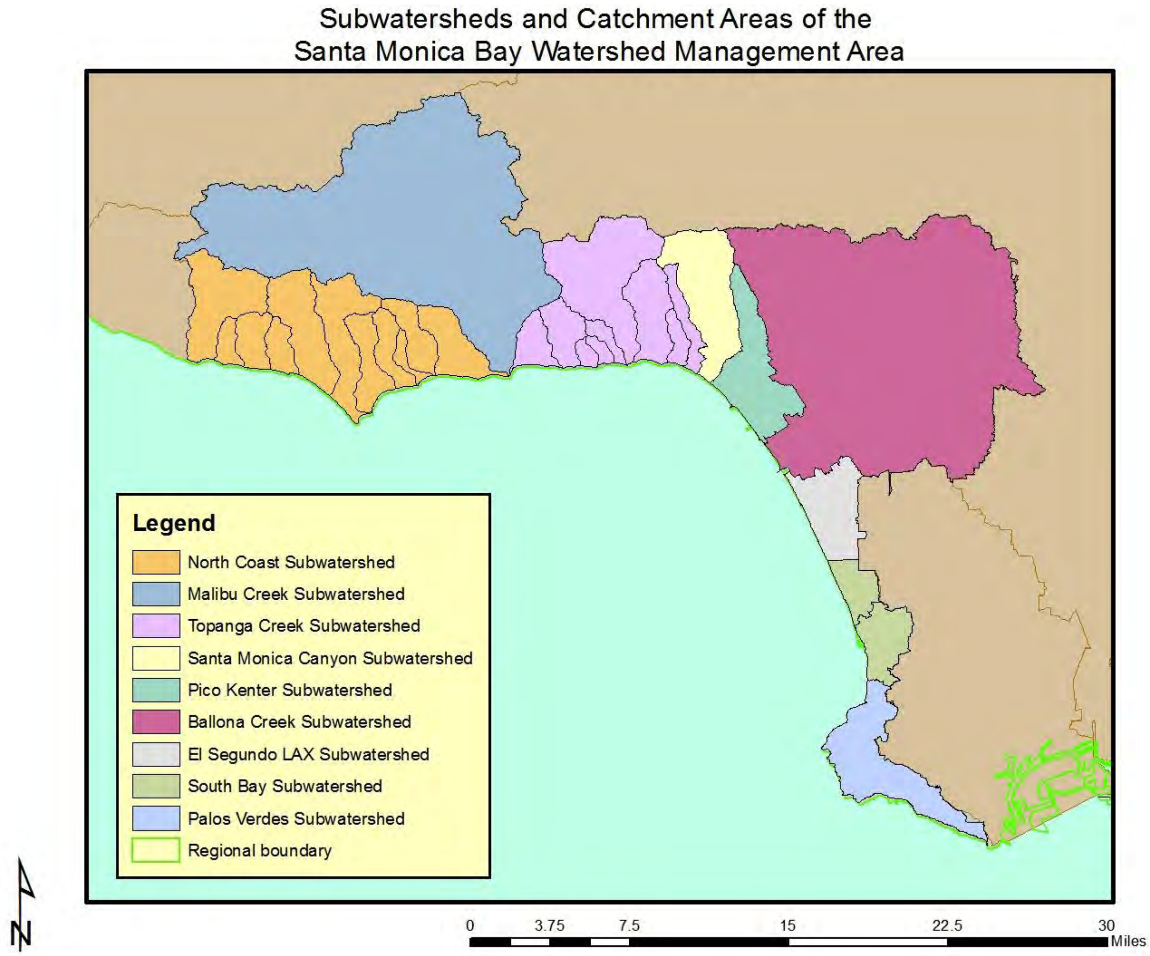
Description of Watershed

The Santa Monica Bay Watershed Management Area (WMA) includes the Santa Monica Bay and the land area that drains into the Bay. The boundary of the Santa Monica Bay, as defined for the National Estuary Program, extends from the Los Angeles/Ventura County line to the northwest, to Point Fermin on the Palos Verdes Peninsula to the southeast. The 414 square mile land area that drains into the Bay follows the crest of the Santa Monica Mountains on the north to Griffith Park. From there it extends south and west across the Los Angeles coastal plain to include the area east of Ballona Creek and north of the Baldwin Hills. South of Ballona Creek the natural drainage is a narrow coastal strip between Playa del Rey and Palos Verdes (CRWQCB, 1997).

The Santa Monica Bay WMA is located in the Los Angeles Coastal Plain. The Bay itself is part of the Southern California Bight, extending from Point Conception to Cape Colnett in Baja California, and with the California Current as its seaward boundary. The mountainous land forming the watershed's northern boundary is largely the results of the slow grind of the Pacific tectonic plate against the North American tectonic plate with the San Andreas fault marking the point of friction between the two. Sediments eroding from surrounding ranges filled the habitable portion of the Los Angeles Coastal Plain. The climate is Mediterranean, characterized by warm, dry summers and mild, wet winters. The average annual rainfall on the Coastal Plain is 12 to 13 inches but ranges from four to 25 inches. Rainfall also varies with elevation, with foothill areas receiving as much as 40 inches (CRWQCB, 1997).

Surface water flows into the Bay through 28 catchment basins that can be grouped into nine subwatershed areas based on their geographic characteristics as shown in the figure below. There are four major groundwater basins in the area, which correspond to geological features seen above the ground (CRWQCB, 1997).

Figure 1



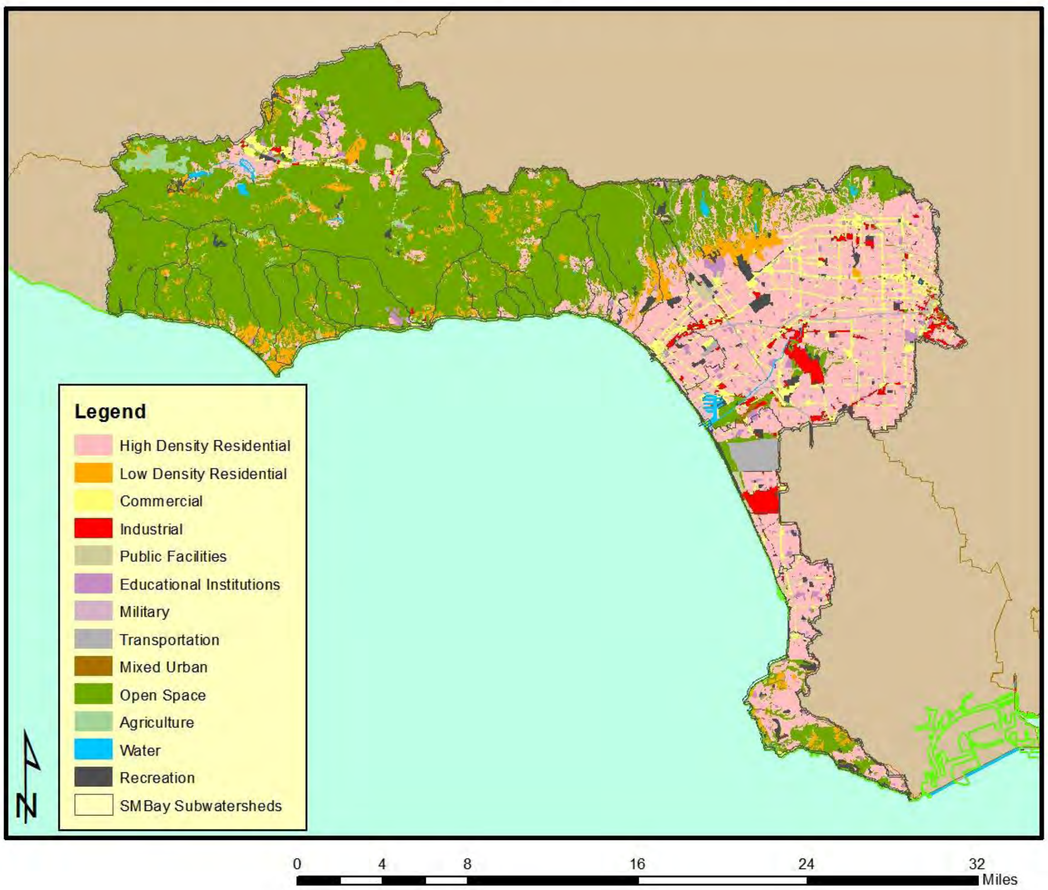
Most land areas of the WMA are located in Los Angeles County, except for a small portion of eastern Ventura County. The cities of Los Angeles and Santa Monica, along with twenty other cities, are located either completed or partially within the watershed. There are also land areas under the jurisdiction of Los Angeles County as well as State and Federal jurisdictions (primarily park lands in the Santa Monica Mountain area) (CRWQCB, 1997).

Approximately 9.86 million people live in Los Angeles County (2008 U.S. Bureau of Census estimate). It is estimated that approximately 2.5 million live within the 414 square mile watershed. In addition, approximately 8.8 million live within the so-called "wasteshed", the area that is served by the large wastewater treatment plants that discharge into the Bay (CRWQCB, 1997).

SCAG land use data from 2005 shows 62% of the area is open space, high density residential is 17% of the area, and low density residential is 2.3% of the area. Commercial and industrial land uses total 6% of the area and are found in all but a handful of the subwatersheds. These land uses are shown in the following figure.

Figure 2

Land Use in the Santa Monica Bay Watershed Management Area



There are large industrial centers in El Segundo, Manhattan Beach, Redondo Beach, and Torrance, which serve as a base for aerospace and other high-tech manufacturing. Other concentrated commercial/ industrial areas in the watershed include Westchester-LAX-Playa del Rey (commercial), Santa Monica-West Los Angeles-Century City (commercial and light industry), Culver City (entertainment industry), Los Angeles Civic Center, and the Highway 101 corridor in Thousand Oaks-Westlake Village (light industry and commercial) (CRWQCB, 1997).

The southern coastal plain portion of the watershed is at or near build-out, therefore, future coastal development in this area will be restricted to scattered infill development, recycling and redevelopment activities. The future population and economic expansion in the area is likely to result in a more dense pattern of human activities and development (CRWQCB, 1997).

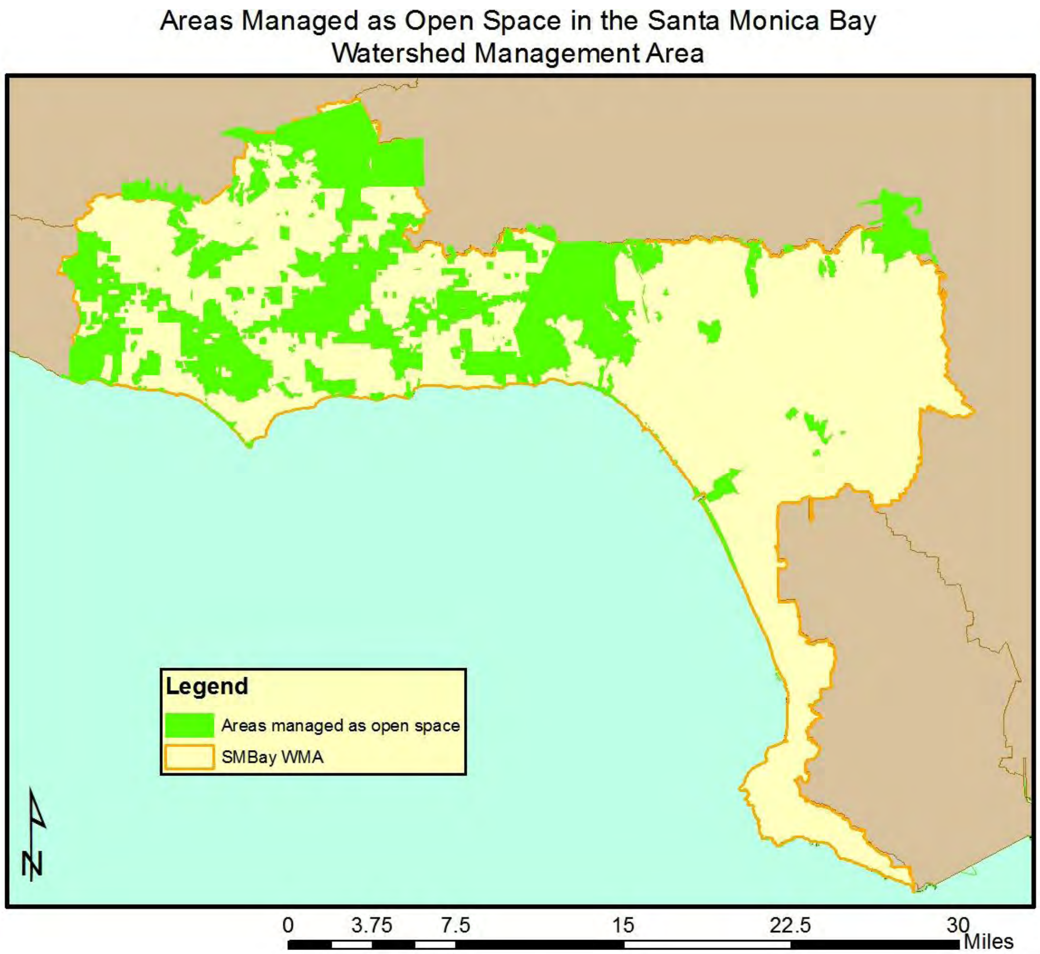
The narrow strip of coastal land in the northern Santa Monica Mountains portion of the watershed is also at or near build-out. Scattered and block new developments take place by encroaching on canyon slopes. New development and business expansion also takes place in the upper watershed, spreading from the Highway 101 corridor to the nearby foothills and even hill-top areas (CRWQCB, 1997).

Economic activities in the watershed are similar to those of Southern California as a whole. Major land-based economic activities include aerospace and other high-tech industries, tourism, entertainment industry, trade, and transportation (CRWQCB, 1997).

Impervious surfaces, which include buildings, roads, sidewalks, parking lots, storm drains and other paved surfaces are inherent to urbanized settings such as the Ballona Creek Watershed; however, these surfaces prevent the natural infiltration of water into the ground. As a result, the volume of storm water runoff increases and water quality deteriorates as polluted water flows to the receiving waters. Most research indicates that water quality is degraded as imperviousness increases; research conducted by Southern California Coastal Water Research Project (SCCWRP) has shown changes in stream channel morphology (which can impact the benthic invertebrate community) can occur at as little as 2-3% total impervious area (Coleman, et al., 2005).. Of the Santa Monica Bay's 414-square mile watershed, 121 square miles (29%) are impervious. The Ballona Creek subwatershed accounts for most of the impervious area, with 72 square miles of impervious surface, (which is 55% of the subwatershed and 17% of the total Bay watershed area). Even the Malibu Creek watershed, with its large expanse of open area, has almost 14 square miles of impervious surface, placing it well above the level of imperviousness at which water quality is impacted (SMBRC, 2004).

The biological and aesthetic resources of the Bay provide many economic benefits to the residents of the watershed. The abundant recreational facilities (including 22 public beaches, a 22-mile-long beach bike path, six piers, small craft harbors with 6,000+ slips, and nine artificial reefs) make the area attractive for a wide range of water-dependent activities. Over 55 million people visit Santa Monica Bay beaches each year to engage in sightseeing, sunbathing, swimming, surfing, and biking. Millions of fishing trips are made to the Bay and on fishing piers each year. The region, especially coastal jurisdictions, depend on tourism associated with these activities to generate jobs and revenues (CRWQCB, 1997). Areas managed as open space by the California Department of Parks and Recreations and the National Park Service, in addition to local agencies, are shown below.

Figure 3



WATER RESOURCES

As is the case for much of coastal Southern California, the Santa Monica Bay watershed is known for its Mediterranean climate – hot, dry summers and cool winters with highly variable amounts of rain influenced by climatic events known as El Nino and La Nina. However, heavy storms do occur and cause catastrophic flooding on occasion. During wet years, the annual total of rainfall can be as great as 40 inches. In addition, the region is rich in groundwater resources with several groundwater basins of large storage capacity. Finally, water imports from the east and north have fundamentally changed the water resources' balance equation and, in a sense, have dramatically expanded the boundary of the watershed (CRWQCB, 1997).

Surface Water

Until storms shifted its course in 1825, the Los Angeles River was the largest river system entering Santa Monica Bay. It once meandered through extensive swamp forests, marshes and lakes between the

Baldwin and Beverly Hills. Today, there is no major river system in the watershed but rather smaller perennial and intermittent streams; Ballona Creek in the Los Angeles Basin and Malibu Creek in the Santa Monica Mountains are the largest (CRWQCB, 1997).

Today, Ballona Creek and its tributaries, which drain a watershed of about 127 square miles, are mostly concrete-lined channels or covered culverts. Besides Ballona Creek, numerous reservoirs, channels, and debris basins have been constructed to control flooding and speed surface flows directly to the ocean (CRWQCB, 1997).

By contrast, Malibu Creek and its tributaries, which drain an area of 110 square miles, are for the most part not channelized. Relatively few tributaries in the upper portions of the Creek drainage have been dammed for recreational and water supply reservoirs. There are about 18 other smaller perennial or seasonal streams which flow through deep and narrow canyons to Santa Monica Bay. Most of these streams remain in their natural condition except for some fills and streambank stabilization due to road and house construction (CRWQCB, 1997). Major surface waters in the WMA are shown below.

Figure 4

Major Surface Waters of the Santa Monica Bay Watershed Management Area

Despite little or no rain throughout much of the year, about two dozen streams or storm drains (including Ballona and Malibu Creeks) have flow in the summer months. Several sources contribute to this phenomenon. Springs and seeps historically were common along the base of the Beverly Hills, Baldwin Hills, the hills above present-day Santa Monica, and in the various canyons in the mountainous area of the watershed. Some of these natural springs and seeps still exist today. Various point and nonpoint source discharges are also contributors to the summer low flow. The former are mostly from groundwater pumped from dewatering projects and from cooling tower discharges. The latter are from over-irrigation, or domestic/industrial illicit connections. Regardless of the sources, these are considered excessive flow because they result at least partly from water imported from outside the watershed (CRWQCB, 1997).

Groundwater

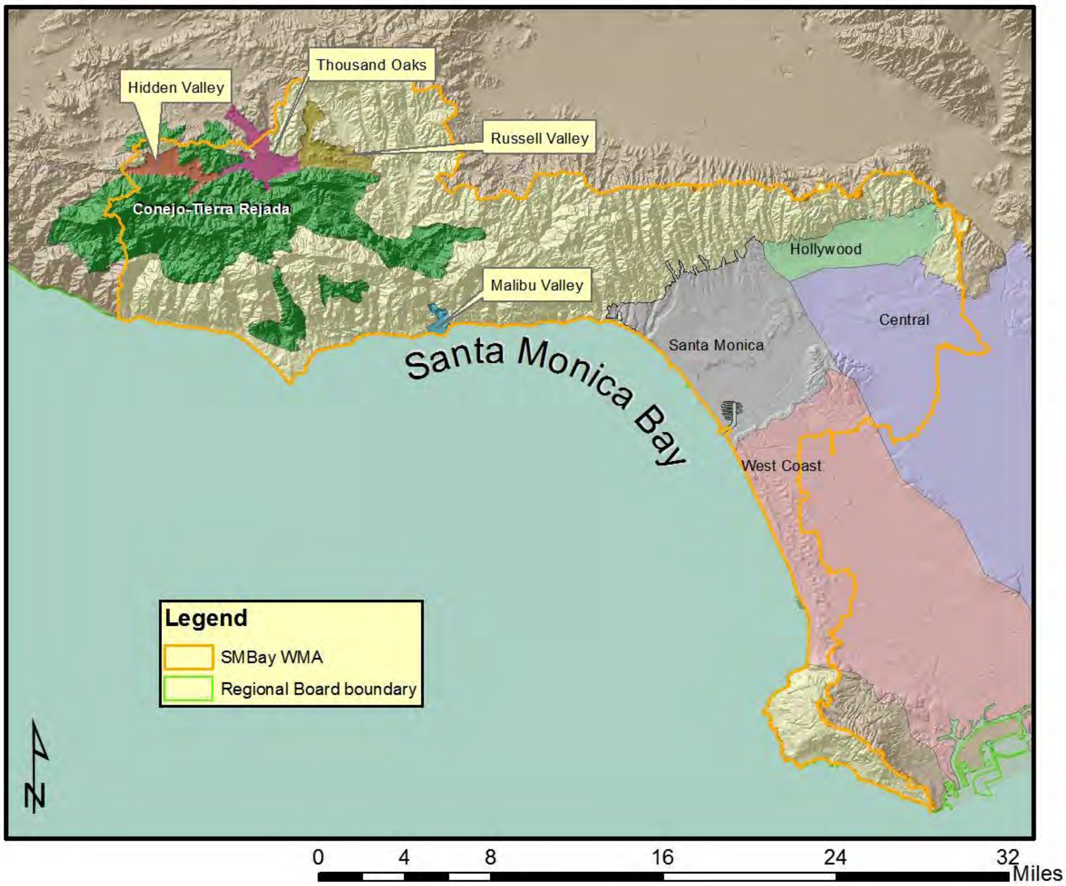
Water in the ground (groundwater) is present at varying depths below land surfaces everywhere. Aquifers, which are permeable units of soil and rock, store ground water that can be easily transmitted and pumped to provide water for uses such as drinking, irrigation and industrial processing. In the Santa Monica Bay watershed (as well as throughout all of southern California), groundwater accounts for most of the local (non-imported) supplies of fresh water (CRWQCB, 1997).

Of the four groundwater basins within the LA Coastal Plain, the Santa Monica Basin and parts of the West Coast, Hollywood, and Central Basins lie within the WMA. Additionally, limited groundwater resources exist in Malibu and Russell Valleys in the Malibu hydrologic area (CRWQCB, 1997). The Metropolitan Water District of Southern California (MWD) has reported that groundwater was once the primary source of drinking water in the Malibu area; with the introduction of imported water to the area in 1965, all known private and public water supply wells have since been abandoned (MWD, 2007). The Los Angeles County Waterworks District No. 29, which provides potable water to coastal areas in the Malibu area, has stated the geology below the District's service area lacks groundwater basins capable of producing an adequate supply of groundwater and, therefore, the District does not have plans to use groundwater sources for future water supply within the District service areas (LACDPW, 2005). Groundwater basins are depicted in Figure 5.

The West Coast Basin Barrier Project recharges aquifers in the West Coast Basin by direct injection into 153 wells of a blend of advanced-treated recycled water and potable water imported from other Regions. The barrier recharges aquifers and prevents seawater intrusion into the West Coast Basin (CRWQCB, 1997).

Figure 5

Groundwater Basins of Santa Monica Bay Watershed Management Area



Water Imports

Water has been imported into the Los Angeles Region from other areas since 1913 when the Los Angeles Aqueduct began delivering water from the Owens Valley. Since that time, southern California has developed a complex system of aqueducts to import water to a rapidly growing population and economy. Water imported to the Region presently meets approximately half of the demand for potable water (CRWQCB, 1997).

The principal systems for importing water are the Los Angeles Aqueduct, which diverts water from the Mono and Owens Rivers Basins; the California Aqueduct (State Water Project), which transports water from northern California; and the Colorado River Aqueduct, which carries water from Lake Havasu on the Colorado River. Importing these waters brings several problems as well as the obvious benefits. Water from the Owens Valley is usually treated for turbidity. Water from the Colorado River generally has a higher mineral content than either local waters or other imported waters although exceptions exist in those Santa Monica Bay watersheds with significant deposits of Tertiary age marine sedimentary rock of the Monterey Formation (Mundy, comm. ltr.). This hardness is the result of dissolved material from soil and rocks in that river's watershed. Water from northern California accumulates organic materials as it flows through the Sacramento-San Joaquin Delta. These organic materials when combined with the chlorine used during typical disinfection treatment processes can result in by-products called trihalomethanes (THMs). These substances have been linked to cancer. A 100 parts per billion (ppb) standard has been established to mitigate the occurrence of THMs in drinking water, while still allowing for adequate disinfection with chlorine (CRWQCB, 1997).

Chloride is one component of hardness in water and, during drought periods, water supplies from northern California often have higher than normal concentrations of chlorides. Excessive chlorides can impair the use of water for human consumption and application on crops. Currently, surface waters within the Santa Monica Bay watershed are not experiencing excessive chloride concentrations due to imported water (CRWQCB, 1997).

About half of the City of Los Angeles' water supply now comes from the Metropolitan Water District, imported water from northern California through the State Water Project (SWP), while about a third is imported from the Los Angeles Aqueduct. Local groundwater accounts for about 10% of the water supply. Another major water supplier in the WMA, the West Basin Municipal Water District, imports about 65% of its water. About 20% is from groundwater and 7% is from recycled water (SMBRC, 2010). The remainder of the water imported in the northern Santa Monica Bay area is provided by the Las Virgenes Municipal Water District (LVMWD) and consists of 100% SWP water. LVMWD also provides recycled water derived from SWP water to meet approximately 20% of total demand (Mundy, comm. ltr.).

Biological Setting

Santa Monica Bay is the submerged portion of the Los Angeles basin and is an integral part of the larger geographic region commonly known as the Southern California Bight. It has a gently sloping continental shelf which extends seaward to the shelf break about 265 feet underwater, then drops more steeply to the floor of the Santa Monica Basin, at about 2,630 feet (CRWQCB, 1997).

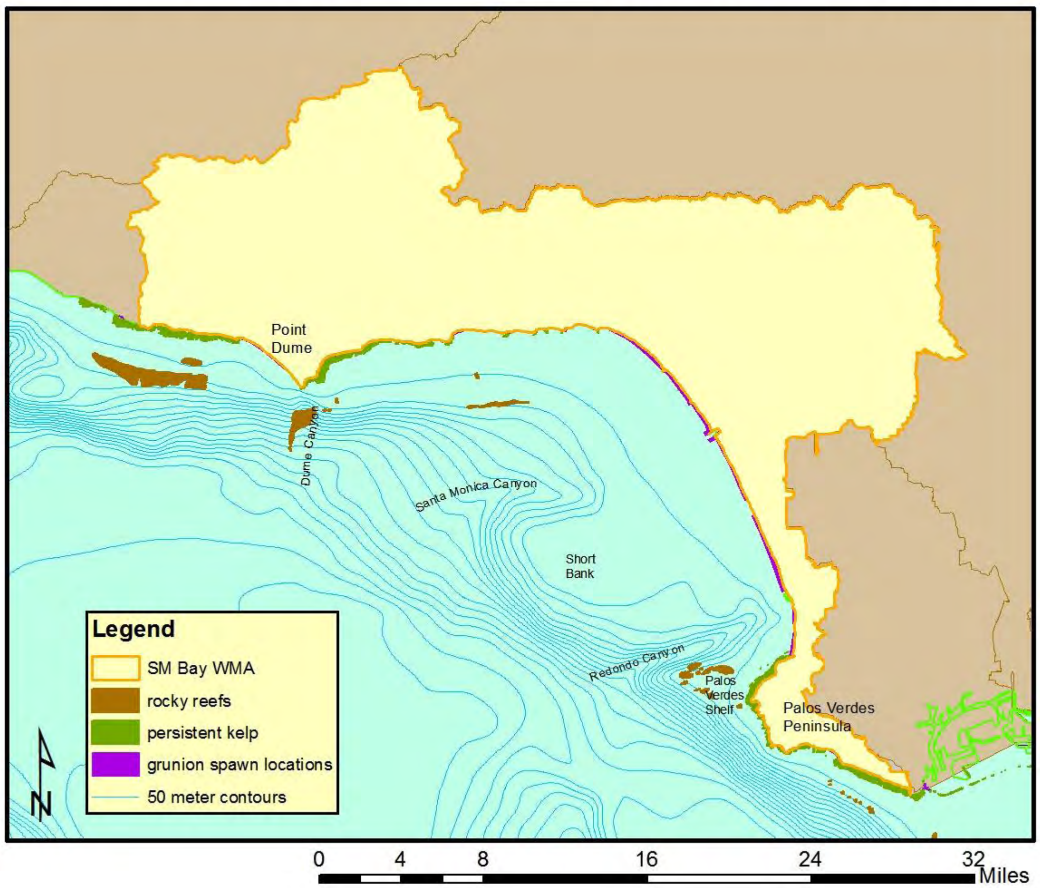
The shelf ranges in width from a few hundred yards to about 12 miles. It is broadest off El Segundo, narrowest off Redondo Beach, and is transected by three submarine canyons: Dume Submarine Canyon off Point Dume; Santa Monica Submarine Canyon seven miles offshore of Ballona Creek; and Redondo Submarine Canyon, a few hundred yards of King Harbor (CRWQCB, 1997).

MARINE HABITATS

The Bay provides a variety of habitats and homes for a highly diverse group of plants and animals, at least 5,000 at last count. The dominant *benthic habitat* in Santa Monica Bay is soft bottom which

Figure 6

Marine Habitat Areas of Santa Monica Bay Watershed Management Area



consists of fine to moderately coarse sediments. Few attached plants live in this habitat but invertebrates are abundant and diverse. Resident animals include crabs and shrimp, snails, worms and echinoderms. Hard bottom areas consist of seafloor covered with bedrock, gravel, and phosphorite. It also includes the deep-water plateau called Short Bank. Kelp beds will often be found in these hard bottom areas at depths of 20 to 70 feet in the subtidal regions west of Malibu and around the Palos Verdes Peninsula. Although far less in acreage than soft bottom, kelp beds in the Bay provide cover and protection, and thus habitat for more than 800 species of fishes and invertebrates, some of which are uniquely adapted for life in the beds. Consequently, kelp beds are important for sport fishing, commercial harvesting of abalone and sea urchins, and recreational diving (CRWQCB, 1997).

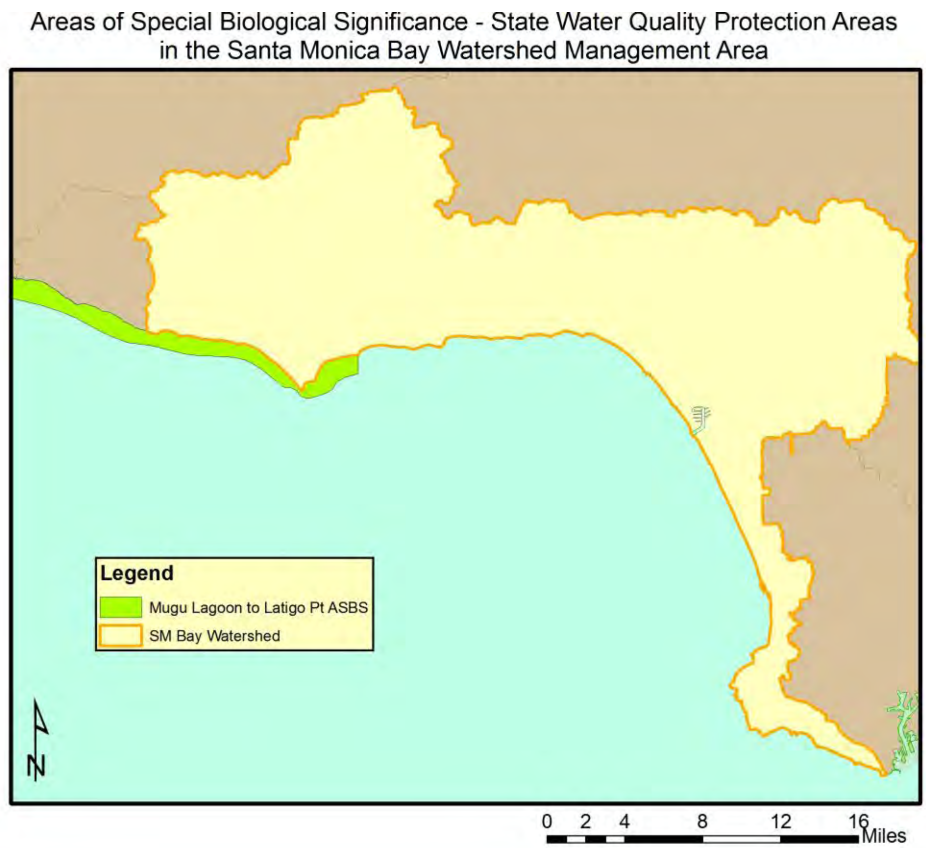
The *pelagic, or open-ocean habitat* is the primary home to fish such as Pacific sardine, northern anchovy, Pacific mackerel, and Pacific bonito; as well as marine mammals such as seals and sea lions. Many species of whales and dolphins are also observed in Bay waters during the winter/spring migration. The thin uppermost layer of the water column (microlayer) is also home to the eggs and larvae of many invertebrates. Phytoplankton are the dominant plant life in the pelagic environment. Red tides (which are typically dominated by dinoflagellates) sometimes develop in nearshore areas when warm temperatures, high light levels, abundant nutrients, and a shallow pycnocline (density gradient) occur together. Localized red tides occur almost every year; extensive ones occur less frequently (CRWQCB, 1997).

BEACH AND INTERTIDAL HABITATS

Sandy beaches are the most prominent and dominant habitat along the Santa Monica Bay shoreline, extending over fifty miles. Sandy beaches in southern California support species of macro invertebrates such as sand crabs and Pismo clams; they also support surf fish, such as California corbina, barred surfperch, and shovelnose guitarfish. Many sandy beaches along the Bay are important spawning grounds for California grunion (SMBRC, 2010). *Intertidal zones* include mud flats, tide pools, sandy beaches, and wave-swept rocks. They provide important habitat and breeding grounds for a variety of plants such as marine algae, fish such as grunion, and many invertebrates. Both beaches and other intertidal zones of Santa Monica Bay are important nesting and feeding grounds for migratory waterfowl and shore birds such as egrets, herons, gulls, terns, sanderlings, and plovers (CRWQCB, 1997).

Because of the existence of kelp beds, tidepools, and significant ecological diversity, the nearshore area between Ventura County line and Latigo Point was designated by the State Water Resources Control Board (SWRCB) an Area of Special Biological Significance (ASBS), now known as a State Water Quality Protection Area (SWQPA). A SWQPA is afforded special protection for marine life to the extent that waste discharge are prohibited within the areas. The same area and the nearshore area between Palos Verdes Point and Flat Rock Point is also designated a "significant ecological area" by the County of Los Angeles (CRWQCB, 1997).

Figure 7



COASTAL WETLANDS AND SHALLOW WATER HABITATS

Enclosed shallow water habitats are important features of the Santa Monica Bay coastline. These waterbodies are protected from rough seas and winter storms and provide a certain amount of stability in the physical environment and availability of food, and serve as important nurseries for local marine fishes (e.g., juvenile California halibut, juvenile white seabass). The relative complexity of the physical environment (piers, mudflats, sandy bottom) tends to allow for considerable diversity in the flora and fauna living there (CRWQCB, 1997).

The Santa Monica Bay WMA contains five estuaries/lagoons (Dume Lagoon, Malibu Lagoon, Topanga Lagoon, Ballona Lagoon and Del Rey Lagoon) and Ballona Wetlands. Lagoons may form at the mouths of rivers (the estuary) periodically when sand bars build up and close off the area. Considerable fluctuations in salinity often result. Coastal wetlands not part of a river system are often a mix of tidal influx and freshwater water inputs (including from urban runoff) which may result in fluctuations in salinity. Many of the species living in estuaries are either adapted to changing salinity (such as some species of pickleweed) or relocate to stay within the appropriate salinity range (such **as** tidewater goby).

Some estuarine fauna have adapted by producing large amounts of offspring with the likelihood that only some will survive. Lagoons are popular overwintering sites for migrating birds and are utilized by species nesting locally (such as the California least tern) during foraging. Many of the species found in estuaries are unique to that habitat and consequently are very sensitive to estuarine habitat loss (CRWQCB, 1997).

The enclosed waters of Marina del Rey and King Harbors also function to a large extent as shallow water habitats. Salinity in these areas is relatively constant and reflective of the nearby ocean waters. Many species of fish use these enclosed waters as nurseries. The mix of hard and soft bottoms yields a large array of organisms; many which might normally attach to rocks will also attach to piers in great abundance (mussels, tunicates). Organisms living in these waters are in constant contact with any pollutants found there (CRWQCB, 1997).

INLAND RIPARIAN HABITATS

Riparian habitat exists along each natural watercourse flowing to the ocean and around the lakes of the watershed. Riparian corridors include those found throughout the Malibu Creek watershed, in other Santa Monica Mountain watersheds such as Arroyo Sequit and Solstice Creek, and adjacent to lakes such as Westlake Lake, Lake Sherwood, and Malibou Lake. Riparian habitat generally consists of plants that need to be in close proximity to water at least for part of the year. Typical riparian vegetation includes sycamore trees, willows, mulefat, and cattails (near lakes). The generally large sycamore trees are used by birds for nesting and are particularly important to birds of prey since they give the height needed for these birds to hunt by sight. Shrubs will supply food and nesting habitat to a large variety of birds and rodents. Larger mammals such as coyote, gray fox, and the occasional bobcat are the common predators. Overhanging vegetation tends to minimize the water's temperature which can be very important to fish such as steelhead trout which migrate upstream to spawn. Continuous habitat along streams leads to the watercourse functioning as a wildlife corridor which allows movement of wildlife from one part of the watershed to another and opens up the amount of habitat available to them to use. Loss of this continuity, as occurs during development next to watercourses and when large roads cross them, can lead to excessive segmentation of the habitat and loss of overall species abundance and diversity (CRWQCB, 1997).

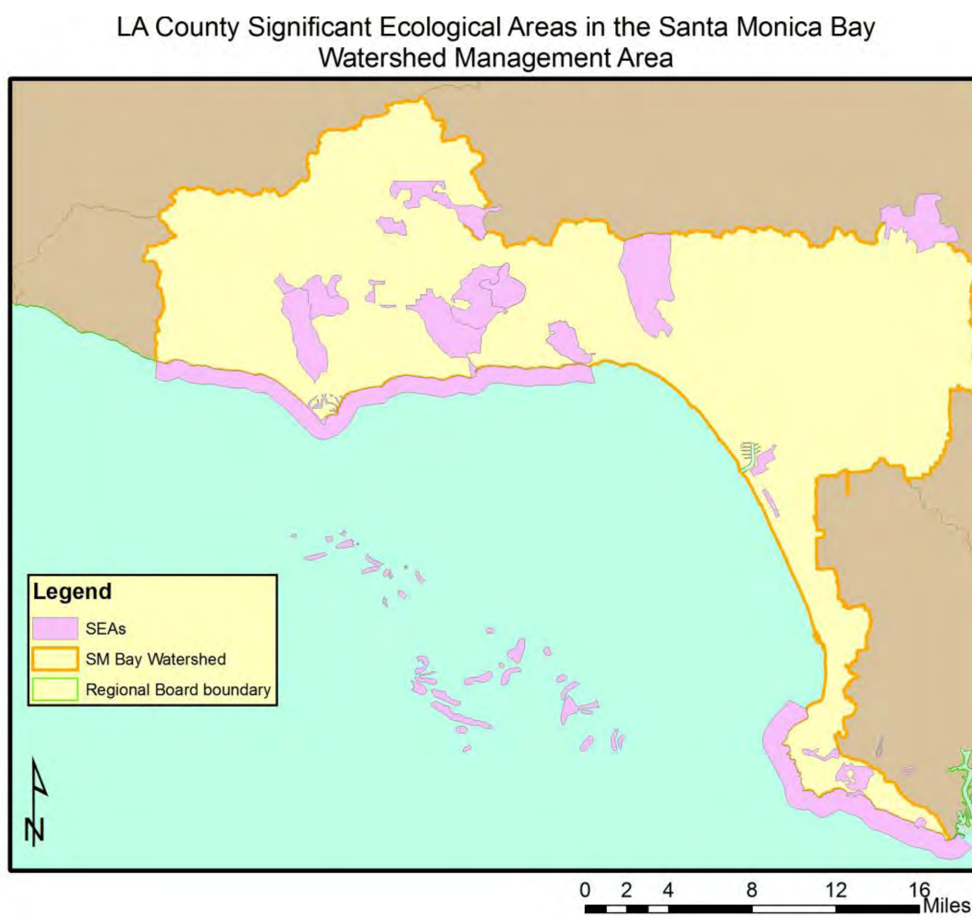
UPLAND HABITATS

Further inland the landscapes are primarily of two types: the Los Angeles coastal plain to the south and the Santa Monica Mountains to the north. Less than 300 years ago, much of the plain was rolling grassland scattered with oak trees. In low-lying areas between hills and bluffs, a major river and dozens of lesser streams meandered through broad valleys and wetlands to the sea. Two higher points of land were the peaks of the Baldwin and Palos Verdes hills where coastal scrubs grew, with chaparral vegetation covering the north-facing slopes and oak savannah blanketing the drier south-facing slopes (CRWQCB, 1997).

However, the grassland today has been replaced by human dwelling structures to become one of the most urbanized areas in the world. Only some coastal scrub habitat remains at the two higher points. Almost all natural waterways were channelized and/or converted to underground culverts. The largest drainage in the coastal plain is Ballona Creek; the Pico-Kenter drainage is second largest. Most others are small storm drains near the coast that extend only a short distance inland and receive no natural flow during summer months (CRWQCB, 1997).

The land in the Santa Monica Mountains to the north by contrast is still mostly open space and remains in a somewhat natural state, mostly free of alteration or development, but impacted by invasive species and mostly bacteria- and nutrient-related water quality issues. Besides coastal riparian, wetlands, grassland and scrub habitats, there are four habitats that are specific to the Santa Monica Mountains. The valley oak woodland occurs exclusively in the western part of the Santa Monica Mountains, particularly in the upper Malibu Creek drainage. It is dominated by valley oak, a deciduous oak 50-110 feet tall. The habitat usually merges with grassland or riparian vegetation near streams. Coastal oak woodland also occurs in the Santa Monica Mountains. This habitat is dominated by coast oak and California walnut.

Figure 8



The mixed chaparral generally occurs above the coastal scrub habitat predominantly on moist coastal or north- and east-facing slopes while the chamise-redshank chaparral predominates on drier, south- and west-facing slopes. The former is dominated by shrubs with stiff evergreen leaves such as scrub oak, ceanothus, and manzanita. The latter is almost exclusively dominated by chamise with some redshank occurring at higher elevations. Both habitat types are fire-adapted. These habitats are heavily used by small herbivores such as rodents and seed/insect-eating birds, as well as by large ones such as deer. Predators include owls, hawks, coyotes, and foxes (CRWQCB, 1997).

ENDANGERED SPECIES

Santa Monica Bay habitats (marine, aquatic, and terrestrial) are home to a number of rare, threatened or endangered species. Birds include California brown pelican, California least tern, western snowy plover, Belding's savannah sparrow, American peregrine falcon, and California gnatcatcher. Butterflies include the El Segundo blue, Palos Verdes blue, and wandering skipper. Endangered plants include Santa Monica Mountains dudleya, Lyon's pentachaeta, Conejo buckwheat, and Santa Susanna tarweed. Fish include tidewater goby and southern steelhead trout; amphibians include the Arroyo toad and the threatened California red-legged frog (CRWQCB, 1997).

Key Water Quality Issues

Though relatively small in size compared with watersheds for major rivers, lakes, or estuaries in other parts of the country, the Santa Monica Bay WMA includes a remarkably high diversity of geological and hydrological characteristics, habitat features, and human activities. Every beneficial use defined in the Basin Plan is identified in water bodies somewhere in the watershed. A complete list of beneficial uses are shown under the "The WMA's Designated Beneficial Uses" section; those identified for each subwatershed area can be found in each Subwatershed section (CRWQCB, 1997).

Beneficial use impairment problems in the watershed fall into two broad categories: those relating to human health and those relating to aquatic life/habitat/wildlife. The former are issues primarily associated with recreational uses of the Santa Monica Bay. The latter are issues associated with terrestrial, aquatic, and marine environments. Pollutant loadings that originate from human activities are common causes of both human health risks and habitat degradation. Encroachment by human development is another major cause for disappearance or degradation of natural habitats (CRWQCB, 1997). General improvement strategies to reduce the risks and degradation are shown. More specific information on assessments conducted by the SMBRC in fulfillment of their mission as well as formal water quality assessments required by the Clean Water Act and conducted by the Regional Board are also shown. General improvement strategies are listed here; strategies specific to subwatersheds are listed in each Subwatershed section.

ADVERSE HUMAN HEALTH IMPACTS

Santa Monica Bay is heavily used by the public for fishing, swimming, surfing, and diving activities; these types of activities are classified as beneficial uses water contact recreation and commercial and sportfishing. However, the ability of people to enjoy these activities has been lost to a certain degree because of the acute health risks associated with swimming in runoff-contaminated surfzone waters, and the chronic (cancer) risk associated with consumption of certain sport fish species in areas impacted by DDT and PCB contamination (CRWQCB, 1997).

Swimming

The First Edition State of the Watershed Report described reports of swimmers increasingly complaining about ear, eye, wound and intestinal infections, skin rashes and other illnesses that allegedly occurred as a result of contact with Bay waters. In investigating sources of contaminants that could be responsible for possible adverse health effects, researchers found evidence that pointed to pathogens possibly carried by urban runoff through storm drains into the Bay. Review of shoreline monitoring data showed higher indicator bacteria (total coliform, fecal coliform, and enterococcus) in waters surrounding storm drain outlets. These are called "indicator" bacteria since their presence suggests pathogenic bacteria and viruses may be also present and do not themselves cause disease (CRWQCB, 1997).

Stronger evidence was found in SMBRP studies completed between 1989 and 1991, when enteric viruses were found in the storm drain effluent at three widely-dispersed locations during dry-weather periods (CRWQCB, 1997).

In summer 1995, the SMBRP conducted a landmark epidemiological study of possible adverse health effects of swimming in Santa Monica Bay. The study found solid evidence that (1) there was an increased risk of illness associated with swimming near flowing storm drain outlets in Santa Monica Bay; (2) there was an increased risk of illness associated with swimming in areas with high densities of bacterial indicators; (3) illnesses were reported more often on days when the samples were positive for enteric viruses; and (4) high densities of bacterial indicators were measured on a significant number of survey days, particularly in front of drains. The study also showed that the total coliform to fecal coliform ratio was one of the better indicators for predicting health risks (CRWQCB, 1997).

As will be seen below under the General Improvement Strategies section, what followed during the next decade was an intensive effort to divert dry-weather flows and, at times, portions of storm flows. With forty drains now diverted during dry-weather, the miles of beach area affected by bacterial indicators should be reduced. SCCWRP is currently conducting epidemiological studies to assess the risk of swimming-related illnesses following exposure to nonpoint source-contaminated waters at three beaches in southern California including Surfrider Beach in Malibu. These studies will examine several new techniques for measuring traditional fecal indicator bacteria, new species of bacteria, and viruses to determine whether they yield a better relationship to human health outcomes than the indicators presently used in California (SCCWRP Website #1).

General Improvement Strategies

- **Implement TMDLs** Adopted bacteria TMDLs include those for Santa Monica Bay Beaches Wet Weather and Dry Weather (2003); Ballona Creek, Ballona Estuary, and Sepulveda Channel (2007); Malibu Creek (2006); and Marina del Rey Back Basins (2004). The TMDLs, implementation plans, and related technical documents for these are available on the Regional Board website as follows:

  Santa Monica Bay Beaches Dry Weather

  http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

  http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

  http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

  Santa Monica Bay Beaches Wet Weather

  http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

  http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

  http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

  http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

  http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Ballona Creek, Ballona Estuary, and Sepulveda Channel

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_45_2006-011_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2006-011/2006-011_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2006-011/2006-011_RB_BPA.pdf

Malibu Creek

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_23_2004-019R_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2004-019R/05_0309/Resolution%202004-19R%20and%20Attachment%20A.pdf

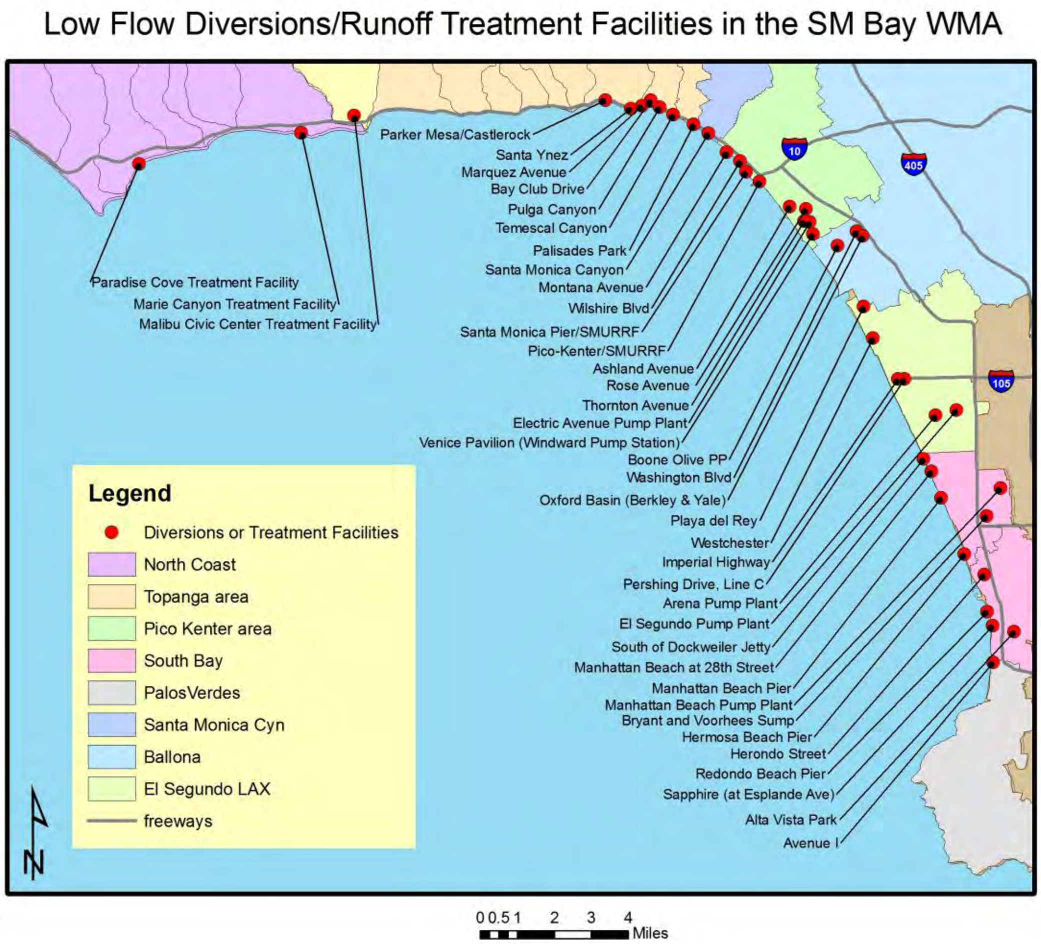
Marina del Rey Back Basins

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_19_2003-012_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_43_2006-009_td.shtml

- **Implement plans for low-flow diversions/treatment facilities** Forty low-flow diversions (LFDs) or runoff treatment facilities have thus far been installed at storm drains leading to Santa Monica Bay in order to reduce coliform levels and beach closures. Some of the LFDs have become full-time diversions. Of the twenty-seven high priority storm drains listed in the beaches dry weather bacteria TMDL, all have been diverted. Lead agencies on these projects include the cities of Los Angeles, Malibu, Manhattan Beach, Redondo Beach, Hermosa Beach, and Santa Monica, and the Los Angeles County Flood Control District (District). More information about LFDs may be found at http://www.lastormwater.org/Siteorg/program/poll_abate/lowflowdiv/lfdpage.htm. The locations of known diversion projects/treatment facilities are shown below.

Figure 9



Seafood Consumption

The general public has been concerned about potential health risks associated with the consumption of contaminated seafood from Santa Monica Bay for a number of years. Eating contaminated seafood is the primary pathway through which humans are exposed to toxic chemicals found in the marine environment. While studies have shown that health risks are limited to consumption of certain seafood species from certain locations, the public perception remains that all seafood in the Bay is contaminated (CRWQCB, 1997).

The most extensively studied contaminants in Santa Monica Bay are dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), heavy metals, and their by-products. PCBs and DDT (and its derivatives DDD and DDE) present the greatest risk to individuals who consume seafood from Santa Monica Bay. Over the past 25 years, several species from contaminated areas have exhibited very high levels of PCBs and DDTs. After the discharge of these chemicals was stopped in the early 1970s, contaminant levels in fish tissues declined steeply, but additional decreases have been slower since about 1992. However, both PCBs and DDT degrade naturally at a very slow rate and the earlier sharp decline may have been reflective of the cessation of discharges and reduced bioavailability, while continued evidence of contamination today is a reflection of the slow degradation rate (CRWQCB, 1997).

A series of studies were conducted by the State Office of Environmental Health Hazard Assessment (OEHHA) and the SMBRP to assess the potential risk to humans associated with consumption of seafood species taken from the Bay. According to OEHHA's risk assessment, white croaker is generally considered to be the most contaminated fish in the Bay, especially individuals from areas such as the Palos Verdes Shelf (white croaker have naturally high lipid levels in which the organic pollutants accumulate). Other species found to be relatively contaminated at certain locations are California corbina, queenfish, surfperches and California scorpionfish (CRWQCB, 1997). The 1991 OEHHA study has been supplemented and updated by more recent SMBRP studies as well as by the Palos Verdes Shelf Superfund studies which has led to an updated health advisory by OEHHA released in 2009 which is discussed elsewhere in this document (OEHHA website).

General Improvement Strategies

- **Address consumption of contaminated fish** Implement the Fish Contamination Education Collaborative (FCEC) which is the public outreach and education component of the USEPA's program to protect the most vulnerable populations from the health effects of consuming contaminated fish related to the Palos Verdes Shelf Superfund Site. FCEC is a major part of USEPA's Institutional Controls program and works in conjunction with monitoring and enforcement efforts. More information on the FCEC can be found at http://www.pvsfish.org/.
- **Remediate contaminated sediments** USEPA signed an interim Record of Decision in September 2009 that selects a cleanup remedy for Palos Verdes Shelf. The selected remedy has three components: placing a cover of clean silty sand over the portion of the contaminated sediment deposit that has the highest contaminant surface concentrations and appears to be erosive; monitoring the natural recovery that is occurring in other areas of the Shelf; and continuing the Institutional Controls program that uses outreach and education, enforcement and monitoring to minimize consumption of fish that contain DDTs and PCBs. More information can be found at http://www.epa.gov/region09/superfund/pvshelf/.
- **Develop TMDLs** Specifically, develop TMDLs for the coastal waters impairments based on the fish consumption advisory for DDT and PCBs. These TMDLs are under development by USEPA.

Consumption of Inland Fish

The State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) released a technical report in 2009 which presented results from the first year of a two-year screening survey of the potential for human exposure and health risks from consuming contaminated sport fish from California lakes and reservoirs. This effort begins a new long-term, statewide, comprehensive bioaccumulation monitoring program for California surface waters. The results presented in this report provide a preliminary assessment of the statewide scope of the bioaccumulation problem in California lakes and reservoirs. The report also provides lake-specific information that can be used to establish priorities for cleanup actions, and identifies lakes where additional sampling may be needed to support fish consumption advisories (Davis, et al., 2009). A number of lakes in this WMA were sampled. Results from two of the pollutants of most concern, PCBs and mercury (the latter shown with the locations of historic gold mines, a potential source for mercury), are shown in the figures below.

Figure 10

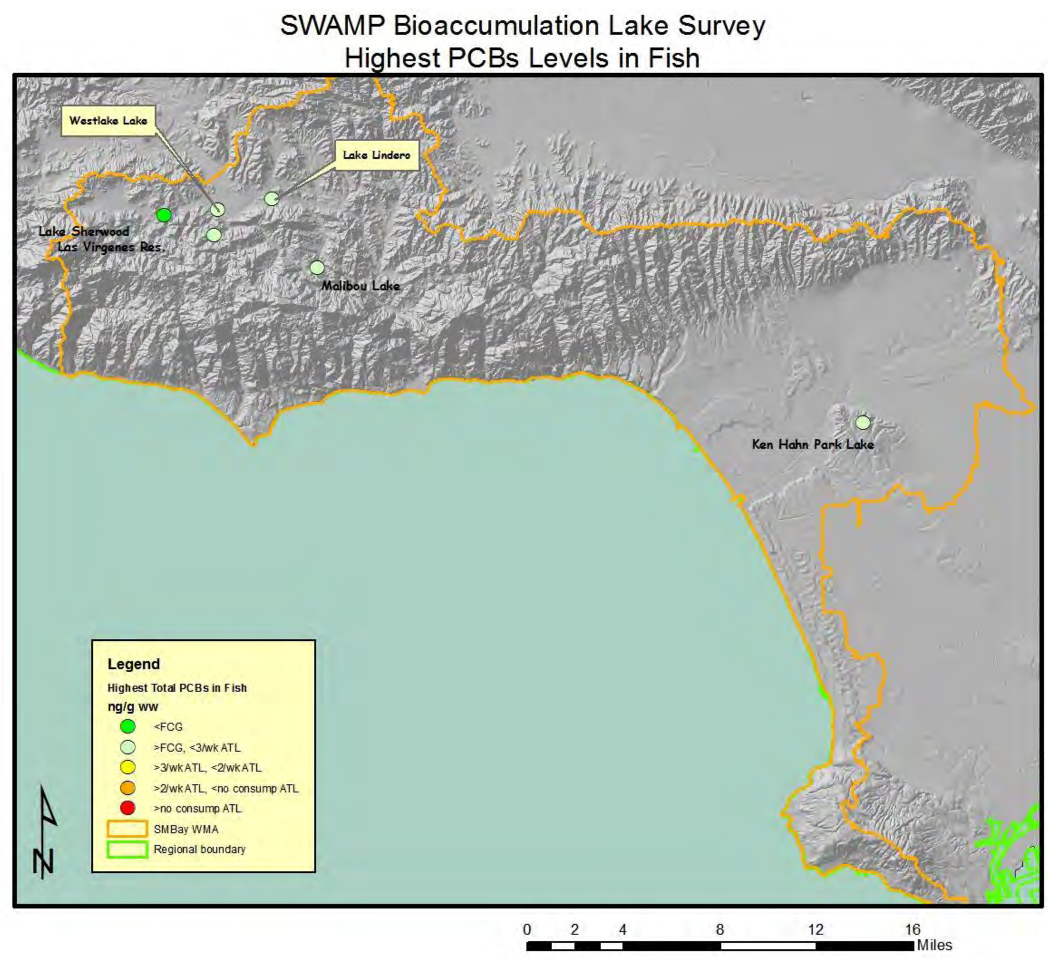
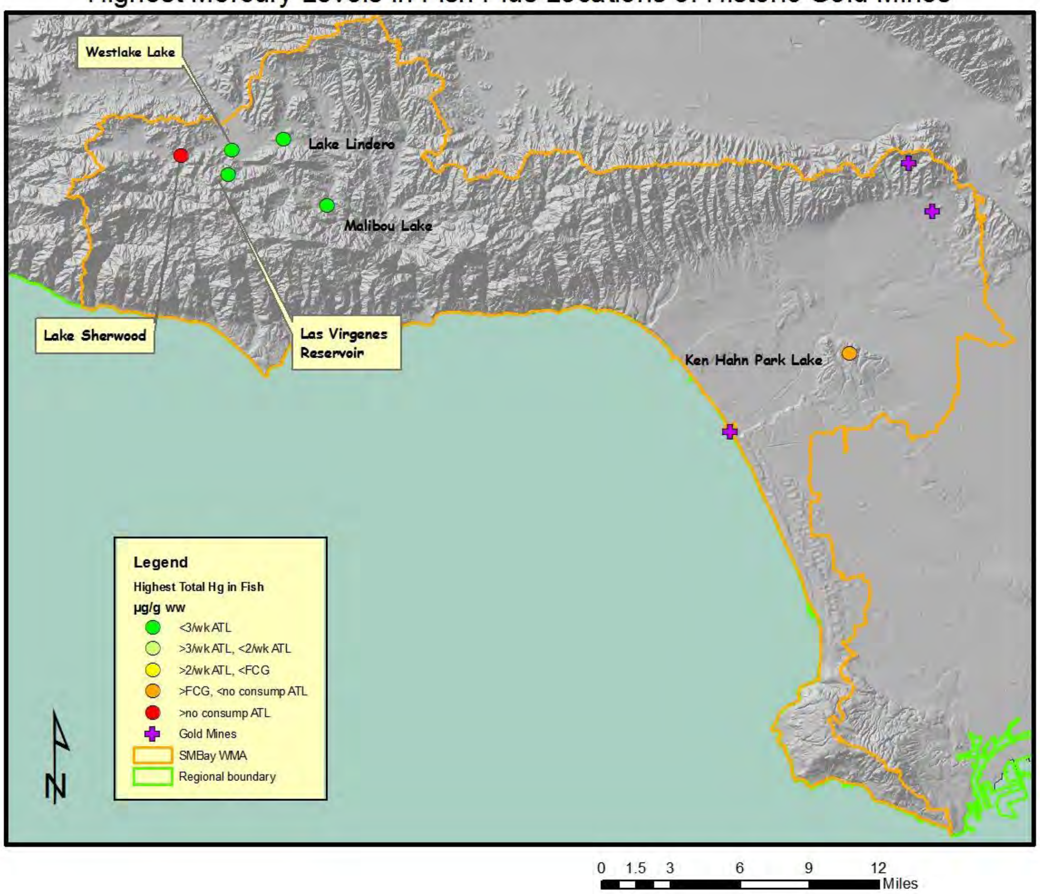


Figure 11

SWAMP Bioaccumulation Lake Survey
Highest Mercury Levels in Fish Plus Locations of Historic Gold Mines



Fish provide unique nutritional benefits while also serving as a significant exposure pathway for several chemicals of concern. Fish Contaminant Goals (FCGs) are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week (32 g/day), prior to cooking, over a lifetime and can provide a starting point for the California Office of Environmental Health Hazard Assessment (OEHHA) to assist other agencies that wish to develop fish tissue-based criteria with a goal toward pollution mitigation or elimination. FCGs prevent consumers from being exposed to more than the daily reference dose for non-carcinogens or to a risk level greater than 1x10-6 for carcinogens (not more than one additional cancer case in a population of 1,000,000 people consuming fish at the given consumption rate over a lifetime). FCGs are based solely on public health considerations without regard to economic considerations, technical feasibility, or the counterbalancing benefits of fish consumption (Klasing and Brodberg, 2008).

Advisory Tissue Levels (ATLs), while still conferring no significant health risk to individuals consuming sport fish in the quantities shown over a lifetime, were developed by OEHHA with the recognition that there are unique health benefits associated with fish consumption and that the advisory process should be expanded beyond conveying simple risk in order to best promote the overall health of the fish consumer. ATLs provide a number of recommended fish servings that correspond to the range of contaminant concentrations found in fish and are used to provide consumption advice to prevent consumers from being exposed to more than the average daily reference dose for non-carcinogens or to a risk level greater than 1x10-4 for carcinogens (not more than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime). ATLs are designed to encourage consumption of fish that can be eaten in quantities likely to provide significant health benefits, while discouraging consumption of fish that, because of contaminant concentrations, should not be eaten or cannot be eaten in amounts recommended for improving overall health (eight ounces total, prior to cooking, per week). ATLs are one of the criteria that will be used by OEHHA for issuing fish consumption guidelines (Klasing and Brodberg, 2008).

The figures above indicate there is relatively little risk from PCBs in fish caught from the WMA's lakes but some caution needs to be exercised with regards to mercury in fish at Lake Sherwood and at Ken Hahn Park Lake. The figures show the worst-case results from several species collected and analyzed; large-mouth bass by far accumulated the most mercury while other species showed much lower concentrations.

The Southern California Coastal Water Research Project produced a report in 2008 which presented the results of a study into the extent of fishing and fish consumption by fishers in Ventura and Los Angeles County Watersheds in 2005 (Allen et al., 2008). Surveyed sites included both lakes and streams. There were relatively few fishers at Lake Sherwood, a private lake; it was unknown how many consumed fish that were caught. Many more fishers were seen at Ken Hahn Park Lake but only about a quarter of those were interviewed about consumption; most of those interviewed consumed the fish they caught.

General Improvement Strategy

- **Develop TMDLs** Specifically, develop TMDLs for those lakes listed as impaired for fish consumption, namely, Lake Sherwood. Development of these TMDLs by USEPA is underway.

HABITAT DEGRADATION AND WILDLIFE IMPACTS

Human activities such as farming, urbanization, and commercial and industrial development, have significantly changed or degraded the watershed's habitats since the era of Spanish missions and ranchos. The natural habitats have either disappeared or been reduced to a great degree to make space for man-made structures, and/or the flora and fauna have been degraded or altered by pollution, the encroachment of non-native species, or overharvesting. Water temperature changes brought on by El Nino events as well as by releases of pollutants following earthquakes and fires have also contributed to changes in the watershed's ecological community (CRWQCB, 1997).

Marine Habitats

One of the impacts most evident in marine habitats is sediment contamination, which also biologically affects the food web. Contaminant release may occur through natural sediment dynamics, or through disturbance of the sediment, e.g., following vigorous winter storms. Organic compounds such as DDT, PCBs, polynuclear aromatic hydrocarbons (PAHs), and tributyltin (TBT) are found in sediments in concentrations that are harmful to marine organisms at various locations in the Bay. Also found in Bay sediments are heavy metals such as cadmium, copper, chromium, nickel, silver, zinc, and lead. The major historic sources of sediment contamination have been wastewater treatment facilities, thus the accumulations are highest near treatment plant outfalls off of Palos Verdes and Playa del Rey (CRWQCB, 1997).

Bioaccumulation of DDT in white croaker, Dover sole, and California brown pelicans are well-known examples of the impacts caused by sediment contamination. Prior to the 1980s, high concentrations of DDT were found in muscle tissues and/or eggshells of these organisms. DDT in these organisms are implicated in fin erosion and other diseases in fish as well as eggshell thinning and subsequent species decline in the California brown pelican (CRWQCB, 1997).

In addition to tissue damage to individuals caused by contaminated sediment, the health of benthic communities has been affected by discharge of solids and contaminants by wastewater treatment plants. The assemblages of benthic fauna found in areas impacted by historical discharges (pre-1987) near the outfalls have relatively lower diversity compared with other areas in the Bay, and are dominated by several opportunistic species (CRWQCB, 1997).

While areas with high levels of contamination from DDT, PCBs, and lead still remain, the top layer of sediment over most of the Bay is now much cleaner than it was in the 1970s. Banning the use of the most toxic chemicals (DDT and PCBs in the 1970s), initiation of wastewater pretreatment programs (in the 1970s), and improved treatment technology have all contributed to this improvement. Since the early 1980s, contaminant concentrations both in sediment and in the tissues of organisms continue to decrease, though at a much slower rate (CRWQCB, 1997).

The Marine Life Protection Act (MLPA) Initiative is a public-private partnership designed to help the State of California implement the MLPA using the best readily available science. The MLPA requires the state to redesign existing state marine protected areas (MPAs), and to establish a cohesive network of MPAs to protect, among other things, marine life, habitats, and ecosystems such as those described above. More information may be found at http://www.dfg.ca.gov/mlpa (CDFG website).

According to the 2010 State of the Bay report, most of the soft bottom habitat can now be considered in fair to excellent condition because it supports healthy benthic infaunal communities similar to those present within reference areas (except for in the sediments around the JWPCP outfall on the Palos Verdes Shelf). The condition of nearshore rocky reef habitat varies greatly from location to location and ranges from critical to fair condition with some sign of improvement. The recovery of kelp canopy has been considerable but its current extent is still less than 25% of the highs recorded one hundred years ago. Rocky reefs considered in critical condition are those off the southeast end of Malibu and near the Portuguese Bend landslide on Palos Verdes, both of which have been affected by excessive sedimentation. The open ocean, or pelagic, habitat is the most extensive habitat in the Bay; its condition is considered fair to good based on limited data from studies of algal blooms, phytoplankton and zooplankton, fish and mammal assemblage and population, contaminant burdens, and commercial and sportfish catch efforts. Offshore areas appear in better shape than nearshore areas due to distance from human activities (SMBRC, 2010).

General Improvement Strategies

- **Implement the Marine Life Protection Act** The State is in the process of accomplishing this.
- **Remediate contaminated sediments** USEPA signed an interim Record of Decision in September 2009 that selects a cleanup remedy for Palos Verdes Shelf. The selected remedy has three components: placing a cover of clean silty sand over the portion of the contaminated sediment deposit that has the highest contaminant surface concentrations and appears to be erosive; monitoring the natural recovery that is occurring in other areas of the Shelf; and continuing the Institutional Controls program that uses outreach and education, enforcement and monitoring to minimize consumption of fish that contain DDTs and PCBs. More information can be found at http://www.epa.gov/region09/superfund/pvshelf/.
- **Develop TMDLs** Specifically, develop TMDLs for the Santa Monica Bay nearshore and offshore impairments of sediment toxicity and DDTs/PCBs in sediment and fish tissue. Development of these TMDLs by USEPA is underway.

Beach and Intertidal Habitats

Prior to development, the coast between Santa Monica and the Palos Verdes Peninsula consisted primarily of sand dunes and sandy beaches which shifted due to the action of air and water currents. The process of urban development over the years has greatly reduced the size of these dunes and beaches at many locations due to jetties and other man-made structures which increase beach erosion and interfere with sediment transport (CRWQCB, 1997).

Certain species are of particular concern specifically because of the loss or degradation of southern California beach habitat. These include the endangered California least tern, El Segundo blue butterfly and Western snowy plover. Oil spills are also a potential threat to beaches and intertidal habitats, especially to such species as the California grunion, which lays its eggs on sandy beaches. With intense and increasing human use of the beaches and waters of Santa Monica Bay, both trash and the need for beach clean-up have increased. In addition, beaches and rocky intertidal habitats are vulnerable to the contaminants often contained in urban runoff. Filter-feeding intertidal organisms have a particularly high potential for bioaccumulating toxic organic compounds or trace metals. This is demonstrated by the fact that elevated levels of trace metals such as lead and chromium have been found in the tissues of California mussels near Marina del Rey (CRWQCB, 1997).

The 2010 State of the Bay report states that most of the rocky intertidal habitats are considered to be in poor condition with only a few areas, such as Inspiration Point on the Palos Verdes Peninsula, being in fair condition. The poor condition determination is based on a dramatic decline in the population of rocky intertidal organisms and evidence of decreased biodiversity, percentage of plant cover, organism size, and density of species such as octopi and sea hares. The conditions of sandy beach habitats range from poor to fair depending on location and level of manipulation, such as beach grooming, beachfront development, beach infrastructure, and storm drain inputs. Santa Monica Bay beaches are managed primarily for recreation and human safety rather than for value as habitat. The coastal dunes and bluffs along the Bay and on the Palos Verdes Peninsula are considered to be in poor condition due to severe degradation from invasive plants, coastal development, and erosion. The largest remaining contiguous habitat, located near Los Angeles

International Airport, is considered in good condition, largely due to greatly restricted access to the public; a population of the El Segundo blue butterfly persists there (SMBRC, 2010).

General Improvement Strategies

Implement TMDLs Adopted toxics TMDLs include Ballona Creek Metals (2005), Ballona Creek Estuary Toxic Pollutants (2005), and Marina del Rey Harbor Toxics (2006). Implementation plans, where available, and other information for these are available on the Regional Board website as follows:

Ballona Creek Metals

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_28_2005-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_60_2007-015_td.shtml

Ballona Creek Estuary Toxic Pollutants

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_29_2005-008_td.shtml

Marina del Rey Harbor Toxics

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_32_2005-012_td.shtml

Malibu Creek Trash

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_63_2008-007_td.shtml

Ballona Creek Trash

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_7_2001-014_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_25_2004-023_td.shtml

Santa Monica Bay Marine Debris

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Implement species recovery plans Particularly related to dunes and beaches habitats are recovery plans for the El Segundo blue butterfly and the California least tern. Five-year reviews of the recovery plans can be found at http://www.fws.gov/cno/es/California%20least%20tern%205-year%20review.FINAL.pdf

(California least tern) and http://ecos.fws.gov/docs/five_year_review/doc1896.pdf (El Segundo blue butterfly).

Implement beach bluff restoration master plan As described in the 2010 State of Bay report, 38 acres of potential sites in the South Bay area have been identified (SMBRC, 2010).

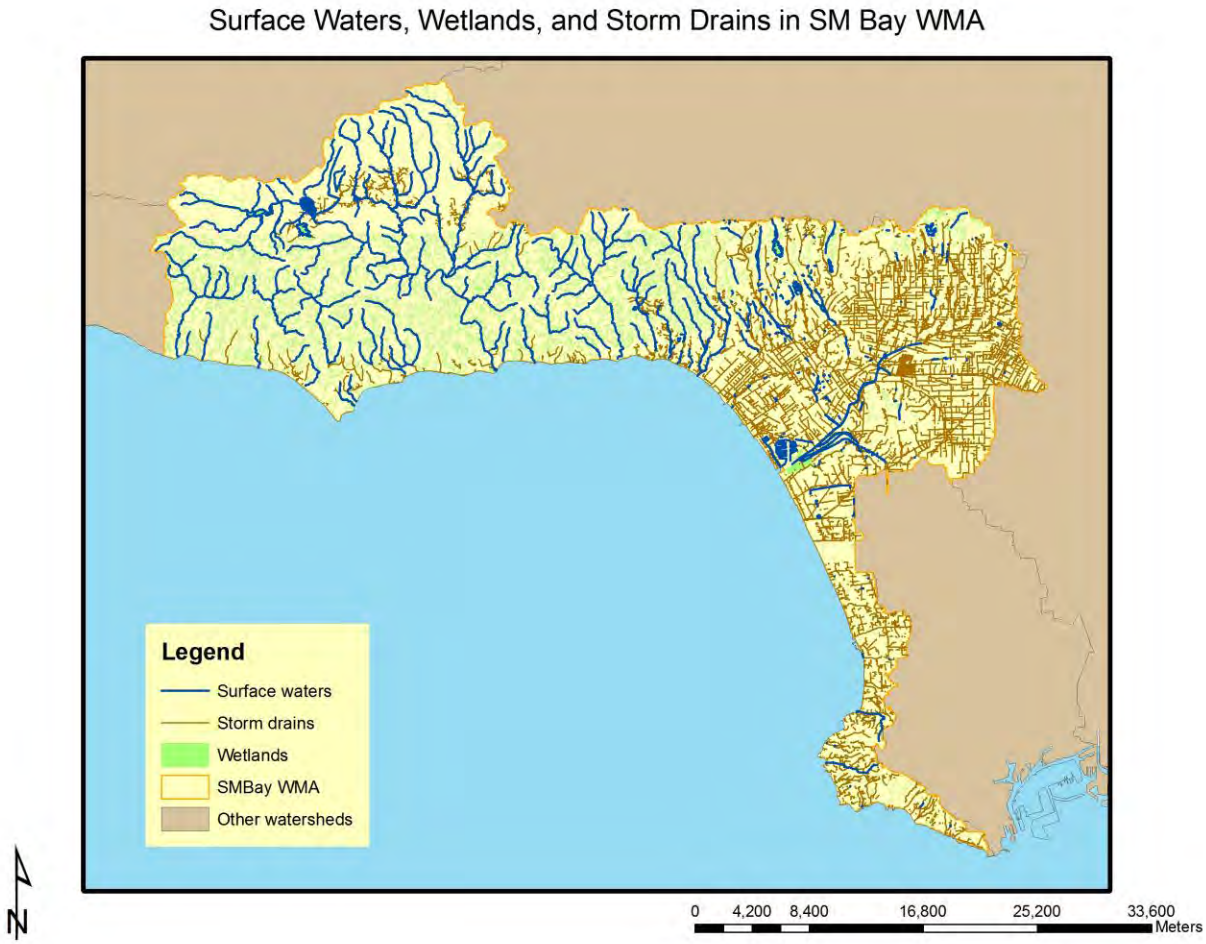
Coastal Wetlands and Riparian Habitats

Wetlands in southern California include freshwater, saltwater and brackish water marshes, swamps and mud flats. Wetlands help mitigate flooding, filter and recharge groundwater, and provide feeding and breeding habitat for fish and waterfowl. Urbanization has had a significant impact on the riparian and wetland resources of the watershed, primarily through filling, alteration of flows, and decrease in water quality. It is estimated that 90% of the historic wetlands of the Santa Monica Bay watershed have been eliminated, with the remaining wetlands significantly degraded (CRWQCB, 1997).

A number of brackish wetlands occur along the edge of Santa Monica Bay; the largest are the Ballona Wetlands Complex (Ballona Wetlands, Ballona Lagoon, Del Rey Lagoon, Oxford Flood Control Basin, and Venice Canals) and Malibu Lagoon. At one time, the Ballona Complex was 2,100 acres of coastal estuary and wetlands. But due to the development of Marina del Rey, the Venice canals, and other residential and commercial properties, as well as the drainage of wetlands for agricultural use and to control insects, and finally, channelization of Ballona Creek, the Ballona Complex had been reduced to approximately 430 acres until a recent acquisition by the State increased it to 600 acres. The site is a mixture of habitats dominated by coastal salt marsh. The 16-acre Ballona Lagoon is an artificially confined tidal channel that connects the Venice Canals to the Pacific Ocean. The 40-acre Malibu Lagoon, at the mouth of Malibu Creek, is also a remnant of a large system (CRWQCB, 1997).

The map below, utilizing a mix of draft and final wetlands data from the National Wetlands Inventory and a recent effort by the State to map coastal wetlands (not mapped for regulatory purposes), shows the much more extensive networks of wetlands remaining within the northern Santa Monica Bay area as compared to the more urbanized southern Santa Monica Bay watersheds. It also shows the dense network of storm drains which have replaced many of the wetlands in the southern Santa Monica Bay area.

Figure 12



The shrinking local wetlands support less biological diversity and are less productive because of their degraded condition. Restricted water flow, which results in poor water quality (high levels of nutrients and/or contaminants), and the actual loss of wetlands are major concerns at most sites. Additional adverse impacts include the lack of shallow water habitat, disruption of upstream flow, introduction of non-native plants and animals, debris and bacteria from urban runoff, and recreational over-use (CRWQCB, 1997).

The 2010 State of the Bay report describes the status of various habitat types and states the condition of the Bay's remaining coastal wetlands and lagoons is poor due to poor tidal exchange, polluted runoff, and the presence of invasive plants and animals; the one exception is considered to be Zuma Lagoon which is in good condition after completion of a restoration project. The report also states that the condition of most of the streams in coastal plain of the WMA is considered to be critical to poor due to the complete or nearly complete loss of their ecological functions, for instance, the almost complete channelization of the Ballona Creek and its tributaries. In the Santa Monica Mountains, streams such as Arroyo Sequit, Cold Creek, and Solstice Creek remain in relatively natural states and their condition is considered to be good to excellent. However, in the rest of the WMA, many streams can only be considered in fair to poor condition due to water quality problems, impacts from non-native species, and disruptions to natural stream flows (SMBRC, 2010).

General Improvement Strategies

Implement TMDLs Adopted toxics TMDLs which may affect wetlands include Ballona Creek Metals (2005), Ballona Creek Estuary Toxic Pollutants (2005), and Marina del Rey Harbor Toxics (2006). Implementation plans, where available, and other information for these are available on the Regional Board website as follows:

Ballona Creek Metals

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_28_2005-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_60_2007-015_td.shtml

Ballona Creek Estuary Toxic Pollutants

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_29_2005-008_td.shtml

Marina del Rey Harbor Toxics

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_32_2005-012_td.shtml

Implement the Bay Restoration Plan recommendations and the Wetlands Recovery Project's Regional Strategy The strategy for improving the WMA's wetlands focuses on restoration of priority wetlands and employs a local approach to improving protection. The restoration of the Ballona Wetlands is one of the highest priorities of both the Bay Restoration Commission and the Wetlands Recovery Project. Strategies on restoration, protection, and management of wetlands listed in the Bay Restoration Plan and Wetlands Recovery Project Regional Strategy include:

- Preserve and restore coastal wetland ecosystems
- Preserve and restore stream corridors and wetland ecosystems in coastal watersheds
- Recover native habitat and species diversity
- Integrate wetlands recovery with other public objectives
- Promote education and compatible access related to coastal wetlands and watersheds
- Advance the science of wetlands restoration and management in Southern California
- Protect existing wetlands through improved local regulations and policies.
- Enhance inter-agency coordination.
- Acquire private-owned wetlands.

- Ensure long-term management and monitoring for wetlands.
- Develop and implement a long-term education program focusing on wetlands (CRWQCB, 1997; SMBRC, 2010; SCWRP website #1).

Review applications for 401 water quality certifications The strategy for improving the WMA's wetlands focuses on protection of beneficial uses and implementation of appropriate monitoring. Specific activities include:
- Review of 401 water quality certification applications
- Evaluation of cumulative impacts from dredge and fill activities
- Oversight of compensatory mitigation
- Oversight of 401-certified activities

Upland Habitats

While most of the upland habitat in the coastal plain area of the WMA is now in an urbanized state, a much greater portion of the remaining upland habitat in the Santa Monica Mountains area is in public or non-profit ownership. Acquisition of parcels for their habitat or passive recreational value continues; for instance, the Santa Monica Mountains Conservancy works together with many government and nonprofit agencies to achieve the mutual goal of an interlinking network of parks, trails, and open space for public use and wildlife habitat surrounding the metropolitan areas of Los Angeles and Ventura Counties. The Conservancy works together with the National Park Service and the California Department of Recreation and Parks to cooperatively acquire and manage the parks in the Santa Monica Mountains National Recreation Area (SMMC website).

General Improvement Strategy

Implement the Wetlands Recovery Project's Regional Strategy The strategy for improving the WMA's wetlands includes recognition of the need for buffer areas between coastal wetlands and developed lands.

ASSESSING WATER QUALITY

The watershed's identified problems can be categorized in general as those caused by excessive pollutant loads and those caused by loss of sensitive habitats. Monitoring and special studies conducted over the years by the SMBRC, the Regional Board, dischargers, researchers, and citizen groups have mostly been geared toward evaluating problems associated with pollutants and contaminants although in recent years an increased emphasis on monitoring habitat quality has begun. This section concentrates on that aspect of the watershed's problems (CRWQCB, 1997).

Pollutant loading is the generation and dispersal of pollutants into the environment; a byproduct of the millions of people who reside or undertake activities in the Santa Monica Bay watershed. Pollutant loads have contributed to the impairment of beneficial uses of the Bay watershed. The SMBRP (now SMBRC) spent eight years participating in a multi-agency/stakeholder process which led to identifying the watershed's priority problems and the nineteen constituents that are identified as "pollutants of concern," as well as how these pollutants affect beneficial uses; these were presented in the ***1995 Bay Restoration Plan***. The nineteen pollutants of concern were identified because they presented the greatest problems to the Bay. Specifically, these pollutants met one of the following three criteria:

- Current loadings or historic deposits of the pollutant are impacting the beneficial uses in the watershed.
- Elevated levels of the pollutant are found in sediments of waterbodies in the watershed, or the pollutants have the potential to bioaccumulate.
- The detectable inputs of the pollutant are at a level high enough to be considered potentially toxic to humans and aquatic/marine life (CRWQCB, 1997).

The nineteen pollutants of concern identified were: DDT, PCBs, PAHs, chlordane, tributyltin (TBT), cadmium, chromium, copper, lead, nickel, silver, zinc, bacteria/viruses, total suspended solids, nutrients, trash, chlorine, oxygen demand, and oil & grease. It is important to recognize that not all pollutants of concern are applicable throughout the Bay and its watersheds. In many cases, the sources and the receiving water areas impacted by pollutant loading are restricted to a specific area of the region, as discussed in subsequent sections (CRWQCB, 1997).

Of these pollutants of concern, the organic pollutants DDT, PCBs, PAHs, and chlordane have the highest potential to bioaccumulate in living tissue and accumulate in sediments. The attributes of these chemicals are such that they are hydrophobic (do not mix well in water) and will adsorb onto particles that settle to the bottom or are incorporated into the fatty tissues of organisms living in the water or sediment. People will generally only be at risk should they consistently consume organisms such as fish which may have already bioaccumulated large amounts of these pollutants. DDT, chlordane, and PCBs are manmade chemicals; the first two are banned pesticides while PCBs are a class of chemicals formerly used in hydraulic fluids, paints, and transformers. PAHs are naturally occurring substances found in petroleum hydrocarbons and released through anthropogenic activities such as oil dripping from cars or spills during transport. Storm drains ultimately carry the material to sensitive coastal estuaries or to the ocean. Excessive concentrations of these chemicals in living tissue can lead to problems such as impaired reproduction and pre-cancerous lesions in marine organisms, and may raise the cancer risk in humans who consume these organisms (CRWQCB, 1997).

The metals cadmium, chromium, copper, lead, nickel, silver, and zinc can bioaccumulate in living tissue and accumulate in the sediment, but not to the degree of organic pollutant accumulation. On the other hand, metals can dissolve in the water column to some extent and occur at high enough concentrations to be toxic to aquatic organisms. Thus organisms may be impacted through both bioaccumulation and direct exposure in the sediment and water column. For example, copper is a component of anti-fouling paints applied to boats because it is very toxic to the fouling organisms which would normally attach to any available surface exposed under water. These metals are generally not a human health problem since metals concentrations in fish tissue are generally not high enough to impact humans and the amount of water a person may swallow while swimming is not enough to pose a risk (CRWQCB, 1997).

TBT is an organo-metal previously used extensively in anti-fouling paints. It is highly toxic to aquatic organisms and can be acutely toxic to humans applying the paint without proper safety equipment. It dissolves fairly easily in water but also degrades quickly. It can bioaccumulate in organisms to high concentrations and has been implicated in growth abnormalities in shellfish. Its high toxicity led to a ban in 1987 on its use except on boats of over 82 feet in length or on those with aluminum hulls. The rationale for the length restriction was that most boats moored in the water on a semi-continuous basis were smaller ones and the toxic components of paint leach out during that time (CRWQCB, 1997).

The impacts associated with bacteria and viruses primarily center on human health concerns (CRWQCB, 1997).

Suspended solids can convey organic pollutants to other locations. These solids also create turbidity in the water column and may impact plants such as kelp since light penetration may be reduced. Suspended solids are contributed by urban runoff and discharges from POTWs (CRWQCB, 1997).

Nutrients such as ammonia, nitrates, and phosphates can pose a variety of problems. In the Santa Monica Bay WMA, a major concern is their contribution to excessive growth of algae in streams and enclosed coastal lagoons. Nutrients are both naturally-occurring and produced by anthropogenic activities. Degradation of plant material will contribute nutrients but runoff from over-fertilized lawns and effluent resulting from the treatment of human waste will also contribute. While some algae should be expected, excessive amounts of nutrients added to shallow waters warmed during a summer day can result in a large explosion in algal growth. This growth can be considered a nuisance but may also be harmful if, during algal die-off, oxygen levels drop dramatically and kill fish (CRWQCB, 1997).

Trash is not only an aesthetics problem but poses an aquatic life hazard through consumption or entanglement (CRWQCB, 1997).

Chlorine is a chemical used for disinfection purposes at POTWs and is also used to kill off algae and slime growths in pipes at generating stations and elsewhere. Chlorine can be acutely toxic to aquatic organisms at excessive concentrations (CRWQCB, 1997).

Oxygen demand refers to a situation rather than a specific pollutant. Consumption of oxygen occurs with degradation of organic material such as dead leaves and algae. When this occurs in a water body with little circulation, an excessive demand is put on the available oxygen and fish kills can result. Although not likely to be a problem throughout the Bay, localized problems can occur near large discharge sites and in smaller enclosed receiving waters (CRWQCB, 1997).

Oil & grease is the physical manifestation of PAHs contamination. Usually mufti-colored sheens of oil will appear on the water surface. In most cases, the ultimate fate of the PAHs is of more concern than the sheen, however, if thick enough, oil may coat aquatic life and cause direct injury (CRWQCB, 1997).

The ***2004 State of the Bay Report*** re-evaluated environmental indicators. A diverse panel of environmental professionals chose 27 environmental indicators used in the report. The Bay's health was evaluated in three areas: pollutant loads, health risks to Bay users, and health of the Bay's living resources and habitats. The environmental indicators chosen for each area include:

Pollutant loads

- Mass loads of TSS and trace metals from wastewater treatment facilities
- Mass loads of TSS and trace metals from storm water runoff
- Watershed imperviousness
- Atmospheric input of trace metals
- Mass loading of trash from storm water runoff; trash inputs to the Bay were estimated at 1.4 million tons per year in 2004 (SMBRC, 2004)

Health risks

- Exceedances of bacterial indicator health risk thresholds at Santa Monica Bay beaches during dry and wet seasons
- Annual Average Beach Report Card grades
- Beach closures from sewage spills along the Bay coast
- Muscle tissue concentration of DDT and PCBs in white croaker, kelp bass and other sportfish

Habitats and living resources

- Acreage of protected and specially designated areas in the Bay and the Bay's watersheds
- Concentration of DDTs and trace metals in Bay bottom sediments
- Muscle tissue concentration of DDTs in Dover sole and hornyhead turbot
- Muscle tissue concentration of heavy metals in hornyhead turbot
- Benthic Response Index
- Fish Response Index
- Incidence of fish diseases
- Recreational catch per unit effort for indicator fish species
- Commercial catch per unit effort for indicator fish species
- Size of kelp canopy on Palos Verdes Shelf and along the Malibu Coast
- Available kelp-growing substrates
- Condition (size and density) of target rocky intertidal species
- Condition of grunion runs
- Percentage and acres of open space in the Bay watershed
- Acres of habitats acquired, and/or restored
- Linear miles of riparian habitats restored through non-native removal, fish passage restoration, etc.
- Breeding success of least tern at Venice Beach
- Condition of El Segundo blue butterflies (population and habitat) (SMBRC, 2004)

The SMBRC identified the following priority areas on which to focus resources:

- Achieve zero beach closure due to sewage spills.
- Achieve dry-weather bacteria TMDL limit along Bay beaches.
- Significantly reduce health risks associated with consuming Bay seafood.
- Reduce trash loading to the Bay by 50% by 2006.
- Restore Ballona Wetlands and Malibu Lagoon (SMBRC, 2004)

The ***2008 Update of the Bay Restoration Plan*** noted that significant progress had been made in improving water quality in the WMA. Major milestones accomplished included the upgrade to full secondary treatment by the City of Los Angeles' Hyperion treatment plant, and the County Sanitation Districts of Los Angeles County's Joint Water Pollution Control Plant (JWPCP), the two largest wastewater treatment facilities in the region; the development and implementation of Total Maximum Daily Loads (TMDLs) for waterbodies impaired by poor water quality; and adoption and implementation of the standard urban storm water mitigation plan under the municipal storm water permit (SMBRC, 2009).

The update report stated that despite this progress, significant amounts of pollutants such as trash, pathogens, and heavy metals continue to reach receiving waters. New challenges include addressing the loading and impacts of nutrients and emerging contaminants. Concerted efforts by regulatory and regulated communities are needed to overcome obstacles to further progress and address these new challenges (SMBRC, 2009).

The ***2010 State of the Bay Report*** observed that the pollutants of greatest concern, due to their adverse or potentially adverse impacts on the Bay's beneficial uses, are pathogens, trash, metals, DDT, PCBs, and nutrients. Known impacts of these pollutants include health hazards for humans due to pathogens in the surf zone, aesthetic impacts of trash along the Bay's beaches and streams, and chemical contamination of local fish. The report described the reduction of pollutant loads from wastewater treatment facilities with the greater relative contribution of pollutants through the storm drain system with, in particular, trash, pathogens, metals, and nutrients washing off the urban landscape, into storm drains, and out to the Bay. In addition, historical deposits of toxic pollutants in Bay sediments, such as DDT and PCBs, continue to be released into the environment through biological processes and resuspension, thus contaminating local marine life. Atmospheric deposition, boating activities, and septic systems are also known to contribute to contaminants to the Bay (SMBRC, 2010).

The development and adoption of TMDLs by the Regional Board which serve to assign load reductions needed to prevent impairment of beneficial uses, and their implementation largely through new control measures incorporated into existing National Discharge Elimination System (NPDES) permits was acknowledged. With regards to bacteria for example, the effort began with multiple low-flow diversions to the sanitary sewer at those drains with the most indicator bacteria exceedances. In some cases, year-round diversions have been necessary or installation of disinfection systems (SMBRC, 2010).

Today, impacts from invasive species is a growing concern in this WMA and, in fact, throughout the State. The invasive plant, giant reed, and the invasive animals, crayfish and New Zealand mudsnails, in particular are displacing native biota and degrading habitat (SMBRC, 2010).

California's 2010 Water Quality Assessment – Updating List of Impaired Waters

The State is required to assess the quality of its waters regularly and the results become part of a Water Quality Assessment document produced by the State Water Resources Control Board. Part of that assessment includes updating the State's list of impaired waters (Clean Water Act Section 303(d) list). It should be pointed out that all existing beneficial uses in each waterbody may not have been evaluated due to lack of data.

Surface Waters

The 2010 list of impaired waters indicates impairments of 30 square miles (out of 226 total square miles) of the Santa Monica Bay nearshore and offshore zones due to impacts on aquatic life, fish consumption, and shellfish harvesting. Various beaches are assessed as not supporting body contact recreation. Water quality in some streams within the Malibu subwatershed is impaired by excessive nutrients, bacteria, salts, and in some instances, metals. While natural sources contribute to the problem, nonpoint pollution from human activities is strongly implicated. The quality of the waterways draining more urbanized areas, such as Ballona Creek, is impaired due to a much longer list of pollutants including many metals and organic substances such as DDT and PCBs. Enclosed coastal waterbodies such as Malibu Lagoon are not fully supporting aquatic life, contact recreation, fish consumption, or shellfish harvesting beneficial uses, while many of the watershed's lakes are not supporting contact recreation, aquatic life, or fish consumption beneficial uses. The full report should be consulted for more detailed information (SWRCB website #1).

Table 1. List of Impaired Waters (Clean Water Act Section 303(d)) Approved by USEPA for 2010

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Santa Monica Bay Beaches				
Abalone Cove Beach	DDT (sediment)	TMDL required	1/1/2019	
Abalone Cove Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Abalone Cove Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Amarillo Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Amarillo Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Big Rock Beach	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Big Rock Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Big Rock Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Bluff Cove Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Bluff Cove Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Bluff Cove Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Carbon Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Carbon Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Carbon Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Castlerock Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Castlerock Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Castlerock Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Dan Blocker Memorial (Coral) Beach (includes the area of the beach at Latigo Beach and Solstice Canyon)	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Dockweiler Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Escondido Beach	DDT (fish consumption advisory)	TMDL required	1/1/2021	
Escondido Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Escondido Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Flat Rock Point Beach Area	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Flat Rock Point Beach Area	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Flat Rock Point Beach Area	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Hermosa Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Inspiration Point Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Inspiration Point Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Inspiration Point Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
La Costa Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
La Costa Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
La Costa Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Las Flores Beach	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Las Flores Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Las Flores Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Las Tunas Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Las Tunas Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Las Tunas Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Leo Carillo Beach (South of County Line)	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Long Point Beach	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Long Point Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Long Point Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Lunada Bay Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Malaga Cove Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Malaga Cove Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Malaga Cove Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Malibu Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Malibu Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Malibu Lagoon Beach (Surfrider)	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Malibu Lagoon Beach (Surfrider)	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Malibu Lagoon Beach (Surfrider)	PCBs (fish consumption advisory)	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Manhattan Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Nicholas Canyon Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Nicholas Canyon Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Nicholas Canyon Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Palo Verde Shoreline Park Beach	Pathogens	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Palo Verde Shoreline Park Beach	Pesticides	TMDL required	1/1/2019	
Paradise Cove Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Paradise Cove Beach	Fecal Coliform	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Paradise Cove Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Point Dume Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Point Dume Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Point Dume Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Point Fermin Park Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Point Fermin Park Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Point Fermin Park Beach	Total Coliform	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Point Vicente Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Portuguese Bend Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Portuguese Bend Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Portuguese Bend Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Puerco Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	

Water Quality Limited Segment	**Pollutant**	**TMDL Status**	**Expected TMDL Completion Date**	**Completed TMDL**
Puerco Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Puerco Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Redondo Beach	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Redondo Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Redondo Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Resort Point Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Robert H. Meyer Memorial Beach	Beach Closures	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Robert H. Meyer Memorial Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Robert H. Meyer Memorial Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Royal Palms Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Royal Palms Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Royal Palms Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Santa Monica Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Sea Level Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Sea Level Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Sea Level Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Topanga Beach	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Topanga Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Topanga Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Torrance Beach	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Trancas Beach (Broad Beach)	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Trancas Beach (Broad Beach)	Fecal Coliform	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Trancas Beach (Broad Beach)	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Venice Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Whites Point Beach	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Whites Point Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Whites Point Beach	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Will Rogers Beach	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Zuma Beach (Westward Beach)	DDT (fish consumption advisory)	TMDL required	1/1/2019	
Zuma Beach (Westward Beach)	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Zuma Beach (Westward Beach)	PCBs (fish consumption advisory)	TMDL required	1/1/2019	
Ballona Creek Subwatershed				
Ballona Creek	Cadmium (sediment) (a USEPA-approved TMDL has made a finding of non-impairment for this pollutant)	TMDL completed		Ballona Creek Metals TMDL, 2008
Ballona Creek	Coliform Bacteria	TMDL completed		Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL, 2007
Ballona Creek	Copper, Dissolved	TMDL completed		Ballona Creek Metals TMDL, 2008
Ballona Creek	Cyanide	TMDL required	1/1/2019	
Ballona Creek	Lead	TMDL completed		Ballona Creek Metals TMDL, 2008
Ballona Creek	Selenium	TMDL completed		Ballona Creek Metals TMDL, 2008
Ballona Creek	Toxicity	TMDL completed		Ballona Creek Metals TMDL, 2008
Ballona Creek	Trash	TMDL completed		Ballona Creek and Wetlands Trash TMDL; 2002, 2005
Ballona Creek	Viruses (enteric)	TMDL completed		Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL, 2007
Ballona Creek	Zinc	TMDL completed		Ballona Creek Metals TMDL, 2008

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Ballona Creek Estuary	Cadmium	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	Chlordane (tissue & sediment)	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	Coliform Bacteria	TMDL completed		Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL, 2007
Ballona Creek Estuary	Copper	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	DDT (tissue & sediment)	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	Lead (sediment)	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	PAHs (Polycyclic Aromatic Hydrocarbons) (sediment)	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	PCBs (tissue & sediment)	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	Sediment Toxicity	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Estuary	Shellfish Harvesting Advisory	TMDL required	1/1/2006	
Ballona Creek Estuary	Silver	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Ballona Creek Estuary	Zinc (sediment)	TMDL completed		Ballona Creek Estuary Toxic Pollutants TMDL, 2006
Ballona Creek Wetlands	Exotic Vegetation	TMDL required	1/1/2019	
Ballona Creek Wetlands	Habitat alterations	TMDL required	1/1/2019	
Ballona Creek Wetlands	Hydromodification	TMDL required	1/1/2019	
Ballona Creek Wetlands	Reduced Tidal Flushing	TMDL required	1/1/2019	
Ballona Creek Wetlands	Trash	TMDL completed		Ballona Creek and Wetlands Trash TMDL; 2002, 2005
Marina del Rey Harbor - Back Basins	Chlordane (tissue & sediment)	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor - Back Basins	Copper (sediment)	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor - Back Basins	DDT (tissue) (a USEPA-approved TMDL has made a finding of non-impairment for this pollutant)	TMDL required	1/1/2005	
Marina del Rey Harbor - Back Basins	Dieldrin (tissue) (a USEPA-approved TMDL has made a finding of non-impairment for this pollutant)	TMDL required	1/1/2005	
Marina del Rey Harbor - Back Basins	Fish Consumption Advisory	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor - Back Basins	Indicator Bacteria	TMDL completed		Marina del Rey Harbor Mothers' Beach and Back Basins Bacteria TMDL, 2004

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Marina del Rey Harbor - Back Basins	Lead (sediment)	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor - Back Basins	PCBs (tissue & sediment) (shellfish harvesting advisory)	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor - Back Basins	Sediment Toxicity	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor - Back Basins	Zinc (sediment)	TMDL completed		Marina del Rey Harbor Toxics TMDL, 2006
Marina del Rey Harbor Beach	Indicator Bacteria	TMDL completed		Marina del Rey Harbor Mothers' Beach and Back Basins Bacteria TMDL, 2004
Malibu Creek Subwatershed				
Lake Lindero	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lake Lindero	Chloride	TMDL required	1/1/2019	
Lake Lindero	Eutrophic	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lake Lindero	Odor	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lake Lindero	Selenium	TMDL required	1/1/2019	
Lake Lindero	Specific Conductivity	TMDL required	1/1/2019	
Lake Lindero	Trash	TMDL	1/1/2019	

		required		
Water Quality Limited Segment	**Pollutant**	**TMDL Status**	**Expected TMDL Completion Date**	**Completed TMDL**
Lake Sherwood	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lake Sherwood	Ammonia	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lake Sherwood	Eutrophic	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lake Sherwood	Mercury (tissue)	TMDL required	1/1/2019	
Lake Sherwood	Organic Enrichment/Low Dissolved Oxygen	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Las Virgenes Creek	Benthic-Macroinvertebrate Bioassessments	TMDL required	1/1/2021	
Las Virgenes Creek	Coliform Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Las Virgenes Creek	Invasive Species	TMDL required	1/1/2021	
Las Virgenes Creek	Nutrients (Algae)	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Las Virgenes Creek	Organic Enrichment/Low Dissolved Oxygen	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Las Virgenes Creek	Scum/Foam-unnatural	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Las Virgenes Creek	Sedimentation/Siltation	TMDL required	1/1/2019	
Las Virgenes Creek	Selenium	TMDL required	1/1/2019	
Las Virgenes Creek	Trash	TMDL required	1/1/2019	
Lindero Creek Reach 1	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lindero Creek Reach 1	Benthic-Macroinvertebrate Bioassessments	TMDL required	1/1/2021	
Lindero Creek Reach 1	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Lindero Creek Reach 1	Invasive Species	TMDL required	1/1/2021	
Lindero Creek Reach 1	Scum/Foam-unnatural	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lindero Creek Reach 1	Selenium	TMDL required	1/1/2019	
Lindero Creek Reach 1	Trash	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Lindero Creek Reach 2 (Above Lake)	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lindero Creek Reach 2 (Above Lake)	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Lindero Creek Reach 2 (Above Lake)	Scum/Foam-unnatural	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Lindero Creek Reach 2 (Above Lake)	Selenium	TMDL required	1/1/2019	
Lindero Creek Reach 2 (Above Lake)	Trash	TMDL required	1/1/2019	
Malibou Lake	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Malibou Lake	Eutrophic	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Malibou Lake	Organic Enrichment/Low Dissolved Oxygen	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Malibu Creek	Benthic-Macroinvertebrate Bioassessments	TMDL required	1/1/2021	
Malibu Creek	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Malibu Creek	Fish Barriers (Fish Passage)	TMDL required	1/1/2019	

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Malibu Creek	Invasive Species	TMDL required	1/1/2021	
Malibu Creek	Nutrients (Algae)	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Malibu Creek	Scum/Foam-unnatural	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Malibu Creek	Sedimentation/Siltation	TMDL required	1/1/2019	
Malibu Creek	Selenium	TMDL required	1/1/2019	
Malibu Creek	Sulfates	TMDL required	1/1/2019	
Malibu Creek	Trash	TMDL completed		Malibu Creek Watershed Trash TMDL, 2009
Malibu Lagoon	Benthic Community Effects	TMDL required	1/1/2011	
Malibu Lagoon	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Malibu Lagoon	Eutrophic	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Malibu Lagoon	pH	TMDL required	1/1/2006	
Malibu Lagoon	Swimming Restrictions	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Malibu Lagoon	Viruses (enteric)	TMDL completed		Malibu Creek Bacteria TMDL, 2006

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Medea Creek Reach 1 (Lake to Confl. with Lindero)	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Medea Creek Reach 1 (Lake to Confl. with Lindero)	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Medea Creek Reach 1 (Lake to Confl. with Lindero)	Sedimentation/Siltation	TMDL required	1/1/2019	
Medea Creek Reach 1 (Lake to Confl. with Lindero)	Selenium	TMDL required	1/1/2019	
Medea Creek Reach 1 (Lake to Confl. with Lindero)	Trash	TMDL required	1/1/2019	
Medea Creek Reach 2 (Abv Confl. with Lindero)	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Medea Creek Reach 2 (Abv Confl. with Lindero)	Benthic-Macroinvertebrate Bioassessments	TMDL required	1/1/2021	
Medea Creek Reach 2 (Abv Confl. with Lindero)	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Medea Creek Reach 2 (Abv Confl. with Lindero)	Invasive Species	TMDL required	1/1/2021	
Medea Creek Reach 2 (Abv Confl. with Lindero)	Sedimentation/Siltation	TMDL required	1/1/2019	
Medea Creek Reach 2 (Abv Confl. with Lindero)	Selenium	TMDL required	1/1/2019	
Medea Creek Reach 2 (Abv Confl. with Lindero)	Trash	TMDL required	1/1/2019	
Palo Comado Creek	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006
Stokes Creek	Coliform Bacteria	TMDL completed		Malibu Creek Bacteria TMDL, 2006

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Triunfo Canyon Creek Reach 1	Lead	TMDL required	1/1/2019	
Triunfo Canyon Creek Reach 1	Mercury	TMDL required	1/1/2019	
Triunfo Canyon Creek Reach 1	Sedimentation/Siltation	TMDL required	1/1/2019	
Triunfo Canyon Creek Reach 2	Benthic-Macroinvertebrate Bioassessments	TMDL required	1/1/2021	
Triunfo Canyon Creek Reach 2	Lead	TMDL required	1/1/2019	
Triunfo Canyon Creek Reach 2	Mercury	TMDL required	1/1/2019	
Triunfo Canyon Creek Reach 2	Sedimentation/Siltation	TMDL required	1/1/2019	
Westlake Lake	Algae	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Westlake Lake	Ammonia	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Westlake Lake	Eutrophic	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)
Westlake Lake	Lead	TMDL required	1/1/2019	
Westlake Lake	Organic Enrichment/Low Dissolved Oxygen	TMDL completed		Malibu Creek Watershed Nutrients TMDL, 2003 (established by USEPA)

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Other Areas				
Santa Monica Canyon	Indicator Bacteria	TMDL completed		Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
Santa Monica Canyon	Lead	TMDL required	1/1/2019	
Santa Monica Bay Offshore/Nearshore	DDT (tissue & sediment)	TMDL required	1/1/2019	
Santa Monica Bay Offshore/Nearshore	Debris	TMDL completed		Santa Monica Bay Nearshore and Offshore Debris TMDL, 2010
Santa Monica Bay Offshore/Nearshore	Fish Consumption Advisory (due to DDT and PCBs)	TMDL required	1/1/2019	
Santa Monica Bay Offshore/Nearshore	PCBs (tissue & sediment)	TMDL required	1/1/2019	
Santa Monica Bay Offshore/Nearshore	Sediment Toxicity	TMDL required	1/1/2019	
Sepulveda Canyon	Ammonia	TMDL required	1/1/2019	
Sepulveda Canyon	Copper	TMDL completed		Ballona Creek Metals TMDL, 2008
Sepulveda Canyon	Indicator Bacteria	TMDL completed		Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL, 2007
Sepulveda Canyon	Lead	TMDL completed		Ballona Creek Metals TMDL, 2008
Sepulveda Canyon	Selenium	TMDL completed		Ballona Creek Metals TMDL, 2008
Sepulveda Canyon	Zinc	TMDL completed		Ballona Creek Metals TMDL, 2008

Water Quality Limited Segment	Pollutant	TMDL Status	Expected TMDL Completion Date	Completed TMDL
Solstice Canyon Creek	Invasive Species	TMDL required	1/1/2021	
Topanga Canyon Creek	Lead	TMDL required	1/1/2019	

Groundwaters

Groundwater accounts for only a limited portion of the Santa Monica Bay WMA's supply of fresh water; however, the general quality of groundwater in the watershed has degraded from background levels. Much of degradation reflects land uses (CRWQCB, 1997).

In this watershed area, fertilizers and pesticides, typically used on agricultural lands, contribute to degrade groundwater. In areas that are unsewered, such as Malibu, nitrogen and pathogenic bacteria from overloaded or improperly sited septic tanks can seep into ground water and result in health risks to those who rely on groundwater for domestic water supplies. In areas with aboveground and underground storage tanks, toxics have leaked or are leaking, which can result in volatile organic compounds or petroleum compounds pollution in groundwater. An example of this is the methyl tertiary butyl ether (MTBE) contamination in the city of Santa Monica which has affected a number of wells in the Santa Monica Basin. Compared to surface water pollution, investigation and remediation of polluted groundwater are often more difficult, costly, and time-consuming (CRWQCB, 1997).

Seawater intrusion created by overpumping also has been a problem in the West Coast groundwater basin. However, it is under control in most areas through an artificial recharge system consisting of spreading grounds and injection wells that form a fresh water barrier along the coast. Other replenishment programs are underway using storm runoff, imported water, and recycled water to accomplish reversal of intrusion (CRWQCB, 1997).

The USGS sampled the Los Angeles Region's coastal priority groundwater basins as part of State Board's Groundwater Ambient Monitoring and Assessment (GAMA) program in 2006. Groundwater basins within the Santa Monica Bay WMA included in this sampling were the Santa Monica, Hollywood, West Coast, and Central Basins. The study was designed to provide a spatially unbiased assessment of raw groundwater quality within the targeted basins, as well as a statistically consistent basis for comparing water quality throughout California (USGS, 2009).

The study did not attempt to evaluate the quality of drinking water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, and/or blended with other waters to maintain acceptable drinking water quality. VOCs were detected in almost three-quarters of the grid wells, and pesticides and pesticide degradates were detected in 42 percent of the grid (randomized) wells. Potential wastewater indicators were detected in 44 percent of the grid wells. All of the detections of these organic compounds in samples from grid wells were below health-based thresholds, with the exception of tetrachloromethane (carbon tetrachloride), a VOC, which was detected above the maximum contaminant level set by the California Department of Public Health (CDPH) (MCL-CA). In targeted wells, there were two detections of trichloroethene (TCE) and one detection of perchloroethene (PCE) above the maximum contaminant level set by USEPA (MCL-US) (USGS, 2009).

Nutrient and trace element concentrations in the grid wells were below health-based thresholds. There were two detections of boron above the California notification level set by the CDPH (NL-CA) in the targeted wells. Activities of radioactive constituents in water samples collected in grid wells were below health-based thresholds, with the exception of two detections of radon-222 that were above the proposed MCL-US; however, none of the samples had an activity above the proposed alternative MCL-US. Total coliforms were detected at one of the targeted wells. Most of the samples from grid wells had concentrations of major elements and total dissolved solids below the non-enforceable thresholds set for aesthetic concerns. Four grid wells had total dissolved solids concentrations above the secondary maximum contaminant level set by the CDPH (SMCL-CA). There were two detections of manganese, and four detections of iron in grid wells above their respective SMCL-CAs, and a single detection of arsenic above the MCL-US. Two targeted wells had concentrations of chloride and sulfate above the recommended SMCL-CA (USGS, 2009).

The WMA's Designated Beneficial Uses

The Regional Board designates beneficial uses of all waterbodies in the Water Quality Control Plan for the Ventura and Los Angeles Coastal Watersheds (usually referred to as Basin Plan). These beneficial uses are the cornerstone of the State and Regional Board's efforts to protect water quality, as water quality objectives are set at levels that will protect the most sensitive beneficial use of a waterbody. Together, beneficial uses and water quality objectives form water quality standards (CRWQCB, 1994).

Twenty beneficial uses for surface waters and four beneficial uses for ground waters in the Santa Monica Bay WMA are designated in the Regional Board's Basin Plan. These beneficial uses are listed by waterbody and hydrologic unit in the table below for surface waters and by basin name and number for ground waters in a separate table. Certain site-specific water quality objectives, namely TDS, sulfate, chloride, boron, and--for surface waters--nitrogen, reflect background levels of constituents in the mid-1970s, in accordance with the State Board's Antidegradation Policy. Water quality objectives for these and for other constituents and parameters can be found in the Basin Plan (CRWQCB, 1994). It should be pointed out that more detailed analyses of beneficial uses occur as needed; these issues are often identified during the Basin Plan Triennial Review process.

Table 2. Beneficial uses of surface waters within the Santa Monica Bay WMA (combined from multiple tables in the Basin Plan) (CRWQCB, 1994)

Coastal Feature or Waterbody[a]	Hydro Unit #	MUN	IND	PROC	AGR	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET[b]
Arroyo Sequit	404.44	P*				I		E	E		E	E			E		E	E	E		E
San Nicholas Canyon Creek	404.43	P*						I	I		I				E						
Los Alisos Canyon Creek	404.42	P*						I	I		I				E		E				
Lachusa Canyon Creek	404.42	P*						I	I		I				E						
Encinal Canyon Creek	404.41	P*						I	I		I				E		E				
Trancas Canyon Creek	404.37	E*						Em	E		E				E		E				
Dume Lagoon [c]	404.36						E	E	E	E			E		E		Ee	Pf	Pf		E
Dume Creek (Zuma Canyon)	404.36	E*						E	E		E	E			E		E	P	P		
Ramirez Canyon Creek	404.35	I*						I	I		I				E				P		
Escondido Canyon Creek	404.34	I*						I	I		I				E		E				
Latigo Canyon Creek	404.33	I*						I	I		I				E		E				
Solstice Canyon Creek	404.32	E*						E	E		E				E			P	P		
Puerco Canyon Creek	404.31	I*						I	I		I				E						
Corral Canyon Creek	404.31	I*						I	I		I				E						
Carbon Canyon Creek	404.16	P*						I	I		I				E						
Las Flores Canyon Creek	404.15	P*						I	I		I				E						
Piedra Gorda Canyon Creek	404.14	P*						I	I		I				E						
Pena Canyon Creek	404.13	P*						I	I		I	E			E						
Tuna Canyon Creek	404.12	P*						I	I		I				E						
Topanga Lagoon [c]	404.11						E	E	E	E			E		E		Ee	Ef	Ef		E

Coastal Feature or Waterbody[a]	Hydro Unit #	MUN	IND	PROC	AGR	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET[b]
Topanga Canyon Creek	404.11	P*						I	I		E	E			E			P	I		
Santa Ynez Canyon	405.13	P*						I	E		I				E		E				
Santa Ynez Lake (Lake Shrine)	405.13	P*						Pk	E		E				E						
Santa Monica Canyon Channel	405.13	P*						Ps	I		P				E						
Rustic Canyon Creek	405.13	P*						I	I		I				E						
Sullivan Canyon Creek	405.13	P*						I	I		I				E						
Mandeville Canyon Creek	405.13	P*						I	I		I				E						
Coastal Streams of Palos Verdes	405.11	P*				I		I	I		I				P		E				
Canyon Streams trib. to Coastal Streams of Palos Verdes	405.12	P*				I		I	I		I				E E		Et				
Stone Canyon Reservoir	405.13	E*	E	E		P		Pk	E		E				E						
Hollywood Reservoir	405.14	E*	E	E		P		Pk	E		E				E						
Franklin Canyon Reservoir	405.14	E*						Pk,u			Pu										
Upper Franklin Canyon Reservoir	405.14	E*	E	E		P		P	E		E				E						E
Malibu Lagoon c	404.21						E	E	E				E	E	E		Ee	Ef	Ef		E
Malibu Creek	404.21	P*						E	E		E	E			E		E	E	E		E
Cold Creek	404.21	P*						E	E			P			E		E		P		E
Las Virgenes Creek	404.22	P*						Em	E		E	P			E		E	P	P		E
Century Reservoir	404.21	P*						E	E		E				E						E
Malibou Lake	404.24	P*					E	E	E		E				E		E				E

Coastal Feature or Waterbody[a]	Hydro Unit #	MUN	IND	PROC	AGR	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET[b]
Medea Creek	404.23	P*				I		Im	I		I	P			E		E				E
Medea Creek	404.24	P*				I		Em	E		E				E						E
Lindero Creek	404.23	P*						I	I		I				E						
Triunfo Creek	404.24	P*						Im	I		I				E						
Triunfo Creek	404.25	P*				I		Im	I		I				E		E				
Westlake Lake	404.25	P*					E	E	E		E				E						
Potrero Valley Creek	404.25	P*				I		I	I		P				E						
Lake Eleanor Creek	404.25	P*				I		I	I		I				E						
Lake Eleanor	404.25	P*				E		E	E		E				E		E				E
Las Virgenes (Westlake) Reservoir	404.25	E	E	E	E			Pk,v	E		P				E						
Hidden Valley Creek	404.26	I*				I		I	I		I				E						
Lake Sherwood	404.26	P*				E	E	E	E		E				E						E
Ballona Creek Estuary c,w	405.13						E	E	E	E			E	E	E		Ee	Ef	Ef	E	
Ballona Lagoon/ Venice Canals c	405.13						E	E	E	E			E	E	E		Ee	Ef	Ef	E	E
Ballona Wetlands c	405.13							E	E				E		E		Ee	Ef	Ef		E
Del Rey Lagoon c	405.13						E	E	E	E			E		E		Ee	Ef	Ef		E
Ballona Creek to Estuary	405.13	P*						ELac, ad	Ead		P				P						
Ballona Creek	405.15	P*							Ead		P				E						
Nearshore Zone ^			E				E	E	E	E				E	E	Ean	Ee	Ef	Ef	Ear	
Offshore Zone			E				E	E	E	E				E	E		Ee	Ef	Ef	E	
Nicholas Canyon Beach	403.43						E	E	E	E				E	E				P	E	
Trancas Beach	403.37						E	E	E	E				E	E				P	E	
Zuma County (Westward) Beach	404.35						E	E	E	E				E	E				P	Ear	
Dume State Beach	404.36						E	E	E	E				E	E				P	E	

Coastal Feature or Waterbody[a]	Hydro Unit #	MUN	IND	PROC	AG R	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET[b]
Dume Lagoon c	404.36						E	E	E	E			E		E		Ee	Pf	Pf		E
Escondido Beach	404.34						E	E	E	E				E	E				P	E	
Dan Blocker Memorial (Corral) Beach	404.31						E	E	E	E	E			E	E				P	E	
Puerco Beach	404.31						E	E	E	E				E	E				P	E	
Amarillo Beach	404.21						E	E	E	E				E	E				P	E	
Malibu Beach	404.21						E	E	E	E				E	E			E	Eas	Ear	
Malibu Lagoon c	404.21						E	E	E				E	E	E		Ee	Ef	Ef		E
Carbon Beach	404.16						E	E	E	E				E	E				P	E	
La Costa Beach	404.16						E	E	E	E				E	E				P	E	
Las Flores Beach	404.15						E	E	E	E				E	E				P	E	
Las Tunas Beach	404.12						E	E	E	E				E	E				P	E	
Topanga Beach	404.11						E	E	E	E				E	E				P	E	
Topanga Lagoon c	405.11						E	E	E	E			E		E		Ee	Ef	Ef		E
Will Rogers State Beach	405.13						E	E	E	E				E	E				P	E	
Santa Monica Beach	405.13						E	E	E	E				E	E			E	Eas	E	
Venice Beach	405.13						E	E	E	E				E	E		E	E	Eas	E	
Marina Del Rey								E													
Harbor	405.13						E	E	E	E				E	E					E	
Public Beach Areas	405.13						E	E	E	E				E	E		E				
All other Areas	405.13						E	P	E	E				E	E		E			E	
Entrance Channel	405.13						E	E	E	E				E	E		E			E	
Dockweiler Beach	405.12		E				E	E	E	E				E	E				P		
Manhattan Beach	405.12						E	E	E	E				E	E				P	E	
Hermosa Beach	405.12						E	E	E	E				E	E				Eas	E	
King Harbor	405.12		E				E	E	E	E				E	E		E				
Redondo Beach	405.12		E				E	E	E	E				E	E		E	E	Eas	E	

Coastal Feature or Waterbody[a]	Hydro Unit #	MUN	IND	PROC	AGR	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET[b]
Torrance Beach	405.12						E	E	E	E				E	E			E	Eas	E	
Port Vicente Beach	405.11						E	E	E	E				E	E				P	E	
Royal Palms Beach	405.11						E	E	E	E				E	E				P	E	
Whites Point County Beach	405.11						E	E	E	E				E	E				P	E	

a Waterbodies are listed multiple times if they cross hydrologic area or subarea boundaries. Beneficial use designations apply to all tributaries to the indicated waterbody, if not listed separately.
b Waterbodies designated as WET may have wetlands habitat associated with only a portion of the waterbody. Any regulatory section would require a detailed analysis of the area.
c Coastal waterbodies which are also listed in Coastal Features Table (2-3) or in Wetlands Table (2-4)..
e One or more rare species utilize all ocean, bays, estuaries, and coastal wetlands for foraging and/or nesting/
f Aquatic organisms utilize all bays, estuaries, lagoons and coastal wetlands, to a certain extent, for spawning and early development. This may include migration into areas which are heavily influenced by freshwater inputs
k Public access to reservoir and its surrounding watershed is prohibited by Los Angeles County Department of Public Works.
m Access prohibited by Los Angeles County Department in the concrete-channelized areas.
s Access prohibited by Los Angeles Count DPW.
t Rare applies only to Agua Magna Canyon & Sepulveda Canyon areas.
u This reservoir is covered and thus inaccessible.
v Public water supply reservoir. Owner prohibits public entry.
w These areas are engineered channels. All references to Tidal Prisms in Regional Board documents are functionally equivalent to estuaries.
x Owner prohibits entry.
ac Limited (L) REC-1 use based on shallow water depths and infrequent use
ad The High Flow Suspension only applies to water contact recreational activities associated with the swimmable goal as expressed in the federal Clean Water Action Section 101(a)(2) and regulated under the REC-1 use, non-contact water recreation involving incidental water contact regulated under the REC-2 use, and the associated bacteriological objectives set to protect those activities. Water quality objectives set to protect (1) other recreational uses associated with the fishable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use and (2) other REC-2 uses (e.g., uses involving the aesthetic aspects of water) shall remain in effect at all times for waters where this footnote appears.
an Areas of Special Biological Significance (along coast from Latigo Point to Laguna Point) and Big Sycamore Canyon and Abalone Cove Ecological Reserves and Point Femin Marine Life Refuge.
ar Areas exhibiting large shellfish populations include Malibu, Point Dume, Point Fermin, White Point and Zuma Beach.
as Most frequently used grunion spawning beaches. Other beaches may be used as well.
E: Existing beneficial use
P: Potential beneficial use
I: Intermittent beneficial use
E,P, and I: shall be protected as required
***** Asterisked MUN designations are designated under SB 88-63 and RB 89-03. Some designations may be considered for exemption at a later date (See Basin Plan pages 2-3, 4 for more details).
^: Nearshore is defined as the zone bounded by the shoreline and a line 1000 feet from the shoreline or the 30-foot depth contours, whichever is further from the shoreline. Longshore extent is from Rincon Creek to the San Gabriel River Estuary

Table 3. Beneficial uses of groundwaters within the Santa Monica Bay WMA[ac] (CRWQCB, 1994)

DWR[ad] Basin No.	BASIN	MUN	IND	PROC	AGR
4-11	**LOS ANGELES COASTAL PLAIN**				
	Central Basin	E	E	E	E
	West Coast Basin	E	E	E	E
	Hollywood Basin	E	E	E	E
	Santa Monica Basin	E	E	E	E
4-16	**HIDDEN VALLEY**	E	P		E
4-19	**THOUSAND OAKS AREA**	E	E	E	E
4-20	**RUSSELL VALLEY**				
	Russell Valley	E	P		E
	Triunfo Canyon area	P	P		E
	Lindero Canyon area	P	P		E
	Las Virgenes Canyon area	P	P		E
4-21	**CONEJO-TIERRA REJADA VOLCANIC AREA** [ak]	E			E
	SANTA MONICA MOUNTAINS-SOUTHERN SLOPES [al]				
	Camarillo area	E	P		E
	Point Dume area	E	P		E
4-22	Malibu Valley	P	P		E
	Topanga Canyon area	P	P		E

ac Beneficial uses for groundwaters outside of the major basins listed on this table have not been specifically listed. However, groundwaters outside of the major basins are, in many cases, significant sources of water. Furthermore, groundwaters outside of the major basins are either potential or existing sources of water for downgradient basins, and such, beneficial uses in the downgradient basins shall apply to these areas.

ad Basins are numbered according to DWR Bulletin No. 118-80.

ak Groundwater in the Conejo-Tierra Rejada Volcanic Area occurs primarily in fractured volcanic rocks in the western Santa Monica Mountain areas.

al With the exception of groundwater in Malibu Valley (DWR Basin No. 4-22) groundwaters along the southern slopes of the Santa Monica Mountains are not considered to comprise a major basin and accordingly have not been designated a basin number by DWR

Beneficial Use Definitions

Beneficial uses in the Regional Board's Basin Plan that are found in the WMA are defined below. The uses are listed in no preferential order.

Municipal and Domestic Supply (MUN)
Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR)
Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Process Supply (PROC)
Uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND)
Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Ground Water Recharge (GWR)
Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Navigation (NAV)
Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Water Contact Recreation (REC-1)
Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

> **Limited Water Contact Recreation (LREC-1):** Uses of water for recreational activities involving body contact with water, where full REC-1 use is limited by physical conditions such as very shallow water depth and restricted access and, as a result, ingestion of water is incidental and infrequent.

Non-contact Water Recreation (REC-2)
Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

A High Flow Suspension shall apply to water contact recreational activities associated with the swimmable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use, non-contact water recreation involving incidental water contact regulated under the REC-2 use, and the associated bacteriological objectives set to protect those activities. Water quality objectives set to protect (1) other recreational uses associated with the fishable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use and (2) other REC-2 uses (e.g., uses involving the aesthetic aspects of water) shall remain in effect at all times for waters where the (ad) footnote appears in the beneficial use table. The High Flow Suspension shall apply on days with rainfall greater than or equal to ½ inch and the 24 hours following the end of the ½-inch or greater rain event, as measured at the nearest local rain gauge, using local Doppler radar, or using widely accepted rainfall estimation methods. The High Flow Suspension only applies to engineered channels, defined as inland, flowing surface water bodies with a box, V-shaped or trapezoidal configuration that have been lined on the sides and/or bottom with concrete.

Commercial and Sport Fishing (COMM)
Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Warm Freshwater Habitat (WARM)
Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Cold Freshwater Habitat (COLD)
Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST)
Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Wetland Habitat (WET)
Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Marine Habitat (MAR)
Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Wildlife Habitat (WILD)
Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats (BIOL)
Uses of water that support designated areas or habitats, such as **Areas of Special Biological Significance (ASBS),** established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE)
Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Migration of Aquatic Organisms (MIGR)
Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadramous fish.

Spawning, Reproduction, and/or Early Development (SPWN)
Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL)
Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

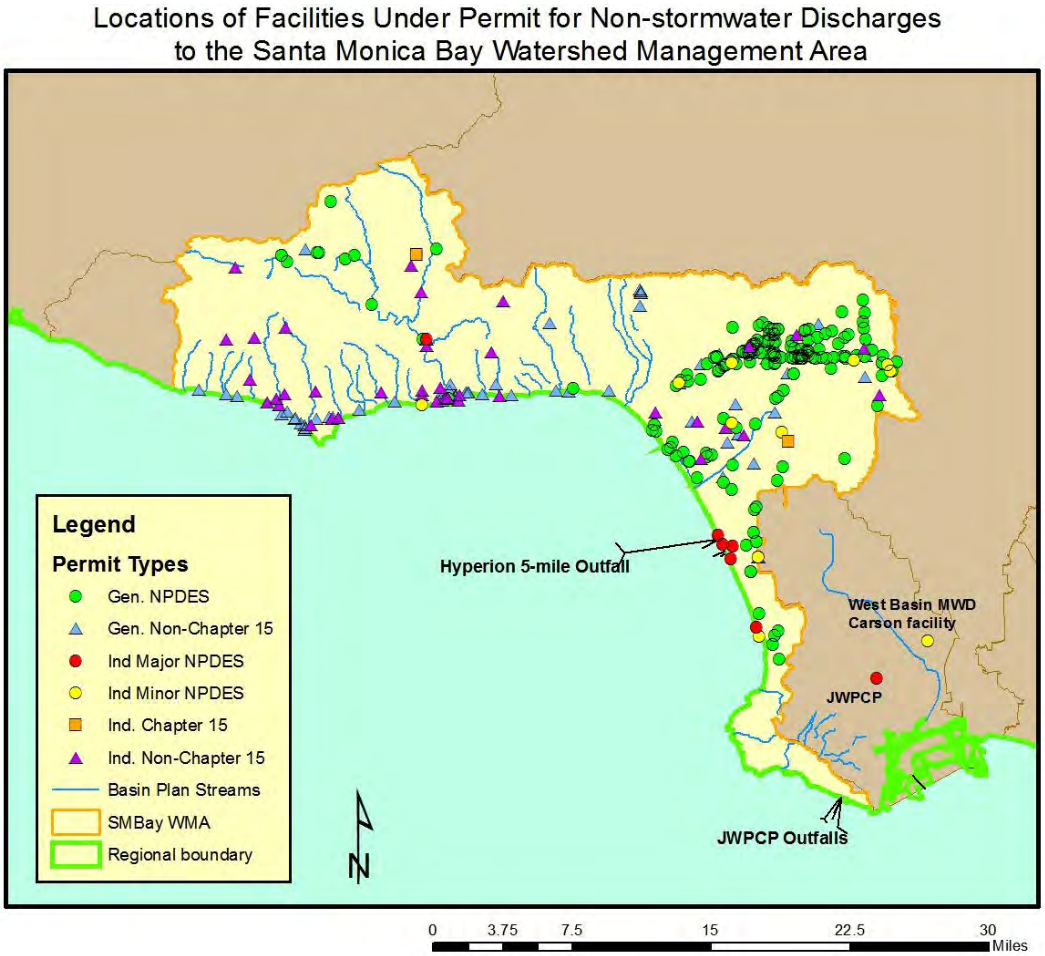
Discharges/Sources

PERMITTED DISCHARGES

There are 193 traditional NPDES discharges into the WMA including seven major NPDES permit discharges (three POTWs [two direct ocean discharges], one refinery, and three generating stations); 18 minor discharges covered under individual permits, and 175 dischargers covered under general permits. In addition, 87 dischargers are covered by an industrial storm water permit and 401 dischargers are covered by the construction storm water permit. Finally, there are 22 municipal dischargers covered under the Los Angeles County Municipal Storm Sewers System (MS4) NPDES permit; Caltrans is covered under its statewide stormwater permit. Of the major NPDES dischargers in the Santa Monica Bay WMA, the three POTWs (particularly the two direct ocean discharges) are the largest traditional point sources of pollutants to Santa Monica Bay. Pollutants from the minor discharges have been estimated to contribute less than two percent of the total pollutants being discharged to the Bay (CRWQCB, 2007).

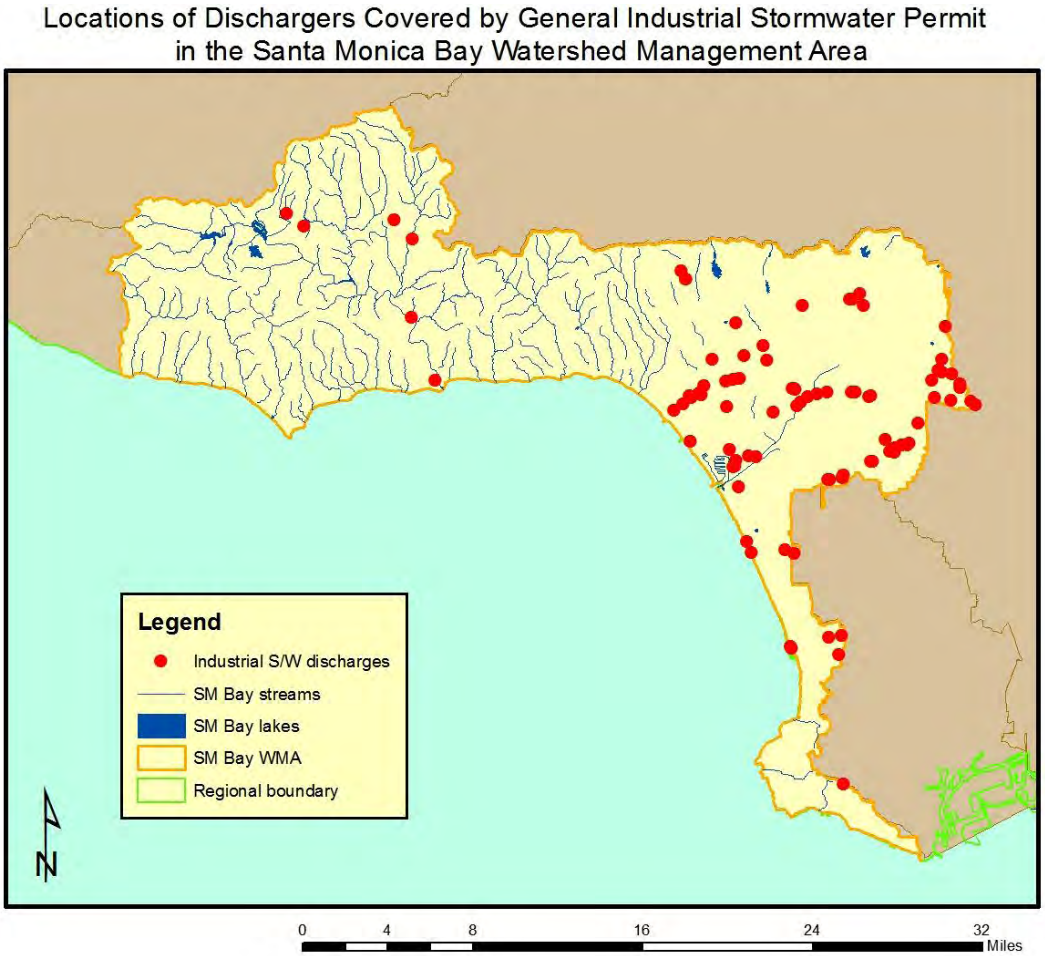
The locations of facilities with non-stormwater discharges to surface water or to the ground (other than those covered by general industrial or construction stormwater permits) are shown in the following figure. Major NPDES discharges are from either POTWs with a yearly average flow of over 0.5 MGD, from an industrial source with a yearly average flow of over 0.1 MGD, or are those discharges with lesser flows but with potential acute or adverse environmental impacts to surface waters. Minor NPDES discharges are all other discharges to surface waters that are not categorized as a Major (CRWQCB, 2007).

Figure 13



Minor discharges may be covered by general NPDES permits, which are issued administratively, for those that meet the conditions specified by the particular general permit. Non-Chapter 15 discharges are those to land or groundwater such as commercial septic systems or percolation ponds that are covered by Waste Discharge Requirements, a State permitting activity. Chapter 15 discharges generally relate to land disposal (landfills) under Chapter 15 of the California Code of Regulations, again an exclusively State permitting activity (CRWQCB, 2007).

Figure 14



Discharges covered by the statewide industrial stormwater permit are shown in the figure below. A complete list of discharges in the watershed is available at http://www.waterboards.ca.gov/losangeles/water_issues/programs/regional_program/wmi/ws_santamonica.shtml . Copies of many permits may be downloaded at http://www.waterboards.ca.gov/losangeles/board_decisions/adopted_orders/by_permits_tools.shtml.

Maps showing discharges focused on individual subwatersheds, as appropriate, are shown in the separate subwatershed section of the report. Information on some of the larger discharges to the watershed follows.

Major/Significant NPDES Discharges

City of Los Angeles - Hyperion Treatment Plant

The City owns and operates the Hyperion Treatment Plant, a publicly-owned treatment works (POTW). The Hyperion Treatment Plant is a secondary treatment facility located at 12000 Vista del Mar Boulevard in Playa Del Rey. It is interesting to compare today's information on the facility with that presented in the first edition of this report in 1997. At that time, the Hyperion plant had a design capacity of 420 gallons per day (mgd) and discharged an average of 360 mgd of treated wastewater which was a combination of about 50 percent advanced primary and 50 percent secondary effluent (CRWQCB, 1997). Today, the plant has a dry weather average design treatment capacity of 450 mgd and a wet weather peak hydraulic capacity of approximately 850 mgd. In 2008, the Hyperion Treatment Plant received an average of 320 mgd of influent and discharged an average of 286 mgd of secondary treated effluent to the Pacific Ocean through the five-mile outfall. Approximately 24 mgd of secondary effluent is sent to West Basin Water Recycling Plant - El Segundo for advanced treatment. The Hyperion Treatment Plant ceased the irrigation use of in-plant chlorinated secondary treated wastewater in July 1999 and started using tertiary recycled water from West Basin MWD in August 1999 (CRWQCB website #1).

The Hyperion Treatment Plant is part of a joint outfall system commonly known as the Hyperion Treatment System that consists of the wastewater collection system, the Hyperion Treatment Plant, and three upstream wastewater treatment plants: Donald C. Tillman Water Reclamation Plant (Tillman WRP), Los Angeles-Glendale Water Reclamation Plant (LAGWRP), and Burbank Water Reclamation Plant (Burbank WRP)(owned and operated by a contract city). The Hyperion Treatment System collects, treats, and disposes of sewage from the entire City (except the Wilmington - San Pedro Area, the strip north of San Pedro, and Watts) and from a number of cities and agencies under contractual agreements (CRWQCB website #1).

Approximately 85% of the sewage and commercial/industrial wastewater comes from the City of Los Angeles. The remaining 15% comes from the Contract Cities and Agencies. There are approximately four million people in the Hyperion Treatment System Service Area (CRWQCB website #1).

Currently, the Hyperion Treatment Plant also accepts dry weather urban runoff that is diverted from storm drains into the City's collection system from April 1 to October 31. In October 2009, the City extended this diversion operation from the dry summer months to year-round in order to conform to the compliance schedule for bacteria concentration during winter dry weather, contained in the Santa Monica Bay Beach Dry-weather Bacteria TMDL adopted by the Regional Board (CRWQCB website #1).

The Hyperion Treatment System is an interconnected system and includes approximately 6,500 miles of sewer lines located within the City (including trunk sewers in contract cities and agencies) and additional sewer lines under the control of the contract cities and agencies. Sludge from the City's two upstream plants (Tillman WRP and LAGWRP) is returned to the wastewater collection system and flows to the Hyperion Treatment Plant for treatment. In addition, sludge generated from the Burbank WRP is also returned to the City of Burbank sewer system for treatment at the Hyperion Treatment Plant. The influent to the Burbank WRP can be diverted/bypassed to the Hyperion Treatment Plant during periods of emergency (CRWQCB website #1).

The Hyperion Treatment Plant has provided full secondary treatment since December 1998. Preliminary and primary wastewater treatments consist of screening, grit removal, and primary sedimentation with coagulation and flocculation. In secondary treatment, the primary effluent is biologically treated in a high purity oxygen activated sludge process. After clarification, undisinfected secondary effluent is discharged into Santa Monica Bay through a five mile submerged outfall pipe (CRWQCB website #1).

The fine solids recovered from wastewater treatment processes that consist of primarily inorganic materials are hauled away to landfills. The remaining sludge is anaerobically digested onsite. The digested sludge is screened and dewatered using centrifuges. Starting on January 1, 2003, the Hyperion Treatment Plant implemented full thermophilic digestion to generate Class A “EQ” biosolids (treated sewage sludge) which are beneficially reused offsite for land application and composting projects. The digester gas is cleaned and a major part of the gas is currently exported to the Los Angeles Department of Water and Power’s Scattergood Steam Generating Plant, located immediately adjacent to the Hyperion Treatment Plant. The exported digester gas is used as fuel in the generation of electricity. In return, the generating plant provides steam for digester heating for the Hyperion Treatment Plant. During interruptions in the export of steam from the DWP Scattergood Steam Generation Plant, digester gas can be used as fuel for in-plant boilers that provide steam to heat the anaerobic digesters. Any remaining non-exported digester gas may be flared, if necessary, and is regulated under a flare operation permit from the South Coast Air Quality Management District (AQMD) (CRWQCB website #1).

The Hyperion Treatment Plant has developed an industrial wastewater pretreatment program which was approved by USEPA and the Regional Board. The facility also collects and treats in-plant storm water runoff except that, during intense storms, undisinfected storm water overflows may be discharged through Outfall 001. This storm water discharge is regulated under the State Board’s storm water general permit for industrial activities (CRWQCB website #1).

The Hyperion Treatment Plant has three ocean outfalls. However, only two outfall discharge points (i.e., 001 and 002) are utilized to discharge treated wastes to the Pacific Ocean. The three ocean outfalls are described as follows:

<u>Discharge Serial No. 001</u> - This is commonly referred to as the “one-mile outfall”. It is a 12-foot diameter outfall terminating approximately 5,364 feet west-southwest of the treatment plant at a depth of approximately 50 feet below the ocean surface. This outfall is permitted for emergency discharge of chlorinated secondary treated effluent during extremely high flows, power failures, and preventive maintenance, such as routine opening and closing the outfall gate valve(s) for exercising and lubrication. However, during intense storms or storms associated with plant power outages, direct discharge of undisinfected storm water overflow is also permitted at this outfall. The facility’s NPDES permit requires the City to notify the Regional Board and USEPA in advance of any planned preventive maintenance that results in discharges through Discharge Serial No. 001 (CRWQCB website #1). There were three planned preventive maintenance diversion events in 2008. This outfall was inspected twice in 2008 via submarine and SCUBA divers (City of LA, 2009c).

<u>Discharge Serial No. 002</u> - This is commonly referred to as the “five-mile outfall”. It is a 12-foot diameter outfall terminating approximately 26,525 feet west-southwest of the treatment plant at a depth of approximately 187 feet below the ocean surface. This outfall is located north of Discharge Serial No. 001 and ends in a "Y" shaped diffuser consisting of two 3,840-foot legs. This is the only outfall permitted for

the routine discharge of undisinfected secondary treated effluent. This outfall was inspected twice in 2008 via submarine and SCUBA divers (City of LA, 2009c).

<u>Discharge Serial No. 003</u> – This is a 20-inch diameter outfall terminating approximately 35,572 feet west of the treatment plant, at the head of a submarine canyon at a depth of approximately 300 feet below the ocean surface. This outfall had been used to discharge sludge. Under a 1987 amended Consent Decree, this outfall was deactivated in November 1987 when sludge discharge to the ocean was terminated. The outfall has been modified to prevent any possible discharge of sewage or sludge into the Pacific Ocean. The outfall has not been maintained since it was taken out of service. Any discharge from this outfall is prohibited (CRWQCB website #1).

The City has collected and assessed extensive chemical and physical data from Santa Monica Bay at 36 sites during varying conditions, including El Niño, La Niña and winter storm conditions in order to evaluate movement of the discharge plume. The data show that movement of the plume is dictated by the depth of the thermocline or stratification and the direction and strength of highly variable Santa Monica Bay currents. Under typical conditions, the plume is detected within 6,562 feet of the outfall terminus, although it has been detected as far as 26,247 feet away from the outfall. Also, the plume has almost always been detected below the thermocline at a depth ranging from 33 – 180 feet. Infrequently, during winter storm conditions, the plume has been detected at the surface in the vicinity of the outfall. On rare occasions, it has been impossible to detect the plume (CRWQCB website #1).

As the waters of Santa Monica Bay approach the shore, the thermocline intersects the rising sea bottom. This point is typically 3,281 feet (1,000 m) or more offshore and is the theoretical limit of the approach of the plume to the shoreline. The plume has never been detected less than 8,202 feet (2.5 km) from shore, at the 148 feet (45 m) depth contour (CRWQCB website #1).

The City has conducted shoreline and nearshore/inshore water quality monitoring in Santa Monica Bay since the late 1940s. The monitoring results indicated that effluent from Hyperion's five-mile outfall does not reach the shoreline and that elevated bacterial counts are associated with runoff from storm drains and discharges from piers. The direct impacts of the discharge from Hyperion's one-mile outfall on shoreline water quality have not been studied due to the lack of routine discharge. However, it is expected to be very minimal in that effluent discharged from the one-mile outfall is disinfected, and the volume of the discharge is usually much less than five million gallons occurring at most quarterly. This discharge is intended for conducting a functional test of equipment (CRWQCB website #1).

County Sanitation Districts of Los Angeles County - Joint Water Pollution Control Plant

The County Sanitation Districts of Los Angeles County (Districts) owns and operates the Joint Water Pollution Control Plant **(**JWPCP), a POTW. The JWPCP is a secondary treatment facility located at 24501 South Figueroa Street in Carson. The plant has a dry weather average design treatment capacity of 400 mgd and a peak design capacity of 540 mgd (CRWQCB website #1). During 2008, the effluent discharge flow from JWPCP averaged 295.6 mgd (CSDLAC, 2009). As a comparison, information on the facility presented in the first edition of this report included a description that the JWPCP was an advanced primary treatment facility with a dry weather average flow design capacity of 400 mgd, a permitted capacity of 385 mgd and a peak design capacity of 540 mgd. Secondary treatment was provided for only 200 mgd of wastewater (CRWQCB, 1997).

JWPCP is part of a Joint Outfall System with six upstream water reclamation plants - La Cañada, Whittier Narrows, San Jose Creek, Pomona, Los Coyotes and Long Beach. It treats municipal and industrial wastewater. The flow from the six upstream plants can be bypassed, to a limited extent, to JWPCP. The sludge generated from the upstream plants are returned to the joint outfall trunk sewers and conveyed to JWPCP for further treatment. There are approximately five million people in the Joint Outfall System service area and JWPCP receives discharges from more than 1,200 significant industrial users (CRWQCB website #1).

In addition to the JWPCP effluent, the waste brine generated by the West Basin Municipal Water District's Carson Regional Water Recycling Plant is discharged to the ocean through the JWPCP's outfalls via a waste brine line connected to the JWPCP effluent tunnel. This discharge of waste brine is regulated under separate waste discharge requirements and NPDES permit (CRWQCB website #1).

The JWPCP has provided full secondary treatment since 2003. Treatment consists of screening, grit removal, primary sedimentation, pure oxygen activated sludge reactors, secondary clarification, and chlorination. Effluent from the primary sedimentation tanks is biologically treated in pure oxygen activated sludge reactors. The secondary treated effluent is then clarified, chlorinated and pumped into the outfall manifold (CRWQCB website #1).

The fine solids recovered from wastewater treatment processes which are primarily inorganic materials are hauled away to a landfill. The remaining solid fractions are anaerobically digested onsite. The digested solids are screened, and dewatered using centrifuges. The dewatered cake contains approximately 25% solids (Class B biosolids). JWPCP generates approximately 11,000 wet tons of Class B biosolids per week. More than half of the biosolids are managed by composting operations in Riverside and Kern County. One quarter of the biosolids are sent to southwestern Arizona for air drying and direct land application. The remaining biosolids are lime stabilized for Class A land application in Kern County, incinerated in a cement kiln in San Bernardino County, and co-disposed with municipal solid waste in Los Angeles County (CRWQCB website #1).

Digester gas (containing approximately 65% methane), produced from anaerobic digestion of sludge, is used onsite to fuel a combined cycle power plant (gas turbines followed by boilers and a steam turbine) which generates 22 MW of electricity for plant equipment and steam for digester heating. The power plant allows JWPCP to be essentially self-sufficient with respect to its energy requirements and even produces surplus electricity for export to Southern California Edison Co. sufficient to power approximately 1,500 homes (CRWQCB website #1).

After chlorination, the secondary treated effluent travels about 6 miles through tunnels to the outfall manifold and then is discharged to the Pacific Ocean, at Whites Point off the Palos Verdes Peninsula. JWPCP has fifteen discharge points (Discharge Serial Nos. 001 through 015). Four outfalls (Discharge Serial Nos. 001 through 004) are located at Whites Point, off the Palos Verdes Peninsula. Discharge Serial Nos. 001 and 002 are routinely used for discharge of treated wastewater. Discharge Serial No. 003 is used only during times of heavy rains to provide hydraulic relief for flow in the outfall system. Discharge Serial No. 004 serves as a standby outfall to provide additional hydraulic relief during the very heaviest flows. Two discharge points (Serial Nos. 006 and 013) have been eliminated following facility modifications. The remaining nine discharge points, with seven of them being bypass points (Discharge Serial Nos. 007-012, and 014) located prior to the headworks, provide for overflow, emergency bypass, and/or hydraulic relief of the JWPCP. The NPDES permit does not authorize any discharge from these nine discharge points (Discharge Serial Nos. 005, 007-012, 014, and 015). The four permitted ocean discharge points are described in more detail below:

Discharge Serial No. 001 - This outfall routinely discharges approximately 65% of the effluent from the JWPCP. It discharges south of the shoreline off Whites Point, San Pedro. The outfall is 7,440 ft long to the beginning of a single L-shaped diffuser leg which is 4,440 ft long. Depth at the beginning of the diffuser is 167 ft and at the end of the diffuser is 190 ft.

Discharge Serial No. 002 - This outfall routinely discharges approximately 35% of the effluent from the JWPCP. It discharges southwest of the shoreline off Whites Point, San Pedro. The outfall is 7982 ft long to the beginning of a y-shaped diffuser with two legs. Each leg is 1208 ft long. Depth at the beginning of the diffusers is 196 ft and at the end of the diffusers is 210 ft.

Discharge Serial No. 003 - This outfall is used only during times of heavy rains to provide hydraulic relief for flow in the outfall system. When used, it discharges off the Whites Point shoreline between Discharge Points 001 and 002 and about 160 ft below the ocean surface. The outfall is about 6500 ft long and connects to one of three legs of a y-shaped diffuser upstream of the y-intersection. Each leg is approximately 200 ft long. This discharge point was not used in 2008.

Discharge Serial No. 004 - This outfall is used as a standby to provide additional hydraulic relief during the heaviest flow. When used, it discharges off the Whites Point shoreline between Discharge Serial Nos. 002 and 003 and about 110 ft below the ocean surface. The outfall is about 5000 ft long and connects to a single, very short diffuser. This discharge point was not used in 2008 (CRWQCB website #1).

Las Virgenes Municipal Water District - Tapia Water Reclamation Facility

The Tapia Water Reclamation Facility (Tapia) is jointly owned by the Las Virgenes Municipal Water District (LVMWD) and Triunfo Sanitation Districts (Triunfo). Tapia is located at 731 Malibu Canyon Road, in an unincorporated area of Los Angeles County. Tapia treats municipal wastewater from domestic, commercial, and industrial sources to obtain California Title 22 recycled water. The design flow for the facility is 16.1 MGD. In 2008, on average, Tapia treated 8.95 MGD and discharged 4.03 MGD to Malibu Creek (with no discharge in June and July) and less than 0.1 MGD to the Los Angeles River. Tapia recycled the remainder of the tertiary-treated wastewater. Currently, Tapia serves approximately 80,000 residents in western Los Angeles and eastern Ventura Counties (Agoura Hills, Calabasas, Hidden Hills, Thousand Oaks, and Westlake Village) with a service area of over 109 square miles (CRWQCB website #1).

In 1965, LVMWD and Triunfo in a joint venture, built the Tapia facility which discharged 750,000 gpd of secondary treated effluent by spray irrigation. In 1968, the plant's design capacity was expanded to 2 mgd. From 1969 to 1980, year-round discharge to the Creek was prohibited by the Regional Board because of human health and nutrient concerns, and maximum use of recycled water for spray irrigation of fields was required. Discharge was allowed to occur only during, and immediately following, periods of rain when spray fields or percolation areas could not be used; and, between mid-November and mid-April when reclamation and use of all spray fields had been maximized. In 1982, the plant's design capacity was expanded to 8 mgd and the Rancho Las Virgenes Farm was established for injection of biosolids. In 1984, a year-round discharge to the Creek was permitted after the tertiary filters were installed. In 1989, the plant was expanded to 10 mgd. In 1989, the Regional Board adopted an order that permitted a phased increase in the discharge rate up to 16.1 mgd. The construction of facilities for Tapia's treatment capacity expansion, from 10 mgd to 16.1 mgd, was completed in 1994 (CRWQCB website #1).

Tapia treats both the liquid and solid fractions of the municipal wastewater. Treatment starts with coarse screening, grit removal, and primary sedimentation. The flow stream then separates into two routes, one for solids and the other for liquid. The liquid treatment route consists of secondary treatment, tertiary treatment, chlorination, and dechlorination. Prior to 1993, the principal solids treatment route was aerobic digestion at Tapia and land application at the Rancho Las Virgenes Farm. After startup of the Rancho Las Virgenes Composting Facility (Rancho) in 1993, the solids were anaerobically digested, dewatered using centrifuges and then composted (CRWQCB website #1).

The facility conducts coarse screening, grit removal, primary sedimentation, secondary treatment, tertiary treatment, chlorination, and dechlorination. For secondary treatment, Tapia employs an activated sludge process with nitrification and denitrification, followed by secondary clarification. Tertiary 'treatment includes coagulant addition, flocculation and physical filtration through a mono-media coal filter. Sodium hypochlorite solution is added for effluent disinfection, and sodium bisulfate is added for dechlorination (CRWQCB website #1).

Under standard operations, the waste activated sludge (WAS) is sent to Rancho Las Virgenes Composting Facility (Rancho Facility). Generally the digested sludge is centrifuged to remove most of the liquid. The liquid generated by centrifugation (centrate) is sent to a centrate treatment facility where it is treated to reduce ammonia and nitrogen levels before being returned to Tapia via the sanitary sewer. The majority of the WAS is treated at Rancho Facility and recycled as compost. The composting and farm facilities eliminate the need for hauling and disposal of biosolids to landfills. WAS can be aerobically digested and screened at Tapia and pumped to Rancho Las Virgenes Farm, a 91-acre site located at 3240 Las Virgenes Road, for subsurface biosolids injection (the last injection was performed in 2003). The fields are planted with a variety of pasture grasses to agronomically remove nutrients from the injection operation (CRWQCB website #1).

Approximately 60 percent of the treated wastewater is used on an annual basis for landscaping irrigation. Recycled water is also used at Tapia WRF, Pepperdine University, Rancho Las Virgenes Composting Facility and Rancho Las Virgenes Farm. The use of recycled water is regulated under separate water recycling requirements (CRWQCB website #1).

The following are the discharge points to Malibu Creek:

<u>Discharge Serial No. 001</u> – This is the primary discharge point to Malibu Creek located adjacent to the treatment plant. The waste discharged to Malibu Creek is limited to winter months from November 16 through April 14 of each calendar year to minimize the contribution of Tapia's discharge to the excess freshwater flow into Malibu Lagoon (which leads to elevated Lagoon level and frequent breaching of the sandbar once, or if, the sandbar has formed), thus impacting both wildlife and human health beneficial uses (CRWQCB website #1). The average discharge to Malibu Creek in 2008 during months that a discharge occurred was 5.76 mgd (LVMWD, 2009).

The discharge prohibition is in place except under certain conditions:

i. Treatment plant upset or other operational emergencies;
ii. Storm events as determined by the Executive Officer; or

iii. The existence of minimal streamflow conditions that require flow augmentation in Malibu Creek to sustain endangered species as determined by the Executive Officer (CRWQCB website #1).

For a rainfall event of less than 0.4 inches in 24 hours at the Facility Rain Gauge, the Discharger may discharge to Malibu Creek during the prohibition period during storm events with prior approval of the Executive Officer provided that *all* of the following conditions have been met:

1. The Malibu Lagoon Sand Bar is open; and
2. The spray fields at Rancho Las Virgenes Farm are saturated; and
3. There is no demand for recycled water; and
4. The capacity to send 'wastewater to the Los Angeles River has been exhausted; and
5. All other disposal options are exhausted.

The Discharger may discharge to Malibu Creek during the prohibition period during storm events without prior approval of the Executive Officer provided that *all* of the following conditions have been met:

1. The rainfall event produces 0.4 inches or greater of precipitation in 24 hours at the Facility Rain Gauge; and
2. The Malibu Lagoon Sand Bar is open; and
3. The spray fields at Rancho Las Virgenes Farm are saturated; and
4. There is no demand for recycled water; and
5. The capacity to send wastewater to the Los Angeles River has .been. exhausted; and
6. All other disposal options are exhausted.

Discharge Serial No. 002 – This discharge point is used to release surplus effluent from LVMWD's Reservoir #2 which stores water for distribution to the recycled water system. Reservoir #2 has a capacity of 17 million gallons, which is less than a two-day supply during the high demand in summer. Overflow from this reservoir is discharged to Las Virgenes Creek, a tributary to Malibu Creek, near the LVMWD headquarters building located at 4232 Las Virgenes Road in Calabasas. Stormwater runoff enters the reservoir and causes overflow. Such discharges are unintentional and infrequent.

Discharge Serial No. 003 – This discharge point is located 0.2 miles downstream of Cold Creek and is no longer used routinely. No recycled water has been discharged at this location except during the storms of 1998. This discharge location was established along with the percolation ponds to offer a bypass option in times of extremely high flow conditions to regulate flow and protect the pond structures (CRWQCB website #1).

West Basin Municipal Water District

West Basin Water Recycling Plant, El Segundo

The West Basin Municipal Water District (West Basin MWD) operates the West Basin Water Recycling Plant (El Segundo Plant) in El Segundo. West Basin MWD is contractually entitled to receive up to 70 mgd of secondary effluent from the Hyperion Treatment Plant for advanced treatment. The El Segundo Plant provides tertiary treatment and/or advanced treatments such as microfiltration and reverse osmosis (RO) to the Hyperion secondary effluent to produce Title 22 and high purity recycled water. Title 22 recycled water is used for beneficial irrigation, industrial applications including cooling water and boiler feed water, and other purposes. The RO treated recycled water is primarily injected into the West Coast Basin Barrier Project to control seawater intrusion. The El Segundo Plant receives an average of 24 mgd of secondary effluent from the Hyperion Treatment Plant (CRWQCB website #1).

The waste brine from the El Segundo Plant is discharged to the ocean through Hyperion's five-mile outfall via a waste brine line from the recycling facility; the waste brine is regulated under these separate waste discharge requirements and NPDES permit (CRWQCB website #1).

Carson Regional Water Recycling Plant, Carson

The West Basin MWD owns and operates the Carson Regional Water Recycling Plant (Carson Plant) located at 21029 South Wilmington Avenue in Carson. The Carson Plant provides advanced treatment to Title 22 recycled water produced by the El Segundo Plant that is also owned and operated by the West Basin MWD. The Carson Plant may discharge up to 0.9 MGD of reverse osmosis brine waste from the treatment process to the Pacific Ocean (offshore of Palos Verdes), via the JWPCP outfalls. 3 During 2008, the Carson Plant discharged an average of 0.53 mgd of brine through the JWPCP outfalls. ? Brine waste is not treated prior to discharge (CRWQCB website #1).

Chevron Products Company – El Segundo Refinery

Chevron has operated the El Segundo Refinery since 1911. The facility is located at 324 West El Segundo Blvd in El Segundo. It manufactures the following products from crude oil: reformulated gasoline, jet fuel, diesel fuel, fuel oils, liquefied petroleum gases, fuel blending components, coke, ammonia, and molten sulfur. Manufacturing processes used at the refinery include atmospheric and vacuum distillation, catalytic cracking, alkylation, isomerization, coking, catalytic reforming, hydrogenation, sulfur recovery, chemical treating, and product blending. Chevron plans to process a long-term average throughput estimated at 265,000 bpod (CRWQCB website #1).

The El Segundo Refinery's wastewater treatment facility discharges an average flow of 7.0 mgd of treated wastewater, with up to 8.8 mgd during dry weather and up to 27 mgd during wet weather, to Santa Monica Bay. The wastewater is comprised of refinery wastewater (6.45 mgd), petroleum hydrocarbon contaminated shallow well groundwater (up to 2.34 mgd), other intermittence sources (4 mgd), and rainfall runoff, which may be contaminated (14 mgd) (CRWQCB website #1).

The discharge occurs through an outfall located approximately 2,200 feet south of Grand Avenue that extends approximately 3,500 feet offshore with its terminus at a depth of 42 feet. In 1994, Chevron constructed a 3,200-foot outfall line extension consisting of a 60-inch nominal diameter, high density polyethylene pipe that was fitted to the existing 300 foot outfall line. A diffuser was attached at the end of the extension. The extended outfall provides a minimum dilution ratio of 80 parts of seawater to one part of effluent . The previous outfall was about 300 feet offshore and had a minimum dilution ratio of 38 parts of seawater to one part of effluent (CRWQCB website #1).

The El Segundo Refinery's wastewater treatment facility consists of two separate drain and treatment systems: the "unsegregated" and the "segregated" system. The unsegregated system is normally used for non-process wastewater including cooling tower blowdown, steam condensate, a portion of the refinery's recovery well groundwater, and other wastewater streams containing free oil removed with primary treatment only. This system is also used to collect and treat storm water. The unsegregated system includes a gravity separator and an induced air flotation unit. The segregated system is normally used to treat petroleum process wastewater containing emulsified oils and a portion of the refinery's recovery well groundwater. It is comprised of gravity separators, a dissolved air flotation unit, and activated sludge units for secondary (biological) treatment (CRWQCB website #1).

The El Segundo Refinery currently uses recycled water from the West Basin MWD for both irrigation and the cooling towers. The refinery's daily consumption of recycled water for irrigation purposes is approximately 200,000 gallons per day (gpd). Additionally, the cooling towers use approximately 3 mgd of nitrified recycled water: The low and high pressure boiler feeds consume approximately 1.23 mgd and 2.57 mgd of recycled water, respectively (CRWQCB website #1).

El Segundo Power, LLC (El Segundo Power Generating Station)

El Segundo Power, LLC, has operated the El Segundo Generating Station (El Segundo Station) since April 4, 1998. The El Segundo Station was formerly operated by Southern California Edison (from the 1950's to April 1998). The El Segundo Station is steam electric generating facility located at 301 Vista del Mar in El Segundo and has a design capacity of 1,020 megawatts. However, by 2000, the El Segundo Generating Station was consistently running less than its full capacity of 1,020 megawatts. The El Segundo Station is permitted to discharge up to 607 mgd of wastes consisting of once-through cooling water from four steam electric generating units (Units 1 through 4), treated chemical metal cleaning wastes, non-chemical metal cleaning wastes, low volume wastes, stormwater runoff, and treated sanitary wastes into the Pacific Ocean through two outfalls (CRWQCB website #1).

To cool generating units 1 and 2, ocean water is supplied at a rate of about 144,000 gallons per minute (gpm) through a concrete conduit (10-feet inside diameter) which extends approximately 2,600 feet offshore to a depth of -30 feet Mean Lower Low Water (MLLW). The intake structure is constructed with a velocity cap that is designed to divert fish away from the intake structure. It also has a screening structure that removes trash, algae, and marine organisms that enter the intake structure with the seawater. Marine fouling of the cooling water conduits (intake and discharge) is controlled by temporarily recirculating (thus increasing the temperature) and reversing the flow of the once-through cooling water alternately in each offshore conduit (i.e., the discharge point becomes the intake point, and the intake point becomes the discharge point). This procedure, referred to as heat treatment, is typically conducted every six weeks and lasts for about six hours per conduit. During the heat treatment, the high temperature last for one hour. The water temperature is increased 23°F when the units are operated at full capacity. The heated water is discharged through Outfall No. 001, a 10-feet diameter conduit that terminates approximately 1,900 feet offshore at a water depth of -26 feet MLLW. During the heat treatment, the temperature of the water discharged through the intake conduit must be raised to 125°F for two hours to kill the fouling organisms (CRWQCB website #1). No heat treatments were conducted on discharge point 001 during 2008. On January 1, 2003, Units 1 and 2 ceased commercial operation; the cooling water system continued to remain in operation. The average discharge flow from Outfall No. 001 was 29.2 mgd in 2008. Chlorination to control biological growths ceased at the end of February 2008 (El Segundo Power, 2009).

The cooling water system for Units 3 and 4 is separate from Units 1 and 2 but is a similar cooling system. The intake conduit (11-feet inside diameter) also extends 2,600 feet to a depth of -30 feet MLLW; it supplies ocean water at a rate of about 295,000 gpm. The water temperature is increased 22°F when the units are operated at full capacity. The heated water is discharged to the ocean through Outfall No. 002

which extend about 2,100 feet offshore at a depth of about -20 feet MLLW. To control biological growths, the condenser tubes are treated by intermittently injecting chlorine, for a maximum of two hours per generating unit per day, into the cooling water stream (CRWQCB website #1). The average discharge flow from Outfall No. 002 was 130.8 mgd in 2008 (El Segundo Power, 2009).

AES Redondo Beach, LLC (Redondo Generating Station)

AES Redondo Beach, LLC (Redondo Generating Station) discharges wastes from its Redondo Generating Station; the permit was originally issued to Southern California Edison, the previous owner of the facility. AES Redondo Beach, LLC, acquired the Redondo Generating Station in 1998. The Redondo Generating Station is a steam electric generating facility located at 1100 Harbor Drive in Redondo Beach. The facility has eight generating units. However, Units 1, 2, 3, and 4 have not been operated for at least four years and because the Discharger has no plans to place them into service in the future, these units are being dismantled. The remaining units (5, 6, 7, and 8) have a design capacity of 1,310 megawatts and are permitted to discharge up to 898 mgd of wastes consisting of once-through cooling water, treated chemical metal cleaning wastes, groundwater seepage, and low volume wastes into Santa Monica Bay (CRWQCB website #1).

The wastes are discharged through two outfalls; Discharge Serial No. 001 consists of two conduits, each extending approximately 1,600 feet offshore, which terminate at a depth of 25 feet MLLW. Wastes discharged through this outfall consist of up to 215 mgd of once-through cooling water from steam electric generating units 5 and 6, five mgd of groundwater seepage from basement areas of the generating station, and four mgd of low-volume wastes (CRWQCB website #1). The average discharge flow from outfall 001 was 41.375 mgd in 2008 (AES Redondo Beach, 2009). Discharge Serial No. 002 consists of one conduit, which extends approximately 300 feet off the beach at King Harbor, Redondo Beach, and terminates at a depth of 20 feet MLLW. Wastes discharged through this outfall consist primarily of once-through cooling water from Units 7 and 8 (up to 674 mgd), with small amounts of condensate overboard overflow, fuel oil tank farm rainfall run-off, and yard drains (CRWQCB website #1). The average discharge flow from outfall 002 was 37.175 mgd in 2008 (AES Redondo Beach, 2009).

Marine fouling of the cooling water conduits (intake and discharge) is controlled by temporarily recirculating (thus increasing the temperature) and reversing the flow of the once-through cooling water alternately in each offshore conduits. This procedure, referred to as heat treatment, is typically conducted every six weeks and lasts for about two hours per conduit. During the heat treatment, the temperature of the water discharged through the intake conduit must be raised to 125°F for two hours to kill the fouling organisms. To control biological growths, the condenser tubes are treated by intermittently injecting chlorine (in the form of sodium hypochlorite), for a maximum of two hours per generating unit per day, into the cooling water stream (CRWQCB website #1).

City of Los Angeles, Department of Water and Power - Scattergood Generating Station

The Scattergood Generating Station is located about 1,500 feet south of the Hyperion Treatment Plant at 12700 Vista del Mar in Los Angeles. The plant is comprised of three steam electric generating units with a total capacity of 820 megawatts and is permitted to discharge up to 496 mgd of wastes containing once-through cooling water, pretreated metal cleaning wastes, low-volume in-plant wastes, cooling tower blowdown, and stormwater runoff into Santa Monica Bay near Dockweiler State Beach in El Segundo (CRWQCB website #1). The average discharge during 2008 was 314.75 mgd (City of LA, 2009a).

Cooling water is drawn from Santa Monica Bay through a single 12 feet diameter conduit, which extends about 1,600 feet offshore. The conduit is equipped with a velocity cap to deter marine life from entering the system. After passage through the generating units' once-through cooling system, wastewater is then discharged to the same size conduit that runs parallel to the intake pipe (CRWQCB website #1).

Marine fouling of the cooling water conduits (intake and discharge) is controlled by temporarily recirculating (thus increasing the temperature) and reversing the flow of the once-through cooling water alternately in each offshore conduit. This procedure, referred to as heat treatment, is typically conducted every six weeks and lasts between two and six hours for the three generating units. To control biological growths, the condenser tubes are treated by intermittently injecting chlorine (in the form of sodium hypochlorite) or a combination of chlorine and sodium bromide, for a maximum of two hours per generating unit per day, into the cooling water stream (CRWQCB website #1).

Storm Water/Urban Runoff

Urban and storm water runoff are carried to waterbodies through the Region's massive storm drain system. In some areas of the watershed, the drainage system consists of natural streams, riparian corridors and wetlands, and therefore are waterbodies with considerable ecological value as previously described. The rest is part of the 5,000 mile concrete-lined storm drain network within Los Angeles County that was built to move flood waters quickly to the ocean. The storm drain system is completely separate from the sewer system except where storm drain diversions have been installed (CRWQCB, 1997).

Storm water and urban runoff are discharged to Santa Monica Bay through more than 200 outlets; some are as large as a 370 feet-wide concrete channel connected to other channels many miles inland, while others are so small that they are hard to detect and only drain one or two, blocks near the coast. About a dozen of these outlets have flows during dry-weather, discharging 10 to 25 gallons of water/second. On a rainy day, however, 10 billion gallons can flow through the system. Each year an average of 30 billion gallons of storm water and urban runoff are discharged into Santa Monica Bay (CRWQCB, 1997). Storm drains in the Los Angeles County portion of the WMA are shown in the map below.

Figure 15

Urban and storm water runoff contains greatly varying types of material. Land use strongly influences the types and concentrations of materials found in runoff. Runoff quantity and velocity increases when roads, buildings or pavement (impervious surfaces) cover land that once absorbed and filtered rainfall (CRWQCB, 1997).

The quality, and to some extent, the quantity of storm water runoff is controlled primarily through the use of structural and non-structural best management practices (BMPs). This approach is embodied in the MS4 NPDES permit, which was reissued in December 2001 and subsequently amended in 2006, 2007, 2009, and 2011, to the District (as principal permittee), 85 cities, and County of Los Angeles (as co-permittees) by the Regional Board. Activities such as increased street sweeping decrease the amounts of suspended solids in the receiving waters as well as pollutants which normally adhere to the solids. Public education programs strive to inform people of the impacts of activities such as pouring antifreeze or used motor oil down storm drains or overfertilizing lawns, and can offer alternatives to negative behaviors (CRWQCB, 1997).

General storm water discharge permits for industrial facilities and construction sites were issued by the State Board beginning in the summer of 1992 (CRWQCB, 1997). Currently, approximately 87 general industrial and 401 construction activity permits exist within the WMA (CRWQCB, 2007).

A study entitled, "Sources, Patterns and Mechanisms of Storm Water Pollutant Loading From Watersheds and Land Uses of the Greater Los Angeles Area" was conducted by SCCWRP in 2007. Storm water runoff and the associated contaminants from urban areas is one of the leading sources of water quality degradation in surface waters. Runoff from pervious and impervious areas carries accumulated contaminants (i.e., atmospheric dust, trace metals, street dirt, hydrocarbons, fertilizers and pesticides) directly into receiving waters. Because of the environmental effects of these contaminants, effective storm water monitoring and management requires identification and characterization of the sources, patterns, and mechanisms that influence pollutant concentrations and loads. Little is known about the mechanisms and processes that influence spatial and temporal factors that affect the magnitude and patterns of constituent loading from specific land uses. Specifically, storm water managers need to understand how sources vary by land use type, how patterns of loading vary over the course of a single storm, how loading varies over the course of a storm season, and how applicable national or regional estimates of land use-based loading are to southern California. Ballona Creek, Santa Monica Canyon, and Arroyo Sequit were three sites in the Santa Monica Bay WMA sampled both during dry and wet weather (Stein, et al., 2007).

The study concluded:

- Storm water runoff from watershed and land use-based sources is a significant contributor of pollutant loading and often exceeds water quality standards.
- No single land use type was responsible for contributing the highest loading for all constituents measured.
- All constituents were strongly correlated with total suspended solids.
- Storms sampled from less developed watersheds (i.e., Santa Monica Canyon and Arroyo Sequit) produced constituent event mean concentrations and fluxes that were one to two orders of magnitude lower than comparably-sized storms in urbanized watersheds.
- Storm water runoff of trace metals from the urban watersheds in this study produced a similar range of annual loads as those from traditional point sources such as large publicly-owned treatment plants. However, when combined with dry weather estimates of pollutant loading, the total urban and stormwater runoff from contribution from all watersheds in the greater Los Angeles area far exceeds that of the traditional point sources.
- For all storms sampled, the highest constituent concentrations occurred during the early phases of storm water runoff with peak concentrations usually preceding peak flow.
- Highest constituent loading was observed early in the storm season with intra-annual variability driven more by antecedent dry period than amount of rainfall. This seasonal pattern suggests that focusing management actions on early season storms may provide relatively greater efficiency than distributing lower intensity management actions throughout the season (Stein, et al., 2007).

Highway Stormwater Runoff

Land-use analyses indicate that approximately 0.5 square miles (sq mi) in Malibu Creek/other Rural watersheds and 6.2 sq mi in Ballona Creek/Urban Watersheds are made up of roadways, highways and freeways (CRWQCB, 2007).

Transportation and related activity on roadways, freeways and highways generate a number of pollutants of concern which arise from several sources. For example, hydrocarbons are present in fuels, motor-oil and other lubricating oils; suspended solids are generated during construction; pesticides wash-off from landscape overuse; nitrogen and phosphorous are present as additives in lubricants and in fertilizers; and heavy metals occur in fuel, lubricants, brakepads, vehicle tires, and as by-products of vehicle wear-and-tear (CRWQCB, 2007).

Pursuant to Clean Water Act Section 402(p), storm water permits are required for discharges from a municipal separate storm sewer system (MS4) serving a population of 100,000 or more. USEPA defines an MS4 as a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a State (SWRCB website #2).

The California Department of Transportation (Caltrans) is responsible for the design, construction, management, and maintenance of the State highway system, including freeways, bridges, tunnels, Caltrans' facilities, and related properties. Caltrans' discharges consist of storm water and non-storm water discharges from State owned right-of-ways (SWRCB website #2)

Before July 1999, storm water discharges from Caltrans' storm water systems were regulated by individual NPDES permits issued by the Regional Water Boards. On July 15, 1999, the State Water Board issued a statewide permit (Order No. 99-06-DWQ) which regulated all storm water discharges from Department owned MS4s, maintenance facilities and construction activities. The existing permit (Order No. 99-06-DWQ) will be replaced upon adoption of a new permit (SWRCB website #2).

Caltrans' Storm Water Management Plan (SWMP) describes the procedures and practices used to reduce or eliminate the discharge of pollutants to storm drainage systems and receiving waters. Additional information, including technical reports characterizing various aspects of runoff from highways and BMP effectiveness, can be found at the following websites (SWRCB website #2).
http://www.waterboards.ca.gov/water_issues/programs/stormwater/gen_caltrans.shtml

http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/index.htm#SWMP

Each Caltrans district has a workplan which outlines the planned stormwater activities for the upcoming fiscal year. The Los Angeles Regional Board is contained entirely with Caltrans District 7; its workplan includes information about the district's water bodies, best management practices (BMPs) by each division, monitoring programs, corridor studies and TMDLs. It describes how the District will specifically implement the requirements of the Statewide Stormwater Management Plan (SWMP) during fiscal year 2009-2010.

Current goals of District 7 include improving compliance-monitoring practices, enhancing BMP implementation, and extending public outreach. Following are some of the goals for the respective Stormwater Departments:

- To achieve these goals, the District Stormwater Coordinator and Design Stormwater Coordinator have committed to update the Treatment BMP spreadsheet for Treatment BMP locations which fulfills the requirement from Headquarters to maintain a database of all treatment BMPs implemented in each District, and as a result, the entire department.

- The Design Stormwater Unit facilitates the incorporation of water pollution and erosion control recommendations into the planning, design, and construction of all projects in District 7.
- The TMDL Unit participates in implementation plans of adopted TMDLs with waste load allocations assigned to the District.
- The Corridor Studies Unit will oversee the studies for the treatment or reduction of the Department's stormwater discharges, in each identified watershed, by at least 20% below 1994 levels.
- The Construction Stormwater Unit properly implements the SWMP and the DWP within the Division of Construction.
- The Maintenance Unit implements a stormwater program with its allocations that utilizes best management practices for stormwater projection during all of its roadway maintenance activities. The District is committed to applying vegetation control products to minimize usage and/or eliminate pollutant runoff. The District is committed to inspect, repair or clean storm drain systems.
- The Encroachment Permit Stormwater Unit ensures that all permits issued to agencies and other public entities encroaching into the Department's Right-of-Way comply with the NPDES Permit that is consistent with what is required of Maintenance, Construction, and Design.
- The Right-of-Way Stormwater Unit complies with the NPDES permit as required through the SWMP.

The District has also committed to implement BMPs appropriate to the projects, additional education for the staff and the public in partnership with other stakeholders bring the urgency of eliminating stormwater runoff pollution (Caltrans, 2010).

ADDITIONAL SOURCES

Atmospheric Deposition

Deposition of airborne pollutants is recognized as a potentially significant source of contamination to waterbodies in the watershed. The Santa Monica Bay Watershed is situated within the South Coast Air Basin, which experiences the nation's worst air quality. Contaminants that are found to originate from atmospheric deposition include, but are not limited to, chlorinated organic compounds, metals, PAHs, and oxides of nitrogen. The most plausible sources of these pollutants (except chlorinated organic compounds) are deposition of vehicle fuel exhaust and wear of auto parts (CRWQCB, 1997).

It is estimated that most airborne pollutants are carried eventually to waterbodies by storm water runoff, both wet deposition as intercepted by rain drops, and dry deposition as scoured by surface flows. Atmospheric deposition directly to the Bay can be significant when wind direction changes and push air from inland to the sea. Other notable sources of direct deposition include air traffic and wildfire (CRWQCB, 1997).

A study that measured and modeled atmospheric deposition on Santa Monica Bay and the Santa Monica Bay WMA was conducted by SCCWRP and reported on in 2001. This study was designed to answer the following questions:

- What is the total annual load of toxic contaminants and nutrients to Santa Monica Bay/Watershed via atmospheric deposition?
- What proportion of the annual load of toxic contaminants and nutrients from atmospheric deposition is contributed during specific meteorological events or conditions?
- How do atmospheric concentrations of toxic contaminants and nutrients and associated loads vary spatially within the Santa Monica Bay watershed and receiving water and among other regions of Los Angeles (Stolzenbach, et al., 2001)?

The major findings and conclusions of this study were:

- The annual rate of atmospheric transport and deposition of trace metals to Santa Monica Bay, defined as the sum of direct and indirect (on the watershed) deposition, is significant relative to other inputs of metals to the Bay.
- The annual total of atmospheric deposition of metals on Santa Monica Bay and its watershed is primarily the result of chronic daily dry deposition throughout the year, which far exceeds the estimated annual dry deposition of metals resulting from Santa Ana conditions and the annual wet deposition of metals.
- Most of the mass of metals deposited by dry deposition on Santa Monica Bay and its watershed originates as relatively large (bigger than 10 microns) aerosols from area sources (off-road vehicles and small businesses) in the Santa Monica Bay watershed.
- The relative amounts of chromium and zinc contributed by atmospheric and non-atmospheric sources are approximately equal; on the other hand, almost all of the lead inputs to Santa Monica Bay are through atmospheric sources. Non-atmospheric inputs contribute the majority of copper and nickel to the Bay.

The major implications for environmental management are:

- At least for metals, direct atmospheric deposition, primarily chronic daily dry deposition, must be considered as a significant nonpoint source in establishing TMDLs for Santa Monica Bay and waterbodies in the Bay's watershed.
- For some metals, the majority of the metal mass in the urban runoff during the wet season may be material originally associated with aerosols that are transported some distance from their original point of emission into the atmosphere before being deposited in the watershed.
- Reductions of nonpoint source inputs may require a coupling between air quality and water quality regulatory actions and policies. For metals, the most important sources of emission to the atmosphere are non-permitted area sources, which may be relatively difficult to regulate.
- For some sources, the deposition may be primarily composed of large aerosols and may occur very locally, perhaps within 100-500 meters of the source. This pattern of deposition will be difficult to monitor on a regional scale and will require a larger number of localized measurements (Stolzenbach, et al., 2001).

Contaminated Sediments

Contaminated sediment problem areas in the Bay include DDT- and PCB-contaminated sediments around the JWPCP outfall on the Palos Verdes Shelf and Slope, and around the Hyperion Plant outfall in the Santa Monica submarine canyon (CRWQCB, 1997).

Over the last 20 years, there has been a substantial increase in our knowledge about the characteristics of sediments and sediment contamination on the Palos Verdes Shelf. Most of the information comes from the natural resource damage assessment conducted by trustees of a National Oceanic and Atmospheric Administration (NOAA) lawsuit and studies conducted by the SMBRP (CRWQCB, 1997).

Based on the NOAA assessments and other existing information, the U.S. EPA in July 1996 began a Superfund investigation of the contaminated sediments on the Palos Verdes Shelf. Under this investigation, EPA recently completed a site characterization investigation and feasibility analysis and selected a preferred alternative for cleanup of the site (CRWQCB, 1997). More information on these studies are found elsewhere in this document.

Currently, disposal of dredged material is not a significant source of pollutant loading in Santa Monica Bay. The Ballona Creek Entrance Channel is one area of concern for sediment buildup and where periodic maintenance dredging is carried out. Dredged material from these sites is disposed of directly on the beach if it is deemed "clean" and is otherwise compatible (coarse-grained) or is placed in the nearshore zone so that waves can redistribute the sand onto the beach. No permanent solution has been reached for disposal of contaminated sediment. Ocean disposal within Santa Monica Bay is unlikely since there is no permitted ocean dumpsite located in the Bay at this time (CRWQCB, 1997).

Sediment resuspension has been and will continue to be the major loading source for historically deposited toxic chemicals, most notably, DDT and PCBs on the Palos Verdes Shelf. Because of the large size of the contaminated area, capping will only reduce, but not eliminate the input from this source (CRWQCB, 1997).

Water Supply

Water supply could become a source of pollutant loading if the concentration of certain pollutants in either imported water or pumped ground water exceeds the "background" level of existing surface waters. It could be a concern when water supply is considered the only or major source of the pollutant (CRWQCB, 1997).

Natural Sources

In 2007 SCCWRP released a report entitled “Assessment of Water Quality Concentrations and Loads from Natural Landscapes.” The overall goal of this study was to evaluate the water quality contributions and properties of stream reaches in natural catchments throughout southern California. Specific questions addressed by this study were:

- What are the ranges of concentrations, loads, and fluxes of various metals, nutrients, solids, algae, and bacteria associated with storm and non-stormwater runoff from natural areas?
- How do the ranges of constituent concentrations and loads associated with natural areas compare with those associated with urban (developed) areas and existing water quality standards?
- How do the environmental characteristics of catchments influence constituent concentrations and loads from natural landscapes?

These questions were addressed by measuring surface water quality at 22 natural open-space sites spread across southern California’s coastal watersheds including two sites within the Santa Monica Bay WMA; Arroyo Sequit in the North Coast Area and Cold Creek within the Malibu Creek Watershed.

The results of this study yielded the following conclusions:

- Concentrations and loads in natural areas are typically between one to two orders of magnitude lower than in developed watersheds.
- The wet-weather TSS concentration from natural catchments was similar to that from developed catchments.
- Differences between natural and developed areas are greater in dry weather than in wet weather
- Dry weather loading can be a substantial portion of total annual load in natural areas.
- Peak concentration and load occur later in the storm in natural areas than in developed areas.
- Natural catchments do not appear to exhibit a stormwater first flush phenomenon.
- Concentrations of metals from natural areas were below the California Toxic Rule criteria.
- The ratio of particulate to dissolved metals varies over the course of the storm.
- Wet-weather bacteria concentrations for *E. coli*, *enterococcus*, and total coliform exceeded freshwater standards in 40 to 50% of the samples.
- Concentrations of several nutrients were higher than the proposed USEPA nutrient guidelines.
- Catchment geology was the most influential factor on variability in water quality from natural areas.
- Catchments underlain by sedimentary rock generally produce higher constituent concentrations than those underlain by igneous rock.
- Other environmental factors such as catchment size, flow-related factors, rainfall, slope, and canopy cover as well as land cover did not significantly affect the variability of water quality in natural areas (Stein and Yoon, 2007).

Other Sources

Besides trash and debris generated in the watershed and carried to the ocean via storm flows, beach littering and boating wastes are two other important sources of marine debris. Although the high number of beachgoers and recreational boats utilizing the Bay suggests that the scale of the problem could be large, there is little information regarding the contribution of marine debris from these sources compared with stormwater/urban runoff (CRWQCB, 1997).

In, addition to marine debris, boating activities (and in particular boat maintenance) have been known to be the major source of TBT found in marinas and harbors. Boating activities are also potential sources of pathogens, oil and debris, and the heavy metals copper and zinc (the former from anti-fouling paint and the latter from zinc anodes) (CRWQCB, 1997).

If. not contained, a major oil or hazardous materials spill can cause considerable ecological damage and contribute to the total pollutant loading of polycyclic aromatic hydrocarbons in the watershed. However, large scale spills are generally rare in Santa Monica Bay; most reports of oil spills/sheens over the past three years involve amounts of a few gallons. The majority of larger spills into the Santa Monica Bay WMA involve sewage (CRWQCB, 1997). Spills reported to the California Emergency Management Agency can be viewed as reports at the website http://www.oes.ca.gov/operational/malhaz.nsf/$defaultView?OpenView&Start=1; the spill list can be narrowed down through a search (CEMA website).

Watershed Stakeholder Groups

There are a large number of watershed stakeholder groups with interests in the Santa Monica Bay, both the ocean and the watersheds draining to it. While many meet and conduct activities that focus on their own areas of interest, they will often participate in some of the larger scale groups as well which are highlighted below.

Santa Monica Bay Restoration Commission (formerly, Santa Monica Bay Restoration Project) The Santa Monica Bay Restoration Project (SMBRP) was formed in 1989 under the National Estuary Program in response to the crucial problems of the Bay. The SMBRP was charged with the responsibility of assessing the Bay's problems, developing solutions and putting them into action. Under the five year development process outlined in the Clean Water Act, a comprehensive characterization of the Bay's environmental condition and a plan of action was structured with the involvement of a diverse group of stakeholders organized into SMBRP's Management Conference (Management Committee, Technical Advisory Committee and Public Advisory Committee). The organization and membership of the Bay Watershed Council expanded from the pre-BRP SMBRP Management Conference and became representative of the key stakeholders for the watershed (CRWQCB, 1997). The Bay Commission is now composed of a Watershed Council, Governing Board, Executive Committee, and Technical Advisory Committee (CRWQCB, 2007) More information may be found at http://www.santamonicabay.org .

The scientific characterization of the Bay was described in the SMBRP's "State of the Bay, 1993" report and other technical investigations. This report, along with the Project's recommendations for action, comprised the Bay Restoration Plan (BRP), which was approved by the Governor Wilson and the EPA Administrator Carol Browner in March 1995. With over 200 actions, the Plan addressed the need for pollution prevention, public health protection, habitat restoration and comprehensive resource management (CRWQCB, 1997).

Guided by a watershed perspective, the Bay Restoration Plan recommended many watershed/ subwatershed-based pollutant management strategies and actions and thus became the first watershed management plan developed in the Los Angeles Region (CRWQCB, 1997).

Malibu Creek Watershed Council (with subcommittees) A number of stakeholders began meeting in the late 1980's/early 1990's in the Malibu area. Through their efforts, a list of priority issues that need to be resolved was formulated. This lead to the development of a Natural Resources Plan for the watershed which was prepared by the U.S. Natural Resources Conservation Service. Separate task forces and subcommittees have formed over the years to address specific issues. The Watershed Council consists of members from State and local agencies and organizations, environmental groups, business and dischargers, special districts and the general public. Their mission is to oversee and implement actions that will protect, enhance and restore habitats of the watershed, as well as improve water quality. Current active committees/task forces under the Council include those focusing on habitat/species, monitoring/ water quality, education, and Rindge Dam. The Council's Malibu Lagoon Task Force served as an advisory group to a recently completed lagoon restoration plan. A copy of the final lagoon restoration plan funded by the Coastal Conservancy may be found at http://www.healthebay.org/currentissues/mlhep/default.asp. The Monitoring Subcommittee also met regularly to serve as a Technical Advisory Committee to a Proposition 13-funded watershed-wide monitoring program which has been completed. It is currently working to establish a central repository for monitoring metadata for the watershed. A Malibu Creek Ecosystem Restoration Feasibility Study is underway. The U.S. Army Corps of Engineers and California Department of Parks and Recreation are the major partners in this effort which will evaluate, among other options, the feasibility of restoring the ecosystem through removal of Rindge Dam. The technical advisory group for the effort meets approximately monthly while a larger stakeholder focus group meets as needed. Watershed Council meetings occur every other month while subcommittees may meet intermittently or regularly. More information may be found at http://www.malibuwatershed.org/ (CRWQCB, 2007).

Ballona Creek Watershed Task Force The task force was formed in 2000 as a stakeholder group addressing water quality and habitat issues in the watershed and developing a Ballona Creek Watershed Management Plan which can be found at http://www.ladpw.org/wmd/watershed/bc. The group continues to meet in pursuit of Plan implementation (CRWQCB, 2007).

Topanga Watershed Committee The committee was formed in 1998 as a followup to previous a community group working on developing alternatives to traditional flood control measures. Their focus has expanded to include general watershed management and protection activities as well as volunteer monitoring. Work has also been completed to define the extent of restoration feasible to Topanga Lagoon. A 205(j) grant-funded project conducted baseline water quality monitoring for two years during both dry- and wet-weather. A watershed management plan was finalized in 2002. Watershed residents continue work on implementation of actions identified in the Management Plan. The group meets on an as-needed basis. More information about this group may be found at their website http://www.topangacreekwatershedcommittee.org (CRWQCB, 2007).

Water Quality and Beneficial Use Issues By Subwatershed Areas

This section provides summaries of water quality issues for nine subwatershed areas in the Santa Monica Bay watershed. These nine subwatershed areas are grouped from 28 catchment basins based on their distinctive geographical (topographical and land use) characteristics. Descriptions on each of the nine regions are confined to the land and coastal water areas (areas defined as "waters of the state") and span 414 square miles. Collectively they are known as the ***Santa Monica Bay Watershed Management Area***. Issues related to ocean water outside the "waters of the state" are addressed in a separate "Ocean" section (CRWQCB, 1997).

Each summary of the subwatersheds (including the "Ocean" section) includes a general description of the region, listed of identified beneficial uses, evidence of beneficial use impairments, list of pollutants of concern, information on sources and loading, and water quality improvement strategies. Descriptions and discussion emphasize issues that are specific to and/or a priority in a subwatershed area (CRWQCB, 1997). As appropriate or useful, maps shown in earlier sections of the report are shown again, now zoomed to the subwatershed under discussion.

North Coast

The North Coast region represents one of nine different subwatershed groups that drain to Santa Monica Bay. This subwatershed drains an area of approximately 55 square miles and borders the eastern portion of Ventura County to the west, the Malibu Creek subwatershed to the north and east, and the Pacific Ocean to the south. Several minor streams and creeks discharge directly to the Bay, but there are no major traditional point sources discharges in this subwatershed; permits for discharges to land are generally for on-site septic systems. The area is largely undeveloped, has similar land use activities and pollutant load characteristics, and the immediate receiving waterbody is generally considered pristine (CRWQCB, 1997).

Flows

A number of creeks and streams in the North Coast subwatershed flow directly into Santa Monica Bay. The largest of these creeks are Arroyo Sequit and Trancas. Together, the flows in this region total approximately 5,500 acre-feet per year (CRWQCB, 1997).

Land Uses

Although this region is rural, there is still evidence of development in the North Coast subwatershed. Most of the development is located close to the coastline, near Point Dume and just north of Malibu Creek and Lagoon. Additionally, a few areas in the upper subwatershed area have been developed, but the percentage is relatively small. Land use activities can be broken down into the following: 92% open space, 7% residential, and less than 1% for commercial/industrial and public (CRWQCB, 1997).

Wetlands

The North Coast region is home to some of the County's last remaining wetlands. They can be found in the drainage areas of Arroyo Sequit Canyon, Trancas Lagoon and Lower Zuma Creek and Lagoon; each varies in both type and function. The Arroyo Sequit Canyon, and Zuma Creek and Lagoon areas are considered riparian freshwater wetlands while Trancas Lagoon represents a more typical saltwater coastal wetland. The drainage areas of these creeks and lagoons lie within the Santa Monica Mountains National Recreation Area, as do several others in this subwatershed. Local wetlands serve several purposes, including providing essential habitats for a diversity of species such as birds, fish, amphibians, reptiles, invertebrates, and mammals. They also act as natural filters which are able to absorb, retain and remove pollutants from the water, recharge groundwater, and they provide flood protection, recreational use, and aesthetic value. The lagoons provide feeding and resting areas for shore birds and migratory waterfowl (CRWQCB, 1997).

Arroyo Sequit Canyon Arroyo Sequit is located approximately 28 miles west of the City of Santa Monica and is one of the best preserved small coastal drainages in the Santa Monica Bay watershed. The drainage area of this canyon is approximately 7,203 acres. The riparian wetlands located there begin at the confluence of the East and West Forks of Arroyo Sequit and extend 3.2 miles to the Pacific Ocean, where a small coastal lagoon has formed. The habitat is primarily sycamore alluvial woodland. Stream flow supports a wide variety of native aquatic animals, including resident and migratory populations of rainbow and steelhead trout. However, the lower floodplain has been encroached upon by the camping facility for Leo Carillo State Beach. Barriers to fish passage and the presence of various invasive species are also concerns. Restoration of the riparian and lagoon habitats is important for native plant and wildlife species (CRWQCB, 1997).

Zuma Creek and Lagoon The Zuma Creek and Lagoon drainage area, of approximately 5,722 acres, is mostly undeveloped national parkland and open space. Lower portions of the creek are channelized in places, and there is a residential area adjacent to the stream just north of the Pacific Coast Highway bridge. The riparian corridor is supported by a small perennial stream, providing the primary source of water for the generally closed lagoon. Freshwater wetland vegetation can also be found there, although it is severely stressed during periodic drought conditions. This area also supports a dune habitat. In dry years, there is typically little water present, but with increased runoff from development and during "wet" years, a larger two-acre lagoon has formed. However, this lagoon has most likely fluctuated in size over time. The area is currently degraded due to past dumping practices and the presence of non-native vegetation. Barriers to fish passage are also of concern and a top priority of the SMBRC (CRWQCB, 1997).

Trancas Creek and Lagoon Trancas Lagoon is a small coastal lagoon approximately nine acres in size located several miles west of Point Dume in Los Angeles County and is fed by numerous small tributaries. However, some runoff enters the lagoon from hillsides and from adjacent land uses, such as residential, commercial, and local roadways (CRWQCB, 1997).

Trancas Creek drains a watershed of 6,233 acres. The mouth of the creek is often closed by sand bars which form due to wave action and littoral transport of sand. The berm closes the system to tidal action and causes the creek flow to back up within the lagoon. In the past, the lagoon was mechanically breached periodically in order to allow outflow and to prevent local flooding. A cement and boulder lined debris basin has been built 0.8 miles up Trancas Canyon and ends at a broad basin just east of PCH near Trancas Beach. The mouth of Trancas Creek has been highly constricted by fill. A shopping center and nursery operation border one side of the lagoon and an old, vacant horse riding area borders the other side (CRWQCB, 1997).

Solstice Canyon Creek Solstice Canyon is home to some of Santa Monica Bay watershed's unique wetlands. Specifically, the Solstice Canyon wetlands are palustrine, i.e., non-tidal wetlands dominated by vegetation. Streams feeding these wetlands are intermittent, flowing only part of the year and the stream corridors are typically steep, narrow and highly erosive. This confines riparian vegetation to the immediate stream channel area (CRWQCB, 1997). The invasive New Zealand mudsnail is of great concern in this area.

Beneficial Uses

The North Coast subwatershed is host to many beneficial uses as can be seen in the table below (CRWQCB, 1994).

Table 4. Beneficial uses of the waters within the North Coast subwatershed

Coastal Feature or Waterbody	Hydro Unit #	MUN	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL	WET
Arroyo Sequit	404.44	P	I		E	E		E	E			E	E	E	E		E
San Nicholas Canyon Creek	404.43	P			I	I		I				E					
Los Alisos Canyon Creek	404.42	P			I	I		I				E	E				
Lachusa Canyon Creek	404.42	P			I	I		I				E					
Encinal Canyon Creek	404.41	P			I	I		I				E	E				
Trancas Canyon Creek	404.37	E			E	E		E				E	E				
Dume Lagoon	404.36			E	E	E	E			E		E	E	Pf	P		E
Dume Creek (Zuma Canyon)	404.36	E			E	E		E	E			E	E	P	P		
Ramirez Canyon Creek	404.35	I			I	I		I				E			P		
Escondido Canyon Creek	404.34	I			I	I		I				E	E				
Latigo Canyon Creek	404.33	I			I	I		I				E	E				
Solstice Canyon Creek	404.32	E			E	E		E				E		P	P		
Puerco Canyon Creek	404.31	I			I	I		I				E					
Corral Canyon Creek	404.31	I*			I	I		I				E					
Nicholas Canyon Beach	403.43			E	E	E	E				E	E			P	E	
Trancas Beach	403.37			E	E	E	E				E	E			P	E	
Zuma County (Westward) Beach	404.35			E	E	E	E				E	E			P	E	
Dume State Beach	404.36			E	E	E	E				E	E			P	E	
Dume Lagoon	404.36			E	E	E	E			E		E	E	P	P		E
Escondido Beach	404.34			E	E	E	E				E	E			P	E	
Dan Blocker Memorial (Corral) Beach	404.31			E	E	E	E	E			E	E			P	E	
Puerco Beach	404.31			E	E	E	E				E	E			P	E	
Amarillo Beach	404.21			E	E	E	E				E	E			P	E	

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Significant Regions

Sections offshore of the North Coast subwatershed (from the Ventura County line to Latigo Point) have been designated as an Area of Special Biological Significance (ASBS) by the State Water Resources Control Board (SWRCB); portions of the land area have been designated as Significant Ecological Areas (SEA) by Los Angeles County. These areas require protection of species or biological communities to the extent that alteration of natural water quality is undesirable, and that the preservation of natural water quality be maintained to the extent practicable. Zuma Canyon, Arroyo Sequit and Point Dume are three such designated areas in this region (CRWQCB, 1997).

The North Coast is also home to state and federally listed endangered species such as *Pentachaeta lyonii* (an endangered plant), *Vireo Belli/* pusillus (an endangered bird), and steelhead trout (an endangered anadramous fish) (CRWQCB, 1997).

The area falls within the Santa Monica Mountains biogeographic population group described in the Draft Steelhead Recovery Plan; the value of and threats to the Core 1 population of fish within Arroyo Sequit, specifically, are highlighted while Solstice Creek is considered to be currently occupied by a Core 2 population. The Core 1 populations are those populations identified as a high priority for recovery actions based on a variety of factors, including: the intrinsic potential of the population in an unimpaired condition; the role of the population in meeting the spatial and/or redundancy viability criteria; the conditions of the population, the severity of the threats facing the populations; the potential ecological or genetic diversity the watershed and population could provide to the species; and the capacity of the watershed and population to respond to the critical recovery actions needed to abate those threats. Core 1 populations form the nucleus of the recovery strategy. Core 2 populations must eventually meet the biological recovery criteria; however, these populations are considered to be of secondary importance in terms of recommended priority of recovery efforts (NOAA, 2009).

Local Parks and Beaches

Zuma Beach is one of the most heavily used beaches in Los Angeles County. Hundreds of thousands of residents and tourists use the area for sunbathing and surfing activities each year. Additionally, educational meetings and field trips are held there for local students and the general public. In 2000, the SMBRC, together with the National Park Service, Los Angeles County Department of Beaches and Harbors, with additional funding from USEPA, completed the restoration and enhancement of lower Zuma Creek and Lagoon. Zuma Wetlands is a small, 6-acre, freshwater marsh and creek situated just north of Point Dume. The wetlands have historically served as a wildlife corridor and nesting site for a variety of birds and small mammals. By the early 1990s, periodic dumping of surplus construction and road building material had heavily impacted the wetlands and surrounding uplands. The existing wetlands had been greatly reduced and, in many areas, native species had been completely replaced by exotic ornamental trees, annual grasses, fennel, mustards, and thistles. High visitation at Zuma Beach also impacted the site (SMBRC website). Barriers to fish passage are also of concern and a top priority of the SMBRC.

Despite the long-term habitat degradation, studies indicated that the site had high potential for successful restoration. In the fall of 1993, federal, state, and nonprofit conservation agencies began planning efforts for a restoration of the remnant freshwater marsh, riparian woodland, saltgrass terrace, and locally rare foredunes at the site. A final restoration plan was completed in April 1997 and in 1998 restoration began. Over the next two years, excavation of construction fill, recontouring of upland habitats, removal of exotic plant species, in-planting of more than 5000 native plants, and the re-creation of an additional two acres of freshwater wetland/dune/riparian habitat was accomplished. The resulting restored wetland has an unusually diverse and highly valuable habitat for wildlife. As an example, more than 110 bird species were recorded over a one-year monitoring period. The project continues to be monitored for exotic species control and habitat protection (SMBRC website).

Leo Carillo State Beach is another popular beach in the North Coast subwatershed. This beach offers many of the same opportunities **as** Zuma Beach, in addition to providing camping grounds, hiking and biking opportunities and many other outdoor activities (CRWQCB, 1997).

Evidence of Impairment

While the beaches are listed as impaired for indicator bacteria and fish consumption, to date there is no documented evidence of impairment from pollutants of concern in the North Coast subwatershed streams, although potential pollution problems exist for areas not in public stewardship (CRWQCB, 1997).

However, this region is threatened by invasion of non-native plant and animal species, sedimentation and erratic stream flows, trash and debris, septic systems and is frequently used by transients which limit diversity and density of plants and wildlife, and pose public safety concerns (CRWQCB, 1997).

Habitat Degradation

Invasive New Zealand mudsnails were first discovered in Solstice Creek in 2007 and in Ramirez and Trancas Creeks in 2009. The individual snails are very small, only 3 – 5 mm long. Each snail can reproduce enormous amounts of offspring through a cloning process called parthenogenesis which can result in very high snail densities on the bottoms of streams which displace native aquatic invertebrates utilized by fish and amphibians for food; they can easily be transferred to other streams through contact with animals or recreational/monitoring equipment. They do not appear to have any natural native predators (SMBRF, 2009).

Pollutants of Concern

There are no associated pollutants of concern for the inland waters of the North Coast subwatershed due to limited human activity in this area. However, as mentioned above, the threat of trash and debris, oil spills and possibly even excessive sedimentation are potential issues for the region. Beaches along Santa Monica Bay, including the ones of this subwatershed, are listed as impaired for indicator bacteria and fish consumption (CRWQCB, 1997).

Sources and Loadings

There are links between potential sources of pollution with pollutants (as identified above) that may threaten the waterbodies and habitats of this region (CRWQCB, 1997).

Trash and Debris

Trash and debris found in the creeks and lagoons most likely comes from improper disposal of waste by beach-goers, visitors, transients and residents. This trash and debris adversely impacts the sensitive habitats of the area as well as creating an aesthetic nuisance (CRWQCB, 1997).

Oil Spills

The threat of spills to the Bay resulting from oil tankers exists given the continual oil transporting activities that occur along California's coastline. Ocean currents have the potential to transport oil from spills directly to the shoreline, thereby significantly degrading this sub-watershed's special coastal habitats (CRWQCB, 1997).

TSS and Fine-grained Sediments

Sediments and total suspended solids (which hinder light transmission into waters, smother spawning areas and hard-bottom subtidal habitats, and provide a transport medium for other pollutants such as heavy metals and pesticides) also have several known and suspect sources. Non-stabilized hillsides, development activities where best management practices have not been properly implemented, improper land grading activities, horse and animal farms located too close to waterbodies, and other relevant agricultural activities all contribute sediments and TSS to this watershed's creeks and streams, which ultimately flow to the lagoons and ocean. Furthermore, fire residual may be washed down by storm runoff, thereby contributing excessive sediments and nutrients to the watershed's receiving waters (CRWQCB, 1997).

Water Quality Improvement Strategies

In accordance with previously identified problems and in order to protect the beneficial uses of waterbodies in this region, the greatest benefits in achieving water quality improvements in the North Coast subwatershed could be achieved by focusing efforts on the following:

- Protect and restore remaining wetlands in the North Coast subwatershed.
- Implement measures to control excessive sedimentation.
- Implement measures to reduce the amount of trash and debris.
- Prevent the introduction of and reduce/eliminate non-native invasive species where feasible.
- Examine the use of septic systems in this subwatershed, particularly near the coastline (CRWQCB, 1997)
- Conduct source identification
- Implement TMDLs

Wetlands Protection and Restoration

Although federal and state regulations seek to protect wetlands from being filled in unnecessarily and assure mitigation of unavoidable impacts, there needs to be more coordination at the local level to ensure protection of the unique wetlands found in this region. Because the wetlands in this subwatershed are affected by the land use activities and water quality impacts that occur upstream, as well as invasion of non-native species, any restoration activities taking place should consider these issues. The SMBRC's Bay Restoration Plan identifies specific actions that can be taken to protect and restore Trancas Lagoon, Arroyo Sequit Canyon and other priority wetlands found throughout the Santa Monica Bay watershed. Development of a comprehensive plan should address identified pollutants and sources found in the North Coast subwatershed and should be based on water quality, salinity, habitat and biodiversity objectives for wetlands restoration (CRWQCB, 1997). Additionally, the State's Wetlands Policy and the Southern California Wetlands Recovery Project (WRP) (described elsewhere in the document) are working to ensure wetlands protection and restoration occurs.

Zuma Canyon Creek and Lagoon In 2000, restoration and enhancement of lower Zuma Creek and Lagoon was completed. The project continues to be monitored for exotic species control and habitat protection (SMBRC website).

A Zuma Canyon restoration and steelhead enhancement feasibility study is on the WRP workplan as a Tier 2 project. The project is estimated to cost $400,000 and would restore 3.5 acres of agricultural area near the entrance of Zuma Canyon on steep slopes that has been planted in avocados. About four acres of agricultural land adjacent to the creek in the coastal plain has already been restored with SMBRC funds. In addition, the National Park Service will expand on the initial baseline habitat assessment by Caltrout, and determine habitat quality and feasibility of steelhead restoration in Zuma Creek, including a habitat assessment, fish passage evaluation, and development of a conceptual restoration plan. A funding source has not yet been identified for the remaining 3.5 acres (SCWRP website #2).

Trancas Canyon Creek and Lagoon The WRP has identified a parcel adjacent to the lagoon for acquisition (Birosik, personal notes).

Solstice Canyon Creek Solstice Creek has been identified as a primary candidate for recovery of the southern steelhead trout, a federal endangered species. Design plans were completed for a project on the WRP workplan to restore steelhead access to approximately 1.5 miles of Solstice Creek. Seven barriers in the National Recreation Area were removed in 2006 and a box culvert within the City of Malibu at the Corral Canyon Road crossing was replaced with a clear span bridge over Solstice Creek. The final fish passage barrier is at Pacific Coast Highway. This project will be a CalTrans Environmental Enhancement and Mitigation program project that would modify the culvert at PCH downstream of the proposed project area. Additionally, acquisition of various parcels near the creek are of importance to preserve habitat linkages (SCWRP website #2).

Arroyo Sequit The middle to upper Arroyo Sequit between State Parks and National Park has an identified gap that could be filled through acquisition from a willing seller (Birosik, personal notes).

Control of Excessive Sedimentation

Sediments are transported by creeks and streams to lagoons and ultimately the ocean. It is a necessary and natural function that replenishes beaches along the coastline. However, excessive sedimentation can be harmful to downstream habitats (as discussed previously) and efforts must be made to control unnatural sediment loads from reaching the local creeks and streams. These efforts should include promoting proper implementation of runoff controls at construction sites, planting native species that will prevent erosion of hillsides and stabilize topsoils, educate appropriate audiences about the impacts of improper land grading activities, and educate owners of horse/animal farms about how the location of their livestock can contribute to sedimentation of adjacent creeks and streams (CRWQCB, 1997).

Reduction of Trash and Debris

Although problems resulting from trash and debris are intermittent and do not pose a constant threat to this watershed, appropriate action should be taken where recurrent problems arise. This may include installing additional trash receptacles, educating the local public and visitors, posting informational signs, installing "trash nets" and establishing volunteer programs where people can serve as both watchdogs and support for cleanup activities (CRWQCB, 1997).

Removal of Non-native Invasive Species

Non-native species limit diversity of local, native plants and animals. Location and types of non-native species throughout the North Coast subwatershed should be identified and mapped. Once this information has been prepared, an assessment should be performed in priority habitats on the feasibility of eliminating non-native species and restoring the area with native, indigenous species (CRWQCB, 1997).

In 2002, the California Department of Fish and Game began developing a plan to coordinate state programs, create a statewide decision-making structure and provide a shared baseline of data and agreed-upon actions so that state agencies may work together more efficiently. In January 2008, with input from multiple state agencies, the public, and other stakeholders, the California Aquatic Invasive Species Management Plan (CAISMP) was approved by the Governor. The CAISMP seeks to identify the steps necessary to minimize the harmful impacts of aquatic invasive species (AIS) in California. More than 160 management actions are organized under the following eight objectives: Coordination & Collaboration, Prevention, Early Detection & Monitoring, Rapid Response & Eradication, Long-term Control & Management, Education & Outreach, Research, and Laws & Regulation. The implementation of the highest priority actions was initiated in 2008 with the formation of the California Aquatic Invasive Species Team (CAAIST). The CAAIST's mission is to coordinate the activities of state agencies charged with implementation of the CAISMP. CAAIST is composed of representatives from over 25 California state agencies, including the Santa Monica Bay Restoration Commission. If the priority actions of the CAISMP can be successfully implemented, California resource managers and policy makers will have taken a huge step forward in the effort to prevent new invasions and minimize impacts from established AIS (SMBRF, 2009).

Examination of Septic Systems

Septic systems are located throughout the North Coast subwatershed. Although there is no direct evidence that septic systems have impaired the beneficial uses or degraded water quality of this subwatershed, they have the potential to leak bacteria and nutrients which can then migrate to sensitive habitats and the surf zone. Special attention should be given to them due to these concerns and other associated problems found in adjacent subwatersheds. Special focus could be given to monitoring water quality in the creeks and lagoons for presence of human pathogens and along the surf zone where potentially problematic septic systems have been identified (CRWQCB, 1997).

Conduct Source Identification

Source Identification Pilot Study The beaches adjacent to the mouths of Ramirez and Escondido Canyons exhibited high levels of fecal indicator bacteria from 2004 through 2006, prompting a study to identify the sources of fecal indicator bacteria and to develop a source tracking protocol that can be used at other beaches in southern California. SCCWRP has been conducting a source identification pilot study in Ramirez Canyon and Escondido Canyon, funded largely by the County Supervisors (SCCWRP website #2).

During the first phase of the study, bacterial surveys of the entire watershed were conducted to identify problem locations that might be contributing to high concentrations at the beach. Fecal bacteria indicators (Enterococcus and total and fecal coliforms), human Bacteroides, optical brighteners, and flow rates were sampled adjacent to key land use areas and at critical tributary confluences. The beach was sampled at the creek mouth and at sites up and down coast. The surveys were conducted weekly from March through May in 2007-2009 (SCCWRP website #2).

The two key findings from this first phase were that: 1) the high bacterial counts observed at the beach during the summers of 2004-2006 were no longer prevalent, and 2) the few beach exceedances we observed did not appear to result from the watershed, which generally had low bacterial concentrations (SCCWRP website #2).

In 2010, the studies will refocus on investigating alternative sources near the mouth of the creek and offshore. These include: 1) birds on the beach and pier, 2) activities at Paradise Cove Beach Café (i.e., washing down restaurant equipment, inadequate disinfection of wastewater), 3) regrowth of enterococci in the concrete channel right near the creek mouth, and 4) contaminated groundwater (SCCWRP website #2).

Implement TMDLs

The TMDLs in effect which impact the North Coast are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay nearshore and offshore debris TMDL. Trancas and Zuma Beaches among others in this subwatershed are listed as impaired for indicator bacteria. On the other hand, the North Coast also contains the reference subwatershed for the Santa Monica Bay beach bacteria TMDLs, Arroyo Sequit and its associated beach, Leo Carrillo. For the purpose of implementing the bacteria TMDLs, the area has been divided up into "jurisdictional groups" (JG) – most of the North Coast falls into JG1. The Nicholas Canyon area however falls into JG4. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The number of exceedance days for Nicholas Canyon is fifteen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The District, City of Los Angeles, and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned. (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the bacteria TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Santa Monica Bay Nearshore and Offshore Debris TMDL

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

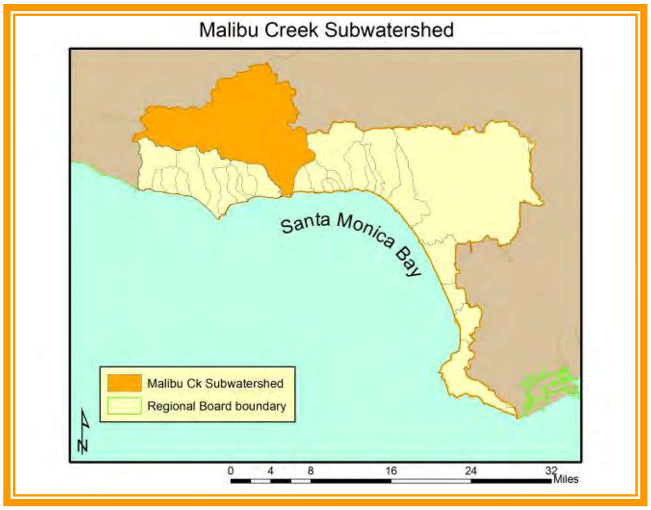
Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean (City of LA website #2). Low flow diversions/treatment facilities found within the North Coast subwatershed are show in the table below.

Table 5. Low flow diversions/treatment facilities within the North Coast subwatershed

Diversion/Facility	Year Operational	Agency
Paradise Cove	2010	Malibu
Marie Canyon	2007	District

Malibu Creek



The Malibu Creek subwatershed is one of the largest draining to Santa Monica Bay. With its discharge point to the Bay at the mouth of Malibu Creek and Lagoon, it drains an area of about 109 square miles. Approximately two-thirds of this subwatershed lies in Los Angeles County and the remaining third in Ventura County. Much of the land is part of the Santa Monica Mountains National Recreation area and is under the purview of the National Parks Service. The region borders the eastern portion of Ventura County to the west and north, the North Coast subwatershed to the south, and portions of the Topanga Canyon subwatershed and Los Angeles River watershed to the east. Major tributaries contributing flows to Malibu Creek and Lagoon include Cold Creek, Lindero Creek, Las Virgenes Creek, Medea Creek, and Triunfo Creek. Additionally, five lakes and two reservoirs are located upstream from Malibu Creek; they are Malibou Lake, Lake Sherwood, Westlake Lake, Lake Lindero, Lake Eleanor, and the Las Virgenes and Century Reservoirs. Located at the end of and receiving flows from Malibu Creek is the 40-acre Malibu Lagoon. The Lagoon includes coastal salt marshes and wetlands, and is home to several diverse plant, marine and animal species (CRWQCB, 1997). The subwatershed is underlain by portions of four groundwater basins (Russell Valley, Conejo-Tierra Rejada, Hidden Valley, and Thousand Oaks) and by the entire Malibu Valley groundwater basin; the latter has not been used as a drinking water supply since 1965 and shows evidence of seawater intrusion (MWD, 2007; DWR, 2004).

Flows

At the mouth of Malibu Creek, the estimated dry-weather base flow is approximately 4-11 cfs although peak flows of more than 24,000 cfs have been recorded at the Los Angeles County gauging station in Malibu Creek during the rainy season, which is significantly more that minimum dry-weather flows (CRWQCB, 1997). The broad difference in values between minimum dry-weather and maximum wet-weather flows reflect the dominant influence of storm water runoff, which is typical of stream flow patterns in Southern California. In fact, in the Malibu Creek subwatershed over 70% of the total annual runoff occurs during the winter months, which results in approximately 13,565 acre-feet of water discharged to the Bay each year (Stenstrom and Strecker, 1993).

Land Uses

Although still relatively rural, this region's population has risen to 90,000, resulting in significant changes in types of land use activities. Consequently, artificial flows in the Malibu Creek subwatershed have increased. Today, the region's land uses are 88% open space, 3% commercial/light industry, 9% residential and less than 1% public. However, approximately 22% this subwatershed region is either part of the Santa Monica Mountains National Recreation Area or state park land and development opportunities are limited (CRWQCB, 1997).

Wetlands

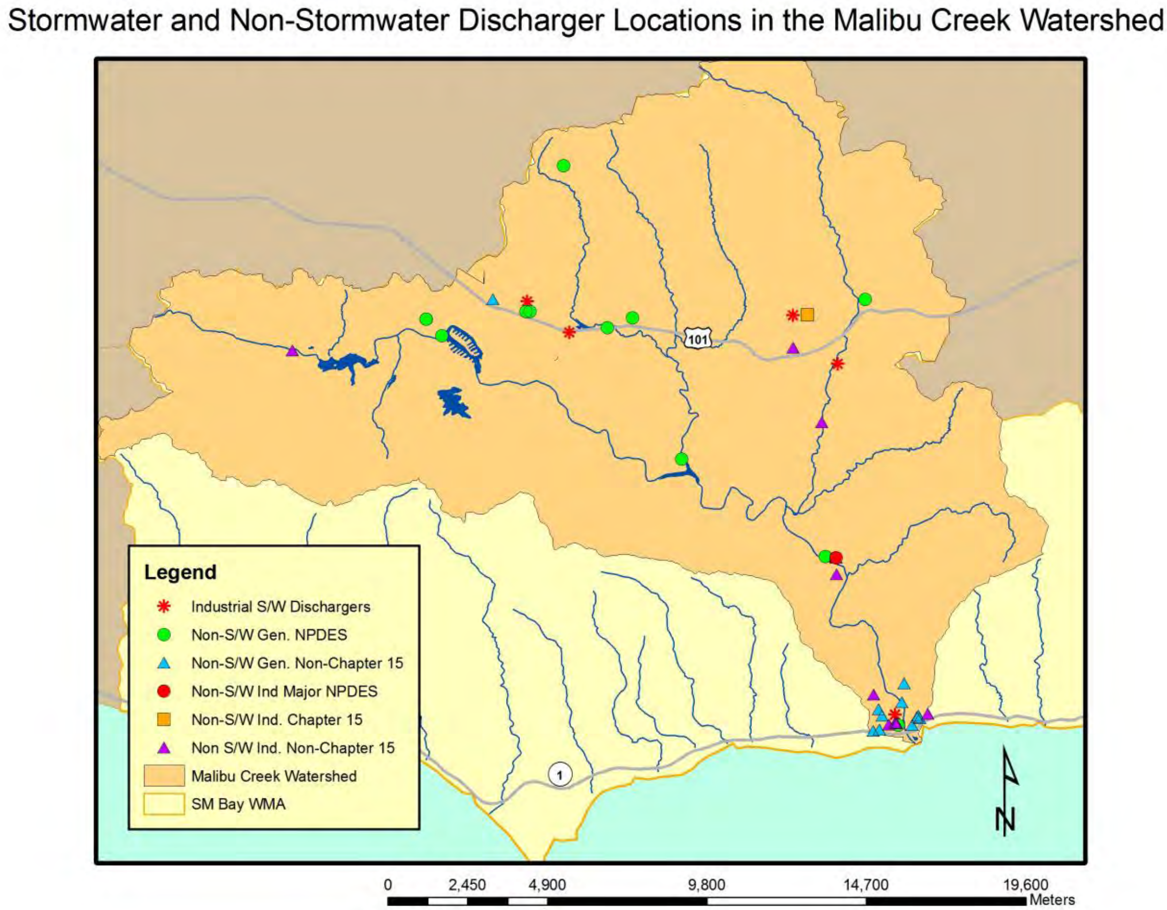
The Malibu Creek subwatershed is also home to some of Southern California's last remaining wetlands. Malibu Lagoon, located at the mouth of Malibu Creek, occupies approximately 40 acres and is characterized as a coastal saltwater wetland habitat. Prior to commercial and residential development of the adjacent and upstream areas, the total acreage of wetlands was approximately 272 acres. Although the area has been severely impacted by urbanization, it supports a variety of species including steelhead trout and tidewater goby (CRWQCB, 1997).

Permitted Discharges

The Malibu Creek subwatershed includes one permitted wastewater treatment facility, the Tapia Water Reclamation Facility, located on Malibu Canyon Road near Tapia Park serves a population of approximately 80,000 from five cities, the western portion of Los Angeles County, and a small portion of Ventura County. Tapia is a tertiary wastewater treatment plant with a design capacity of 16.1 mgd. Pollutant loadings such of TSS, BOD, and metals found in Tapia's wastewater discharges are low. The waste discharged to Malibu Creek is limited to winter months from November 16 through April 14 of each calendar year (except under certain conditions) to minimize the contribution of Tapia’s discharge to the excess freshwater flow into Malibu Lagoon (which leads to elevated Lagoon level and frequent breaching of the sandbar once, or if, the sandbar has formed), thus impacting both wildlife and human health beneficial uses (CRWQCB, 1997). The average discharge to Malibu Creek in 2008 during months that a discharge occurred was 5.76 mgd (LVMWD, 2009). Tapia's recycled water is used for such activities as landscape irrigation; the biosolids generated are recycled at a state-of-the-art composting facility located nearby, then sold or given away (CRWQCB website #1). .

The Malibu Creek subwatershed also includes a number of additional permitted facilities, some of which are covered by the general industrial stormwater permit as can be seen in the figure below (CRWQCB, 2007). In addition, municipal dischargers in the watershed are covered by the Los Angeles County and Ventura County MS4 permits.

Figure 16



Beneficial Uses

The Los Angeles Regional Water Quality Control Board has designated several beneficial uses for the Malibu Creek subwatershed, including unique habitats that support a variety of marine life and wildlife, waters that are used for municipal and domestic supply and commercial and sport fishing opportunities, recreational areas that provide outdoor opportunities for tourists and residents, parks that provide educational opportunities, and groundwater recharge projects. The table below summarizes the beneficial uses designated for all waterbodies in this subwatershed (CRWQCB, 1994).

Table 6. Beneficial uses of the waters within the Malibu Creek subwatershed

Coastal Feature or Waterbody	Hydro Unit #	MUN	IND	PROC	AGR	GWR	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL	WET
Malibu Lagoon	404.21						E	E	E				E	E	E	E	E	E		E
Malibu Creek	404.21	P						E	E		E	E			E	E	E	E		E
Cold Creek	404.21	P						E	E			P			E	E		P		E
Las Virgenes Creek	404.22	P						E	E		E	P			E	E	P	P		E
Century Reservoir	404.21	P						E	E		E				E					E
Malibou Lake	404.24	P					E	E	E		E				E	E				E
Medea Creek	404.23	P				I		I	I		I	P			E	E				E
Medea Creek	404.24	P				I		E	E		E				E					E
Lindero Creek	404.23	P						I	I		I				E					
Triunfo Creek	404.24	P						I	I		I				E					
Triunfo Creek	404.25	P				I		I	I		I				E	E				
Westlake Lake	404.25	P					E	E	E		E				E					
Potrero Valley Creek	404.25					I		I	I		P				E					
Lake Eleanor Creek	404.25	P				I		I	I		I				E					
Lake Eleanor	404.25	P				E		E	E		E				E	E				E
Las Virgenes (Westlake) Reservoir	404.25	E	E	E	E			P	E		P				E					
Hidden Valley Creek	404.26	I				I		I	I		I				E					
Lake Sherwood	404.26	P				E	E	E	E		E				E					E
Malibu Beach	404.21						E	E	E	E				E	E		E	E	E	

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Significant Regions

Certain sections offshore of the Malibu Creek subwatershed have been designated as Areas of Special Biological Significance by the State Water Resources Control Board (SWRCB); other land-based portions have been designated as Significant Ecological Areas (SEA) by Los Angeles County. These areas require protection of species or biological communities to the extent that 1) alteration of natural water quality is undesirable and that 2) the preservation of natural water quality be maintained to the extent practicable. The Malibu coastline, Malibu Canyon and Lagoon, Las Virgenes, Malibu Creek State Park and Cold Creek are all such designated areas (CRWQCB, 1997).

The area falls within the Santa Monica Mountains biogeographic population group described in the Draft Steelhead Recovery Plan; the value of and threats to the Core 1 population of fish within Malibu Creek are highlighted. The Core 1 populations are those populations identified as a high priority for recovery actions based on a variety of factors, including: the intrinsic potential of the population in an unimpaired condition; the role of the population in meeting the spatial and/or redundancy viability criteria; the conditions of the population, the severity of the threats facing the populations; the potential ecological or genetic diversity the watershed and population could provide to the species; and the capacity of the watershed and population to respond to the critical recovery actions needed to abate those threats. Core 1 populations form the nucleus of the recovery strategy (NOAA, 2009).

Malibu Lagoon Located at the mouth of Malibu Creek, the lagoon is a brackish waterbody, influenced by intermittent breaching events and inflows from Malibu Creek. The Lagoon serves several purposes such as providing essential habitats for a diversity of species -- birds, fish, reptiles, invertebrates and mammals -- and is an important feeding/nesting area for birds migrating along the Pacific flyway. The Tidewater Goby was reintroduced here, and subsequently declared an endangered species. The lagoon also acts as natural filter which is able to absorb, retain and remove pollutants from the water. It provides recreational use, educational opportunities, aesthetic value, flood protection and is a source of groundwater recharge. In fact, Malibu Lagoon represents one of the most significant coastal lagoons in the entire Santa Monica Bay watershed; Malibu Creek, which feeds the Lagoon, continues to be a significant steelhead trout watercourse and spawning area (CRWQCB, 1997). Malibu Lagoon is currently undergoing the initial phases of a large restoration.

Local Parks and Beaches There are several parks located in this sub-watershed, most notably Malibu Creek State Park and Malibu Creek State Beach. These grounds provide hiking, picnicking, horseback riding, bicycling and educational opportunities as well as swimming, surfing and sunbathing activities. Thousands of visitors flock to this subwatershed's parks and beaches each year and take advantage of the opportunities they provide (CRWQCB, 1997).

Evidence of Impairment

This region's environmental quality is impaired by three major causes: alterations of natural flow regime, pollutant inputs, and degradation of sensitive habitat (CRWQCB, 1997).

Alterations of Natural Flow

Due to the population increase in the Malibu Creek subwatershed, there has been a continued increase of pollutants to Santa Monica Bay from this region. At the terminus of Malibu Creek, Malibu Lagoon receives the natural and artificial runoff from the entire 109-sq. mi. watershed, which reaches as far north as Simi Hills and as far west as Thousand Oaks. While the population utilizes imported water which can lead to increased flows to the creek from irrigation overflows, flow increases can also be attributed to increased hardscaping, and to reduced surface water diversions and withdrawals from wells since local water is no longer being utilized for domestic use (Mundy, comm. ltr.).

Rindge Dam, which was constructed in the 1924-25, has long since filled up with sediment deposits. The 100ft dam now poses problems for fish migration and spawning, where available upstream habitats are crucial to their existence. Most notably impacted by this structure are steelhead trout; the dam impacts their ability to spawn further upstream. Nevertheless, how best to deal with impacts from Rindge Dam are currently underway via a U.S. Army Corps of Engineers ecosystem restoration feasibility study (CRWQCB, 1997).

Contamination

As the volume of runoff in the Malibu Creek subwatershed increases, additional pollutant loads have impaired the region's recreational and biological resources. Advisories are posted discouraging the collection of mussels from the lagoon due to bacteria contamination. Sensitive habitats and native species also found at the Lagoon may be threatened by increased flows from the creek which disrupts the salinity regime and natural flow conditions. Critical habitats are smothered by high TSS loading. Suspended sediments also provide a transport medium for heavy metals, pesticides and other pollutants. Potential problems resulting from increased temperatures also exists in this subwatershed, due to sparse vegetative cover along segments of the creeks. Bacterial counts from water samples taken in the subwatershed creeks and Malibu Lagoon suggest the presence of harmful pathogens in downstream receiving waterbodies (CRWQCB, 1997). While algae is abundant throughout creeks and streams in the Santa Monica Mountains, Busse, et al. (2003) found while studying algae and nutrients in Malibu Creek that human development affects stream algal communities. Both algal biomass and nutrient concentrations were much lower at undisturbed and rural sites than at developed sites.

Furthermore, multiple sources such as storm drain runoff, street runoff, and development activities contribute sediments, trash and debris, and other contaminants to the waterbodies and wetlands located in the Malibu Creek subwatershed. Another source of pollution in this region, especially recently, has been what remains after fires burn in the area. Unfortunately, fire season comes directly before the rainy season so there is little or no opportunity for hillsides to restabilize naturally. The rain, consequently, washes fire residue directly to the local streams and ultimately to Malibu Creek and Lagoon. The result is an increased TSS, nitrogen compounds, and trash and debris (CRWQCB, 1997).

Densely populated suburban commercial and residential developments have encroached upon the Malibu Creek subwatershed and further contribute to the pollution problems it faces. The presence of livestock and intense grazing activities also degrade water quality by denuding vegetation cover, increasing the erodability of soils and hence the sediment load carried by the streamflow. Septic systems, which are located primarily in the lower watershed and coastal stretches, have the potential to leach pathogens and nutrients to local area waterbodies (CRWQCB, 1997).

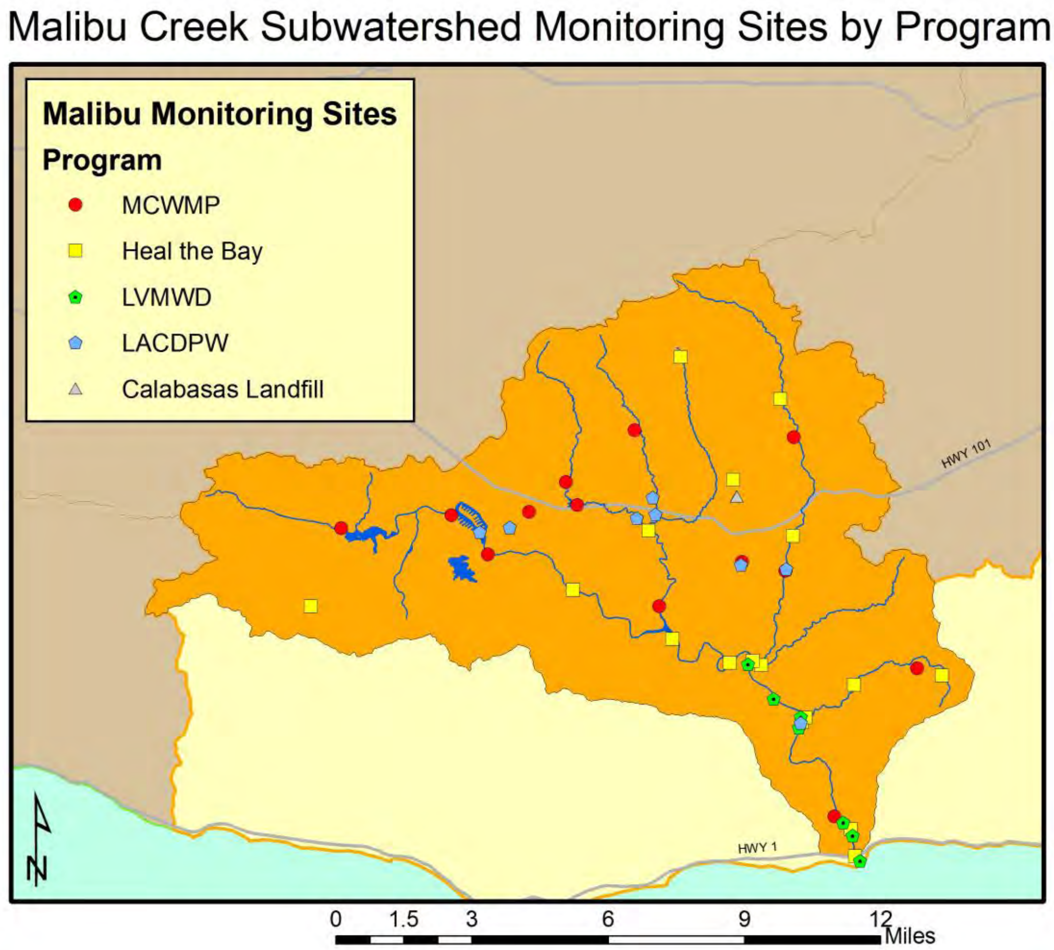
Epidemiology studies are used to identify if swimmers are at risk of developing illnesses based on water contact recreation. Historically, these studies have been conducted infrequently, predominantly at freshwater beaches with known sources of human fecal contamination. The largest benefit from these studies is the identification of relationships between the frequency of illness and levels of fecal indicator bacteria such as total coliforms, fecal coliforms or E. coli, and enterococcus. Such knowledge helps shoreline managers to make appropriate decisions about beach closures and other management measures based on measures of fecal indicator bacteria (SCCWRP website #1). A SMBRP epidemiological study conducted during the summer of 1995 strongly suggested an increased risk of a relatively broad range of symptoms caused by swimming in ocean water near storm drains with positive associations between adverse health effects and a) distance from the drain, and b) bacterial indicators and presence of enteric viruses (SMBRC, 1996).

Epidemiology studies being conducted by SCCWRP address at least two outstanding issues. The first involves potential differences in health risk due to contamination from point source versus nonpoint source discharges. Point sources typically consist of a single predominant source of largely human-derived fecal contamination, while nonpoint sources typically consist of numerous smaller sources, sometimes entirely nonhuman and partially non-fecal in origin. The second involves the application of new water quality indicators. Recent advances in technology have improved indicator measurement methods producing new methods that are more human specific and quite rapid. Before shoreline managers use any of these new methods or indicators for making decisions regarding risk to swimmers, they need to be tested in an epidemiological study to assess their correlation with actual illness rates (SCCWRP website #1).

SCCWRP is currently conducting epidemiological studies to assess the risk of swimming-related illnesses following exposure to nonpoint source contaminated waters at three beaches: Doheny Beach in Dana Point, Avalon Bay Beach on Santa Catalina Island and Surfrider Beach in Malibu. These studies will examine several new techniques for measuring traditional fecal indicator bacteria, new species of bacteria, and viruses to determine whether they yield a better relationship to human health outcomes than the indicators presently used in California (SCCWRP website #1).

Monitoring in the watershed by various agencies over the years has been fairly extensive but also somewhat uncoordinated. The map below shows the major monitoring programs underway; except for the Malibu Creek Watershed Monitoring Program (MCWMP) which was a grant–funded program developed to locate watershed “hot spots” and monitoring by Heal the Bay, the majority of monitoring occurs for rather specific program purposes which may not answer questions concerning watershed health. However, even those programs with common goals may not collect samples on the same day or under similar weather conditions, analyze samples using compatible methods and parameters, and report results in a similar manner.

Figure 17



The MCWMP collected samples twice a month during dry and wet weather at thirteen sites in the watershed between February 2005 and February 2006. Water quality parameters were chosen based on general categories of 303(d)-listed pollutants, including bacteria indicators and those related to sediment and nutrient impairments. After analyzing first year baseline data, "hot spots" were identified for further testing in order to identify the sources of biological and ecological degradation in the watershed. These hot spots were determined by the reoccurrence of high levels of pollutants, especially bacteria and nutrients. Additional monitoring was then conducted in the second (and last) year of the program. The report produced at the end of the two-year period summarized available data for all of the sites shown on the above map; some of the conclusions provided include:

- Bacteria concentrations are generally greatest downstream of urbanized land use areas in most waterbodies.
- Nutrient concentrations are greatest downstream of agricultural areas in the Hidden Valley Creek subwatershed. Organic nitrogen was the predominant form of nitrogen in the Malibu Creek streams, except for Malibu Creek downstream of Tapia WRF during the winter months, when effluent is discharged to the creek.
- Upstream land use alone was not a strong predictor of water quality concentrations.
- Ammonia concentrations were below acute and chronic toxicity targets in most samples.
- The Index of Biotic Integrity (IBI) scores, which grade the health of the invertebrates living on the bottom of streams, were poor or very poor throughout watershed, except in Lower Malibu Creek, where conditions were categorized as fair. Similar results were found by the LA County municipal stormwater permit bioassessment monitoring. Poor IBI scores were influenced by degradation of stream habitat and anthropogenic inputs.
- Calabasas Landfill may be a significant source of total suspended solids in Cheseboro and Liberty Canyon Creeks.
- Most “hot spots” monitoring found exceedances for metals not currently on the 303d list, including aluminum, iron, molybdenum, manganese, and strontium. Mercury and lead generally were below water quality targets (except at the landfill) although on the 303(d) list for Triunfo Creek.
- Selenium concentrations exceeded targets in most subwatersheds. Selenium is positively correlated with nitrate, suggesting that nitrate in groundwater may be mobilizing Se from marine sedimentary bedrock.
- Summer season total phosphorus frequently exceeded the 0.1 mg/l target at most sites (City of Calabasas, 2008). A study conducted by the LVMWD utilizing multiple datasets indicates that summer baseflow and storm runoff from the rock of the Monterey Formation, which dominates the northern headwaters of the watershed, may be naturally high in phosphorus (LVMWD, 2011).

The 2008-2009 Los Angeles County Municipal Stormwater Permit mass emissions monitoring station on Malibu Creek is located at Piuma Road, above the area of tidal influence. Approximately, 105 square miles of land drains to this site; 79% is vacant, close to 6% of the area is used as single family high density residential, about 1% is multi-family residential, and 12.5% is designated as other uses (LACDPW website).

Mass loading While there are considerable loading differences between results for wet- and dry-weather sampling events as well as between the various wet-weather events, the variability is much less here than in an urban watershed such as Ballona Creek. For example, during 2009-2009, copper varied from a low of 0.15 lbs during one dry-weather sampling event to a high of 70.83 lbs during a wet-weather event. Within the dry-weather sampling events, copper loads ranged up to 1.25 lbs. Other metals followed a similar pattern with zinc loading ranging from a low of 0.63 lbs during dry-weather to a high of 258.23 lbs during a wet-weather sampling event (LACDPW website).

Toxicity testing Two dry-weather toxicity sampling events during 2008-2009 resulted in no acute or chronic toxicity to a freshwater organism (*Ceriodaphnia*); a toxic effect was seen during one of the two chronic sea urchin fertilization tests. There was a toxic effect with both species during one the two wet-weather sampling events; there was an effect on the sea urchin only during the other sampling event (LACDPW website).

Chemical/bacteriological testing During the three dry-weather sampling events, fecal coliform bacteria attained the applicable water quality objective (400 mpn/100 ml); however, during two of three sampling events, sulfate did not meet the watershed-specific water quality objective of 500 mg/l (LACDPW website).

During the four wet-weather sampling events, fecal coliform was at excessive concentrations three of four times. Sulfate did not attain the watershed-specific water quality objective in two out of five wet weather events sampled in Malibu Creek. Total dissolved solids (TDS) did not attain the watershed-specific water quality objective (2000 mg/L) once out of five wet weather events sampled (LACDPW website).

The Malibu Creek Watershed falls within the Santa Monica Mountains National Recreational Area for which the National Park Service has developed the Mediterranean Coast Network Vital Signs Monitoring Plan. The network also includes Cabrillo National Monument and Channel Islands National Park. The monitoring plan includes assessing a wide variety of ecosystem elements and process, including water quality (NPS, 2005).

Habitat Degradation

In addition to increased water supplies, major modifications of natural land features such as channelization of tributaries, destruction of riparian zones and wetlands, changes in soil infiltration characteristics and the construction of dams cause additional adverse impacts. The invasion of non-native plant species further upsets the natural condition of wetlands and other riparian zones, which in turn impairs their biological functions. Only 5% of the 133 plant species identified at Malibu Lagoon are native estuarine species, and only 30% are native to California (CRWQCB, 1997).

Non-native aquatic species are found in the creeks, streams and lakes of the Malibu Creek sub-watershed and include species such as large-mouth bass, black bullhead, and green sunfish, as well as, a number of non-native invertebrates including Oriental shrimp, crayfish, and the latest threat, New Zealand mudsnail. These non-native aquatic species may adversely affect indigenous species of the area. Crayfish is one such non-native species likely responsible for the severe decline in salamanders and frogs (CRWQCB, 1997).

New Zealand mudsnails were discovered a number of locations in the watershed in 2006 although they likely existed there since at least 2005. The individual snails are very small, only 3 – 5 mm long. Each snail can reproduce enormous amounts of offspring through a cloning process called parthenogenesis which can result in very high snail densities on the bottoms of streams which displaces native aquatic invertebrates utilized by fish and amphibians for food; they can easily be transferred to other streams through contact with animals or monitoring/recreational equipment. They do not appear to have any natural native predators (SMBRF, 2009).

Malibu Lagoon Malibu Lagoon, which for the past 11 years has been managed by State Parks and Recreation Department, now faces new problems. Previously, under an Interim Water Management Plan, State Parks breached the Lagoon's sand berm barrier when water levels rose above 3.7 feet. However, concern for the impacts on endangered species and habitats, the possible adverse health effects to surfers and swimmers, and abrupt changes in salinity of the Lagoon have changed the breaching protocol. Additionally, the California Coastal Commission requires a Coastal Development Permit before breaching activities continue (CRWQCB, 1997). Lagoon enhancements were recommended in the 1999 Malibu

Lagoon enhancement plan prepared by UCLA for the State Coastal Conservancy and a restoration plan has since been developed (SCWRP website #2).

Pollutants of Concern

The pollutants of concern identified for this subwatershed include nutrients (nitrogen and phosphorus compounds), sediments, pathogens, TSS, trash and debris, and oil spills . This region has the second highest loading of TSS in the Santa Monica Bay watershed, which may be in part due to natural causes (CRWQCB, 1997).

Although the Bay Restoration Plan has identified heavy metals as pollutants of concern within the entire Santa Monica Bay, they have not been specifically identified as pollutants of concern in the Malibu Creek sub-watershed. However, heavy metals should continue to be monitored in runoff, especially since models suggest inputs to the Bay from this subwatershed. Likely sources contributing to heavy metals loadings include runoff contaminated from transportation-related activities, as well as, air deposition. More monitoring is warranted before the overall impacts of heavy metals can be confirmed (CRWQCB, 1997).

Sources and Loadings

In the Malibu Creek subwatershed, many point and nonpoint sources of pollution have been identified and can be linked to pollutants of concern (CRWQCB, 1997).

Permitted Discharges

The Tapia Water Reclamation Facility, this subwatershed's major discharger, contributes pollutants including nutrients to Malibu Creek and Lagoon and monitors both effluent and receiving water; no discharge is allowed from April 15 to November 15 except under certain specific circumstances. The concentrations of the majority of pollutants discharged are within the effluent limitations set forth within the NPDES permit; however, there have been exceedances of a few parameters in the effluent: average monthly limitations for total dissolved solids, total suspended solids, total phosphorus, and dichlorobromomethane were exceeded one to two times over a five-year period prior to the last permit renewal. Monitoring is also required by both the Ventura County and Los Angeles County MS4 permits. There are currently no monitoring sites in the Ventura County portion of this subwatershed; a mass emissions site is monitored in Malibu Creek at a Los Angeles County location. There were exceedances of water quality objectives for fecal coliform and sulfate during two of the four wet-weather sampling events in 2009-2010. During dry weather, sulfate exceeded the water quality objective during two of four monitoring events while total dissolved solids did not meet water quality objectives during one of the four sampling events.

Nutrients

Nutrients, which are a major source of pollution to the receiving waterbodies, are found throughout the watershed and have several suspect and known sources. The Tapia Water Reclamation Facility, area storm drains, horse and animal farms, land grading activities, septic systems, agricultural activities and transportation-related activities have all been identified as contributors to the nutrient loads found in the local creeks, streams and the Lagoon (CRWQCB, 1997). Additionally, Stein and Yoon (2008) found watershed geology to be a major factor that influences constituent concentrations from natural catchments.

Catchments underlain by sedimentary rock had higher concentrations of metals, nutrients, and total suspended solids, as compared to areas underlain by igneous rock.

A recent evaluation of available nitrogen data, and modeling to estimate nitrogen loads to Malibu Lagoon from discharges of wastewater through onsite wastewater disposal systems (OWDSs) in the Malibu Civic Center area, was conducted by Regional Board staff. The results estimate that wastewaters transport 30 lb/day of total nitrogen into Malibu Lagoon. The model also indicates that loads are increasing. Nitrogen loads from OWDSs are significantly above the waste load allocation of 6 lb/day established in a TMDL adopted by the US EPA in 2003; staff has determined that OWDSs in the Malibu Civic Center area cumulatively release nitrogen at rates that contribute to eutrophication and impair aquatic life in Malibu Lagoon (CRWQCB website #4).

TSS and Fine-grained Sediments

Sediments and total suspended solids (which hinder light transmission into waters, smother spawning areas and hard-bottom subtidal habitats, and provide a transport medium for other pollutants such as heavy metals and pesticides) also have several known and suspect sources. Non-stabilized hillsides, development activities where best management practices have not been implemented, improper land grading activities, horse and animal farms located to close to creeks and stream and other relevant agricultural activities all contribute sediments and TSS to this watershed's creeks and stream, which ultimately flow to Malibu Creek and Lagoon. Furthermore, fire residual may be washed down by storm runoff and contribute acute excessive sediments and nutrients to the watershed's receiving waters (CRWQCB, 1997).

Pathogens

Malfunctioning septic systems have long been suspected of contributing to the pathogen loads found in Malibu Creek and Lagoon (CRWQCB, 1997). Although the Tapia Water Reclamation Facility also discharges to Malibu Creek, the discharge is in compliance with the 2.2 cfu/100 ml limits for indicator coliform bacteria set by the Regional Board (CRWQCB website #1). Other potential sources of pathogens include recreational inputs and wildlife, households, and storm drain discharges. Regional Board staff recently conducted an evaluation of available indicator bacteria data in the Malibu Civic Center area to examine the hydraulic connection of discharges from OWDSs through groundwater to nearby surface waters. Staff determined that pathogens from wastewaters are likely to migrate to surface waters and that, consistent with data supporting the designations of impairments, threaten human health. The levels of enterococcus do not meet standards protective of human health. Staff also determined that risks of infectious disease from water contact recreation were elevated at beaches in the Malibu Civic Center (CRWQCB website #4).

Oil Spills

Although not currently an issue, the threat of oil spills to the Bay from tankers exists due to continual oil transporting activities along California's coastline. Ocean currents have the potential to transport oil from spills directly to the shoreline, thereby significantly degrading this sub-watershed's special coastal habitats (CRWQCB, 1997).

Water Quality Improvement Strategies

In accordance with previously identified problems and in order to protect the beneficial uses of waterbodies in this region, the greatest benefits in achieving water quality improvements in the Malibu Creek subwatershed could be achieved by focusing efforts on the following:

- Protect and restore remaining wetlands in the Malibu Creek subwatershed.
- Reduce nonpoint source, and urban and stormwater runoff pollutant loading
- Enhance and protect beach and intertidal habitats for threatened and endangered species.
- Develop specific erosion and sediment-control strategies; consider the impacts of hillside developments.
- Implement TMDLs.
- Reduce/eliminate non-native invasive species where feasible.
- Fully implement the provisions of the Basin Plan amendment passed in November 2009 to prohibit On-Site Wastewater Disposal Systems in the Malibu Civic Center Area.
- Encourage water conservation, water recycling, and other steps to reduce the Malibu Creek subwatershed's dependence on imported water and input of unseasonal freshwater into the Creek (CRWQCB, 1997)

Wetlands Protection and Restoration

Because Malibu Lagoon and other wetlands in this subwatershed are affected by the land use activities and water quality impacts that occur upstream, any restoration activities taking place should consider these issues. Development of a comprehensive plan should address pollutants of concern for this region and should be based on water quality, salinity, habitat and biodiversity objectives for wetlands restoration. The SMBRC's Bay Restoration Plan and the WRP's Regional Strategy identify specific actions to protect and restore Malibu Lagoon, as well as other priority wetlands found throughout the Santa Monica Bay watershed (CRWQCB, 1997; SCWRP website #1).

Malibu Lagoon   A Tier 1 project on the WRP workplan is restoration of Malibu Lagoon. A restoration and enhancement plan was developed on 2005; Phase 1 of the Restoration and Enhancement Plan included relocation and redesign of the existing public parking and staging areas to maximize habitat restoration area in Phase 2 and to improve water quality in the Lagoon through implementation of BMPs. Phase 2 will involve restoration of the lagoon, including recontouring western lagoon channels, enhancing circulation in the lagoon, creating bird nesting habitat and providing improved educational and recreational opportunities for the public. Ultimately, the goal is restoration and enhancement of the ecological structure and function of Malibu Lagoon by increasing circulation and enhancing wetland habitat. The wetland habitat could potentially be enlarged in the future by restoring the adjacent property once it is acquired (SCWRP website #2). A copy of the lagoon restoration plan, funded by the Coastal Conservancy, may be found at http://www.healthebay.org/currentissues/mlhep/default.asp.

Malibu Creek/Cold Creek   A completed WRP project is acquisition of 71.5 acres of upland and riparian habitat along Cold Creek which is a major tributary to Malibu Creek. Other completed WRP projects include the replacement of the Cross Creek Road Arizona crossing of Malibu Creek, which blocked steelhead passage, with a one-lane bridge; and removal of *Arundo donax* from approximately 5.2 miles of stream corridor along Malibu Creek (SCWRP website #2).

Current projects on the WRP workplan include the Upper Malibu Creek Feasibility Study led by the U.S. Army Corps of Engineer with the California Department of Parks and Recreation as the local sponsor. The feasibility study is evaluating options for restoration and enhancement of riparian and aquatic systems above Malibu Lagoon, including the possible removal of Rindge Dam, located about 3 miles upstream from the lagoon. The dam, which is almost completely silted in, acts as a complete barrier to steelhead migration. The study is also focusing on enhancements for endangered steelhead trout and riparian bird habitat. Another current project is the acquisition of approximately 90 acres of wetland, riparian and upland habitat that support La Sierra Lake. The acquisition includes a portion of the lake, four blue-line streams, and the seeps and ephemeral watercourses in the uplands that protect the water source for this three-acre, year-round lake. The primary vegetation communities found on the project site include riparian woodlands, dominated by coast live oak, California bay-laurel, and western sycamore. La Sierra Lake supports 35 obligate and associated wetland plant species, two aquatic mosses, and a rare vernal pool species which has only been reported one other time since 1891 in the Santa Monica Mountains. The project site is immediately downstream from a primarily undisturbed watershed that supports a series of oak, sycamore, willow, and mixed oak and bay riparian plant communities, and is adjacent to the county-designated La Sierra Canyon Significant Ecological Area (SCWRP website #2).

Reduce Nonpoint Source Pollutant Loading

Critical Coastal Area Designations California's Nonpoint Source (NPS) Pollution Control Program includes requirements for Critical Coastal Area (CCA) designation. The intent of CCA designation is to direct needed attention to coastal areas of special biological, social, and environmental significance and to provide an impetus for these areas to receive special support and resources. These areas include Environmentally Sensitive Habitat Areas (ESHAs) currently designated in California's Coastal Zone Management (CZM) program, as well as areas adjacent to Areas of Special Biological Significance (ASBS), California's National Estuarine Research Reserves (NERRs), National Estuary Program (NEP), and National Marine Sanctuaries. A long-term goal for the NPS program is to improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. The short-term plan to achieve this goal is to identify, educate, and promote stakeholder involvement. The State's 2002 CCA Draft Strategic Plan identifies 101 CCAs statewide of which 13 are in the Los Angeles Region (CRWQCB, 2007).

Malibu Creek is identified as CCA #60 in the State's Draft Strategic Plan. It has been identified as such since it flows into a Marine Protected Area and is an impaired water body. The major efforts listed to implement NPS management measures include: work by the Malibu Creek Watershed Advisory Council, various efforts to manage septic systems near Surfrider Beach, projects to capture and treat runoff from Malibu Creek and storm drains in the area, the Assessment of Water Quality and Loadings From Natural Landscapes project conducted by SCCWRP, and implementation of the Santa Monica Bay Restoration Plan (CRWQCB, 2007).

Beaches and Intertidal Habitats

Malibu Creek and Lagoon, as well as several other unique habitats in this sub-watershed, are home to a few threatened and endangered species such as tidewater goby and steelhead trout. Many non-threatened/non-endangered species also rely on these habitats for their existence and may become threatened if habitat degradation continues. Long-term, protective management strategies should be implemented for their protection and may include acquisition of land, public education about the values of these species/habitats, increased enforcement activities, on-going monitoring, and interagency cooperation (CRWQCB, 1997).

Erosion Control Strategies

Development of an erosion and sediment control strategy must consider several factors, including pre-development sediment transport volumes and the impacts of development on the normal sediment transport process. Although natural erosion and sedimentation transport activities are both necessary and desirable for natural beach replenishment and healthy functioning wetlands, excessive erosion and sediment transport can adversely impact downstream sensitive habitats. Assessing appropriate and necessary transport volumes is key to developing this overall control strategy (CRWQCB, 1997).

Implement TMDLs

The Malibu Creek Watershed Monitoring Report also describes the Integrated TMDL Implementation Plan developed by those entities in the watershed affected by current and future TMDLs. The structural and nonstructural BMPs noted address multiple impairments. The targeted pollutants are: trash, sediment (TSS), nutrients (nitrogen and phosphorus), metals, and bacteria (City of Calabasas, 2008).

Beach Bacteria TMDLs Two of the TMDLs in effect which impact Malibu are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches. Surfrider and Malibu Beaches are listed as impaired for indicator bacteria. For the purpose of implementing those TMDLs, the area has been divided up into "jurisdictional groups" (JG) – Malibu Creek falls into JG9. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site, in this case, Leo Carrillo Beach upcoast (CRWQCB website #3).

The dry-weather TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The District, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions and treatment facilities have been completed and others are planned. (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

Malibu Creek Bacteria TMDL The bacteria TMDL allows 3 to 6 years for compliance with applicable bacteria water quality standards during dry-weather conditions, and 10 years for compliance during wet-weather conditions, or up to 18 years for wet weather, if an integrated water resources approach is pursued. The implementation plan provides minimum prescriptive criteria for identifying high-risk areas, where onsite-wastewater treatment systems (OWTS) are potentially contributing to bacteria exceedances in the Malibu Creek watershed. Local agencies (city and county health departments and/or building departments) are required to focus their efforts to monitor and require upgrades to OWTS located in high-risk areas. In addition to the areas falling within the high-risk areas, local agencies must also use their knowledge to identify other areas, outside of the high-risk areas, that are likely to impact surface water quality due to local conditions (e.g., fractured bedrock). Legacy Park, in the Malibu Civic Center, which will include treatment wetlands, is a major water quality improvement project aimed at reducing bacteria levels.

Malibu Creek Trash TMDL Compliance with the TMDL is based on the Numeric Target and the Waste Load (point sources) and Load Allocations (nonpoint sources) which are defined as zero trash in and on the shorelines of the listed reaches and lakes of the Malibu Creek Watershed. Consequently, compliance is based on installation of structural best management practices such as full capture or partial capture systems, or implementing a program for trash assessment and collection, or any best management practices approved by the Executive Officer of the Regional Board, to attain a progressive reduction in the amount of trash in the waterbodies of concern.

Santa Monica Bay Nearshore and Offshore Debris TMDL The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather Bacteria

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather Bacteria

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Malibu Creek Bacteria

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_23_2004-019R_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2004-019R/05_0309/Resolution%202004-19R%20and%20Attachment%20A.pdf

Malibu Creek Trash

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_63_2008-007_td.shtml

Santa Monica Bay Nearshore and Offshore Debris TMDL

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean (City of LA website #2). A low flow diversion/treatment facility in the subwatershed has been in operation since 2007 in the Civic Center.

Reduction of Non-native Invasive Species

Non-native species limit diversity of indigenous plants and animals. Location and types of non-native species throughout the Malibu Creek subwatershed should be identified and mapped. Once this information has been prepared, an assessment should be performed in priority habitats on the feasibility of eliminating non-native species and restoring the area with native, indigenous species (CRWQCB, 1997).

In 2002, the California Department of Fish and Game began developing a plan to coordinate state programs, create a statewide decision-making structure and provide a shared baseline of data and agreed-upon actions so that state agencies may work together more efficiently. In January 2008, with input from multiple state agencies, the public, and other stakeholders, the California Aquatic Invasive Species Management Plan (CAISMP) was approved by the Governor. The CAISMP seeks to identify the steps necessary to minimize the harmful impacts of aquatic invasive species (AIS) in California. More than 160 management actions are organized under the following eight objectives: Coordination & Collaboration, Prevention, Early Detection & Monitoring, Rapid Response & Eradication, Long-term Control & Management, Education & Outreach, Research, and Laws & Regulation (SMBRF, 2009).

The implementation of the highest priority actions was initiated in 2008 with the formation of the California Aquatic Invasive Species Team (CAAIST). The CAAIST's mission is to coordinate the activities of state agencies charged with implementation of the CAISMP. CAAIST is composed of representatives from over 25 California state agencies, including the Santa Monica Bay Restoration Commission. If the priority actions of the CAISMP can be successfully implemented, California resource managers and policy makers will have taken a huge step forward in the effort to prevent new invasions and minimize impacts from established AIS (SMBRF, 2009).

Septic System Management Strategy

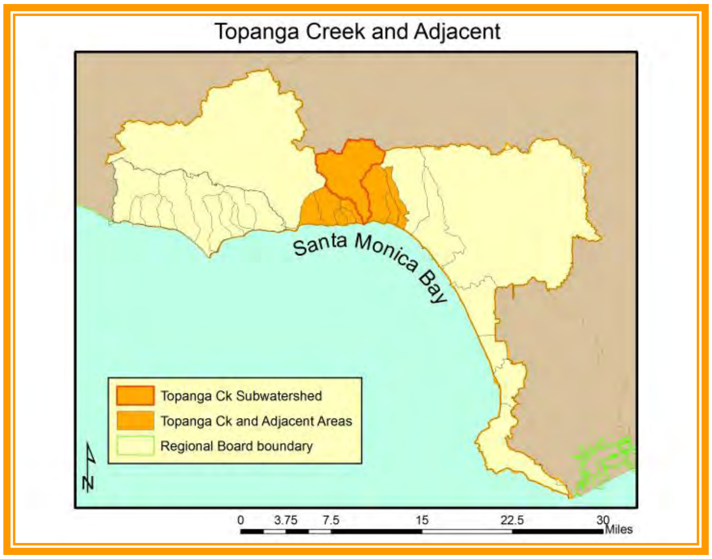
Septic systems are located throughout the lower Malibu Creek subwatershed. Water quality monitoring results suggest that septic systems might be contributing factors to the impairment of beneficial uses and degrade sensitive habitats in certain areas of this region. These systems have the potential to leak bacteria, pathogens and nutrients which can then migrate through sensitive habitats, and ultimately to the surf zone (CRWQCB, 1997).

At a November 5, 2009 public hearing, the Regional Board voted to adopt Resolution No. R4-2009-007, an amendment to the Basin Plan to prohibit on-site wastewater disposal systems in the Malibu Civic Center area. The amendment prohibits all new discharges, except certain specific projects which have already progressed through the entitlement process and prohibits discharges from existing systems within six years in commercial areas and within ten years in residential areas from the date of adoption by the Regional Board. This prohibition does not preclude a publicly owned, community-based, solution that includes specific wastewater disposal sites subject to waste discharge requirements to be prescribed by the Regional Board (CRWQCB website #2).

Water Conservation

Water conservation practices, spearheaded by the Las Virgenes Municipal Water District, are already being encouraged in this subwatershed. They have a number of existing programs and pilot projects underway to reduce the importation of water into the watershed, including residential and light commercial water use efficiency surveys, rebates for a variety of outdoor and indoor equipment such as appliances and fixtures including weather-based irrigation controllers, rotating sprinkler nozzles, and high-efficiency clothes washers, among others. LVMWD offers water conservation landscape and irrigation training classes throughout the year to professional and home gardeners, supports conservation education in local schools, provides facility tours, supports local public events and recycles wastewater biosolids into compost which it gives away for free. LVMWD continually seeks to partner with local cities both in and out of its service area, and with other watershed stakeholder groups on projects that reduce water demand and/or benefit the watershed in various ways (Mundy, comm. ltr.). Nearly all the programs implemented by LVMWD are co-funded with local, state and federal funds and are administered with the cooperation of the Municipal Water District of Southern California. Bond funds available through the IRWMP process would be another way to improve water conservation. Currently, over 20% (5,000 acre-feet) of the watershed's urban water demands are being met by water conservation and wastewater recycling (CRWQCB, 1997).

Topanga Creek and Adjacent



Located approximately 4.5 miles west of the City of Santa Monica, the Topanga sub-watershed includes Puerco, Corral, Carbon, Las Flores, Piedra, Pena, Tuna, Topanga, and Santa Ynez Canyons, which covers an area of 18 square miles within the Santa Monica Mountains. This subwatershed borders the Malibu Creek subwatershed to the west, the Los Angeles River watershed to the north, the Santa Monica Canyon and Ballona Creek subwatersheds to the east and the Pacific Ocean to the south. Several creeks and streams discharge directly to the Bay. There are no major point source discharges in this subwatershed (CRWQCB, 1997).

Flows

The creeks in this region flow through towns in the upper reaches and through steep, narrow gorges in the lower reaches, ultimately emptying into the ocean just south of Highway 1. In the lower reaches, the canyons broaden into floodplains with dense riparian vegetation, houses, shacks, and stream crossings. In many places, Topanga Canyon Creek has been lined with boulders and concrete, and banks have been sandbagged to protect from erosion. Abandoned partially-buried vehicles and buildings attest to recurrent flooding experienced in this region. Topanga Canyon has the largest drainage area (and corresponding average annual storm runoff volume), then Santa Ynez, Puerco and Corral Canyons, Las Flores Canyon, Carbon Canyon, and finally Piedra Gorda Canyon, Pena Canyon and Tuna Canyon have the smallest drainage area (CRWQCB, 1997).

Land Uses

Though this region is rural, there is still evidence of residential development in the Topanga sub-watershed. Additionally, a few areas in the upper sub-watershed area have been developed, but the percentage is relatively small. Land use activities can be broken down into the following: 92% open space, 7% residential, and less than 1% for commercial/industrial and public (combined) (CRWQCB, 1997).

Topanga Canyon

A small lagoon exists at the mouth of the creek due to a berm created by littoral drift and wave action. The lagoon is constrained to a narrow, linear basin defined by the high bluffs to either side of the creek. Tidal action occurs, as evidenced by aquatic marine vegetation within this lower part of the creek (CRWQCB, 1997).

Beneficial Uses

The Topanga subwatershed is host to many beneficial uses, including recreational (swimming and surfing), wildlife and marine/aquatic habitat, fish spawning and migration, tidepools, intertidal and beach habitats, among others shown below (CRWQCB, 1994).

Table 7. Beneficial uses of the waters within the Topanga Creek subwatershed and adjacent areas

Coastal Feature or Waterbody	Hydro Unit #	MUN	NAV	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL	WET
Carbon Canyon Creek	404.16	P		I	I		I				E					
Las Flores Canyon Creek	404.15	P		I	I		I				E					
Piedra Gorda Canyon Creek	404.14	P		I	I		I				E					
Pena Canyon Creek	404.13	P		I	I		I	E			E					
Tuna Canyon Creek	404.12	P		I	I		I				E					
Topanga Lagoon	404.11		E	E	E	E			E		E	E	E	E		E
Topanga Canyon Creek	404.11	P		I	I		E	E			E		P	I		
Santa Ynez Canyon	405.13	P		I	E		I				E	E				
Santa Ynez Lake (Lake Shrine)	405.13	P		P	E		E				E					
Carbon Beach	404.16		E	E	E	E				E	E			P	E	
La Costa Beach	404.16		E	E	E	E				E	E			P	E	
Las Flores Beach	404.15		E	E	E	E				E	E			P	E	
Las Tunas Beach	404.12		E	E	E	E				E	E			P	E	
Topanga Beach	404.11		E	E	E	E				E	E			P	E	
Will Rogers State Beach	405.13		E	E	E	E				E	E			P	E	

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Areas within the Topanga subwatershed have been designated as *Significant Ecological Areas (SEA)* by Los Angeles County. These areas require protection of species or biological communities to the extent that alteration of natural water quality is undesirable and that the preservation of natural water quality be maintained to the extent practicable. Tuna Canyon is one such designated area in this region (CRWQCB, 1997).

Topanga Canyon is home to some of the unique wetlands that can be found throughout the Santa Monica Bay watershed. Specifically, the Topanga Canyon wetlands are palustrine, i.e., non-tidal wetlands dominated by vegetation (trees, shrubs, herbs, mosses and lichens). Many of the streams feeding these wetlands are intermittent, flowing only part of the year and the stream corridors are typically steep, narrow and highly erosive. This in turn confines riparian vegetation to the immediate stream channel area (CRWQCB, 1997).

The area falls within the Santa Monica Mountains biogeographic population group described in the Draft Steelhead Recovery Plan; Topanga Creek is considered to be currently occupied by a Core 2 population. The Core 1 populations are those populations identified as a high priority for recovery actions based on a variety of factors, including: the intrinsic potential of the population in an unimpaired condition; the role of the population in meeting the spatial and/or redundancy viability criteria; the conditions of the population, the severity of the threats facing the populations; the potential ecological or genetic diversity the watershed and population could provide to the species; and the capacity of the watershed and population to respond to the critical recovery actions needed to abate those threats. Core 1 populations form the nucleus of the recovery strategy. Core 2 populations must eventually meet the biological recovery criteria; however, these populations are considered to be of secondary importance in terms of recommended priority of recovery efforts (NOAA, 2009).

Local Parks

There are several parks located in this subwatershed, most notably Topanga Creek State Park, Will Rogers State Park and Will Rogers State Beach. These grounds provide hiking, picnicking, horseback riding and bicycling opportunities as well as swimming, surfing and sunbathing activities. Semi-regular interpretive and educational meetings are also held at these locations. Thousands of visitors visit these locations each year and take advantage of the opportunities they provide (CRWQCB, 1997).

Evidence of Impairment

There is a certain amount of loss and degradation of riparian habitat, as well as, degradation of coastal wetlands such as Topanga Lagoon. While there is limited development in this area, the potential for pollution problems increases as the percentage of developed land increases (CRWQCB, 1997).

The proposed lower Topanga restoration area encompasses almost 204 acres of land including 1.2 miles of Topanga Creek and its surrounding floodplain. Development within the watershed has caused erosion, degraded water quality and habitat values. For example, concrete sacks, rocks, and debris have been used for erosion control, reducing the vegetation along the stream (this problem has recently been corrected). Stream temperatures are high, and because of the high nutrients discharged to the stream summer algal growth is significant. The area is also affected by debris, trash, uncontrolled discharges and vegetation removal (CRWQCB, 1997).

Pollutants of Concern

The pollutants of concern identified for this subwatershed include pathogens, TSS and lead (CRWQCB, 1997).

Likely sources contributing to heavy metals loadings include runoff contaminated from transportation-related activities and air deposition. More monitoring is warranted before the overall impacts of heavy metals can be confirmed (CRWQCB, 1997).

Sources and Loadings

Potential sources of pollution may be linked with the pollutants of concern (identified above) found to threaten the waterbodies of this region.

TSS and Fine-grained Sediments

Sediments and total suspended solids (which hinder light transmission into waters, smother spawning areas and hard-bottom subtidal habitats, and provide a transport medium for other pollutants such as heavy metals and pesticides) also have several known and suspect sources. Non-stabilized hillsides, development activities where best management practices have not been implemented, improper land grading activities, horse and animal farms located too close to creeks and stream and other relevant agricultural activities all contribute sediments and TSS to this watershed's creeks and stream, which ultimately flow to Santa Monica Bay. Furthermore, fire residue may be washed down by storm runoff and contribute acute excessive sediments to the watershed's receiving waters (CRWQCB, 1997).

Water Quality Improvement Strategies

In accordance with previously identified problems and in order to protect the beneficial uses of waterbodies in this region, the greatest benefits in achieving water quality improvements in the Topanga subwatershed could be achieved by focusing efforts on the following:

- Protect and restore remaining wetlands in the Topanga subwatershed.
- Reduce nonpoint source, urban runoff, and stormwater pollutant loading.
- Implement TMDLs.

Wetlands Protection and Restoration

Because the wetlands in this subwatershed are affected by the land use activities and water quality impacts that occur upstream, any restoration activities taking place should consider these issues. Development of a comprehensive plan should address pollutants of concern for this region and should be based on water quality, salinity, habitat and biodiversity objectives for wetlands restoration. Special focus should be given to the Lower Topanga Canyon wetlands area. The SMBRP's Bay Restoration Plan identified specific actions to protect and restore Lower Topanga Canyon as well as other priority wetlands throughout the Santa Monica Bay watershed (CRWQCB, 1997).

Topanga Creek and Lagoon   Completed WRP projects include feasibility studies needed to determine the potential for restoring some of the historic extent and function of Topanga Creek and Lagoon, technical assessments for restoration of Topanga Lagoon based on a conceptual plan in the Topanga Lagoon and Watershed Restoration Feasibility Study, and acquisition of approximately 120 acres in the upper Topanga watershed including Zuniga Pond, a constructed pond, in order to protect western pond turtle habitat, a state-listed species of special concern.   A Tier 1 project on the WRP workplan is implementation of the recommendations of the 2002 Topanga Creek Watershed and Lagoon Restoration Feasibility Study. This is a multi-phased program that will be implemented over several years and in partnership with multiple agencies, particularly State Parks. The primary goals of the program are to:

1. Restore habitat at identified priority locations in order to increase benefits to the endangered steelhead trout and tidewater goby, as well as other aquatic species of special concern in the watershed.

2. Improve passage opportunities for steelhead trout and extend the reach of creek providing suitable habitat for spawning and rearing.
3. Identify ways to improve sediment transport and delivery in order to enhance conditions in the creek and restore beach nourishment opportunities.
4. Improve water quality in all areas of the watershed where impairments have been identified.
5. Continue monitoring of water quality, sediment loads, streambank condition and target species populations (steelhead trout, tidewater gobies, western pond turtles, CA newts, etc.) in order to identify population trends related to restoration actions (SCWRP website #2).

Steelhead trout passage has been improved recently through removal of a berm created previously by private landowners to protect their homes in the floodplain. This land is now owned by the California Department of Parks and Recreation and removal of the berm material was accomplished through funding from multiple agencies. Vegetation in the affected area was also restored with native species plantings and invasives removal (SMBRF, 2009).

<u>Tuna Canyon</u> A completed WRP project is acquisition of approximately 417 acres of land at the lower end of Tuna Canyon to protect a perennial spring and well-developed riparian habitat (SCWRP website #2).

<u>Las Flores Creek</u> A project on the WRP workplan is the restoration of ecological function to Las Flores Canyon Creek, resulting in improved channel stability, protection of the emergent wetland downstream and increased potential habitat for steelhead trout and other native species. Las Flores Canyon drains a watershed of 2,646 acres. The project area is approximately 3.4 acres and involves 2,400 linear feet of the creek. In-stream habitat features will expand the number of current pools available to steelhead trout and create larger pools. Improved passage, resting pools and escape cover will also provide for movement of steelhead to larger upstream spawning pools. The project will install biotechnical bank stabilization to protect against sediment loading and landslides, which are deleterious to native aquatic species as well as the downstream emergent wetland. It will also remove and manage invasive exotic plant species including a small cluster of arundo. The project will preserve and expand native tree canopy to improve in-stream and riparian habitat. Finally, the site will be revegetated with native species (coastal scrub, riparian, sycamore woodland) to restore cover, vegetative structure and increase native diversity. Revegetation will result in increased physical steelhead habitat as well as improved water temperature regulation (SCWRP website #2).

<u>Corral Canyon</u> A Tier 1 project on the WRP workplan is Acquisition of two blocks of property to preserve 849 acres of wildlife and riparian habitat within the Santa Monica Mountains National Recreation Area and reaches of Corral Canyon Creek, a perennial stream that flows into Santa Monica Bay. The objectives of this project are to prevent further fragmentation of wildlife habitat in an area under severe development pressure, as well as to help protect the water quality of the Corral Canyon watershed. Both properties have entitlements that would allow for development. But they both currently remain as undeveloped open space and are part of a major core of coastal habitat and wildlife corridors in the Santa Monica Mountains. Primary vegetation communities include a mosaic of coastal sage scrub and chaparral, oak riparian woodland and upland coastal live oak woodland. Acquisition of these areas would provide an opportunity to link Malibu Creek State Park with parkland owned by the Santa Monica Mountains Conservancy within the SMMNRA. Both properties have the highest priority in the SMMNRA Land Protection Plan (SCWRP website #2).

Reduce Nonpoint Source Pollutant Loading

Critical Coastal Area Designations California's Nonpoint Source (NPS) Pollution Control Program includes requirements for Critical Coastal Area (CCA) designation. The intent of CCA designation is to direct needed attention to coastal areas of special biological, social, and environmental significance and to provide an impetus for these areas to receive special support and resources. These areas include Environmentally Sensitive Habitat Areas (ESHAs) currently designated in California's Coastal Zone Management (CZM) program, as well as areas adjacent to Areas of Special Biological Significance (ASBS), California's National Estuarine Research Reserves (NERRs), National Estuary Program (NEP), and National Marine Sanctuaries. A long-term goal for the NPS program is to improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. The short-term plan to achieve this goal is to identify, educate, and promote stakeholder involvement. The State's 2002 CCA Draft Strategic Plan identifies 101 CCAs statewide of which 13 are in the Los Angeles Region (CRWQCB, 2007).

Topanga Canyon Creek is identified as CCA #61 in the State's Draft Strategic Plan since it flows into a Marine Protected Area and is an impaired water body. The major efforts listed to implement NPS management measures include: work by the Malibu Creek Watershed Advisory Council (the small Topanga watershed is adjacent to the much larger Malibu watershed), various efforts to manage septic systems, participation with the Topanga Watershed Committee, implementation of the watershed management plan, and continuance of creek monitoring (CRWQCB, 2007).

Implement TMDLs

The TMDLs in effect which impact the Topanga Creek and adjacent area are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay nearshore and offshore debris TMDL. Topanga and Carbon Beaches, among others in this subwatershed, are listed as impaired for indicator bacteria. For the purpose of implementing the bacteria TMDLs, the area has been divided up into "jurisdictional groups" (JG) – the Topanga and adjacent area fall s into JG1 and JG2. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The County of Los Angeles, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the bacteria TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

Santa Monica Bay Nearshore and Offshore Debris TMDL The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Santa Monica Bay Nearshore and Offshore Debris TMDL

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean (City of LA website #2). Low flow diversions found within the Topanga and adjacent area are show in the table below.

Table 8. Low flow diversions within the Topanga Creek subwatershed and adjacent areas

Low Flow Diversion	Year Operational	Agency
Palisades Park	2000	City of LA
Bay Club Drive	2001	City of LA
Temescal Canyon	2003	City of LA
Pulga Canyon	2004	District
Santa Ynez	2006	District
Marquez Avenue	2006	City of LA
Parker Mesa/Castlerock	2006	District

Santa Monica Canyon

Santa Monica Canyon drains runoff into Santa Monica Bay at the stretch of Will Rogers State Beach near the intersection of Chautauqua Boulevard and Pacific Coast Highway in Pacific Palisades, a community of the City of Los Angeles. The drain receives runoff from an approximately 5,600 acre drainage area, including the Pacific Palisades and the Brentwood/Palisades communities, and a nominal portion of the City of Santa Monica. It also drains runoff from popular attractions such as Will Rogers State Park, Riviera Country Club and portions of Topanga State Park (CRWQCB, 1997).

The Santa Monica Canyon storm drain has two major branches, Santa Monica Canyon and Rustic Canyon. Santa Monica Canyon is a concrete-lined, rectangular open channel, except for a stretch where it traverses underground through the Riviera Country Club. It branches off to Mandeville Canyon and Sullivan Canyon storm drains, near the intersection of Sunset Boulevard and Mandeville Canyon Road. Mandeville Canyon is approximately 1.5 miles long. Sullivan Canyon is first intercepted by the Sullivan Canyon Park Debris Basin, then extends towards Mulholland Drive. Including Sullivan Canyon, the Santa Monica Canyon has a total length of approximately eight miles. Rustic Canyon joins Santa Monica Canyon near the intersection of Entrada Way and Short Avenue. It also has a total length of approximately eight miles and is an open, natural creek for most of its length. Its upper reach extends to the Topanga State Park near Mulholland Drive (CRWQCB, 1997).

The drainage area of Santa Monica Canyon is comprised of mostly low density residential and open spaces, with minimal manufacturing and industrial activities (CRWQCB, 1997).

Santa Monica Canyon flows year round with a typical dry flow of approximately 100-300 thousand gallons/day. As occurs in the storm drain system elsewhere in the county, flow in the drain can increase to an estimated hundred million gallons per day during a significant storm event (CRWQCB, 1997).

Beneficial Uses

Beneficial uses are identified for this subwatershed in two areas: those associated with the creeks and those associated with ocean water influence by discharges from the land. The table below summarizes the beneficial uses designated for waterbodies in this subwatershed (CRWQCB, 1994).

Table 9. Beneficial uses of the waters within the Santa Monica Canyon

Coastal Feature or Watershed	Hydro Unit #	MUN	REC1	REC2	WARM	WILD
Santa Monica Canyon Channel	405.13	P	P	I	P	E
Rustic Canyon Creek	405.13	P	I	I	I	E
Sullivan Canyon Creek	405.13	P	I	I	I	E
Mandeville Canyon Creek	405.13	P	I	I	I	E

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Evidence of Impairments

The Will Rogers State Beach is one of the heavily used recreational area in Santa Monica Bay. Yet the area has also developed a reputation for severe pollution as indicated by bacterial count measurements and special studies. Over the years, high indicator bacterial counts have been found in nearshore waters surrounding the nearby drain's outlet. As a result, warning signs advising people not to swim in the adjacent area are permanently posted. However, although a SMBRP study found enteric viruses in Pico-Kenter drain (now diverted to a treatment facility), enteric viruses were not found in runoff samples collected at Santa Monica Canyon (CRWQCB, 1997).

The strongest evidence of impairment is provided by the SMBRP epidemiological study conducted in summer 1995. The beach adjacent to Santa Monica Canyon was one of the three sites surveyed. Besides finding higher health risks associated with swimming near the storm drains, the study also showed that bacterial indicator counts were higher near the Santa Monica Canyon drain than farther from it (CRWQCB, 1997).

Pollutants of Concern

The pollutants of concern identified for this subwatershed area include pathogens and total suspended solids (CRWQCB, 1997).

Sources and Loadings

The occurrence of pathogenic contamination of runoff and surfzone water as measured by bacterial indicator concentrations is highly episodic. Generally the incidence of contamination occurs only when there is storm drain flow. However, the frequency and magnitude of contamination does not seem to be related to the frequency and amount of the flow, nor the size of the drainage area. Surfzone water is more likely be contaminated when a storm drain discharges directly to the surfzone (CRWQCB, 1997).

In 1994, the City of Los Angeles conducted a study of the possible sources of bacterial contamination in the Santa Monica Canyon. In this study, samples from the Santa Monica Canyon upstream sub-drainage basin were collected at 10 locations and were analyzed for total and fecal coliform in order to isolate the pollutant sources. The test results appear to show no discernible pattern. However, the test results did indicate consistently higher bacterial contamination counts coming from the Santa Monica Canyon branch, specifically from the upper watershed (CRWQCB, 1997).

Septic tanks do not seem to be a major source of bacterial contamination. Only about 2% of the total number of homes in the drainage area have no sewer connections and, therefore, have septic tanks. The most likely bacterial contamination sources are fecal matter being released from horse stables, pets, and wild animals, and decomposed organic matter from trees. There are several horse stables built adjacent to Sullivan Canyon, Mandeville Canyon, and Rustic Canyon. Rustic Canyon is used as a trail by horseback riders. Finally, Will Rogers State Park has continuous equestrian activities and maintains some horse stables within the facility (CRWQCB, 1997).

Water Quality Improvement Strategies

There is a general consensus among stakeholders that the greatest impact and need for improvement in this subwatershed area is to reduce acute health risks associated with swimming at beaches impacted by pathogen-contaminated surfzone waters. Control of pathogen inputs into the nearshore areas should be the priority for pollutant control measures planned in this area (CRWQCB, 1997).

However, unlike in Pico-Kenter and adjacent drain area, diversion of low flow to treatment plant is not a desirable solution to the problem because the sewer facilities in this area do not have the extra capacity to receive and transport the expected amount of added low flow. Re-design and construction of the pipeline would be costly. There are two other alternative measures that are considered more suitable at this time. The first one is a public education program. The second is to promote implementation of BMPs by horse stable operators, by disseminating pamphlets, conducting employee training, and installing runoff containment devices (CRWQCB, 1997).

Reduce Nonpoint Source Pollutant Loading

Critical Coastal Area Designations California's Nonpoint Source (NPS) Pollution Control Program includes requirements for Critical Coastal Area (CCA) designation. The intent of CCA designation is to direct needed attention to coastal areas of special biological, social, and environmental significance and to provide an impetus for these areas to receive special support and resources. These areas include Environmentally Sensitive Habitat Areas (ESHAs) currently designated in California's Coastal Zone Management (CZM) program, as well as areas adjacent to Areas of Special Biological Significance (ASBS), California's National Estuarine Research Reserves (NERRs), National Estuary Program (NEP), and National Marine Sanctuaries. A long-term goal for the NPS program is to improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. The short-term plan to achieve this goal is to identify, educate, and promote stakeholder involvement. The State's 2002 CCA Draft Strategic Plan identifies 101 CCAs statewide of which 13 are in the Los Angeles Region (CRWQCB, 2007).

Santa Monica Canyon is identified as CCA #62 in the State's Draft Strategic Plan; it is an impaired water body that flows into a Marine Protected Area. Santa Monica Canyon is formed by the confluence of three major watersheds. Approached from the shoreline it extends upstream for a couple of miles to include lower Rustic Canyon and lower Sullivan Canyon, both entering tangentially from the northwest and ends at the entrance to Mandeville Canyon which extends six miles farther north to the crest of the Santa Monica Mountain. The major efforts listed to implement NPS management measures include: work by the nearby Malibu Creek Watershed Advisory Council; dry weather diversions at Will Rogers State Beach; and participation with the North Santa Monica Bay Water Quality Improvement Project (CRWQCB, 2007).

Implement TMDLs

The TMDLs in effect which impact the Santa Monica Canyon are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay nearshore and offshore debris TMDL. For the purpose of implementing the bacteria TMDLs, the area has been divided up into "jurisdictional groups" (JG) – the Santa Monica Canyon area falls into JG2. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The District, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the bacteria TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

<u>Santa Monica Bay Nearshore and Offshore Debris TMDL</u> The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from

achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Santa Monica Bay Nearshore and Offshore Debris TMDL

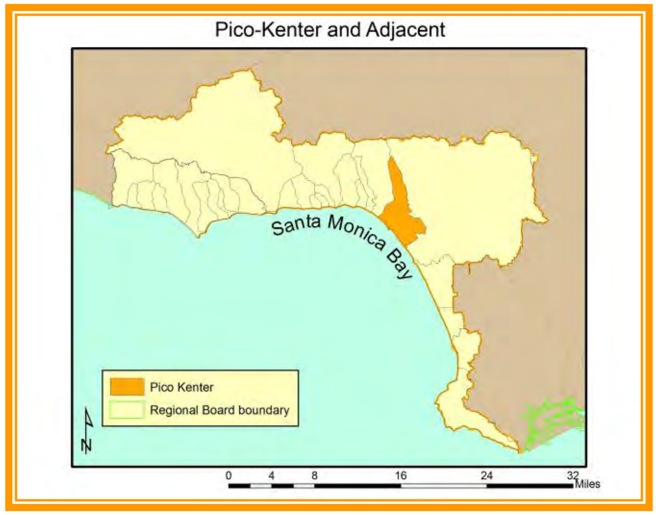
http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean. A low flow diversion was installed in 2003 by the City of Los Angeles to treat dry weather runoff from this drainage.

Pico-Kenter and Adjacent



The land use in this mostly urbanized subwatershed is 48% single family, 21% multiple family, 6% commercial, 3% public, and 19% open space. The subwatershed is named after the Pico-Kenter drain which is located where Pico Boulevard intersects the beach in the City of Santa Monica. The drain enters Santa Monica Bay in a 20-foot-wide by 8-foot high reinforced concrete box. The storm drain system drains a 4,147 acre area that includes much of Santa Monica and part of West Los Angeles and Brentwood. There are two drains: one owned by Los Angeles County and the other by CalTrans. Except for some upstream canyon areas, the drain is largely underground pipe. The storm drain flows year round with a typical dry flow of approximately 0.5 cubic feet per second (100-300 thousand gallons/day). Like storm drain channels in the rest of the watershed, flows in the drain can swell to an estimated hundred million gallons per day during a significant storm (CRWQCB, 1997).

Besides the Pico-Kenter drain, there are about a dozen relatively small catchment basins with beach or surfzone outlets between Pacific Palisades and Marina del Rey. These drains are also mostly concrete underground pipes. Combined with and including the Pico-Kenter drain, they drain a subwatershed of 9,105 acres. The other drains, in order of size of drainage area are: Rose Avenue, Wilshire Boulevard, Montana Avenue, Brooks Avenue, Thornton Avenue, Ashland Avenue, Venice Pavilion, and Santa Monica Pier (CRWQCB, 1997). Dry weather diversion/treatment facilities are in operation at these drains.

Beneficial Uses

Beneficial uses for waterbodies in this subwatershed are primarily identified for the coastal waters that receive discharges from the storm drains. Beaches in the area include the Santa Monica Beach and Venice Beach. These beaches are often heavily used, especially on weekends and in summer months. Santa Monica Beach is the busiest beach in the County, with up to 2.5 million visits each year (CRWQCB, 1994).

Table 10. Beneficial uses of the waters within the Pico-Kenter and adjacent area

Coastal Feature or Waterbody	Hydro Unit #	NAV	REC1	REC2	COMM	MAR	WILD	RARE	MIGR	SPWN	SHELL
Santa Monica Beach	405.13	E	E	E	E	E	E		E	E	E
Venice Beach	405.13	E	E	E	E	E	E	E	E	E	E

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Despite the high usage by humans, the beaches do provide habitats for many species of seabirds. A breeding site for the California least tern is located at Venice Beach (CRWQCB, 1997).

The nearshore surfzone areas are sandy bottom and are popular swimming and surfing areas. Like most offshore zones of the Bay, the sea floor consists of soft-bottom habitat that supports a diverse number of organisms, including more than 100 species of demersal fish. It is also an area with significant recreational boat traffic (CRWQCB, 1997).

Evidence of Impairments

Health Risks Associated with Swimming

The beaches and surfzone in the Santa Monica-Venice area are probably the most heavily used recreational area in Santa Monica Bay. Yet the area has also developed a reputation for severe pollution as indicated by bacterial count measurements and special studies. Over the years, high indicator bacterial counts have been found in nearshore waters surrounding several storm drain outlets. Prior to diversion of low flows to Hyperion treatment plant in 1992, total coliform and enterococcus counts in surfzone near Pico-Kenter storm drain exceeded Ocean Plan objectives as high as 18 percent of times. As a result, warning signs advising people not to swim in the adjacent area were posted permanently. Warning signs were also posted near other area drains with low flows. In a study conducted by the SMBRP in 1992, enteric viruses were found in runoff samples collected at the Pico-Kenter storm drain (CRWQCB, 1997).

The strongest evidence of impairment is provided by the SMBRP epidemiological study conducted in summer 1995 as presented earlier. Ashland Avenue storm drain was one of the three study sites surveyed during the study. Besides finding that higher health risks are associated with swimming near flowing storm drains such as Ashland, the study also showed that bacterial indicator counts were higher near the Ashland storm drain than farther from it (CRWQCB, 1997).

Elevated Contaminant Levels and Toxicity

Data collected over the years have shown that contaminants have accumulated in marine organisms in the nearshore area of the watershed. Studies conducted by the SMBRP in 1993 found that dry-weather runoff from Ashland Avenue was toxic to marine organisms. Toxicity exhibited at this site in general was higher than the toxicity exhibited in Ballona Creek and other sites investigated during the study. Toxicity identification and evaluation indicated that the sources of toxicity likely resulted from heavy metals (CRWQCB, 1997).

In a SMBRP pilot study conducted in 1991, chemical analysis of low flow runoff samples from Kenter Canyon drain showed that mean concentrations of chromium, copper, lead and zinc exceeded Ocean Plan Water Quality objectives. The levels of PAHs were about 35 times the Ocean Plan objectives. Furthermore, in a two week episode, high concentration of chlordane were detected in the runoff (CRWQCB, 1997).

The storm drains in this area also carry trash and debris to the nearshore waters. This trash and debris, either washing back onto beaches, or deposited on the sea floor, create a nuisance and health hazard to beach goers, swimmers, and boaters, and pose danger to marine life. Significant hazardous material spills infrequently occur in the drainage areas and wash down to the ocean, caused beach closures and the posting of warning signs (CRWQCB, 1997).

Pollutants of Concern

The pollutants of concern identified for this subwatershed area include pathogens, heavy metals (Pb, Cu, Zn, Cd, Ag), debris, oil and grease, PAHs, and chlordane (CRWQCB, 1997).

Sources and Loadings

Pathogens

Besides Pico-Kenter and Ashland Avenue drains, high concentrations of bacterial indicators were also found in effluent from drains at Santa Monica, Thornton Avenue, and Brooks Avenue. The occurrence of pathogenic contamination of runoff and surfzone water as measured by bacterial indicator concentrations is highly episodic. Surfzone water is more likely be contaminated when a storm drain outlet discharges directly to the surfzone (CRWQCB, 1997).

Potential sources of pathogens to storm drains include illegal sewer connection and sewer dumping, sewer leak, domestic animals, food service business, and outdoor camping (CRWQCB, 1997).

Heavy Metals, TSS, PAHs, and Oil and Grease

The Pico-Kenter storm drain has the second (to Ballona Creek) largest drainage area in the southern urban area of the watershed. Due to its large size and urban land use, the Pico-Kenter drainage contributes significantly to total loadings of several pollutants to the Bay. The SMBRP in 1993 estimated that the drain is the third largest loading source among 28 catchment basins (second in the southern urban area) for lead, copper, zinc, total suspended solids, and oil and grease. Combined, the area contributes approximately 5% of heavy metals, 4% of total suspended solid, and 6% of oil and grease (CRWQCB, 1997).

The MS4 discharge apparently is the primary source of pollutant loading in this subwatershed. There are fourteen non-stormwater permitted discharges in the area; the majority are discharges of treated groundwater and are of small volume. There are ten discharges covered by the general industrial stormwater NPDES permit and nine (a mix of residential and commercial) covered by the general construction stormwater NPDES permit. On the other hand, transportation-related activities are identified as probably the most important source for heavy metals, PAHs, and oil and grease. The loading of these (heavy metals and PAHs) are likely result of deposition of auto fuel exhaust and auto part wear (tires, brake pad, etc.). Other potential sources of heavy metals are excessive fungicide and insecticide use (CRWQCB, 1997).

Chlordane

Since the use of chlordane has been restricted since 1988, the source of chlordane in runoff is believed to be from unauthorized usage and dumping of stocked chemicals (CRWQCB, 1997).

Trash and Debris

Littering and illegal dumping are the primary sources of trash and debris found in the Pico-Kenter Area. However, the amount of trash and debris collected (through street sweeping and annual cleanup of catch basins and storm drain channels) is unknown at this time (CRWQCB, 1997).

Water Quality Improvement Strategies

There is a general consensus among stakeholders that the greatest impact and need for improvement in this area is the acute health risks associated with swimming in runoff contaminated surfzone waters. Control of pathogen inputs in the nearshore water should be the priority for pollutant control measures planned in this area. Other pollutants of concern identified for this area should continue be monitored (CRWQCB, 1997).

Several alternatives for pathogenic contamination control have been investigated in this area. The outlet of the Pico-Kenter storm drain was first extended 600 yard beyond the surfzone in 1991 Then in 1992, the Pico-Kenter storm drain became the first drain in the watershed to have its low-flow temporarily diverted to a treatment plant (CRWQCB, 1997).

Planned as a long-term solution, the City of Santa Monica and City of Los Angeles partnered to construct a facility that uses ultraviolet light to treat the effluent of Pico-Kenter and Santa Monica Pier storm drains on site at the Santa Monica Urban Runoff Recycling Facility (SMURRF). The facility became active in 2001 and began diverting and treating 500,000 gallons per day to recycled water quality. Additionally, the City of Los Angeles and the District conducted a series of studies that evaluated the feasibility and cost-effectiveness of diverting other problematic storm drains in the area to the sanitary sewer. The City of Los Angeles is diverting runoff from eleven drains during the dry season to the Hyperion treatment facility. These drainage areas include eight within the City of Los Angeles: Temescal Canyon, Palisades Park, Santa Monica Canyon, Rose Avenue Drain, Thornton Avenue Drain, Venice Pavilion Drain, Imperial Avenue Drain, and the Bay Club Drain. The District has built three low-flow diversions: Ashland Avenue Drain, Brooks Avenue Drain, and Playa del Rey. This combined effort prevents seven million gallons a day of contaminated runoff from flowing untreated into Santa Monica Bay (City of Santa Monica website, SWRCB website #3).

Implement TMDLs

The TMDLs in effect which impact the Pico-Kenter area are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay nearshore and offshore debris TMDL. For the purpose of implementing the bacteria TMDLs, the area has been divided up into "jurisdictional groups" (JG) – the Pico-Kenter area falls into JG3. Both Santa Monica and Venice Beaches are listed as impaired for indicator bacteria. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The District, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the bacteria TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

<u>Santa Monica Bay Nearshore and Offshore Debris TMDL</u> The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in

any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

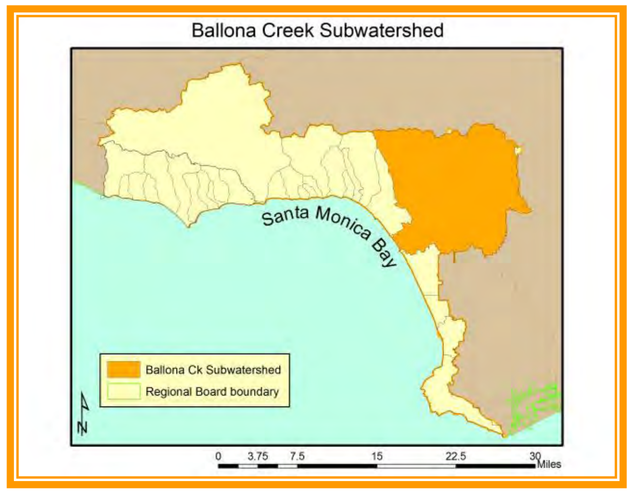
Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean (City of LA website #2). Low flow diversions found within the Pico Kenter and adjacent area are show in the table below.

Table 11. Low flow diversions within the Pico-Kenter and adjacent areas

Low Flow Diversion	Year Operational	Agency
Ashland Avenue	2006	District
Electric Avenue Pump Plant	2001	District
Montana Avenue	2005	Santa Monica
Pico-Kenter	2001	Tri-agency
Rose Avenue	2005	District
Santa Monica Pier	2001	Santa Monica
Thornton Avenue	1999	City of LA
Venice Pavilion (Windward Ave Pump Station)	2003	City of LA
Wilshire Avenue	2005	Santa Monica

Ballona Creek



Ballona Creek, with its discharge point to Santa Monica Bay adjacent to the entrance of the Marina del Rey harbor, drains a watershed of about 127 square miles. It is the largest drainage tributary to Santa Monica Bay. The watershed boundary extends in the east from the crest of the Santa Monica Mountains southward and westward to the vicinity of central Los Angeles and thence to Baldwin Hills. Tributaries of Ballona Creek include Centinela Creek, Sepulveda Canyon Channel, Benedict Canyon Channel, and numerous other storm drains. Ballona Creek is concrete lined upstream of Centinela Boulevard. All of its tributaries are either concrete channels or covered culverts. The channel downstream of Centinela Boulevard is trapezoidal composed of grouted rip-rap side slopes and an earth bottom (CRWQCB, 1997).

Adjacent to the downstream channel of Ballona Creek are Marina del Rey small craft harbor, Ballona Lagoon and Venice Canals, Del Rey Lagoon, and Ballona Wetlands. Although they do not discharge directly into the Creek, they are grouped as waterbodies in this subwatershed because of their proximity and various forms of hydrological connections to the Ballona Creek (CRWQCB, 1997).

Flows

Ballona Creek conveys approximately 10 cfs of dry-weather base flow and up to 36,000 cfs of wet-weather flow (100-year storm event). The maximum wet-weather flow can be about 400 times the minimum dry-weather flow. This is suggestive of the dominant influence of stormwater runoff, which is typical of the stream flow pattern in Southern California (CRWQCB, 1997). The average annual runoff from Ballona Creek is 34 billion gallons per year; runoff from a 0.45 inch storm is 0.5 billion gallons based on an average rainfall of 14.95 inches per year (City of LA, 2009).

Land Uses

Ballona Creek collects runoff from several partially urbanized canyons on the south slopes of the Santa Monica Mountains as well as from intensely urbanized areas of West Los Angeles, Culver City, Beverly Hills, Hollywood, and parts of central Los Angeles. The urbanized area accounts for 80 percent of the watershed area; the partially developed foothill and mountains make up 20 percent. There are some areas of undeveloped land in the Santa Monica Mountains on the north side of the subwatershed, and a section along the east side of Ballona Creek near the Pacific Ocean. Some open space also remains in the Baldwin Hills area along with an oil field. All other areas are typically urbanized (CRWQCB, 1997).

Beneficial Uses

Beneficial uses are identified for this subwatershed in three areas: beneficial uses associated with the Ballona Creek channel, those associated with other waterbodies such as Marina del Rey, Ballona Wetlands and Lagoon, and those associated with ocean water influenced by discharges from the land. and are shown below (CRWQCB, 1994).

Table 12. Beneficial uses of the waters within the Ballona Creek subwatershed

Coastal Feature or Waterbody	Hydro Unit #	MUN	NAV	REC1	REC2	COMM	WARM	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL	WET
Marina Del Rey				E											
Harbor	405.13		E	E	E	E			E	E				E	
Public Beach Areas	405.13		E	E	E	E			E	E	E				
All other Areas	405.13		E	P	E	E			E	E	E			E	
Entrance Channel	405.13		E	E	E	E			E	E	E			E	
Ballona Creek Estuary	405.13		E	E	E	E		E	E	E	E	E	E	E	
Ballona Creek to Estuary	405.13	P		EL	E		P			P					
Ballona Creek	405.15	P			E		P			E					
Ballona Lagoon/Venice Canals	405.13		E	E	E	E		E	E	E	E	E	E	E	E
Ballona Wetlands	405.13			E	E			E		E	E	E	E		E
Del Rey Lagoon	405.13		E	E	E	E		E		E	E	E	E		E

E: Existing beneficial use
P: Potential beneficial use
I: Intermittent beneficial use
EL: Limited beneficial use

Marina del Rey/Ballona Creek Complex

Marina del Rey Harbor and the estuarine portion of Ballona Creek together provide many important beneficial uses. Marina del Rey is one of the largest small craft harbors in the world accommodating more than 6,000 private pleasure boats. Besides the recreational value provided, the Marina/Creek complex is an important habitat for many invertebrates, fish, bird, and mammal species (CRWQCB, 1997).

The benthic fauna in the area is typical of areas with shallow warm waters, a fine-grained, silty bottom and, in the marina, with limited circulation. The most common benthic species in the area are roundworms that account for about 30% of the total benthic population and found primarily in the channel entrance. Polychaetes are also common in the poorly-circulated inner marina. The fish population has limited diversity due to the less favorable physical and environmental conditions in the area. Certain seabirds are seasonally common in the area. The species found here are those that occur in sheltered waters of shallow depths (e.g., grebes and scoters), or generalist species (e.g., gulls). California sea lions and harbor seals are often seen on the breakwater and jetties (CRWQCB, 1997). Sampling during 2004 yielded 77,674 total fish of all age groups (including larvae and eggs) representing 56 different species. By far, the majority of these were eggs, larvae, and juveniles, which attests to the Harbor's continued value as a nursery ground (ABC Labs, 2005).

Several federally defined threatened, endangered, and candidate species may occur in the complex and adjacent beach areas. The species that are sensitive to environmental disturbances include the California least tern, California brown pelican, and western snowy plover (CRWQCB, 1997).

Ballona Wetland Complex

The Ballona Wetlands ecosystem represents one of the few remaining regionally significant coastal wetlands available in Santa Monica Bay. Within Los Angeles County, it is estimated that coastal wetlands have been reduced by 96% compared with pre-development conditions. The nearest comparable wetlands are Malibu and Mugu Lagoons to the north and Los Cerritos Wetlands to the south. The Ballona Wetlands play not only a crucial role in sustaining regionally limited habitats and species, but also an important role in providing opportunities for the public to experience these environments (SCC, 2006).

The project site is owned by the State of California, the California Department of Fish & Game (CDFG) owns 540 acres and the State Lands Commission (STC) owns 60 acres. The California Fish and Game Commission also recently designated the Ballona Wetlands as an Ecological Reserve. This designation covers the land owned by CDFG and part of the land owned by SLC. The designation provides additional protection for the natural resources of the site and specifies compatible public uses for the area (SCC, 2006).

In previous studies the site has been divided into three areas designated as Areas A, B, and C. In addition, the Freshwater Marsh lies within the project area (SCC, 2006).

Area A includes approximately 139 acres north of the Ballona Creek, west of Lincoln Boulevard and south of Fiji Way. Site elevations range between approximately 9 and 17 ft MSL, fill was placed on Area A during the excavations of Ballona Creek and Marina Del Rey. Area A is undeveloped with the exception of a parking area along the western boundary and a drainage channel along the northern boundary. In addition, the Gas Company currently maintains four monitoring well sites in the western end of this Area (SCC, 2006).

Area B, approximately 338 acres in size, lies south of Ballona Creek and west of Lincoln Boulevard. Area B extends south to Cabora Drive, a utility access road near the base of the Playa Del Rey Bluff. To the west, Area B extends into the dunes that border homes along Vista del Mar. Site elevations range between approximately 2 and 5 ft in the lower flat portions, and up to 50 ft MSL below the Del Rey Bluff. Area B contains the largest area of remnant unfilled wetlands with abandoned agricultural lands to the northeast, and the Freshwater Marsh to the southeast. The Gas Company has easements for oil wells, one of which is active, and supporting access routes in Area B (SCC, 2006).

Area C is north of the Ballona Creek and east of Lincoln Boulevard in the City of Los Angeles. The Harbor Freeway forms the sites northeastern border. The site is approximately 66 acres in size and is traversed in an east-west direction by Culver Boulevard. Area C contains fill from the construction of the Ballona Creek Flood Control Channel, and developments such as Marina del Rey, the Pacific Electric Railroad, the raising of Culver Boulevard and the Marina Freeway. Elevations within Area C range approximately between 4.5 and 25 ft MSL. Area C is mostly undeveloped with exception of ball fields and supporting minor structures (SCC, 2006).

The *Freshwater Marsh* is located west of Lincoln Blvd, south of Jefferson Boulevard adjacent to Area B in the City of Los Angeles. The Freshwater Marsh was constructed between 2001 and 2003 and treats urban runoff and stormwater from the Playa Vista development and from Jefferson Boulevard. It is operated and managed by the Ballona Wetlands Conservancy, a non-profit organization established for that purpose. A riparian corridor east of Lincoln Boulevard and outside of the project area is currently being constructed that will connect to the south end of the Freshwater Marsh (SCC, 2006).

CDFG owns the *Ballona Creek* through the project area. The channel is trapezoidal, with bottom widths varying from 80 to 200 feet and depths varying from 19 to 23 feet from the top of the levee. The side slopes are lined with concrete, paving stones and riprap; the channel bottom is not armored (SCC, 2006).

The Del Rey Lagoon/Ballona Wetlands is a mixture of habitats dominated by coastal salt marsh. Freshwater riparian habitat also exists along the foot of the bluff. The wetlands support hundreds of species of plants, insects, and animals. Common plant species include pickleweed, salt grass, frankenia, jaumea, saltbush, etc. in the salt marsh area and tale, cattail, willows, cottonwood, threesquare, umbrella sedge, etc. in the freshwater riparian area. Animal species across all major taxonomic groups are observed in the wetlands, including many special status species such as Belding's Savannah sparrow, salt marsh shrew, Dorothy's El Segundo dune weevil, and salt marsh skipper, etc. The wetlands also provide spawning ground for fish species such as California halibut (CRWQCB, 1997).

The 16-acre Ballona Lagoon is an artificially confined tidal channel that connects the Venice canal to the Pacific Ocean (CRWQCB, 1997).

Beaches

The adjacent beaches of the area include Venice Beach located upcoast and Dockweiler State Beach located downcoast. These beaches are often heavily used, especially on weekends and in summer months. Jetties along the channels are also regularly used by pedestrians and fishers (CRWQCB, 1997).

Nearshore and Offshore Areas

The nearshore and offshore zones near the discharge point of Ballona Creek are areas heavy in traffic for recreational boat activities because its vicinity to Marina del Rey. Like in most parts of the Bay, the sea floor is consisted of soft-bottom habitat that supports a diverse number of organisms, including more than 100 species of demersal fish (CRWQCB, 1997).

Evidence of Impairments

The Ballona Creek subwatershed is part of the Santa Monica Bay region that continues to experience significant development in response to demand for housing and business with coastal amenities. Two of many consequences associated with modern human inhabitation are natural habitat replacement/ destruction, and increased pollutant loading to waterbodies within the subwatershed (CRWQCB, 1997).

Habitat Degradation

At one time, the Ballona Wetland Complex was 2,100 acres of coastal estuary and wetlands. With the development of Marina del Rey, the Venice canals, and other residential and commercial properties, the draining of wetlands for agricultural use, oil drilling, and to control insects; and the channelization of Ballona Creek; the Wetland Complex has been reduced to approximately 430 acres (CRWQCB, 1997). The 2001 graduate thesis, "Seeking Streams", produced by a team of students in the Cal Poly Pomona Department of Landscape Architecture 606 Studio Program, documented the locations of the underground remnants of the stream system which once drained from the Santa Monica Mountains to the coastal wetlands (Braa, et al., 2001).

Most parts of the 260-acre Ballona Wetlands are degraded or severely degraded. After channelization of Ballona Creek, the wetland's only connection to the ocean is culverts with flap gates. However, these flap gates allow only limited amounts of sea water into the marsh. The tidal range rarely exceeds one meter. In Area A of the wetlands next to the Marina, there is no tidal exchange through the culvert to the Marina because bank height and elevation of the surrounding lands are above the tidal amplitude (CRWQCB, 1997).

The degraded wetlands support fewer species and is less productive. Many species characteristic of pristine salt marshes in the area are lacking. Additional adverse impacts include the introduction of non-native plants and animals, debris and bacteria from urban runoff, and recreational overuse (CRWQCB, 1997).

Elevated Contaminant Levels and Toxicity

Data collected over the years have shown that contaminants are accumulated in the estuarine area of the watershed both in sediments and in marine organisms (CRWQCB, 1997).

Studies conducted by the SMBRP in 1993 and 1995 found that both dry- and wet-weather runoff were toxic to marine organisms. Almost all samples collected from the main channel and two major tributaries exhibited toxicity using the sea urchin fertilization test until the runoff/storm waters were diluted 10 times. Tests conducted on sediment samples also exhibited toxic effects. Toxicity identification and evaluation indicated that the probable sources of toxicity varies. In one case the source was consistent with the presence of organic chemicals. On another occasion the source was consistent with the presence of toxic metals (CRWQCB, 1997).

Sediment samples have been collected in the harbor and analyzed for a number of pollutants for years by ABC Labs for the Los Angeles County Department of Beaches and Harbor; and prior to that, by USC Harbors Environmental Projects. Recently, more intensive characterization sampling has been conducted by Weston Solutions. The figures below show a small subset of the available data; namely, copper in the sediment in 1997 versus in 2007 when compared to sediment quality guidelines which serve as a simple general point of reference.

Figure 18

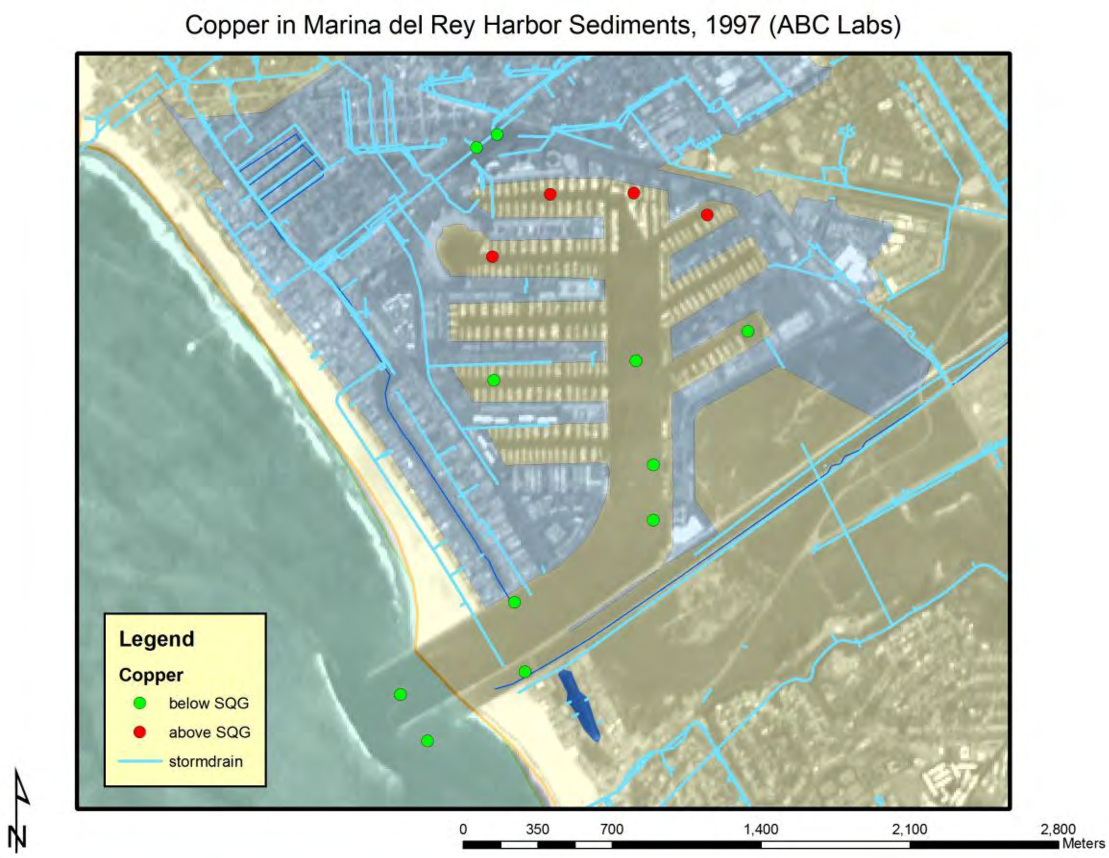
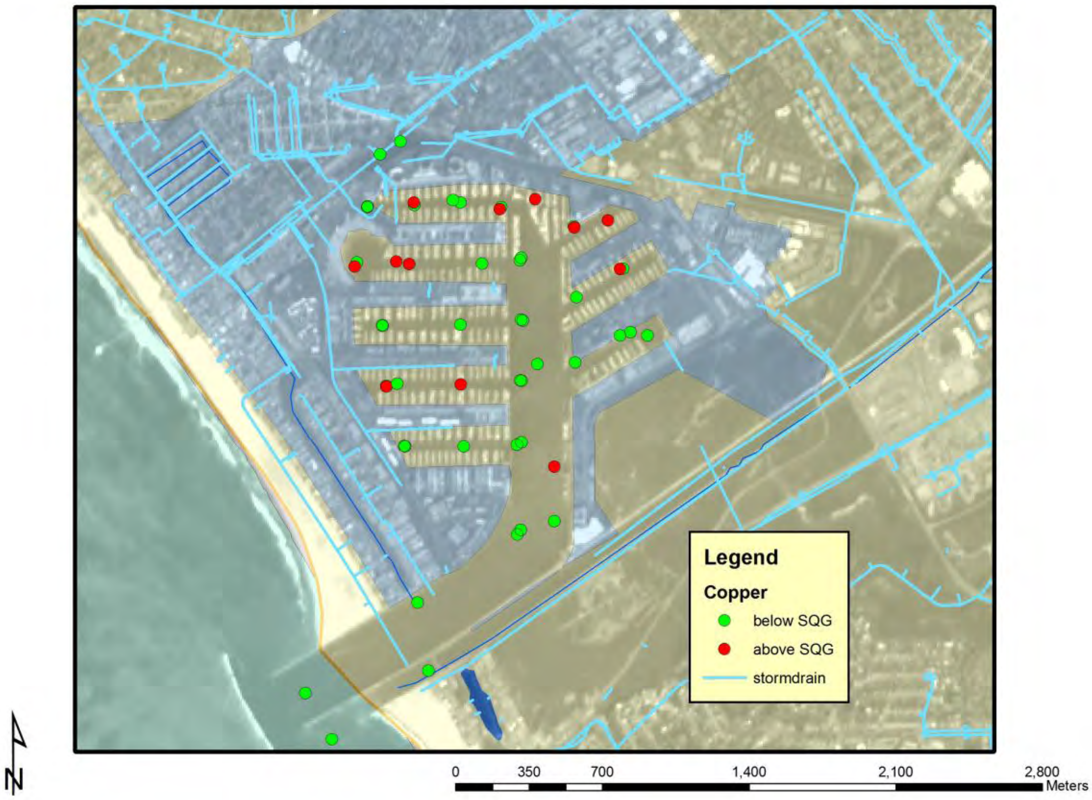


Figure 19

Copper in Marina del Rey Harbor Sediments, 2007 (Weston Solutions and ABC Labs)



Broadly speaking, at least with regards to copper, concentrations which may be of concern are mostly found in the back basins of the harbor.

Bacterial indicator levels measured at stations near Ballona Creek entrance frequently exceed levels prescribed in the Basin Plan. As a result, warning signs are posted permanently on each side of the Creek to advise people not to swim in the area. Over the years, beach areas were closed many times due to sewage spills and illegal dumping (CRWQCB, 1997).

Everyday, tons of trash and debris wash into the sea from Ballona Creek. When floating on the water surface, washed back onto beaches, or deposited on the sea floor, trash creates a nuisance and health hazard to beach goers, swimmers, and boaters, and pose dangers to marine life (CRWQCB, 1997).

The results of a study on watershed-based sources of contaminated sediments in San Pedro Bay-area harbors (in this case, the Ballona Creek Watershed as a source to Marina del Rey Harbor) conducted by SCCWRP and reported on in 2003, found typical modeled wet-weather annual loads to Marina del Rey from Ballona Creek range from 7 kg/year for cadmium to 381 kg/yr for lead, 1,081 kg/yr for copper, and

6,901 kg/year for zinc. Suspended solid loadings typically range from approximately 3,000 metric tons/year from Ballona Creek. General conclusions reached included that the majority of contaminants to the Harbor were deposited from Ballona Creek while industrial discharges represented a fraction of the total annual load. In some years, dry season loading may equal or exceed wet weather loading and constitute the majority of total annual load from the watershed. The magnitude of dry season flow translates to large dry season loading for several contaminants, such as copper, nickel, and zinc. Long-term trends in annual loading of metals appear consistent, while trends in annual loading of DDTs and PCBs appear to have declined. Annual loads of most metals are in the 103 – 105 kg/year range, with zinc and copper loading typically exceeding loads of other metals, most likely due to their relatively ubiquitous use and distribution. As a result, management strategies would need to account for typical annual variations of up to five orders of magnitude. Industrial and residential land uses contribute the greatest percent of annual contaminant loading (Stein, et al., 2003).

Another study conducted by SCCWRP and reported on in 1999 addressed the effect of stormwater and urban runoff discharge into Santa Monica Bay and found the following:

- Virtually every sample of Ballona Creek stormwater tested was toxic to sea urchin fertilization.
- The first storms of the year produced the most toxic stormwater in Santa Monica Bay during the study.
- The toxic portions of the stormwater plume were variable in size, extending from ¼ to 2 miles offshore of Ballona Creek.
- Surface water toxicity caused by unidentified sources was frequently encountered during dry weather in Santa Monica Bay.
- Zinc was the most important toxic constituent identified in stormwater. Copper and other unidentified constituents may also be responsible for some of the toxicity measured in Santa Monica Bay.
- The measured concentrations of zinc and copper in Ballona Creek stormwater were estimated to account for only 5 to 44 percent of the observed toxicity.
- Sediments offshore of Ballona Creek generally had higher concentrations of urban contaminants, including common stormwater constituents such as lead and zinc.
- Sediments offshore of Ballona Creek showed evidence of stormwater impacts over a large area (Bay, et al., 1999).

Pollutants of Concern

The pollutants of concern identified for this subwatershed include heavy metals (Pb, Cu, Zn, Cd, Ag), debris, pathogens, oil and grease, PAHs, and chlordane. Possible future hydrological modifications of existing infrastructure such as dredging, fill, damming, channelization, and other types of construction are also a major concern because of their potential for impairment of water quality and aquatic and marine habitats (CRWQCB, 1997).

Although not identified as pollutants of concern initially in the Bay Restoration Plan, DDTs and PCBs should continue be monitored in the runoff from this subwatershed. Traces of DDTs and PCBs are still detected in sediment samples collected near the mouth of the Creek, and higher concentrations are still present in mussel tissues in the area (CRWQCB, 1997).

Sources and Loadings

Ballona Creek

Early Mass Loading Studies Because of its large size and urban land use, Ballona Creek contributes significantly to total loadings of several pollutants to the Bay and to Marina del Rey Harbor. In 1993, the SMBRP estimated that Ballona Creek is the largest loading source among 28 catchment basins for lead, copper, zinc, total suspended solid, and oil and grease. A reconnaissance study performed by the Army Corps of Engineers in 1995 estimated that Ballona Creek yielded about 46,000 cubic yards of sandy material and about 5,300 cubic yards of silt annually (CRWQCB, 1997).

Sampling and analysis conducted during the 1995/96 wet season indicated that the metals (Ag, Cd, Cu, Cr, Ni, Pb, and, Zn) mass load contributed by the three main tributaries is proportional to their flow (Ballona main channel>Sepulveda channel>Centinela channel). However, the load from each channel was a significant contributor to the overall pollution load from this subwatershed (CRWQCB, 1997).

Current MS4 Monitoring The 2008-2009 mass emissions monitoring station on Ballona Creek is located at Sawtelle Blvd., above the area of tidal influence. Approximately, 89 square miles of land drains to this site; 40% of the area is used as single family high density residential, 12% is multi-family residential, 11% is vacant, 10% is retail/commercial, nearly 7% is mixed residential, 3.5% is light industrial, and 12% is designated as other uses. Despite this subwatershed's prevalence of impervious surfaces, Ballona Creek produced much more sediment per square mile compared to Malibu Creek, even though the two watersheds have comparable areas (LACDPW website).

Mass loading Not surprisingly, there are very large loading differences between results for wet- and dry-weather sampling events as well as between the various wet-weather events which can have very different rainfall amounts and patterns. For example, during 2008-2009, copper varied from a low of 1.24 lbs during one dry-weather sampling event to a high of 1,163.29 lbs during a wet-weather event. Within the dry-weather sampling events, copper loads ranged up to 11.52 lbs. Other metals followed a similar pattern with zinc loading ranging from a low of 2.53 lbs during dry-weather to a high of 4385.44 lbs during a wet-weather sampling event (LACDPW website).

Toxicity testing Two dry-weather toxicity sampling events during 2008-2009 resulted in no acute or chronic toxicity to a freshwater organism (*Ceriodaphnia*); a toxic effect was seen with the chronic sea urchin fertilization test. Similar results were found during the two wet-weather sampling events. 42

Chemical/bacteriological testing During the three dry-weather sampling events, fecal coliform bacteria did not attain the applicable water quality objective (400 mpn/100 ml) two out of three times sampled during dry weather (LACDPW website).

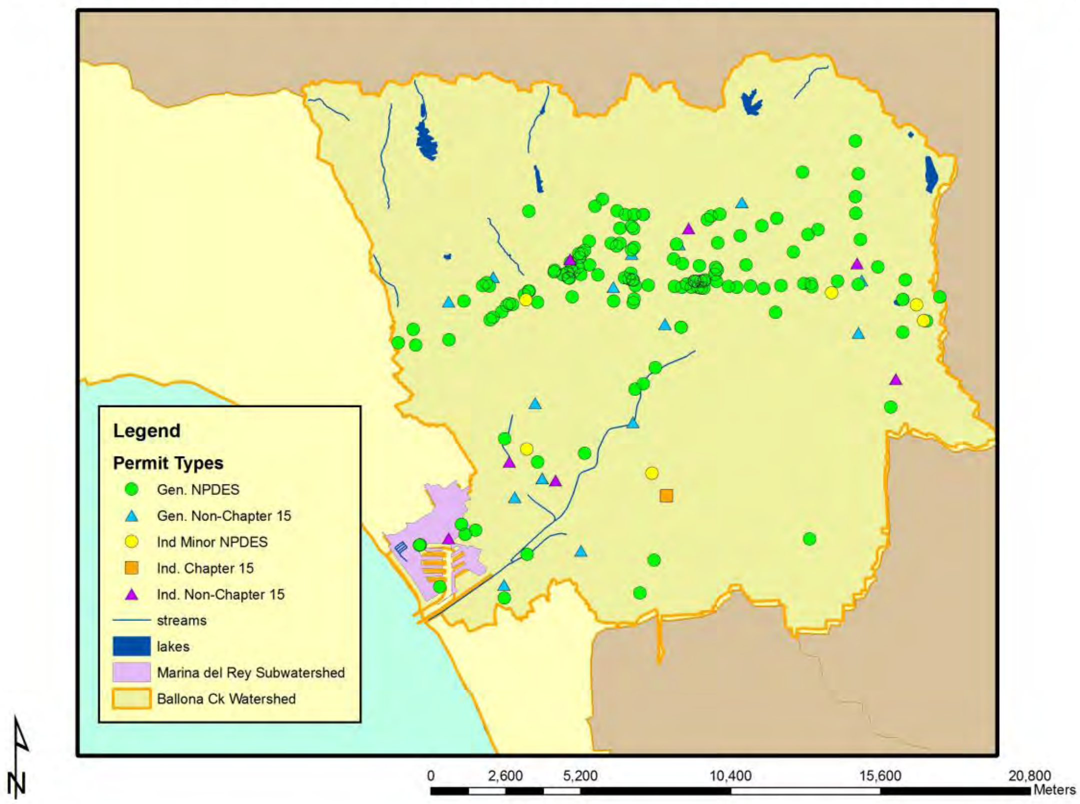
During the five wet-weather sampling events, two constituents were at excessive concentrations for most or all of the events: fecal coliform and zinc. Fecal coliform bacteria did not attain the applicable water quality objective five out of five times sampled during wet weather in Ballona Creek which is subject to the wet weather suspension of the REC-1 beneficial use during high flow periods. Dissolved copper did not attain the hardness-based water quality objective during wet weather at Ballona Creek for three of the five events measured. Dissolved copper concentrations were fairly consistent but the hardness at Ballona Creek was quite variable. Dissolved zinc did not attain the hardness-based water quality objective during one of the five wet-weather sampling events (LACDPW website).

Dry Weather Metals and Bacteria Loading Distribution into Ballona Creek A study conducted by SCCWRP and reported on in 2004 characterized the spatial distribution of sources of dry weather metals and bacteria loading to Ballona Creek. Metals concentrations in Ballona Creek were below chronic criteria under the California Toxics Rule between 96% and 100% of the in-river samples. In contrast, bacteria concentrations at the majority of storm drains and in-river sites were consistently above AB411 water quality standards. In general, Ballona Creek exhibits a bimodal distribution of elevated metals and bacteria, with the highest levels occurring between km 3 and 6, immediately upstream of the tidal portion of the creek and between km 9 and 12, below the portion of the watershed where Ballona Creek daylights from an underground storm drain to an exposed channel. These two portions of Ballona Creek correspond to locations where storm drains with consistently high concentrations and loads discharge to the creek. Of the 40 drains sampled, four account for 85% of the daily storm drain volume. Between 91% and 93% of the total daily load for metals is contributed by eight drains. Nine drains consistently have the highest concentrations of metals and bacteria. Metals concentrations may vary by 5-fold and bacteria concentrations may vary by up to five orders of magnitude on an intra- and inter-annual basis. The authors report that despite this variability, managing a relatively small number of storm drain inputs has the potential to result in substantial improvement in water quality in Ballona Creek (Stein and Tiefenthale, 2004).

Permitted Discharges There are 170 permitted non-stormwater discharges in the Ballona Creek Watershed; six are into the Marina del Rey Subwatershed. The majority of these permitted discharges are ground water seepage drained for construction site preparation and treated contaminated groundwater. Some are discharges of cooling water. These permitted discharges of non-stormwater into the storm drains have a combined discharge that is about 8% of the discharges from stormwater runoff (CRWQCB, 1997).

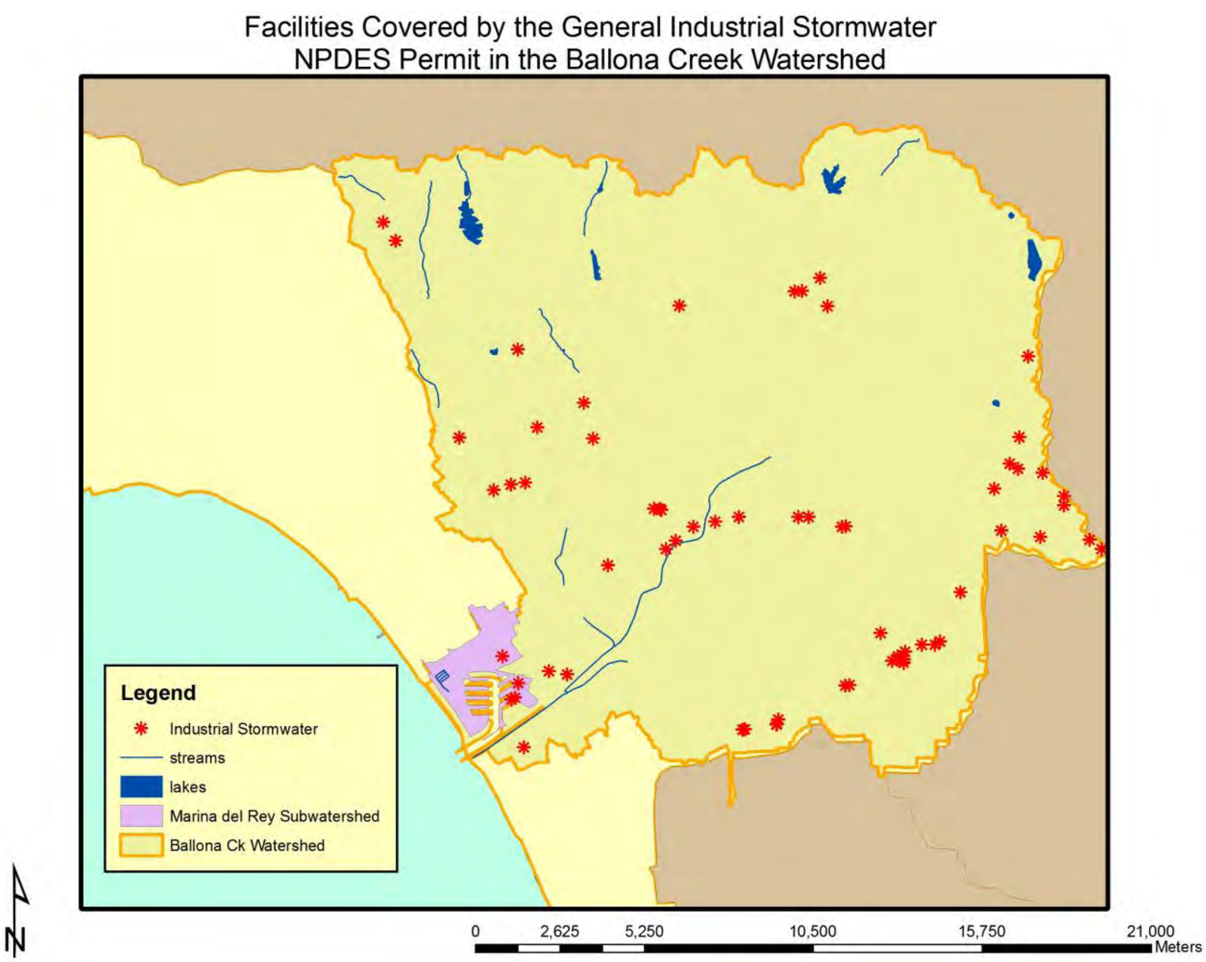
Figure 20

Non-Stormwater NPDES Discharger Locations in the Ballona Creek Watershed



There are 66 facilities covered by the general industrial stormwater NPDES permit. Electric, gas and sanitary services; local and interurban passenger transit; and fabricated metal products are a large component of these businesses based on their Standard Industrial Classification (SIC) code. There are approximately 70 facilities covered by the general construction stormwater NPDES permit in the Ballona Creek Watershed (CRWQCB, 2007).

Figure 21



Transportation-Related Sources There are many potential sources for pollutants of concern in this region. Among them, transportation-related activities are identified as probably the most important source for heavy metals, PAHs, and oil and grease. Monitoring of highway runoff conducted by California Department of Transportation has shown high concentrations of copper, lead, and zinc. The loading of these (heavy metals and PAHs) likely are resulting from deposition of auto fuel exhaust, an auto part wear (tires, brake pad, etc.). Other potential sources of heavy metals are fungicide and insecticide use. In addition, natural oil seeps, which are far more abundant in this region than other parts of Santa Monica Bay, may be an important contributor of oil and grease loading to Ballona Creek (CRWQCB, 1997).

Sources of Trash and Debris Littering and illegal dumping are major sources of trash and debris found in Ballona Creek. Los Angeles County Department of Beaches and Harbors collects tons of trash on adjacent beaches after major rain storm each year. Most of the trash collected by the Department are materials carried downstream by the Creek and then washed on shore by tidal action. Since 1994, the District installed a trash net near the mouth of the Ballona Creek (CRWQCB, 1997). The amount of trash collected during each month of 2002, ranged from practically zero during dry-weather months to about 95 tons during wet periods (LACDPW, 2004). Another major source of specifically plastic debris are industries that manufacture, store, process, and otherwise handle plastic pellets as raw material which is being addressed through the Santa Monica Bay Nearshore and Offshore Debris TMDL (CRWQCB website #3).

Sources of Pathogens Potential sources of pathogens to the Creek also include illegal sewer connections and sewage dumping, domestic animals, and the transient population. A study is being undertaken by the City of Los Angeles to evaluate the effects of street washing on loading of pathogenic materials into the storm drain system (CRWQCB, 1997).

Sewer leaks occurred in the past at various locations within the watershed, especially in areas where sewer lines are in parallel to the storm drain system. There were several incidences of sewer overflows during winter storms each year. In response, the City of Los Angeles has been replacing old sewer lines (CRWQCB, 1997).

Marina del Rey Harbor

There are four drainages that are located around and drain directly into Marina del Rey Harbor. Although these drainage areas constitute only about 1% of the total drainage area of Ballona Creek subwatershed, two of the drainages, Oxford Basin and Washington Drain, are significantly more industrialized than the Ballona Creek average, and thus are potentially significant sources of industrial contaminants such as heavy metals. Also, the area with surface drainage to Marina del Rey Harbor area has a high percentage of commercial use and thus is a potentially significant source for contaminants such as oil and grease in the harbor (CRWQCB, 1997). Finally, the five NPDES-permitted non-stormwater discharges to the harbor are covered by a general permit for discharges of groundwater from construction dewatering to surface waters; there is also an individual non-Chapter 15 waste discharge requirements for discharge to the ground (CRWQCB website #1).

Contaminants due to nonpoint sources from marine activities in the harbor include primarily lead, copper, zinc, PAHs, TBT and bacteria. Compared with contaminant loading in Ballona Creek, lead releases due to marine activities are essentially negligible but zinc releases may be higher. This estimate is based on the assumption that the extent of zinc anode use has remained essentially the same over the last decades. The use of TBT as an antifouling agent in vessel paints has been restricted since 1987. Monitoring data has indicated a decline in TBT concentration in sediment in the harbor (CRWQCB, 1997).

Water Quality Improvement Strategies

In accordance with the problems identified previously, greatest benefits could be achieved should water quality improvement efforts be focused on the following:

- Protect and restore remaining wetland and riparian habitats in the region.
- Prevent and reduce mass loading of pollutants that accumulate in sediments of the Creek and near shore sea floor and that are toxic and/or bioaccumulate in marine organisms.
- Prevent and reduce loading of pollutants that may deplete the recreational value of nearby beaches and nearshore water by either imposing health risk or aesthetic nuisance (CRWQCB, 1997).
- Implement TMDLs.

Protect and Restore Wetlands and Riparian Habitats

Restoration of the Ballona Wetlands Complex Acquisition of parcels within the Ballona Wetlands Complex is a completed project of the Wetlands Recovery Project (SCWRP website #2). The project site is now owned by the State of California; the California Department of Fish & Game (CDFG) owns 540 acres and the State Lands Commission (SLC) owns 60 acres. The California Fish and Game Commission also recently designated the Ballona Wetlands as an Ecological Reserve. This designation covers the land owned by CDFG and part of the land owned by SLC. The designation provides additional protection for the natural resources of the site and specifies compatible public uses for the area. A wetlands restoration plan is currently being developed for the area. More information may be found at http://www.balloanrestoration.org (SCC, 2006).

Coordinating with Ballona Wetlands restoration planning, an Army Corps-funded Ecosystem Restoration Feasibility Study is also underway. The goal of the study is to restore, enhance, and create estuarine and riparian habitat and function in the Ballona wetlands and creek and enhance endangered species habitat. Sub-goals include, 1) provide an optimal mix of coastal dependant wetland habitats in terms of ecological integrity, function, diversity, and productivity; 2) restore riparian and aquatic habitat and contribute to the regional habitat connectivity and corridors, and to future restoration activities; and 3) contribute to regional wildlife, and recreation linkages and corridors (USACE website).

Ballona Lagoon was the site of a major restoration in 1997. Activities included: dredging at the southern end of the lagoon to create a deep water pool, removal of inactive oil pipelines and an abandoned concrete structure from the middle of the lagoon, stabilizing the lagoon banks with native vegetation, and constructing a visitor's overlook (SMBRC website).

<u>Related Studies and Plans</u> The State Coastal Conservancy, through the Santa Monica Bay Restoration Foundation, has funded a number of studies which will aid in overall watershed/wetlands restoration. They include:

1) The Historical Ecology of the Ballona Creek Watershed - The purpose of this study is to understand the unique watershed characteristics that shape the current system and that can guide appropriate restoration work. This project requires extensive historical research as well as GIS mapping work and will result in a publication that illustrates the geologic, hydrologic and human development of Ballona Creek watershed. As was done for the San Gabriel watershed, it will identify historical reference points in the watershed, as well as factors that influence landscape change, including land use, climate, floods and fires. It will help define restoration and management options for various locations and purposes throughout the watershed (SCC website).

2) Water Budget for the Ballona Creek Watershed - This study will identify inputs and outputs for the watershed including mapping natural springs and identifying natural flows in storm drains and stream channels. The information will help guide restoration planning to maximize water quality and habitat improvement benefits. The study will help inform decisions about where to place water treatment facilities and other BMPs, to ensure greatest benefit from treating stormwater rather than treating the cleaner, natural flows, which will ultimately contribute to more efficiently and cost-effectively meeting TMDL requirements in the watershed (SCC website).

3) Ballona Greenway Plan - This project will complete the Ballona Greenway Plan. The Greenway Plan was initiated by the Ballona Watershed Task Force and preliminary design work has been done. The outcome of this project will be final designs for portions of the Greenway including landscape guidelines for a Ballona-specific plant palette. This project has proceeded in close consultation with the MRCA and Baldwin Hills Conservancy on their pocket park and bike path beautification plans (SCC website).

<u>Restoration of Stone Canyon Creek</u> Funding from the Coastal Conservancy has been granted to the Santa Monica Baykeeper, in cooperation with other entities, to restore a stretch of Stone Canyon Creek on the UCLA campus. Out of the estimated 419 acres of campus, less than 12 acres remain of natural native habitat. The creek banks are filled with invasive vegetation and are suffering from erosion despite artificial shoring efforts (SCC website).

This site was part of previous small-scale year restoration effort funded by the Southern California Wetland Recovery Project's small grants program. That effort removed non-native vegetation from 0.36 acres of the site. The current project will build upon that work by conducting continued weeding of invasive vegetation, maintenance of existing plants, planting of new native vegetation, and the replacement of 8 exotic trees with native trees. The project will expand the restoration effort to approximately 0.25 additional acres of area along Stone Canyon Creek making the total area restored along the creek approximately 0.60 acres (SCC website).

<u>Recommendations for Daylighting Streams</u> The 2001 Cal Poly Pomona graduate thesis, "Seeking Streams", provided a framework for daylighting streams within the upper Ballona Creek subwatershed

through providing general design guidelines for re-creating streams in an urban setting and more detailed designs for Sacatela Creek and flows through Lafayette Park (Braa, et al., 2001).

Strategies for Reducing Mass Loading of Heavy Metals, PAHs, and Chlordane

Many storm water control BMPs have been implemented in this subwatershed, primarily under the municipal stormwater NPDES program. Most of the BMPs implemented to date are general pollution prevention measures such as public education, street sweeping, and household hazardous waste collection. Additionally, source-specific BMPs have been developed and are being implemented to address these pollutants of concern more effectively (CRWQCB, 1997).

Ballona Creek Watershed Management Plan The Los Angeles County Department of Public Works was awarded a Proposition 13 Watershed Protection Grant by the State Water Resources Control Board to prepare a watershed plan for Ballona Creek. The Ballona Creek Watershed Task Force met for about a year during Plan development and the final Plan was released in 2004. The overarching goal of the Plan was to "Set forth pollution control and habitat restoration actions to achieve ecological health." The Plan includes an extensive list of priority actions, best management practices, and potential demonstration projects to achieve that goal including those specifically related to improving water quality. Some of these activities have been accomplished including the development of a GIS-based comprehensive storm drain map for the county (LACDPW, 2004).

Ballona Creek Watershed Stormwater BMP Implementation Program The Ballona Creek Watershed Stormwater BMP Planning and Implementation Strategy was funded with Proposition 12 funds granted to the City of Los Angeles by the Coastal Conservancy in 2003 and was completed in September 2005. This study identified and prioritized locations within the Ballona Creek watershed, identified and selected specific BMPs for those locations and developed a strategic implementation plan. The study involved numerous watershed stakeholders and resulted in a short list of preferred BMP projects in the watershed. From that list, the Rain Barrels Pilot Project (Downspout Retrofit Program) was selected for implementation. The goal of this project is to significantly reduce the amount of precipitation that becomes runoff from the targeted residential areas (Jefferson, Sawtelle, and Mar Vista areas). This will be accomplished by implementing a Downspouts Disconnection Program, on private properties, to reroute roof runoff from the stormwater collection system to on-site pervious areas, infiltration planters, and/or rain barrels. This pilot program will help improve water quality and manage floods, especially in areas with limited storm drain capacity. The project is expected to control the runoff from 600 out of the 1,600 properties within the two targeted areas. Based on that and based on typical level of imperviousness associated for each land use, the estimated annual average volume that will be eliminated from discharging into Ballona Creek is 1,130,000 cubic feet. Downspouts in the targeted areas were retrofitted during summer 2009 with funding from the SMBRC. Up to 100 on-site treatment BMPs (bioretention/filtration planter boxes/rain barrels) were also proposed to be installed. Subsequent to the implementation of this program, its success will be assessed, and runoff reduction and water quality impacts will be quantified. This pilot program, if successful, will have broader application within the Santa Monica Bay region, especially on areas with limited storm drain capacity and flood-prone locations (City of LA website #1).

Critical Coastal Area Designations California's Nonpoint Source (NPS) Pollution Control Program includes requirements for Critical Coastal Area (CCA) designation. The intent of CCA designation is to direct needed attention to coastal areas of special biological, social, and environmental significance and to provide an impetus for these areas to receive special support and resources. These areas include Environmentally Sensitive Habitat Areas (ESHAs) currently designated in California's Coastal Zone Management (CZM) program, as well as areas adjacent to Areas of Special Biological Significance (ASBS), California's National Estuarine Research Reserves (NERRs), National Estuary Program (NEP), and National Marine Sanctuaries. A long-term goal for the NPS program is to improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. The short-term plan to achieve this goal is to identify, educate, and promote stakeholder involvement. The State's 2002 CCA Draft Strategic Plan identifies 101 CCAs statewide of which 13 are in the Los Angeles Region (CRWQCB, 2007).

Ballona Creek is identified as CCA #68 in the Draft Strategic Plan; it is an impaired water body that flows into a Marine Protected Area. The major efforts listed to implement NPS management measures include: work by the Ballona Wetlands Foundation to preserve and protect the Ballona Wetlands ecosystem through research, educational programs and activities; activities at the Friends of Ballona Wetlands Education/Ecology Center; construction of the Ballona Creek Stormwater Trash Capture System; work undertaken by the nonprofit Ballona Creek Renaissance; implementation of the Santa Monica Bay Restoration Plan; posting of creek pollution warning signs; a metals source study; various TMDLs; implementation of the Ballona Creek Watershed Management Plan; and use of Clean Beaches Initiative funds to implement the Santa Monica Bay Restoration Plan (CRWQCB, 2007).

Water Quality Compliance Master Plan for Urban Runoff In 2007, the City of Los Angeles' Energy and the Environment/AdHoc River Committee directed the City's Bureau of Sanitation to create a Water Quality Compliance Master Plan for Urban Runoff (WQCMPUR). It was intended this plan would outline the City's strategy in achieving Clean Water Act standards as well as compliance with all urban runoff regulations and mandates (City of LA, 2009b).

The plan was asked to address how the City will incorporate public input and follow the principles:

- Identify all pollutants of concern in the City by type and location, including watershed or water body;
- Prioritize polluted areas within the City and create a compliance timetable;
- Identify existing efforts to reduce pollutants of concern and comply with all state and federal regulations;
- Identify strategies — such as on-site retention/infiltration, structural best management practices, regional multi-use benefit projects (including the identification of potential sites for such projects), and non-structural educational and regulatory measures (including ordinance changes to encourage on-site infiltration) for the City to meet Clean Water Act standards by pollutant and by water body or watershed;
- Provide a technical nexus between the strategies and water quality standards attainment and demonstrate that strategy implementation will result in standards compliance;

- Identify water quality data gaps including those that need to be filled in order to determine if the City is in full compliance with water quality requirements in the Los Angeles County stormwater permit and applicable TMDLs; and
- Identify estimated costs and sources of financial support including, but not limited to state and local bonds, stormwater pollution abatement funds, County flood control fees, and sewer service charges.

The plan was intended to integrate existing efforts already underway such as the Integrated Resources Plan, Integrated Regional Water Management Plan, and other relevant watershed management plans, and developed in partnership with stakeholders from the public, environment groups, and regulators including the Los Angeles Regional Water Quality Control Board and local municipalities (City of LA, 2009).

The plan was finalized in 2009. Its strategy is to build on ongoing successful initiatives and programs, identify common grounds (for benefits and funding), and seek new initiatives that will address complex problems. This approach will also promote water conservation and factor in objectives identified by other plans, including increased recreation opportunities and support for the greening of Los Angeles. The plan's implementation strategy is divided into three initiatives:

Water Quality Management Initiative - Describes how Water Quality Management Plans for each of the City's four watersheds and TMDL-specific Implementation Plans will be developed to ensure compliance with water quality regulations. Using the guidelines of the WQCMPUR, these Water Quality Management Plans and TMDL Implementation Plans will:

- Identify BMPs for implementation that will result in compliance with water quality regulations by using design storm and BMP performance criteria;
- Select and prioritize the BMPs for implementation in the watersheds, focusing on the BMPs outlined in the Citywide Collaboration and the Outreach Initiatives;
- Coordinate with ongoing watershed management activities where common goals exist;
- Support the urban runoff management goals of the Water IRP;
- Establish a quantitative nexus between the BMPs selected for implementation and water quality standards attainment;
- Establish metrics to measure success.

Citywide Collaboration Initiative – Recognizes that urban runoff management is closely linked with urban development and redevelopment, requiring:

- Citywide collaboration and coordination of urban runoff management;
- City policies and guidelines for urban development and redevelopment that focus on using green solutions to manage urban runoff; and
- Strategies to promote Low Impact Development (LID) and stormwater use.

Outreach Initiative – Promotes public education and community engagement with a focus on preventing urban runoff pollution and will:

- Enhance outreach activities to reach appropriate target audiences;
- Establish methods to quantify water quality benefits achieved through outreach activities; and

promote community engagement in all of the City's urban runoff management activities (City of LA, 2009).

Strategies for Reducing Trash Load and Incidence of Pathogen Contamination

Initially a trash net installed by the Los Angeles County Department of Public Works in Ballona Creek proved effective in stopping trash from entering the ocean during dry weather. However, dry-weather trash load only counts for a small portion of the annual total. Preventing trash loads during wet-weather storms must rely on thorough cleanup of the storm drain channel, the catch basins, and ultimately the streets that drain to the creek (CRWQCB, 1997).

The Ballona Creek Trash TMDL was adopted by the Regional Board in 2002 and, per the TMDL, a trash baseline load was determined in 2004. The County also monitored results obtained with Automatic Retractable Screen partial-capture devices. Eventually, in 2007 after extensive testing, a full-capture device, the connector pipe screen, was certified by the Regional Board as a full-capture device. At that point, the County changed its implementation strategy from partial capture with trash monitoring to installation of full-capture devices. A full-capture device requires no monitoring since it has been certified to trap all particles retained by a 5-millimeter mesh screen and has a design treatment capacity of no less than the peak-flow rate resulting from a one-year, one-hour storm. The County is installing full-capture systems in all Ballona Creek Watershed County-unincorporated areas. Therefore, no additional baseline and compliance monitoring is necessary. The first phase of the Full-Capture Project included retrofitting 225 of the 310 catch basins within the Ballona Creek Subwatershed with full-capture devices, yielding a 78.41 percent reduction of the trash baseline. This phase of the project was completed on December 12, 2008. The TMDL requires a 50 percent reduction of the trash baseline by September 30, 2009 (Implementation Year 6). Incorporated areas subject to the trash TMDL include the cities of Los Angeles, West Hollywood, Culver City, Santa Monica, and Beverly Hills (LACDPW website).

In 2007, the City of Los Angeles also obtained Regional Board certification for two full-capture devices, horizontal screen inserts and vertical trash capture screen inserts (City of LA website #1).

The City of West Hollywood continues to implement BMPs such as enhanced street sweeping, hand pick-up of litter, daily pickup from streetside trash containers, the addition of streetside recycling containers, and retrofit of catch basins with trash excluders. The City of Beverly Hills has similar BMPs it continues to implement with public education instead of hand pickup being the fourth BMP (LACDPW website).

The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. WLAs for plastic pellets are assigned to permittees of the Industrial Storm Water General Permit within the Santa Monica Bay WMA that have Standard Industry Classification (SIC) codes associated with industrial activities involving plastic pellets which may include, but are not limited to, 282X, 305X, 308X, 39XX, 25XX, 3261, 3357, 373X, and 2893. Additionally, industrial facilities with the term "plastic" in the facility or operator name, regardless of the SIC code, may be subject to the WLA for plastic pellets. Other industrial permittees within the Santa Monica Bay WMA that fall within the above categories, but are regulated through other general permits and/or individual industrial storm water permits are also required to comply with the WLA for plastic pellets.

Industries must comply with the Statewide Industrial Permit or other general or individual industrial permits, which require a Stormwater Pollution Prevention Plan (SWPPP) to be prepared and kept onsite at all times. The SWPPP addresses the areas where pellets tend to spill, as well as an overall plan to keep plastic pellets from being released off of the premises. The SWPPP incorporates structural and nonstructural BMPs that are implemented to keep pellets on site, including specific practices that are used to clean up incidental or large spills. Jurisdictions and agencies identified as responsible jurisdictions for point sources of trash in the Santa Monica Bay debris TMDL and in the Ballona Creek trash TMDLs shall either prepare a Plastic Pellet Monitoring and Reporting Plan (PMRP), or demonstrate that a PMRP is not required under certain circumstances. The PMRP serves to monitor the amount of plastic pellets being discharged from the MS4, establishes triggers for a possible need to increase industrial facility inspections and enforcement of SWPPP requirements for industrial facilities identified as responsible for the plastic pellet WLA, and addresess possible plastic pellet spills.

Given the ample size of the Creek and its flow, dry-weather diversion of its flow does not seem to be as feasible as it has been planned for many other storm drains for remediating the pathogen input problem. Therefore, in order to reduce the pathogen input from the creek, public agencies must explore upstream options such as a better surveillance system, an effective sanitary survey tool, and an expanded public education campaign (CRWQCB, 1997).

Here, again, many actions and practices described in the Ballona Creek Watershed Management Plan if implemented would serve to reduce trash loading and the incidence of pathogen contamination (LACDPW, 2004).

Implement TMDLs

Ballona Creek Trash TMDL The Regional Board adopted the Ballona Creek Trash TMDL in 2002. The implementation schedule requires a 10 percent progressive reduction of the trash baseline load each year starting two years (2004) after the establishment of the TMDL until the numeric target of zero trash is achieved (2015) (CRWQCB website #3).

Santa Monica Bay Beaches Wet- and Dry-Weather Bacteria TMDLs For the purpose of implementing those TMDLs, the area has been divided up into “jurisdictional groups” (JG) – the Ballona Creek area falls into JG8. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing “end-of-pipe” treatment. The District, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the TMDLs’ responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

<u>Ballona Creek Bacteria TMDL</u> The TMDL has multi-part numeric targets for wet-weather and winter dry-weather based on the updated bacteria objectives for marine and fresh waters designated for contact recreation (REC-1), and fresh waters with Limited REC-1 and REC-2 beneficial use designations. However, in all cases, there are zero summer dry-weather exceedance days allowed. Ballona Creek is subject to the high flow suspension of recreational beneficial uses for engineered channels during and immediately following large wet-weather events. The bacteria water quality objectives do not apply during these periods. Historical rainfall data for the watershed indicate a median value of 16 days per year during which the suspension of the recreational beneficial uses would apply. The “natural sources exclusion” approach may be used if an appropriate reference system cannot be identified due unique characteristics of the target water body. Del Rey Lagoon and the Ballona Wetlands are connected to Ballona Estuary via connecting tide gates. Preliminary data suggest that Ballona Wetlands is a sink for bacteria from Ballona Creek and it is therefore not considered a source in this TMDL. Inputs to Ballona Estuary from Del Rey Lagoon are considered nonpoint sources of bacterial contamination. Del Rey Lagoon may be considered for a natural source exclusion if its contributing bacteria loads are determined to be as a result of wildlife in the area, as opposed to anthropogenic inputs. The TMDL will require a source identification study for the lagoon in order to apply the natural source exclusion (CRWQCB website #3).

Two different strategies for achieving compliance with the TMDL were developed by the stakeholders using a combination of treatment and control options. The “Preferred Strategy” provides an integrated resources approach to the TMDL implementation and meets a range of other long-term watershed planning goals. This "Preferred Strategy" relies on a combination of options, including flow and bacteria source control, with limited treatment and discharge as well as small amount of diversion to the Hyperion

Treatment Plant. Some of the activities and projects that can begin to address this strategy are already in the planning phase by certain stakeholder groups in some areas of the watershed. An "Alternative Strategy" was also developed that relies more heavily on the capture, treatment and discharge of stormwater. This strategy was developed to compare the preferred strategy against an alternative based on more conventional engineering and construction with potentially lower risk but much greater investment in infrastructure and much less opportunity to achieve multiple objectives. Implementing some of these strategies is likely to require investigative studies to determine their potential environmental impact to the Creek and Estuary. In addition, various environmental and regulatory feasibility issues would need to be addressed early in the implementation phase when stakeholders develop the Implementation Plan (CRWQCB website #3).

The City of Los Angeles has funded the Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST) for the purpose of developing plans to restore impaired waters and protect water quality. CREST was formed in 2004 through a partnership initiated by the City of Los Angeles, the Regional Board, and US EPA Region 9. CREST began focusing on the Ballona Creek Bacteria TMDL in Spring of 2005. CREST partners were closely involved with many aspects of the TMDL during its development and worked on the details of compliance strategies (CRWQCB website #3).

Ballona Creek Metals TMDL The metals TMDL for Ballona Creek contains both wet- and dry-weather allocations for point and nonpoint sources. The County of Los Angeles, City of Los Angeles, Beverly Hills, Culver City, Inglewood, Santa Monica, West Hollywood, and Caltrans may jointly decide how to achieve the necessary reductions in metals loading by employing one or more potential implementation strategies. Examples of non-structural controls include more frequent and appropriately timed storm drain catch basin cleanings; improved street cleaning by upgrading to vacuum type sweepers; and, educating industries of good housekeeping practices. Structural BMPs may include placement of storm water treatment devices specifically designed to reduce metals loading such as infiltration trenches or filters at critical points in the storm water conveyance system. The diversion and treatment strategy includes the installation of facilities to provide capture and storage of dry- and/or wet-weather runoff and diversion of the stored runoff to the wastewater collection system for treatment at the City's Hyperion Treatment Plant during low flow conditions at the plant, if possible. Other strategies such as small dedicated runoff treatment facilities such or alternative BMPs may be implemented to meet the TMDL requirements (CRWQCB website #3).

Ballona Creek Estuary Toxic Pollutants TMDL The TMDL is for toxic pollutants, such as metals, legacy pesticides, and toxicity in the sediments of the estuary. Numeric targets for the Ballona Creek Toxics TMDL are based on sediment quality guidelines compiled by the National Oceanic and Atmospheric Administrations (NOAA) Effects Range-Low (ER-L) guidelines. Potential implementation strategies for this TMDL are similar to those of the Ballona Creek Metals TMDL (CRWQCB website #3).

A coordinated monitoring plan has been developed by the cities in the watershed, along with the County of Los Angeles and CalTrans, for the Ballona Creek Metals TMDL and Ballona Creek Estuary Toxic Pollutants TMDL. Testing of dry- and wet-weather water quality and sediment quality effectiveness monitoring is included (CRWQCB website #3).

Marina del Rey Harbor Bacteria TMDL The TMDL covers the area of Marina del Rey Harbor called Mothers' (Marina) Beach and the Back Basins. While there are no allowable exceedance days at any of the locations during dry-weather, the allowable number of winter dry-weather exceedance days is three at most locations (except it is zero at one location near Mothers' Beach). The allowable number of winter wet-weather exceedance days varies by location but is no more than seventeen. An implementation plan was by the County of Los Angeles, Cities of Los Angeles and Culver City, and California Department of Transportation through a collaborative effort with interested stakeholders. A hybrid of three different compliance approaches was eventually selected. It utilizes an iterative adaptive process and features the following Control Programs: Public Information and Participation Program, Institutional Control Program, and Structural BMPs Program (CRWQCB website #3).

Santa Monica Bay Nearshore and Offshore Debris TMDL The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Marina del Rey Harbor Toxics

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_32_2005-012_td.shtml

Marina del Rey Back Basins

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_19_2003-012_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_43_2006-009_td.shtml

Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_45_2006-011_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2006-011/2006-011_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2006-011/2006-011_RB_BPA.pdf

Ballona Creek Metals

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_28_2005-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_60_2007-015_td.shtml

Ballona Creek Estuary Toxic Pollutants

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_29_2005-008_td.shtml

Ballona Creek Trash

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_7_2001-014_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_document s/bpa_25_2004-023_td.shtml

Santa Monica Bay Nearshore and Offshore Debris TMDL

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility such as the SMURRF, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean or is reused (City of LA website #2). Low flow diversions found within the Ballona Creek subwatershed are show in the table below.

Table 13. Low flow diversions within the Ballona Creek subwatershed

Low Flow Diversion	Year Operational	Agency
Boone Olive PP	2007	District
Oxford Basin (Berkley at Yale)	2008	District
Washington Blvd	2007	District

El Segundo/LAX Area

The El Segundo subwatershed drains an area of about 6,680 acres. The subwatershed extends from Playa del Rey to the north, Westchester, the Los Angeles International Airport (LAX) area of the City of Los Angeles, the City of El Segundo, the area adjacent to Chevron refinery and adjacent area and a small portion of the City of Manhattan Beach to the south. Major subdrainage areas in this region include, in order of size starting with the largest, North Westchester, Imperial Highway, Chevron Refinery, El Segundo Boulevard, Playa del Rey, the Hyperion Treatment Plant, and the Scattergood Power Plant (CRWQCB, 1997).

Land Uses

Land use in this region is a mixture of residential, industrial and commercial development and public beaches. The land use can be broken down as 54% commercial/industrial and other urban use, 29% residential use, 14% vacant/open space, and 3% public use (CRWQCB, 1997).

Major Industrial and/or Commercial Facilities

There are several major industrial and/or commercial facilities of regional significance in this area, including an airport, a wastewater treatment plant, two electrical power generation stations, and an oil refinery. There are also some aerospace-related industries located in this region (CRWQCB, 1997).

LAX The Los Angeles International Airport that serves as the hub of the regional airport system is in this area. It also represents one large contributor to runoff which in the past discharged to Santa Monica Bay largely via the Imperial drain. However, in late 1989 a retention basin and pretreatment facility was completed that handles about 1.8 million gallons of storm water "first flush" as well as dry weather low flow (CRWQCB, 1997).

Hyperion Treatment Plant The Hyperion Treatment Plant is also located in the area. It is one of the largest POTWs in the country that serves over three million residents in a 480 square mile area. It also provides solids treatment for sludge discharged from two upstream facilities located in the San Fernando Valley. LAX and the Hyperion plant comprise a large percentage of the commercial and other urban land use in this region. Both facilities are either in the planning stage for or undergoing expansion and capital improvement of its treatment works (CRWQCB, 1997).

Power Stations There are two power generation stations in this area: Los Angeles Department of Water and Power's Scattergood Generating Station, and Southern California Edison's El Segundo Generating Station. The power generating stations use seawater from Santa Monica Bay to cool steam condensers. Cool seawater is pumped into the station, circulated through a non-contact heat exchanger, and discharged at temperatures above the intake temperature. Chlorine *is* also injected periodically to control biological growth (CRWQCB, 1997).

El Segundo Refinery The Chevron El Segundo Refinery has been in operation since 1911 and now manufactures various petroleum products including gasoline, jet fuel, kerosene, solvent, coke, fuel oil, liquefied petroleum gases and propylene polymer. Since the early 1970s, Chevron had discharged secondary treated wastewater through an outfall 300 feet offshore. In September 1994, the outfall pipe was extended to 3,500 feet which effectively removed the last point source discharge from the near shore environment (CRWQCB, 1997).

Parks and Beaches

The major beach in the area is the Dockweiler State Beach which extends from Playa del Rey in the north to Manhattan Beach in the south. The beach is heavily used on weekends and in the summer (CRWQCB, 1997).

Beneficial Uses

The major beneficial uses identified for this subwatershed are use of seawater as industrial cooling water for power generation, use of the Bay to transport crude and refined petroleum, and use of seawater for swimming, boating, and sport fishing (CRWQCB, 1994).

Table 14. Beneficial uses of the waters within the El Segundo/LAX area

Coastal Feature or Waterbody	Hydro Unit #	IND	NAV	REC1	REC2	COMM	MAR	WILD	SPWN
Dockweiler Beach	405.12	E	E	E	E	E	E	E	P

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Evidence of Impairments

Sewage Spills

Over the years, there were many incidents of untreated or partially treated wastewater overflowing from the Hyperion Treatment Plant or spills flowing through storm drain channels to the Bay due to either broken pipes, excessive quantity of flow or waste processing errors. The incidents caused beach closure or swimming warning for a period of time (CRWQCB, 1997).

Oil Spills /Seepage

Crude oil and refined petroleum products can enter the marine environment through tanker accidents, fueling, tank cleaning, bilge pumping, improper disposer or on-land spills into storm drains. Possible seeping of crude oil or the refined petroleum products from the pipelines as well as spills of oil occur every year in the Bay (including the ocean area adjacent to this subwatershed), each with the potential for serious impacts on the water quality and marine resources (CRWQCB, 1997).

Wildlife Habitat

The El Segundo Dunes are a remnant of a once-vast coastal ecosystem. The physical features of the dunes themselves constitute an endangered landform. Nine hundred species of plants and animals have recently been recorded on these dunes, 35 of which are limited in range to Southern California. At least eleven species exist only within the boundaries of the El Segundo Dunes and all of them are in danger of extinction. The best example is the El Segundo blue butterfly which is a federal and state-listed endangered species (CRWQCB, 1997).

Pollutants of Concern

The pollutants of concern identified for the El Segundo/LAX sub-watershed area include pathogens, debris, heavy metals, oil and grease, PAHs and chlordane (CRWQCB, 1997).

Source and Loading

Potential sources of pathogens to storm drains include illegal sewer connections and sewage dumping, sewer leaks, domestic animals, food service business, and outdoor camping. During major sewage spills, the Hyperion Treatment Plant also becomes the source of pathogen inputs into the Bay (CRWQCB, 1997).

Sources of debris include illegal waste dumping into storm drains, improper solid waste disposal, and construction activities. Sources for pollutants such as heavy metals, PAHs, oil and grease are more likely from transportation-related activities. The waste jet fuel from LAX and petroleum piping activities from the oil refinery are also considered possible pollutant sources (CRWQCB, 1997).

Chlordane found in the runoff is believed to be from the unauthorized usage and dumping of stocked chemicals into storm drains (CRWQCB, 1997).

Water Quality Improvement Strategies

Source reduction of pathogen inputs in near shore waters should be the priority for water quality improvement in this region. Other pollutants of concern should also be monitored regularly. Source control BMPs should be implemented to reduce the sources of pollutants loading into storm runoff. If feasible, diversion of some problematic storm drains into the sewer system should also be pursued (CRWQCB, 1997).

Another priority is augmenting the ongoing restoration of the El Segundo Dunes and creating an El Segundo Dunes Habitat Preserve. Restoration is urgently needed in order to halt the spread of invasive species, and avoid further extinctions and the extirpation of native species. The long-term goal of the restoration program is to create a Dunes Habitat Preserve of approximately 200 contiguous acres and to restore and preserve the natural ecology of the area (including the adjacent acreage owned by Chevron (CRWQCB, 1997).

Implement TMDLs

The TMDLs in effect which impact the El Segundo/LAX area are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay Nearshore and Offshore Debris TMDL. Dockweiler Beach is listed as impaired for indicator bacteria. For the purpose of implementing the bacteria TMDLs, the area has been divided up into "jurisdictional groups" (JG) – the El Segundo/LAX area falls into JG2. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The District, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the bacteria TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather TMDLs (CRWQCB website #3).

The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Santa Monica Bay Nearshore and Offshore Debris

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean (City of LA website #2). Low flow diversions found within the El Segundo-LAX area are show in the table below.

Table 15. Low flow diversions within the El Segundo/LAX area

Low Flow Diversion	Year Operational	Agency
Arena Pump Plant	2006	District
El Segundo Pump Plant	2006	District
Imperial Highway	2003	City of LA
Pershing Drive, Line C	2006	District
Playa del Rey	2001	District
Westchester	2004	District

South Bay

The South Bay subwatershed drains an area of approximately 7,054 acres. The subwatershed includes major portions of the City of Manhattan Beach, the City of Hermosa Beach, the City of Redondo Beach, and the City of Torrance. Storm drains in the area are all narrow and rather small. The notable drains include the Redondo Pier and Herondo Drains (CRWQCB, 1997).

Land Uses

The major land use of the region is high density single- or multiple-family residential use. The land uses include 81% residential use, 9 % commercial/industrial and other urban use, 8% public use, and 3% vacant/open space (CRWQCB, 1997).

Major Industrial/Commercial Facilities

Although most land uses are residential, the Redondo Generating Station, a major industrial facility operated by Southern California Edison, is located in this area. There are also some aerospace-related industries established in various places within the region (CRWQCB, 1997).

Parks, Beaches and Harbors

There are three very popular beaches in this subwatershed: Redondo Beach, Hermosa Beach, and Torrance Beach. Three piers are located at Manhattan Beach, Redondo Beach, and Hermosa Beach respectively. These piers draw large crowds on weekends and in the summer time. King Harbor, located in Redondo beach, docks 1,500 recreational boats (CRWQCB, 1997).

Beneficial Uses

The major beneficial uses identified for this sub-watershed are use of seawater as industrial cooling water for power generation, and various recreational uses including swimming, boating and sport fishing. Marine and wild life habitats also exist in beach and nearshore areas. For example, beaches in the area provide spawning ground for California grunion each year. Shallow nearshore protected areas such as King Harbor serve as important nurseries for local marine fishes (e.g., California halibut, white seabass) (CRWQCB, 1994).

Table 16. Beneficial uses of the waters within the South Bay area

Coastal Feature or Watershed	Hydro Unit #	IND	NAV	REC1	REC2	COM M	MAR	WIL D	RARE	MIG R	SPWN	SHELL
Redondo Beach	405.12	E	E	E	E	E	E	E	E	E	E	E
King Harbor	405.12	E	E	E	E	E	E	E	E			
Manhattan Beach	405.12		E	E	E	E	E	E			P	E
Hermosa Beach	405.12		E	E	E	E	E	E			E	E

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Evidence of Impairments

Enteric viruses were found in the Herondo drain in a SMBRP study. Beaches in the area were infrequently closed due to sewage spills in storm water drains (CRWQCB, 1997).

Data collected over the years have shown that contaminants are accumulated in marine organisms in the nearshore area of the watershed (CRWQCB, 1997).

Trash and debris were often found on the beaches and there is continuous need for beach cleanup (CRWQCB, 1997).

Pollutants of Concern

The major pollutants of concern within the South Bay subwatershed are debris, pathogens, oil and grease, heavy metals, and PAHs (CRWQCB, 1997).

Source and Loading

Potential sources of pathogens to storm drains include illegal sewer connection and sewage dumping, sewer leaks, domestic animals, food service business, and outdoor camping. During major sewage spills, the Hyperion Treatment Plant also becomes the source of pathogens to surfzone in this area (CRWQCB, 1997).

Sources of debris include illegal waste dumping into storm drains, improper solid waste disposal, and construction activities. Sources of pollutants such as heavy metals, PAHs, oil and grease are more likely from transportation-related activities in the area. Advection from the adjacent wastewater treatment facility outfall is also a potential source (CRWQCB, 1997).

Water Quality Improvement Strategies

The reduction of the pathogens input in the near shore water should be the priority for pollution control measures in this region. Implementation of storm water source control BMPs will likely to reduce the loading of pollutants of concern. Alternatively additional problematic storm drains can be diverted into sewer system (CRWQCB, 1997).

Implement TMDLs

The TMDLs in effect which impact the South Bay are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay nearshore and offshore debris TMDL. Redondo, Manhattan, and Hermosa Beaches are listed as impaired for indicator bacteria. For the purpose of implementing the bacteria TMDLs, the area has been divided up into "jurisdictional groups" (JG) – the South Bay falls into JG5 and JG6. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31). This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The District, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather bacteria TMDLs (CRWQCB website #3).

The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4.

Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Santa Monica Bay Nearshore and Offshore Debris

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean or reused (City of LA website #2). Low flow diversions found within the South Bay area are show in the table below.

Table 17. Low flow diversions within the South Bay area

Low Flow Diversion	Year Operational	Agency
Herondo Street	2005	District
Manhattan Beach at 28th Street (The Strand)	2006	District
Manhattan Beach Pump Plant	2004	District
South of Dockweiler Jetty	2001	District
Manhattan Beach Pier	1990	Manhattan Beach
Hermosa Beach Pier	2010	Hermosa Beach
Redondo Beach Pier	2005	Redondo Beach
Sapphire (at Esplande Ave)	2010	Redondo Beach
Bryant and Voorhees Sump	2008	Manhattan Beach
Alta Vista Park	2010	Redondo Beach

Palos Verdes Peninsula

The Palos Verdes Peninsula subwatershed extends from near the southern boundary of the City of Redondo Beach to Point Fermin along the coastline. Inland, the subwatershed consists of a 10,977 acre area on the north west slope of the Palos Verdes Peninsula. Municipalities in this area include the Cities of Palos Verdes Estates, Rolling Hills Estates, and Rancho Palos Verdes (CRWQCB, 1997) and portions of Redondo Beach and Torrance. The notable drain is Avenue I.

Land Uses

The majority of land uses in this region is low-density residential development with some horse properties; There are some open spaces including beaches, wildlife habitats and natural preserves. Only limited areas within this region are identified for commercial or industrial uses. The land uses include 59% residential use, 36% vacant/open space, 3% commercial/industrial use, and 3% public use (CRWQCB, 1997).

Beaches and Coves

Along the rugged coast there are several coves and bays including Malaga Cove, Bluff Cove, Lunada Bay, and Abalone cove. These coves and bays provide the habitats for a variety of marine life. In addition, areas such as Pt. Vicente, Abalone Cove County Beach, Portuguese Pt., Inspiration Pt., Portuguese Bend, Royal Palms Beach, and Whites Point County Beach are popular destinations that attract tourists or residents for recreational purposes (CRWQCB, 1997).

Beneficial Uses

Beneficial uses identified in this subwatershed are primarily recreational uses including swimming, diving, boating and sport fishing. The waterbodies in this region also contain important marine and wild life habitats. The rocky tidal and nearshore zones provide unique habitats for filter-feeding shellfish (e.g., clams, oysters, abalone, and mussels). With the biodiversity of tidepools, spawning ground for the California grunions and other marine organisms, the whole coastal area of this region is designed as "significant ecological area" by the County of Los Angeles (CRWQCB, 1994).

Table 18. Beneficial uses of the waters within the Palos Verdes Peninsula

Coastal Feature or Waterbody	Hydro Unit #	MUN	GWR	NAV	REC1	REC2	COMM	WARM	MAR	WILD	RARE	SPWN	SHELL
Coastal Streams of Palos Verdes	405.11	P	I		I	I		I		P	E		
Canyon Streams Trib. To Coastal Streams of Palos Verdes	405.12	P	I		I	I		I		E	E		
Port Vicente Beach	405.11			E	E	E	E		E	E		P	E
Royal Palms Beach	405.11			E	E	E	E		E	E		P	E
Whites Point County Beach	405.11			E	E	E	E		E	E		P	E

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial use

Evidence of Impairments

Elevated concentrations of contaminants such as PCBs, DDT, and heavy metals including: lead, copper, chromium, nickel, silver, zinc and mercury were found in the Bay sediments in this region. Highly contaminated discharges through the JWPCP's White Point outfall prior to the 1980s left a contamination zone of several square miles with approximately 100 tons of DDT deposition (CRWQCB, 1997).

The accumulation and biomagnification of such contaminants have been observed in various. species of fish and shellfish. According to a comprehensive seafood contamination study and risk assessment conducted by the State Office of Environmental Health Hazard Assessment (OEHHA) and SMBRP, elevated concentrations of several contaminants (including PCBs and DDTs) in fishes was found, especially from this region. White croaker was found to be the most contaminated fish from this area as well as in other areas of the Bay. Other species found to be relatively contaminated are California corbina, queenfish, surfperches and California scorpionfish (CRWQCB, 1997).

Land slides in the area have destroyed some coastal habitats. Population declines of some bird species and certain species of shellfish such as black abalone have also been observed in this region (CRWQCB, 1997).

Pollutants of Concern

The main pollutants of concern in this subwatershed are total suspended solid (TSS) and nutrients. Historical deposits of PCBs and DDT on the Palos Verdes Shelf continue to be of concern because the risk that it poses to marine organisms and individuals who consume seafood from this area (CRWQCB, 1997).

Sources and Loading

TSS originate primarily from the erosion of hillsides. Nutrients originate from application of fertilizers. Some horse properties may also be sources of excessive nutrient inputs in this region. Historic deposits are the primary sources of DDT, PCBs, and heavy metals in sediments offshore of the Peninsula (CRWQCB, 1997).

Water Quality Improvement Strategies

Nonpoint source best management practices (BMPs) should be implemented to reduce the nutrients and TSS inputs to the Bay from this subwatershed. Restoration and protection of intertidal habitats and protection of endangered species (either from over harvesting or water pollution) should continue to be water quality improvement priorities (CRWQCB, 1997).

In 2009, USEPA released a feasibility study which describes the development, evaluation, and comparison of remedial action alternatives to manage the contaminated sediment at the Palos Verdes Shelf site. The report also presents potential remediation goals for the protection of human and ecological health and presents remedial alternatives including dredging and capping of various amounts of contaminated sediment. USEPA announced their preferred alternative for remediating the Palos Verdes Shelf Superfund site in June 2009. The alternative is an interim remedy that proposes institutional controls, monitored natural recovery and a containment cap. Construction is expected to take three years and cost an estimated $36,000,000 (USEPA and CH2M Hill, 2009).

Implement TMDLs

The TMDLs in effect which impact the Palos Verdes Peninsula are the dry- and wet-weather bacteria TMDLs for Santa Monica Bay beaches and the Santa Monica Bay nearshore and offshore debris TMDL. Whites Point, Point Vicente, and Royal Palms Beaches are listed as impaired for indicator bacteria. For the purpose of implementing the bacteria TMDLs, the area has been divided up into “jurisdictional groups” (JG) – the Palos Verdes Peninsula falls into JG7. Compliance measures include a number of activities that in combination would result in reducing the number of days in which water quality objectives are exceeded to less than or equal to that of the reference watershed (CRWQCB website #3).

The wet-weather bacteria TMDL stipulates a threshold number of exceedance days based on daily monitoring activities. The number of allowed exceedance days varies somewhat among the beaches but is no more than seventeen. The TMDL features a reference system/anti-degradation approach. The purpose of utilizing this approach is to ensure that bacteriological water quality is at least as good as that of a reference site and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of a reference site (CRWQCB website #3).

The dry-weather bacteria TMDL also stipulates compliance targets. The general implementation schedule includes two phases:

Phase I: Compliance during Summer Dry Weather. Within three years of the effective date of the TMDL, there may be no exceedances at any location during summer dry weather (April 1 to October 31).

This compliance target may be achieved by employing a number of strategies, including diverting storm drain flows to treatment plants, eliminating illicit discharges, controlling sources of bacteria, or implementing "end-of-pipe" treatment. The County of Los Angeles, City of Los Angeles and several other cities adjacent to Santa Monica Bay have been implementing aggressive summer, dry-weather storm drain diversion programs. All 27 priority storm drains have been diverted; additional diversions have been completed and others are planned (CRWQCB website #3).

Phase II: Compliance during Winter Dry Weather. Within six years of the effective date of this TMDL, compliance with the allowable number of exceedance days (varies by beach) during winter dry weather must be achieved (CRWQCB website #3).

A Coordinated Shoreline Monitoring Plan was developed by a Technical Steering Committee, co-chaired by the County and City of Los Angeles and consisting of representatives from many of the TMDLs' responsible agencies. In addition, other area stakeholders provided input. The plan is designed to comply with the monitoring requirements of both the dry- and wet-weather bacteria TMDLs (CRWQCB website #3).

The Santa Monica Bay Nearshore and Offshore Debris TMDL was adopted by the Regional Board in 2010 and requires that industries that manufacture, store, transport, or otherwise handle plastic pellets as raw material comply with a waste load allocation (WLA) of zero plastic pellets. The zero WLA for the plastic pellets requires that no plastic pellets are allowed to be released, found, or accumulated outside of the premises of the industries or in any stormwater capture device that may be connected with the MS4. Various tasks are required to be completed within a certain time period after the effective date of the TMDL. Key tasks range from achieving 20% reduction of trash from the baseline WLA within four years from the effective date of the TMDL to achieving 100% reduction of trash from the baseline WLA within eight years of the effective date of the TMDL.

Implementation plans and other information for these TMDLs are available on the Regional Board website as follows:

Santa Monica Bay Beaches Dry Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_9_2002-004_td.shtml

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/2002-004/2002-004_RB_BPA.pdf

Santa Monica Bay Beaches Wet Weather

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_14_2002-022_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_39_2006-005_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_40_2006-006_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_41_2006-007_td.shtml

http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_42_2006-008_td.shtml

Santa Monica Bay Nearshore and Offshore Debris

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_RSL.pdf

http://63.199.216.6/larwqcb_new/bpa/docs/R10-010/R10-010_RB_BPA.pdf

Low Flow Diversions/Treatment Facilities

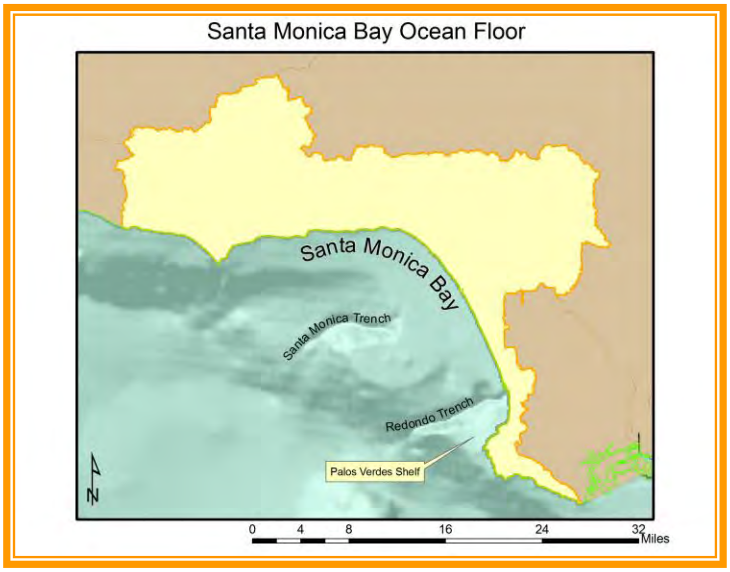
An increasingly utilized approach to eliminating bacteria from storm drains at its source is the installation of low flow diversions or treatment facilities. A low flow diversion is a structural device that routes urban runoff from canyons, streets and small watersheds away from the storm drain system or waterway, and redirects it into the sanitary sewer system or to a local treatment facility, where the contaminated runoff then receives treatment and filtration before being discharged into the ocean (City of LA website #2). Low flow diversions found within the Palos Verdes area are show in the table below.

Table 19. Low flow diversions within the Palos Verdes area

Low Flow Diversion	Year Operational	Agency
I Street	2006	District
Alta Vista Park	2010	Redondo Beach

Pacific Ocean

This section provides characterization of the nearshore and offshore regions of Santa Monica Bay (from the low-tide line to the outer boundary of the Bay). The areas surrounding the two POTW outfalls are highlighted in this section because more information is available and/or more impacts have been observed (CRWQCB, 1997).



Santa Monica Bay is the submerged portion of the Los Angeles Basin. The sea floor of the Bay is primarily soft bottom which consists of fine to moderately coarse sediments. Far less in acreage than soft bottom, hard bottom areas are generally restricted to the subtidal regions at 20 to 70 feet west of Malibu and around the Palos Verdes Peninsula. There is only one naturally occurring deep rocky area. Called Short Bank, it is located approximately six miles offshore of Ballona Creek, between Santa Monica and Redondo Submarine Canyons (CRWQCB, 1997).

The two largest POTWs in the region have for years discharged treated municipal wastewater directly into the Bay through their ocean outfalls. Over the last 50 years, the City of Los Angeles' Hyperion Treatment Plant has constructed and used three offshore pipes into Santa Monica Bay. A 1-mile offshore pipe was used between 1950 and 1960s at a water depth of 50 ft. to discharge approximately 190 mgd of chlorinated secondary effluent. This pipe is still used occasionally to divert overflows from a 5-mile offshore pipe. The 5-mile offshore pipe has been in full service since 1960 discharging, at a water depth of 190 ft, primary-treated effluent in the early years, and secondary-treated effluent at the present time. Finally, a 7-mile long sludge pipe was constructed to discharge at the head of Santa Monica Canyon to a depth of 320 ft. The pipe became operational in 1957 but use was discontinued in 1987. Since that time all sludge has been either transported to a landfill or used to produce a claylike product (CRWQCB, 1997).

The Los Angeles County Sanitation Districts' Joint Water Pollution Control Plant (JWPCP) began ocean disposal of wastewater onto the Palos Verdes Shelf in 1937 through a 5-ft diameter pipe; a 6-ft. diameter pipe was added in 1947. These outfalls discharged at water depths of 110 and 160 ft., respectively. Today these two pipes are only used as standbys for hydraulic relief during heavy rains. The current outfalls are a 7.5 ft. diameter pipe completed in 1956 that ends in a Y-shaped multiport diffuser, and a 10 ft. diameter pipe added in 1966 with a dog-legged, multi-port diffuser. Both are discharging secondary-treated effluent 1.9 mile offshore at 200 ft. depth (CRWQCB, 1997).

In addition to the two ocean POTW outfalls, the Chevron El Segundo Refinery has an outfall pipe 3;500 ft. offshore which discharges primary and secondary-treated wastewater. The pipe was extended from a 300 ft. pipe in 1994 (CRWQCB, 1997).

Chevron also maintains, a two-berth offshore tanker mooring facility in 42 to 66 feet of water. This facility transports crude oil and refined products to tankers at a frequency of approximately 20 tankers per month. Except for this tanker movement, most commercial and naval shipping activities occur outside Santa Monica Bay, in the shipping lanes offshore, and in nearby Los Angeles and Long Beach Harbors (CRWQCB, 1997).

Three power generating stations (the City of Los Angeles Department of Water and Power's Scattergood Plant, El Segundo Power's El Segundo Plant, and AES' Redondo Beach Plant) use seawater from Santa Monica Bay to cool steam condensers. Cool seawater is pumped into the station, circulated through noncontact heat exchangers, and discharged at temperatures above the intake temperature. In addition to elevated temperatures, the once-through cooling water may include treated wastewater which is determined to be non-hazardous as defined. by state and federal regulations. Chlorine is also injected periodically to control biological growth (CRWQCB, 1997).

Although oil and gas reserves are believed to occur on the Santa Monica Bay shelf, oil and gas development in or near Santa Monica Bay has been limited However, two natural. oil seeps are known in Santa Monica Bay. One, with three seepage zones, is located about 2 3 miles off Redondo Beach, near the head of the Redondo Submarine Canyon; the other has two seepage zones and is located about 4 6 miles off Manhattan Beach. The daily flow (to the surface) is estimated to range from 64 to 756 gallons per day, but maybe several times this amount during and after local earthquakes (CRWQCB, 1997).

At present, there is one permitted dump site (LA2) near, but outside of, Santa Monica Bay. The material disposed of at this site originates from maintenance and construction dredging in Los Angeles and Long Beach Harbors; material deposited here must be very clean.

Beneficial Uses

Twelve beneficial uses are identified for nearshore and offshore areas of Santa Monica Bay, including industrial and navigational uses, recreational uses, and biological/ecological uses (CRWQCB, 1994).

Table 20. Beneficial uses of the nearshore and offshore areas of the Santa Monica Bay

Coastal Feature or Waterbody	IND	NAV	REC1	REC2	COM M	MAR	WIL D	BIO L	RARE	MIG R	SPWN	SHELL
Nearshore Zone	E	E	E	E	E	E	E	E	E	E	E	E
Offshore Zone	E	E	E	E	E	E	E		E	E	E	E

E: Existing beneficial use; **P:** Potential beneficial use; **I:** Intermittent beneficial us

The Bay provides a variety of habitats for a great diversity of plant and animal species at least 5,000 at last count. Soft bottom, the dominant benthic habitat in Santa Monica Bay, has few attached plants as residents but has an abundant and diverse invertebrate population. Kelp beds, located in hard bottom areas in the subtidal regions west of Malibu and around the Palos Verdes Peninsula, provide cover and protection and thus habitat for more than 800 species of fishes and invertebrates, some of which are uniquely adapted for life in the beds. Consequently, kelp beds are important for sport fishing, commercial harvesting of abalone and sea urchins, and recreational diving. Short Bank, the only naturally occurring deep rocky area, thrives with populations of several rockfish species and unique invertebrates (CRWQCB, 1997).

The pelagic, or open-ocean habitat is the primary home to fish such as Pacific sardine, northern anchovy, Pacific mackerel, and Pacific bonito; as well as marine mammals such as seals and sea lions. Many species of whales and dolphins are also observed in Bay waters; passing through the Bay during the winter/spring migration. The pelagic habitat (microlayer) is also home to the eggs and larvae of many invertebrates. One of the unique habitats is the shallow nearshore protected areas of the Bay (e.g., Malibu Lagoon, Marina del Rey Harbor), which serve as important nurseries for local marine fishes such as California halibut and white seabass). Finally, the pelagic habitat is utilized for foraging by several endangered bird species such as California brown pelican and California least tem (CRWQCB, 1997).

Tankers travel in and out of the Bay to transport oil at Chevron's mooring facility. Otherwise, no major shipping lanes cross into the Bay. Commercial fishing has been prohibited in about 62% of the Bay proper to protect local fish populations. Since December 1993, commercial fishing using gill and trammel nets are banned within three nautical miles of the mainland (CRWQCB, 1997).

Evidence of Impairments

The marine habitats of Santa Monica Bay have historically experienced severe impacts from human activities. The most obvious impacts are changes observed in benthic habitats as a result of POTW ocean discharges. Overfishing has been linked to depletion and/or decline of many marine species. Finally, natural phenomena such as El Nino have also played an important role in downturn and upturn of habitat conditions in the Bay (CRWQCB, 1997).

Over the years, discharge of biosolids from the Hyperion Treatment Plant and the JWPCP created a large sludge field around outfalls. These sludge fields, especially those formed before the 1980s, contain high concentrations of toxic chemicals. Between 1950 and 1970s, large amounts of DDT and PCBs from local chemical manufacturers and other industrial facilities were dumped into the ocean through the POTW outfalls. What remains today is a heavily contaminated zone of approximately 320 acres on the Palos Verdes Shelf near the JWPCP outfall where the median total DDT concentration exceeds 2 ppm and median total PCBs concentration exceeds 200 ppb. Besides DDT and PCBs, there has been little evidence that the concentrations of toxic organic, compounds such as PAHs, and heavy metals (including cadmium, copper, chromium, nickel, silver, zinc, and lead) are at levels, deemed harmful to marine organisms. However, the concentrations of these metals are significantly higher than the background levels in most parts of Santa Monica Bay. They are also relatively higher than the rest of the Southern California Bight (CRWQCB, 1997; USEPA and CH2M Hill, 2009).

DDT in white croaker, Dover sole, and brown pelicans are well-known examples of the damage caused by sediment contamination. High concentrations of DDT were found in muscle tissues of these organisms. In the 1970s, biomagnifcation of DDT in these organisms resulted in fin erosion and other diseases in fish, and eggshell thinning and a subsequent decline in the population of California brown pelicans. Although fish tissue concentrations of DDT have declined since the 1970s, consumption of fish from the shelf area remains a problem (CRWQCB, 1997). The State of California Office of Environmental Health Hazard Assessment (OEHHA) website at http://www.oehha.ca.gov/fish/so_cal/socal061709.html provides updated information from June 2009 regarding a health advisory and safe eating guidelines for marine fish caught along the southern California coastline from Ventura Harbor to San Mateo Point (OEHHA website).

In addition to the risks posed to human and animals by contaminated sediment, the health of benthic community has been affected by discharge of solids from wastewater treatment plants. Assemblages of benthic fauna in sludge fields near the outfalls had relatively lower diversity compared with other areas in the Bay and were dominated by several opportunistic species. There has been substantial improvement of the benthic community from the conditions of the mid-1980s in the vicinity of the Hyperion 5-mile outfall since the elimination of solids discharge through this outfall (CRWQCB, 1997).

Pollutants of Concern

The pollutants of concern identified for the ocean area of Santa Monica Bay include TSS, DDT, PCBs, heavy metals (Pb, Cu, Zn, Ni, Cd, Cr, and Ag), PAHs, and trash and debris (marine debris). Although not identified as a pollutant of concern in this area, pathogens should continue to be monitored in popular nearshore recreational areas (CRWQCB, 1997).

Sources and Loadings

The region's two largest POTWs used to contribute significant mass loadings of TSS to areas adjacent to their outfalls. However, the annual mass emissions of TSS have decreased steadily, from 160,000 metric tons (combined) in the early 1980s to approximately 43,000 metric tons in 1994, due to advances in treatment technologies and land disposal of solids (CRWQCB, 1997).

The mass load of TSS estimated for storm water in 1994 was 54,000 metric tons. However, it is unknown to what extent the mass load in storm water should be considered a natural phenomenon (CRWQCB, 1997).

Since DDT and PCBs were banned in early 1970s, sediment resuspension of historical deposition has been and will continue to be the major loading source for these toxic chemicals, especially on and near the toxic "hot spot" on the Palos Verdes Shelf though the exact amount of DDT and PCB loading through resuspension and other process is not well understood. Concentrations of DDT and PCBs in surface sediments on the PV Shelf has shown a decrease as the heavily contaminated layer, produced principally in the 1950s to early 1970s, as these sediments have gradually been covered by less contaminated effluent and natural sediment. However, the concentrations of DDTs and PCBs in the surface sediments have remained relatively high since late 1980s in the area of the JWPCP outfall. This suggests that a portion of the "historical" DDT (largely as the metabolite p,p'-DDE) as well as PCBs are being brought to the sea floor surface by a combination of natural physical, chemical or biological processes that operate within or on the sediment. In 1992, the maximum concentration of buried DDTs exceeded 300 ppm near the outfall pipes while maximum buried PCBs exceeded 20 ppm. Sampling conducted in 2001 revealed the maximum concentration of buried DDE exceeded 200 ppm near the outfall pipes with similar maximum surface concentrations. Combined data from 1992 – 2004 showed surface concentrations of DDTs in the area of the outfalls up to 155 ppm while 1992 data showed PCBs up to 2 ppm in surface sediments. The subareas with surface concentration of DDTs greater than 1 ppm covered 11,000 acres in 1992 while during 2002/2004 they covered 9,660 acres, a decrease of 12%. Subareas with surface concentrations of DDTs greater than 10 ppm decreased 56% during the same time period, from 2,000 acres to 8,900 acres. The subareas with surface concentrations of PCBs greater than 0.3 ppm decreased 49% between 1992 and 2002/2004, going from 5,560 acres to 3,385 acres. Subareas with surface concentrations of PCBs greater than 1 ppm decreased 26% during the same time period, from 2,075 acres to 1,532 acres. The mass of DDT in surface sediments remaining in the most heavily contaminated subarea is estimated to be approximately 5,000 lbs; the PCBs mass in this are is estimated to be 188 lbs (CRWQCB, 1997; USEPA and CH2M Hill, 2009).

Current loading of DDT and PCBs from effluents of POTWs and storm water is considered minimal (below detection limits most of the time). Atmospheric deposition and advection (from LA Harbor which receives runoff from the Dominguez Channel drainage area, where many DDT-contaminated land sites are located) are considered potential sources of DDTs (CRWQCB, 1997).

As for TSS, the two POTWs used to be the largest source of loading for the six heavy metals of concern. However, mass emissions of most metal constituents have decreased in recent years due to better source control and an upgrading of treatment levels at the two POTWs (CRWQCB, 1997). As a result, stormwater runoff of trace metals from urban watersheds now produce a similar range of annual loads as those from point sources such as the large POTWs. However, when combined with dry estimates of pollutant loading, the total nonpoint source contribution from all watersheds in the greater Los Angeles area far exceeds that of the point sources (Stein, et al., 2007). In general, sediment concentrations of lead, copper, zinc, and cadmium are higher in areas influenced by POTW effluent, primarily due to historical discharges. There is also evidence of enrichment of these metals in nearshore areas impacted by storm water runoff. If the current trend in metal loading continues, the distribution of metal concentration in sediments may be different in the future (CRWQCB, 1997).

Sources of PAH loadings are more diverse. POTWs are a significant (but probably not the largest) source of PAHs to the Bay. A larger portion of PAHs likely originates from nonpoint sources such as storm water runoff and atmospheric deposition. A portion of loadings measured in storm water runoff may originate from indirect atmospheric deposition as well. PAHs are also an important component of oil and grease (CRWQCB, 1997).

Sources of marine debris include storm water runoff, beach litter, boating activities, illegal dumping, and occasionally, discharge from POTWs. Besides fragmentary information collected on beach litter and trash and debris carried by storm runoff, very little is known about the current loading and deposition of trash and debris in Santa Monica Bay (CRWQCB, 1997).

Water Quality Improvement Strategies

Progressive water quality improvement efforts over the last two decades have brought many significant improvements. There are many signs that the Bay has been recovering and no longer deserves its reputation as one of the most contaminated ocean areas in the nation. However, two of the major challenges remaining are how to continue the trend of pollutant loading reductions as projected population growth occurs in the region, and how to effectively remediate the historical deposition of DDT and PCBs in the Bay's sediment (CRWQCB, 1997).

With information provided by long-term, extensive compliance monitoring conducted by POTWs and industrial dischargers, the general environmental conditions of the Bay are relatively well-understood. However, the information is still limited; far more data have been gathered from soft and hard bottom benthic habitats where the POTW and industrial discharge outfalls are located, while much less is known about the conditions of habitats (primarily hard bottom and rocky intertidal) in other areas of the Bay where no direct discharges occur. On the other hand, mass loadings of pollutants from sources other than POTWs and direct industrial dischargers cannot be reliably made due to lack of monitoring data (CRWQCB, 1997).

Aimed at solving the identified problems, marine water quality improvement efforts should focus on the following areas:

- Continue to prevent and reduce mass loading of pollutants that accumulate in the Bay's sediments through completion of the treatment upgrades at POTWs and implementation of storm water runoff BMPs;
- Implement a mass emissions policy for pollutants of concern that accumulate in marine environment and integrate the approach into NPDES permits;
- Implement the identified preferred alternative for remediation of historic DDT/PCBs deposits in the Palos Verdes shelf's sediments; and
- Develop TMDLs for impairments
- Implement the Comprehensive Bight-wide monitoring program developed in 2007.

  The monitoring program is was developed to collect information on the relative loading, distribution, and impacts of pollutants of concern, which are crucial for determining the best pollutant management approach. Generally, the program focuses on ecosystem resources rather than on anthropogenic inputs and impacts and seeks to put together a picture of the overall conditions in the Bay. It lays out new monitoring designs for five major habitat types within the Bay. Each includes a core motivating question, a number of related objectives, specific monitoring approaches, indicators, and data products, and sampling designs detailing number and locations of stations, sampling frequency, and measurements to be collected. The program incorporates key monitoring efforts that extend from the outer Bay to the high tide line along the shore and is intended to complement other efforts, such as TMDLs, that link land and marine environments. Five major habitat (or ecosystem) types are covered in the Comprehensive Monitoring Program:

- Pelagic Ecosystem
- Soft Bottom Ecosystem
- Hard Bottom Ecosystem
- Rocky and Sandy Intertidal
- Wetlands (SMBRC website)

Watershed Restoration Plans in the WMA

Some items in this section may also function as assessment and improvement strategies which are discussed in the next section. Some of the more planning-oriented documents below eventually led to improvement strategies or set the stage for active implementation work. The emphasis is on plans which contain either a large water quality improvement/restoration component or some other actions which indirectly lead to water quality improvement; the list is not meant to be an exhaustive documentation of all planning documents.

- Santa Monica Mountains Comprehensive Planning Commission, 1979. Santa Monica Mountains Comprehensive Plan.

  The natural resource value of the Santa Monica Mountains was recognized as early as the 1930s. By 1972, the Ventura-Los Angeles Mountains and Coastal Study Commission recommended establishing a continuing planning and permit-issuing agency to assure environmentally sound use. Four years later, the Legislature passed AB 163 that would, in part, carry out that recommendation. The bill created the Santa Monica Mountains Comprehensive Planning Commission and empowered it to prepare "a comprehensive and specific plan which is capable of implementation, for the conservation and development of (the mountains) consistent with the preservation of the resource."

  The Preliminary Comprehensive Plan, consisting of the land use, conservation, recreation, transportation, scenic parkways and corridors, and public services and facilities elements, was adopted in July 1978. Following final adoption of the policy and economic elements of the plan, the Commission identified alternative implementation strategies and potential responsible implementation agencies in February 1979.

  In 1978, Congress created the Santa Monica Mountains National Recreation Area, in part implementing policies recommended in the Commission's Preliminary Report. The National Parks and Recreation Act of 1978 authorized the appropriation of $125 million for National Park Service land acquisition within the National Recreation Area, $500,000 for National Park Service park development, and $30 million in grants to the State of California for specific uses in the Santa Monica Mountains Zone. Furthermore, Congress recognized the Santa Monica Mountains Comprehensive Planning Commission as the planning entity for the Santa Monica Mountains Zone and required that the Commission identify agencies responsible for implementing the Comprehensive Plan.

  The Santa Monica Mountains Conservancy Act was enacted in 1979 by AB 1312 based on the recommendations of the Santa Monica Mountains Comprehensive Planning Commission. The Santa Monica Mountains Conservancy was established by the California State Legislature in 1980. For more information, see the Santa Monica Mountains Conservancy webpage http://www.smmc.ca.gov.

- Santa Monica Bay Restoration Project, 1995. The Bay Restoration Plan.
  http://santamonicabay.org/smbay/AboutUs/TheBayRestorationPlan/tabid/55/Default.aspx

The Bay Restoration Plan outlined actions to promote pollution prevention and source reduction, integrate pollution management, more effectively manage of storm water and urban runoff, cleanup contaminated sediments, address oil and hazardous materials spills, improve information about risks associated with seafood consumption and swimming in the Bay, and continue improvement of municipal wastewater discharges.

- Las Virgenes/Malibu/Conejo Council of Governments. 2001. Watershed Management Area Plan for the Malibu Creek Watershed. Prepared by PCR Services Corporation and WaterCycle LLC

  The goals of the Watershed Management Area Plan (WMAP) report are to establish a framework for sustainable watershed management and to recommend further actions to be carried out, in order to:

  - Identify and manage processes contributing to water quality degradation and water quantity problems;
  - Identify protection, conservation, enhancement, restoration, and retrofit opportunities that support biodiversity and improve water quality;
  - Develop long-term programs for evaluating natural resources, water quantity issues and water quality data collection and analysis; and
  - Restore natural processes with respect to the hydrological cycle, which can result in better overall water quality.

- Owens, Bradley. 2001. A Protection Revitalization Plan for Las Virgenes Creek. California State Polytechnic University, Pomona Graduate Program in Landscape Architecture.

  The purpose of this report was to provide a document with which to manage Las Virgenes Creek watershed with regard to biodiversity and human use, provide a tool on which to base grant requests for related projects, expand the existing educational base, and to provide a model from which to draw from in other similar geographic areas. It provided specific recommendations to improve water quality, increase habitat connectivity, and provide educational opportunities. A copy can be obtained at http://www.owenswatershedplanning.com/LV/.

- City of Calabasas, 2003. Las Virgenes, McCoy, and Dry Canyon Creeks Master Plan for Restoration, Phase I: Comprehensive Study. Prepared by EDAW, Inc.

  The overall objectives of the Clean Water Act 205(j) grant study were to: establish baseline environmental conditions; evaluate historical changes in the watershed; define opportunities and constraints for improving water quality (related both to Total Maximum Daily Loads and aquatic habitat); assess opportunities and constraints to restore creek and riparian habitat; and identify recreational and educational facilities and opportunities. The Phase I report can be downloaded at http://www.cityofcalabasas.com/environmental/water-resources.html

- Los Angeles County Department of Public Works, Watershed Management Division, 2004. Ballona Creek Watershed Management Master Plan. Prepared by EIP Associates.

  The Los Angeles County Department of Public Works was awarded a Proposition 13 Watershed Protection Grant by the State Water Resources Control Board to prepare a watershed plan for Ballona

Creek. The Ballona Creek Watershed Task Force met for about a year during Plan development and the final Plan was released in 2004.

http://www.ladpw.org/wmd/watershed/bc/bcmp/masterplan.cfm

- Santa Monica Bay Restoration Commission, 2004. State of the Bay. http://santamonicabay.org/smbay/Library/DocumentsReports/tabid/97/Default.aspx

  The 2004 State of the Bay report described the environmental health of the Bay and measured progress towards achieving the goals of the Bay Restoration Plan which outlines 74 priority actions that address critical environmental problems facing the Bay.

- City Of Calabasas, 2005. Las Virgenes, McCoy, and Dry Canyon Creeks Master Plan for Restoration, Phase II: Feasibility Study. Prepared by Willdan.

  In 2005 the City of Calabasas wanted to complete the next step toward implementing the projects identified in the Phase I study and investigate the cost and feasibility of implementing the projects. The Phase II study provides this information. It can be downloaded at http://www.cityofcalabasas.com/environmental/water-resources.html.

- California State Coastal Conservancy and California Department of Parks and Recreation, 2005. Malibu Lagoon Restoration and Enhancement Plan. Prepared by Moffatt & Nichol and Heal the Bay.

  The Malibu Lagoon Restoration and Enhancement Plan presents detailed information to implement and monitor the preferred restoration alternative, the Modified Restore and Enhance Alternative (Alternative 1.5), as specified in the Malibu Lagoon Feasibility Study Final Alternatives Analysis. Implementation details are provided in the form of plans for water management, habitat management, access, and monitoring to facilitate implementation of the monitoring program and subsequent environmental review and permitting. Alternative 1.5 includes relocating the existing parking lot to the northwest while installing BMPs to minimize or eliminate runoff, leaving the main channel essentially untouched, deepening and recontouring the channel on the east side In order to create a new avian island, and changing the layout of the west lagoon system of channels. The Plan may be downloaded at http://www.healthebay.org/assets/pdfdocs/mlhep/issues_mlhep_finalplan.pdf.

- Los Angeles County Department of Public Works, 2007. North Santa Monica Bay Watersheds Regional Watershed Implementation Plan, 3rd Draft. Prepared by CDM.

  There are three water quality regulations of concern in the mostly rural North Santa Monica Bay Watersheds area – NPDES permits, particularly the ones for municipal separate storm sewer systems (MS4); TMDLs; and AB 885 which will regulate on-site wastewater systems (septic systems). To address these regulations, municipalities and agencies within the NSMBW are developing a Regional Watershed Implementation Plan (RWIP). The goal of the NSMBW RWIP is to address watershed management principles through strategic implementation of best management practices (BMPs) to obtain optimal regional benefits in a cost-efficient manner.

The objectives of the RWIP are:

- To improve and maintain water quality within the NSMBW consistent with MS4 NPDES permits, TMDLs, and AB 885 regulations;
- To recommend a plan of action to address compliance with the MS4 NPDES permits, TMDLs, and AB 885 regulations;
- To compile and link all relevant existing plans and documents in the North Santa Monica Bay and address any information gaps among these documents;
- To integrate all existing and future TMDLs in the NSMBW into the RWIP; and
- To be a living document that is updated as the RWIP is implemented and as requirements in the NPDES permits, TMDL requirements, and AB 885 evolve.

- Santa Monica Bay Restoration Commission, 2008. Bay Restoration Plan 2008 Update. http://santamonicabay.org/smbay/AboutUs/TheBayRestorationPlan/tabid/55/Default.aspx

  The 2008 Update of the Bay Restoration Plan noted that significant progress had been made in improving water quality in the WMA. Major milestones accomplished included the upgrade to full secondary treatment of the two largest wastewater treatment facilities in the region; the development and implementation of TMDLs for waterbodies impaired by poor water quality; and adoption and implementation of the standard urban storm water mitigation plan under the municipal storm water permit. The report also noted that despite this progress, significant amounts of pollutants such as trash, pathogens, and heavy metals continue to reach receiving waters. New challenges include addressing the loading and impacts of nutrients and emerging contaminants.

- Santa Monica Bay Restoration Commission, 2009 draft. A Ballona Greenway Plan.

  The Greenway Plan was initiated by the Ballona Watershed Task Force and preliminary design work has been done. The outcome of this project will be final designs for portions of the Greenway including landscape guidelines for a Ballona-specific plant palette. This project has proceeded in close consultation with the MRCA and Baldwin Hills Conservancy on their pocket park and bike path beautification plans. The final plan will be a vision of how needs for flood management, water quality improvements, habitat, and recreational access might be accomplished. http://www.santamonicabay.org/smbay/Library/DocumentsReports/tabid/97/grm2id/405/Default.aspx

- Santa Monica Bay Restoration Commission, 2010. State of the Bay Report.

  The 2010 State of the Bay Report observed that the pollutants of greatest concern, due to their adverse or potentially adverse impacts on the Bay's beneficial uses, are pathogens, trash, metals, DDT, PCBs, and nutrients. Known impacts of these pollutants include health hazards for humans due to pathogens in the surf zone, aesthetic impacts of trash along the Bay's beaches and streams, and chemical contamination of local fish. The report described the reduction of pollutant loads from wastewater treatment facilities with the greater relative contribution of pollutants through the storm drain system with, in particular, trash, pathogens, metals, and nutrients washing off the urban landscape, into storm drains, and out to the Bay. In addition, historical deposits of toxic pollutants in

Bay sediments, such as DDT and PCBs, continue to be released into the environment through biological processes and resuspension, thus contaminating local marine life. Atmospheric deposition, boating activities, and septic systems are also known to contribute to contaminants to the Bay.

The development and adoption of TMDLs by the Regional Board which serve to assign load reductions needed to prevent impairment of beneficial uses, and their implementation largely through new control measures incorporated into existing NPDES permits was acknowledged. With regards to bacteria for example, the effort began with multiple low-flow diversions to the sanitary sewer at those drains with the most indicator bacteria exceedances. In some cases, year-round diversions have been necessary or installation of disinfection systems.

Impacts from invasive species is a growing concern in this WMA. The invasive plant, giant reed, and the invasive animals, crayfish and New Zealand mudsnails, in particular, are displacing native biota and degrading habitat. The report can be downloaded at http://santamonicabay.org/smbay/NewsEvents/StateoftheBay/StateoftheBayReport/tabid/176/Default.aspx.

Summaries of Key Assessment and Improvement Strategies Affecting Water Quality Issues and Beneficial Uses

Much has happened in the Region since the first edition report was produced. While the precursor of today's Santa Monica Bay Restoration Commission (the Santa Monica Bay Restoration Project) led much of the active restoration work in the WMA then, today a multitude of efforts are underway – some specific to the WMA (or subwatersheds) and some that affect the entire State. More information on these activities are presented elsewhere in the subwatershed sections as relevant; however, below is a listing of major efforts underway that may span several subwatersheds along with the lead agencies/partners. Virtually all of these efforts have engaged multiple stakeholders active on multiple fronts. Additionally, many of the projects/studies described below overlap or coordinate at some level with each other. Also, they may be part of watershed restoration strategies described in the previous section. For instance, a number of fairly watershed-specific activities are underway in the Ballona Creek Watershed including wetlands restoration, watershed plan implementation, and ecosystem restoration. But all of these watershed-specific activities occur within a larger regional context such as the Santa Monica Bay Restoration Commission's area of influence which is itself embedded within the Los Angeles Regional Water Quality Control Board's area which in turn is part of the area being addressed through the Southern California Wetlands Recovery Project. Along the way, there's a mix of jurisdictions (federal/state/local), a mix of regulatory authority (from no regulatory mechanisms in place to those mandated by regulation), and a mix of focus on land versus ocean.

Wetlands Recovery Project – multiple partners

The Southern California Wetlands Recovery Project (WRP) was formed in 1998 to develop and implement a regional strategy to increase the pace and effectiveness of wetlands recovery in the region. It is a partnership of public agencies working cooperatively to acquire, restore, and enhance coastal wetlands and watersheds between Point Conception and the International border with Mexico. Using a non-regulatory approach and an ecosystem perspective, the WRP works to identify wetland acquisition and restoration priorities, prepare plans for these priority sites, pool funds to undertake these projects, implement priority plans, and oversee post-project maintenance and monitoring.

The WRP Regional Strategy involves long-term goals and specific implementation strategies to guide the efforts of the WRP and its partners. The Regional Strategy was developed through a multi-year planning process involving all the WRP partners, including the Science Advisory Panel and County Task Forces, As such, the Strategy articulates a shared vision that each partner – at the federal, state, and local level – can turn to for guidance in how to manage staff effort, direct resources, and measure progress. Information on the WRP can be found at http://www.scwrp.org.

The WRP is headed by a Board of Governors (BOG) comprised of top officials from each of the participating agencies. The Wetlands Managers Group and the Public Advisory Committee serve as advisory groups to the Board. The Wetlands Managers Group consists of staff-level personnel from the participating agencies and is responsible for drafting the regional restoration plan and advising the Governing Board on regional acquisition, restoration, and enhancement priorities.

County Task Forces help solicit projects for consideration for WRP funding by the Managers Group and Board of Governors. The program provides funding for acquisition, restoration, and enhancement projects for coastal wetlands and watersheds in Southern California.

The WRP also has a Science Advisory Panel (SAP) and a wetlands ecologist who acts as liaison with the SAP. Recent activities have focused on coordination with a statewide effort to develop methods for rapid assessment of wetlands and development of a wetlands regional monitoring program. A paper on the habitat value of treatment wetlands has also been written and is available on the WRP's webpage at http://www.scwrp.org/documents/SAP/Treatment_wetlands/LitReviewWebCover.pdf. Additionally, the SAP developed the general framework for an Integrated Wetlands Regional Assessment Program (IWRAP) – a regional wetlands monitoring program - as well as detailed recommendations for estuarine and coastal lagoon monitoring.

Wetlands Mapping - multiple partners

Describing the extent and distribution of current-day wetlands, in the form of wetland and riparian inventories, is essential to long-term protection of wetland resources. The WRP, as well as other partners in coastal Northern and Central California, have embarked on detailed mapping of the State's coastal wetlands. These maps will serve as the foundation for the IWRAP within the WRP's area of influence. Work on these maps is expected to finish in 2010 and is being funded primarily through grant monies. More information, including downloads, can be found at the following website: http://www.socalwetlands.com/website/main.htm. In parallel with this work is a project which is digitizing coastal survey maps from the 1800s in order to document the extent and type of wetlands present in southern California before much of the major development took place in the area. In certain areas, such as Ballona, more intensive "historical ecology" work is underway and is expected to finish in 2010. In these areas, in addition to the digitized historic maps, other historical documents are researched to portray a more accurate and complete picture of an area's wetlands and events which affected them such as floods and droughts, as well as, narrative anecdotal information describing in the first person activities and events in the watershed. This historical information eventually will be available via a website for download.

Wetlands Policy – State

In April 2008, the State Water Resources Control Board (State Water Board) adopted Resolution No. 2008-0026. The resolution gave the Wetland Policy Development Team (staff from the State Water Board and the North Coast and San Francisco Bay Regional Water Quality Control Boards), specific directions on the process to follow as they developed a statewide policy to protect wetland and riparian areas (Policy). The Team's Charter states it will develop the Policy in three phases:

Phase 1 – establish a Policy to protect wetlands from dredge and fill activities. The Development Team is directed to develop and bring forward for State Water Board consideration: (a) a wetland definition that would reliably define the diverse array of California wetlands based on the U. S. Army Corps of Engineers' existing wetland delineation methods to the extent feasible, (b) a wetland regulatory mechanism based on the existing Federal Clean Water Act 404 (b)(1) guidelines that includes a watershed focus, and (c) an assessment method for collecting wetland data to monitor progress toward wetland protection and to evaluate program development.

Phase 2 – Amend the Policy to protect wetlands from all other activities potentially impacting water quality. The Development Team is directed to develop and bring forward for State Water Board consideration: (a) new and/or revised beneficial use definitions, (b) water quality objectives, and (c) a program of implementation to achieve the water quality objectives, as necessary, to protect wetland-related functions.

Phase 3 – Amend the Policy to protect surface waters from impacts that may result from riparian areas disturbances. The Development Team is directed to develop, and bring forward for State Water Board consideration: (a) new and/or revised beneficial use definitions, (b) water quality objectives, and (c) a program of implementation to achieve the water quality objectives, as necessary, to protect riparian area water quality related functions.

As of the date of this report, Phase 1 is underway and the Team has proposed a wetlands definition. More information may be found at http://www.waterboards.ca.gov/water_issues/programs/cwa401/wrapp.shtml.

Once-through Cooling Water Policy – State

A draft policy, entitled Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling has been developed by the State Water Resources Control Board and applies to the State's thermal power plants that currently withdraw water from the State's navigable waters using a single-pass system, also known as once-through cooling (OTC). Adoption of technology-based standards will address the adverse effects associated with cooling water withdrawals from the State's coastal and estuarine waters. The federal Clean Water Act addresses OTC's adverse impacts in Section 316(b), which mandates technology-based measures to minimize adverse environmental impacts from cooling water intake structures.

OTC can cause adverse impacts when aquatic organisms are trapped against a facility's intake screens (impinged) and cannot escape, or when they suffer injuries that increase mortality. Smaller organisms, such as larvae and eggs, can be drawn through a facility's entire cooling system (entrained) and subjected to rapid pressure changes, chemical treatment systems, and violent shearing forces, only to be discharged along with the now heated cooling water and other facility wastewaters. The State's active coastal power plants that use OTC maintain the capacity to withdraw more than 16 billion gallons of cooling water per day. Over the course of a year, billions of eggs and larvae are effectively removed from coastal waters, while millions of adult fish are lost due to impingement. These OTC systems, many of which have been in operation for 30 years or more, present a considerable and chronic stressor to the State's coastal aquatic ecosystems by reducing important fisheries and contributing to the overall degradation of the State's marine and estuarine environments.

The Policy adopts appropriate technology-based standards that will significantly reduce these adverse impacts and implements a statewide process by which this goal can be achieved without disrupting the critical needs of the State's electrical generation and transmission system. This approach further reduces the permitting burden on the Regional Water Boards by coordinating implementation at the state level.

More information concerning the Policy may be found at http://www.waterboards.ca.gov/water_issues/programs/npdes/cwa316.shtml.

Recycled Water Policy – State

The State Board's Recycled Water Policy was adopted on February 3, 2009, and became effective on May 14, 2009. The overarching goal of the policy is to increase the use of recycled water while protecting water quality. More specifically the Policy looks to:

- Increase the use of recycled water over 2002 levels by at least one million acre-feet per year (afy) by 2020 and by at least two million afy by 2030.
- Increase the use of stormwater over use in 2007 by at least 500,000 afy by 2020 and by at least one million afy by 2030.
- Increase the amount of water conserved in urban and industrial uses by comparison to 2007 by at least 20 percent by 2020.
- And, substitute as much recycled water for potable water as possible by 2030.

Additionally, it is the intent of the Policy that local water and wastewater entities, together with salt/nutrient contributing stakeholders, will fund locally driven and controlled collaborative processes open to all stakeholders to prepare salt/nutrient management plans for each groundwater basin/sub-basin in California. It is also the intent of the State Board that because stormwater is typically lower in nutrients and salts and can augment local water supplies, inclusion of a significant stormwater use and recharge component within the salt/nutrient management plans is critical to the long-term sustainable use of water in California. A copy of the policy may be downloaded at http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/recycledwaterpolicy_approved.pdf .

Proposed Regulations and Waiver For Onsite Wastewater Treatment Systems (OWTS) – State

The State Water Board proposes to adopt regulations and a statewide conditional waiver (waiver) that establish minimum requirements for the permitting, monitoring, and operation of OWTS, as required by AB 885. The waiver allows owners of OWTS to discharge wastewater without having to file a report of waste discharge (and obtain WDRs) with a Regional Water Board as long as the existing or new OWTS and its owner comply with the applicable minimum requirements set forth in the waiver. The regulations and waiver contain requirements that are substantially the same. On February 23, 2009, the State Board closed the public comment period for draft regulations regarding OWTS. During the comment period (Nov. 7, 2008 to Feb. 23, 2009), the State Board received more than 2,500 e-mail comments and hundreds of comment letters, and recorded many hours of oral comments from 12 public workshops held throughout the State. Board Staff will be recommending substantial changes based on all of the input from the public, will draft revised regulations based on the public comments received, will work with the agencies and groups identified in the enabling legislation (AB 885), and when a new set of draft regulations is written, will notice another public comment period so that all stakeholders have a chance to provide input. More information on the proposed regulations may be found at http://www.waterboards.ca.gov/water_issues/programs/septic_tanks/

Report on Discharges into State Water Quality Protection Areas - State

In the mid-1970's, thirty-four areas on the coast of California were designated as areas requiring protection by the State Water Resources Control Board, and were called Areas of Special Biological Significance (ASBS). As of January of 2003, these areas have been re-designated as State Water Quality Protection Areas (SWQPAs). The Public Resources Code states that point source waste and thermal discharges into SWQPAS are prohibited or limited by special conditions, and nonpoint sources discharging into SWQPAs must be controlled to the extent practicable.

Despite the designation of these areas for protection, little was known about the presence and types of discharges that occurred in these areas. The goal of the survey was to document the number and types of discharges into each of the thirty-four SWQPAs. Of relevance to this WMA is the Mugu Lagoon to Latigo Point SWQPA which runs along the northern end of the Santa Monica Bay coastline covering approximately 22.5 miles and is the largest of the SWQPAs adjacent to the mainland. The survey revealed 444 outlets and discharges, the most of all the SWQPAs. An outlet is defined as any naturally occurring water body that drains into or immediately adjacent to a SWQPA. This includes the following: perennial streams (or their estuaries), ephemeral streams, naturally occurring gullies in coastal bluffs and cliffs, and naturally occurring springs or seeps in wild areas (not associated with anthropogenic activities). Some of naturally occurring streams surveyed were modified with bridges, culverts or other road crossings, but the determination was made to still classify these as outlets and not discharges. It should be noted that many of the outlets, while naturally occurring, were known or suspected to be impacted from pollution sources upstream, and therefore may be contributors to pollution in the SWQPAs.

Storm water discharges that occupied what previously were natural drainage channels, but which are now heavily urbanized and modified to carry urban runoff, were not considered natural outlets and were instead labeled as "discharges"; 410 of the 444 total in the Mugu Lagoon to Latigo Point SWQPA were labeled as discharges rather than natural outlets. More information may be found at http://www.waterboards.ca.gov/water_issues/programs/ocean/asbs.shtml.

Santa Monica Mountains Steelhead Habitat Assessment Project, 2006 – multiple partners

Steelhead are migratory rainbow trout that are born in freshwater streams and spend a portion of their lives in the ocean before returning to freshwater to spawn. During the early 1900's steelhead were abundant in some coastal streams of the Santa Monica Mountains. Over the past century, human modification of riverine habitat greatly reduced steelhead populations in southern California and the National Marine Fisheries Service (NMFS) listed the southern steelhead Ecologically Significant Unit (ESU) as a federally endangered species in 1997. The NMFS estimates the southern steelhead population to be less than 1% of its historic population size (it has decreased from 50,000 prior to the 1950's to fewer than 500 today). The loss of freshwater habitat due to the construction of migration barriers such as road crossings, dams, and flood control structures presents the single greatest limiting factor for steelhead in the Santa Monica Mountains. Ultimately, NMFS seeks to recover the southern California steelhead population. The purpose of this 2006 assessment was to identify the best opportunities for restoring habitat to recover the Santa Monica Mountains population of steelhead. The project was funded by the SMBRC and the California Department of Fish and Game with in-kind services provided by multiple agencies and individuals.

There were two major goals of the assessment; one was identification and prioritization of the streams within the 23 watersheds of the Santa Monica Mountains that should be selected for steelhead restoration actions. Experts familiar with the region then selected thirteen focal watersheds based on hydrology, historic and current steelhead distribution, and best professional judgment. The second goal, within each focal watershed, was to recommend what specific actions could be implemented, where, and at what cost.

To evaluate the benefit of restoration actions, project objectives sought to determine:

- The amount of high quality steelhead habitat for spawning and rearing that currently exists;
- The amount of degraded steelhead habitat for spawning and rearing and the types of degradation; and
- The potential causes of degraded habitat quality.

In order for decision makers to achieve cost effective restoration projects, three prioritization analyses were developed. The results of applying these three evaluation analyses point to three general ranking categories, and thus three groups of prioritized watersheds on which to potentially focus prime steelhead restoration activities:

1. Top Priority: The Malibu, Topanga, and Arroyo Sequit watersheds were consistently identified as the highest priority watersheds. Of these, Arroyo Sequit is receiving the least amount of restoration attention or activity.

2. Middle Priority: The prioritization evaluations discovered four candidate watersheds (Zuma, Trancas, Big Sycamore, and Las Flores) where little prior or current steelhead restoration activity exists. Zuma and Trancas have significant restoration potential and many opportunities exist in these two watersheds.

3. Lowest Priority: Escondido, Lechuza, Corral, Encinal, and Little Sycamore were identified as the lowest priority watersheds. These streams, based on the amount and quality their habitat, small size of their watersheds, limited hydrologic capabilities, and apparent absence of steelhead lead this report to conclude higher priorities and better opportunities exist elsewhere.

Restoration Recommendations In addition to identifying Keystone barrier restoration activities, the assessment found a variety of opportunities to aid and possibly accelerate steelhead recovery in the region. The report recommends that the following actions be pursued:

- Existing steelhead restoration activity at Malibu and Topanga should be continued and strengthened.
- While concerted efforts are underway at Malibu and Topanga creeks, Arroyo Sequit also is being utilized by steelhead but no comprehensive watershed-based plan is in place. A comprehensive watershed plan should be developed and implemented.
- Existing steelhead restoration actions, albeit noteworthy, are fragmented and without a single entity to maximize effectiveness or public outreach opportunities. Support to enhance/coordinate the capacity of existing organizations is needed.
- A comprehensive steelhead monitoring program for the Santa Monica Mountains is essential to fill voids in steelhead biology. Life history and discernable population trends, as the result of current and future restoration actions, is needed.
- The agencies funding this report should sponsor and host within one year a conference gathering all interested parties, agencies, and municipalities to identify and select a firm set of projects from this report in a prioritized fashion so that efforts to restore steelhead and streams of the Santa Monica Mountains are done with the greatest biological and cost effectiveness possible.

Fish Passage Recommendations Restoring steelhead access to upstream habitat requires a bottom to top approach. Keystone barriers, which are the most downstream barrier blocking or significantly impeding upstream adult steelhead passage, were identified in focal watersheds. Providing effective upstream steelhead passage at Keystone barriers is an essential step to steelhead recovery within each watershed and the region.

Of the 110 steelhead migration barriers, 43% are natural. The majority (62%) of the 110 barriers are severe, 33% modest, and 3% of minor severity to steelhead upstream migration. Each of the 13 focal watersheds in the Santa Monica Mountains contained a least one Keystone barrier to adult steelhead spawning migration. If all barriers were remedied, over 29 miles of suitable steelhead stream habitat would become available. The cost estimates to take corrective actions at the individual Keystone barriers ranged from as little as $70,000 to as high as $40 million. In total the cumulative cost exceeds $70 million.

The full document may be downloaded at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=10485.

Steelhead/Rainbow Trout Resources South of the Golden Gate, California - Center for Ecosystem Management and Restoration

This report, with accompanying database, was released in 2008 and presents a distillation of the large amount of available information regarding steelhead/rainbow trout habitat. It includes information concerning presence/absence and other natural history and habitat features in specific streams necessary for an understanding of how steelhead resources may have changed over time. Information on both historical and current presence/absence of steelhead/rainbow trout is described in a narrative fashion and also presented in both tabular form and on maps which are available for download at http://www.cemar.org (CEMAR, 2008).

Integrated Resources Plan – City of Los Angeles

The Integrated Resources Plan (IRP) is a 2020 strategic facilities plan for the City of Los Angeles' wastewater, runoff, and recycled water programs. There are a number of features relevant to this WMA including onsite percolation of wet weather runoff at schools and government properties, and neighborhood-scale percolation at vacant lots. It also calls for continued implementation of water conservation programs, such as smart irrigation devices to reduce outdoor water use and urban runoff.

The implementation strategy for the IRP will be directed by certain "triggers" that include policy decisions regarding recycled water and groundwater replenishment, and regulatory decisions regarding POTW discharges to inland waters such as the Los Angeles River (no POTWs discharge to inland waters in this WMA within the City of Los Angeles).

Specific directions were given to City staff on the next studies and evaluations required for progress. The following provide direction to staff on immediate activities and actions for recycled water, water conservation, and runoff management, dependent on staff and funding availability.

Water Conservation

- Direct the City of Los Angeles Department of Water and Power (DWP) to continue conservation efforts, including programs to reduce outdoor usage, including using smart irrigation devices on City properties, schools and large developments (those with 50 dwelling units or 50,000 gross square feet or larger), and to increase incentives to residential properties.
- Direct DWP to work with Building and Safety in continued conservation efforts, including evaluating and considering new water conservation technologies, including no-flush urinal technology.
- Direct DWP to continue conservation efforts, including working with Building and Safety to evaluate and develop policy that requires developers to implement individual water meters for all new apartment buildings
- Direct DWP to continue conservation awareness efforts, including increasing education programs on the benefits of using climate-appropriate plants with an emphasis on California friendly plants for landscaping or landscaped areas and to develop a program of incentives for implementation.
- Direct Planning to consider the development of City Directive to require the use of California friendly plants in all City projects where feasible and not in conflict with other facilities usage.

Runoff Management – Wet Weather Runoff

- Direct Public Works to review SUSMP (Standard Urban Stormwater Management Plan) requirements to determine ways to require where feasible on-site infiltration and/or treat/reuse, rather than treat and discharge, including in-lieu fees for projects where infiltration is infeasible.
- Direct Building and Safety to evaluate and modify applicable codes to encourage all feasible Best Management Practices (BMPs) for maximizing on-site capture and retention and/or infiltration of stormwater instead of discharge to the street and storm drain, including porous pavement. (This is currently handled through variances). Direct Public Works and Department of Planning to evaluate the possibility of requiring porous pavements in all new public facilities larger greater than 1 acre. Program feasibility should consider slope and soil conditions.

- Direct Department of Planning to evaluate ordinances that would need to be changed to reduce the area on private properties that can be paved with non-permeable pavement.
- Direct Public Works to evaluate and implement integration of porous pavements into the sidewalks and street programs where feasible.
- Direct Public Works and DWP and Department of Recreation and Parks to prepare a concept report and determine the feasibility of developing a powerline easement demonstration project (for greening, public access, stormwater management, and groundwater replenishment).
- Direct Public Works and DWP to work with the Los Angeles Unified School District (LAUSD) to determine the feasibility of developing projects for both new schools and for retrofitted schools, as well as government/city-owned facilities with stormwater management BMPs. [Provide wet weather runoff storage (cisterns) to beneficially use wet weather runoff for irrigation. Also, schools and government properties to reduce paving and hardscape and add infiltration basins to allow percolation of wet weather runoff into the ground where feasible.]
- Direct Public Works and General Services and the Department of Transportation (DOT) to maximize unpaved open space in City-owned properties and parking medians through using all feasible BMPs and by removing all unnecessary pavement.
- Direct Public Works to include all feasible BMPs in the construction or reconstruction of highway medians under its jurisdiction.
- Direct Public Works to coordinate with the Million Trees LA team on identifying potential locations of tree plantings that would provide stormwater benefit, with consideration of slope and soil conditions .

Runoff Management - Dry Weather Runoff

- In the context of developing TMDL implementation plans, direct Public Works to consider diversion of dry weather runoff from Ballona Creek to constructed wetlands, wastewater system, or urban runoff plant for treatment and/or beneficial use. Coordinate with the Department of Recreation and Parks.
- In the context of developing TMDL implementation plans, direct Public Works to consider diversion of dry weather runoff from inland creeks and storm drains to wastewater system or constructed wetlands or treatment/retention/infiltration basins with consideration for slope and topography.

General

- Direct the Department of Planning to consider opportunities to incorporate IRP policy decisions in the General Plan, Community Plan, and Specific Plan updates or revisions.
- Direct Department of Recreation and Parks to coordinate with Public Works on including stormwater management BMPs in all new parks.
- Direct General Services in coordination with Planning and Public Works to evaluate feasibility of all City properties identified as surplus for potential development of multiple-benefit projects to improve stormwater management, water quality and groundwater recharge.

The IRP can be downloaded at http://www.lacitysan.org/irp/

TMDLs – Regional Board

Information is available at
http://www.waterboards.ca.gov/losangeles/water_issues/programs/tmdl/tmdl_list.shtml for

- Ballona Creek Trash TMDL, 2002 (and 2005 revision)
- Santa Monica Bay Beaches Wet Weather and Dry Weather Bacteria TMDLs, 2003
- Ballona Creek Metals TMDL, 2005
- Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL, 2007
- Ballona Creek Estuary Toxic Pollutants, 2005
- Malibu Creek Bacteria TMDL, 2006
- Malibu Creek Watershed Nutrients TMDL, established by USEPA in 2003
- Marina del Rey Harbor Toxics TMDL, 2006
- Marina del Rey Back Basins Bacteria TMDL, 2004
- Santa Monica Bay Nearshore and Offshore Debris TMDL, 2010

Ocean Protection Council – State

The Ocean Protection Council (OPC) was created pursuant to the California Ocean Protection Act which was signed into law in 2004 by Governor Arnold Schwarzenegger.

The OPC is guided by principles included in Act:

- Recognizing the interconnectedness of the land and the sea, supporting sustainable uses of the coast, and ensuring the health of ecosystems
- Improving the protection, conservation, restoration, and management of coastal and ocean ecosystems through enhanced scientific understanding, including monitoring and data gathering
- Recognizing the "precautionary principle": where the possibility of serious harm exists, lack of scientific certainty should not preclude action to prevent the harm
- Identifying the most effective and efficient use of public funds by identifying funding gaps and creating new and innovative processes for achieving success
- Making aesthetic, educational, and recreational uses of the coast and ocean a priority
- Involving the public in all aspects of OPC process through public meetings, workshops, public conferences, and other symposia

The OPC is tasked with the following responsibilities:

- Coordinate activities of ocean-related state agencies to improve the effectiveness of state efforts to protect ocean resources within existing fiscal limitations
- Establish policies to coordinate the collection and sharing of scientific data related to coast and ocean resources between agencies
- Identify and recommend to the Legislature changes in law
- Identify and recommend changes in federal law and policy to the Governor and Legislature

The 2009-2011 priorities of the OPC are outlined in A Vision for Our Ocean and Coast: Five-Year Strategic Plan. For the upcoming years, more specific guidance is given in the 2009-2011 OPC priorities document. The priorities are focused around six areas of interest, including: governance, research and mapping, ocean and coastal water quality, physical processes and habitat structure, ocean and coastal ecosystems, and education and outreach. The OPC's website is http://www.opc.ca.gov/

Marine Life Protection Act – State

The Marine Life Protection Act (MLPA) Initiative is a public-private partnership designed to help the State of California implement the MLPA using the best readily available science, as well as the advice and assistance of scientists, resource managers, experts, stakeholders and members of the public. The MLPA requires the state to redesign existing state marine protected areas (MPAs), and to establish a cohesive network of MPAs to protect, among other things, marine life, habitats, ecosystems and natural heritage, as well as to improve recreational, educational and study opportunities provided by marine ecosystems.

Marine protected areas within the MLPA South Coast Study Region (Point Conception south to the California/Mexico border) will be evaluated and redesigned with input from a regional stakeholder group, a science advisory team, a blue ribbon task force, the California Department of Fish and Game (DFG), the California Department of Parks and Recreation, and other interested parties. An available document, the "Regional Profile of the MLPA South Coast Study Region", is intended to support the MPA planning process by providing background information and data on the biological, oceanographic, socioeconomic, and governance characteristics of the south coast study region. The regional profile has been reviewed and revised based on input from regional stakeholders. This profile will assist stakeholders and decision-makers in evaluating existing MPAs in the study region and developing alternative proposals for a network of MPAs which meet the goals of the MLPA and which form a component of the statewide MPA network. More information may be found at http://www.dfg.ca.gov/mlpa.

Integrated Regional Water Management Plan – Greater Los Angeles County

The Santa Monica Bay WMA falls within the Greater Los Angeles County Integrated Regional Water Management Plan (IRWMP) Region as well as within two of its subregions, North Santa Monica Bay and South Bay. Although originally envisioned as a mechanism to secure bond funds in the short-term, the Greater Los Angeles County IRWMP, as well as the many others around the State, are envisioned as providing the roadmap to improve water supplies, enhance water supply reliability, improve surface water quality, preserve flood protection, conserve habitat, and expand recreational access in the Region. The Plan is also intended to define a comprehensive vision for the Region which will generate local funding, position the Region for future state bonds, and create opportunities for federal funding. Details on the Plan and opportunities for stakeholder involvement can be found at http://www.lawaterplan.org

Green Solution Project, Phase II

Green Solution Project, Phase I, provided quantification and identification of urban lands within LA County that would be needed for conversion to pervious, multi-benefit projects (park, recreation, wetlands and natural lands) to help meet water quality improvement goals and regulatory requirements through the infiltration or treatment of stormwater before it reaches Santa Monica Bay. The study also identified publicly owned lands within the County to assess the extent to which these lands could be used for these projects. The products of Phase I include a series of GIS-based maps depicting publicly-owned parcels within the Santa Monica Bay watershed, along with their size and general land uses.

The Coastal Conservancy, through Community Conservancy International, is funding Phase II which is needed to refine parcel data for selected land use categories; analyze hydrology and other parcel attributes related to suitability for stormwater infiltration/treatment; develop a ranking matrix to screen and prioritize candidate parcels for water quality project implementation; and develop concept designs for five high-ranking priority parcels. More information can be found at http://www.ccint.org/greensolution.html.

Low Impact Development Ordinance – County of Los Angeles

Los Angeles County adopted Ordinance No. 2008-0063 in November 2008 which established low impact development standards for developments constructed after January 1, 2009. The standards are intended to mimic undeveloped stormwater and urban runoff rates and volumes in any storm event up to and including a 50-year storm, prevent pollutants of concern from leaving a development site as the result of storms, and minimize hydromodification impacts to natural drainage systems. To aid implementation of this ordinance, the County prepared a Low Impact Development Standards Manual. The ordinance is available at http://planning.lacounty.gov/view/green_building_program while the Development Standards Manual can be downloaded at http://planning.lacounty.gov/green.

Low Impact Development Ordinance – City of Los Angeles

In January 2010, he City of Los Angeles Board of Public Works approved a low impact development (LID) ordinance which will require 100% of runoff from a storm of ¾ inch magnitude be captured or reused at new homes, larger commercial developments, and some redevelopments. If these requirements are not met, developers will be required to pay a stormwater pollution fee that will be allocated to other public LID projects. To aid implementation of this ordinance, the City prepared a Development Best Management Practices Handbook. Information on the LID program can be found at http://www.lastormwater.org/Siteorg/program/LID/lidintro.htm.

Low Impact Development Ordinance – City of Santa Monica

The City of Santa Monica's Urban Runoff Pollution Cotnrol Control Ordinance requires that all new developments and substantial remodels prepare an Urban Runoff Mitigation Plan to ensure the site maximizes permeable surface area and minimizes the amount of runoff directed to impermeable areas. Runoff from a ¾ inch rain event must be treated or infiltrated. More information may be found at http://santamonica.org/Departments/OSE/Categories/Green_Building/Guidelines/Siting_and_Form/Runoff_Mitigation_Plan.aspx

Water Quality Compliance Master Plan for Urban Runoff - City of Los Angeles

This 2009 plan utilizes a strategy to build on ongoing successful initiatives and programs, identify common grounds (for benefits and funding), and seek new initiatives that will address complex problems. This approach will also promote water conservation and factor in objectives identified by other plans, including increased recreation opportunities and support for the greening of Los Angeles. It may be downloaded at http://www.lastormwater.org/Siteorg/program/masterplan.htm.

Summaries of Key Monitoring Programs and Large-scale Studies

Historic Statewide Monitoring Programs (CRWQCB, 1997)

The first edition of this State of the Watershed Report noted that there had been a considerable number of short- and long-term monitoring programs implemented in the WMA, particularly over the previous twenty years, that focused on urban runoff effects in general along the coastline and the fate of PCBs- and DDT-contaminated sediment on the Palos Verdes Shelf. The results of three statewide monitoring programs, State Mussel Watch (SMW), Toxic Substances Monitoring (TSM), and Bay Protection and Toxic Cleanup (BPTC), which included biological measurements, were summarized in an appendix of the first edition report. The TSM sampled fish for bioaccumulation of toxic pollutants, generally but not exclusively in fresh waters; the SMW Program sampled shellfish, generally in marine waters, for bioaccumulation; and the BPTC Program sampled sediments, generally in harbors and estuaries, for pollutants, toxicity, and the health of the benthic community. While the former two programs sampled from the early 1980s until the late 1990s, the BPTC Program operated from the early 1990s until the late 1990s.

The first edition report stated that the SMW Program had found that the open coastline of the Santa Monica Bay WMA was much cleaner than its enclosed waters (harbors and marinas, generally), at least for most substances that are both bioaccumulative and bioavailable to mussels either placed in a location or that naturally occur at a site. The pattern of accumulation for DDT and PCBs was different, however, and this may have represented the residual effects of past coastal discharges and historic sediment contamination reflected by the BPTC Program data. Fish bioaccumulation problems which might have human health implications were relatively minor in those fresh and estuarine waters sampled (except for concerns over mercury in Lake Sherwood fish which continue today) while the potential for aquatic life impacts existed in Marina del Rey Harbor and Ballona Creek (also concerns which continue today).

With regards to sediment contamination found through the BPTC Program, one group of chemicals sampled was polynuclear aromatic hydrocarbons (PAHs) which are found in oil products. The PAHs that are categorized as low molecular weight PAHs (LPAHs) are considered indicative of spills or recent releases of oil from natural seeps. High molecular weight PAHs (HPAHs) are indicative of hydrocarbon combustion such as would be found in runoff from streets or in marinas from boating activities. Grouped in that fashion, LPAHs and HPAHs can be roughly indicative of sources.

Sediments in the Ballona Creek estuary were more contaminated with PAHs than the other sites sampled in the WMA. Approximately 80-90% of the PAHs found at all of the sampled sites were HPAHs which are indicative of combustion.

Polychlorinated biphenyls (PCBs) may also be evaluated in a similar manner. PCBs are composed of mixtures of various congeners which differ mostly in the number of chlorine atoms they contain. The number of chlorine atoms determines the chemical and physical characteristics of the final PCB mixture. A higher number of chlorine atoms is associated with thicker, heavier PCBs while less chlorine atoms are associated with lighter PCBs. Heavier PCBs are also more injurious to animals and humans. The results of sediment analyses by the number of chlorine atoms gives a characteristic "fingerprint" which may reveal a common source. PCB congener data for Palos Verdes, Marina del Rey, and Ballona Creek were assessed and showed no clear indication of a common fingerprint among the three areas which could mean there is either no common source or no recent common source since PCBs do degrade over time.

With regards to concentrations of other organic chemicals in the sediments of the WMA, it was clear DDT was still being found at highly elevated levels in sediments off of the Palos Verdes Peninsula, almost certainly due to past discharges and dumping practices. Chlordane is a banned insecticide that was used to control ants and termites. It is highly persistent and was likely still being used in residential areas where individuals may have remaining stocks. This was reflected in the higher levels found in Ballona Creek.

Marina del Rey sediments contained the highest levels of metals overall with copper levels especially high compared to other embayments in the WMA. Ballona Creek contained very high levels of zinc and lead but not copper. These numbers were considered expected since copper was and continues to be used extensively in antifouling bottom paints which is likely used on the majority of boats moored in the marina. On the other hand, copper is not as large a component in urban or storm water runoff and thus should not be as high in Ballona Creek. However, at that time, lead and zinc were still commonly found in urban runoff although lead occurred in much lower concentrations since the advent of unleaded gasoline.

Sediments were also evaluated for toxicity. Survival of test organisms in Malibu Lagoon sediments was quite good. The average survival of organisms tested during four sampling runs spanning three years in the Palos Verdes area was also good. On the other hand, survival of test organisms in sediments from Marina del Rey and Ballona Creek was relatively poor.

Palos Verdes Shelf Studies and Planning for Cleanup - USEPA

Coastal Marine Fish Contaminants Survey

In 2007, the National Oceanographic and Atmospheric Administration (NOAA) and the USEPA released a report on the results of a 2002-2004 coastal marine fish contaminants survey. NOAA participated on behalf of the natural resources trustees which include NOAA, US Fish and Wildlife Service, National Park Service, California Department of Fish and Game, California State Lands Commission, and California Department of Parks and Recreation. The highest concentration of total DDT found in white croaker (a bottom-feeding fish with a high lipid content) in 2002 was almost 33,700 ppb at a sampling location near the west side of the JWPCP outfall. Total PCBs were found at 2,950 ppb at that location. Samples collected by the County Sanitation Districts of Los Angeles County in both 2002 and 2005 near the east side of outfall were an order of magnitude lower (NOAA and USEPA, 2007).

Palos Verdes Shelf Superfund Site Operable Unit 5 of the Montrose Chemical Corp. Final Feasibility Study

In 2009, USEPA released a feasibility study which describes the development, evaluation, and comparison of remedial action alternatives to manage the contaminated sediment at the Palos Verdes Shelf site (USEPA and CH2M Hill, 2009).

The report describes the results of the aforementioned 2002 – 2004 coastal marine fish contaminant survey and summarizes the results of sampling for DDT and PCBs in white croaker off the Palos Verdes Peninsula (including near the outfall) from 1999 through 2006. The data show a general decline in PCBs concentration and a more dramatic decline in DDT concentrations, particularly near the outfall. The report also compares total DDT and total PCBs concentration in pelagic fish (anchovy, mackerel, and sardine) and squid in the Southern California Bight in the early 1980s during various studies and during a 2003-2004 study conducted by SCCWRP. While there are differences in species and sampling locations, these studies show a general decline in both DDT and PCBs concentrations in the Bight over the twenty-year time period (USEPA and CH2M Hill, 2009).

Using recreational angler consumption rates developed during the1994 SMBRP Seafood Consumption Study, fish tissue concentrations found to be protective of human health were, for DDTs in fish fillet, 490 ppb and for PCBs in fish fillet, 80 ppb, based on 21.4 g/day consumption. This would result in an excess lifetime cancer risk of 1×10^{-5}. When consumption was based on 116 g/day, protective levels were at 400 ppb for DDTs and 70 ppb for PCBs with an excess lifetime cancer risk of 1×10^{-4}. Pelagic fish concentrations of PCBs and DDTs are generally below those levels while higher concentrations are associated with bottom-feeding fish, particularly, white croaker (USEPA and CH2M Hill, 2009).

The document reported on ecological risk to the fauna of the Palos Verdes Shelf area including effects on the benthic community, fish, and predators of fish through contaminated sediment. The evaluation found that the highest risks are in the vicinity of the JWPCP outfalls. Intermediate-risk areas are generally to the north and northwest of the outfalls. Low-risk areas occur south of the outfalls, in waters less than 30 m in depth, at the far northern areas of the Palos Verdes Shelf, and throughout the remainder of the Bight. Benthic invertebrates and local fish would be directly affected by contaminated sediment whereas predators of fish, such as birds, would be affected through food-chain transfer of the pollutants. Sediment concentrations of PCBs in the Palos Verdes Shelf area are below levels considered to be protective of benthic infauna and concentrations of DDTs are of concern only in the immediate area around the outfalls. Regarding risk to fish-eating birds and mammals, concentrations of DDTs continue to pose a risk while PCBs pose a much lower risk (USEPA and CH2M Hill, 2009).

The report also presents potential remediation goals for the protection of human and ecological health and presents remedial alternatives including dredging and capping of various amounts of contaminated sediment (USEPA and CH2M Hill, 2009).

USEPA announced their preferred alternative for remediating the Palos Verdes Shelf Superfund site in June 2009. Public meetings were held in June and comments were accepted into July. A news release on June 11, 2009, stated "The EPA's Preferred Alternative Plan is an interim remedy that proposes institutional controls, monitored natural recovery and a containment cap. On October 5, 2009, a news release issued by USEPA announced, in part "The U.S. Environmental Protection Agency has selected a cleanup strategy for the Palos Verdes Shelf Superfund Site, where a large area on the ocean floor off the Palos Verdes peninsula is contaminated with DDT and PCBs. The EPA will spend more than $50 million to cap the most contaminated sediment on the shelf, as well as continue the highly effective public outreach program to protect at-risk populations from consuming contaminated fish." More information on the Palos Verdes Shelf contamination issues and potential federal remediation actions can be found at http://www.epa.gov/region09/superfund/pvshelf.

Municipal Separate Storm Sewer System (MS4) Monitoring (Municipal Stormwater NPDES Permit) – MS4 permittees

The major objectives of the Monitoring Program outlined in the Municipal Stormwater Permit are to:

- Assess permit compliance,
- Measure and improve the effectiveness of the Stormwater Quality Management Plans,
- Assess the chemical, physical, and biological impacts of receiving waters resulting from urban runoff,
- Characterize stormwater discharges,
- Identify sources of pollutants,
- Assess the overall health and evaluate long-term trends in receiving water quality.

The required monitoring includes the following components:

- Core Monitoring Program: mass emission, water column toxicity, tributary, shoreline, and trash monitoring. Mass emission and toxicity monitoring conducted in the Santa Monica Bay WMA were located in Malibu and Ballona Creeks. The most recent tributary monitoring took place outside of the WMA. Trash monitoring occurred on Ballona Creek.
- Regional Monitoring Program: estuary sampling and bioassessment and the results of three special studies. Estuary sampling was completed in conjunction with Bight '03 work. Bioassessment sampling occurred at one site on Ballona Creek and at four sites tributary to the mainstem of Malibu Creek.

An Integrated Receiving Water Impacts Report was created in 2004-2005 that incorporates results, analysis, and progress of the Core and Regional Monitoring Programs. That report also looked at trends for the period 1994-2005. Annual Stormwater Monitoring Reports can be found on the Los Angeles County Department of Public Works website at http://dpw.lacounty.gov/wmd/NPDES/report_directory.cfm. Results for Ballona and Malibu Creeks sampling are summarized in those subwatershed sections. The reporting on the most recent shoreline monitoring results for bacterial indicators is briefly summarized here (LACDPW website).

Dry-weather Approximately, 2,400 samples were collected for bacteria indicator monitoring during the most recent sampling year at eighteen sites along Santa Monica Bay. Stations located at Santa Monica Canyon Storm Drain and Santa Monica Pier were the northern Bay sites with the highest geometric means for all bacterial indicators during dry-weather. Stations at Ashland and Windward had the lowest dry-weather geometric means in the northern Bay area for all indicators. Southern Bay stations located at the mouth of Ballona Creek and at Redondo Beach Pier had the highest bacterial densities for all indicator bacteria during dry-weather with the Ballona Creek site the highest (of all sites sampled) and the Redondo Beach Pier site the next highest. The higher geometric means were recorded for northern stations when compared to stations to the south; storm drains flow more consistently in the north (LACDPW website).

Wet-weather Annual geometric means for FY 2008-2009 revealed higher bacterial densities for all three fecal indicators during wet-weather when compared to dry-weather. Water quality will deteriorate during and immediately after a rainstorm, but generally return to previous levels within two to four days. Northern Bay stations exhibited higher mean values during wet-weather than those to the south for all fecal indicators. Northern stations with the highest wet-weather bacterial densities were stations at Surfrider Beach, Santa Monica Canyon Storm Drain, and Pico-Kenter Storm Drain. Although total coliform and E. coli means were comparable among these three stations, the Enterococcus mean value at the Santa Monica Canyon Storm Drain was almost twice as high as means at the other two sites. For stations to the south, wet-weather mean values at the Ballona Creek station were highest for all fecal indicators. Comparing all stations, north and south, the total coliform wet-weather mean was highest at Ballona Creek; E. coli was highest at Surfrider Beach, Santa Monica Canyon Storm Drain; and the enterococcus mean value was highest at Santa Monica Canyon Storm Drain (LACDPW website).

Surface Water Ambient Monitoring Program (SWAMP) – State

Santa Monica Bay Streams Study California's Surface Water Ambient Monitoring Program (SWAMP) is a comprehensive monitoring program designed to assess the quality of the beneficial uses of the State's water resources. In 2003-2004, the Santa Monica Bay WMA was sampled. The main goal of the sampling in the WMA was to obtain an overall view of the health of the watershed. Additionally, the monitoring plan was designed to provide information on potential reference sites in the watershed, and beneficial use attainment or non-attainment. Sixty-one sites distributed among the approximately 30 coastal sub-watersheds of the WMA were selected for sampling. In most cases, two stations were sampled in each sub-watershed. Sampling was completed at 59 sites; two sites were dry during sampling events. Sampling was conducted during the spring seasons of 2003 and 2004. Sampling at all stations included field measurements (conductivity, DO, pH, salinity, temperature, turbidity, and current speed), conventional water column chemistry (alkalinity, ammonia-N, boron, chloride, chlorophyll a, conductivity, dissolved oxygen, fluoride, hardness, nitrate-N, nitrite-N, orthophosphate, sulfate, total dissolved solids (TDS), temperature, total Kjeldahl nitrogen (TKN), total phosphorous (P), and turbidity) and bacteriology. Bioassessment was conducted at 39 sites and enzyme-linked immunosorbent assay (ELISA) analyses for chlorpyrifos and diazinon were conducted at 37 sites. During spring 2003, a subset of twenty stations was sampled for water column toxicity, dissolved metals, and organophosphate chemistry, and another subset of five stations was sampled for dissolved metals only. Additionally, two sites located near gas stations were tested for MTBE (SWRCB, 2005).

Some highlights of the findings were: DO was < 90% saturation at 34 sites during at least one sampling event while pH was > 8.5 at nine sites. Chloride exceeded USEPA criteria for protection of aquatic life at thirteen sites. Sulfate and TDS concentrations exceeded California Secondary MCLs (generally associated with taste) at most sites. E. coli and fecal coliform exceeded freshwater single sample limits at sites throughout the WMA. Metals were generally below criteria, objectives or action levels. With the exception of chorpyrifos and diazinon, no other organic compounds were detected. Acute and chronic water column toxicity were detected at six sites in the WMA. Five of these sites were each in the lower portion of their respective sub-watersheds (Lower Trancas Canyon, Lower Puerco Canyon, Lower Marie Canyon, Lower Ramirez Canyon, and Ballona Creek at Centinela) with one in the upper portion (Upper Escondido Canyon). Benthic IBI scores ranged from 4 to 78 and represented four condition categories ranging from Very Poor to Good. No scores were in the Very Good category. Very Poor scores were found at Lower Marie Canyon, Malibu Lagoon, Middle Santa Ynez Canyon, Lower Santa Monica Canyon, Lower Rustic Canyon, Ballona Creek at Centinela, and unnamed drainages into Upper and Lower Malaga Cove. The majority of Very Poor and Poor sites were located toward the southern end of Santa Monica Bay. On the other hand, sites rated as Good were mostly found more toward the northern end of Santa Monica Bay. Inconsistent patterns in physical habitat, water chemistry, and toxicity data prevent the conclusion of which factors contribute to degraded biotic condition. There were differences between upper and lower sites within individual watersheds. However, differences were not consistent among watersheds. In several watersheds, more water quality problems were indicated in the lower portions, while in other watersheds conditions were similar among sites. However, in some cases the upper and lower sites were located very close together and may not truly represent the upper and lower portions of the watershed (SWRCB, 2005).

The deterministic sampling design used in the study did not have the statistical power necessary for making conclusions with regard to the watershed as a whole (percentage of streams in the watershed or region that support beneficial uses, and how that percentage is changing over time). Additionally, the original study design called for locating two sites in a sub-watershed, one site in the upper watershed and the other in the lower watershed near its intersection with Pacific Coast Highway. However, due to the inability to find sites with running water and access, sites designated “Upper” were not always in the true upper portion of the watershed, and in some cases were located in close proximity to the “Lower” sites. Thus, not all paired Upper and Lower sites in this study represented a true comparison of the characteristics of the upper and lower portions of the watersheds. However, this may be virtually impossible due to the ephemeral nature of southern California streams (SWRCB, 2005).

<u>California Lakes Fish Contamination Study</u> The State Water Resources Control Board released a report entitled *Contaminants in Fish from California Lakes and Reservoirs*, that presents initial results from a statewide survey. The monitoring indicates that concentrations of mercury in indicator species are above human health thresholds across much of the state. PCBs were second to mercury in exceeding thresholds, although far fewer lakes reached concentrations that pose potential health concerns to consumers of fish from California lakes. Concentrations of other pollutants were generally low and infrequently exceeded thresholds (Davis, et al., 2009).

The report was a product of the Surface Water Ambient Monitoring Program and presented findings from the first year (2007) of a two-year study. The study marks the beginning of a new program that will track sport fish contamination in California lakes, rivers, streams, and coastal waters (Davis, et al., 2009).

The study sampled more than 200 of the most popular fishing lakes in the state and also conducted a random sampling of 50 of California's other 9,000 lakes to provide a statistical statewide assessment. The species selected for sampling are known to accumulate high concentrations and be good indicators of contamination problems, however, the study was not design to provide consumption advice which would require more detailed monitoring and a much higher level of funding (Davis, et al., 2009).

Fish tissue concentrations were evaluated using thresholds developed by the California Office of Environmental Health Hazard Assessment (OEHHA) for methylmercury, PCBs, dieldrin, DDTs, chlordanes, and selenium. Fish Contaminant Goals (FCGs) were developed; these are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week, prior to cooking. FCGs prevent consumers from being exposed to more than the daily reference dose for non-carcinogens or to a risk level greater than one additional cancer case in a population of 1,000,000 people consuming fish at the given consumption rate over a lifetime. FCGs are based solely on public health considerations relating to exposure to each individual contaminant, without regard to economic considerations, technical feasibility, or the counterbalancing benefits of fish consumption (Davis, et al., 2009).

OEHHA determined that there is a compelling body of evidence and general scientific consensus that eating fish at dietary levels that are easily achievable, but well above national average consumption rates, appears to promote significant health benefits, including decreased mortality, i.e., there are unique health benefits associated with fish consumption. Advisory tissue levels (ATLs) were developed as a result. ATLs were calculated using the same general formulas as those used to calculate FCGs, with some adjustments in order to incorporate the benefits of fish consumption. ATLs provide a number of recommended fish servings that correspond to the range of contaminant concentrations found in fish and are designed to prevent consumers from being exposed to more than the average daily reference dose for non-carcinogens or to a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. The use of ATLs still confers no significant health risk to individuals consuming sport fish in the quantities shown over a lifetime, while encouraging consumption of fish that can be eaten in quantities likely to provide significant health benefits and discouraging consumption of fish that, because of contaminant concentrations, should not be eaten or cannot be recommended in amounts suggested for improving overall health (Davis, et al., 2009).

While the Lake Study report said that lakes were considered "clean" if all average pollutant concentrations in all species were below all OEHHA thresholds, for the purposes of this State of the Watershed Report, the data were assessed for the worst case scenario, i.e., the highest values found rather than average values for each of the chemicals of concern (mercury and PCBs, for the most part) (Davis, et al., 2009).

High mercury levels were found at two of the WMA's lakes, Ken Hahn Park Lake and Lake Sherwood. Atmospheric deposition is a possibility; the size of the lakes, how often maintenance dredging occurs, and the potential for fish to survive and be long-lived (thus bioaccumulating more pollutants) are all factors to be considered. The other chemical of concern in fish is total PCBs in a few lakes; however, PCBs levels in fish tissue in the WMA's lakes are much lower relative to mercury levels in fish when compared to the OEHHA thresholds (Davis, et al., 2009).

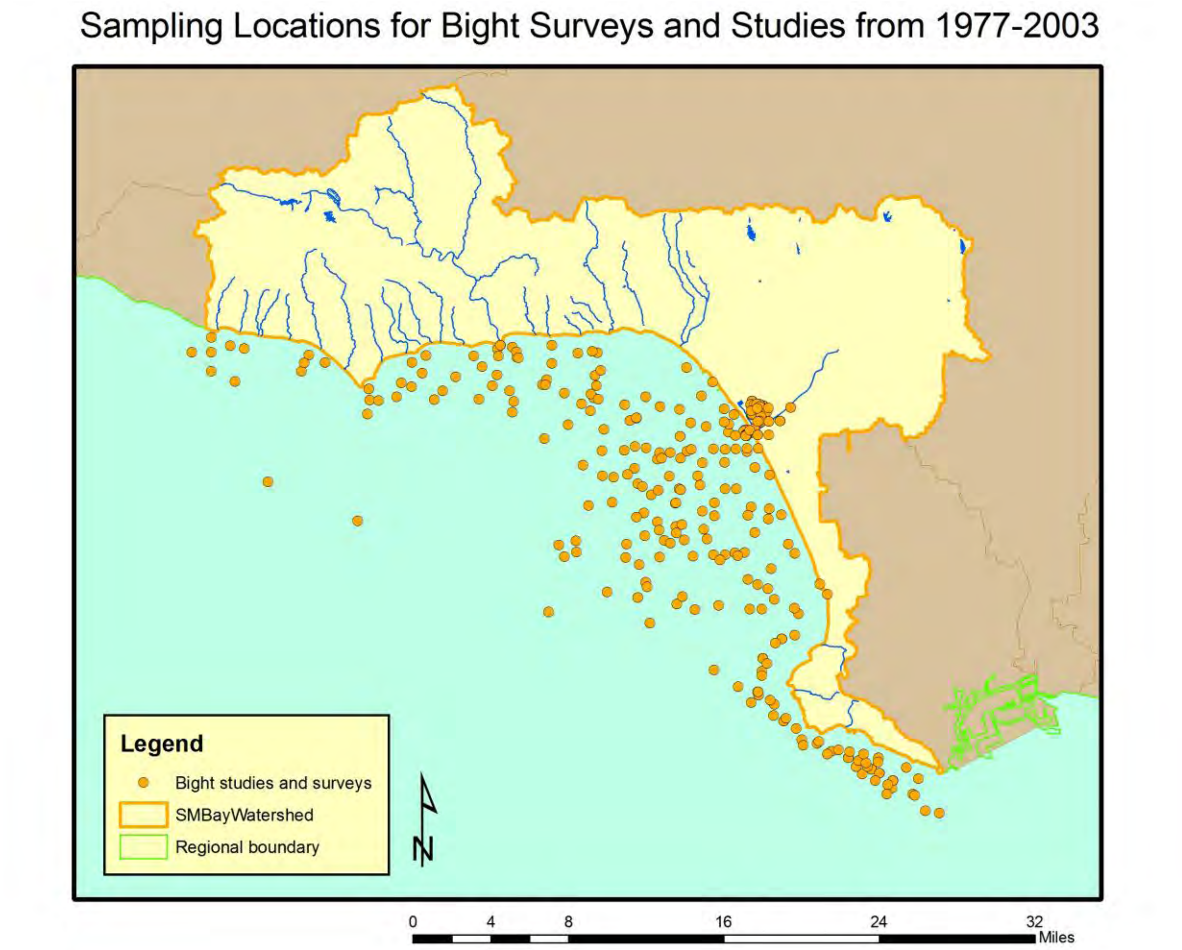
Southern California Bight-wide Monitoring (and Related Coordinated Monitoring) – multiple partners

A massive amount of data has been collected in the Southern California Bight and its adjacent coastal water bodies through large-scale monitoring programs which began in 1977 with a Bight-wide reference survey, coordinated by SCCWRP, which included sampling sediment chemistry and fish abundance and was followed by multiple additional surveys and studies which added to the large dataset of chemistry and biology. The 1977 survey was followed by more limited reference surveys in 1985 and 1990. In 1994, the Southern California Bight Pilot Project was undertaken. Additional biological and chemical measures were added with the Pilot Project and coordination of ocean monitoring required of major NPDES dischargers occurred in order to maximize use of resources among all the agencies already conducting monitoring. Bight-wide monitoring conducted in such a fashion became a regular occurrence beginning in 1998 and has followed every five years since. In 2003, additional focus was put on harbors while in 2008 estuaries were given additional attention. The effort continues to be led by SCCWRP in coordination with the other funding agencies and interested stakeholders. Datasets from these surveys and Bight projects are available for download from the SCCWRP website at http://www.sccwrp.org.

Much of the sediment data collected through the survey and Bight monitoring programs were subsequently collected and combined into a single Microsoft Access database along with sediment data from various special studies of Santa Monica Bay and the Palos Verdes Shelf. The consolidated sediment database can also be downloaded off the SCCWRP website.

The figure below shows the sampling locations from 1977-2003 associated with the many surveys and studies conducted in the Bight and its adjacent harbors with a sediment component.

Figure 22



The southern California Stormwater Monitoring Coalition (SMC) is also conducting large-scale, coordinated monitoring. The SMC was formed in 2000 by the Phase I municipal stormwater NPDES lead permittees and the NPDES regulatory agencies in southern California. Their research agenda, published in 2001, consisted of fifteen projects focusing on three major areas: 1) developing a regional monitoring infrastructure; 2) understanding stormwater runoff mechanisms and processes; and 3) assessing receiving water impacts. As an example, the SMC developed a regional coordinated freshwater stream bioassessment monitoring program which began in 2009. The invertebrates which are collected during bioassessment sampling integrate the effects of multiple stressors, including chemical pollutants and physical alterations in receiving waters and thus are of great use in assessment impacts to sensitive beneficial uses. This work has been closely coordinated with bioassessments being conducted in southern California by the state's Surface Water Ambient Monitoring Program (SMC website).

Summary/Conclusions

The years since the first edition report was published in 1997 have seen incredible changes in the ability to share information. Virtually no reference materials were available electronically at that time and data were maintained in completely separate locations, often in very different formats. Maps were often hand-drawn or copied from USGS quad sheets. Digitized geographic information was relatively rare and the programming to utilize such information required considerable training. The ability to access the Internet was in its infancy and the use of Email was just beginning. Although there is an enormous amount of electronic information available today, much remains in paper form that is of considerable value. This report focuses almost exclusively on electronically-available information. Considering the great interest by the public and elected officials that continues in Santa Monica Bay and its adjacent land areas, there was no shortage of useful, readily available electronic information.

These reference materials speak to a concerted and quite collaborative effort to repair the damaged resources of the WMA. While much voluntary work is occurring at a neighborhood/citizen group scale, agency-driven actions, often regulatory in nature, are setting the stage for most of the work through mandated results with strict timelines and requirements. The references also highlight the increasing contributions of stormwater and urban runoff, relative to more traditional point sources, to impairments of beneficial uses. It is clear urbanized areas produce more pollutants than areas that are mostly open space. It is also clear that runoff from large areas of impervious surfaces are detrimental to aquatic life.

Increasingly, agencies are turning to integrated approaches to resolve seemingly disparate problems such as lack of open space, degraded wetlands and riparian habitats, impaired water quality, contaminated sediments and marine life, and flooding. These integrated approaches often promote increased open space through policies such as low impact development, which in turn, reduce impervious surfaces, increase infiltration, reduce flooding, improve the water quality of runoff, and put less stress on the riparian areas and wetlands that remain. The Regional Board encourages these types of integrated water resources approaches to addressing the water quality issues in the Santa Monica Bay WMA. Targeted use of structural and non-structural BMPs along with public education and outreach in the short-term also continues to be an important part of the overall solution.

The ability to access data (as opposed to "information") electronically continues to be a problem. While the Water Boards are moving toward use of "regional data centers" with the assistance of the California Water Quality Monitoring Council (see http://www.waterboards.ca.gov/water_issues/programs/monitoring_council/index.shtml), in the meantime, obtaining raw data (particularly, historic data) is a sometimes tortuous process. Virtually every entity that conducts monitoring or special studies stores their data electronically yet formats are quite different and are at times completely incompatible. This will no doubt continue to be a problem until regional data centers are in full operation.

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Table 7-1. Effectiveness of Wetlands and Riparian Areas for NPS Pollution Control

1 - Tar River Basin, North Carolina

Riparian Forests

This study looks at how various soil types affect the buffer width necessary for effectiveness of riparian forests to reduce loadings of agricultural nonpoint source pollutants.

- A hypothetical buffer with a width of 30 m and designed to remove 90% of the nitrate nitrogen from runoff volumes typical of 50 acres of row crop on relatively poorly drained soils was used as a standard.
- Udic upland soils and sandy entisols met or exceeded these standards.
- The study also concluded that slope gradient was the most important contributor to the variation in effectiveness. Phillips, J.D. 1989. Nonpoint Source Pollution Control Effectiveness of Riparian Forests Along a Coastal Plain River. *Journal of Hydrology*, 110 (1989):221-237.

2 - Lake Tahoe, Nevada

Riparian

Three years of research on a headwaters watershed has shown this area to be capable of removing over 99% of the incoming nitrate nitrogen. Wetlands and riparian areas in a watershed appear to be able to "clean up" nitrate-containing waters with a very high degree of efficiency and are of major value in providing natural pollution controls for sensitive waters. Rhodes, J., C.M. Skau, D. Greenlee, and D. Brown. 1985. Quantification of Nitrate Uptake by Riparian Forests and Wetlands in an Undisturbed Headwaters Watershed. In *Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*. USDA Forest Service GTR RM-120, pp. 175-179.

3 - Atchafalaya, Louisiana

Riparian

Overflow areas in the Atchafalaya Basin had large areal net exports of total nitrogen (predominantly organic nitrogen) and dissolved organic carbon but acted as a sink for phosphorus. Ammonia levels increased dramatically during the summer. The Atchafalaya Basin floodway acted as a sink for total organic carbon mainly through particulate organic carbon (POC). Net export of dissolved organic carbon was very similar to that of POC for all three areas. Lambou, V.W. 1985. Aquatic Organic Carbon and Nutrient Fluxes, Water Quality, and Aquatic Productivity in the Atchafalaya Basin, Louisiana. In *Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*. USDA Forest Service GTR RM-120, pp. 180-185.

4 - Wyoming

Riparian

The Green River drains 12,000 mi2 of western Wyoming and northern Utah and incorporates a diverse spectrum of geology, topography, soils, and climate. Land use is predominantly range and forest. A multiple regression model was used to associate various riparian and nonriparian basin attributes (geologic substrate, land use, channel slope, etc.) with previous measurements of phosphorus, nitrate, and dissolved solids. Fannin,T.E., M. Parker, and T.J. Maret. 1985. Multiple Regression Analysis for Evaluating Non-point Source Contributions to Water Quality in the Green River, Wyoming. In *Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*. USDA Forest Service GTR RM-120, pp. 201-205.

5 - Rhode River Subwater-shed, Maryland

Riparian

A case study focusing on the hydrology and below-ground processing of nitrate and sulfate was conducted on a riparian forest wetland. Nitrate and sulfate entered the wetland from cropland ground-water drainage and from direct precipitation. Data collected for 3 years to construct monthly mass balances of the fluxes of nitrate and sulfate into and out of the soils of the wetland showed:

- Averages of 86% of nitrate inputs were removed in the wetland.
- Averages of 25% of sulfates were removed in the wetland.
- Annual removal of nitrates varied from 87% in the first year to 84% in the second year.
- Annual removal of sulfate varied from 13% in the second year to 43% in the third year.
- On average, inputs of nitrate and sulfate were highest in the winter.
- Nitrate outputs were always highest in the winter.
- Nitrate removal was always highest in the fall (average of 96%) when input fluxes were lowest and lowest in winter (average of 81%) when input fluxes were highest. Correll, D.L., and D.E. Weller. 1989. Factors Limiting Processes in Freshwater: An Agricultural Primary Stream Riparian Forest. In *Freshwater Wetlands and Wildlife*, ed. R.R. Sharitz and J.W. Gibbons, pp. 9-23. U.S. Department of Energy, Office of Science and Technology, Oak Ridge, Tennessee. DOE Symposium

Series #61.

6 - Carmel River, California

Riparian

Ground water is closely coupled with streamflow to maintain water supply to riparian vegetation, particularly where precipitation is seasonal. A case study is presented where Mediterranean climate and ground-water extraction are linked with the decline of riparian vegetation and subsequent severe bank erosion on the Carmel River. Groenveld, D. P., and E. Griepentrog. 1985. Interdependence of Groundwater, Riparian Vegetation, and Streambank Stability: A Case Study. In *Riparian Ecosystems and their Management: Reconciling Conflicting Issues*. USDA Forest Service GTR RM-120, pp. 201-205.

7 - Cashe River, Arkansas

Riparian

A long-term study is being conducted to determine the chemical and hydrological functions of bottomland hardwood wetlands. Hydrologic gauging stations have been established at inflow and outflow points on the river, and over 25 chemical constituents have been measured. Preliminary results for the 1988 water year indicated:

- Retention of total and inorganic suspended solids and nitrate;
- Exportation of organic suspended solids, total and dissolved organic carbon, inorganic carbon, total phosphorus, soluble reactive phosphorus, ammonia, and total Kjeldahl nitrogen;
- All measured constituents were exported during low water when there was limited contact between the river and the wetlands; and
- All measured constituents were retained when the Cypress-Tupelo part of the floodplain was inundated. Kleiss, B. et al. 1989. Modification of Riverine Water Quality by an Adjacent Bottomland Hardwood Wetland. In *Wetlands: Concerns and Successes*, pp. 429-438. American Water Resources Association.

8Scotsman Valley, New Zealand

Riparian

Nitrate removal in riparian areas was determined using a mass balance procedure in a small New Zealand headwater stream. The results of 12 surveys showed:

- The majority of nitrate removal occurred in riparian organic soils (56-100%) even though the soils occupied only 12% of the stream's border.
- The disproportionate role of organic soils in removing nitrate was due in part to their location in the riparian zone. A high percentage (37-81%) of ground water flowed through these areas on its passage to the stream.
- Anoxic conditions and high concentrations of denitrifying enzymes and available carbon in the soils also contributed to the role of the organic soils in removing nitrates. Cooper, A.B. 1990. Nitrate Depletion in the Riparian Zone and Stream Channel of a Small Headwater Catchment. *Hydrobiologia*, 202:13-26.

9 - Wye Island, Maryland

Riparian

Changes in nitrate concentrations in ground water between an agricultural field planted in tall fescue (*Festuca arundinacea*) and riparian zones vegetated by leguminous or nonleguminous trees were measured to:

- Determine the effectiveness of riparian vegetation management practices in the reduction of nitrate concentrations in ground water;
- Identify effects of leguminous and nonleguminous trees on riparian attenuation of nitrates; and
- Measure the seasonal variability of riparian vegetation's effect on the chemical composition of ground water.

Based on the analysis of shallow ground-water samples, the following patterns were observed:

- Ground-water nitrate concentrations beneath non-leguminous riparian trees decreased toward the shoreline, and removal of the trees resulted in increased nitrate concentrations.
- Nitrate concentrations did not decrease from the field to the riparian zone in ground water below leguminous trees, and removal of the trees resulted in decreased ground-water nitrate concentrations.
- Maximum attenuation of nitrate concentrations occurred in the fall and winter under non-leguminous trees. James, B.R., B.B. Bagley, and P.H. Gallagher, P.H. 1990. Riparian Zone Vegetation Effects on Nitrate Concentrations in Shallow Groundwater. Submitted for publication in the *Proceedings of the 1990 Chesapeake Bay Research Conference*. University of Maryland, Soil Chemistry Laboratory, College Park, Maryland.

10 - Little Lost Man Creek, Humboldt, California

Riparian

Nitrate retention was evaluated in a third-order stream under background conditions and during four intervals of modified nitrate concentration caused by nutrient amendments or storm-enhanced discharge. Measurements of the stream response to nitrate loading and storm discharge showed:

- Under normal background conditions, nitrate was exported from the subsurface (11% greater than input).

- With increased nitrate input, there was an initial 39% reduction from the subsurface followed by a steady state reduction of 14%.
- During a storm event, the subsurface area exported an increase of 6%. Triska, F.J., V.C. Kennedy, R.J. Avanzino, G.W. Zellweger, and K.E. Bencala. 1990. In Situ Retention-Transport Response to Nitrate Loading and Storm Discharge in a Third-Order Stream. *Journal of North American Benthological Society*, 9(3):229-239.

11 - Toronto, Ontario, Canada

Riparian

Field enrichments of nitrate in two spring-fed drainage lines showed an absence of nitrate depletion within the riparian zone of a woodland stream. The results of the study indicated:

- The efficiency of nitrate removal within the riparian zone may be limited by short water residence times.
- The characteristics of the substrate and the routes of ground-water movement are important in determining nitrate attenuation within riparian zones. Warwick, J., and A.R. Hill. 1988. Nitrate Depletion in the Riparian Zone in a Small Woodland Stream. *Hydrobiologia*, 157:231-240.

12 - Little River, Tifton, Georgia Riparian

A study was conducted on riparian forests located adjacent to agricultural uplands to test their ability to intercept and utilize nutrients (N, P, K, Ca) transported from these uplands. Tissue nutrient concentrations, nutrient accretion rates, and production rates of woody plants on these sites were compared to control sites. Data from this study provide evidence that young (bloom state) riparian forests within agricultural ecosystems absorb nutrients lost from agricultural uplands. Fail, J.L. Jr., Haines, B.L., and Todd, R.L. Undated. Riparian Forest Communities and Their Role in Nutrient Conservation in an Agricultural Watershed. *American Journal of Alternative Agriculture*, II(3):114-120.

13 - Chowan River Watershed, North Carolina

Riparian

A study was conducted to determine the trapping efficiency for sediments deposited over a 20-year period in the riparian areas of two watersheds. 137CS data and soil morphology were used to determine areal extent and thickness of the sediments. Results of the study showed:

- approximately 80% of the sediment measured was deposited in the floodplain swamp.
- Areater than 50% of the sediment was deposited within the first 100 m adjacent to cultivated fields.
- aediment delivery estimates indicated that 84% to 90% of the sediment removed from cultivated fields remained in the riparian areas of a watershed. Cooper, J.R., J.W. Gilliam, R.B. Daniels, and W.P. Robarge. 1987. Riparian Areas as Filters for Agriculture Sediment. *Soil Science Society of America Journal*, 51(6):417-420.

14 - New Zealand

Riparian

Several recent studies in agricultural fields and forests showed evidence of significant nitrate removal from drainage water by riparian zones. The results of these studies showed:

- d typical removal of nitrate of greater than 85% and
- dn increase of nitrate removal by denitrification where greater contact occurred between leaching nitrate and decaying vegetative matter. Schipper, L.A., A.B. Cooper, and W.J. Dyck. 1989. Mitigating Non-point Source Nitrate Pollution by Riparian Zone Denitrification. Forest Research Institute, Rotorua, New Zealand.

15 - Georgia

Riparian

A streamside, mixed hardwood, riparian forest near Tifton, Georgia, set in an agricultural watershed was effective in retaining nitrogen (67%), phosphorus (25%), calcium (42%), and magnesium (22%). Nitrogen was removed from subsurface water by plant uptake and microbial processes. Riparian land use was also shown to affect the nutrient removal characteristics of the riparian area. Forested areas were more effective in nutrient removal than pasture areas, which were more effective than croplands. Lowrance, R.R., R.L. Todd, and L.E. Asmussen. 1983. Waterborne Nutrient Budgets for the Riparian Zone of an Agricultural Watershed. *Agriculture, Ecosystems and Environment*, 10:371-384.

16 - North Carolina

Riparian

Riparian forests are effective as sediment and nutrient (N and P) filters. The optimal width of a riparian forest for effective filtering is based on the contributing area, slope, and cultural practices on adjacent fields. Cooper, J. R., J. W. Gilliam, and T. C. Jacobs. 1986. Riparian Areas as a Control of Nonpoint Pollutants. In *Watershed Research Perspectives,* ed. D. Correll, Smithsonian Institution Press, Washington, DC.

17 - Unknown

Riparian

A riparian forest acted as an efficient sediment trap for most observed flow rates, but in extreme storm events suspended solids were exported from the riparian area. Karr, J.R., and O.T. Gorman. 1975. Effects of Land Treatment on the Aquatic Environment. In *U.S. EPA Non-Point Source Pollution Seminar*, pp. 4-1 to 4-18. U.S. Environmental Protection Agency, Washington, DC. EPA 905/9-75-007.

18 - Arkansas

Riparian

The Army Corps of Engineers studied a 20-mile stretch of the Cashe River in Arkansas where floodplain deposition reduced suspended solids by 50%, nitrates by 80%, and phosphates by 50%. Stuart, G., and J. Greis. 1991. *Role of Riparian Forests in Water Quality on Agricultural Watersheds.*

19 - Maryland

Riparian

Phosphorus export from the forest was nearly evenly divided between surface runoff (59%) and ground-water flow (41%), for a total P removal of 80%. The mean annual concentration of dissolved total P changed little in surface runoff. Most of the concentration changes occurred during the first 19 m of the riparian forest for both dissolved and particulate pollutants. Dissolved nitrogen compounds in surface runoff also declined. Total reductions of 79% for nitrate, 73% for ammonium-N and 62% for organic N were observed. Changes in mean annual ground-water concentrations indicated that nitrate concentrations decreased significantly (90-98%) while ammonium-N concentrations increased in concentration greater than threefold. Again, most of the nitrate loss occurred within the first 19 m of the riparian forest. Thus it appears that the major pathway of nitrogen loss from the forest was in subsurface flow (75% of the total N), with a total removal efficiency of 89% total N. Peterjohn, W.T., and D.L. Correll. 1984. Nutrient Dynamics in an Agricultural Watershed: Observations on the Role of a Riparian Forest. *Ecology*, 65:1466-1475.

20 - France

Riparian

Denitrification explained the reduction of the nitrate load in ground water beneath the riparian area. Models used to explain the nitrogen dynamics in the riparian area of the Lounge River indicate that the frequency, intensity, and duration of flooding influence the nitrogen-removal capacity of the riparian area.

Three management practices in riparian areas would enhance the nitrogen-removal characteristics, including:

- fiver flow regulation to enhance flooding in riparian areas, which increases the waterlogged soil areas along the entire stretch of river;
- feduced land drainage to raise the water table, which increases the duration and area of waterlogged soils; and
- fecreased deforestation of riparian forests, which maintains the amount of carbon (i.e., the energetic input that allows for microbial denitrification). Pinay, G., and H. Decamps. 1988. The Role of Riparian Woods in Regulating Nitrogen Fluxes Between the Alluvial Aquifer and Aurface Water: A Conceptual Model. *Regulated Rivers: Research and Management*, 2:507-516.

21 - Georgia

Riparian

Processes within the riparian area apparently converted primarily inorganic N (76% nitrate, 6% ammonia, 18% organic N) into primarily organic N (10% nitrate, 14% ammonia, 76% organic N). Lowrance, R.R., R.L. Todd, and L.E. Assmussen. 1984. Nutrient Cycling in an Agricultural Watershed: Phreatic Movement. *Journal of Environmental Quality*, 13(1):22-27.

22 - North Carolina

Riparian

Subsurface nitrate leaving agricultural fields was reduced by 93% on average. Jacobs, T.C., and J.W. Gilliam. 1985. Riparian Losses of Nitrate from Agricultural Drainage Waters. *Journal of Environmental Quality*, 14(4):472-478.

23 - North Carolina

Riparian

Over the last 20 years, a riparian forest provided a sink for about 50% of the phosphate washed from cropland. Cooper, J.R., and J.W. Gilliam. 1987. Phosphorus Redistribution from Cultivated Fields into Riparian Areas. *Soil Science Society of America Journal*, 51(6):1600-1604.

24 - Illinois

Riparian

Small streams on agriculture watersheds in Illinois had the greatest water temperature problems. The removal of shade increased water temperature 10-15 degrees Fahrenheit. Slight increases in water temperature over 60 øF caused a significant increase in phosphorus release from sediments. Karr, J.R., and I.J. Schlosser. 1977. *Impact of Nearstream Vegetation and Stream Morphology on Water Quality and Stream Biota*. Ecological Research Series, EPA-600/3-77-097. U.S. Environmental Protection Agency, Washington, DC.

A. Management Measure for Protection of Wetlands and Riparian Areas

Protect from adverse effects wetlands and riparian areas that are serving a significant NPS abatement function and maintain this function while protecting the other existing functions of these wetlands and riparian areas as measured by characteristics such as vegetative composition and cover, hydrology of surface water and ground water, geochemistry of the substrate, and species composition.

1. Applicability

This management measure is intended to be applied by States to protect wetlands and riparian areas from adverse NPS pollution impacts. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measure and will have flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

The purpose of this management measure is to protect the existing water quality improvement functions of wetlands and riparian areas as a component of NPS programs. The overall approach is to establish a set of practices that maintains functions of wetlands and riparian areas and prevents adverse impacts to areas serving an NPS pollution abatement function. The ecosystem and water quality functions of wetlands and riparian areas serving an NPS pollution abatement function should be protected by a combination of programmatic and structural practices.

The term *NPS pollution abatement function* refers to the ability of a wetland or riparian area to remove NPS pollutants from runoff passing through the wetland or riparian area. Acting as a sink for phosphorus and converting nitrate to nitrogen gas through denitrification are two examples of the important NPS pollution abatement functions performed by wetlands and riparian areas.

This management measure provides for NPS pollution abatement through the protection of wetland and riparian functions. The permit program administered by the U.S. Army Corps of Engineers, EPA, and approved States under section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the United States, including wetlands. The measure and section 404 program complement each other, but the focus of the two is different.

The measure focuses on nonpoint source problems in wetlands, as well as on maintaining the functions of wetlands that are providing NPS pollution abatement. The nonpoint source problems addressed include impacts resulting from upland development and upstream channel modifications that erode wetlands, change salinity, kill existing vegetation, and upset sediment and nutrient balances. The section 404 program focuses on regulating the discharge of dredged or fill materials in wetlands, thereby protecting wetlands from physical destruction and other pollutant problems that could result from discharges of dredged or fill material.

The nonpoint source pollution abatement functions performed by wetlands and riparian areas are most effective as parts of an integrated land management system that combines nutrient, sediment, and soil erosion control. These areas consist of a complex organization of biotic and abiotic elements. Wetlands and riparian areas are effective in removing suspended solids, nutrients, and other contaminants from upland runoff, as well as maintaining stream channel temperature (Table 7-1). In addition, some studies suggest that wetland and riparian vegetation acts as a nutrient sink (Table 7-1), taking up and storing nutrients (Richardson, 1988). This function may be related to the age of the wetland or riparian area (Lowrance et al., 1983). The processes that occur in these areas include sedimentation, microbial and chemical decomposition, organic export, filtration, adsorption, complexation, chelation, biological assimilation, and nutrient release.

Pollutant-removal efficiencies for a specific wetland or riparian area may be the result of a number of different factors linked to the various removal processes:

1. Frequency and duration of flooding;
2. Types of soils and slope;
3. Vegetation type;
4. The nitrogen-carbon balance for denitrifying activity (nitrate removal); and
5. The edge-to-area ratio of the wetland or riparian area.

Watershed-specific factors include land use practices and the percentage of watershed dominated by wetlands or riparian areas.

A study performed in the southeastern United States coastal plain illustrates dramatically the role that wetlands and riparian areas play in abating NPS pollutants. Lowrance and others (1983) examined the water quality role played by mixed hardwood forests along stream channels adjacent to agricultural lands. These streamside forests were shown to be effective in retaining nitrogen, phosphorus, calcium, and magnesium. It was projected that total conversion of the riparian forest to a mix of crops typically grown on uplands would result in a twenty-fold increase in nitrate-nitrogen loadings to the streams (Lowrance et al., 1983). This increase resulted from the introduction of nitrates to promote crop development and from the loss of nitrate removal functions previously performed by the riparian forest.

3. Management Measure Selection

Selection of this management measure was based on:

1. The opportunity to gain multiple benefits, such as protecting wetland and riparian area systems, while reducing NPS pollution;
2. The nonpoint pollution abatement function of wetlands and riparian areas, i.e., their effectiveness in reducing loadings of NPS pollutants, especially sediment, nitrogen, and phosphorus, and in maintaining stream temperatures; and
3. The localized increase in NPS pollution loadings that can result from degradation of wetlands and riparian areas.

Separate sections below explain each of these points in more detail.

a. Multiple Benefits

The preservation and protection of wetlands and riparian areas are encouraged because these natural systems have been shown to provide many benefits, in addition to providing the potential for NPS pollution reduction (Table 7-2 *(15k)*). The basis of protection involves minimizing impacts to wetlands and riparian areas serving to control NPS pollution by maintaining the existing functions of the wetlands and riparian areas, including vegetative composition and cover, flow characteristics of surface water and ground water, hydrology and geochemical characteristics of substrate, and species composition (Azous, 1991; Hammer, 1992; Mitsch and Gosselink, 1986; Reinelt and Horner, 1990; Richter et al., 1991; Stockdale, 1991).

Wetlands and riparian areas perform important functions such as providing a source of food for a variety of wildlife, a source of nesting material, habitat for aquatic animals, and nursery areas for fish and wildlife (Atcheson et al., 1979). Animals whose development histories include an aquatic phaseÄamphibians, some reptiles, and invertebratesÄneed wetlands to provide aquatic habitat (Mitsch and Gosselink, 1986). Other important functions of wetlands and riparian areas include floodwater storage, erosion control, and ground-water recharge. Protection of wetlands and riparian areas should allow for both NPS control and other corollary benefits of these natural aquatic systems.

b. Nonpoint Pollution Abatement Function

Table 7-1 is a representative listing of the types of research results that have been compiled to document the effectiveness of wetlands and riparian areas in serving an NPS pollution abatement function. Wetlands and riparian areas remove more than 50 percent of the suspended solids entering them (Karr and Gorman, 1975; Lowrance et al., 1984; Stuart and Greis, 1991). Sixty to seventy-five percent of total nitrogen loads are typically removed from surface and ground waters by wetlands and riparian areas (Cooper, 1990; Jacobs and Gilliam, 1985; James et al., 1990; Lowrance et al., 1983; Lowrance et al., 1984; Peterjohn and Correll, 1984; Pinay and Decamps, 1988; Stuart and Greis, 1991). Phosphorus removal in wetlands and riparian areas ranges from 50 percent to 80 percent (Cooper and Gilliam, 1987; Peterjohn and Correll, 1984; Stuart and Greis, 1991).

c. Degradation Increases Pollution

Tidal wetlands perform many water quality functions; when severely degraded, however, they can be a source of nonpoint pollution (Richardson, 1988). For example, the drainage of tidal wetlands underlain by a layer of organic peat can cause the soil to rapidly decompose and release sulfuric acid, which may significantly reduce pH in surrounding waters. Removal of wetland or riparian area vegetation along the shorelines of streams, bays, or estuaries makes these areas more vulnerable to erosion from storm events, wave action, or concentrated runoff. Activities such as channelization, which modify the hydrology of floodplain wetlands, can alter the ability of these areas to retain sediment when they are flooded and result instead in erosion and a net export of sediment from the wetland (Reinelt and Horner, 1990).

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

- *a. Consider wetlands and riparian areas and their NPS control potential on a watershed or landscape scale.*

Wetlands and riparian areas should be considered as part of a continuum of filters along rivers, streams, and coastal waters that together serve an important NPS abatement function. Examples of the practice were outlined by Whigham and others (1988). They found that a landscape approach can be used to make reasonable decisions about how any particular wetland might affect water quality parameters. Wetlands in the upper parts of the drainage systems in particular have a greater impact on water quality. Hanson and others (1990) used a model to determine the effect of riparian forest fragmentation on forest dynamics. They concluded that increased fragmentation would lead to lower species diversity and an increased prevalence of species that are adapted to isolated conditions. Naiman and others (1988) discussed the importance of wetlands and riparian areas as boundary ecosystems, providing a boundary between terrestrial and aquatic ecosystems. Wetlands and riparian areas are particularly sensitive to landscape changes and fragmentation. Wetland and riparian boundaries covering large areas may persist longer than those on smaller spatial scales and probably have different functional values (Mitsch, 1992).

Several States have outlined the role of wetlands and riparian areas in case studies of basinwide and statewide water quality plans. A basinwide plan for the restoration of the Anacostia River and associated tributaries considered in detail the impacts of wetlands creation and riparian plantings (USACE, 1990). In Louisiana and Washington State, EPA has conducted studies that use the synoptic approach to consider wetlands' water quality function on a landscape scale (Abbruzzese et al., 1990a, 1990b). The synoptic approach considers the environmental effects of cumulative wetlands losses. In addition, this approach involves assembling a framework that ranks watersheds according to the relative importance of wetland functions and losses. States are also encouraged to refine their water quality standards applicable to wetlands by assigning wetlands-specific designated uses to classes of wetlands.

- *b. Identify existing functions of those wetlands and riparian areas with significant NPS control potential when implementing NPS management practices. Do not* *alter wetlands or riparian areas to improve their water quality function at the expense of their other functions.*

In general, the following practices should be avoided: (1) location of surface water runoff ponds or sediment retention basins in healthy wetland systems and (2) extensive dredging and plant harvesting as part of nutrient or metals management in natural wetlands. Some harvesting may be necessary to control the invasion of exotic plants. Extensive harvesting for surface water runoff or nutrient management, however, can be very disruptive to the existing plant and animal communities.

- *c. Conduct permitting, licensing, certification, and nonregulatory NPS pollution abatement activities in a manner that protects wetland functions.*

There are many possible programs, both regulatory and nonregulatory, to protect wetland functions. Table 7-3 contains a representative listing of Federal, State, and Federal/State programs whose primary goals involve the identification, technical study, or management of wetlands protection efforts. Table 7-4 *(31k)* provides a list of Federal programs involved in the protection and restoration of wetlands and riparian areas on private lands. Federal programs with cost-share funds are designated as such in Table 7-4 *(31k)*. The list of possible programmatic approaches to wetlands protection includes the following:

Acquisition. Obtain easements or full acquisition rights for wetlands and riparian areas along streams, bays, and estuaries. Numerous Federal programs, such as the U.S. Department of Agriculture (USDA) Wetlands Reserve, administered by USDA's Agricultural Stabilization and Conservation Service (USDA-ASCS) with technical assistance provided by USDA's Soil Conservation Service (USDA-SCS) and U.S. Department of the Interior - Fish and Wildlife Service (USDOI-FWS), and the Fish and Wildlife Service North American Waterfowl Management Plan can provide assistance for acquiring easements or full title. Acquisition of water rights to ensure maintenance of minimum instream flows is another means to protect riparian/wetland areas, and it can be a critical issue in the arid West. In Arizona, The Nature Conservancy has acquired an instream water rights certificate for its Ramsey Canyon preserve in the Huachuca Mountains. The certificate gives the Arizona Nature Conservancy the legal right to maintain instream flows in the stretch of Ramsey Creek along their property, which in turn preserves instream and riparian habitat and wildlife (Andy Laorenzi, personal communication, 5 October 1992). in turn preserves instream and riparian habitat and wildlife (Andy Laurenzi, personal communication, 5 October 1992).

Zoning and Protective Ordinances. Control activities with a negative impact on these targeted areas through special area zoning and transferable development rights. Identify impediments to wetland protection such as excessive street standards and setback requirements that limit site-planning options and sometimes force development into marginal wetland areas.

Baltimore County, Maryland, has adopted legislation to protect the water quality of streams, wetlands, and floodplains that requires forest buffers for any activity that is causing or contributing to pollution, including NPS pollution, of the waters of the State. Baltimore County has also developed management requirements for the forest buffers, including those located in wetlands and floodplains, that specify limitations on alteration of the natural conditions of these resources. The provisions call for public and private improvements to the forest buffer to abate and prevent water pollution, erosion, and sedimentation of stream channels and degradation of aquatic and riparian habitat.

Water Quality Standards. Almost all wetlands are *waters of the United States*, as defined in the Clean Water Act. Ensure that State water quality standards apply to wetlands. Consider natural water quality functions when specifying designated uses for wetlands, and include biological and hydrologic narrative criteria to protect the full range of wetland functions.

The State of Wisconsin has adopted specific wetlands water quality standards designed to protect the sediment and nutrient filtration or storage function of wetlands. The standards prohibit addition of those substances that would "otherwise adversely impact the quality of other waters of the State" beyond natural conditions of the affected wetland. In addition, the State has adopted criteria protecting the hydrologic conditions in wetlands to prevent significant adverse impacts on water currents, erosion or sedimentation patterns, and the chemical and nutrient regimes of the wetland. Wisconsin has also adopted a sequenced decision-making process for projects potentially affecting wetlands that considers the wetland dependency of a project; practicable alternatives; and the direct, indirect, and cumulative impacts of the project.

Regulation and Enforcement. Establish, maintain, and strengthen regulatory and enforcement programs. Where allowed by law, include conditions in permits and licenses under CWA .401, .402, and .404; State regulations; or other regulations to protect wetlands.

Restoration. Programs such as USDA's Conservation Reserve and Wetlands Reserve Program provide opportunities to set aside and restore wetlands and riparian areas. Also, incentives that encourage private restoration of fish and wildlife productivity are more cost-effective than Federal acquisition and can in turn reduce property tax receipts by local government.

Education and Training. Educate farmers, urban dwellers, and Federal agencies on the role of wetlands and riparian areas in protecting water quality and on best management practices (BMPs) for restoring stream edges. Teach courses in simple restoration techniques for landowners.

Comprehensive Watershed Planning. Provide a mechanism for private landowners and agencies in mixed-ownership watersheds to develop, by consensus, goals, management plans, and appropriate practices and to obtain assistance from Federal and State agencies. Establish a framework for multiagency program linkage, and present opportunities to link implementation efforts aimed at protection or restoration of wetlands and riparian areas. EPA's National Estuary Program and the Fish and Wildlife Service's Bay/Estuary Program are excellent examples of this multiagency approach. A number of State and Federal agencies carry out programs with compatible NPS pollution reduction goals in the coastal zone. For example, Maryland's Nontidal Wetlands Protection Act encourages development of comprehensive watershed plans for addressing wetlands protection, mitigation, and restoration issues in conjunction with water supply issues. In addition, the U.S. Army Corps of Engineers (USACE) administers the CWA .404 program; USDA implements the Swampbuster, Conservation Reserve, and Wetlands Reserve Programs; EPA, USACE, and States work together to perform advanced identification of wetlands for special consideration (.404); and States administer both the Coastal Zone Management (CZM) program, which provides opportunity for consistency determinations, and the CWA .401 certification program, which allows for consideration of wetland protection and water quality objectives.

As an example of a linkage to protect NPS pollutant abatement and other benefits of wetlands, a State could determine under CWA .401 a proposed discharge or other activity in a wetland that is inconsistent with State water quality standards. Or, if a proposed permit is allowed contingent upon mitigation by creation of wetlands, such mitigation might be targeted in areas defined in the watershed assessment as needing restoration. Watershed- or site-specific permit conditions may be appropriate (e.g., specific widths for streamside management areas or structures based on adjacent land use activities). Similarly, USDA's Conservation Reserve Program or Wetlands Reserve Program could provide landowner assistance in areas identified by the NPS program as needing particular protection or riparian area reestablishment.

- *d. Use appropriate pretreatment practices such as vegetated treatment systems or detention or retention basins (Chapter 4) to prevent adverse impacts to wetland functions that affect NPS pollution abatement from hydrologic changes, sedimentation, or contaminants.*

For more information on the technical implementation and effectiveness of this practice, refer to Management Measure C in this chapter and Sections II.A and III.A of Chapter 4.

5. Costs for All Practices

This section describes costs for representative activities that would be undertaken in support of one or more of the practices listed under this management measure. The description of costs is grouped into the following categories:

1. For implementation of practice "a": costs for mapping, which aids in locating wetlands and riparian areas in the landscape and determining their relationship to land uses and their potential for NPS pollution abatement.
2. For implementation of practices "b" and "c": costs for wetland and riparian area protection programs.
3. For implementation of practice "d": costs for pretreatment such as filter strips, constructed wetlands, and detention or retention basins.

a. Mapping

The identification of wetlands within the watershed landscape, and their NPS pollution abatement potential, involves using maps to determine the characteristics as described in the management measure. These may include vegetation type and extent, soil type, distribution of fully submerged and partially submerged areas within the wetland boundary, and location of the boundary between wetlands and uplands. These types of features can be mapped through a variety of methods.

Lower levels of effort would characteristically involve the acquisition and field-checking of existing maps, such as those available for purchase from the U.S. Fish and Wildlife Service in the National Wetlands Inventory and U.S. Geological Survey (USGS) land use maps (information on these maps is available by calling 1-800-USA-MAPS). An intermediate level of effort would involve the collection and analysis of remote-sensing data, such as aerial photographs or digital satellite imagery. Depending on the size of the study area and the extent of the data to be categorized, the results of photo interpretation or of digital image analysis can be manipulated manually with a computerized database or electronically with a Geographic Information System. The most costly and labor-intensive approach involves plane-table surveys of the areas to be investigated.

Three separate costs are reported below from actual examples of recent projects involving wetland identification and assessment for purposes similar to the goal of the management measure. The examples represent different levels of effort that could be undertaken in support of practice "a" under the management measure.

1. A project in Clarks Fork, Montana, used remote sensing data for identification of wetlands that were potentially impaired from NPS pollution originating in adjacent portions of the watershed. In addition to identifying the type and extent of wetlands and riparian vegetation along Clarks Fork and the tributary streams, the mapping effort categorized land use in adjoining portions of the landscape. The results were used to identify areas within the watershed that could possibly be contributing NPS pollution in runoff to the wetlands and riparian areas (Lee, 1991).
   Total costs for this project were estimated at $0.06 per acre. The items of work include project management, collection of aerial photographs, film processing, and photo interpretation (Lee, 1991).

2. Remote sensing data have also been used as part of a statewide assessment of wetlands in Wisconsin. The purpose of the project is to determine areas within the landscape where changes are occurring in wetlands. Three or four counties are evaluated each year. The results are used to provide an ongoing update of changes to wetlands characteristics such as hydrology and vegetation (Lee, 1991).
   Total costs for this project are approximately $0.07 per acre. The items of work include collection of aerial photography, film processing, photo interpretation, and development and maintenance of a Geographic Information System (Lee, 1991).

3. The National Wetlands Inventory (NWI) has maps for 74 percent of the conterminous United States, 24 percent of Alaska, and all of Hawaii. Wetlands maps have been updated for wetlands assessment in three areas of the southeastern United States. The purpose of the project is to provide current data on the distribution of wetlands for project reviews, site characterizations, and ecological assessment (Kiraly et al., 1990).
   Total costs reported for this work are listed in Table 7-5. The items of work include staff time, travel expenses, and per diem (Kiraly et al., 1990).

It is important to note that each of these three cases is presented for illustration purposes only. It is not necessary to acquire new data or maps to implement the practices and meet the management measure. Existing maps, surveys, or remotely sensed data (such as aerial photographs) can easily be used. These typically exist in files of State and local governments or educational institutions. Additional data on wetlands functions, locations, or ecological assessments can be culled from existing environmental impact statements, from old permit applications, or from watershed inventories. These sources of information in particular should be evaluated for their usefulness in categorizing historical conditions.

Where the need for new maps is recognized to meet the management measure, several Federal agencies provide mapping products that could be useful. Examples include the following:

- USDA aerial photography. Depending on the locality, this photography is available in black-and-white, color, or color-infrared (color-IR) formats.
- USGS aerial photography. A variety of photo products are available, for example, through the National Aerial Photography Program (NAPP).
- EPA Environmental Monitoring and Assessment Program (EMAP). Some opportunities for cost-shared projects are available to collect and analyze new imagery

on the ecosystem or watershed level (Kiraly et al., 1990).

b. Wetland and Riparian Area Protection Programs

Examples of programmatic costs for implementing practices "b" and "c" under this management measure include costs for personnel, the administrative costs of processing applications for permits, and costs for public information brochures and pamphlets. Since some programs may already be in place, the need for apportionment of existing programmatic capabilities to NPS-related issues regarding wetlands and riparian areas will vary widely, depending on the size of the local jurisdiction, the nature and extent of wetland and riparian ecosystems present within the jurisdictional boundaries, and the severity of the NPS problem. Other programs may need to be adapted to include NPS-related issues regarding wetlands.

Six separate examples of costs for existing State wetland programs are shown in Table 7-6 for illustrative purposes. The costs reflect a range of low to high levels of effort, as measured through the assignment of individual full-time equivalents (FTEs) and the task-specific dedication of discrete levels of clerical and administrative support. A low-level scenario consists of costs for one FTE. A high-level scenario consists of staffing of 10 or more FTEs, including clerical and administrative positions.

If the costs for individual FTEs are estimated at $50,000 each, which includes salary plus fringe benefits, then some of the reported program budgets on the list mentioned above exceed reasonable estimates of salaries. This indicates that additional funding has been allocated for activities ranging from office support to technical assistance in the field.

c. Pretreatment

The use of appropriate pretreatment practices to prevent adverse impacts to wetlands that ultimately affect NPS pollution abatement involves the design and installation of vegetated treatment systems such as vegetated filter strips or constructed wetlands, or the use of structures such as detention or retention basins. These types of systems are discussed individually elsewhere in this guidance document. Refer to Chapter 4 for a discussion of detention and retention basins. See the discussion of Management Measure C later in Chapter 7 for a description of constructed wetlands and filter strips. The purpose of each of these BMPs is to remove, to the extent practicable, excessive levels of NPS pollutants and to minimize impacts of hydrologic changes. Each of these BMPs can function to reduce levels of pollutants in runoff or to attenuate runoff volume before it enters a natural wetland or riparian area.

Whether these BMPs are used individually or in series will depend on several factors, including the quantity and quality of the inflowing runoff, the characteristics of the existing hydrology, and the physical limitations of the area surrounding the wetland or riparian area to be protected.

Costs are reported below for three potential scenarios to implement practice "d" under this management measure.

1. One filter strip at a cost of $129.00
   - Includes design and installation of a grass filter strip 1,000 feet long and 66 feet wide.
   - Most effective at trapping sediments and removing phosphorus from surface water runoff.
2. One constructed wetland at a cost of $5,000.00
   - Includes design and installation of a constructed wetland whose surface area is 0.25 acre in size. The constructed wetland is planted with commercially available emergent vegetation.
   - Most effective to remove nutrients and decrease the rate of inflow of surface water runoff into the natural wetland located further downstream.
3. One combined filter strip/constructed wetland - $5,129.00

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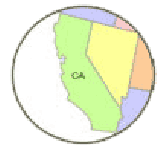
Water: Nonpoint Source Success Stories

California: Chorro Creek

Watershed Restoration Efforts Improve Dissolved Oxygen Levels

Waterbody | Problem | Project Highlights | Results | Partners & Funding

Waterbody Improved



Excess nutrients from urban and agricultural runoff in the Chorro Creek watershed contributed to the growth of nuisance algae. The breakdown of the algae caused dissolved oxygen levels in Chorro Creek to decline, preventing the creek from supporting its cold freshwater habitat designated use. As a result, California's Central Coast Regional Water Quality Control Board (CCRWQCB) added 14 miles of Chorro Creek to California's 1998 Clean Water Act (CWA) section 303(d) list of impaired waters for dissolved oxygen. Public and private landowners implemented a variety of water quality restoration efforts to reduce nutrients, including upgrading a wastewater treatment plant, restoring wetlands and stream channels, removing livestock grazing from riparian areas, and controlling erosion. Water quality improved, and the CCRWQCB has proposed removal of Chorro Creek from the state's 2008 CWA section 303 (d) list of impaired waters for dissolved oxygen.

Problem

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Chorro Creek drains into the Morro Bay Estuary (an estuary of national significance) and is on central California's coast in northern San Luis Obispo County, northwest of the city of San Luis Obispo. Chorro Creek is designated as a critical coastal area along the central coast of California. For more information, see California's Critical Coastal Areas Web site. EXIT Disclaimer

Nutrients (nitrogen and phosphorus) and elevated temperatures in Chorro Creek fuel the growth of nuisance algae, which decrease dissolved oxygen levels. Sources of nutrients in the creek include land-based nonpoint source runoff, point source discharge and animal waste. The 27,670-acre Chorro Creek watershed is composed mostly of valley grassland, coastal scrub and oak savanna, along with mixed conifer forest and oak woodlands in the upper elevations (Figure 1). The watershed supports agricultural uses, with some low-density residential and commercial areas.

The CCRWQCB first added Chorro Creek to the CWA section 303(d) list in 1998 and identified it as being impaired by nutrients. In 2004/2006 the CCRWQCB also listed Chorro Creek as impaired because of low dissolved oxygen levels.

PDF version of story
(2 pp, 388K, About PDFs)

Data show that the water quality objective for the cold freshwater habitat designated use was not being met. The numeric target used to protect the cold freshwater habitat designated use is a minimum concentration of at least 7.0 parts per million (ppm) of dissolved oxygen. This concentration is thought to be adequate to protect the creek's steelhead trout populations.
Chorro Creek stakeholders have a long history of actively addressing water quality and ecosystem health in Chorro Creek. The stakeholders' coordinated efforts to monitor and restore the waterway prompted the CCRWQCB and other agencies and organizations to nominate the watershed for the National Estuary Program.

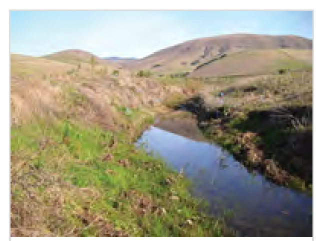

Figure 1. This fencing and revegetation project occurred along a tributary in Chorro Creek's valley grassland area.

The U.S. Environmental Protection Agency approved the Chorro Creek Nutrients and Dissolved Oxygen TMDL and Implementation Plan on July 19, 2007. The TMDL identifies the main factors influencing dissolved oxygen levels in Chorro Creek as respiration of benthic algae, lack of turbulent flow, loading of nutrients and increases in water temperature.

Project Highlights

Efforts to restore and monitor Chorro Creek have been ongoing since the early 1990s. An estimated 40 to 60 percent of managed public and private lands in the watershed are now operated with water quality management practices in place. Key projects include restoring Chorro Flats floodplain, which is designed to reestablish riparian habitat and trap sediment upstream of Morro Bay. In this project, partners converted approximately 100 acres of agricultural land to a floodplain by realigning the Chorro Creek channel (i.e., removing levees and planting appropriate native riparian vegetation to trap sediments). The project restored approximately 67 acres of riparian and wetland habitat (Figures 2 and 3).

Figure 2. A view of the Chorro Flats floodplain before the restoration.

Other projects included switching from conventional (i.e., free roaming) grazing to intensive rotational grazing with offchannel watering facilities; excluding cattle from the riparian corridor adjacent to upper Chorro Creek and Dairy Creek; and replacing an aging wastewater treatment plant at the California Men's Colony Prison (Figure 4). In addition, the CCRWQCB and the California State Polytechnic University implemented a study comparing Chumash and Walters creeks (tributaries to Chorro Creek) to evaluate and demonstrate how erosion control practices can improve water quality.

Actions implemented in the Chorro Creek watershed are consistent with Morro Bay's Comprehensive Conservation and Management Plan (CCMP). The CCMP is a state- and federally-approved plan that guides the work for the Morro Bay National Estuary Program (MBNEP).

Results

California's Central Coast Ambient Monitoring Program and MBNEP have collected and analyzed water quality samples in Chorro Creek. Data collected since 2002 show that water quality has improved. Dissolved oxygen levels have stabilized above 7.0 ppm and now consistently support the creek's cold freshwater habitat designated use.

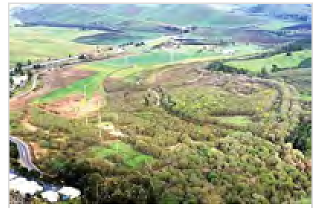

Figure 3. After restoration, Chorro Flats' channel sinuosity and riparian vegetation has been reestablished. See additional photo. EXIT Disclaimer

On the basis of these data, the CCRWQCB proposed to remove 14 miles of Chorro Creek from California's 2008 CWA section 303(d) list for its dissolved oxygen impairment. While data demonstrate that restoration efforts have restored dissolved oxygen levels, stakeholders will continue to implement practices to address the remaining nutrient impairment.

Partners and Funding

Partners involved in protecting and enhancing the Chorro Creek watershed include the Natural Resources Conservation Service, Coastal San Luis Resource Conservation District, California Coastal Conservancy, MBNEP, Farm Bureau, Bay Foundation of Morro Bay, San Luis Obispo County, California Men's Colony Prison Water Treatment Plant, Camp San Luis Obispo, U.S. Environmental Protection Agency, CCRWQCB, California State Water Resources Control Board and numerous private landowners.

Figure 4. Building this new wastewater treatment plant helped remove point source discharges from Chorro Creek.

Over the past 15 years, stakeholders have spent more than $10 million (local, state and federal dollars) to restore the Chorro Creek watershed. Approximately $4 million in CWA section 319 funds have supported planning ($300,000), monitoring ($1 million) and implementation ($2.7 million) activities. Additionally, CWA section 319 funds supported one half-time CCRWQCB staff position to support the Chumash and Walters Paired Watershed Study and the Chorro Flats floodplain and riparian corridor restoration projects.

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The Economics of Low-Impact Development: A Literature Review

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EXECUTIVE SUMMARY

Low-impact development (LID) methods can cost less to install, have lower operations and maintenance (O&M) costs, and provide more cost-effective stormwater management and water-quality services than conventional stormwater controls. LID also provides ecosystem services and associated economic benefits that conventional stormwater controls do not.

The available economic research on some of these conclusions is preliminary or limited in scope. For example, most economic studies of LID describe the costs of installing LID, or compare the costs of installing LID with the costs of installing conventional controls. Few reports quantify the economic benefits that LID can provide in addition to managing stormwater. Fewer researchers report results of studies that measure at least some costs *and* at least some benefits of LID vs. conventional controls.

The costs and benefits of LID controls can be site specific and will vary depending on the LID technology (e.g., green roof vs. bioswale), and local biophysical conditions such as topography, soil types, and precipitation. Including developers, engineers, architects and landscape architects early in the design process can help minimize the LID-specific construction costs.

Despite the fact the LID technologies have been promoted and studied since the early 1990s, for many stormwater managers and developers, LID is still a new and emerging technology. As with most new technologies, installation and other costs of LID are highest during the early phases of development and adoption. Over time, as practitioners learn more about the technology, as the number of suppliers of inputs expands, and as regulations adapt to the new technology, costs will likely decline.

Combined sewer overflows (CSO), and the resulting biophysical and economic consequences, are major concerns for municipal stormwater managers. LID can help minimize the number of CSO events and the volume of contaminated flows by managing more stormwater on site and keeping flows out of combined sewer pipes. Some preliminary evidence exists that LID can help control CSO volumes at lower cost than conventional controls.

Many municipalities have zoning and building-inspection standards in place that were adopted many years ago, long before LID was an option. Municipalities with outdated stormwater regulations typically require that builders file variances if they want to use LID controls. This can increase a builder's design and regulatory costs, which delays construction and can increase a builder's financing costs. Updating building regulations to accommodate LID can help reduce the regulatory risk and expense that builders face.

The large majority of the economic studies on LID focus on the costs of including LID in new construction. Replacing curbs, gutters and stormwater pipes with bioswales, pervious pavers and other LID controls can reduce construction costs. Protecting a site's existing drainage patterns can reduce the need for pipe infrastructure and a developer may be able to do away with surface stormwater ponds, which also increases the number of developable lots. Some researchers report that developments that emphasize LID controls and protected natural grass and forest drainage areas cost less to develop and sell for more than traditionally-developed lots with conventional stormwater controls.

Few studies considered the economic outcomes of including LID in urban redevelopment projects. Some evidence exists that LID controls cost more than conventional controls under these conditions, however, these studies excluded O&M costs of the two alternatives and the economic benefits that the LID controls can provide.

I. INTRODUCTION

Conventional stormwater controls collect stormwater from impervious surfaces, including roads, parking lots and rooftops, and transport the flow off site through buried pipes to treatment facilities or directly to receiving bodies of water. This approach efficiently collects and transports stormwater, but also can create high-velocity flows polluted with urban contaminants, including sediment, oil, fertilizers, heavy metals, and pet wastes. Such flows can erode stream banks and natural channels, and deposit pollutants that pose ecosystem and public health risks (Kloss and Calarusse 2006).The resulting ecosystem and public health consequences can create significant economic costs.

A study of the biophysical and public health damages and associated economic costs of stormwater runoff in the Puget Sound estimates these costs at over $1 billion during the next decade (Booth et al. 2006). These costs include flood-related property damage and financial losses, capital costs of new stormwater infrastructure, cleaning up stormwater-polluted water resources, and habitat restoration and protection efforts. The Natural Resources Defense Council (Kloss and Calarusse 2006) describes similar impacts attributed to conventional controls across the U.S.: stormwater sewers collect and discharge untreated stormwater to water bodies, while combined sewer and stormwater systems overflow during heavy rains, discharging both untreated sewage and stormwater into the nation's rivers and lakes. Both contribute to impaired water quality, flooding, habitat degradation, and stream bank erosion. The U.S. Environmental Protection Agency (EPA) estimates the costs of controlling combined sewer overflows (CSO) throughout the U.S. at approximately $56 billion. Developing and implementing stormwater-management programs and urban-runoff controls will cost an additional $11 to $22 billion (Kloss and Calarusse 2006).

In contrast to conventional stormwater controls, low-impact development (LID) techniques emphasize on-site treatment and infiltration of stormwater. The term low-impact development encompasses a variety of stormwater-management techniques. Examples include bioswales, rain gardens, green streets, and pervious pavers (U.S. EPA 2000). The name LID came into use around the late 1990s, however stormwater managers employed LID techniques prior to this. Technicians in Prince George's County, Maryland were some of the first to install what eventually became known as LID techniques in the early 1990s as an alternative to conventional stormwater controls. Soon after, a few communities in the Chesapeake Bay area followed, experimenting with a number of LID demonstration projects. Over time, interest in LID as an alternative or complement to conventional controls grew, and so did the number of LID demonstration projects and case studies across the United States. The EPA reviewed the early literature on LID and described their assessment of this literature in a report released in 2000 (U.S. EPA and Low Impact Development Center 2000). Their review assessed the availability and reliability of data on LID projects and the effectiveness of LID at managing stormwater. While this report focused primarily on the potential stormwater-management benefits of LID, it concluded that LID controls can be more cost effective and have lower maintenance costs than conventional stormwater controls. In December of the following year, the Center for Watershed Protection published one of the earliest studies that focused primarily on the economic aspects of "better site design," which included many LID principles (Center for Watershed Protection 2001).

The amount of information available on the economics of managing stormwater using LID has grown since the publication of these first reports. Most studies describe the costs of installing LID, or compare the costs of installing LID with the costs of installing conventional controls. Other reports focus on the economic benefits that LID can provide in addition to managing stormwater. These benefits include mitigating flooding, improving water-quality, and providing amenity values for properties adjacent to LID, such as green streets. A few—very few—researchers report results of studies that attempt to characterize at least some costs *and* at least some benefits of LID vs. conventional controls in a *single* study. In this report we summarize our review of the literature on the economic costs and benefits of managing stormwater by LID.

This literature review has three objectives. First, to describe briefly, and in plain language, the methods economists use when measuring the costs and benefits of LID and conventional stormwater controls. This information provides the reader with a context for the economic descriptions of costs and benefits that follow. Second, to summarize the literature that identifies and measures the economic costs and benefits of managing stormwater using LID, or that compares costs or benefits, or both, between LID and conventional controls. Third, to organize and present this information in a way that non-economist municipal officials, stormwater managers, ratepayer stakeholders and others can use as they consider and deliberate stormwater-management plans.

This literature review differs from literature reviews that accompany academic studies. Typically, academic literature reviews provide an introduction and a context for an analysis of a specific economic issue, e.g., a new analytical technique that measures economic benefits. In this case, the literature review is a stand-alone document that summarizes information on the broad issue of economic costs and benefits of LID. Academic literature reviews also target academic and professional economists. This literature review targets non-economist readers.

The technical effectiveness of LID stormwater controls is outside the scope of our review. Our analysis assumes that the LID techniques described in the economic studies that we reviewed provide the necessary or expected stormwater controls. As we understand, there is a growing body of literature on LID effectiveness, and we include some of these references in the Appendix to this report. Also, the more general topic of the economic values of ecosystem services, while somewhat related, was outside the scope of our review. Our analysis focused on the values of ecosystem services as affected by LID techniques.

We began our search for relevant literature by developing a list of key words with which to find reports or articles that contained relevant information. After a cursory search of LID literature, we identified LID- and economics-related key words that researchers and practitioners use when describing LID projects and analyses. The list includes words often used synonymously with LID (i.e., source control, natural drainage systems, sustainable stormwater management), or that describe a set of conservation-design strategies that include LID techniques (i.e., green infrastructure and conservation development). We also searched the literature using economics-related terms (i.e., costs, benefits, and savings). Table 1-1 lists the LID- and economics-related search terms we used in our search of the literature.

Using the terms listed in Table 1-1, we searched databases that contained the widest-possible range of sources including academic literature, reports produced by government agencies and non-profit organizations, news coverage, and articles in the popular press. These databases include information published in peer-reviewed articles, books, reports, conference papers and presentations, and web pages. Table 1-2 lists the databases included in our search.

Table 1-1: Search Terms

LID-Related Search Terms	Economics-Related Search Terms
Low-impact development	Economics
Source control	Benefits, economic benefits
Green infrastructure	Costs, economic costs
Natural drainage systems	Cost comparison
Sustainable stormwater management	Savings
Conservation development	Benefit cost analysis, cost benefit analysis
Alternative stormwater management	Cost effectiveness
Better site design	
Low-impact urban design and development	

Source: ECONorthwest

Table 1-2: Databases

Database	Description
Academic Search Premier	Index of 8,000 academic journals in the social sciences, humanities, and general science, back to 1965.
Article First	Index of 16,000 journal titles in business, humanities, popular culture, science, social science, and technology, back to 1990.
Econlit	American Economic Association's index of economic research, back to 1969.
Environmental Protection Agency (EPA) website	Database of studies, reports, educational material, and newsletters authored or supported by the EPA.
Environmental Valuation Reference Inventory (EVRI)	Database of empirical studies conducted internationally on the economic values of ecosystem services.
Google	Source for non-peer reviewed reports, articles, websites and other publications.
Journal Storage (JSTOR)	Index of over 100 major research journals in a variety of academic disciplines, some back to 1870.
Web of Science	Index of science and social science journals, back to 1975.
WorldCat	Index of bibliographic records of books, journals, manuscripts, etc. archived in university, public and private library catalogs around the world.

Source: ECONorthwest

We reviewed potential sources for relevance. If a source contained LID-related cost or benefit information, we indexed it in our own database, summarized the information on costs or benefits, and reviewed its bibliography for additional sources of information.

This report of our review of the literature is organized as follows. The next two sections provide background information to the discussion of the economic costs and benefits of managing stormwater. This background information provides a context or economic frame-of-reference that will help the reader consider the descriptions of costs and benefits that follow.

In **Section II** we list the range of benefits associated with LID, as identified in the LID literature, along with illustrations of the values of these benefits as reported in the economic literature. We found that many more reports simply list these benefits rather than quantify them.

In **Section III** we describe two of the more common methods of measuring the economic costs and benefits of stormwater controls: the cost-effectiveness and benefit-cost methods. As the names imply, cost-effectiveness studies compare alternatives looking exclusively at the alternatives' costs. This method assumes away benefits or holds them constant across alternatives. A benefit-cost analysis considers the range of costs and benefits for each alternative. The benefit-cost method has greater data demands and can be more expensive than the cost-effectiveness approach—primarily because it adds benefits into the analysis—but it can also yield a more accurate economic picture of the full range of economic consequences of implementing the alternatives.

In **Section IV** we summarize the literature that considers the costs and benefits of LID. The large majority of these studies focus exclusively on the costs of installing LID, or compare the costs of installing LID with the costs of installing conventional controls. Some studies look beyond installation costs to include operations and maintenance costs. Few studies consider both the costs and benefits of LID or compare costs and benefits of LID with conventional controls.[1] When the literature allowed, we described the economic aspects of adopting LID from the perspective of municipal decisionmakers, ratepayer stakeholders, and private developers.

In **Section V** we describe LID from the perspective of property developers. As with other new technologies, adopting LID includes opportunities and risks. We describe the risks and challenges that developers face when they include LID controls in their projects and the successes developers have had adopting LID.

In **Section VI** we discuss areas of future research that would increase our understanding of the economics of LID. For example, limited information exists on the life-cycle costs of LID, the economic benefits of LID beyond stormwater control, and the economic impacts of installing LID in urban-redevelopment settings.

The **Bibliography** lists the references we cite in this report. During our search for information on the economic aspects of LID, we encountered non-economic information that supports the use of LID. We list this information in the **Appendix** to this report.

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[1] We list the reported dollar amounts of costs and benefits without converting to current, 2007-year, dollars because in most cases, the available information prevented such a conversion.

II. ECOSYSTEM SERVICES PROVIDED OR ENHANCED BY LOW-IMPACT DEVELOPMENT

Conventional controls and LID techniques both manage stormwater flows. By promoting stormwater management on site using a variety of techniques, LID controls can provide a range of ecosystem services beyond stormwater management. Braden and Johnston (2004), Coffman (2002), and the Natural Resources Defense Council (Lehner et al. 2001) list and describe the kinds of ecosystem services that LID can provide or enhance. Taken together, these researchers describe the following ecosystem services: reduced flooding, improved water quality, increased groundwater recharge, reduced public expenditures on stormwater infrastructure, reduced ambient air temperatures and reduced energy demand, improved air quality, and enhanced aesthetics and property values. We briefly describe each of these services below.

Reduced Flooding

Braden and Johnston (2004) studied the flood-mitigation benefits of managing stormwater on site, including reduced frequency, area, and impact of flooding events. In a follow-up study, Johnston, Braden, and Price (2006) focus on the downstream benefits accrued from flood reduction accomplished by greater upstream on-site retention of stormwater. These benefits include reduce expenditures on bridges, culverts and other water-related infrastructure.

Improved Water Quality

Brown and Schueler (1997), Center for Watershed Protection (1998), U.S. EPA and Low Impact Development Center (2000), and Braden and Johnston (2004) describe the water-quality benefits that LID stormwater controls can provide. These benefits include effectively capturing oil and sediment, animal waste, landscaping chemicals, and other common urban pollutants that typically wash into sewers and receiving water bodies during storm events. Plumb and Seggos (2007) report that LID controls that include vegetation and soil infiltration, e.g., bioswales, can prevent more stormwater pollutants from entering New York City's harbor than conventional controls.

Increased Ground Water Recharge

On-site infiltration of stormwater helps recharge groundwater aquifers. According to a report by American Rivers, the Natural Resources Defense Council, and Smart Growth America (Otto et al. 2002), areas of impervious cover can significantly reduce ground water recharge and associated water supplies. The study found that impervious surfaces in Atlanta reduced groundwater infiltration by up to 132 billion gallons each year—enough water to serve the household needs of up to 3.6 million people per year.

Braden and Johnston (2004) distinguish between two services associated with increased groundwater recharge: the increased volume of water available for withdrawal and consumption, and maintaining a higher water table, which reduces pumping costs and increases well pressure.

Reduced Public Expenditures on Stormwater Infrastructure

The Center for Watershed Protection (1998), Lehner et al. (2001), and U.S. EPA (2005) report that LID techniques, such as bioswales, rain gardens, and permeable surfaces, can help reduce the demand for conventional stormwater controls, such as curb-and-gutter, and pipe-and-pond infrastructure. Braden and Johnston (2004) report that retaining stormwater runoff on site reduces the size requirements for downstream pipes and culverts, and reduces the need to protect stream channels against erosion.

Two recent studies by the Natural Resources Defense Council (Kloss and Calarusse 2006) and Riverkeeper (Plumb and Seggos 2007) report that by managing stormwater on site, LID techniques can help reduce combined sewer overflows. Combined sewer systems transport both sewage and stormwater flows. Depending on the capacity of the pipes and the amount of rainfall, the volume of combined sewer and stormwater flows can exceed the capacity of the pipes when it rains. When this happens, overflows of sewage and stormwater go directly to receiving bodies of water untreated. LID helps to keep stormwater out of the combined system, which reduces CSO events. Thurston (2003) found that decentralized stormwater controls, such as LID, can control CSO events at a lower cost than conventional controls.

Reduced Energy Use

LID techniques, such as green roofs and shade trees incorporated into bioswales and other controls can provide natural temperature regulation, which can help reduce energy demand and costs in urban areas. Plumb and Seggos (2007) estimate that covering a significant amount of the roof area in New York City with green roofs could lower ambient air temperatures in summer by an estimated 1.4 degrees Fahrenheit. The U.S. EPA and Low Impact Development Center (2000) report that the insulation properties of vegetated roof covers can help reduce a building's energy demand, and notes that green roofs in Europe have successfully reduced energy use in buildings.

Improved Air Quality

Trees and vegetation incorporated into LID help improve air quality by sequestering pollutants from the air, including nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter (American Forests 2000-2006). In a study by Trees New York and Trees New Jersey, Bisco Werner et al. (2001) report similar air-quality benefits of trees and vegetation in urban areas. Plumb and Seggos (2007) cite one study that found that a single tree can remove 0.44 pounds of air pollution per year.

Enhanced Aesthetics and Property Values

Several studies including Lacy (1990), Mohamed (2006), U.S. Department of Defense (2004), and Bisco Werner et al. (2001) report that the natural features and vegetative cover of LID can enhance an area's aesthetics, and increase adjacent property values. The U.S. Department of Defense (2004) highlights how LID can improve the aesthetics of the landscape and increase adjacent property values by providing architectural interest to otherwise open spaces. On commercial sites, Bisco Werner et al. (2001) found that LID on commercial sites provided amenities for people living and working in the area and complemented the site's economic vitality, which improved its competitive advantage over similar establishments for customers and tenants.

III. Economic Framework: Measuring Costs and Benefits of Low-Impact Development

Researchers and practitioners assess the economic aspects of LID using several methodologies. These methodologies range from rough cost evaluations, that compare a subset of costs of LID against the same costs for conventional management techniques, to benefit-cost analyses, that compare a range of costs and benefits of LID to the same for conventional stormwater controls. This section examines the differences in these methodologies.

Most economic evaluations of LID reported in the literature emphasize costs. The overwhelming majority of these studies confined their analyses to measuring installation costs. Evaluators prefer this method perhaps because from a developer's perspective, installation cost is one of the most important considerations when choosing between LID or conventional controls. LID can compare favorably with conventional controls in a side-by-side analysis of installation costs (*see for example* Foss 2005; Conservation Research Institute 2005; U.S. EPA 2005; Zickler 2004), however, focusing on installation costs misses other relevant economic information. For example, such a focus excludes operation and maintenance (O & M) costs, differences in the effectiveness of LID versus conventional systems, and the environmental and economic benefits that LID can provide, but which conventional controls cannot.

Evaluating projects based on installation costs has advantages of costing less than studies that include other economic factors, e.g., O & M costs, taking less time than more extensive analyses, and relying on readily available construction-cost data. The tradeoff for stormwater managers is an incomplete and possibly biased description of economic consequences, especially over the long term.

Some researchers look beyond comparisons of installation costs and evaluate LID and conventional controls using a method know as a life-cycle cost analysis (LCCA) (Powell et al. 2005; Sample et al. 2003; Vesely et al. 2005). This approach considers a comprehensive range of stormwater-management costs including planning and design costs, installation costs, O & M costs, and end-of-life decommissioning costs. An LCCA method requires more data than a comparison of installation costs, and this data, particularly data on lifetime O & M costs, may not exist or is difficult and costly to obtain. The tradeoff for policy makers is more accurate information on the cost implications of alternative stormwater-management options. However, LCCA, like more limited cost comparisons, excludes measures of economic benefits.

Another limitation of cost comparisons is that they ignore differences in effectiveness between LID and conventional controls. For this reason, researchers recommend that LCCA should compare projects that provide the similar levels of services (Powell et al. 2005). Brewer and Fisher (2004), Horner, Lim, and Burges (2004), and Zielinski (2000) found, however, that LID approaches can manage stormwater quantity and quality more effectively than the conventional approaches, either controlling more flow, or filtering more pollutants, or both. In these cases, an LCCA study could conclude that an LID option costs more than the conventional control, without accounting for the fact that the LID option can manage a larger volume of stormwater.

The benefit-cost approach overcomes the limitations of simple cost comparisons or LCCA by considering the full range of costs and benefits of alternative management options. The tradeoff is that the benefit-cost approach requires more data than cost comparison, which increases the time and costs of conducting the economic analysis.

The benefit-cost approach evaluates the net economic benefits of a project, or compares outcomes among projects, by comparing relevant costs with relevant economic benefits (Boardman et al. 2005; Field and Field 2006; Gramlich 1990; Kolstad 2000). Economic researchers in academic, business, and public-policy sectors have for many years conducted benefit-cost analyses in a wide variety of applications. Since at least the middle of the twentieth century, economic evaluations of large-scale public projects included some type of benefit-cost analysis, and since 1981, the federal government required that new programs and regulations include a benefit cost analysis (Freeman 2003). The U.S. Office of Management and Budget (OMB) considers the benefit-cost method the "recommended" technique when conducting formal economic analyses of government programs or projects (U.S. OMB 1992). Over the years, the technique has grown more sophisticated, especially with respect to measuring and incorporating non-market goods and services, such as the values of ecosystem services (Croote 1999).

The economic literature on benefit-cost analysis is voluminous and growing, but the basic process can be broken into four steps (Field and Field 2006).[2]

1. The first step defines the scope of the analysis, including the population that will experience the benefits and costs, and the elements of the project, including location, timing, and characteristics of the work to be done.

2. The second step determines a project's full range of inputs and effects, from the planning and design phase through the end of the project's lifespan.

3. The third step identifies and, where possible, quantifies the costs and benefits resulting from the project's inputs and effects. Where quantification is not possible, qualitatively describe the cost or benefit in as much detail as possible, including degree of uncertainty and expected timing of impacts (long-term or short-term).

4. The final step compares the benefits and costs of the project, either in terms of net benefits (the total benefits minus the total costs) or in terms of a benefit-cost ratio (the amount of benefits produced per unit of cost). If relevant, compare results among alternative projects.

We found few benefit-cost evaluations of LID projects. The large majority of studies estimate installation costs, a few consider additional costs, such as O & M costs, and a handful compared some measures of costs against some measures of benefits. The reported benefit-cost studies of LID include Bachand (2002) and Fine (2002),[3] Devinny

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[2] For a more complete discussion of benefit-cost analysis, see Field and Field (2006), Gramlich (1990) and Harberger and Jenkins (2002).

[3] We reviewed summaries of Bachand (2002) and Fine (2002) because we were unable to acquire copies of the full articles.

et al. (2005), and Doran and Cannon (2006). Data limitations may explain part of the reason for the limited number of benefit-cost analyses of LID. This is especially true for lifetime O & M costs and the economic importance of LID benefits. Sample et al. (2003), Powell et al. (2005), Johnston, Braden, and Price (2006), and Conservation Research Institute (2005), among others, describe the need for more research quantifying the benefits of LID practices.

Another reason may be that economic benefits or lifetime O & M costs have no relevance to a given economic study. For example, property developers pay installation costs of stormwater controls, but not lifetime O & M costs. Nor do they benefit directly from the ecosystem services that LID can enhance or provide. Economic results reported by developers will therefore likely focus exclusively on installation costs of LID or compare installation costs for LID and conventional controls.

Using the benefit-cost approach has challenges that the other analytical methods do not. However, benefit-cost analysis has advantages in that it can provide decisionmakers, ratepayers and other stakeholders with a more complete picture of the economic consequences of stormwater-management alternatives than other analytical methods. This is especially true for costs and benefits of alternatives over the long term. In situations in which time, budget, or other information constraints limit quantifying economic benefits or costs, the next best alternative is identifying the range of costs and benefits, quantifying what can be measured and describing the remaining impacts qualitatively. The federal government takes this approach in that the OMB recommends that when benefits and costs cannot be quantified, agencies should provide qualitative descriptions of the benefits and costs. These qualitative descriptions should include the nature, timing, likelihood, location, and distribution of the unquantified benefits and costs (U.S. OMB 2000).

IV. Costs and Benefits of Low-Impact Development

The large majority of literature that describe economic assessments of LID focus on the costs of installing the technology. Most studies report the costs of building LID stormwater controls, or compare the costs of installing LID to the costs of conventional controls. The organization of this section reflects this emphasis in the literature. We begin by summarizing studies that list the costs of installing various LID techniques. Most of these reports describe the outcomes of case studies of LID installed as new or developing stormwater-management technologies. We then discuss studies that compare the costs of building LID controls with the costs of building conventional controls.

A number of researchers looked beyond installation costs and considered the impacts that operations and maintenance costs can have on economic evaluations of LID. Analysts sometimes refer to these as life-cycle studies because they consider the relevant costs throughout the useful life of a technology. We summarize three studies that took this approach with LID evaluations.

Combined sewer overflows, and the resulting biophysical and economic consequences, are major concerns for municipal stormwater managers. LID can help minimize the number of CSO events and the volume of contaminated flows by managing more stormwater on site and keeping flows out of combined sewer pipes. We summarize five studies that evaluated the costs of managing CSO events using LID.

A relatively small percentage of the economic evaluations of LID reported in the literature include assessments of the economic benefits of the technology. We summarize a number of these reports at the end of this section.

A. Cost of Low-Impact Development

Brown and Schueler (1997) surveyed construction costs for different methods of managing stormwater in urban areas. Their survey emphasized conventional controls but also included a number of LID techniques. At the time of their study, LID techniques were considered “next generation” best-management practices (BMPs). The report lists construction costs for sixty-four BMPs including wet and dry stormwater ponds, bioretention areas, sand filters and infiltration trenches. The authors’ major conclusion is that a BMP’s construction cost increases with the volume of stormwater the BMP stores. The report’s construction costs may be out-of-date, however they provide insights into relative cost differences between LID and other controls listed in the report.

In a more recent study, Tilley (2003) reports construction costs for LID case studies implemented in Puget Sound and Vancouver, B.C. The report describes a range of case studies from small-scale projects implemented by homeowners to large installations completed by universities, developers and municipal governments. The LID techniques studied include rain gardens, permeable pavement and green roofs. The amount of cost information varies by case study. In some cases the report lists per-unit costs to install an LID, e.g., a pervious concrete project cost $1.50 per square foot for materials (excluding labor). Other descriptions report costs generally, but not costs specific to the case study described, e.g., the cost for pervious concrete is typically $6 to $9 per square foot. Some descriptions have no cost information, and others list total construction costs without a detailed breakdown of cost components.

The U.S. Department of Defense (DoD) (2004) developed a manual of design guidelines to incorporate LID into DoD facilities. The manual describes 13 stormwater-management techniques and their most appropriate uses, maintenance issues, and cost information. The list of LID techniques includes bioretention, grassed swales, and permeable pavers. The manual describes costs in some detail but also notes the site-specific nature of construction costs and factors that can influence construction costs for certain LIDs.

Liptan and Brown (1996) describe one of the earliest comparisons of construction costs for LID with that for conventional controls.[4] They focus on two projects in Portland, Oregon, which they refer to as the OMSI and FlexAlloy projects, and the Village Homes development in Davis, California. In all cases, the LID option cost less. The LID design implemented at the OMSI project saved the developer $78,000 in construction costs by reducing manholes, piping, trenching, and catch basins. At the FlexAlloy site, the City of Portland conducted a retrospective study of LID vs. conventional development, after the builder installed conventional controls. The City calculated that the developer could have saved $10,000 by implementing the LID option. The description of the FlexAlloy case study includes a detailed comparison of construction costs for the two options. The Village Homes case study concluded that by using vegetated swales, narrow streets, and a cluster layout of building lots, the developer saved $800 per lot, or $192,000 for the development. The Village Homes description includes no additional details on construction costs for the two options. The report also includes brief descriptions of other LID case studies, some with cost comparisons for LID vs. conventional controls. The authors conclude that involving developers, engineers, architects and landscape architects early in the design of a development that includes LID can help minimizing the LID-specific construction costs.

Hume and Comfort (2004) compared the costs of constructing conventional roads and stormwater controls with the costs of building LID options, such as bioretention cells and pervious pavement. The researchers added complexity to some of their comparisons by paring the same conventional and LID controls, e.g., infiltration trench (conventional) vs. bioretention cell (LID) on a different soil types and with different sources of stormwater runoff (e.g., driveway vs. roof top) to see how this affected construction costs. In some comparisons the LID option cost more than the conventional option, in other cases the results were opposite. These comparisons illustrate the site-specific nature of LID construction costs. Local conditions, e.g., less pervious soils, can influence the costs of LID controls.

In some cases, LID can help lower construction costs by making use of a site's existing or undisturbed drainage conditions in ways that conventional controls cannot. Planners of a 44-acre, 80-lot residential development in Florida took advantage of the site's natural drainage patters to help lower stormwater-management costs (PATH 2005). The site's low-lying areas convey the large majority of stormwater runoff to forested basins. The developer minimized disturbing natural drainage patterns by clustering building sites and connecting sites with narrow roads. Relying on natural infiltration and drainage patterns help the developer save $40,000 in construction costs by avoiding the costs of constructing stormwater ponds.

[4] In this Section we describe some of the developments associated with costs comparisons reported in the LID literature. The next Section focuses on LID from the perspective of property developers and contractors. In that Section we list results for a larger number of cost comparisons

Comparing construction costs between LID and conventional options, while informative, provides no information on the relationship between the cost and effectiveness. For example, in cases where the LID option costs more to build, it may also control a larger volume of stormwater relative to the conventional option. LID that keeps stormwater out of pipes and treatment facilities help lower operations and maintenance (O & M) costs, and help extend the useful life of the infrastructure, which can reduce future construction costs. The relative importance of construction or O & M costs depends on who pays for them. Builders likely focus exclusively on construction costs, however, cost and effectiveness information would help stormwater managers better evaluate control options and plan for future demands on stormwater infrastructure.

Brewer and Fisher (2004) report the results of four case studies that compared the cost and effectiveness of LID to that of conventional controls. The case studies modeled stormwater costs and conditions on four developments: high- and medium-density residential, an elementary school, and a commercial development. In both residential developments LID controls cost less than conventional controls. LID cost more for the school and commercial development. However, in all four cases, the LID option managed a larger volume of stormwater than the conventional option. We reproduce Brewer and Fisher's results in Table 4-1.

Table 4-1: Comparison of Runoff Controlled and Cost Savings for Conventional and LID Design.

Site Example	Runoff Storage (acre-feet)		LID Net Cost or Savings
	Conventional	LID	
Medium Density Residential	1.3	2.5	$476,406
Elementary School	0.6	1.6	$(48,478)
High Density Residential	0.25	0.45	$25,094
Commercial	0.98	2.9	$(9,772)

Source: Brewer and Fisher 2004

We calculated the economic value of the additional storage provided by the LID designs reported in Brewer and Fisher (2004), using data on the national average of construction costs as reported by American Forests. American Forests' CITYgreen analyses calculate the national-average cost of storing 1 acre-foot of runoff at $87,120.[5] American Forests uses a value of $2.00 per cubic foot of storage, obtained from national estimates of stormwater construction costs. This amount represents the avoided costs of not building stormwater detention ponds. This value may vary, depending on a project's location. In some of its analyses, American Forests uses local estimates of construction costs, which can be lower or higher than the national average. For example, American Forests uses

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[5] *See, for example,* American Forests. 2003. *Urban Ecosystem Analysis: San Diego, California*. July. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_SanDiego.pdf, American Forests. 2003. *Urban Ecosystem Analysis: Buffalo-Lackawanna Area, Erie County, New York*. June. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_Buffalo.pdf.

$0.66 per cubic foot of storage in Houston, TX,[6] $5.00 per cubic foot of storage in the Washington D.C. Metro Area,[7] and $6.00 per cubic foot of storage in Portland, OR.[8] Table 4-2 shows the results of our calculation.

Table 4-2: Value of the Difference in Runoff Storage Provided by LID Designs.

Site Example	Runoff Storage (acre-feet)			Runoff Storage Difference (cubic-feet)[a]	Value of Difference in Runoff Storage ($2/cf)
	Conventional	LID	Difference		
Medium Density Residential	1.3	2.5	1.2	52,272	$104,544
Elementary School	0.6	1.6	1	43,560	$87,120
High Density Residential	0.25	0.45	0.2	8,712	$17,424
Commercial	0.98	2.9	1.92	83,635	$167,270

Source: ECONorthwest
Notes: [a] To convert from an acre foot to cubic feet, multiply by 43,560 (the number of cubic feet in an acre-foot).

Based on the results reported in Table 4-1, and taking the perspective of a builder, LID is the higher-cost alternative for the school and commercial development. Including the results from Table 4-2, and taking the perspective of a municipal stormwater manager—that is, considering construction costs and the cost savings associated with reductions in stormwater volume in our example calculation above—the LID option dominates the conventional choice in all four cases. The LID options control a larger volume of stormwater, which helps avoid municipal expenditures on stormwater management.

Doran and Cannon (2006) studied the relationship between construction costs of LID and conventional controls and effectiveness as measured by improvements in water quality. They studied the impacts of incorporating LID into a downtown redevelopment project in Caldwell, Idaho. The analysis modeled construction costs and improvements to water quality as measured by reduced concentrations of sediment and phosphorus in stormwater runoff. The LID techniques used in the project included permeable pavers, bioretention swales, riparian wetlands, and plantings of restored native vegetation. The study evaluated the LID and conventional controls using the cost of a 1-percent reduction in sediment and phosphorus concentrations. Conventional stormwater controls had lower

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[6] American Forests. 2000. *Urban Ecosystem Analysis for the Houston Gulf Coast Region*. December. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_Houston.pdf.

[7] American Forests. 2002. *Urban Ecosystem Analysis: The District of Columbia*. February. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_WashingtonDC2.pdf.

[8] American Forests. 2001. *Regional Ecosystem Analysis for the Willamette/Lower Columbia Region of Northwestern Oregon and Southwestern Washington State*. October. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_Portland.pdf.

installation costs, but also had a lesser impact on water quality. Conventional controls cost $8,500 and reduced sediment and phosphorus concentrations by 5 percent, or $1,700 per percent reduction. LID stormwater controls cost more, $20,648, but had a greater impact on water quality, reducing sediment by 32 percent and phosphorus by 30 percent. The authors calculated a cost of $645 per percent reduction for the LID option. The LID option produced a better return on initial investment, as measured by improvements to water quality, than did investments in conventional controls.

As the previous two studies illustrate, comparing LID and conventional controls based on costs may bias the assessment against the most effective management option, and the option that yields the greatest return on investment. LID may cost more to build, but from an investment perspective, it may also control more stormwater and better improve water quality. The studies above considered separately LID effectiveness as measured by volume of stormwater managed and improvements in water quality of stormwater runoff. A more complete and accurate assessment of effectiveness and costs would consider the impacts on both in a single study. That is, compare LID and conventional controls based on costs and effectiveness as measured by volume of stormwater *and* water quality. We found no such studies in the literature.

Looking beyond construction costs to O & M and other costs gives a more complete description of the economic consequences of adopting LID or conventional controls. Sample et al. (2003) promotes evaluating stormwater BMPs using life-cycle-cost (LCC) analysis. LCC analysis includes the initial capital expenditures for construction, planning, etc., and the present value of lifetime O & M costs, and the salvage value at the end of the BMP's useful life. In addition, the authors suggest including the opportunity cost of land in the cost analysis. BMPs that occupy more land area have a higher opportunity cost valued at the next-best use for the land, e.g., residential value.

Vesely et al. (2005) compared the LCC for LID controls in the Glencourt Place residential development in Auckland, New Zealand with LCC results for conventional controls. The LID option had the added benefit of reusing stormwater collected on site as grey water for laundry, flushing toilets and irrigation. The LID option had LCCs that were 4 to 8 percent higher than the conventional option, depending on the discount rate and number of years in the analysis. These results do not account for the value of recycled stormwater. Including the avoided cost associated with water saved by recycling stormwater as household gray water, the LCC for the LID option were 0 to 6 percent higher, again, depending on the discount rate and number of future years in the analysis. The authors conclude that accounting for the value of water saved, the LID option was cost competitive with the conventional approach, as measured by the LCC method.

Data constraints on this study included difficulty estimating current and future maintenance costs and future decommissioning costs. Accounting for the opportunity cost of land also proved challenging give the available data. Data limitations also prevented the authors from considering the economic aspects of environmental externalities associated with the LID and conventional options.

LCC evaluations are an improvement over comparisons of construction costs in that they provide a more comprehensive assessment of relevant costs. On the other hand, LCC analyses require more data and results are sensitive to the discount rate applied to future values and the number of years of the analysis. Powell et al. (2005) underscore these advantages and challenges associated with LCC analysis. They recommend a checklist of factors to consider when conducting a LCC for LID and conventional controls. The checklist includes *quantitative* assessments of the components of LCC costs including acquisition, construction, O & M, and salvage value. Also included are *qualitative* assessments of the effectiveness of managing stormwater and the benefits attributed to the management option. The authors note that effectively and accurately implementing LCC analyses for LID will require more research into the costs of LID design, construction and O & M. Further research is also need in assessing the monetary benefits of LID controls.

Despite the fact that LID technologies have been promoted and studied since the early 1990s, in many ways, and to many stormwater managers, LID is still a new and emerging technology (Coffman 2002). As with most new technologies, installation and other costs for LID are highest during the early phases of development and adoption. Over time, as practitioners learn more about the technology, as the number of suppliers of inputs increases, and as regulations adapt to the new technology, costs will likely decline.

Foss (2005) describes this relationship between a learning curve and construction costs for greenstreet technology in Seattle. The city spent $850,000 implementing a greenstreet pilot project, known as the "Street Edge Alternative" (SEA) street. The City's street planners expect that based on their experience with the pilot project, building greenstreets in the future will cost substantially less. Foss quotes the manager of the City's surface water program on this point:

> *"You could take $200,000 off the price just from what we didn't know. … The pilot phases that we are currently in are more expensive, but as the project becomes institutionalized, all the costs will come down. Even still, these projects are less expensive than standard projects." (p. 7)*

B. Costs of Managing Combined Sewer Overflows By Low-Impact Development

One of the earliest studies of the economic aspects of managing combined sewer overflows by LID evaluated a project that disconnected downspouts as a means of reducing the number of CSO events and costs (Kaufman and Wurtz 1997). In 1994, the Beecher Water District (BWD) near Flint, Michigan, provided free downspout diversions from home sites to sanitary-sewer pipes for the 6,020 residential customers in their service area. The purpose of the program was to reduce the volume of sewer flows from the BWD to the City of Flint's stormwater facility—and reduce the fees that BWD paid the city to manage these flows—and reduce the number and volume of CSO events in the BWD.

The program was a success on many levels and is an example of a small-scale and inexpensive approach that effectively managed CSO events. Disconnecting downspouts cost the BWD just over $15,000. After the diversions, the mean volume of sewer flows measured across all precipitation events decreased 26 percent. The program saved the BWD over $8,000 per month in reduced fees to the City of Flint's stormwater facility, and in reduced costs of managing CSO events. The program paid for itself in two months. Other benefits included reduced CSO-related customer complaints, improved recharge of groundwater and reduced pollution of the Great Lakes, the receiving waters for CSO from the District.

In another study looking at controlling CSO events on a smaller scale, Thurston et al. (2003) modeled the costs of CSO controls for a small watershed in Cincinnati, Ohio. The modeling exercise was part of a study that evaluated the theoretical considerations of developing a market for tradable stormwater credits as a means of reducing CSO events and costs. One part of the study compared the construction costs of controlling CSO events by building tunnels and storage vaults with the costs of building LID controls on each of the 420 mostly-residential lots in the study area.

They calculated that building the tunnel and vault option would cost between $8.93 to $11.90 per cubic foot of storage capacity. Building LID controls on individual lots would cost $5.40 per cubic foot of capacity. Based on these results the researchers suggest that the costs of managing CSOs by implementing LID throughout the watershed would cost less than building a large centralized tunnel and vault system to store excess flows. They also note, however that their analysis does not include the opportunity cost of land that the LID controls would occupy, and so the cost of the LID option would be higher than they report. Their analysis also excludes O & M costs for both options, as well as the costs of education and outreach to property owners, and managing the construction of a large number of dispersed LID projects as components of the LID option. The project also excludes the economic benefits of the LID option.

Kloss and Calarusse (2006) developed a set of policy guidelines for decisionmakers interested in implement LID controls as a means of reducing CSO events in their jurisdictions. Regarding the costs of LID controls, the authors distinguish between new and retrofit construction projects. In new developments, they conclude, LID typically cost less than conventional stormwater controls. They note, however, that retrofit developments in urban areas that include LID typically cost more than conventional controls. This is especially true for individual, small-scale retrofit projects. The relative costs of LID controls can be reduced when they are incorporated into larger-scale redevelopment projects. The report provides conclusions with limited details on cost information. The report also describes the experiences of nine municipalities across the country that include LID in their policies to control CSO events and related costs.

Montalto et al. (2007) described the relationship between public agencies tasked with controlling CSO events, and private land owners on whose property the large majority of LID controls would be sited. The public agencies benefit from the reduced stormwater flows and CSO events that LID provides. The land owner, however, pays the LID installation and O & M costs, but may see little benefit beyond reduced stormwater fees or increased property values from LID such as greenstreets. These benefits may not outweigh the costs to the land owner, and so they may choose not to install LID controls. Given this disconnect, the authors note the benefits of public policies, incentives and subsidies to promote LID adoptions by private-property owners.

In an effort, in part, to measure the amount of subsidy that may be required, the authors developed a model to assess the cost-effectiveness of mitigating CSO events in urban areas using LID. They applied their model to a case study in the Gowanus Canal area of Brooklyn, NY. The case study compared the costs of installing porous pavement, green roofs, wetland developments and other LID throughout the study area to the costs of installing storage tanks to catch excess stormwater flows. As part of their analysis they collected and report installation and O & M costs for a range of LID techniques.

They conclude that under a range of cost and performance assumptions, LID installed throughout the study area could potentially reduce the number of CSO events and volume at a cost that would be competitive or less than the costs of the conventional storage-tank option. They note that they could improve the performance of their model if more data were available on LID performance, costs and public acceptance.

Plumb and Seggos (2007) studied the impacts of diverting monies currently designated to building storage tanks and other conventional CSO controls for New York City to building LID controls throughout the city. They compared the effectiveness of storage tanks and LID controls based on gallons of stormwater managed per $1,000 invested. We reproduce their results in Table 4-3 below. Except for greenroofs, the LID options control more stormwater per $1,000 invested than the conventional storage-tank option.

Table 4-3: Gallons of Stormwater Managed per $1,000 Invested.

Stormwater Control	Gallons per $1,000 Invested
Conventional Storage Tanks	2,400
Greenstreet	14,800
Street Trees	13,170
Greenroof	810
Rain Barrel	9,000

Source: Plumb and Seggos 2007

They describe their analysis as a simple and preliminary cost comparison and conclude that their results demonstrate that LID controls can be cost competitive with conventional controls, if not more so. The authors recommended further detailed study of the issue. Their analysis focused on the costs of LID vs. conventional controls and did not consider economic benefits of the LID techniques.

C. Economic Benefits of Low-Impact Development

Many reports and articles describe the potential benefits that LID stormwater controls can provide—benefits that conventional controls can not offer.[9] Very few studies, however, quantify these benefits, either in biophysical measures or in dollar amounts. A study by CH2MHill (2001) is a typical example. The analysis compared the costs and benefits of managing stormwater in two residential developments using LID or conventional controls. The cost analysis included detailed information for the LID and conventional controls. In this case, results of the cost analysis were mixed. In one development the LID option cost less to build and in the other development the conventional control cost less. In both cases the LID option had higher maintenance costs but homeowners would benefit from lower stormwater and water fees.

[9] We list a number of these sources in Section II of this report.

The analysis of benefits included much less detailed information. The study lists the benefits that the LID option would provide, benefits that the conventional approach would not. These benefits include reduced auto traffic, increased open space, improved downstream water quality, and increased groundwater recharge. However, the benefits were not quantified in dollar amounts.

In another example, Bachand (2002) studied the costs and benefits of developing wetlands as a stormwater management option. The analysis described the construction and O & M costs associated with the wetlands option, and the benefits including adding new recreational opportunities, increased wildlife habitat and increase property values for near-by homeowners. However, they did not measure the benefits in economic terms. An accompanying study by Fine (2002) quantified some of the recreational benefits that derive from wildlife watching in the wetlands, but left unquantified the benefits of other direct uses of the wetlands, as well as the value of habitat improvements and other non-use benefits.[10]

When researchers cite the needs for further research into LID-related topics, quantifying benefits and measuring their economic importance invariably makes the list. For example, Sample et al. (2003) cites the need for more research into measuring the technical and economic benefits of LID, including benefits to downstream receiving waters. Powell et al. (2005) note the need for more research into monetary measures of the benefits of LID, e.g., the impact that a greenstreet can have on adjacent property values. Vesely et al. (2005) state that future studies should include not only the economic benefits of LID but also the negative economic impacts of conventional controls. Failing to do so will continue biasing management decisions in favor of conventional controls:

> *"Exclusive reliance on profitability and market value will favour [sic] the conventional approach to stormwater management by disregarding both the negative environmental externalities associated with this approach, and the positive environmental externalities associated with the low impact approach." (page 12)*

A number of studies do measure some of the economic benefits of on-site stormwater controls. For example, Braden and Johnson (2004) studied the economic benefits that on-site stormwater management could have on properties downstream. The researchers first estimated the impacts that on-site stormwater controls could have on the frequency and extent of downstream flooding. Using information reported in the literature on the extent to which property markets discount the value of properties in a floodplain, they approximated the economic value of reduced flooding attributed to on-site management of stormwater. They then calculated the value of avoided flood damage as a percentage of property values. They estimate that a marginal reduction in flooding would increase property values 0 to 5 percent for properties in a floodplain, depending on the extent to which the on-site controls reduce stormwater runoff.

They then took a similar approach to valuing improvements in water quality. Based on values reported in the literature, they estimate that the benefits of improved water quality could reach 15 percent of market value for properties that border the water body at issue

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[10] We were unable to obtain a copy of the full report. We base our description on a summary of the analysis.

if water quality improves significantly. The increase is much less for smaller improvements in water quality, for undeveloped properties, and for properties not adjacent to the water body.

They conclude with a best-guess estimate of a 2 to 5 percent increase in property values for properties in a floodplain from on-site management of stormwater. Other benefits that could not be quantified or valued given available information include reduced infrastructure expenditures for culverts, bridges and other drainage infrastructure.

In a follow-up case study, Johnston, Braden, and Price (2006) applied the analytical method developed in the previous study to properties in the one-hundred-year floodplain portion of a watershed in the Chicago area. They estimate the economic benefit of avoided flooding two ways and extend the analysis to approximate reduced municipal expenditures on culverts.

Applying the 0 to 5 percent impact on property values calculated in the previous study to properties in the case study, the researchers estimated an economic benefit of $0 to $7,800 per acre of increased property value attributed to reduced flooding. They also calculated the economic benefit of reduced flooding based on the avoided flood damage to structures and contents for properties in the floodplain. This analytical method included data compiled by the U.S. Army Corps of Engineers on the relationship between flooding and damages to properties in floodplains. This approach yields an economic benefit of avoided flooding of $6,700 to $9,700 per acre for properties in the floodplain.

The researchers approximate that for the case-study portion of the watershed, conservation-design practices such as LID techniques that retain more stormwater on site and reduce flooding could generate $3.3 million in avoided costs for road culverts.

The estimated economic benefit of increased on-site management of stormwater for properties in the case study for both avoided flooding and reduced municipal expenditures on culverts is $380 to $590 per acre.

A series of analyses by American Forests (2000-2006) report the economic benefits of stormwater services provided by trees in various cities and regions throughout the United States. These reports describe results from American Forests' CITYgreen model, which calculates the volume of stormwater absorbed by existing tree canopies and estimates the avoided costs in stormwater management that the trees provide. The model includes city-specific per-unit stormwater-management costs when available. The model substitutes national per-unit costs when city-specific data are not available. In Table 4-4 below we report the results for some of American Forests' city and regional analyses. The dollar amounts represent the costs of expanding stormwater infrastructure to manage the stormwater that existing trees otherwise absorb and transpire.

Table 4-4: Avoided stormwater-construction costs attributed to trees, as measured by the American Forests' CITYgreen model.

Urban Area	Amount that trees save in one-time stormwater-construction costs
Houston, Texas	$1.33 billion
Atlanta, Georgia	$2.36 billion
Vancouver, Washington/ Portland-Eugene, Oregon	$20.2 billion
Washington D.C. Metro Area	$4.74 billion
New Orleans, Louisiana	$0.74 billion
San Antonio, Texas	$1.35 billion
San Diego, California	$0.16 billion
Puget Sound Metro Area, Washington	$5.90 billion
Detroit, Michigan	$0.38 billion
Chesapeake Bay Region	$1.08 billion

Source: American Forests 2000-2006

The Bisco Werner et al. (2001) analysis of the economic benefits of trees attributed to stormwater management also employed the CITYgreen model. Researchers applied the CITYgreen model to a case study that included the commercial corridor along a major highway through central New Jersey. The analysis modeled the change in tree canopy between 1975 and 1995, and calculated the value of lost stormwater services. During this time, the value of services declined from $1.1 million to $896,000, a 19-percent reduction. If existing trends continue, the expected value in 2015 will be $715,000, a 35-percent reduction relative to the value of services available in 1975. As services supplied by street trees declines, demand on municipal stormwater controls, and associated costs, increase.

The researchers extended their study to include the economic benefits of tree cover attributed to removing air pollutants. This portion of their analysis studied the tree cover at a number of commercial properties in the New York and New Jersey area. In this case the CITYgreen model calculated avoided stormwater-construction costs associated with stormwater services provided by trees on site and, using values reported in the literature, the amounts of air pollutants absorbed by trees, and the per-unit value for each pollutant.

In one case study of a shopping mall, the analysis estimated that the trees currently on the site manage approximately 53,000 cubic feet of stormwater. The CITYgreen model estimated the value of the associated avoided infrastructure costs at just over $33,000. The value of air-pollutant removed is estimated at $1,441 per year. The report lists results for fifteen such case studies.

Wetlands that absorb stormwater runoff can help minimize stormwater-related management and infrastructure costs. Depending on their location and makeup, wetlands may provide other benefits, such as wildlife habitat and recreational opportunities. Fine (2002)[11] studied the recreational benefits provided by wetlands proposed as part of the Treasure Island redevelopment in San Francisco Bay. The analysis assumes that the wetlands will attract visitors year round, with the winter months providing the best opportunity to view migratory birds. Based on recreational expenditures for similar sites in the San Francisco Bay area, Fine calculates that area visitors will spend $4 to $8 million annually. Other benefits that Fine was unable to quantify and value include fisheries enhancement and water-quality services.

Devinny et al. (2005) developed a first-approximation of a benefit-cost analysis of complying with water-quality requirements throughout Los Angeles County using LID and other stormwater BMPs. They present their analysis as an alternative to the approach described by Gordon et al. (2002), which relies on collecting and treating the county's stormwater using conventional controls. The Devinny et al. approach assumes widespread adoption of LID and other on-site stormwater BMPs.

The Devinny et al. analysis accounts for the fact that the density of existing development will limit the extent to which LID and other BMPs can be retrofitted into developments. As an alternative they propose a combination of LID and BMPs along with directing stormwater to regional wetlands and other infiltration systems. As the density of development increases, so does the size and costs of developing regional wetlands.

This study differs from other benefit-cost analyses of stormwater-management options in that the researchers quantify a range of potential benefits associated with the approach that emphasizes on-site treatment of stormwater. They estimate the cost of their approach at $2.8 billion if disbursed LID and other on-site BMPs sufficiently control stormwater quality. Costs increase to $5.7 to $7.4 billion if regional wetlands and other infiltration systems are needed. This approach costs less than the estimated cost of $44 billion to implement the option that emphasizes conventional controls (California Department of Transportation 2005).

The estimated value of the economic benefits of implementing LID, other on-site BMPs and regional wetlands range from $5.6 to $18 billion. Benefits include the economic aspects of reduced flood control, increased property values adjacent to new greenspaces and wetlands, additional groundwater supplies, improved beach tourism, and reduced sedimentation of area harbors. The conventional approach would provide none of these economic benefits.

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[11] We were unable to obtain a copy of the full report. We base our description on a summary of the analysis.

V. Developers' Experiences With Low-Impact Development

Baring regulations that mandate LID controls, developers adopt LID because they help reduce construction costs, increase sales, boost profits, or some combination of the three. These deliberations focus primarily on the extent to which local property markets account for the direct costs and benefits that LID can provide. Typically these deliberations do not include indirect costs and benefits and the potential non-market impacts of LID that may be important to others such as municipal stormwater managers and area residents. These non-market impacts may include reduced downstream flooding, improved water quality and habitat of water bodies that receive stormwater, reduced CSO events, or impacts on the costs of operating municipal-stormwater infrastructure.

In this section we summarize developers' experiences installing LID. As with other new technologies, adopting LID includes opportunities and risks. We begin by describing the risks and challenges that developers face by including LID in their projects. These risks include uncertain construction delays as the developer applies for variances to local zoning codes because the codes do not explicitly recognize LID as an accepted stormwater control.

Next, we describe some of the efforts by municipal governments to reduce the developers' regulatory risk and uncertainty of using LID. Finally, we list some of the successes developers have had adopting LID and the resulting impacts on construction costs, sales, and profits.

A. Challenges Developers Face Using LID

Much of the general public is still unaware of LID attributes, the benefits they can provide, or their O & M costs. As such, they may not understand or appreciate why a developer included LID in a project. This may give developers pause because they supply products that they believe their customers—homebuyers—want and will purchase. Potential buyers may shy away from homes that include an unfamiliar technology.

A general lack of understanding of LID may concern developers in part because including on-site treatment of stormwater will also require on-site management of stormwater facilities, the LID technologies. Homeowners unfamiliar with LID likely will have no understanding of their maintenance requirements (Lewis 2006; England 2002; Foss 2005). For example, a bioswale clogged with sediment may not control stormwater volume or quality, which could negatively reflect on the builder. Another concern has to do with the lack of understanding as to the life-expectancy of LID controls (Lewis 2006). A builder may be concerned that an untimely failure of stormwater controls could negatively affect their reputation.

Similar to the public's general lack of understanding of LID, many builders are also unfamiliar with the technology. A builder may not be able to identify the most effective and least-cost LID technology for a given development from the wide variety of possible LID controls (Foss 2005; Lewis 2006). A related point is that construction costs for LID technologies are site specific. For example, not all soils can support LID technologies that emphasize stormwater infiltration. Assessing a site and designing LID technologies that will function on the site may also increase a builder's design costs (Coffman 2002; Strassler et al. 1999).

A much-mentioned impediment to builders' adoption of LID is building codes that do not account for LID as stormwater controls. Many municipalities have zoning and building-inspection standards in place that were adopted many years ago, long before LID was an option (Coffman 2002; NAHB Research Center Inc. 2003; Foss 2005; Lewis 2006). These standards emphasize conventional stormwater controls that collect stormwater and transport it off site to a receiving body of water or to a treatment facility. Municipalities with outdated stormwater regulations typically require that builders file variances if they want to use LID controls. Filing variances for LID increases design and regulatory costs, which delays construction and can increase a builder's financing costs (Clar 2004; Coffman 2002; Lewis 2006; NAHB Research Center Inc. 2003).

A related constraint in some jurisdictions with outdated regulations is a lack of technical expertise or understanding by regulators regarding LID stormwater controls. In some cases, regulators unfamiliar with LID technology must be convinced of their effectiveness, which also increases a builder's design and regulatory costs (Coffman 2002; NAHB 2003; Lewis 2006).

B. Municipal Actions To Increase LID Adoption On Private Developments

Some jurisdictions help promote LID adoption on private lands and take steps that reduce the regulatory uncertainty and risk that builders face when including LID in private developments. These jurisdictions may have CSO problems, or are trying to extend the useful life of their stormwater infrastructure in the face of increasing population and economic activity. In any case, they recognize the importance of managing as much stormwater on site as possible and keeping it out of the jurisdiction's stormwater pipes.

One way that jurisdictions promote LID adoption on private lands is by updating their zoning codes and building-inspection standards to explicitly address LID stormwater controls (Coffman 2002; NAHB Research Center Inc. 2003; Foss 2005; Lewis 2006). This helps reduce a builder's regulatory risk because it eliminates the need to file variances. Rather than spending time convincing regulators as to the desirable stormwater attributes or effectiveness of LID controls, builders can instead proceed with their development.

Granting density bonuses for developments that install LID stormwater controls is another way jurisdictions encourage the proliferation of LID techniques. In this case, the jurisdiction grants the developer a greater number of individual building lots than would have been allowed if the development relied on conventional stormwater controls (Coffman 2002; NAHB Research Center Inc. 2003). This type of incentive not only reduces a builder's regulatory risk, and associated costs, but also increases the number of lots that can be sold, which can increase the builder's revenue and profits. Jurisdictions also promote LID installation on private lands by reducing development-related fees, such as inspection fees (Coffman 2002; NAHB Research Center Inc. 2003).

C. Benefits To Developers of Including LID Controls in Their Projects

Developers who accept the regulatory uncertainty and other challenges of adopting LID do so with the expectation that controlling stormwater on site can have economic advantages. These advantages include increasing the number of developable lots and reducing expenditures associated with stormwater infrastructure. Managing stormwater on site using LID controls can mean doing away with stormwater ponds, thus increasing a site's developable area (Coffman 2002; NAHB Research Center Inc. 2003). Selling additional lots can increase a builder's revenues and profits. Replacing curbs, gutters and stormwater pipes with bioswales, pervious pavers and other LID controls reduces construction costs for some developers (Coffman 2002; NAHB Research Center Inc. 2003; Center for Watershed Protection 2001).

An analysis of a development in Prince George's County, Maryland, documented the impacts that controlling stormwater on site with LID can have on the site's buildable area and construction costs. The Somerset Community development installed rain gardens, grass swales along streets, and other LID controls. Substituting LID for conventional controls saved the developer approximately $900,000. Doing away with the site's stormwater ponds gave the developer six additional lots (Foss 2005).

A study of the Pembroke Woods Subdivision in Frederick County, Maryland found similar results (Clar 2004). The developer substituted LID for conventional controls, doing away with curbs, gutters, sidewalks, and eliminated two stormwater ponds. Eliminating the curbs and gutters saved the developer $60,000. Installing narrower streets eliminated impervious area and reduced paving costs by 17 percent. Excluding the stormwater ponds saved $200,000 in construction costs and added two developable lots, valued at $45,000 each. Other economic benefits to the developer include reduced costs of clearing land for development of $160,000, and adding 2.5 additional acres of open space, which reduced the developer's wetland-mitigation requirements.

Conservation subdivisions take a comprehensive approach to stormwater management by combining LID controls with a site design that takes advantage of existing drainage patterns. Narrow streets and clustered building lots make maximum use of natural stormwater controls, thus reducing construction costs (Center for Watershed Protection 2001). A study of ten subdivisions found that conservation subdivisions that emphasized LID and protected natural drainage patterns cost, on average, thirty-six percent less than subdivisions that relied on conventional stormwater controls (Conservation Research Institute 2005).

Researchers note that some conservation subdivisions have an additional benefit in that there's greater demand for lots in these subdivisions compared with the demand for lots in conventional subdivisions. Greater demand for lots means the developer can charge more for the lot and lots may sell faster (Center for Watershed Protection 2001).

A case study of conservation and conventional subdivisions in South Kingstown, Rhode Island quantified the market benefits of conservation developments. The study compared the costs of developing the lots and the market value of the lots (Mohamed 2006). Results show that conservation lots cost less to develop and sell for a higher price. On average, conservation lots cost $7,400 less to produce than lots in conventional subdivisions, and sold for 12 to 16 percent more, per acre, than conventional lots. Lots in the conservation subdivision also sold in approximately half the time as lots in conventional subdivisions.

Another study of cluster developments in New England found that houses in these types of developments appreciate faster than houses in conventional developments (Lacy 1990). Lacy identified developments in Concord and Amherst, Massachusetts that were characterized by smaller individual lots surrounded by natural open space, limited lot clearing, and narrower streets. He compared these with nearby conventional developments. The Concord cluster development appreciated 26 percent more than conventional developments over an eight-year study period. The Amherst cluster development also yielded a higher rate of return on investment over a 21-year study period, compared to nearby conventional development.

In Tables 5-1 and 5-2 below we summarize the results of studies that compared construction costs using LID vs. conventional stormwater controls for residential and commercial developments (respectively). We included information in the tables if a study described the source of the cost difference, e.g., substituting a bioswale for curbs and gutters saved $Z. We excluded studies that reported a cost difference, but did not describe the details of the cost comparison. We found many studies in the literature that did not provide details of cost comparisons.

We distinguish between study results for built developments from results for proposed or modeled developments. In some cases the studies report total cost savings for a development but not savings per lot in the development. In these cases we calculated the per-lot cost savings. We recognize that the cost savings values reported below are in dollars from different years, and so comparisons of cost savings between examples may not be appropriate. We found insufficient data in most case studies to convert all values to the same-year dollars.

The large majority of studies listed in Tables 5-1 and 5-2 describe LID installed or proposed to be installed in new developments. We found very few studies that measured the economic outcomes of including LID stormwater controls in urban, redevelopment projects. We identified these studies as “retrofits” in the tables.

Table 5-1: Cost savings attributed to installing LID stormwater controls in residential developments.

Location	Description	LID Cost Savings[a]
Meadow on the Hylebos Residential Subdivision Pierce County, WA	9-acre development reduced street width, added swale drainage system, rain gardens, and a sloped bio-terrace to slowly release stormwater to a creek. Stormwater pond reduced by 2/3, compared to conventional plan. (Zickler 2004)	LID cost 9% less than conventional
Somerset Community Residential Subdivision Prince George's Co., MD	80-acre development included rain gardens on each lot and a swale drainage system. Eliminated a stormwater pond and gained six extra lots. (NAHB Research Center Inc. 2003)	$916,382 $4,604 per lot
Pembroke Woods Residential Subdivision Frederick County, MD	43-acre, 70-lot development reduced street width, eliminated sidewalks, curb and gutter, and 2 stormwater ponds, and added swale drainage system, natural buffers, and filter strips. (Clar 2004; Lehner et al. 2001)	$420,000 $6,000 per lot[b]
Madera Community Residential Subdivision Gainesville, FL	44-acre, 80-lot development used natural drainage depressions in forested areas for infiltration instead of new stormwater ponds. (PATH 2005)	$40,000 $500 per lot[b]
Prairie Crossing Residential Subdivision Grayslake, IL	667-acre, 362-lot development clustered houses reducing infrastructure needs, and eliminated the need for a conventional stormwater system by building a natural drainage system using swales, constructed wetlands, and a central lake. (Lehner et al. 2001; Conservation Research Institute 2005)	$1,375,000- $2,700,000 $3,798-$7,458 per lot[b]
SEA Street Retrofit Residential street retrofit Seattle, WA	1-block retrofit narrowed street width, installed swales and rain gardens. (Tilley 2003)	$40,000
Gap Creek Residential Subdivision Sherwood, AK	130-acre, 72-lot development reduced street width, and preserved natural topography and drainage networks. (U.S. EPA 2005; Lehner et al. 2001; NAHB Research Center Inc. 2003)	$200,021 $4,819 per lot
Poplar Street Apartments Residential complex Aberdeen, NC	270-unit apartment complex eliminated curb and gutter stormwater system, replacing it with bioretention areas and swales. (U.S. EPA 2005)	$175,000
Kensington Estates* Residential Subdivision Pierce County, WA	24-acre, 103-lot hypothetical development reduced street width, used porous pavement, vegetated depressions on each lot, reduced stormwater pond size. (CH2MHill 2001; U.S. EPA 2005)	$86,800 $843 per lot[b]
Garden Valley* Residential Subdivision Pierce County, WA	10-acre, 34-lot hypothetical development reduced street width, used porous paving techniques, added swales between lots, and a central infiltration depression. (CH2MHill 2001)	$60,000 $1,765 per lot[b]
Circle C Ranch Residential Subdivision Austin, TX	Development employed filter strips and bioretention strips to slow and filter runoff before it reached a natural stream. (EPA 2005)	$185,000 $1,250 per lot

Location	Description	LID Cost Savings[a]
Woodland Reserve* Residential Development Lexana, KS	Reduced land clearing, reduced impervious surfaces, and added native plantings. (Beezhold 2006)	$118,420
The Trails* Multi-Family Residential Lexana, KS	Reduced land clearing, reduced impervious surfaces, and added native plantings. (Beezhold 2006)	$89,043
Medium Density Residential* Stafford County, VA	45-acre, 108-lot clustered development, reduced curb and gutter, storm sewer, paving, and stormwater pond size. (Center for Watershed Protection 1998b)	$300,547 $2,783 per lot[b]
Low Density Residential* Wicomico County, MD	24-acre, 8-lot development eliminated curb and gutter, reduced paving, storm drain, and reforestation needs. Eliminated stormwater pond and replaced with bioretention and bioswales. (Center for Watershed Protection 1998b)	$17,123 $2,140 per lot[b]

Source: ECONorthwest, with data from listed sources.
Notes: * indicates hypothetical or modeled project, not actually constructed.
[a] Dollar amounts as reported at the time of study.
[b] Per-lot cost savings calculated by ECONorthwest.

Table 5-2: Cost savings attributed to installing LID stormwater controls in commercial developments.

Location	Description	LID Cost Savings[a]
Parking Lot Retrofit Largo, MD	One-half acre of impervious surface. Stormwater directed to central bioretention island. (U.S. EPA 2005)	\$10,500-\$15,000
Old Farm Shopping Center* Frederick, MD	9.3-acre site redesigned to reduce impervious surfaces, added bioretention islands, filter strips, and infiltration trenches. (Zielinski 2000)	\$36,230 \$3,986 per acre[b]
270 Corporate Office Park* Germantown, MD	12.8-acre site redesigned to eliminate pipe and pond stormwater system, reduce impervious surface, added bioretention islands, swales, and grid pavers. (Zielinski 2000)	\$27,900 \$2,180 per acre[b]
OMSI Parking Lot Portland, OR	6-acre parking lot incorporated bioswales into the design, and reduced piping and catch basin infrastructure. (Liptan and Brown 1996)	\$78,000 \$13,000 per acre[b]
Light Industrial Parking Lot* Portland, OR	2-acre site incorporated bioswales into the design, and reduced piping and catch basin infrastructure. (Liptan and Brown 1996)	\$11,247 \$5,623 per acre[b]
Point West Shopping Center* Lexana, KS	Reduced curb and gutter, reduced storm sewer and inlets, reduced grading, and reduced land cost used porous pavers, added bioretention cells, and native plantings. (Beezhold 2006)	\$168,898
Office Warehouse* Lexana, KS	Reduced impervious surfaces, reduced storm sewer and catch basins, reduced land cost, added bioswales and native plantings. (Beezhold 2006)	\$317,483
Retail Shopping Center*	9-acre shopping development reduced parking lot area, added porous pavers, clustered retail spaces, added infiltration trench, bioretention and a sand filter, reduced curb and gutter and stormwater system, and eliminated infiltration basin. (Center for Watershed Protection 1998b)	\$36,182 \$4,020 per acre[b]
Commercial Office Park*	13-acre development reduced impervious surfaces, reduced stormwater ponds and added bioretention and swales. (Center for Watershed Protection 1998b)	\$160,468 \$12,344 per acre[b]
Tellabs Corporate Campus Naperville, IL	55-acre site developed into office space minimized site grading and preserved natural topography, eliminated storm sewer pipe and added bioswales. (Conservation Research Institute 2005)	\$564,473 \$10,263 per acre[b]
Vancouver Island Technology Park Redevelopment Saanich, British Columbia	Constructed wetlands, grassy swales and open channels, rather than piping to control stormwater. Also used amended soils, native plantings, shallow stormwater ponds within forested areas, and permeable surfaces on parking lots. (Tilley 2003)	\$530,000

Source: ECONorthwest, with data from listed sources.
Notes: * indicates hypothetical or modeled project, not actually constructed.
[a] Dollar amounts as reported at the time of study.
[b] Per-acre cost savings calculated by ECONorthwest.

VI. Directions for Future Research

Despite the increasing use of LID stormwater controls, and the growing number of economic studies of this technique, our literature review found areas for further research. These areas include:

- Additional research that quantifies the costs and benefits of stormwater management. This includes economic research on the lifetime O & M costs for LID and conventional controls, as well as, studies that quantify the economic benefits of LID methods.

- More detailed information on costs associated with LID. Specifically, information on the factors that contribute to cost savings or cost increases of LID relative to conventional controls.

- Economic studies of LID and conventional methods that control for the effectiveness of the techniques regarding managing stormwater volumes and improving water quality. Comparing LID techniques that cost more to install than conventional methods, but control larger amounts of stormwater, is an apples-to-oranges comparison.

- The large majority of economic studies of LID methods apply to new construction. More research is needed on the economic outcomes of including LID methods in urban redevelopment projects.

- Some preliminary evidence exists that LID can help control CSO volumes at a lower cost than conventional controls. Stormwater managers and public-policy decisionmakers would benefit from additional economic research on this topic.

- Economic studies that model theoretical LID and conventional controls, while informative, may be less convincing to some stormwater managers, decisionmakers and ratepayer stakeholders than retrospective studies of installed controls.

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APPENDIX: ADDITIONAL LOW-IMPACT DEVELOPMENT RESOURCES

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FEASIBILITY STUDY

FOR THE REMOVAL OF
CONCRETE LINING IN LAS VIRGENES CREEK
DOWN STREAM OF MEADOW CREEK LANE

JULY 2005

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FEASIBILITY STUDY

FOR REMOVAL OF CONCRETE LINING IN LAS VIRGENES CREEK
DOWN STREAM OF MEADOW CREEK LANE
CITY OF CALABASAS, CALIFORNIA

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1. INTRODUCTION

The City of Calabasas has contract Willdan to provide Engineering Services to prepare a Preliminary Feasibility Study investigating the feasibility of removing the failed concrete channel lining in the Las Virgenes Creek between Meadow Creek Lane and Lost Hills Road and restoring the existing channel within this reach to a naturalized streambed. Figure “A” shows the general project location within the City limits.

2. BACKGROUND

This specific project was identified in the "Las Virgenes, McCoy, and Dry Canyon Creeks Master Plan, Phase I: Comprehensive Study" document, dated September 2003. This document reviewed the three creeks listed above and generated a proposed a projects list, but did not provide an investigation as to the feasibility of constructing or implementing the listed projects. The City of Calabasas' Environmental Services Division therefore is intends to investigate the feasibility to design and construct a stream restoration project to remove a failed sections of concrete channel and construct naturalization improvements, to remove the artificial structures and fish barriers along a portion of Las Virgenes Creek.

3. PURPOSE

The purpose of this study is to determine if an environmental enhance project to construct a streambed naturalization project is feasible for this reach of Las Virgenes Creek. This study will also analyze several flood control restoration concepts to utilize the existing channel configuration and geometry with various channel lining protection measures. The proposed improvements to the channel are required to:

- Support wildlife movement
- Support natural vegetation
- Improve the aesthetics of the channel

This Preliminary Feasibility Study will address the following:

1. Channel hydraulic characteristics under the as-built condition;
2. Channel geometry requirements and constraints for a streambed naturalization project;
3. Channel hydraulic characteristics for alternative channel improvements, advantages and disadvantages (Widened Channel Alternative 1, 2 and 3, Grass Lined, Riprap Lined, Gabion Lined, Concrete Revetment);
4. Cost Analysis of Alternatives and
5. Anticipated Regulatory Permit requirements

Figure A -

FIGURE “A” Project Location

4. AS-BUILT CONDITIONS

Description of Improvements

Based on the County as-built records, the existing channel improvements were constructed in or about the year 1988. The as-built channel section geometry varies over the 890 feet between Meadow Creek Lane and Lost Hills Road. The channel is bounded by Lost Hills Road to the west and a residential development within Tract 43787 and existing sewer mainline to the east. The upstream culvert at Meadow Creek Lane is an existing 4-barrel (14x16 feet) reinforced concrete box and the down stream culvert under Lost Hills Road is an existing 4-barrel (14x14 feet) reinforced concrete box.

The as-built channel improvements were modeled using the Water Surface Pressure Gradient (WSPG) hydraulic modeling software. The as-built channel geometry was input into the computer model and run with a discharge rate of 15,300 cfs, referenced from the as-built plans. The composite manning n, roughness coefficient used to mimic the hydraulic data table on the as-built plans was approximated at 0.04.

Table 1 – As-built Channel Geometrics/Hydraulics

From Sta.	To Sta.	Base Width	Side Slopes	Channel Height	Channel Top Width	Depth of Flow	V Ft/Sec	Channel Description
20+24.92	18+59.00	Varies 24-59 feet	2:1	30+/- feet	175 feet	Varies 17/8 feet	Varies 16 to 19	Concrete Lined Trap Channel
18+59.00	13+99.32	24 feet	2:1	30+/- feet	Varies 140 to 190 feet	Varies 17.2 to 15.7 feet	Varies 16.9 to 15.9	Soft Bottom, Riprap Side Slopes, Cut off Walls
13+99.32	11+88.48	Varies 24-59 feet	2:1	30+/- feet	Varies 190 to 220 feet	Varies 17.2 to 8.1 feet	Varies 19.2 to 15.9	Soft Bottom, Riprap Side Slopes, Cut off Walls

The As-built Plans are provided for reference in Figure “B” and illustrate the as-built plan and profile of the channel improvements.

Field Visit Observations

A field visit was conducted on June 8, 2005. The culverts as well as the concrete channel lining immediately up and downstream of Meadow Creek Lane and Lost Hills Road appear to be intact. Deposits of silt within the culverts were observed and the channel was overgrown with trees, shrubs and weeds due to the lack of adequate maintenance. Approximately 100 feet or more of the concrete cut-off walls immediately downstream of the concrete channel lining have overturned as the soft bottom section has scoured over time.

The existing riprap on the channel side slopes has sloughed into the channel invert as a result. A vertical drop in the invert of the channel, of approximately 6-8 feet, was observed at approximate channel Station 18+59 (see photo below). The vertical drop occurs downstream of the existing concrete channel lining where the soft bottom channel, concrete cut off walls and riprap side slopes begin.

Looking upstream at approximate Station 18+59 – Failed cut off wall and vertical drop in channel invert.

FIGURE "B" As-Built Improvement Plans of the Existing Channel

5. ALTERNATIVE CHANNEL IMPROVEMENT CONCEPTS

Alternative Channel Design Geometry and Lining Concepts

The following alternative design geometry and lining concepts were analyzed as part of this study:

- Streambed Naturalization Project utilizing the design criteria outlined in the California Regional Water Quality Control Board, Stream, and River Protection for Regulatory and Program Managers, Technical Reference Circular, dated April 2003.

- Flood Control Restoration Projects utilizing the existing channel configuration and geometry with various channel lining protection measures.

Stream Bed Naturalization Project

Basis of Design

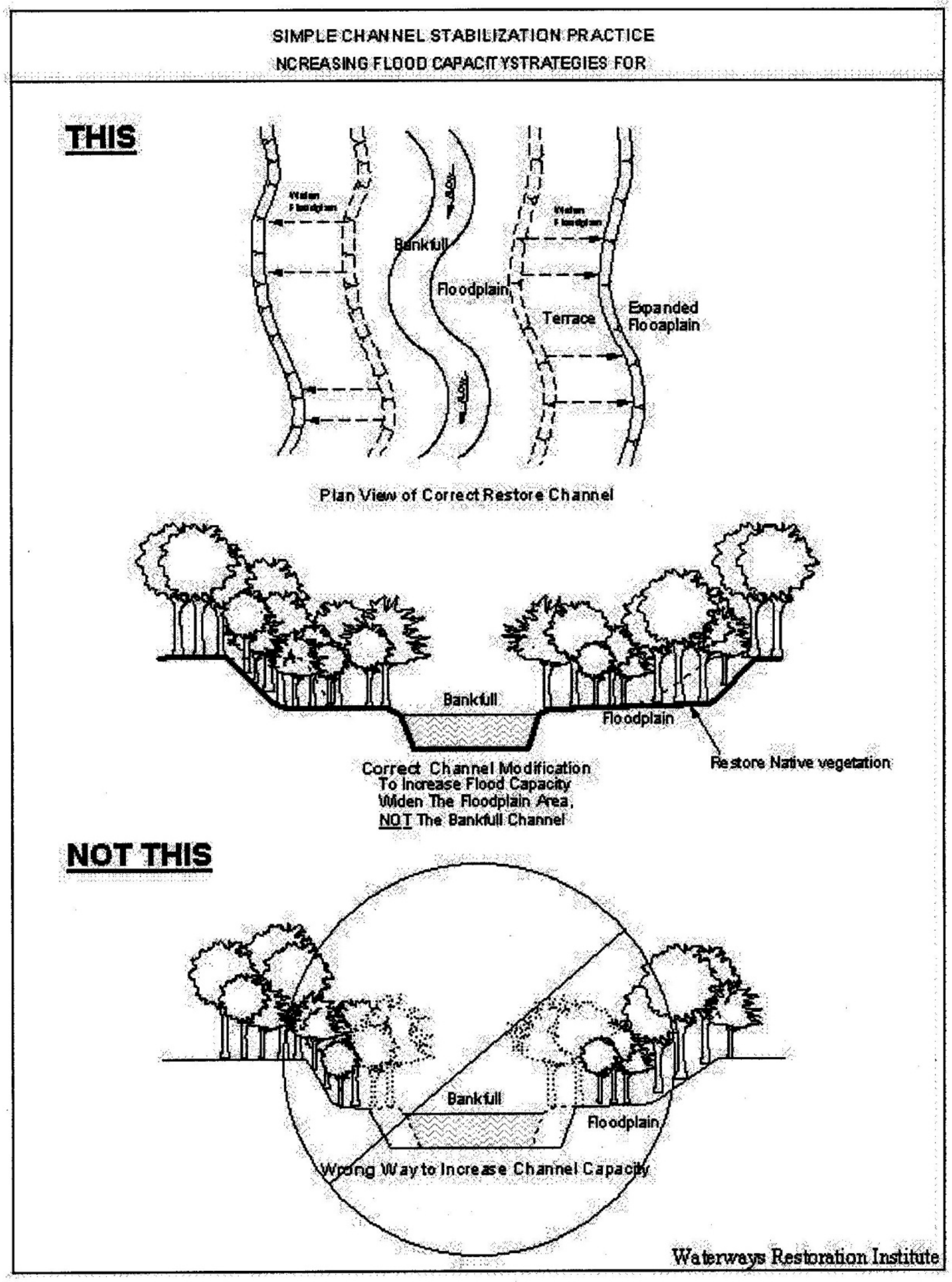
Although, the aforementioned CRWQCB Technical Reference Circular was prepared for the San Francisco Bay Regional Water Quality Control Board, the intent was for other regional boards to adapt the concepts of this circular to address different conditions around the State. It is our understanding that this publication represents the current design requirements for Stream Bed Naturalization Projects and we have based our analysis on the requirements contained therein. The following is a “broad brush” summary of the concepts presented in this circular and only the sections pertaining to the required geometry for a streambed naturalization project were analyzed at this time as part of this preliminary feasibility study

General Description and Design Parameters

In general, the naturalization of streambed channels consists of increasing the stability of the channel, restoring ecological habitat and maintaining the flood capacity of the channel. The stability of the channel is defined as a condition in which the sediment sizes and loads, water discharges, and channel shapes and slopes are in balance. A stable channel is considered to be in equilibrium where the sediment loads entering a channel are equal to those leaving it. The overall approach to obtain a stable channel is to establish a meandering alignment that accounts for the slope, sediment loads, sediment sizes, discharges, roughness of the stream channel and bank-full channel widths and depths. The restoration of ecological habitat is accomplished by re-vegetating the stream banks along with meandering channel to reduce excessive erosion of the channel. Maintaining the flood capacity of the channel by incorporating tiered cross section geometry will contain high flows within the channel banks (Reference, Figure 5, Waterways Restoration Institute). See below.

FIGURE "C" Figure 5 – Waterways Restoration Institute

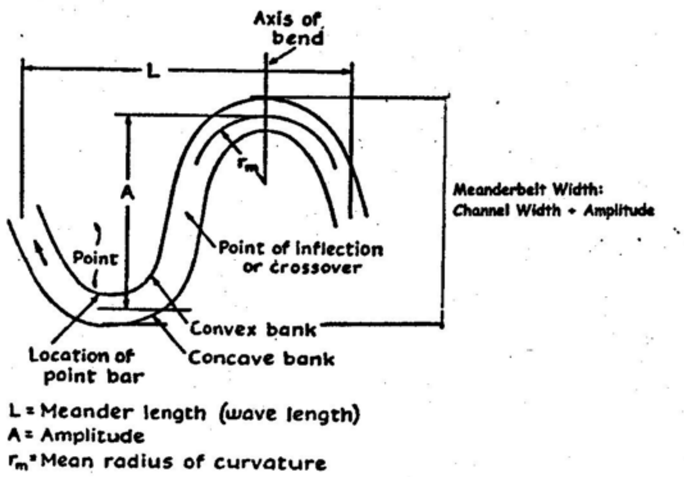
Figure 5



Stable Channel Length and Sinuosity

According to the aforementioned circular, the stable length for an active channel will include matching the channel slope and sinuosity (how much the channel meanders) with the valley slope. The channel slope will be influenced by both the slope of the overall stream valley and by grade controls imposed on the channel slope such as culverts and bridges.

In the absence of historical maps, photos or records to estimate the historic sinuosity, the sinuosity can be determined using regionally based data on the relationship between the length of a meander and the width of a stream. Using national data, on average the meandering length ranges from seven to ten times (used **8.5**) the stream bank-full channel widths. In the Bay Area, the Waterway Restoration Institute determines the radius of curvature of the meanders average **2.3** times the stream channel widths and the amplitudes of the meanders average about **2.7** times the stream channel widths. These values were used in this analysis to determine the approximate horizontal geometry requirements based on an average streambed width of 42 feet ((59+24)/2).



Therefore: L (meandering length) = 42*8.5 = **357 feet**
A (amplitude) = 42*2.7 = **113 feet**
r (radius of curvature) = 42*2.3 = **97 feet**

The basic tendencies of river function and adjustment rely on principles reported by Inglis (1947), Leopold and Wolman (1957, 1960) Leopold et.al (1964), and Langbein and Leopold (1966). In addition, because of the complex interactions associated with individual variables (width, depth, slope, velocity, flow resistance, sediment size, sediment load and stream discharge) a stream classification system was developed to describe combination of the various “integrations” as predictable, morphological stream types. (Rosgen 1985, 1993) Since the sediment size and load are unknown at this time the national averages were utilized as part of this study.

Physical Constraints of Project Site

As shown in Table 1 above, the existing channel width varies from 140 to 220 feet and is approximately 30 feet deep. Since the amplitude calculated above is estimated at 113 feet and the channel invert is approximately 30 feet deep, the required channel width to implement a streambed naturalization project, with 2:1 side slopes, is (113+2*30+2*30) = 233 feet. This width exceeds the available channel top width. Right-of-way acquisition and substantial modifications or protection of the surrounding improvements would be required to implement this type of project (ie. realignment of Lost Hills Road, construction of retaining wall structures, modifications to existing residential improvements including the potential relocation of the existing sewer mainline on the east side of the channel.

Flood Control Restoration Projects

Widened Channel Alternative #1

This alternative would reduce the scour velocities to 5 to 6 feet/sec. Using a normal depth calculation, the required trap channel bottom width required would be approximately 1,500-feet-wide. This alternative meets the minimum scour velocities, but would not be feasible to construct due to the extent of existing improvements that would be effected and the amount of right-of-way acquisition or easements that would be required to accommodate the channel improvements. The existing top width of the existing channel varies from 140 to 220-feet-wide.

Widened Channel Alternative #2

This alternative utilize the available channel width without obtaining right-of way. The maximum channel width that could be accommodated is estimated to be 130 feet. The normal depth calculation for a rectangular channel with vertical concrete channel walls and a soft bottom, n=0.025, the resultant flow velocity is approximately 19 feet/sec. The alternative would not be feasible due to the scour velocities exceeding 5-6 feet/sec, which would scour the soft bottom of the channel.

Grass Lined

Utilizing the existing channel configuration and an “n value” of 0.025 the resultant channel velocities ranged from 18 to 22 feet/sec. The alternative would not be feasible due to the scour velocities exceeding 5-6 feet/sec, which would scour the grass lining from the channel side slopes and invert of the channel.

Riprap Lined

Utilizing the existing channel configuration and an “n value” of 0.040 the resultant channel velocities ranged from 16 to 19 feet/sec. The alternative is feasible since the riprap will be adequate to withstand the anticipated velocities. The riprap lining will also allow for limited vegetative growths and gives a natural appearance. Although the riprap lining does not accommodate easy wildlife movement, it is possible to design and configure the riprap with invert stabilizer in such a way to create pools or steps to eliminate fish barriers and protect the channel side slopes and invert.

Gabion Lined and Concrete Revetment

Utilizing the existing channel configuration and an “n value” of 0.025 to 0.075. The “n-value of 0.025 is typically used for well maintained to obtain highest flow velocity, whereas 0.075 is used for channels that are not maintained well with weeds and brush uncut, high stage of flow. The resultant channel velocities ranged from 18 to 22 feet/sec and 11 to 13 feet/sec for n values of 0.025 and 0.075 respectively. The Gabion Lined and Concreted Revetments are not as conducive to vegetative growth or natural looking as the riprap lining. Although the Gabion Lined and Concreted Revetments does not accommodate easy wildlife movement, it is possible to design and configure these types of linings with invert stabilizer in such a way to create pools or steps to eliminate fish barriers and protect the channel side slopes and invert. However, the construction costs would be more expensive than the riprap channel lining.

Please refer to Appendix A for Hydraulic Calculations

The advantages and disadvantages for the alternative channel configurations are summarized in the following Table 2

Table 2 – Alternative Channel Configurations

ALTERNATIVE	ADVANTAGES	DISADVANTAGES
Streambed Naturalization Project		
Naturalization of streambed channels consists of increasing the stability of the channel, restoring ecological habitat, maintaining flood capacity of the channel	Will reduce velocities, balance erosion, improve water quality by reducing scour and allow for the establishment of vegetation and supports wildlife habitat and movement.	Not economical to construct due to the extent of existing improvements that would be effected and the amount of right-of-way acquisition or easements that would be required to accommodate the channel improvements.
Flood Control Restoration Project		
Widening Channel Alt. No. 1 1500-foot-wide bottom width; riprap side slopes and soft bottom.	Will reduce velocities to eliminate scour and allow for the establishment of vegetation and supports wildlife habitat and movement.	Not economical to construct due to the extent of existing improvements that would be effected and the amount of right-of-way acquisition or easements that would be required to accommodate the channel improvements.
Widening Channel Alt. No. 2 130-foot-wide bottom width with concrete side slopes.	Can be constructed within available right-of-way	High initial construction costs, velocities in the 19ft/sec range, not suitable for intended purpose without incorporating concrete and/or riprap drop structures to reduce scour.
Grass lined Trapezoidal Channel	Economical to construct and maintain, aesthetically blends with the surrounding, gives a natural look and supports wildlife habitat	Cannot withstand velocities greater than 6ft/sec. Existing velocities exceed 18-22 ft/sec. Not suitable for intended purpose without incorporating concrete and/or riprap drop structures
Riprap lined Trapezoidal Channel	Similar to existing channel configuration and moderately economical to construct and maintain. Supports limited vegetative growth and gives natural appearance. Can be configured to create pools to eliminate fish barriers.	Not conducive for establishment of desired vegetative coverage due to movement of the media at high velocities. Does not accommodate easy wildlife movement
Gabion lined Trapezoidal Channel	Withstands high velocities (up to 25 ft/sec), supports limited vegetative growth with permanent anchor. Can be configured to create pools to eliminate fish barriers.	High initial construction cost. Moderate maintenance costs. Does not accommodate easy wildlife movement.
Concrete Block Revetment Trapezoidal Channel	Withstands high velocities (up to 26 ft/sec), provides the environment for vegetative growth with permanent anchor. Accommodates wildlife movement. Can be configured to create pools to eliminate fish barriers.	High initial construction costs

RECOMMENDATIONS

Riprap Lined Trapezoidal Channel.

The conceptual improvements are intended to prevent the erosion of the channel invert and eliminate the existing fish barrier within the Las Virgenes Creek, between the existing channel lining down stream of Meadow Creek Lane and upstream of Lost Hills Road.

CONCEPTUAL IMPROVEMENT DESCRIPTION

The conceptual improvements included the following elements:

1. Clearing and Grubbing the existing vegetation (trees, shrubs and weeds) within the channel invert, including areas for the construction of a temporary access roads.
2. Constructing temporary access roads to access the channel invert from Lost Hills Road. Typically fill material is placed temporarily to construct an earthen ramp into the channel. This ramp will be removed when the improvements within the channel are completed.
3. Removing the failed concrete walls from the channel.
4. Constructing invert stabilization structures (concrete walls) in an arched fashion to create ponds or tiers or steps to allow fish to migrate upstream. There is an elevation drop of approximately seven (7) feet from upstream to down stream, therefore, we have assumed the installation of three (3) invert stabilizers with a two (2) foot max drop between these structures to account for the seven (7) feet of elevation difference.
5. Placing 2-Ton riprap four (4) feet thick, within the channel invert between the existing channel walls, including the reach of channel where the walls will be removed. The riprap will protect the invert from the erosive velocities within the channel.
6. Constructing a trail/maintenance access road along the easterly channel side slope for trail and maintenance purposes. The proposed trail/maintenance access road will be 15 feet wide for maintenance vehicles and assumed to be paved with 2"AC/6"AB.

ENGINEER'S ESTIMATE

Due to the limited access to the site and the proximity of the improvements, the unit costs for construction were escalated. Also, because this is a conceptual design, this preliminary estimate includes a 20% contingency. We have also included a 35% line item to account for the Engineering Design, Contract Administration and Inspection of the project for budgeting purposes. The estimated total cost of this project is: $923,000

Need to discuss before this section is finalized.

6. PERMITS

Any construction activity and changes to the existing condition of a water course requires permits form various regulatory agencies. These permits are designed to protect and/or improve the functionality of the natural resource and public infrastructure. The permits that must be obtained before construction of the project are listed in Table 3.

Table 3 - List of Necessary Permits

AGENCY	TYPE OF PERMIT
1. Los Angeles County Flood Control District 2. U.S. Army Corps of Engineers (U.S. ACOE) 3. California Department of Fish and Game 4. California regional Water Quality Control Board (RWQCB)	1. Encroachment Permit 2. Section 404 Nationwide Permit 3. 1601 Streambed Alteration Agreement 4. National Pollutant Discharge Elimination

APPENDIX “A” HYDRAULIC ANALYSIS

Existing Condition - WSPG run (n=0.40)

Trap Channel – Normal Depth Calculations
Base Width 1500’, 130’, 200’, 300’, 500’ and 1000’

Grasslined Channel – WSPG run (n=0.025)

Gabion and Concrete Revetment – WSPG run (n=0.075)

APPENDIX “B” COST ESTIMATES

Proposed Project Configuration Planning Level Cost Estimate

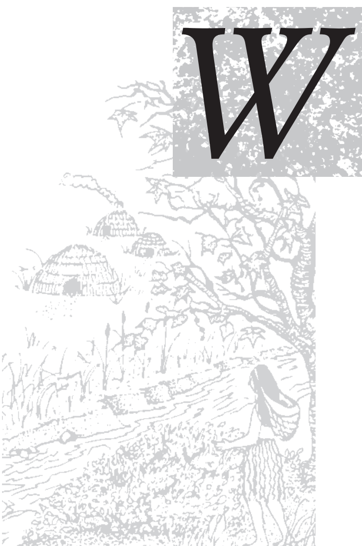
Item No.	Spec. Section NO.	Description	Quantity	Unit	Unit Cost	Cost
1	12	Mobilization	1	Lump Sum	$ 30,000.00	$ 30,000.00
2	13	Clearing and Grubbing; Channel Demolition & Removal	1,500	Ton	$ 75.00	$ 112,500.00
3	14	Earthwork (side slopes, terraces, low-flow channel, rock groin, willow trenches)	3,000	C.Y.	$ 20.00	$ 60,000.00
4	16	Planted Rock Toe Revetment	750	Ton	$ 300.00	$ 225,000.00
5	17	Planted Rock Groin	60	Ton	$ 300.00	$ 18,000.00
6	18	Planted Rock Weirs and Pool	1,400	Ton	$ 300.00	$ 420,000.00
7	19	Willow Trench Staking	1	L.S.	$ 2,200.00	$ 2,200.00
8	20	Rootwads	4	Rootwad	$ 2,000.00	$ 8,000.00
9	21	Planted Coir Bio D Blocks	1,100	L.F.	$ 15.00	$ 16,500.00
10	22	Hydroseeding	1.00	L.S.	$ 2,500.00	$ 2,500.00
11	23	Erosion Control Blankets: Terrace	1,300	S.Y.	$ 11.00	$ 14,300.00
12	23	Erosion Control Blankets: Slopes	800	S.Y.	$ 11.00	$ 8,800.00
13	24	Irrigation	1	L.S.	$ 25,000.00	$ 25,000.00
14	25	Planting	0.75	Acre	$ 30,000.00	$ 22,500.00
15	26	Retaining Walls (4-ft high)	2,200	S.F.	$ 25.00	$ 55,000.00
16	27	Concrete Masonry Floodwalls	200	L.F.	$ 150.00	$ 30,000.00
17	28	Concrete cut-off walls retrofit/outfalls/utility concrete cap	120	yds	$ 500.00	$ 60,000.00
18	28	Educational Component	1	L.S.	$ 18,000.00	$ 18,000.00
19	29	Trail Establishment	1	L.S.	$ 15,000.00	$ 15,000.00
20	30	As-Builts	1	L.S.	$ 2,500.00	$ 2,500.00
					Subtotal	$ 1,145,800.00
					Contingency (10%)	$ 114,580.00
					Total	**$ 1,260,380.00**

National Park Service

Santa Monica Mountains

National Recreation Area

Cheeseboro/Palo Comado Canyons



Welcome to the northernmost section of Santa Monica Mountains National Recreation Area. Here, in the Simi Hills, the waters that flow in Cheeseboro and Palo Comado Canyons begin their journey to the Pacific. In this large expanse of habitat, deer, bobcats, coyotes and rabbits roam. Stroll to Sulphur Springs or hike to the top of Simi Peak and view the cities you've left behind. Walk quietly amid the oaks and grasses or picnic beside a streambed.

The Chumash lived in these canyons for thousands of years. Many trails within the canyons may have originated with the Chumash and then were expanded by the ranchers who followed.

For more than 200 years, ranchers made these canyons their home, bringing about a change in the landscape. Many of the native plants, poorly adapted to heavy grazing, were replaced with European annuals such as wild oats, mustard and thistles. Native plants were not the only things affected. Grizzly bears, once thriving in the canyons, were exterminated by the ranchers.

Today, a great diversity of plants and animals live in the canyons. Widespread oaks and outcrops of sedimentary rock provide excellent nesting sites for owls, hawks and other raptors (birds of prey). The abundance of raptors indicates a large prey population, especially small mammals and reptiles. In more rugged areas where cattle didn't graze, we can still find a variety of native plant communities, including chaparral, coastal sage scrub and riparian woodlands.

With the removal of cattle, the landscape is allowed to renew itself. Oak seedlings can now grow tall without becoming food for cattle. Native annual wildflowers are returning, dotting the landscape with colorful displays in the springtime.

Enjoy your visit to Cheeseboro/Palo Comado Canyons and explore the splendors this area has to offer.

Information & Safety

Be prepared: take water, food, flashlights and first-aid supplies when hiking, biking or horseback riding. Watch for and avoid rattlesnakes, and poison oak.

Water that comes from streams is not safe to drink due to possible contamination or the presence of the giardia protozoan.

Dogs must be on leash at all times. They are allowed only on trails and access roads.

Trail closures will be in effect during and following significant rainfall to protect park resources. Trails will be re-opened when dry enough to sustain public use.

Fire is a constant danger. Fires and barbecues are prohibited. Smoking is not permitted during times of high fire danger.

Natural and historic features are protected by law and may not be collected.

Bicyclists must ride courteously and yield to hikers and horseback riders. Bicycles are allowed only on fire roads and designated trails. Speed limit is 15 mph. Bicycles are required to have lights on when riding at night.

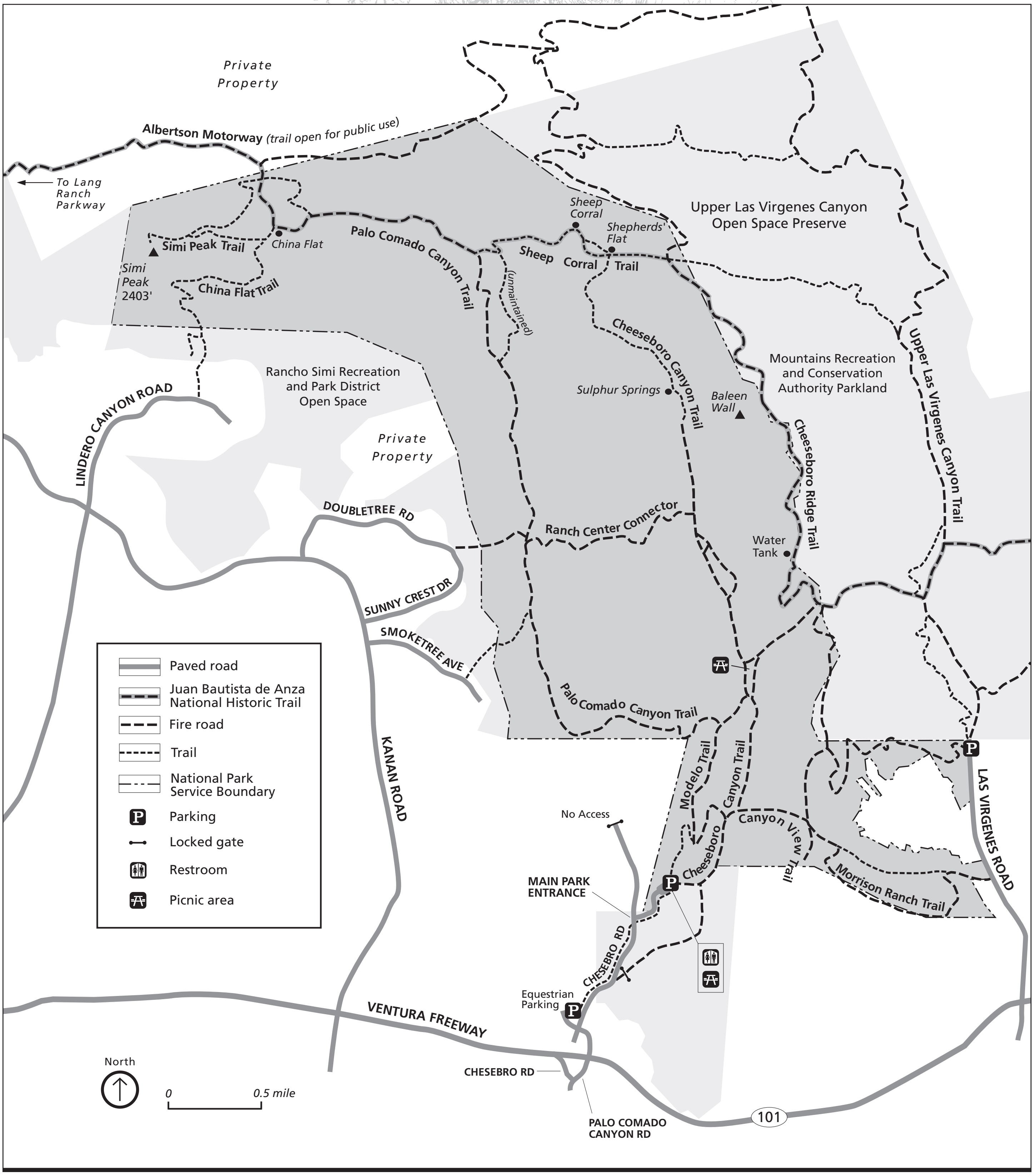
Hikers must yield to horseback riders.

Firearms are not allowed in parklands.

National Park Service
Santa Monica Mountains
National Recreation Area
401 West Hillcrest Drive
Thousand Oaks CA 91360
www.nps.gov/samo

Visitor Center 805-370-2301
In emergency: dial 911
To report suspicious activity, call
Angeles Dispatch: 661-723-3620

Cheeseboro/Palo Comado Canyons



Trails

Modelo Spur *0.7 mile, moderate*—This trail meanders from the parking lot through grasslands to a lone coast live oak on the ridge. The trail drops east and joins the Cheeseboro Canyon Trail.

Modelo Trail *1 mile, easy*—Starting at the ridge line of the Modelo Spur and continuing north along the ridge, this pathway offers views of both canyons. It ends at the Palo Comado Canyon Trail where you can turn right, and travel east to Cheeseboro Canyon, or left, and travel west to Palo Comado Canyon.

Palo Comado Canyon Trail *4.4 miles, moderate to strenuous*—The first 1.2 miles of this trail are a gentle stroll along a creek to the old ranch center. The dramatic elevation gain begins a mile past the ranch site where you will climb from 1,200 feet elevation to scenic China Flat at 2,140 feet elevation.

Cheeseboro Canyon Trail *4.6 miles, easy*—Follow an old ranch road along a streambed through a valley oak savannah and coast live oak riparian zone. A picnic area is located 1.6 miles from the parking lot. Near Sulphur Springs, at 3.3 miles, you can smell the odor of rotten eggs. As you pass under the Baleen Wall, the canyon opens up and chaparral slopes replace the savannah. The trail continues to an old sheep corral where you can picnic near the creek bed or watch the sky for birds of prey.

Canyon View Trail *0.7 mile, moderately strenuous*—This trail splits to the east of the Cheeseboro Canyon Trail and climbs to a knoll above the Lost Hills landfill. Looking back towards the west, you can see most of Cheesboro Canyon.

Ranch Center Connector *1.1 miles, moderate to strenuous*—This trail crosses a chaparral hillside and connects Cheeseboro and Palo Comado Canyons.

Simi Peak Trail *0.8 mile, moderate*—This trail winds from China Flat to Simi Peak, the highest point in the area. Enjoy a spectacular view of Oak Park, Agoura Hills and Simi Valley.

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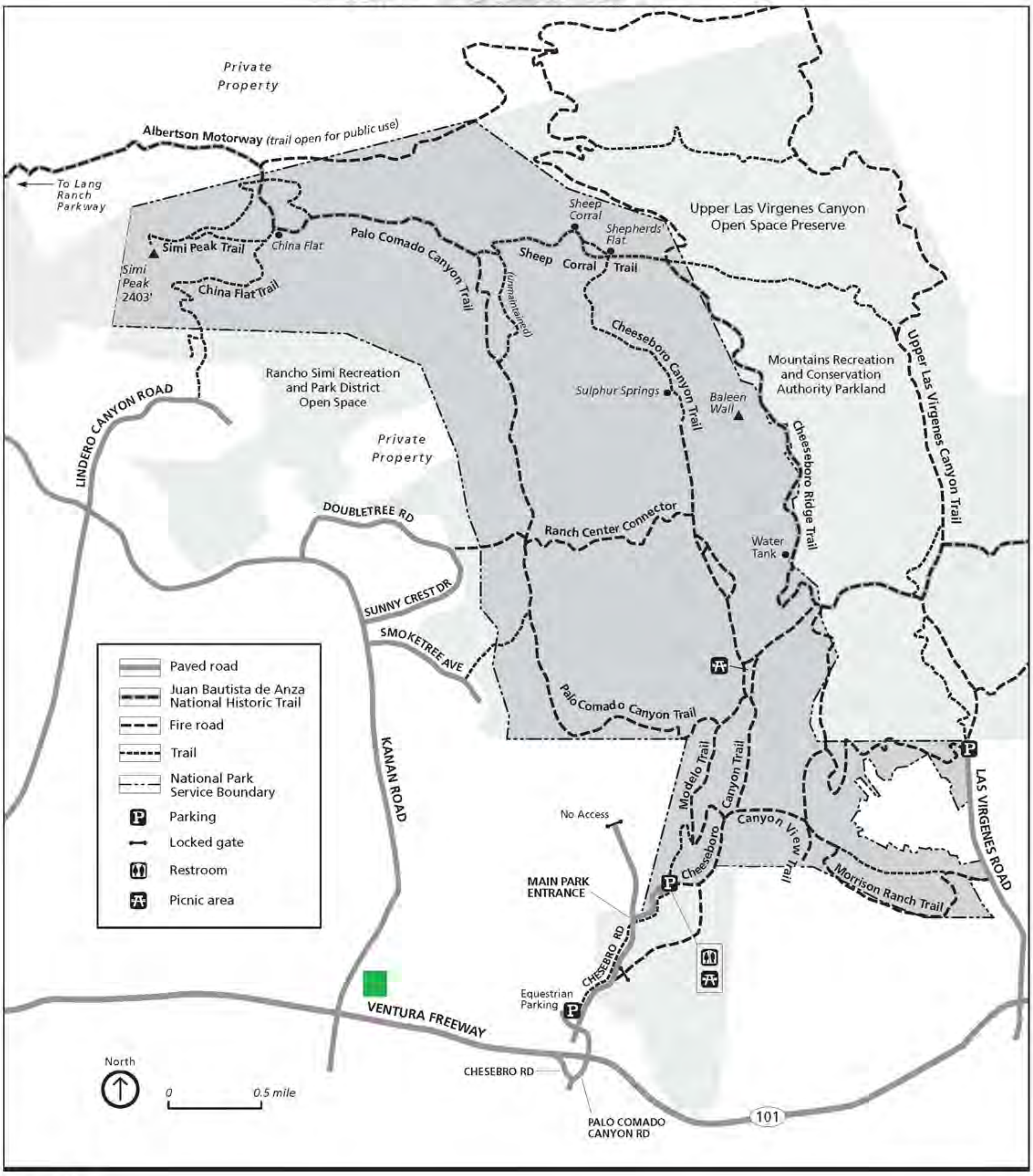
Cheeseboro/Palo Comado Canyons



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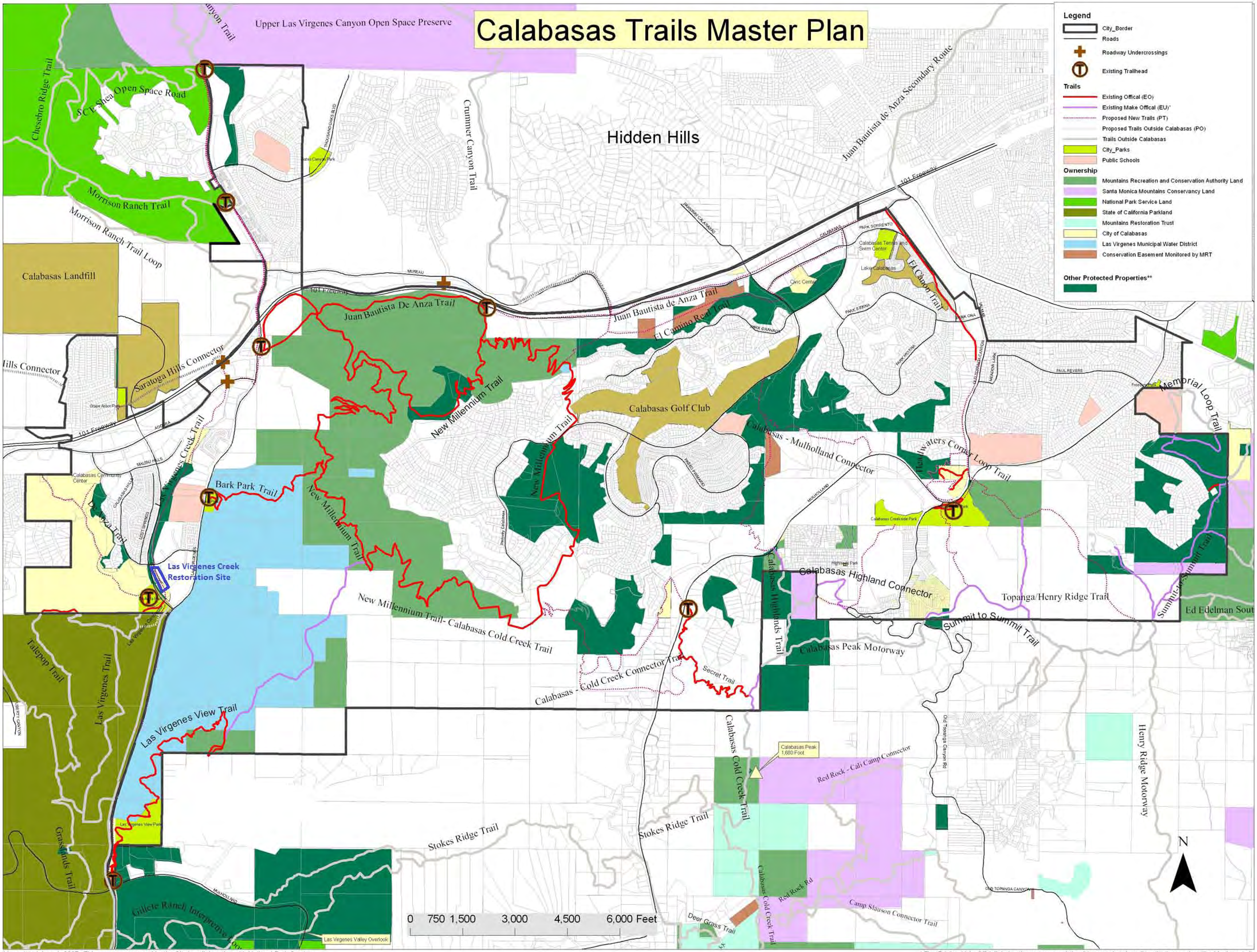
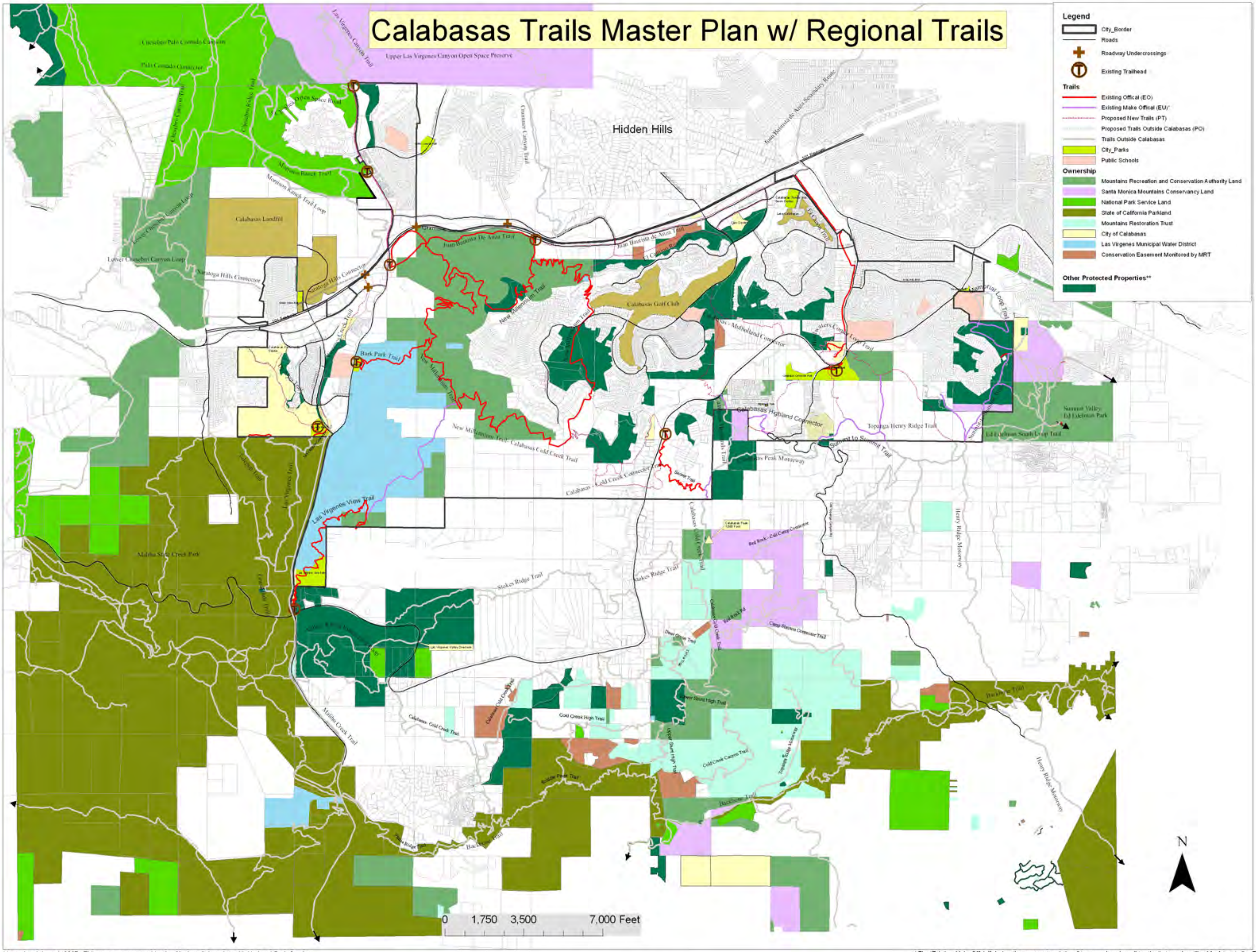


Map printed June 1, 2007. This map was prepared by the City in collaboration with National Park Service.

Disclaimer: This map was created for use by the City of Calabasas for trail planning purposes only. It is an illustrative map and is not inteded to be used as a way finding map. For existing official trails, detailed trail maps may be obtained from the public agency managing the trail. Some trails shown do not exist currently and are planned for the future, or they exist but are not yet officially designated. Permission to use trails shown on this map should not be assumed. Some trails may traverse or abut private property and suggested alignments do not imply rights of public use except as may be accomodated legally via easements or covenents.

* The "Existing, Make Official" designation represents existing dirt or paved roads or dirt paths that may be utilized for future trails. The use of the term "existing" does not grant the City any rights to utilize these roads or pathways without first obtaining a trail easement from the property owner.

** This includes OS-DR zoning, UC Reserve, and other miscellaneous public land.



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Staff Report

Los Angeles Region Integrated Report

Clean Water Act Section 305(b) Report and Section 303(d) List of Impaired Waters

2008 Update

Prepared by
California Regional Water Quality Control Board, Los Angeles Region

July 2009

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Regional Board staff appreciate the assistance given by Peter Kozelka of the United States Environmental Protection Agency and the State Water Resources Control Board Integrated Report Staff.

1 Executive Summary

This Integrated Report provides the recommendations of the staff of the California Regional Water Quality Control Board, Los Angeles Region (Los Angeles Water Board) for changes to the Clean Water Act (CWA) Section 303(d) list of impaired waterbodies and provides a draft Clean Water Act Section 305(b) report (Integrated Report). The Integrated Report includes both the list of impaired waterbodies and identified waters which are known to be meeting beneficial uses within the Los Angeles Region.

The Introduction to this Integrated Report provides the context and purpose and an overview of the approach and describes the public process that will be used for adoption of the changes to the 303(d) list and finalization of the Integrated Report. The remainder of the report describes data sources used, the objectives and criteria against which data were compared, the methodology for comparing the available data to the criteria to assess attainment of water quality standards and determine potential 303(d) listings and the methodology used to categorize waterbody segments according to beneficial use support for the 305(b) report. Results are briefly summarized and discussed following descriptions of the methodology.

Recommendations are shown in detail in the appendices. Appendix A shows the public solicitation letters requesting that the public submit any and all available data to support the assessment of water quality in the Region. Appendices B through E provide lists of waterbodies in Integrated Report categories of beneficial use support. Appendix F presents a list of all impairments by waterbody including those waterbodies in Integrated Report categories 4 and 5 (appendices D and E) which is the list referred to as the 303(d) list. Appendix G presents "fact sheets" for each waterbody-pollutant combination that was analyzed for the proposed 303(d) listing decisions. These fact sheets include at least one "Line of Evidence" describing the data and information used as a basis for each proposed decision. Appendix H presents fact sheets for other miscellaneous changes to the 303(d) list. Appendix I provides citations for all of the references used in developing the Integrated Report.

There are 68 proposed new 303(d) listings in 41 waterbodies and 30 proposed de-listings in 19 waterbodies on the Los Angeles Region 303(d) list.

Additions of new impaired waterbodies to the list ('listings') or deletions of no longer impaired waterbodies from the list ('delistings') were constrained by availability of water quality data. Many waterbodies in the Region are not sampled on a regular basis. In addition, identification of waterbodies which are not impaired by pollutants and meet all beneficial uses has also been driven by availability of data.

Regional Board staff reviewed all data available to determine impairment or the absence of impairment but staff focused on developing listing or delisting decisions and factsheets for the update and did not usually develop do-not-list or do-not-delist decisions and factsheets as these decisions would not alter the final 303(d) list.

The Los Angeles Region Integrated Report and updated 303(d) list included in this staff report is being circulated for public comments. Written comments received before June 17, 2009 will be responded to in writing. The reports and the response to comments will then be brought before the Los Angeles Water Board at a public hearing for potential approval. Public testimony will also be heard at the public hearing. After approval by the Los Angeles Water Board, the Integrated Report, including the updated 303(d) list, will be submitted to the State Water Resources Control Board (State Board) for approval along with the other Region's reports. The full State Integrated Report will then be submitted to the USEPA for approval and will then be final.

2 Introduction

The purpose of this report is to identify those surface waters in the Los Angeles Region which are impaired by pollutants or conditions which prevent them from meeting beneficial uses and to identify those waterbodies which data show are meeting beneficial uses.

An important requirement of the Clean Water Act is to identify those waters which are polluted, not meeting established standards and not supporting the uses expected of those waterbodies. With identification is the recognition of the need for action. Appropriate action after identifying a polluted waterbody is generally the development of a Total Maximum Daily Load (TMDL) but, in some cases, may also include permitting actions or prohibiting discharges to the waterbody, taking cleanup actions, or restoration projects.

2.1 Regulatory Process

The Clean Water Act (CWA) requires each State to assess the status of water quality in the State (Section 305(b)), and provide a list of impaired water bodies (Section 303(d)) to the U.S. Environmental Protection Agency (U.S. EPA) every two years. For water quality limited segments included on the 303(d) list, the state is required to develop a Total Maximum Daily Load (TMDL)or take other action to address the impairment.

The last review and update of the State's 303(d) list occurred in 2006. That review was conducted by the State Water Resources Control Board using the State Board's *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy) (SWRCB 2004) developed in 2004. The 2006 update was the first review and update to use that policy.

For the 2008 update, each Regional Water Board is conducting their own reviews of new and previous water quality data and updating the assessment and list of impaired waterbodies according to the Listing Policy.

This staff report presents this Regional Board's assessment of the current status of water quality in the Los Angeles Region for water bodies with readily available data, and identifies the methods and data used to evaluate the water quality. This report proposes additions, deletions, and changes to the 2006 303(d) list. The water quality assessments also result in the identification of water bodies where water quality standards are met or where not enough information is available to accurately assess water quality.

Certain sections of the Integrated Report require public review and approval by the Regional Board and then approval by the State Board. These sections, or categories, are the lists of water quality limited segments whether being addressed by a TMDL or action other than a TMDL or not yet being addressed (Category lists 4 and 5, the 303(d) list). The other sections of the Integrated Report, which are waters supporting beneficial uses and waters with insufficient data (Categories lists 1, 2, and 3), are provided as information and do not require Board action.

After approval by the Los Angeles Water Board, the Integrated Report will be submitted to the State Water Resources Control Board for approval along with the other Region's reports. The results of the water quality assessments will be compiled with other Regional Board reports into a statewide integrated report referred to as the 303(d)/305(b) Integrated Report by the State Board. The statewide list of all the water quality limited segments will require final approval by the USEPA. The US EPA then compiles these assessments into their biennial "National Water Quality Inventory Report" to Congress.

3 Development of the Integrated Report

3.1 Data solicitation

Federal regulation [(40 CFR § 130.7(b)(5)] states that "Each State shall assemble and evaluate all existing and readily available water quality-related data and information" when developing the 303(d) list. On December 4, 2006, Water Board staff solicited the public to submit any and all water quality data to be considered in preparation of the 2008 303(d) list and 305(b) report. This solicitation established a data submittal deadline of February 28, 2007. On January 30, 2007, staff transmitted a notice clarifying that there were no limits on the type or format of data and information that the public could provide to the Water Boards for their assessment. The notices provided to the public can be found in Appendix A of this report.

The Regional Board received 17 submissions in response to the data solicitation. In addition, staff assembled all other available data. Larger databases considered included:

- National Pollutant Discharge Elimination System (NPDES) permitting data from major NPDES discharges. These data included data collected under the Municipal Separate Storm Sewer System (MS4) NPDES permits.

- Surface Water Ambient Monitoring Program (SWAMP) data. SWAMP is a statewide monitoring effort, administered by the State Water Board, designed to assess the conditions of surface waters throughout the state of California. Monitoring is conducted in SWAMP through the Department of Fish and Game and Regional Boards monitoring contracts.

- Southern California Bight Regional Monitoring (Bight) data. The Southern California Water Research Project (SCCWRP) coordinates the efforts of many participating organization to conduct the Coastal Ecology component of the Bight regional monitoring effort. These surveys seek to determine the spatial extent of contaminant accumulation in marine sediments and assess the effects of this contamination on living marine resources. Coastal Ecology regional monitoring is conducted every five years. More than 60 organizations have participated as partners in the Coastal Ecology portion of SCCWRP's Bight regional monitoring efforts.

3.2 Listing Policy and Evaluation Criteria

The proposed 2008 303(d) list of impaired water bodies in the Los Angeles Region was developed in accordance with the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (State Board Listing Policy) and the Functional Equivalent Document, both adopted by the State Water Resources Control Board in September 2004. The Listing Policy establishes a standardized approach for developing California's section 303(d) list. It outlines an approach that provides the rules for making listing decisions based upon different types of data and establishes a systematic framework for statistical analysis of water quality data.

The Listing Policy also establishes requirements for data quality, data quantity, and administration of the listing process. Decision rules for listing and delisting are provided for: chemical-specific water quality standards; bacterial water quality standards; health advisories; bioaccumulation of chemicals in aquatic life tissues; nuisances such as trash, odor, and foam; nutrients; water and sediment toxicity; adverse biological response; and degradation of aquatic life populations and communities. The listing policy specifies the frequency of exceedance of applicable water quality objectives that is necessary to make a determination that the water is impaired.

Listing and delisting decisions were made in accordance with the listing policy, using all applicable narrative and numeric water quality criteria contained in the Los Angeles Region Basin Plan and in the California and National Toxic Rules.

3.3 Standards Used in the Analysis

Beneficial Uses:
The beneficial uses for waters in the Los Angeles Region are identified in the Los Angeles Regional Water Quality Control Plan (Basin Plan). For consistency with other Regions in California and other States, six "core" beneficial uses were assessed. The designated beneficial uses in the Basin Plans fit within these six "core" beneficial uses categories, which are:

1. Aquatic Life Support
2. Drinking Water Supply
3. Fish Consumption
4. Secondary Contact
5. Shell fishing, and
6. Swimming.

Water Quality Objectives, Criteria and Guidelines:
The water quality objectives and criteria used in the assessments were from existing and available State Policy and Plans and included the following:

- Water Quality Control Plan, Los Angeles Region (Basin Plan)
- Statewide Water Quality Control Plans (e.g., the California Ocean Plan)
- California Toxics Rule (40 CFR 131.38)
- Maximum Contaminant Levels in California Code of Regulations, Title 22.

Narrative water quality objectives were evaluated using evaluation guidelines as allowed by the Listing Policy. When evaluating narrative water quality objectives, staff identified evaluation guidelines that represented standards attainment or beneficial use protection. Depending on the beneficial use and narrative standard, the following were used in the selection of evaluation guidelines:

1. Sediment Quality Guidelines for Marine, Estuarine, and Freshwater Sediments: When applying narrative water or sediment quality criteria, staff used guidelines developed by the U.S. EPA and other government agencies together with findings published in the scientific peer-reviewed literature to interpret data and evaluate the water quality conditions. Sediment quality guidelines published in the peer-reviewed literature or developed by state or federal agencies were used. Acceptable guidelines included selected values (e.g., effects range-median, probable effects level, probable effects concentration), and other sediment quality guidelines. Only those sediment guidelines that were predictive of sediment toxicity were used (i.e., those guidelines that have been shown in published studies to be predictive of sediment toxicity in 50 percent or more of the samples analyzed).

2. Evaluation Guidelines for Protection from the Consumption of Fish and Shellfish: Evaluation guidelines published by USEPA or OEHHA were used.

3. Evaluation Guidelines for Protection of Aquatic Life from Bioaccumulation of Toxic Substances: Evaluation values for the protection of aquatic life published by the National Academy of Science were used.

The State Listing Policy and the use of the same water quality objectives criteria and guidelines ensure that all Regions develop listing or delisting decisions in a consistent manner. Below are three pollutant categories which require some Los Angeles Region-specific elaboration

3.3.1 Indicator bacteria

For indicator bacteria listing decisions, the Los Angeles Region followed the State Listing Policy but used a Los Angeles Region-specific exceedance day approach as outlined below.

Previous iterations of the Los Angeles Region's 303(d) list included impairments for "total coliform," "enterococcus," "viruses (enteric)," "coliform," "beach closures," "swimming restrictions," "high coliform count," "bacteria indicators," and "fecal coliform." In this update, Regional Board staff have begun to categorize these impairments all as "indicator bacteria."

"Indicator bacteria" impairments can include impairments due to any sewage or fecal matter bacterial indicator including total coliform, fecal coliform, *E. coli*, and *enterococcus*.

In this update, Regional Board staff have calculated the frequency of exceedances of standards for indicator bacteria using a exceedance day approach.

Basin Plan

The Los Angeles Region Basin Plan lists bacteria water quality objectives to protect the water contact recreation and non-contact water recreation beneficial uses in marine and fresh water. The marine water objectives for bacteria are also mirrored in the State Water Resources Control Board's Water Quality Control Plan for Ocean Waters of California (Ocean Plan).

Regional Board Resolution **2002-022,** effective on July 15, 2003, to the Basin Plan included Implementation Provisions for Water Contact Recreation Bacteria Objectives which allow a reference system approach. In part, below

> *...In the context of a TMDL, the Regional Board may implement the single sample objectives in fresh and marine waters by using a 'reference system/antidegradation approach' or 'natural sources exclusion approach' as discussed below. ...*
>
> *Under the reference system/antidegradation implementation procedure, a certain frequency of exceedance of the single sample objectives above shall be permitted on the basis of the observed exceedance frequency in the selected reference system or the targeted water body, whichever is less. The reference system/anti-degradation approach ensures that bacteriological water quality is at least as good as that of a reference system and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of the selected reference system.*

Bacterial TMDLs and exceedance days in the Los Angeles Region

All bacterial TMDLs developed in the Los Angeles Region have used the reference system approach and have calculated the number of exceedance days at the reference system to define the reference condition. These TMDLs include the Santa Monica Bay Beaches Dry Weather Bacteria TMDL (effective 2003), the Santa Monica Bay Beaches Wet Weather

Bacteria TMDL (effective 2003), Marina Del Rey Back Basins Bacteria TMDL (effective 2004), Los Angeles Harbor Inner Cabrillo Beach and Main Ship Channel Bacteria TMDL (effective 2005), the Malibu Creek and Lagoon Bacteria TMDL (effective 2006), the Ballona Creek Bacteria TMDL (effective 2007), and the Harbor Beaches of Ventura County (Channel Islands Harbor Beaches) Bacteria TMDL (effective 2008).

With an exceedance day method, all appropriate bacterial indicators (i.e. marine or fresh water indicators) are evaluated in one analysis to determine if the waterbody is impaired as opposed to evaluating each bacterial indicator separately and then considering those two or three evaluations to determine if the waterbody is impaired.

To calculate the number of exceedance days, the number of days during a defined period during which one or more indicator bacteria exceeds the standard is an exceedance day. For example, at a freshwater, REC-1 site, a day in which ***E. coli*** exceeds the standard is one exceedance day, a day in which Fecal Coliform exceeds the standard is one exceedance day and a day in which *both E. coli* and Fecal Coliform exceeds the standard is also one exceedance day.

Calculating exceedance days for all applicable indicators may be in some instances a more conservative approach (i.e. more likely to find a waterbody to be impaired) than a straight indicator by indicator approach and therefore is more protective of human health.

The Listing Policy has specific listing factors for bacterial data from coastal beaches. Section 3.3 and of the Listing Policy discuss methodology for listing water bodies. For *listing* coastal beaches, “if water quality monitoring was conducted April 1 through October 31 only, a four percent exceedance percentage shall be used” (SWRCB, 2004). The 4% exceedance percentage applies to the null hypothesis for the binomial distribution formula at the bottom of Table 3.2. Section 4.3 of the Listing Policy discuss methodology for *delisting* water bodies and does not specifically describe the use of more stringent exceedance percentage for coastal beach water quality monitoring conducted April 1 through October 31 only, though one is inferred. A 19% exceedance percentage was used for water quality monitoring conducted April 1 through October 31 only when assessing delisting status. The 19% exceedance percentage applies to the null hypothesis for the binomial distribution formula at the bottom of Table 4.2. Therefore, for coastal beach datasets in which both year-round monitoring was conducted following by subsequent monitoring from April 1 to October 31 (e.g., year-round from 2000 to 2002 and April 1 to October 31 from 2003 to 2005), the datasets were evaluated in two parts due to differing exceedance percentages for assessing listing and delisting status.

Regional Board staff followed the Listing Policy methodology and exceedance percentages and calculated exceedance days by both single sample exceedances and geometric mean exceedances.

a. Single Sample

The Basin Plan lists four single sample limits for marine waters and two for fresh water. If samples tested for indicator bacteria exceed any of the indicator bacteria limits, a “single sample exceedance day” for indicator bacteria was designated.

b. Geometric Means

The Basin Plan lists three geometric mean bacteria limits for marine waters and two for fresh water. Receiving water data was evaluated based on these numeric limits and the exceedance day approach in a similar manner to single samples. As such, a calendar month approach as opposed to a rolling 30 day sample approach was used to assess geometric mean to maintain sample independence. Two or more samples were used per calendar month for calculating geometric means.

3.3.2 Invasive species

In this update, Regional Board staff propose new listings for invasive species.

Several other Region’s 303 (d) lists include listings for “exotic species,” which were made in recent listing updates. In the Los Angeles Region there is one listing for “exotic vegetation,” a listing made prior to 1998.

Table 3-1 Listings for exotic species in the State 2006 303(d)

	Region	Number of listings	listing	notes
1	North Coast	1	exotic species	european green crab
2	San Francisco Bay	12	exotic species	ballast water
5	Central Valley	10	exotic species	source unknown
4	Los Angeles	1	exotic vegetation	Ballona Creek

For this listing update, Regional Board staff are proposing listings for “invasive species” as opposed to exotic species” Staff prefer not listing for “exotics” or “non-native” because not all exotic or non-native species are invasive or cause loss of beneficial uses and may even support beneficial uses. For example, the Department of Fish and Game has regulations to protect certain non-native species (e.g. striped bass) and mosquito fish are “non-native” but are used as a biological control by most mosquito abatement districts. In fact, in this listing update, The State Board is re-naming the “exotic species” listings as “invasive species” listings to reflect this.

Invasive species is defined as: an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. This definition is taken from United States Executive Order 13112 of February 3, 1999 on Invasive Species (USA, 1999).

However, there are still several issues inherent in listing for such a non-traditional pollutant.

1) While certain "biological materials" have been considered pollutants, populations of animals have not been traditionally considered "pollutants." Section 502(6) of the Clean Water Act defines "pollutants" to include "biological materials…*discharged into water*". The courts have interpreted the term "biological materials" to include "invasive" species that might be found in ballast water which is discharged. It is not clear that these Clean Water Act definitions and court interpretations would apply equally to invasive or non-native species that are already established (i.e. non-native species whose populations are not sustained or increased by ongoing discharges) as they would to invasive species that are continuing to be discharged.

2) Standards have not been written explicitly for invasives.

3) A 303(d) listing would trigger an obligation by the Regional Board to develop a program to address the "invasive" species impairment. It would be a significant challenge to develop the regulatory program to regulate a population of an established invasive species.

In this 2008 update, Regional Board staff have recommended the new listing of Malibu Creek, Medea Creek, Lindero Creek and Las Virgenes Creek in the Malibu Creek watershed and Solstice Canyon Creek in the Santa Monica Bay watershed as impaired for invasive species, specifically the New Zealand mudsnail. Factsheets for these decisions are included in Appendix G.

Cold Creek, and Triunfo Creek also have mudsnails but are not recommended for listing at this time. Factsheets for these decisions are included in Appendix G.

New Zealand mudsnails, *Potamopyrgus antipodarum,* are tiny (3-5 mm), highly invasive aquatic snails. From the Santa Monica Bay Restoration Commission/Santa Monica Baykeeper (2009):

> *In large numbers, these small snails can completely cover a stream bed and wreak havoc on local stream ecosystems. Several studies have documented NZMS [New Zealand Mud Snail] densities in streams at more than 500,000 organisms per square meter. These massive colonies simply outcompete native aquatic invertebrates that the watershed's fish and amphibians rely on for food, disrupting the entire food web. NZMS are easily transported from stream-to-stream by hitchhiking, they attach themselves to shoes (especially waders), equipment (fishing gear, bicycle tires), animals (native and non-native), and even boats. Anything that contacts a stream infested by NZMS will likely become contaminated. New Zealand mudsnails were discovered in Idaho in the mid-1980s, and have since spread to every western state except New Mexico. NZMS were first identified in benthic macroinvertebrate (BMI) samples*

collected in the Malibu Creek watershed in May 2005. Unfortunately, the Malibu Creek watershed samples containing NZMS were not identified until May 2006. NZMS pose a significant danger to streams throughout the Santa Monica Mountains and threaten the many efforts at habitat restoration and protection, particularly those to restore populations of the endangered steelhead trout in this region.

The data available for mudsnails was evaluated by the State Listing Policy, Section 3.10, Trends in Water Quality, using the narrative toxicity standard in the Basin Plan as the criteria. This approach is similar to the approach taken by State Board for listing "exotic species" during the 2006 listing update and is in accordance with the Listing Policy.

For mudsnails in the Los Angeles Region specifically, a waterbody is proposed to be included on the 303(d) list as impaired for invasive species if a negative trend in water quality has been demonstrated and the Aquatic Life Support core beneficial use was not supported. Staff considered a reach to be demonstrating a negative trend in water quality if at least one site in the waterbody exhibited an increase in density of mudsnails (with at least a three years sampled). Staff considered the core beneficial use of Aquatic Life Support not to be supported if at least one site exhibited a medium or high density of mudsnails.

3.3.3 **Biostimulatory Substances- possible future impairment determinations**

In this Integrated Report and 303(d) list update, Regional Board staff have continued to determine impairments and list and de-list decisions for nitrogen compounds as in the past based on Basin Plan nitrogen compound objectives. The Basin Plan contains a specific nitrogen (nitrate nitrite) water quality objective, which is established at 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen. This objective is specifically set to protect drinking water beneficial uses and is consistent with the California Department Public Health nitrate drinking water standard.

This nitrogen water quality objective does not protect waterbodies from impairments related to biostimulatory substances and eutrophication. However, Basin Plan also contains a narrative standard for biostimulatory substances and the Regional Board recognizes the need for a clear approach for determinations of impairment under the biostimulatory substances standard in the Basin Plan.

Previous iterations of the Los Angeles Region's 303(d) list have recognized the need to determine impairment based on biostimulatory substances and eutrophication and have included impairments for 'low DO/org. enrichment,' 'algae,' 'nutrient/(algae),' 'odors, scum,' 'Eutroph,' and 'unnatural scum/foam.' In future updates, Regional Board staff is considering categorizing these impairments all as 'biostimulatory substances' using a Los Angeles Region specific, nutrient concentration/biological response method as described below. In this 2008 list update, however, no "biostimulatory substances" impairments have been included.

The biostimulatory substances water quality objective in the Basin Plan addresses water quality impairments related to nutrient enrichment (eutrophication). The Basin Plan identifies biostimulatory substances as 'nitrogen, phosphorus and other compounds that stimulate growth'. The water quality objective states:

> *Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses.*

Eutrophication and nutrient enrichment problems rank as the most widespread water quality problems nationwide; for example, more lake acres are affected by nutrients than any other pollutant or stressor (EPA 2000). Eutrophication is defined by increased nutrient loading to a waterbody and the resulting increased growth of phytoplankton and other aquatic plants. Additionally, other parameters such as decreased dissolved oxygen and water clarity can also indicate eutrophic conditions. Phosphorus and nitrogen are recognized as key nutrients for the growth of phytoplankton, algae, and aquatic plants and are responsible for the eutrophication of surface waters.

A waterbody's biological response to nutrient loading is often what actually impairs beneficial uses. For example, increased nitrogen and phosphorus loading can lead to harmful algal blooms, which impair the beneficial uses of the waterbody. Therefore, it is useful to evaluate potential biostimulatory substance impairments in terms of both nutrient concentrations and biological response indicators. Key biological response indicators include the following:

Low Dissolved Oxygen (DO)
Dramatic Diurnal Variations in DO
Increased pH
Decreased Water Clarity
Increased Chlorophyll a Concentration
Increase Macro and/or Benthic Algal Biomass
Unpleasant Odors, Taste and/or Aesthetics

By evaluating both nutrient concentrations and biological response indicators together, a more direct linkage is made between water quality conditions and beneficial use impairments. This approach provides a more robust water quality assessment.

The Los Angeles Regional Water Board is considering including waterbodies on the State's 303(d) list of impaired waterbodies for biostimulatory substances when both nutrient concentrations and one or more biological response indicators are at levels which characterize eutrophic conditions and/or beneficial uses of the waterbody are impaired.

However, there are many nutrient and biological response indicator criteria that may be reviewed and applied for the purposes of placing a waterbody on the State's 303(d) list. Table 3.1 and 3.2 below present various nutrient concentrations and associated biological response indicator criteria limits. These criteria are being considered by the Regional Board to assess the biostimulatory substances water quality objective. The sources of these criteria include EPA Nutrient Criteria Technical Guidance Manual, EPA Ambient Water Quality Criteria Recommendations Nutrient Ecoregion III, and California Nutrient Numeric Endpoints. The Regional Board intends to solicit stakeholder comments regarding the criteria presented below for development of the guidelines to be used for listing in future updates of the 303(d) list.

Table 3-2 Rivers and Streams: Nutrient Concentration and Biological Response Indicators Criteria Limits

Potential Criteria to assess Biostimulatory Substances Water Quality Objective						
Rivers and Streams						
Total Nitrogen (mg/L)	**Total Phosphorus (mg/L)**	**Benthic Algal Biomass (mg/m^2)**	**Percent Cover**	**pH**	**Dissolved Oxygen (mg/L)**	**Source**
0.65	0.09	150	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM ≥5 COLD ≥ 6 COLD & SPWN ≥ 7	EPA National Nutrient Criteria Technical Guidance
0.37	0.022	43.9	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM ≥5 COLD ≥ 6 COLD & SPWN ≥ 7	EPA Nutrient Criteria Recommendations Ecoregion III
0.5	0.03	none	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM ≥5 COLD ≥ 6 COLD & SPWN ≥ 7	EPA Nutrient Criteria Recommendations Ecoregion III: Sub -Ecoregion 6 - Southern and Central CA
0.06	0.002	150	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM ≥5 COLD ≥ 6 COLD & SPWN ≥ 7	Nutrient Numeric Endpoints - Malibu Creek Case Study
0.23	0.02	WARM 150 COLD 100	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM ≥5 COLD ≥ 6 COLD & SPWN ≥ 7	Nutrient Numeric Endpoints - SWRCB Nutrient Screening tools for 303(d) Listing
< 0.295 as SIN*	< 0.026 as SRP**	120	Floating 30% Benthic 60%	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM ≥5 COLD ≥ 6 COLD & SPWN ≥ 7	New Zealand Periphyton Guideline. Barry Biggs, June 2000

*Soluble Inorganic Nitrogen (SIN). **Soluble Reactive Phosphorus (SRP)
Basin Plan Water Quality Objectives are applied for pH and dissolved oxygen

Table 3-3 Lakes: Nutrient Concentration and Biological Response Indicators Criteria Limits

Potential Criteria to assess Biostimulatory Substances Water Quality Objective

Lakes

Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)	Secchi Depth (m)	pH	Dissolved Oxygen (mg/L)	Source
1	0.1	14	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM $\geq$5 COLD $\geq$ 6 COLD & SPWN $\geq$ 7	EPA National Nutrient Criteria Technical Guidance
0.4	0.017	3.5	2.8	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM $\geq$5 COLD $\geq$ 6 COLD & SPWN $\geq$ 7	EPA Nutrient Criteria Recommendations Ecoregion III
0.51	0.172	24.6	1.9	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM $\geq$5 COLD $\geq$ 6 COLD & SPWN $\geq$ 7	EPA Nutrient Criteria Recommendations Ecoregion III: Sub - Ecoregion 6 - Southern and Central CA
0.84	0.05	20	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM $\geq$5 COLD $\geq$ 6 COLD & SPWN $\geq$ 7	Nutrient Numeric Endpoints - Malibu Creek Case Study
1.2 (summer mean)	0.1 (summer mean)	WARM 10 COLD 5	none	Shall not be < 6.5 or > 8.5 or change 0.5 units from ambient condition due to waste discharge	WARM $\geq$5 COLD $\geq$ 6 COLD & SPWN $\geq$ 7	Nutrient Numeric Endpoints - SWRCB Nutrient Screening tools for 303(d) Listing

Basin Plan Water Quality Objectives are applied for pH and dissolved oxygen

3.4 Data Analysis

Water Board staff evaluated the submitted data and additional data in accordance with the Listing Policy, taking into account data quality and spatial and temporal representativeness.

LOEs. A determination that a waterbody is impaired by a particular pollutant was dependent on one or more Lines of Evidence (LOE). A Line of Evidence is the specific information for a single pollutant from a single data source in a waterbody. The LOE includes the beneficial use(s) impacted; the pollutant name(s) pertaining to that water segment and data; the water quality objective (WQO), criterion (WQC) or guideline used to assess the data; detailed information specific to that data; how the data was assessed including the type of data, the total number of samples assessed and those samples that exceeded the WQO, WQC or guideline; where and when the data was collected.

Factsheets. The factsheet includes all LOEs developed for a certain pollutant waterbody combination and the resulting listing or delisting decision.

All available data was reviewed by staff. Analyses were documented in Lines of Evidence, factsheets and listing or delisting decisions according to established priorities. All high priority factsheets were completed.

Los Angeles Region Factsheet Development Priorities

1. High Priority

a. factsheets (decision: *list*) for waterbody/pollutant combinations not on the 2006 303(d) list where an examination of the data indicate standards were not met. This factsheet may refer to more than one core beneficial use.

b. factsheets (decision: *de-list*) for waterbody/pollutant combinations on the 2006 303(d) list where an examination of the data indicate standards were met.

c. factsheets (decision: *a core use is being supported*) for waterbody/core use combination where an examination of the data indicate that all standards (for which there are data) are being met for that core use (305(b)). This factsheet may refer to more than one pollutant.

d. factsheets for waterbody/pollutant combinations on the 303(d) list where a TMDL has been completed and approved by EPA (new approved TMDLs since 2006 303(d) list).

2. Medium Priority

a. factsheets (decision *a core use is being supported)* for waterbody/core use combination where a preliminary examination of the data indicate that standards are being met for that core use (305(b)). This factsheet may refer to more than one pollutant. However, there may be a waterbody/pollutant combinations on the list impairing other core uses.

b. factsheets (decision: *clarification*) for waterbody/pollutant combinations where the name of the pollutant has changed (e.g. PAHs to become individual PAHs (e.g. aldrin, fluoranthene)) or it is advisable to make a change in the extent of the waterbody (e.g. one waterbody is broken into two or a the dividing line between two reaches is modified).

c. factsheets (decision: ***do not list or do not de-list)*** for waterbody/pollutant combinations where there is significant new data (new line of evidence) but a preliminary examination of the data indicate that the list status (listed or not listed) would not change.

3. Low Priority

a. factsheets for waterbody/pollutant combinations where a preliminary examination of the data indicate standards were met (the creation of a "do not list" factsheet where the waterbody is listed for some other waterbody/pollutant combination or a 305(b) supporting factsheet has been completed).

b. factsheets for waterbody/pollutant combinations where the waterbody/pollutant combination is on the 303(d) list for that waterbody/pollutant combination and a preliminary examination of the data indicate standards were not met (the creation of a "do not de-list" factsheet).

c. factsheets for waterbody/pollutant combinations where available data is of insufficient quantity or quality to make assessments.

3.5 Integrated Report Categories

In this report, each assessed waterbody segment was assigned to one of five non-overlapping categories.

First, for each core beneficial use associated with each waterbody segment, a rating of fully supporting, not supporting, or insufficient information was assigned based on the readily available data and the analyses and criteria described, above. Then each assessed water segment was placed into one of five non-overlapping categories of water bodies. These Integrated Report categories are based on the USEPA guidance for states' Integrated Reports, but contain some modifications based on the State Listing Policy. The distribution of waterbodies into these categories may not be representative of the true state of waterbodies in the Los Angles Region due to the availability of water quality data and Regional Board decision development priorities.

Category 1: A water segment that 1) supports a minimum of one Beneficial Use for each Core Beneficial Use that is applicable to the water; and 2) has no other uses impaired. (No appendix to this report has been included for this category since, at this time, the Los Angeles Region has no waterbodies for which data supports that all beneficial uses are being supported.)

Category 2 (Appendix B): A water segment that 1) supports some, but not all, of its beneficial uses; 2) can have other uses that are not assessed or lack sufficient information to be assessed; 3) cannot have uses are which not supported; and 4) in agreement with the USEPA, may be included in this category with a minimum of one pollutant assessed for one use.

Category 3: (Appendix C): A water segment with water quality information that could not be used for an assessment, for reasons such as: monitoring data have poor quality assurance, not enough samples in a dataset, no existing numerical objective or evaluation guideline, the information alone cannot support an assessment, etc. Waters completely lacking water quality information are considered “not assessed”.

Category 4A (Appendix D): A water segment where ALL its 303(d) listings are being addressed; and 2) at least one of those listings is being addressed by a USEPA approved TMDL.

Category 4B: A water segment where ALL its 303(d) listings are being addressed by action(s) other than TMDL(s). (No appendix to this report has been included for this category since, at this time, the Los Angeles Region does not have waterbodies in this category.)

Category 4C: A water segment that is impacted by non-pollutant related cause(s). (No appendix to this report has been included for this category since, at this time, the Los Angeles Region does not have waterbodies in this category.)

Category 5 (Appendix E): A water segment where standards are not met and a TMDL is required, but not yet completed, for at least one of the pollutants being listed for this segment.

3.6 Information Management

All LOEs, factsheets and listing or delisting decisions were entered into the statewide *California Water Quality Assessment (CalWQA) Database.* The CalWQA database stores all LOEs, listing decisions, and beneficial use support ratings for assessed water bodies in California. This database was developed in 2007 for the purpose of storing detailed water quality assessment information. The database is designed so that this information can be easily reevaluated in future assessment updates and can be exported to the USEPA’s Assessment Database at the end of each assessment update.

4 Summary of Assessment Results

A full summary of the Los Angeles Region Integrated Report is included as Table 4-1.

Table 4-1 Integrated Report Summary

Integrated Report Category Number	Integrated Report Category definition	Number of waterbodies
1	Waters Supporting All Beneficial Uses	0
2 (Appendix **B**)	Waters Supporting Some Beneficial Uses	26
3 (Appendix C)	Waters With Insufficient Information	23
4 (Appendix D)	Water Quality Limited Segments Addressed	31
5 (Appendix E)	Water Quality Limited Segments not Fully Addressed	158
Total		*238 assessed waterbodies*
(4 and 5) (Appendix F) 303(d) list	*List of All Waterbody Impairments (the updated 303 (d) list)*	*189 waterbodies on the 303(d) list*

Of the waterbodies included in the Integrated Report, a total of 68 new listings are proposed and 30 de-listings are proposed. In addition, in this update, 113 previous listings are now included in the list as ‘being addressed by a TMDL’ because a USEPA approved TMDL has been completed. A summary of new additions to the Integrated Report is found in Table 4-2. In this Table, decisions to List are shown in three categories. “List” is the decision to include a waterbody/pollutant combination on the 303(d) list for the first time; “List (being addressed by TMDL)” is the decision to move a waterbody/pollutant combination from the ‘requires a TMDL” portion of the list to the “being addressed by a TMDL” portion of the list because a USEPA approved TMDL has been completed since the last update to the 303(d) list in 2006; “List (being addressed by action other than TMDL)” is the decision to move a waterbody/pollutant combination from the ‘requires a TMDL” portion of the list to the “being addressed by action other than TMDL” portion of the list because another regulatory action(such as a permitted restoration action) is sufficient to address the impairment. Factsheets for all these decisions are found in Appendix G.

Table 4-2 Integrated Report Summary for NEW decisions in 2008 including *delist, do not delist, do not list and list*

New Decision in 2008	Number of waterbodies	Number of waterbody/pollutant combinations
Delist	19	30
Do Not Delist	23	29
Do Not List	50	86
List	41	68
List (being addressed by TMDL)	55	113
List (being addressed by action other than TMDL)	2	3
Total		329

The total number of waterbody/pollutant combinations in the proposed 2008 303(d) list is 829. 448 of these waterbody/pollutant combinations, or 54%, require the completion of a TMDL or other regulatory action to address the impairment. 381 of these waterbody/pollutant combinations, or 46%, are currently being addressed by an EPA approved TMDL or other regulatory action.

This was the first time that the Water Boards have prepared an Integrated 303(d)/305(b) Report under the current Listing Policy and USEPA Integrated Report Guidance and the first time that the Regional Boards have used the CalWQA database. Combining the 303(d) list update with the 305(b) report and using the same database as all other Regions added efficiency and ensured consistency, but provided challenges in terms of workload and project management. While individual assessments for potential 303(d) listings or de-listings provided valuable information for the 305(b) report, creating the overall 305(b) report using 303(d) listing decisions as the primary input also had limitations. Preparing assessment fact sheets at the level of detail required for 303(d) list changes under the Listing Policy limited the amount of data which could be developed in the manner necessary for inclusion in the CalWQA database. In addition, the readily available data are also often biased towards areas with more potential discharges, since these areas are where the bulk of the monitoring activity takes place. For these reasons, the number of waterbody segments in each Integrated Report category is not necessarily a representative sampling of all the waterbodies within the Los Angeles Region. Despite these limitations, this Integrated Report provides the most complete 305(b) report for the Los Angeles Region to date.

5 TMDL Scheduling

As part of its 1996 and 1998 regional water quality assessments, the Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWQCB, 1996, 1998). A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner, et al. C 98-4825 SBA) (United States District Court, Northern District of California, 1999) approved on March 22, 1999 (USEPA/Heal the Bay Consent Decree).

For the purpose of scheduling TMDL development, the decree combined the over 700 waterbody-pollutant combinations into 92 TMDL analytical units. Proposed de-listings in this report would discharge or partially discharge 12 TMDL analytical units as specified in the USEPA/Heal the Bay Consent Decree between the U.S. EPA and Heal the Bay, Inc. et al. filed on March 22, 1999.

Staff identified the new listings as a low priority, to be started after the USEPA/Heal the Bay Consent Decree commitments are met. A possible exception to this would be if a new listing could be folded into an existing analytical unit without the need for additional resources to develop the resulting TMDL. The assignment of a low priority to these new TMDL analytical units is not a reflection on their importance, but is given because the Regional Board has first prioritized existing USEPA/Heal the Bay Consent Decree commitments before beginning new TMDLs. The maximum time that can elapse between 303(d) listing and TMDL completion is 13 years. Accordingly, staff have assigned all new listings a TMDL completion date of 2021. This does not suggest that all new listings have the same priority, but rather that the factors determining TMDL priorities have not yet been evaluated as part of this listing process.

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

(Those requiring TMDLs (A), being addressed by USEPA approved TMDLs (B), and being addressed by actions other than TMDLs (C))

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Abalone Cove Beach	40511000	1.07 Miles	5	DDT (sediment)	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Alamitos Bay	40512000	328 Acres	5	Indicator Bacteria	A	01/01/2019	
				The listing includes the areas 1st St. and Bayshore and 2nd St. Bridge and Bayshore.			
Aliso Canyon Wash	40521000	10.13 Miles	5	Copper	A	01/01/2019	
				Fecal Coliform	A	01/01/2019	
				Selenium	B		12/22/2005
Amarillo Beach	40431000	0.64 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Arroyo Seco Reach 1 (LA River to West Holly Ave.)	40515010	5.15 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Coliform Bacteria	A	01/01/2009	
				Trash	B		07/24/2008
Arroyo Seco Reach 2 (Figueroa St. to Riverside Dr.)	40515010	4.42 Miles	5	Coliform Bacteria	A	01/01/2009	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Trash	B		07/24/2008
Artesia-Norwalk Drain	40515010	2.5 Miles	5	Indicator Bacteria	A	01/01/2021	
				Selenium	A	01/01/2021	
Avalon Beach	40511000	0.67 Miles	5	Indicator Bacteria	A	01/01/2019	
				Area affected is between Pier and BB restaurant (2/3), between Pier and BB restaurant (1/3), between storm drain and Pier (1/3). and between BB restaurant and the Tuna Club.			
Ballona Creek	40513000	6.47 Miles	5	Cadmium (sediment)	A	01/01/2005	
				A USEPA-approved TMDL has made a finding of non-impairment for this pollutant.			
				Coliform Bacteria	B		03/26/2007
				Copper, Dissolved	B		12/22/2005
				Cyanide	A	01/01/2019	
				Lead	B		12/22/2005
				Selenium	B		12/22/2005
				Shellfish Harvesting Advisory	B		01/01/2006
				Toxicity	B		01/01/2005
				Trash	B		01/01/2001
				Viruses (enteric)	B		03/26/2007
				Zinc	B		12/22/2005
Ballona Creek Estuary	40513000	2.31 Miles	5	Cadmium	B		12/22/2005
				Chlordane (tissue & sediment)	B		12/22/2005
				Coliform Bacteria	B		01/01/2007
				Copper	B		12/22/2005
				DDT (tissue & sediment)	B		12/22/2005
				Lead (sediment)	B		12/22/2005

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				PAHs (Polycyclic Aromatic Hydrocarbons) (sediment)	B		12/22/2005
				PCBs (Polychlorinated biphenyls) (tissue & sediment)	B		12/22/2005
				Sediment Toxicity	B		01/01/2005
				Shellfish Harvesting Advisory	A	01/01/2006	
				Silver	B		12/22/2005
				Zinc (sediment)	B		12/22/2005
Ballona Creek Wetlands	40517000	289.2 Acres	5	Exotic Vegetation	A	01/01/2019	
				Habitat alterations	A	01/01/2019	
				Hydromodification	A	01/01/2019	
				Reduced Tidal Flushing	A	01/01/2019	
				Trash	B		01/01/2019
Bell Creek	40521000	8.92 Miles	5	Coliform Bacteria	A	01/01/2009	
Big Rock Beach	40431000	0.74 Miles	5	Coliform Bacteria	B		06/19/2003
				DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Bluff Cove Beach	40511000	0.55 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Brown Barranca/Long Canyon	40321000	2.6 Miles	4A	Nitrate and Nitrite	B		03/18/2004
Bull Creek	40521000	2.3 Miles	5	Indicator Bacteria	A	01/01/2021	
Burbank Western Channel	40521000	13.17 Miles	5	Copper	B		12/22/2005
				Cyanide	A	01/01/2019	
				Indicator Bacteria	A	01/01/2021	
				Lead	B		12/22/2005
				Selenium	A	01/01/2021	
				Trash	B		07/24/2008
Cabrillo Beach (Outer)	40512000	0.58 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish consumption advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish consumption advisory for PCBs.*	A	01/01/2019	
Calleguas Creek Reach 1 (was Mugu Lagoon on 1998 303(d) list)	40311000	343.79 Acres	4A	Chlordane (tissue)	B		01/01/2005
				Copper	B		03/23/2007

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				DDT (tissue & sediment)	B		01/01/2005
				Dieldrin	B		03/14/2006
				Endosulfan (tissue)	B		03/24/2006
				Mercury	B		03/26/2007
				Nickel	B		03/23/2007
				Nitrogen	B		06/20/2003
				PCBs (Polychlorinated biphenyls) (tissue)	B		01/01/2005
				Sediment Toxicity	B		01/01/2005
				Sedimentation/Siltation	B		01/01/1900
				Toxaphene	B		03/14/2006
				Zinc	B		03/23/2007
Calleguas Creek Reach 2 (estuary to Potrero Rd-was Calleguas Creek Reaches 1 and 2 on 1998 303d list)	40312000	4.31 Miles	5	Ammonia	B		06/20/2003
				ChemA (tissue) *Historical use of pesticides and lubricants.*	B		03/24/2006
				Chlordane (tissue)	B		01/01/2005
				Copper, Dissolved	B		03/23/2007
				DDT (Dichlorodiphenyltrichloroethane)	B		01/01/2005
				DDT (tissue & sediment)	B		01/01/2005
				Dieldrin	B		03/14/2006

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Endosulfan (tissue)	B		03/24/2006
				Fecal Coliform	A	01/01/2006	
				Area affected is at the mouth of the creek.			
				Nitrogen	B		06/20/2003
				PCBs (Polychlorinated biphenyls) (tissue)	B		01/01/2005
				Sediment Toxicity	B		01/01/2005
				Sedimentation/Siltation	A	01/01/2005	
				Toxaphene (tissue & sediment)	B		01/01/2005
				Trash	A	01/01/2021	
Calleguas Creek Reach 3 (Potrero Road upstream to confluence with Conejo Creek on 1998 303d list)	40312000	3.47 Miles	5	Ammonia	B		01/01/2003
				Chlordane	B		03/14/2006
				Chloride	B		12/02/2008
				DDT (Dichlorodiphenyltrichloroethane)	B		01/01/2019
				Dieldrin	B		01/01/2019
				Nitrate and Nitrite	B		06/20/2003
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sedimentation/Siltation	A	01/01/2005	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Total Dissolved Solids	B		12/02/2008
				Toxaphene	B		01/01/2019
				Trash	A	01/01/2021	
Calleguas Creek Reach 4 (was Revolon Slough Main Branch: Mugu Lagoon to Central Avenue on 1998 303d list)	40311000	7.19 Miles	5	ChemA (tissue)	B		03/24/2006
				Historical use of pesticides and lubricants.			
				Chlordane (tissue & sediment)	B		01/01/2005
				Chlorpyrifos (tissue)	B		01/01/2005
				Chlorpyrifos also exceeds in water.			
				DDT (tissue & sediment)	B		01/01/2005
				Diazinon	B		03/14/2006
				Dieldrin (tissue)	B		01/01/2005
				Endosulfan (tissue & sediment)	B		03/24/2006
				Fecal Coliform	A	01/01/2006	
				Nitrate as Nitrate (NO3)	B		01/01/2003
				Nitrogen	B		06/20/2003
				PCBs (Polychlorinated biphenyls) (tissue)	B		01/01/2005
				Sedimentation/Siltation	A	01/01/2005	
				Selenium	B		03/23/2007

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Toxaphene (tissue & sediment)	B		01/01/2005
				Toxicity	B		01/01/2005
				Trash	B		02/27/2008
Calleguas Creek Reach 5 (was Beardsley Channel on 1998 303d list)	40311000	4.34 Miles	5	ChemA (tissue)	B		03/24/2006
				Chlordane (tissue & sediment)	B		01/01/2005
				Chlorpyrifos (tissue) *Chlorpyrifos also exceeds in water.*	B		01/01/2005
				DDT (tissue & sediment)	B		01/01/2005
				Diazinon	B		03/14/2006
				Dieldrin (tissue)	B		01/01/2005
				Endosulfan (tissue & sediment)	B		03/24/2006
				Nitrogen	B		06/20/2003
				PCBs (Polychlorinated biphenyls) (tissue)	B		01/01/2005
				Sedimentation/Siltation	A	01/01/2005	
				Toxaphene (tissue & sediment)	B		01/01/2005
				Toxicity	B		01/01/2005
				Trash	B		02/27/2008

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Calleguas Creek Reach 6 (was Arroyo Las Posas Reaches 1 and 2 on 1998 303d list)	40362000	15.3 Miles	5	Ammonia	B		06/20/2003
				Chlordane	B		03/14/2006
				Chloride	B		12/02/2008
				Chlorpyrifos	B		03/14/2006
				DDT (sediment)	B		01/01/2005
				Diazinon	B		03/14/2006
				Dieldrin	B		03/14/2006
				Fecal Coliform	A	01/01/2006	
				Nitrate and Nitrite	B		06/20/2003
				Nitrate as Nitrate (NO3)	B		06/20/2003
				Sedimentation/Siltation	A	01/01/2005	
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxicity	B		03/14/2006
Calleguas Creek Reach 7 (was Arroyo Simi Reaches 1 and 2 on 1998 303d list)	40367000	13.91 Miles	5	Ammonia	B		06/20/2003
				Boron	B		12/02/2008
				Chloride	B		12/02/2008
				Chlorpyrifos	B		03/14/2006
				Diazinon	B		03/14/2006
				Indicator Bacteria	A	01/01/2019	

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Organophosphorus Pesticides	B		01/01/2005
				Sedimentation/Siltation	A	01/01/2005	
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxicity	B		03/14/2006
				Trash	A	01/01/2021	
Calleguas Creek Reach 8 (was Tapo Canyon Reach 1)	40366000	7.19 Miles	5	Boron	B		12/02/2008
				Chlordane	B		03/14/2006
				Chloride	B		12/02/2008
				Chlorpyrifos	B		03/14/2006
				DDT (Dichlorodiphenyltrichloroethane)	B		03/14/2006
				Diazinon	B		03/14/2006
				Dieldrin	B		03/14/2006
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sedimentation/Siltation	A	01/01/2005	
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene	B		03/14/2006

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Calleguas Creek Reach 9A (was lower part of Conejo Creek Reach 1 on 1998 303d list)	40312000	1.68 Miles	5	ChemA (tissue)	B		03/24/2006
				Chlordane (tissue)	B		01/01/2005
				Historical use of pesticides and lubricants.			
				Chlorpyrifos	B		03/14/2006
				DDT (tissue)	B		01/01/2005
				Diazinon	B		03/14/2006
				Dieldrin (tissue)	B		01/01/2005
				Historical use of pesticides and lubricants.			
				Endosulfan (tissue)	B		03/24/2006
				Fecal Coliform	A	01/01/2006	
				Lindane/gamma-Hexachlorocyclohexane (gamma-HCH) (tissue)	B		03/24/2006
				Historical use of pesticides and lubricants.			
				Nitrate as Nitrate (NO3)	B		06/20/2003
				Nitrogen, Nitrate	B		06/20/2003
				PCBs (Polychlorinated biphenyls) (tissue)	B		01/01/2005
				Historical use of pesticides and lubricants.			
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene (tissue & sediment)	B		01/01/2005

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Toxicity	B		03/14/2006
				Trash	A	01/01/2021	
Calleguas Creek Reach 9B (was part of Conejo Creek Reaches 1 and 2 on 1998 303d list)	40363000	6.2 Miles	5	Ammonia	B		06/20/2003
				ChemA (tissue)	B		03/24/2006
				Chlordane	B		03/14/2006
				Chloride	B		12/02/2008
				Chlorpyrifos	B		03/14/2006
				DDT (tissue)	B		01/01/2005
				Diazinon	B		03/14/2006
				Dieldrin	B		03/14/2006
				Endosulfan (tissue)	B		03/24/2006
				Indicator Bacteria	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene (tissue & sediment)	B		01/01/2005
				Toxicity	B		03/14/2006
				Trash	A	01/01/2021	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Calleguas Creek Reach 10 (Conejo Creek (Hill Canyon)-was part of Conejo Crk Reaches 2 & 3, and lower Conejo Crk/Arroyo Conejo N Fk on 1998 303d list)	40364000	2.96 Miles	5	Ammonia	B		01/01/2002
				ChemA (tissue)	B		03/24/2006
				Chlordane	B		03/14/2006
				Chloride	B		12/02/2008
				Chlorpyrifos	B		03/14/2006
				DDT (tissue)	B		01/01/2005
				Diazinon	B		03/14/2006
				Dieldrin	B		03/14/2006
				Endosulfan (tissue)	B		03/24/2006
				Fecal Coliform	A	01/01/2006	
				Nitrogen, Nitrite	B		06/20/2003
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene (tissue & sediment)	B		01/01/2005
				Toxicity	B		01/01/2005
				Trash	A	01/01/2021	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Calleguas Creek Reach 11 (Arroyo Santa Rosa, was part of Conejo Creek Reach 3 on 1998 303d list)	40365000	8.69 Miles	5	Ammonia	B		06/20/2003
				ChemA (tissue)	B		03/24/2006
				Chlordane	B		03/14/2006
				DDT (tissue)	B		01/01/2005
				Dieldrin	B		03/14/2006
				Endosulfan (tissue)	B		03/24/2006
				Fecal Coliform	A	01/01/2006	
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sedimentation/Siltation	A	01/01/2005	
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene (tissue & sediment)	B		01/01/2005
				Toxicity	B		01/01/2005
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork on 1998 303d list)	40364000	5.49 Miles	4A	Ammonia	B		06/20/2003
				Chlordane (tissue)	B		01/01/2005
				DDT (tissue)	B		01/01/2005

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Dieldrin	B		03/14/2006
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene	B		03/14/2006
Calleguas Creek Reach 13 (Conejo Creek South Fork, was Conejo Cr Reach 4 and part of Reach 3 on 1998 303d list)	40368000	17.15 Miles	4A	Ammonia	B		06/20/2003
				ChemA (tissue)	B		03/24/2006
				Chlordane	B		03/14/2006
				Chloride	B		12/02/2008
				DDT (tissue)	B		01/01/2005
				Dieldrin	B		03/14/2006
				Endosulfan (tissue)	B		03/24/2006
				PCBs (Polychlorinated biphenyls)	B		03/14/2006
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
				Toxaphene (tissue & sediment)	B		01/01/2005
				Toxicity	B		01/01/2005

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Canada Larga (Ventura River Watershed)	40210010	8.01 Miles	5	Fecal Coliform	A	01/01/2019	
				Horse stables, land use, cattle, and wildlife may be sources.			
				Low Dissolved Oxygen	A	01/01/2019	
				Total Dissolved Solids	A	01/01/2021	
Carbon Beach	40416000	1.46 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Castlerock Beach	40513000	0.21 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Channel Islands Harbor Beach	40311000	0.03 Miles	4A	Indicator Bacteria	B		12/08/2008
Colorado Lagoon	40512000	13.23 Acres	5	Chlordane (tissue & sediment)	A	01/01/2019	
				DDT (tissue)	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Dieldrin (tissue)	A	01/01/2019	
				Indicator Bacteria	A	01/01/2019	
				This listing includes the north, center, and south areas of the lagoon.			
				Lead (sediment)	A	01/01/2019	
				PAHs (Polycyclic Aromatic Hydrocarbons) (sediment)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) (tissue)	A	01/01/2019	
				Sediment Toxicity	A	01/01/2019	
				Zinc (sediment)	A	01/01/2019	
Compton Creek	40515010	8.51 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Coliform Bacteria	A	01/01/2009	
				Copper	B		12/22/2005
				Lead	B		12/22/2005
				Trash	B		07/24/2008
				pH	B		03/18/2004
Coyote Creek	40515010	13.31 Miles	5	Ammonia	C		
				Copper, Dissolved	B		03/27/2007
				Diazinon	A	01/01/2019	
				Indicator Bacteria	A	01/01/2009	
				Lead	B		03/27/2007
				pH	A	01/01/2019	
				Toxicity	A	01/01/2008	
				This listing was made by USEPA for 2002.			
Coyote Creek, North Fork	40515010	5 Miles	5	Indicator Bacteria	A	01/01/2021	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Selenium	A	01/01/2021	
Crystal Lake	40543000	3.71 Acres	5	Organic Enrichment/Low Dissolved Oxygen	A	01/01/2019	
Dan Blocker Memorial (Coral) Beach	40431000	2.1 Miles	4A	Coliform Bacteria	B		01/01/2002
				(This listing includes the area of the beach at Latigo Beach and Solstice Canyon.)			
Dockweiler Beach	40512000	4.61 Miles	4A	Indicator Bacteria	B		06/19/2003
Dominguez Channel (lined portion above Vermont Ave)	40351000	6.7 Miles	5	Ammonia	A	01/01/2019	
				Copper	A	01/01/2019	
				Diazinon	A	01/01/2021	
				Indicator Bacteria	A	01/01/2007	
				Lead	A	01/01/2019	
				Toxicity	A	01/01/2021	
				Zinc	A	01/01/2019	
Dominguez Channel Estuary (unlined portion below Vermont Ave)	40512000	140 Acres	5	Ammonia	A	01/01/2019	
				Benthic Community Effects	A	01/01/2019	
				Benzo(a)pyrene (3,4-Benzopyrene -7-d)	A	01/01/2019	
				Benzo[a]anthracene	A	01/01/2019	
				Chlordane (tissue)	A	01/01/2019	
				Chrysene (C1-C4)	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Coliform Bacteria	A	01/01/2007	
				DDT (tissue & sediment)	A	01/01/2019	
				Dieldrin (tissue)	A	01/01/2019	
				Lead (tissue)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Phenanthrene	A	01/01/2019	
				Pyrene	A	01/01/2019	
				Sediment Toxicity	A	01/01/2021	
				Zinc (sediment)	A	01/01/2019	
Dry Canyon Creek	40521000	3.92 Miles	5	Fecal Coliform	A	01/01/2009	
				Selenium, Total	B		12/22/2005
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	40311000	11.86 Miles	4A	ChemA (tissue)	B		01/01/2005
				Chlordane (tissue)	B		01/01/2005
				DDT (tissue & sediment)	B		01/01/2005
				Nitrogen	B		06/20/2003
				Sediment Toxicity	B		01/01/2005
				Toxaphene (tissue)	B		01/01/2005
				Toxicity	B		01/01/2005
Echo Park Lake	40515010	12.95 Acres	5	Algae	A	01/01/2019	
				Ammonia	A	01/01/2019	
				Copper	A	01/01/2019	
				Eutrophic	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Lead	A	01/01/2019	
				Odor	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) (tissue)	A	01/01/2019	
				Trash	A	01/01/2007	
				pH	A	01/01/2019	
El Dorado Lakes	40515010	31.04 Acres	5	Algae	A	01/01/2019	
				Ammonia	A	01/01/2019	
				Copper	A	01/01/2019	
				Eutrophic	A	01/01/2019	
				Lead	A	01/01/2019	
				Mercury (tissue)	A	01/01/2019	
				pH	A	01/01/2019	
Elizabeth Lake	40351000	123.18 Acres	5	Eutrophic	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	A	01/01/2019	
				Trash	B		02/27/2008
				pH	A	01/01/2019	
Escondido Beach	40434000	1.21 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Flat Rock Point Beach Area	40511000	0.11 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Fox Barranca (tributary to Calleguas Creek Reach 6)	40362000	6.72 Miles	4A	Boron	B		12/02/2008
				Nitrate and Nitrite	B		06/20/2003
				Sulfates	B		12/02/2008
				Total Dissolved Solids	B		12/02/2008
Hermosa Beach	40512000	1.98 Miles	4A	Indicator Bacteria	B		06/19/2003
Hobie Beach (Channel Islands Harbor)	40311000	0.1 Miles	4A	Indicator Bacteria	B		12/18/2008
Hopper Creek	40341000	13.38 Miles	5	Sulfates	A	01/01/2019	
				Total Dissolved Solids	A	01/01/2019	
Inspiration Point Beach	40511000	0.14 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
La Costa Beach	40416000	0.74 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Lake Calabasas	40521000	18.01 Acres	5	Ammonia	A	01/01/2006	
				Eutrophic	A	01/01/2019	
				Odor	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	A	01/01/2019	
				pH	A	01/01/2019	
Lake Hughes	40351000	21.43 Acres	5	Algae	A	01/01/2019	
				Eutrophic	A	01/01/2019	
				Fish Kills	A	01/01/2019	
				Odor	A	01/01/2019	
				Trash	B		02/27/2008
Lake Lindero	40423000	14.64 Acres	5	Algae	B		03/21/2003
				Chloride	A	01/01/2019	
				Eutrophic	B		03/21/2003
				Odor	B		03/21/2003
				Selenium	A	01/01/2019	
				Specific Conductivity	A	01/01/2019	
				Trash	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Lake Sherwood	40426000	135.07 Acres	5	Algae	B		03/21/2003
				Ammonia	B		03/21/2003
				Eutrophic	B		03/21/2003
				Mercury (tissue)	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	B		03/21/2003
Las Flores Beach	40415000	1.12 Miles	5	Coliform Bacteria	B		06/19/2003
				DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Las Tunas Beach	40412000	1.15 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Las Virgenes Creek	40422010	11.62 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Coliform Bacteria	B		01/01/2005
				Invasive Species	A	01/01/2021	

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				Nutrients (Algae)	B		03/21/2003
				Organic Enrichment/Low Dissolved Oxygen	B		03/21/2003
				Scum/Foam-unnatural	B		03/21/2003
				Sedimentation/Siltation	A	01/01/2019	
				Selenium	A	01/01/2019	
				Trash	A	01/01/2019	
Legg Lake	40531000	24.76 Acres	5	Ammonia	A	01/01/2019	
				Copper	A	01/01/2019	
				Lead	A	01/01/2019	
				Odor	A	01/01/2019	
				Trash	B		02/27/2008
				pH	A	01/01/2019	
Leo Carillo Beach (South of County Line)	40444000	1.77 Miles	4A	Coliform Bacteria	B		06/19/2003
Lincoln Park Lake	40515010	3.75 Acres	5	Ammonia	A	01/01/2019	
				Eutrophic	A	01/01/2019	
				Lead	A	01/01/2019	
				Odor	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	A	01/01/2019	
				Trash	A	01/01/2007	
Lindero Creek Reach 1	40423000	2.98 Miles	5	Algae	B		03/21/2003
				Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Coliform Bacteria	B		01/01/2005

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				Invasive Species	A	01/01/2021	
				Scum/Foam-unnatural	B		03/21/2003
				Selenium	A	01/01/2019	
				Trash	A	01/01/2019	
Lindero Creek Reach 2 (Above Lake)	40425000	4.49 Miles	5	Algae	B		03/21/2003
				Coliform Bacteria	B		01/01/2005
				Scum/Foam-unnatural	B		03/21/2003
				Selenium	A	01/01/2019	
				Trash	A	01/01/2019	
Long Beach City Beach	40512000	4.7 Miles	5	Indicator Bacteria	A	01/01/2019	
				This listing includes the beach area at 3rd pl., 5th pl., 10th pl., 16th pl., 36th pl., 72nd pl., Coronado ave., Molino ave., and the east side and west side of Belmont Pier.			
Long Point Beach	40511000	0.7 Miles	5	Coliform Bacteria	B		06/19/2003
				DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Los Angeles Harbor - Cabrillo Marina	40512000	77 Acres	5	Benzo(a)pyrene (3,4-Benzopyrene -7-d)	A	01/01/2021	

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				DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
Los Angeles Harbor - Consolidated Slip	40512000	36 Acres	5	2-Methylnaphthalene	A	01/01/2008	
				Benthic Community Effects	A	01/01/2019	
				Benzo(a)pyrene (3,4-Benzopyrene -7-d)	A	01/01/2008	
				Benzo[a]anthracene	A	01/01/2008	
				This listing was made by USEPA for 2006.			
				Cadmium (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants, stormwater runoff, aerial deposition, and historical discharges for metals.			
				Chlordane (tissue & sediment)	A	01/01/2019	
				Chromium (sediment)	A	01/01/2019	
				Chrysene (C1-C4)	A	01/01/2008	
				Copper (sediment)	A	01/01/2019	
				DDT (tissue & sediment)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Dieldrin	A	01/01/2008	
				Lead (sediment)	A	01/01/2019	
				Mercury (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants, stormwater runoff, aerial deposition, and historical discharges for metals.			

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				PCBs (Polychlorinated biphenyls) (tissue & sediment)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
				Phenanthrene	A	01/01/2008	
				Pyrene	A	01/01/2008	
				Sediment Toxicity	A	01/01/2019	
				Toxaphene (tissue)	A	01/01/2019	
				Zinc (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants, stormwater runoff, aerial deposition, and historical discharges for metals.			
Los Angeles Harbor - Fish Harbor	40518000	91 Acres	5	Benzo(a)pyrene (3,4-Benzopyrene -7-d)	A	01/01/2008	
				Benzo[a]anthracene	A	01/01/2019	
				Chlordane	A	01/01/2019	
				Chrysene (C1-C4)	A	01/01/2019	
				Copper	A	01/01/2019	
				DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Dibenz[a,h]anthracene	A	01/01/2019	
				Lead	A	01/01/2019	
				Mercury	A	01/01/2019	
				PAHs (Polycyclic Aromatic Hydrocarbons)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Phenanthrene	A	01/01/2019	

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				Pyrene	A	01/01/2019	
				Sediment Toxicity	A	01/01/2019	
				Zinc	A	01/01/2019	
Los Angeles Harbor - Inner Cabrillo Beach Area	40512000	82 Acres	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Indicator Bacteria	B		01/01/2004
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Los Angeles River Estuary (Queensway Bay)	40512000	207 Acres	5	Chlordane (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants.			
				DDT (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants.			
				PCBs (Polychlorinated biphenyls) (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants.			
				Sediment Toxicity	A	01/01/2019	
				Trash	B		07/24/2008
Los Angeles River Reach 1 (Estuary to Carson Street)	40512000	3.37 Miles	5	Ammonia	B		03/18/2004
				Cadmium	B		12/22/2005
				Coliform Bacteria	A	01/01/2009	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Copper, Dissolved	B		12/22/2005
				Cyanide	A	01/01/2019	
				Diazinon	A	01/01/2019	
				Lead	B		12/22/2005
				Nutrients (Algae)	B		03/18/2004
				Trash	B		07/24/2008
				Zinc, Dissolved	B		12/22/2005
				pH	B		01/01/2003
Los Angeles River Reach 2 (Carson to Figueroa Street)	40515010	18.8 Miles	5	Ammonia	B		03/18/2004
				Coliform Bacteria	A	01/01/2009	
				Copper	B		12/22/2005
				Lead	B		12/22/2005
				Nutrients (Algae)	B		03/18/2004
				Oil	A	01/01/2019	
				Trash	B		07/24/2008
Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)	40521000	7.94 Miles	4A	Ammonia	B		03/18/2004
				Copper	B		12/22/2005
				Lead	B		12/22/2005
				Nutrients (Algae)	B		03/18/2004
				Trash	B		07/24/2008
Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam)	40521000	11.06 Miles	5	Ammonia	B		03/18/2004

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Coliform Bacteria	A	01/01/2009	
				Copper	B		12/22/2005
				Lead	B		12/22/2005
				Nutrients (Algae)	B		03/18/2004
				Trash	B		07/24/2008
Los Angeles River Reach 5 (within Sepulveda Basin)	40521000	1.9 Miles	5	Ammonia	B		03/18/2004
				Copper	B		12/22/2005
				Lead	B		12/22/2005
				Nutrients (Algae)	B		03/18/2004
				Oil	A	01/01/2019	
				Trash	B		07/24/2008
Los Angeles River Reach 6 (Above Sepulveda Flood Control Basin)	40521000	6.99 Miles	5	Coliform Bacteria	A	01/01/2009	
				Selenium	B		12/22/2005
Los Angeles/Long Beach Inner Harbor	40518000	3003 Acres	5	Beach Closures	A	01/01/2004	
				Benthic Community Effects	A	01/01/2019	
				Benzo(a)pyrene (3,4-Benzopyrene -7-d)	A	01/01/2021	
				Chrysene (C1-C4)	A	01/01/2021	
				Copper	A	01/01/2008	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Sediment Toxicity	A	01/01/2009	
				Zinc	A	01/01/2008	
Los Angeles/Long Beach Outer Harbor (inside breakwater)	40512000	4042 Acres	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Sediment Toxicity	A	01/01/2008	
Los Cerritos Channel	40515010	30.5 Acres	5	Ammonia	A	01/01/2019	
				Bis(2ethylhexyl)phthalate (DEHP)	A	01/01/2019	
				Chlordane (sediment)	A	01/01/2019	
				Coliform Bacteria	A	01/01/2019	
				Copper	A	01/01/2019	
				Lead	A	01/01/2019	
				Trash	A		
				Zinc	A	01/01/2019	
Lunada Bay Beach	40511000	0.63 Miles	4A	Indicator Bacteria	B		01/01/2002
Machado Lake (Harbor Park Lake)	40512000	44.98 Acres	5	Algae	B		03/11/2009
				Ammonia	B		03/11/2009
				ChemA (tissue)	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Historical use of pesticides and lubricants.			
				Chlordane (tissue)	A	01/01/2019	
				Fish Consumption Advisory.			
				DDT (tissue)	A	01/01/2019	
				Fish Consumption Advisory.			
				Dieldrin (tissue)	A	01/01/2019	
				Eutrophic	B		03/11/2009
				Odor	B		03/11/2009
				PCBs (Polychlorinated biphenyls) (tissue)	A	01/01/2019	
				Trash	B		03/06/2008
Malaga Cove Beach	40511000	0.39 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Malibou Lake	40424000	39.51 Acres	4A	Algae	B		03/21/2003
				Eutrophic	B		03/21/2003
				Organic Enrichment/Low Dissolved Oxygen	B		03/21/2003
Malibu Beach	40421000	0.77 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Indicator Bacteria	B		01/01/2002
Malibu Creek	40421000	10.85 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Coliform Bacteria	B		01/01/2002
				Fish Barriers (Fish Passage)	A	01/01/2019	
				Invasive Species	A	01/01/2021	
				Nutrients (Algae)	B		03/21/2003
				Scum/Foam-unnatural	B		03/21/2003
				Sedimentation/Siltation	A	01/01/2019	
				Selenium	A	01/01/2019	
				Sulfates	A	01/01/2019	
				Trash	A	01/01/2019	
Malibu Lagoon	40421000	14.72 Acres	5	Benthic Community Effects	A		
				Coliform Bacteria	B		01/01/2005
				Eutrophic	B		03/21/2003
				Swimming Restrictions	B		01/10/2006
				Viruses (enteric)	B		01/10/2006
				pH	A	01/01/2006	
				Possible sources might be septic systems, storm drains, and birds.			
Malibu Lagoon Beach (Surfrider)	40421000	1.01 Miles	5	Coliform Bacteria	B		06/19/2003
				DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Fish Consumption Advisory for PCBs.			
Manhattan Beach	40512000	2 Miles	4A	Indicator Bacteria	B		01/01/2002
Marina del Rey Harbor - Back Basins	40517000	390.91 Acres	5	Chlordane (tissue & sediment)	B		01/01/2005
				Copper (sediment)	B		01/01/2005
				DDT (tissue)	A	01/01/2005	
				A USEPA-approved TMDL has made a finding of non-impairment for this pollutant.			
				Dieldrin (tissue)	A	01/01/2005	
				A USEPA-approved TMDL has made a finding of non-impairment for this pollutant.			
				Fish Consumption Advisory	B		01/01/2005
				Indicator Bacteria	B		03/18/2004
				Lead (sediment)	B		01/01/2005
				PCBs (Polychlorinated biphenyls) (tissue & sediment)	B		01/01/2005
				Historical use of pesticides, storm water runoff/aerial deposition from urban areas. Shellfish harvesting advisory for PCBs in tissue.			
				Sediment Toxicity	B		01/01/2005
				Zinc (sediment)	B		01/01/2005
Marina del Rey Harbor Beach	40517000	0.29 Miles	4A	Indicator Bacteria	B		03/18/2004
Matilija Creek Reach 1 (Jct. With N. Fork to Reservoir)	40220012	0.63 Miles	5	Fish Barriers (Fish Passage)	A	01/01/2019	
Matilija Creek Reach 2 (Above Reservoir)	40220010	14.52 Miles	5	Fish Barriers (Fish Passage)	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Matilija Reservoir	40220012	120.89 Acres	5	Fish Barriers (Fish Passage)	A	01/01/2019	
McCoy Canyon Creek	40521000	4.02 Miles	5	Fecal Coliform	A	01/01/2009	
				Nitrate	A	01/01/2019	
				Nitrogen, Nitrate	A	01/01/2019	
				Selenium, Total	B		12/22/2005
McGrath Beach	40311000	1.7 Miles	4A	Coliform Bacteria	B		11/20/2003
McGrath Lake	40311000	20.14 Acres	5	Chlordane (sediment)	A	01/01/2019	
				DDT (sediment)	A	01/01/2019	
				Dieldrin (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants, storm water runoff/aerial deposition from agricultural fields.			
				Fecal Coliform	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) (sediment)	A	01/01/2019	
				Historical use of pesticides and lubricants, storm water runoff/aerial deposition from agricultural fields.			
				Sediment Toxicity	A	01/01/2019	
Medea Creek Reach 1 (Lake to Confl. with Lindero)	40424000	2.57 Miles	5	Algae	B		03/21/2003
				Coliform Bacteria	B		01/01/2005
				Sedimentation/Siltation	A	01/01/2019	
				Selenium	A	01/01/2019	
				Trash	A	01/01/2019	

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WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Medea Creek Reach 2 (Abv Confl. with Lindero)	40423000	5.41 Miles	5	Algae	B		03/21/2003
				Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Coliform Bacteria	B		01/01/2005
				Invasive Species	A	01/01/2021	
				Sedimentation/Siltation	A	01/01/2019	
				Selenium	A	01/01/2019	
				Trash	A	01/01/2019	
Mint Canyon Creek Reach 1 (Confl to Rowler Cyn)	40351000	8.11 Miles	4A	Nitrate and Nitrite	B		03/18/2004
Monrovia Canyon Creek	40531000	3.36 Miles	4A	Lead	B		12/22/2005
Munz Lake	40351000	6.57 Acres	5	Eutrophic	A	01/01/2019	
				Trash	B		02/27/2008
Nicholas Canyon Beach	40444000	1.65 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Ormond Beach	40311000	3.1 Miles	5	Indicator Bacteria *This listing includes the area of Ormond Beach at Oxnard Drain.*	A	01/01/2015	

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Palo Comado Creek	40423000	6.76 Miles	4A	Coliform Bacteria	B		01/01/2005
Palo Verde Shoreline Park Beach	40511000	0.24 Miles	5	Pathogens	B		06/19/2003
				Pesticides	A	01/01/2019	
Paradise Cove Beach	40435000	1.66 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish consumption advisory for DDT.*	A	01/01/2019	
				Fecal Coliform	B		06/19/2003
				PCBs (Polychlorinated biphenyls) *Fish consumption advisory for PCBs.*	A	01/01/2019	
Peck Road Park Lake	40531000	103.22 Acres	5	Chlordane (tissue)	A	01/01/2019	
				DDT (tissue)	A	01/01/2019	
				Lead	A	01/01/2019	
				Odor	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	A	01/01/2019	
				Trash	A	01/01/2007	
Peninsula Beach	40311000	0.15 Miles	5	Indicator Bacteria *Area affected is beach area north of South Jetty.*	A	01/01/2003	
Piru Creek (from gaging station below Santa Felicia Dam to headwaters)	40342000	67 Miles	5	Chloride	A	01/01/2019	
				pH	A	01/01/2019	

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Point Dume Beach	40435000	2.5 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish consumption advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls) *Fish consumption advisory for PCBs.*	A	01/01/2019	
Point Fermin Park Beach	40512000	1.6 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish consumption advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish consumption advisory for PCBs.*	A	01/01/2019	
				Total Coliform	B		01/01/2002
Point Vicente Beach	40511000	0.63 Miles	4A	Indicator Bacteria	B		01/01/2002
Pole Creek (trib to Santa Clara River Reach 3)	40331000	9.02 Miles	5	Sulfates	A	01/01/2019	
				Total Dissolved Solids	A	01/01/2019	
Port Hueneme Harbor (Back Basins)	40311000	64.8 Acres	4B	DDT (tissue)	C		
				PCBs (Polychlorinated biphenyls) (tissue)	C		
Port Hueneme Pier	40311000	0.33 Miles	5	PCBs (Polychlorinated biphenyls)	A	01/01/2019	

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Portuguese Bend Beach	40511000	1.4 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Promenade Park Beach	40210000	0.58 Miles	5	Indicator Bacteria *Area affected is at south of drain at Figueroa Street.*	A	01/01/2015	
Puddingstone Reservoir	40552000	243.08 Acres	5	Chlordane (tissue)	A	01/01/2019	
				DDT (tissue)	A	01/01/2019	
				Mercury (tissue)	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) (tissue)	A	01/01/2019	
Puente Creek	40515010	5.8 Miles	5	Indicator Bacteria	A	01/01/2021	
				Selenium	A	01/01/2021	
Puerco Beach	40431000	0.5 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		01/01/2002

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				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Redondo Beach	40512000	1.49 Miles	5	Coliform Bacteria	B		06/19/2003
				DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Resort Point Beach	40511000	0.15 Miles	4A	Indicator Bacteria	B		01/01/2002
Rincon Beach	40100010	0.38 Miles	5	Indicator Bacteria	A	01/01/2015	
				Area affected is 50 yards south of mouth of Rincon Creek.			
Rio De Santa Clara/Oxnard Drain No. 3	40311000	1.92 Miles	5	ChemA (tissue)	A	01/01/2019	
				Chlordane (tissue)	A	01/01/2019	
				DDT (tissue)	A	01/01/2019	
				Nitrogen	B		06/20/2003
				PCBs (Polychlorinated biphenyls) (tissue)	A	01/01/2019	
				Sediment Toxicity	A	01/01/2019	
				Toxaphene (tissue)	A	01/01/2019	
Rio Hondo Reach 1 (Confl. LA River to Snt Ana Fwy)	40515010	4.55 Miles	5	Coliform Bacteria	A	01/01/2009	

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				Copper	B		12/22/2005
				Cyanide	A	01/01/2021	
				Lead	B		12/22/2005
				Toxicity	A	01/01/2021	
				Trash	B		07/24/2008
				Zinc	B		12/22/2005
				pH	B		03/18/2004
Rio Hondo Reach 2 (At Spreading Grounds)	40515010	4.92 Miles	5	Coliform Bacteria	A	01/01/2009	
Robert H. Meyer Memorial Beach	40441000	1.17 Miles	5	Beach Closures	B		06/19/2003
				DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Royal Palms Beach	40511000	1.14 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish consumption advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls) *Fish consumption advisory for PCBs.*	A	01/01/2019	

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San Antonio Creek (Tributary to Ventura River Reach 4)	40220023	9.79 Miles	5	Indicator Bacteria	A	01/01/2021	
				Nitrogen	A	01/01/2019	
				Total Dissolved Solids	A	01/01/2023	
San Buenaventura Beach	40210000	1.8 Miles	5	Indicator Bacteria	A	01/01/2015	
				This listing includes the area of San Buenaventura Beach at San Jon Rd.			
San Gabriel River Estuary	40516000	3.36 Miles	5	Copper	B		03/27/2007
				Dioxin	A	01/01/2021	
				Nickel	A	01/01/2021	
				Oxygen, Dissolved	A	01/01/2021	
San Gabriel River Reach 1 (Estuary to Firestone)	40515010	6.37 Miles	5	Coliform Bacteria	A	01/01/2019	
				pH	A	01/01/2009	
San Gabriel River Reach 2 (Firestone to Whittier Narrows Dam	40515010	12.28 Miles	5	Coliform Bacteria	A	01/01/2011	
				Cyanide	A	01/01/2021	
				Lead	B		03/27/2007
San Gabriel River Reach 3 (Whittier Narrows to Ramona)	40531000	7.16 Miles	5	Indicator Bacteria	A	01/01/2021	
San Gabriel River, East Fork	40543000	5.87 Miles	4A	Trash	B		01/01/1999

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San Jose Creek Reach 1 (SG Confluence to Temple St.)	40531000	2.67 Miles	5	Ammonia	C		
				Coliform Bacteria	A	01/01/2009	
				Total Dissolved Solids	A	01/01/2021	
				Toxicity	A	01/01/2007	
				pH	A	01/01/2021	
San Jose Creek Reach 2 (Temple to I-10 at White Ave.)	40531000	17.27 Miles	5	Coliform Bacteria	A	01/01/2019	
San Pedro Bay Near/Off Shore Zones	40512000	8173 Acres	5	Chlordane	A	01/01/2019	
				DDT (tissue & sediment) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish consumption advisory for PCBs.*	A	01/01/2019	
				Sediment Toxicity	A	01/01/2009	
Santa Clara River Estuary	40311000	49.06 Acres	5	ChemA	A	01/01/2019	
				Coliform Bacteria	A	01/01/2019	
				Nitrogen, Nitrate	A	01/01/2021	
				Toxaphene	A	01/01/2019	
				Toxicity	A	01/01/2019	
Santa Clara River Estuary Beach-Surfers Knoll	40311000	1 Miles	5	Indicator Bacteria	A	01/01/2021	

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Santa Clara River Reach 1 (Estuary to Hwy 101 Bridge)	40311000	10 Miles	5	Toxicity	A	01/01/2019	
Santa Clara River Reach 3 (Freeman Diversion to A Street)	40331000	31 Miles	5	Ammonia	B		03/18/2004
				Chloride	B		01/01/2002
				Total Dissolved Solids	A	01/01/2023	
				Toxicity	A	01/01/2021	
Santa Clara River Reach 5 (Blue Cut gaging station to West Pier Hwy 99 Bridge) (was named Santa Clara River Reach 7 on 2002 303(d) list)	40351000	9.4 Miles	5	Chloride	B		01/01/2005
				Chloride was relisted by USEPA in 2002.			
				Coliform Bacteria	A	01/01/2019	
				Iron	A	01/01/2021	
Santa Clara River Reach 6 (W Pier Hwy 99 to Bouquet Cyn Rd) (was named Santa Clara River Reach 8 on 2002 303(d) list)	40351000	5.2 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Chloride	B		01/01/2005
				Chloride was relisted by USEPA in 2002.			

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Chlorpyrifos	A	01/01/2019	
				Coliform Bacteria	A	01/01/2019	
				Copper	A	01/01/2021	
				Diazinon	A	01/01/2019	
				Iron	A	01/01/2021	
				Toxicity	A	01/01/2019	
Santa Clara River Reach 7 (Bouquet Canyon Rd to above Lang Gaging Station) (was named Santa Clara River Reach 9 on 2002 303(d) list)	40351000	21 Miles	5	Coliform Bacteria	A	01/01/2019	
Santa Clara River Reach 11 (Piru Creek, from confluence with Santa Clara River Reach 4 to gaging station below Santa Felicia Dam)	40341000	6.2 Miles	5	Boron	A	01/01/2019	
				Specific Conductance	A	01/01/2021	
				Sulfates	A	01/01/2019	
				Total Dissolved Solids	A	01/01/2021	
Santa Fe Dam Park Lake	40531000	19.76 Acres	5	Copper	A	01/01/2019	
				Lead	A	01/01/2019	
				pH	A	01/01/2019	

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Santa Monica Bay Offshore/Nearshore	40513000	146645 Acres	5	DDT (tissue & sediment)	A	01/01/2019	
				Centered on Palos Verdes Shelf.			
				Debris	A	01/01/2019	
				Fish Consumption Advisory	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) (tissue & sediment)	A	01/01/2019	
				Sediment Toxicity	A	01/01/2019	
Santa Monica Beach	40513000	3.04 Miles	4A	Indicator Bacteria	B		01/01/2002
Santa Monica Canyon	40513000	2.7 Miles	5	Indicator Bacteria	B		01/01/2002
				Lead	A	01/01/2019	
Sawpit Creek	40531000	3.9 Miles	5	Bis(2ethylhexyl)phthalate (DEHP)	A	01/01/2019	
				Fecal Coliform	A	01/01/2019	
Sea Level Beach	40441000	0.21 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			
Sepulveda Canyon	405.13	0.83 Miles	5	Ammonia	A	01/01/2019	
				Copper	B		12/22/2005
				Indicator Bacteria	B		02/20/2007
				Lead	B		12/22/2005
				Selenium	B		12/22/2005

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
				Zinc	B		12/22/2005
Sespe Creek (from 500 ft below confluence with Little Sespe Cr to headwaters)	40332020	54 Miles	5	Chloride	A	01/01/2019	
				pH	A	01/01/2019	
Solstice Canyon Creek	40432000	4.8 Miles	5	Invasive Species	A	01/01/2021	
Stokes Creek	40422020	4.72 Miles	4A	Coliform Bacteria	B		01/01/2005
Surfers Point at Seaside	40210000	0.4 Miles	5	Indicator Bacteria *Area affected is the end of the access path via a wooden gate.*	A	01/01/2015	
Topanga Beach	40413000	2.5 Miles	5	Coliform Bacteria	B		06/19/2002
				DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Topanga Canyon Creek	40411000	8.55 Miles	5	Lead	A	01/01/2019	
Torrance Beach	40512000	1.08 Miles	4A	Coliform Bacteria	B		01/01/2002
Torrance Carson Channel	40512000	3.39 Miles	5	Coliform Bacteria	A	01/01/2007	
				Copper	A	01/01/2019	
				Lead	A	01/01/2019	
Torrey Canyon Creek	40341000	1.74 Miles	4A	Nitrate and Nitrite	B		03/18/2004

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Trancas Beach (Broad Beach)	40437000	1.74 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Fecal Coliform	B		01/01/2002
				PCBs (Polychlorinated biphenyls) *Fish Consumption Advisory for PCBs.*	A	01/01/2019	
Triunfo Canyon Creek Reach 1	40424000	2.51 Miles	5	Lead	A	01/01/2019	
				Mercury	A	01/01/2019	
				Sedimentation/Siltation	A	01/01/2019	
Triunfo Canyon Creek Reach 2	40424000	3.32 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Lead	A	01/01/2019	
				Mercury	A	01/01/2019	
				Sedimentation/Siltation	A	01/01/2019	
Tujunga Wash (LA River to Hansen Dam)	40521000	9.68 Miles	5	Ammonia	B		03/18/2004
				Coliform Bacteria	A	01/01/2009	
				Copper	B		12/22/2005
				Trash	B		07/24/2008
Venice Beach	40513000	2.54 Miles	4A	Indicator Bacteria	B		01/01/2002
Ventura Harbor: Ventura Keys	40311000	178.78 Acres	5	Coliform Bacteria	A	01/01/2019	

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Ventura Marina Jetties	40311000	0.69 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
Ventura River Estuary	40210011	0.2 Miles	5	Algae	A	01/01/2019	
				Eutrophic	A	01/01/2019	
				Total Coliform	A	01/01/2019	
				Stables and horse property may be the sources.			
				Trash	B		02/27/2008
Ventura River Reach 1 and 2 (Estuary to Weldon Canyon)	40210011	4.49 Miles	5	Algae	A	01/01/2019	
Ventura River Reach 3 (Weldon Canyon to Confl. w/ Coyote Cr)	40210011	2.82 Miles	5	Indicator Bacteria	A	01/01/2021	
				Pumping	A	01/01/2019	
				Water Diversion	A	01/01/2019	
Ventura River Reach 4 (Coyote Creek to Camino Cielo Rd)	40220021	19.22 Miles	5	Pumping	A	01/01/2019	
				Water Diversion	A	01/01/2019	
Verdugo Wash Reach 1 (LA River to Verdugo Rd.)	40521000	2.02 Miles	5	Coliform Bacteria	A	01/01/2009	
				Copper	A	01/01/2021	
				Trash	B		07/24/2008

2008 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SECTIONS

WATER BODY NAME	CALWATER WATERSHED	ESTIMATED SIZE AFFECTED	INTEGRATED REPORT CATEGORY	POLLUTANT *Revelant Notes*	TMDL REQUIREMENT STATUS*	EXPECTED TMDL COMPLETION DATE	DATE USEPA APPROVED TMDL
Verdugo Wash Reach 2 (Above Verdugo Road)	40524000	7.55 Miles	5	Coliform Bacteria	A	01/01/2009	
				Trash	B		07/24/2008
Walnut Creek Wash (Drains from Puddingstone Res)	40531000	11.7 Miles	5	Benthic-Macroinvertebrate Bioassessments	A	01/01/2021	
				Indicator Bacteria	A	01/01/2021	
				pH	A	01/01/2007	
Westlake Lake	40425000	118.98 Acres	5	Algae	B		03/21/2003
				Ammonia	B		03/21/2003
				Eutrophic	B		03/21/2003
				Lead	A	01/01/2019	
				Organic Enrichment/Low Dissolved Oxygen	B		03/21/2003
Wheeler Canyon/Todd Barranca	40321000	10.09 Miles	5	Nitrate and Nitrite	B		03/18/2004
				Sulfates	A	01/01/2019	
				Total Dissolved Solids	A	01/01/2019	
Whites Point Beach	40511000	1.11 Miles	5	DDT (Dichlorodiphenyltrichloroethane) *Fish Consumption Advisory for DDT.*	A	01/01/2019	
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	

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				Fish Consumption Advisory for PCBs.			
Will Rogers Beach	40513000	3.01 Miles	4A	Indicator Bacteria	B		01/01/2002
Wilmington Drain	40342000	0.56 Miles	5	Coliform Bacteria	A	01/01/2007	
				Copper	A	01/01/2019	
				Lead	A	01/01/2019	
Zuma Beach (Westward Beach)	40436000	1.59 Miles	5	DDT (Dichlorodiphenyltrichloroethane)	A	01/01/2019	
				Fish Consumption Advisory for DDT.			
				Indicator Bacteria	B		01/01/2002
				PCBs (Polychlorinated biphenyls)	A	01/01/2019	
				Fish Consumption Advisory for PCBs.			

State of California
The Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Biogeographic Data Branch
California Natural Diversity Database

STATE & FEDERALLY LISTED ENDANGERED & THREATENED ANIMALS OF CALIFORNIA

January 2013

This is a list of animals found within California or off the coast of the State that have been classified as Endangered or Threatened by the California Fish & Game Commission (state list) or by the U.S. Secretary of the Interior or the U.S. Secretary of Commerce (federal list). The federal agencies responsible for listing are the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

The official California listing of Endangered and Threatened animals is contained in the California Code of Regulations, Title 14, Section 670.5. The official federal listing of Endangered and Threatened animals is published in the Federal Register, 50 CFR 17.11. The California Endangered Species Act of 1970 created the categories of "Endangered" and "Rare." The California Endangered Species Act of 1984 created the categories of "Endangered" and "Threatened." On January 1, 1985, all animal species designated as "Rare" were reclassified as "Threatened."

Also included on this list are animal "Candidates" for state listing and animals "Proposed" for federal listing; federal "Candidates" are currently not included. A state Candidate species is one that the Fish and Game Commission has formally declared a candidate species. A federal Proposed species is one that has had a published proposed rule to list in the Federal Register.

Designation		Totals as of January 2013
State listed as Endangered	SE	46
State listed as Threatened	ST	34
Federally listed as Endangered	FE	91
Federally listed as Threatened	FT	39
State Candidate (Endangered)	SCE	3
State Candidate (Threatened)	SCT	2
State Candidate (Delisting)	SCD	1
Federally proposed (Endangered)	FPE	0
Federally proposed (Threatened)	FPT	0
Federally proposed (Delisting)	FPD	2
Total number of animals listed (includes subspecies & population segments)		155
Total number of candidate/proposed animals for listing		5
Number of animals State listed only		32
Number of animals Federally listed only		75
Number of animals listed under both State & Federal Acts		50

Common and scientific names are shown as they appear on the state or federal lists. If the nomenclature differs for a species that is included on both lists, the state nomenclature is given and the federal nomenclature is shown in a footnote. Synonyms, name changes, and other clarifying points are also footnoted.

The "List Date" for **final** federal listing is the date the listing became effective. This is usually not the date of publication of the rule in the Federal Register; it is usually about 30 days after publication, but may be longer.

If an animal was previously listed or proposed for listing and no longer has any listing status, the entry has been grayed out.

For taxa that have more than one status entry, the **current status is in bold and underlined**.

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	State Listing		Federal Listing	
GASTROPODS				
Trinity bristle snail *Monadenia setosa*[1]	ST	10-02-80		
Morro shoulderband (=banded dune) snail *Helminthoglypta walkeriana*			FE	1-17-95
White abalone *Haliotis sorenseni*			FE[2] FE	11-16-05 6-28-01
Black abalone *Haliotis cracherodii*			FE[3] FE	4-13-11 2-13-09
CRUSTACEANS				
Riverside fairy shrimp *Streptocephalus woottoni*			FE	8-03-93
Conservancy fairy shrimp *Branchinecta conservatio*			FE	9-19-94
Longhorn fairy shrimp *Branchinecta longiantenna*			FE	9-19-94
Vernal pool fairy shrimp *Branchinecta lynchi*			FT	9-19-94
San Diego fairy shrimp *Branchinecta sandiegonensis*			FE	2-03-97
Vernal pool tadpole shrimp *Lepidurus packardi*			FE	9-19-94
Shasta crayfish *Pacifastacus fortis*	**SE** ST	2-26-88 10-02-80	FE	9-30-88
California freshwater shrimp *Syncaris pacifica*	SE	10-02-80	FE	10-31-88
INSECTS				
Zayante band-winged grasshopper *Trimerotropis infantilis*			FE	2-24-97
Mount Hermon June beetle *Polyphylla barbata*			FE	2-24-97
Casey's June beetle *Dinacoma caseyi*			**FE** FPE	10-24-11 7-09-09
Delta green ground beetle *Elaphrus viridis*			FT	8-08-80
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*			FPD **FT**	10-2-12 8-08-80

[1] Current taxonomy is *Monadenia infumata setosa.*
[2] Listed by NMFS in 2001 and by USFWS in 2005.
[3] Listed by NMFS in 2009 and by USFWS in 2011.

	State Listing			Federal Listing	
Ohlone tiger beetle *Cicindela ohlone*				FE	10-03-01
Kern primrose sphinx moth *Euproserpinus euterpe*				FT	4-08-80
Mission blue butterfly *Icaricia icarioides missionensis*[4]				FE	6-01-76
Lotis blue butterfly *Lycaeides argyrognomon lotis*[5]				FE	6-01-76
Palos Verdes blue butterfly *Glaucopsyche lygdamus palosverdesensis*				FE	7-02-80
El Segundo blue butterfly *Euphilotes battoides allyni*				FE	6-01-76
Smith's blue butterfly *Euphilotes enoptes smithi*				FE	6-01-76
San Bruno elfin butterfly *Callophrys mossii bayensis*				FE	6-01-76
Lange's metalmark butterfly *Apodemia mormo langei*				FE	6-01-76
Bay checkerspot butterfly *Euphydryas editha bayensis*				FT	10-18-87
Quino checkerspot butterfly *Euphydryas editha quino (=E. e. wrighti)*				FE	1-16-97
Carson wandering skipper *Pseudocopaeodes eunus obscurus*				FE	8-07-02
Laguna Mountains skipper *Pyrgus ruralis lagunae*				FE	1-16-97
Callippe silverspot butterfly *Speyeria callippe callippe*				FE	12-05-97
Behren's silverspot butterfly *Speyeria zerene behrensii*				FE	12-05-97
Oregon silverspot butterfly[6] *Speyeria zerene hippolyta*				FT	7-02-80
Myrtle's silverspot butterfly *Speyeria zerene myrtleae*				FE	6-22-92
Delhi Sands flower-loving fly *Rhaphiomidas terminatus abdominalis*				FE	9-23-93

[4] Current taxonomy is *Plebejus icarioides missionensis.*
[5] Current taxonomy is *Plebejus idas lotis.*
[6] Also known by the common name is Hippolyta fritillary.

	State Listing		Federal Listing	
FISHES				
Green sturgeon - southern DPS *Acipenser medirostris*			FT[7]	6-06-06
Mohave tui chub *Gila bicolor mohavensis*[8]	SE	6-27-71	FE	10-13-70
Owens tui chub *Gila bicolor snyderi*[9]	SE	1-10-74	FE	8-05-85
Thicktail chub (**Extinct**) *Gila crassicauda*	**Delisted** SE	10-02-80 1-10-74		
Bonytail[10] *Gila elegans*	**SE** SR	1-10-74 6-27-71	FE	4-23-80
Sacramento splittail *Pogonichthys macrolepidotus*			**Removed**[11] FT	9-22-03 3-10-99
Colorado squawfish[12] *Ptychocheilus lucius*	SE	6-27-71	FE	3-11-67
Modoc sucker *Catostomus microps*	**SE** SR	10-02-80 1-10-74	FE	6-11-85
Santa Ana sucker *Catostomus santaanae*			FT[13]	5-12-00
Shortnose sucker *Chasmistes brevirostris*	**SE** SR	1-10-74 6-27-71	FE	7-18-88
Lost River sucker *Deltistes luxatus*	**SE** SR	1-10-74 6-27-67	FE	7-18-88
Razorback sucker *Xyrauchen texanus*	**SE** SR	1-10-74 6-27-71	FE	10-23-91
Delta smelt *Hypomesus transpacificus*	**SE** ST	1-20-10 12-09-93	FT	3-05-93
Longfin smelt *Spirinchus thaleichthys*	**ST** SCE	4-09-10 2-02-08		
Pacific eulachon - southern DPS *Thaleichthys pacificus*			FT FT	4-13-11[14] 5-17-10
Lahontan cutthroat trout *Oncorhynchus clarkii henshawi*[15]			**FT** FE	7-16-75 10-13-70

[7] Includes all spawning populations south of the Eel River.
[8] Current taxonomy: *Siphateles bicolor mohavensis*.
[9] Current taxonomy: *Siphateles bicolor snyderi*.
[10] Federal common name: bonytail chub.
[11] On 23 June 2000, the Federal Eastern District Court of Calif. found the final rule to be unlawful and on 22 Sept 2000 remanded the determination back to the USFWS for a reevaluation of the final decision. After a thorough review the USFWS removed the Sacramento splittail from the list of Threatened species.
[12] Current nomenclature and federal listing: Colorado pikeminnow.
[13] Populations in the Los Angeles, San Gabriel, and Santa Ana River basins.
[14] Eulachon was listed as Threatened by the NMFS in 2010 and by the USFWS in 2011.
[15] According to the American Fisheries Society Special Publication 29 (2004), "clarkii" has two i's.

	State Listing		Federal Listing	
Paiute cutthroat trout *Oncorhynchus clarkii seleniris*			**FT** FE	7-16-75 3-11-67[16]
Coho salmon - south of Punta Gorda[17] *Oncorhynchus kisutch*	SE[18]	3-30-05	**FE**[19] FT	8-29-05 12-02-96
Coho salmon - Punta Gorda to the N. border of California[20] *Oncorhynchus kisutch*	ST[21]	3-30-05	FT[22] FT	8-29-05 6-05-97
Steelhead - Southern California DPS[23] *Oncorhynchus mykiss*			FE[24] FE	2-06-06 10-17-97
Steelhead - South-Central California Coast DPS[25] *Oncorhynchus mykiss*			FT[26] FT	2-06-06 10-17-97
Steelhead - Central California Coast DPS[27] *Oncorhynchus mykiss*			FT[28] FT	2-06-06 10-17-97
Steelhead - California Central Valley DPS[29] *Oncorhynchus mykiss*			FT[30] FT	2-06-06 5-18-98
Steelhead - Northern California DPS[31] *Oncorhynchus mykiss*			FT[32] FT	2-06-06 8-07-00
Little Kern golden trout *Oncorhynchus mykiss whitei*[33]			FT	4-13-78
Chinook salmon - Winter-run[34] *Oncorhynchus tshawytscha*	SE	9-22-89	FE[35] FE	8-29-05 2-03-94
Chinook salmon - California coastal ESU[36] *Oncorhynchus tshawytscha*			FT[37] FT	8-29-05 11-15-99

[16] All species with a list date of 03-11-67 were listed under the Endangered Species Preservation Act of October 15, 1966.
[17] The Federal listing is for Central California Coast Coho ESU and includes populations from Punta Gorda south to, and including, the San Lorenzo River as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system.
[18] The Coho south of San Francisco Bay were state listed in 1995. In February 2004 the Fish and Game Commission determined that the Coho from San Francisco to Punta Gorda should also be listed as Endangered. This change was finalized by the Office of Administrative Law on March 30, 2005.
[19] The NMFS completed a comprehensive status review in 2005 reaffirming the status.
[20] The Federal listing is for Southern Oregon/Northern California Coast Coho ESU and includes populations in coastal streams between Cape Blanco, Oregon and Punta Gorda, California.
[21] The Fish and Game Commission determined that the Coho from Punta Gorda to the Oregon border should be listed as Threatened on February 25, 2004. This determination was finalized by the Office of Administrative Law on March 30, 2005.
[22] The NMFS completed a comprehensive status review in 2005 reaffirming the status.
[23] Coastal basins from the Santa Maria River (inclusive), south to the U.S.-Mexico Border.
[24] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[25] Coastal basins from the Pajaro River (inclusive) south to, but not including, the Santa Maria River.
[26] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[27] Coastal streams from the Russian River (inclusive) to Aptos Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers; and tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), exclusive of the Sacramento-San Joaquin River Basin of the California Central Valley.
[28] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[29] The Sacramento and San Joaquin Rivers and their tributaries.
[30] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[31] Naturally spawned populations residing below impassable barriers in coastal basins from Redwood Creek in Humboldt County to, and including, the Gualala River in Mendocino County.
[32] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[33] Originally listed as *Salmo aguabonita whitei*. The genus *Salmo* was reclassified as *Oncorhynchus* changing the name to *Oncorhynchus aguabonita whitei*. However, recent studies indicate this is a subspecies of rainbow trout, therefore *Oncorhynchus mykiss whitei*.
[34] The federal designation is for Chinook salmon - Sacramento River winter-run ESU and described as winter-run populations in the Sacramento River and its tributaries in California.
[35] The NMFS completed a comprehensive status review in 2005 reaffirming the status.

	State Listing		Federal Listing	
Chinook salmon - Spring-run[38] *Oncorhynchus tshawytscha*	ST	2-05-99	FT[39] FT	8-29-05 11-15-99
Bull trout *Salvelinus confluentus*	SE	10-02-80	FT	12-01-99
Desert pupfish *Cyprinodon macularius*	SE	10-02-80	FE	3-31-86
Tecopa pupfish (**Extinct**) *Cyprinodon nevadensis calidae*	**Delisted** SE	1987 6-27-71	**Delisted** FE	1-15-82 10-13-70
Owens pupfish *Cyprinodon radiosus*	SE	6-27-71	FE	3-11-67
Cottonball Marsh pupfish *Cyprinodon salinus milleri*	ST	1-10-74		
Unarmored threespine stickleback *Gasterosteus aculeatus williamsoni*	SE	6-27-71	FE	10-13-70
Rough sculpin *Cottus asperrimus*	ST	1-10-74		
Tidewater goby *Eucyclogobius newberryi*			Withdrawn FPD[40] **FE**	12-09-02 6-24-99 2-04-94
AMPHIBIANS				
California tiger salamander[41] *Ambystoma californiense*	ST[42]	8-19-10	(FE) (FT)	
California tiger salamander - central California DPS *Ambystoma californiense*	(ST)		FT[43]	9-03-04
California tiger salamander - Santa Barbara County DPS *Ambystoma californiense*	(ST)		FE[43]	9-15-00
California tiger salamander - Sonoma County DPS *Ambystoma californiense*	(ST)		FE[43]	3-19-03
Santa Cruz long-toed salamander *Ambystoma macrodactylum croceum*	SE	6-27-71	FE	3-11-67
Siskiyou Mountains salamander *Plethodon stormi*	SCD **ST**	9-30-05 6-27-71		

[36] Rivers and streams south of the Klamath River to the Russian River.
[37] The NMFS completed a comprehensive status review in 2005 reaffirming the status.
[38] The State listing is for "Spring-run chinook salmon (*Oncorhynchus tshawytscha*) of the Sacramento River drainage." The Federal listing is for Central Valley spring-run Chinook ESU and includes populations of spring-run Chinook salmon in the Sacramento River and its tributaries including the Feather River.
[39] The NMFS completed a comprehensive status review in 2005 reaffirming the status.
[40] Proposal to delist referred to populations north of Orange County only.
[41] The State listing refers to the entire range of the species.
[42] Adopted May 20, 2010. The Office of Administrative Law approved the listing on Aug 2, 2010 and the effective date of regulations is Aug 19, 2010.
[43] In 2004 the California tiger salamander was listed as Threatened statewide. The Santa Barbara County and Sonoma County Distinct Vertebrate Population Segments (DPS), formerly listed as Endangered, were reclassified to Threatened. On Aug 19 2005 U.S. District court vacated the downlisting of the Sonoma and Santa Barbara populations from Endangered to Threatened. Therefore, the Sonoma & Santa Barbara populations are once again listed as Endangered.

	State Listing		Federal Listing	
Scott Bar salamander *Plethodon asupak*	ST[44]	6-27-71		
Tehachapi slender salamander *Batrachoseps stebbinsi*	ST	6-27-71		
Kern Canyon slender salamander *Batrachoseps simatus*	ST	6-27-71		
Desert slender salamander *Batrachoseps aridus*[45]	SE	6-27-71	FE	6-04-73
Shasta salamander *Hydromantes shastae*	ST	6-27-71		
Limestone salamander *Hydromantes brunus*	ST	6-27-71		
Black toad *Bufo exsul*[46]	ST	6-27-71		
Arroyo toad *Anaxyrus californicus*[47]			FE	1-17-95
California red-legged frog *Rana aurora draytonii*[48]			FT	5-20-96
Southern mountain yellow-legged frog[49] *Rana muscosa*	SCE[50]	9-21-10	FE[51]	8-01-02
Sierra Nevada mountain yellow-legged frog *Rana sierrae*	SCT[52]	9-21-10		
REPTILES				
Desert tortoise *Gopherus agassizii*	ST	8-03-89	FT	4-02-90
Green sea turtle[53] *Chelonia mydas*			**FT** FE	7-28-78 10-13-70
Loggerhead sea turtle - North Pacific DPS[54] *Caretta caretta*			**FE** FPE FT	10-24-11 3-16-10 7-28-78

[44] Since this newly described species was formerly considered to be a subpopulation of *Plethodon stormi,* and since *Plethodon stormi* is listed as Threatened under the CESA, *Plethodon asupak* retains the Threatened designation.
[45] Current taxonomy: *Batrachoseps major aridus.*
[46] Current taxonomy: *Anaxyrus exsul.*
[47] At the time of listing, arroyo toad was known as *Bufo microscaphus californicus,* a subspecies of southwestern toad. In 2001 it was determined to be its own species, *Bufo californicus*. Since then, many species in the genus *Bufo* were changed to the genus *Anaxyrus*, and now arroyo toad is known as *Anaxyrus californicus*.
[48] Current taxonomy: *Rana draytonii.*
[49] Though the scientific name *Rana muscosa* is not disputed, the State used this common name in the 16 Oct 2012 Notice of Proposed Changes in Regulation, whereas the USFWS listing refers to the distinct population segment listed as mountain yellow-legged frog – Southern California DPS. This species is also known by the common name Sierra Madre yellow-legged frog (Vredenburg et al. 2007).
[50] Filed with the Office of Administrative Law on 16 January 2013; Effective Date of Regulation is pending.
[51] Federal listing refers to the distinct population segment (DPS) in the San Gabriel, San Jacinto, and San Bernardino Mountains only, with a recognized common name of Mountain yellow-legged frog - Southern California DPS. MYLF north of the Tehachapi Mountains are a Federal candidate.
[52] Filed with the Office of Administrative Law on 16 January 2013; Effective Date of Regulation is pending.
[53] Current nomenclature: green turtle.

	State Listing			Federal Listing	
Olive (=Pacific) ridley sea turtle *Lepidochelys olivacea*				FT	7-28-78
Leatherback sea turtle *Dermochelys coriacea*				FE	6-02-70
Barefoot banded gecko[55] *Coleonyx switaki*	ST	10-02-80			
Coachella Valley fringe-toed lizard *Uma inornata*	SE	10-02-80		FT	9-25-80
Blunt-nosed leopard lizard *Gambelia silus*[56]	SE	6-27-71		FE	3-11-67
Flat-tailed horned lizard *Phrynosoma mcallii*				**Withdrawn**[57] FPT[58]	3-15-11 11-29-93
Island night lizard *Xantusia riversiana*				FT	8-11-77
Southern rubber boa *Charina bottae umbratica*[59]	ST	6-27-71			
Alameda whipsnake *Masticophis lateralis euryxanthus*	ST	6-27-71		FT	12-05-97
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	SE	6-27-71		FE	3-11-67
Giant garter snake *Thamnophis couchi gigas*[60]	ST	6-27-71		FT	10-20-93
BIRDS					
Short-tailed albatross *Phoebastria albatrus*				FE FE	8-30-00[61] 6-2-1970
California brown pelican[62] (**Recovered**) *Pelecanus occidentalis californicus*	**Delisted** SE	6-03-09 6-27-71		**Delisted** FE	12-17-09 2-20-08 10-13-70
Aleutian Canada goose **(Recovered)** *Branta canadensis leucopareia*[63]				**Delisted** FT FE	3-20-01 12-12-90 3-11-67

[54] 1978 listing was for the worldwide range of the species. The Mar 16, 2010 proposed rule and Oct 24, 2011 final rule are for the North Pacific DPS (north of the equator & south of 60 degrees north latitude).
[55] Current nomenclature: Barefoot gecko.
[56] Current taxonomy: *Gambelia sila*. Both the State and Federal recognize the common name blunt-nosed leopard lizard (SSAR), but also known as bluntnose leopard lizard (CNAH). Originally listed under the ESA as *Crotaphytus wislizenii silus*.
[57] On June 28, 2006 the USFWS determined that the proposed listing was not warranted and the proposed rule that had been reinstated on Nov 17, 2005 was withdrawn. USFWS specifically reiterated that the 29 Nov 1993 proposal to list as Threatened was withdrawn as of 15 Mar 2011.
[58] On November 17, 2005, the U. S. District Court for the District of Arizona vacated the January 3, 2003 withdrawal of the proposed rule to list the flat-tailed horned lizard and reinstated the 1993 proposed rule.
[59] Current taxonomy: *Charina umbratica*.
[60] Current taxonomy and Federal listing: *Thamnophis gigas*.
[61] Listed as Endangered in one of the original species list, but "due to an inadvertent oversight" when the 1973 ESA repealed the 1969 Act, short-tailed albatross was effectively delisted. Proposed listing to fix this error in 1980, with final rule in 2000.
[62] Federal nomenclature: Brown pelican (*Pelecanus occidentalis*).
[63] Current taxonomy: Cackling goose (*Branta hutchinsii leucopareia*).

	State Listing		Federal Listing	
California condor *Gymnogyps californianus*	SE	6-27-71	FE	3-11-67
Bald eagle *Haliaeetus leucocephalus*	**SE** (rev) SE	10-02-80 6-27-71	**Delisted**[64] FT FE (rev) FE	8-08-07 7-06-99 8-11-95 2-14-78 3-11-67
Swainson's hawk *Buteo swainsoni*	ST	4-17-83		
American peregrine falcon **(Recovered)** *Falco peregrinus anatum*	**Delisted** SE	11-04-09 6-27-71	**Delisted** FE	8-25-99 6-02-70
Arctic peregrine falcon **(Recovered)** *Falco peregrinus tundrius*			**Delisted** FT FE	10-05-94 3-20-84 6-02-70
California black rail *Laterallus jamaicensis coturniculus*	ST	6-27-71		
California clapper rail *Rallus longirostris obsoletus*	SE	6-27-71	FE	10-13-70
Light-footed clapper rail *Rallus longirostris levipes*	SE	6-27-71	FE	10-13-70
Yuma clapper rail *Rallus longirostris yumanensis*	**ST** SE	2-22-78 6-27-71	FE	3-11-67
Greater sandhill crane *Grus canadensis tabida*	ST	4-17-83		
Western snowy plover *Charadrius alexandrinus nivosus*[65]			FT[66]	4-05-93
Mountain plover *Charadrius montanus*			**Withdrawn** FPT	5-12-11 12-5-02
California least tern *Sterna antillarum browni*[67]	SE	6-27-71	FE	10-13-70
Marbled murrelet *Brachyramphus marmoratus*	SE	3-12-92	FT	9-30-92
Xantus's murrelet *Synthliboramphus hypoleucus*	ST[68]	12-22-04		
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	**SE** ST	3-26-88 6-27-71		

[64] The Post-delisting Monitoring Plan will monitor the status of the bald eagle over a 20 year period with sampling events held once every 5 years.
[65] Current taxonomy: *Charadrius nivosus nivosus* (AOU 2011).
[66] Federal status applies only to the Pacific coastal population.
[67] Current taxonomy: *Sternula antillarum browni.*
[68] The Fish and Game Commission determined that Xantus's murrelet should be listed as a Threatened species February 24, 2004. As part of the normal listing process, this decision was reviewed by the Office of Administrative Law. The listing became effective on Dec 22, 2004.

	State Listing			Federal Listing	
Elf owl *Micrathene whitneyi*	SE	10-02-80			
Northern spotted owl *Strix occidentalis caurina*				FT	6-22-90
Great gray owl *Strix nebulosa*	SE	10-02-80			
Gila woodpecker *Melanerpes uropygialis*	SE	3-17-88			
Black-backed woodpecker *Picoides arcticus*	SCE or SCT	12-27-11			
Gilded northern flicker[69] *Colaptes auratus chrysoides*	SE	3-17-88			
Willow flycatcher *Empidonax traillii*	SE[70]	1-02-91			
Southwestern willow flycatcher *Empidonax traillii extimus*	(SE)			FE	3-29-95
Bank swallow *Riparia riparia*	ST	6-11-89			
Coastal California gnatcatcher *Polioptila californica californica*				FT	3-30-93
San Clemente loggerhead shrike *Lanius ludovicianus mearnsi*				FE	8-11-77
Arizona Bell's vireo *Vireo bellii arizonae*	SE	3-17-88			
Least Bell's vireo *Vireo bellii pusillus*	SE	10-02-80		FE	5-02-86
Inyo California towhee *Pipilo crissalis eremophilus*[71]	SE	10-02-80		FT	8-03-87
San Clemente sage sparrow *Amphispiza belli clementeae*				FT	8-11-77
Belding's savannah sparrow *Passerculus sandwichensis beldingi*	SE	1-10-74			
Santa Barbara song sparrow **(Extinct)** *Melospiza melodia graminea*				**Delisted** FE	10-12-83 6-04-73
MAMMALS					
Point Arena mountain beaver *Aplodontia rufa nigra*				FE	12-12-91

69 Current taxonomy: Gilded flicker (*Colaptes chrysoides*).
70 State listing includes all subspecies.
71 Current taxonomy: *Melozone crissalis eremophilus*.

	State Listing		Federal Listing	
San Joaquin antelope squirrel[72] *Ammospermophilus nelsoni*	ST	10-02-80		
Mohave ground squirrel[73] *Spermophilus mohavensis*	ST	6-27-71		
Morro Bay kangaroo rat *Dipodomys heermanni morroensis*	SE	6-27-71	FE	10-13-70
Giant kangaroo rat *Dipodomys ingens*	SE	10-02-80	FE	1-05-87
San Bernardino kangaroo rat[74] *Dipodomys merriami parvus*			FE	9-24-98
Tipton kangaroo rat *Dipodomys nitratoides nitratoides*	SE	6-11-89	FE	7-08-88
Fresno kangaroo rat *Dipodomys nitratoides exilis*	**SE** SR	10-02-80 6-27-71	FE	3-01-85
Stephens' kangaroo rat *Dipodomys stephensi*[75]	ST	6-27-71	FE	9-30-88
Pacific pocket mouse *Perognathus longimembris pacificus*			FE	9-26-94
Amargosa vole *Microtus californicus scirpensis*	SE	10-02-80	FE	11-15-84
Riparian woodrat[76] *Neotoma fuscipes riparia*			FE	3-24-00
Salt-marsh harvest mouse *Reithrodontomys raviventris*	SE	6-27-71	FE	10-13-70
American pika *Ochotona princeps*	SCT	10-26-11		
Riparian brush rabbit *Sylvilagus bachmani riparius*	SE	5-29-94	FE	3-24-00
Buena Vista Lake shrew[77] *Sorex ornatus relictus*			FE	4-05-02
Lesser long-nosed bat *Leptonycteris yerbabuenae*			FE	10-31-88
Gray wolf *Canis lupus*	SCE	10-18-12	FE[78]	4-10-78

[72] Current taxonomy: Nelson's antelope squirrel.
[73] Current taxonomy: *Xerospermophilus mohavensis.*
[74] Federal nomenclature: San Bernardino Merriam's kangaroo rat.
[75] Federal taxonomy: included *Dipodomys cascus*, an invalid junior synonym for *Dipodomys stephensi.*
[76] Federal nomenclature: Riparian (=San Joaquin Valley) woodrat.
[77] Federal nomenclature: Buena Vista Lake ornate shrew.
[78] The full species, *Canis lupus*, was listed as Endangered in 1978. Though the status of the gray wolf is being challenged in other states, any gray wolves present or dispersing into California are considered federally Endangered.

	State Listing			Federal Listing	
Island fox *Urocyon littoralis*	ST[79]	6-27-71			
San Miguel Island Fox *Urocyon littoralis littoralis*	(ST)			FE	4-05-04
Santa Catalina Island Fox *Urocyon littoralis catalinae*	(ST)			FE	4-05-04
Santa Cruz Island Fox *Urocyon littoralis santacruzae*	(ST)			FE	4-05-04
Santa Rosa Island Fox *Urocyon littoralis santarosae*	(ST)			FE	4-05-04
San Joaquin kit fox *Vulpes macrotis mutica*	ST	6-27-71		FE	3-11-67
Sierra Nevada red fox *Vulpes vulpes necator*	ST	10-02-80			
Guadalupe fur seal *Arctocephalus townsendi*	ST	6-27-71		**FT** FE	1-15-86 3-11-67
Steller sea lion - Eastern DPS *Eumetopias jubatus*				FPD **FT** FT	4-18-12 6-4-97[80] 4-05-90
Southern sea otter *Enhydra lutris nereis*				FT	1-14-77
Wolverine *Gulo gulo*	ST	6-27-71			
Fisher - West Coast DPS[81] *Martes pennant*	**Not warranted** SCT or SCE[82]	6-23-10 4-14-09			
California (=Sierra Nevada) bighorn sheep *Ovis canadensis californiana*[83]	**SE** ST	8-27-99 6-27-71		FE	1-03-00
Peninsular bighorn sheep DPS[84] *Ovis canadensis cremnobates*	ST	6-27-71		FE	3-18-98
North Pacific right whale *Eubalaena japonica*[85]				FE[86] FE	4-7-08 6-02-70

[79] State listing includes all 6 subspecies on all 6 islands. Federal listing is for only 4 subspecies on 4 islands.
[80] The NMFS reclassified Steller sea lion as two distinct population segments: western DPS west of 144 degrees longitude (Endangered), and eastern DPS east of 144 degrees longitude (Threatened).
[81] The Fish and Game Commission during their review of the fisher petitioning recognized the common name Pacific fisher. Adopted here is the common name used in the USFWS candidacy (2 Apr 2004), fisher, for the West Coast distinct population segment for California, Oregon, and Washington.
[82] The Fish and Game Commission notice of finding stated that the Pacific fisher was a candidate for listing as either an Endangered or a Threatened species. At the June 23, 2010 meeting the Commission determined that the listing was not warranted.
[83] Current & Federal taxonomy: Sierra Nevada bighorn sheep (*Ovis canadensis sierrae)*
[84] Current taxonomy: the subspecies *O.c. cremnobates* has been synonymized with *O.c. nelsoni*. Peninsular bighorn sheep are now considered to be a Distinct Vertebrate Population Segment (DPS).
[85] The scientific name was clarified in the Federal Register Vol. 68, No. 69 April 10, 2003.

	State Listing			Federal Listing	
Sei whale *Balaenoptera borealis*				FE	6-02-70
Blue whale *Balaenoptera musculus*				FE	6-02-70
Fin whale *Balaenoptera physalus*				FE	6-02-70
Humpback whale[87] *Megaptera novaeangliae*				FE	6-02-70
Gray whale **(Recovered)** *Eschrichtius robustus*				**Delisted** FE	6-15-94 6-02-70
Killer whale (Southern resident DPS) *Orcinus orca*				FE[88] FE	4-04-07 2-16-06 12-22-04
Sperm whale *Physeter macrocephalus*[89]				FE	6-02-70

[86] The NMFS completed a status review of right whales in the N. Pacific and N. Atlantic Oceans and determined the previously Endangered northern right whale (*Eubalaena* spp.) as two separate Endangered species: North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*).
[87] Also known as Hump-backed whale.
[88] The killer whale was listed as Endangered by the NMFS on Feb 16, 2006 and by the USFWS on Apr 4, 2007.
[89] Current taxonomy: *Physeter catodon* with *P. macrocephalus* as a synonym.

Abbreviations

CESA: California Endangered Species Act

DPS: Distinct population segment

ESA: Endangered Species Act (Federal)

ESU: Evolutionarily significant unit

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Administration

USFWS: United States Fish and Wildlife Service

Additional Resources

The California Fish and Game Commission publishes notices relating to changes to Title 14 of the California Code of Regulations: http://www.fgc.ca.gov/

Title 14 of the California Code of Regulations can be accessed through The Office of Administrative Law: http://www.oal.ca.gov/

The U.S. Fish and Wildlife Service is responsible for protecting Endangered and Threatened species, and conserving candidate species and at-risk species so that ESA listing is not necessary: http://www.fws.gov/Endangered/

NOAA's National Marine Fisheries Service, Office of Protected Resources is responsible for protecting marine mammals and Endangered and Threatened marine life: http://www.nmfs.noaa.gov/pr/

Fish Migration Barrier Severity and Steelhead Habitat Quality in the Malibu Creek Watershed

Produced for California State Coastal Conservancy and
California Department of Parks and Recreation

By: Heal the Bay June 23, 2005
Analysis conducted by Mark Abramson and Mike Grimmer

The following analysis ranks the severity of steelhead trout migration barriers that block potential spawning and rearing habitat in the Malibu Creek watershed and then rates the pool habitat quality to be gained by removal of each barrier. Heal the Bay's Stream Team has mapped potential fish barriers, in-stream pool habitat, pool substrate quantities, pool substrate embeddedness, percent pool shelter cover, and exotic predator species observed on approximately 70 linear miles of streams in the watershed. A total of 201 potential barriers were mapped over the course of this project.

Barrier Severity- Barrier severity was evaluated based on swimming and leaping ability of adult steelhead trout. McEwan 2001 states that adult steelhead can maintain a speed of 6.0 feet per second (ft/sec.) for 30 minutes and a burst speed of 10.0 ft/sec. for 5 seconds until they reach exhaustion. The maximum jump speed is stated as 12 ft/sec. and the depth of a pool below an obstruction that requires a jump should be 1.25 times greater than the jump height of the structure from the surface of the pool. Heal the Bay's Stream Team barrier mapping data includes jump height (height a fish must jump to pass over a barrier), plunge depth (depth of pool below an obstruction), and the percent slope of cascades, culverts, or crossings. The barrier severity of all culverts were evaluated using "1st phase passage evaluation filter" from California Department of Fish and Game (CDFG) California Salmonid Stream Habitat Restoration Manual. Culverts that were considered "red" (***Fails to meet passage criteria)*** or "grey" (***Partial or temporal* barrier)** were then further evaluated using FishXing V 2 software. Each barrier received one of the following rankings: (Table 1)

Barrier Severity Rankings		
Barrier Severity	Description	Color Code
Passable during most flows	passable during flows > 5 cfs.	Green
Passable during moderate flows	passable at some range of stream flows between 5 and 50 cfs.	White
Passable at moderate/high flows	passable at some range of stream flows greater than 50 cfs.	Light Grey
Passable at high flows*	potentially passable at some range of stream flows greater than 100 cfs.	Dark Grey
Not Passable	impassable by adult steelhead	Red
Natural Not Passable	natural impassable upstream limit	Black
Replaced Barrier	former barrier that has been replaced with a passable structure	Orange +
Project limits	Analysis limited to downstream of this location	Blue X

* Southern California rainfall events generally provide substantial rain over short periods of time. It is not unusual to get a storm providing 3-5 inches of rainfall in a 24-48 hour period. It is believed these large rainfall events may allow steelhead trout to overcome what are deemed more significant barriers during low or moderate flows. The true severity of these barriers can only be determined by watching fish try to overcome the specific barrier or evaluating flow levels and velocities at varying flood stages at each barrier. This category was used for natural barriers with less than 9ft jump height, and man made barriers requiring a substantial rise in stream water surface elevation to allow passage. Natural barriers with less than 4ft jump height were considered passable at moderate and

high flows. Passable high flow barriers provide a very limited window of time for adult steelhead migration and may be impassible barriers during most years.

Stream Reaches – Streams were divided into reaches by cutting the stream layer at Red (Not Passable) or Dark Grey (Passable at high flows) barriers. These stream reaches were then used to calculate the length and quality of stream habitat between the significant migration barriers. Palo Comado and Cheseboro Creeks were not included in the analysis because they contain very little habitat with continuous flow throughout the spring. We also stopped our analysis of upper Medea and Lindero Creeks at their first impassible barrier. If fish passage could be accomplished above Malibou Lake the lower reaches of these streams possess good habitat. Providing passage to reaches above these first barriers would require large scale restoration and concrete removal and were not included in this analysis

Habitat Quality Rating- The in-stream pool habitat quality between barriers was evaluated using the following criteria.

1. Pool to reach ratio
2. Continual flow through May 31.
3. Average depth of pools
4. Percent in-stream pool shelter cover
4. Percent available gravel [0.25 inches- 2.5 inches diameter] as pool substrate
5. Percent of substrate embeddedness [surrounded by sand or fines].
6. Number of exotic invasive known steelhead predator species

1. A stream reach is categorized according to its percentage of pools by length and assigned a score. This resulting score qualifies the reach's pool-to-reach ratio.

Pool to Reach Ratio	Pool Ratio score (factor)
<5%	0.00
≥5% and <10%	0.25
≥10% and < 20%	0.50
≥20% and < 30%	0.75
> 30%	1.00

2. Continual or connected stream flow was evaluated for each reach based on intimate knowledge of these reaches, survey data, or water quality and/or benthic macroinvertebrate sampling data. Continual flow through a given reach of stream is evaluated according to whether or not flow exists through the end of May. This variable is important for evaluating the connectivity of stream reaches, migration ability, and the value of a reach for juvenile fish. First year juvenile fish are often found in habitats other than pools. This criteria scores stream reaches with available spawning habitat and rearing habitat through May but that don't provide year round refuge for steelhead. This variable assigns value to streams where steelhead could spawn in late winter to early spring with enough time for eggs to hatch, fry to emerge and grow, while being sheltered from larger predators and competition, and still provide a migration corridor to larger streams that provide refuge

over the long summers. Reaches with continual flow through May were assigned a score (factor).

Continual Flow through May 31	Pool area score (factor)
Yes	1.00
No	0.00

3. Pools in a given reach of stream are categorized according to their average depth and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by depth.

Range of Average Pool Depths	Pool area score (factor)
< 1.5 feet	0.25
≥1.5 and < 2.5 feet	0.50
≥2.5 and < 4.0 feet	0.75
> 4.0 feet	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's pool depth quality. For example, a reach that happened to have half of its pool area with depths of less than 1.5 ft. and the other half of its pool area was over 4 ft, its Pool area score would be 0.625. [(.25x + 1x)/2] Of course, most reaches have more diversity in its pool depths and areas than this example.

4. **Percent Pool Shelter Cover-**Pools in a given reach of stream are categorized according to their Percent Instream Shelter Cover and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by Percent Cover. Pool Shelter Cover is defined as any cover within a pool that provides areas to hide, escape, and/or shields fish from avian, aquatic or terrestrial predators. Field crews documented the percent of boulders that provide cover, large woody debris (large wood with a diameter greater that 12 inches and/or accumulations of small debris creating a large debris pile), small woody debris (diameter less than 12 inches), aquatic vegetation that provides cover from overhead including emergent vegetation and algae, undercut banks that fish can hide below without being seen from above, and bubble curtain or turbulent water that obscures fish from being seen from above.

Percent Cover Range	Pool area score (factor)
< 5%	0.00
≥5% and < 20%	0.25
≥20% and < 40%	0.50
≥40% and < 60%	0.75
>60%	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's percent pool shelter cover quality.

5. **Percent Available Pool Gravel-**Pools in a given reach of stream are categorized according to their Percent Available Gravel and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by Percent Available Gravel. Field crews measured the available gravel substrate within each pool and quantified the percentage of each substrate type. Course gravel is considered gravel larger than a ladybug (0.25 inches) and smaller than a tennis ball (2.5 inches).

Percent Gravel	Pool area score (factor)
< 1%	0.00
≥1% and < 10%	0.25
≥10% and < 30%	0.50
≥30% and < 50%	0.75
>50%	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's percent available pool gravel quality.

6. **Percent Available Pool Embeddedness**-Pools in a given reach of stream are categorized according to the Percent Embeddedness and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by Percent Embeddedness. Embeddedness was measured by randomly collecting various size substrate particles and evaluating how much of each particle was surrounded by fine sediment or sand at each pool tail and averaging the results.

Percent Embedded	Pool area score (factor)
90-100%	0.00
70-90%	0.25
60-70%	0.50
40-60%	0.75
<40%	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's percent available pool gravels embeddedness quality.

7. Pools in a given reach of stream are categorized according to the presence of known invasive aquatic steelhead predator species (Crayfish, bull frogs, largemouth bass, and sunfish) and assigned a score (factor). The number of different predator species observed in a reach was counted as the ***Number of predator species observed*** (#PSO). The assumption is the higher the number of different predator species observed the higher the risk of steelhead predation, especially for first year juvenile fish. This resulting score qualifies the number of observed steelhead predator species in the stream reach.

# Predators Species Observed (#PSO)	Pool area score (factor)
4	0.00
3	0.25
2	0.50
1	0.75
0	1.00

Each reach's categorical score was weighted in regard to its relative importance in determining habitat quality as follows:

Pool to Reach ratio **P/R** (0.3x) – This ratio helps indicate the amount of available pool habitat in proportion to the total reach length. It was considered in this analysis to be the most important indicator of steelhead habitat.

Consistent Flow **CF** (0.2x) – Flow Duration- One of the most important factors of steelhead habitat suitability in southern California is surface stream flow. Each stream was evaluated to determine if surface flow was maintained from the first large storm event of the season (> 2 inches) through May. This metric was considered critical in determining whether a stream would support steelhead trout at any level. Streams that dry out before May were deemed not suitable for steelhead trout.

Average Pool depth **APD** (0.2x) – Pool depth directly contributes to both habitat quantity and quality. As a result, this category's score was weighed twice as heavily as the following categories.

Percent Instream Pool Shelter Cover **PSC** (0.1x) – Percent instream pool shelter cover is an important factor for determining pool habitat quality and a fish's ability to hide or escape predation.

Available gravel **AG** (0.1x) – Available gravel substrate is important for accessing spawning potential at a given pool. These categories are believed to carry equal weight for determining habitat quality and half the weight of pool depth.

Embeddedness **EMB** (0.05x) – While embeddedness is a factor in overall habitat quality, our field observations demonstrate that thresholds developed for northern California and streams in other regions do not adequately represent southern California conditions. We have seen gravels cleaned and redds dug in areas where adjacent substrates were highly embedded (up to 70%). For this reason, embeddedness was given half the weight of gravel availability.

Predator Species Observed **PSO** (0.05x) – This score indicates the number of known exotic invasive steelhead predators observed in a given reach. It is intended that this variable represents increased risk to the survivability of steelhead eggs and first year juvenile fish. This variable was weighted lower because management practices could dramatically reduce the presence of these predator species and their impacts on steelhead trout.

The weighted scores from the 7 categories are then summed, resulting in the weighted pool habitat quality (**wPHQ**) of a given reach using the following formula:

[**P/R** (0.3) + **CF** (0.2) + **APD** (0.2) + **PSC** (0.1) + **AG** (0.1) + **EMB** (0.05) + **PSO** (0.05) = (**wPHQ**)]

Weighted Pool Habitat Quality (wPHQ) ratings	
≥ 0 and < 25	Poor
≥ 25 and < 50	Fair
≥ 50 and < 75	Good
≥ 75 to 100	Excellent

Chemistry Rating- Monthly water chemistry data and bi-annual benthic macroinvertebrate surveys have been conducted at 18 sites throughout the watershed over the course of this project. These sites were evaluated in terms of water temperature, dissolved oxygen, pH, and Ammonia-Nitrogen, and availability of benthic macroinvertebrate food supply (midge, dragonflies, mayflies and caddisflies). While there is not a water quality or benthic macroinvertebrate monitoring site within each reach, monitoring sites are located at the outlet of each creek and major tributary.

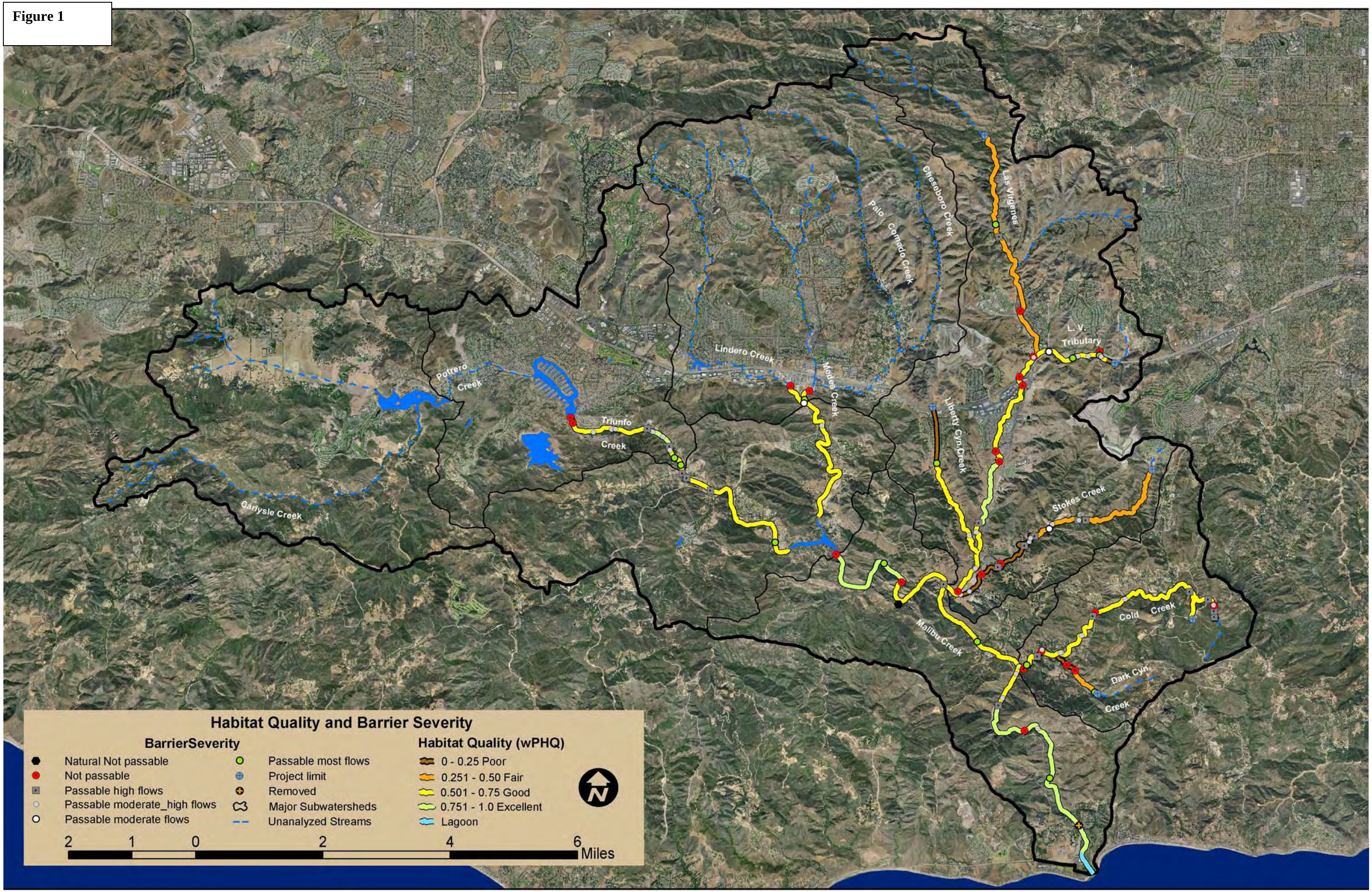
Water temperature can be a limiting factor for both egg survival and time of incubation. High temperatures can reduce a steelhead's ability to feed or even swim (Stoeker et. Al from Tebo 1974) Rainbow trout/juvenile steelhead have been observed in Santa Barbara County streams with water temperatures greater than 81 F (Stoeker et. Al 2002) Heal the Bay's water temperature data is collected monthly between 9:30 am and 2:00 pm from glides (shallow slow moving areas of the stream). While this temperature data does not capture the highest temperatures in the late afternoon, we have examined the data for any measurements above 81 F. All sites showed temperatures below 81 F and were considered to maintain water temperatures supportive of steelhead trout.

NH_3 is the principal form of toxic ammonia. It has proved toxic to fresh water organisms at concentrations ranging from 0.53 to 22.8 mg/L. (Kentucky Water Watch Website http://kywater.org/ww/ramp/rmnh4.htm) Our analysis showed no data within this range for ammonia and all water chemistry sites were considered to maintain ammonia levels supportive of steelhead trout.

Steelhead trout tolerate a range of pH from 5.8-9.6 and prefer slightly alkaline water in the range of 7-8 (Moyle 2002) The lowest pH in all of our site's data was 6.7 and the highest recorded was 9.3 at a site in Malibu Lagoon. All sites recorded pH levels well within the acceptable range, and were deemed supportive of steelhead trout.

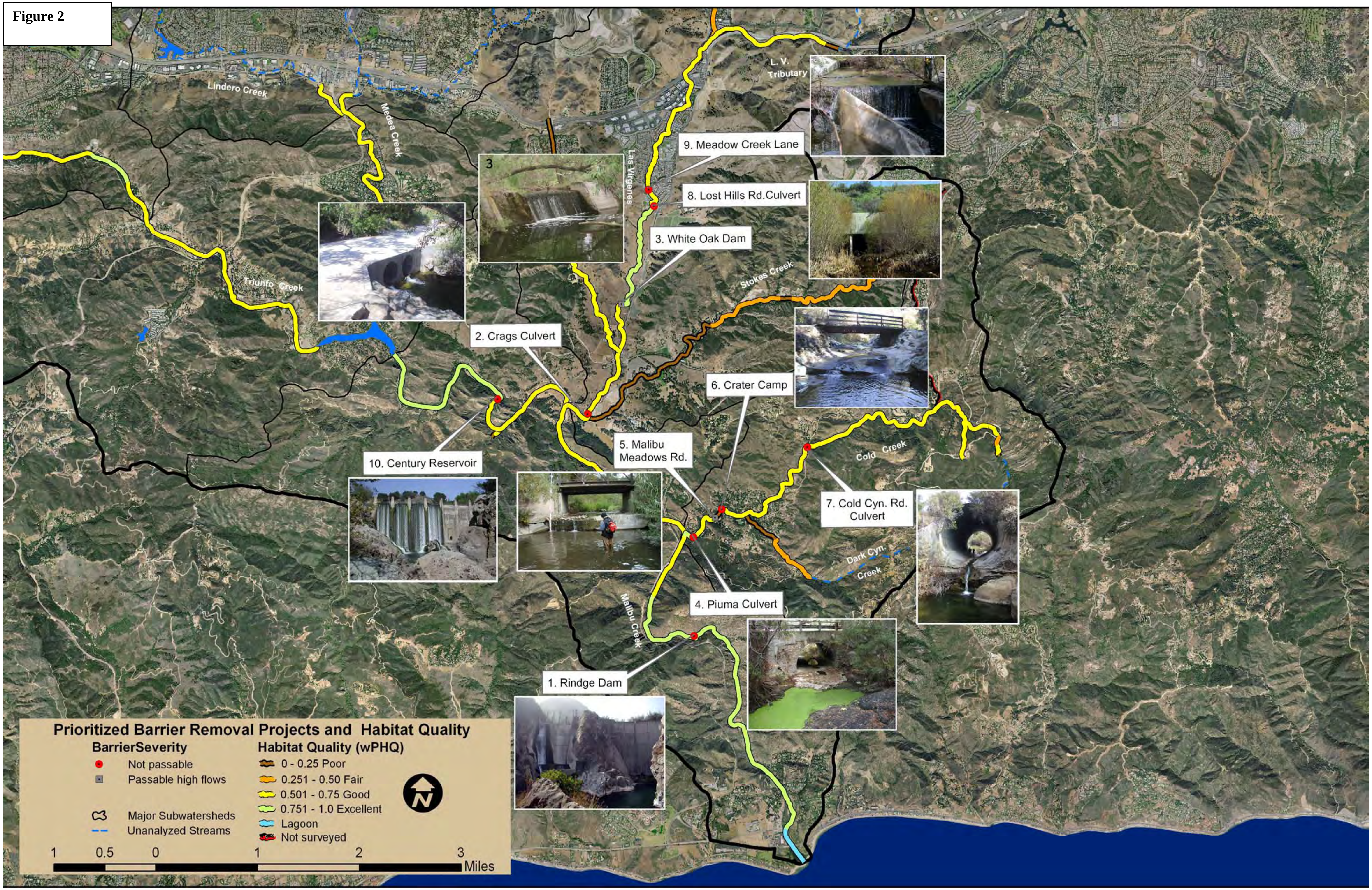
Acceptable levels for dissolved oxygen (DO) range from 3-15 mg/l. (Dagit 2003) Overall dissolved oxygen levels were well within range to support steelhead except for on 4 occasions: Site 1 on 8/8/04 (2.81 mg/l), Site 11 on 7/14/02 (1.9 mg/l), and Site 17 on 10/5/03 (2.55 mg/l) and 8/8/04 (2.17 mg/l). Because DO levels were within range for the entire migration period under analysis, dissolved oxygen was considered supportive of steelhead trout at all chemistry sites in the Malibu Creek watershed. Figure 1 is a map documenting the barrier severity and habitat quality between barriers.

Figure 1



Las Virgenes
Cheseboro Creek
Palo Comado Creek
L. V. Tributary
Lindero Creek
Medea Creek
Potrero Creek
Triunfo Creek
Liberty Cyn. Creek
Stokes Creek
Carlysle Creek
Cold Creek
Malibu Creek
Dark Cyn. Creek
Habitat Quality and Barrier Severity
BarrierSeverity
Natural Not passable
Not passable
Passable high flows
Passable moderate_high flows
Passable moderate flows
Passable most flows
Project limit
Removed
Major Subwatersheds
Unanalyzed Streams
Habitat Quality (wPHQ)
0 - 0.25 Poor
0.251 - 0.50 Fair
0.501 - 0.75 Good
0.751 - 1.0 Excellent
Lagoon
N
2 1 0 2 4 6 Miles

Figure 2



Lindero Creek
Medea Creek
Las Virgenes
L. V. Tributary
Triunfo Creek
Stokes Creek
Cold Creek
Dark Cyn. Creek
Malibu Creek
3
9. Meadow Creek Lane
8. Lost Hills Rd.Culvert
3. White Oak Dam
2. Crags Culvert
6. Crater Camp
10. Century Reservoir
5. Malibu Meadows Rd.
7. Cold Cyn. Rd. Culvert
4. Piuma Culvert
1. Rindge Dam
Prioritized Barrier Removal Projects and Habitat Quality
BarrierSeverity
Not passable
Passable high flows
Major Subwatersheds
Unanalyzed Streams
Habitat Quality (wPHQ)
0 - 0.25 Poor
0.251 - 0.50 Fair
0.501 - 0.75 Good
0.751 - 1.0 Excellent
Lagoon
Not surveyed
N
1 0.5 0 1 2 3
Miles

Steelhead Trout Recommendations: Figure 2

Recommendations for Malibu Creek

1. Providing passage upstream of Rindge Dam is the highest priority for steelhead trout restoration in the Malibu Creek watershed. The Malibu Creek steelhead trout population currently has access to only 16,138 ft. or 3 miles of habitat from Malibu Lagoon up to Rindge Dam. Malibu Creek upstream of Rindge Dam has two impassable dams that create Century Reservoir and Malibou Lake. Two barriers that are only passable by adult fish at high flows occur at Tunnel Falls (a steep tiered 10 ft. tall cascade) and the failed Texas Crossing in Malibu Creek State Park. The Texas Crossing will be removed in the summer of 2005. Providing passage over Rindge Dam would allow steelhead trout access to an additional 4886 ft. of 'excellent' habitat up to Tunnel falls and 21,294 ft. of 'good' habitat upstream of Tunnel Falls to the 45 ft. tall Century Reservoir Dam. This additional steelhead habitat access above Rindge Dam on Malibu Creek comes to a total of 26,262.30 ft. (5 miles) of high quality habitat. Access to habitat above Rindge Dam would also allow direct tributarial access to Cold Creek, Las Virgenes Creek, and Stokes Creek. Cold Creek provides access to 693.33 ft of 'excellent' habitat before hitting an impassable box culvert that takes the creek under Piuma Road. Las Virgenes Creek provides steelhead access to 1687 ft. of 'good' habitat before hitting a double culvert that allows Las Virgenes Creek to flow under the State Parks access road (Crags Road). Stokes creek would provide access to 3053 ft of 'poor' quality habitat up to a barrier where Stokes Creek flows under Las Virgenes Road. Steelhead access over Rindge Dam opens up a total 31,695.07 ft. (6 miles) of additional habitat--tripling what is currently available.

2. Replace the Las Virgenes Creek-Crags Rd. double culvert at the trailhead of Malibu Creek State Park with a larger free span bridge. Replacement of this impassable culvert would allow access to one year or older fish up to the 6 ft. tall dam at White Oak Farms and would provide an additional 1.3 miles on Las Virgenes Creek and 1.8 miles on Liberty Canyon Creek or 3.1 miles of "good" quality steelhead habitat. It is believed that large adult fish could jump the White Oak Farms Dam during years with exceptional flows.

3. Lower the height of the dam at White Oak Farms by notching it over three consecutive years; 1.5 ft. per year. Lowering the height of this "high flow" barrier from 6 ft. to 1.5 ft. would allow upstream passage by one year or older fish. This could be accomplished very inexpensively and would provide steelhead access up to the box culvert at Lost Hills Rd (De Anza Park) an additional 1.2 miles of "excellent " quality habitat.

4. Replace the culvert at Piuma Rd. and Cold Creek with a free span bridge. This undersized box culvert has only a 1 ft. jump height but has very shallow depths of less than 3 inches during most flows and when the depth is high enough for fish to swim the velocity of the water is too great. This should be immediately replaced with a larger free span bridge. Access above this culvert would open an additional 0.13 miles of 'excellent' habitat.

5. Reinforce bridge piers and remove the bottom and apron on the Malibu Meadows Road bridge on Cold Creek. This bridge has a solid concrete bottom which is downcut and requires a 3 ft. jump and then a 41 ft. swim through very shallow fast moving water. We believe that large adult fish could pass this barrier during high flows. Removing the concrete bottom and

reinforcing the existing piers will provide one year and older fish access to an additional 0.36 miles of ‘good’ quality habitat.

6. Replace Crater Camp Rd. bridge with free span natural bottom bridge on Cold Creek. This bridge is severely undercut and failing. The channel has downcut requiring a minimum 2 ft. jump and a swim over 47 ft. of steep concrete. This bridge is a depth barrier during all but the highest flows and is a velocity barrier at high flows. Replacement of this barrier provides access to 1.3 miles of “good” quality habitat and 0.24 miles of “poor” habitat on Dark Canyon Creek.

7. Replace round culvert with bottomless culvert or free span bridge at Cold Canyon Rd. This culvert has severely downcut the channel and requires a 7 ft. jump followed by a 130 ft. swim through shallow fast moving waters. This culvert is a jump, depth and velocity barrier at most flows. Predominantly natural small waterfalls exist above this barrier and are believed passable during high flows. Removal of this barrier would provide a minimum access to 2.9 miles and access to the Dry Canyon Tributary which was not surveyed during this project.

8. Create a low flow channel for fish passage or replace the Lost Hills Rd. Box Culvert upstream of De Anza Park with a wider bridge or bottomless culvert. The obstruction includes an inlet apron and 4 square box culvert openings 14 ft. x 14 ft. by 300 ft long including inlet apron. We believe it is possible to utilize one of these 14 ft. openings for fish passage by creating a low flow channel. Two of the current openings are collecting sediments. The culvert is currently a depth and velocity barrier. Passage upstream of this barrier gives steelhead access to 0.21 miles of “good” quality habitat up to Meadow Creek Lane.

9. Meadow Creek Lane drop structure 5 ft. jump, 4 opening box culvert 14ft. x14 ft. and concrete channel aprons upstream and downstream 480 ft. long. This whole stretch is in a state of serious failure and has severe undercutting and leaning wingwalls. It will need to be replaced in the near future or will completely fail. It is recommended that the stream channel and banks be restored to have an appropriate meander pattern and more gently sloping streambanks. This should be done without any armoring as was done just downstream by the Resource Conservation District of the Santa Monica Mountains. This project will reduce the massive downstream bank scour on State Parks property, improve flood control, and allow fish passage. It will also be a significant cost savings over replacement of the armored channel and banks. Providing Passage through this area would open up access of 1.3 miles of “good” quality habitat up to Agoura Rd.

SPECIAL NOTE(9A)The City of Calabasas has funds to remove a 400ft. section of concrete channel just upstream of Agoura Rd. It is recommended that this project include no armoring and provide fish passage. Using no armoring is critical to protect downstream banks from lateral scour and to begin the dissipation of energy as far upstream as possible. An appropriately designed stream channel with proper meander wave length and habitat is highly desirable for this site.

10. Remove the Century Reservoir Dam and restore the natural stream channel. Century Reservoir is within Malibu Creek State Park and is nearly full with sediment. It will need to be dredged in the near future. It currently prevents course sediments from replenishing steelhead habitat downstream. If State Parks were to dredge the reservoir they would be required to

provide for fish passage over the dam. This would likely involve an extensive fish ladder that would need constant maintenance and would be costly to build. It is recommended that the structure be removed and the stream channel be restored. This solution will be more cost effective for the long term. Passage above Century Dam would open up 1.9 miles of “excellent” quality steelhead habitat.

Addressing these 10 barriers (Figure 2) will add 6.86 miles of additional habitat on Malibu Creek, 4.39 miles on Las Virgenes Creek and 4.83 miles on Cold Creek. In addition, steelhead trout will have access to 0.58 miles of Stokes Creek, 1.78 miles on Liberty Canyon Creek. 0.24 miles on Dark Canyon Creek and undetermined amount of habitat on Dry Canyon Creek, a tributary of Cold Creek that was not mapped. This would provide a minimum of 18.68 additional miles of available habitat for steelhead trout.(622% increase) This increase would meet a minimum of 93% of the Santa Monica Bay Restoration Commission’s overall goal of increasing steelhead trout habitat in the Santa Monica Mountains by 20 miles.

About the Watershed
44 Action Items
Top 10 Watershed Restoration Priorities
Living Lightly in Our Watersheds Guide
About the Watershed Council
Watershed Council Meetings
Available Watershed Data
Completed Studies and Projects
Simple Things You Can Do
Creature Feature
Contact Us

About the Watershed

malibu creek watershed council

At 109 square miles, the Malibu Creek Watershed is one of the largest discrete watersheds draining into Santa Monica Bay, second only to the Ballona Creek Watershed. Malibu Creek and its tributaries reach east into Ventura County, winding through the Santa Monica Mountains and neighborhoods like yours until eventually reaching Santa Monica Bay.

Click here to see a map of Malibu Creek and adjoining watersheds.

Over 90,000 human residents in five cities and unincorporated areas of Los Angeles County call this watershed home, as do countless plant and animal species. Some animal species, such as the steelhead trout, tidewater goby and brown pelican are endangered. Many others, such as the snowy plover and peregrine falcon, are threatened. The watershed also hosts the popular Malibu Creek State Park, many hiking/biking trails, and spectacular scenery spanning from the ocean to the mountains.

Protecting this watershed is important not only for residential quality of life, but also to ensure the long-term health of the ecosystem. However, increased urbanization has resulted in water quality and quantity issues, as well as loss of critical habitat. Collectively, our actions can either harm or help this amazing place we call home. By taking responsibility for ensuring the overall health of the watershes and minimizing actions that adversely impact our natural resources, we can assure its viability for future generations.

The Malibu Creek Watershed Advisory Council works to protect and restore the watershed by implementing the 44 action items outlined in the 1995 Malibu Creek Watershed Natural Resources Plan. For more information on what you can do, ask for a copy of our Living Lightly in Our Watersheds guide. Not only will you find information on the watershed's many natural resources, you will also find great tips and information on how to improve your immediate environment - and even save money in the process.

Malibu Creek Watershed Council
Santa Monica Mountains Watersheds Council
Interesting Information for Locals
Keep Your Green - Sustainable Landscape Consultation
Special Events
RCDSMM in the news
Board Meeting Agendas

Prepared for:

Greater Los Angeles County
Integrated Regional Water Management Plan

The Greater Los Angeles County Open Space for Habitat and Recreation Plan

(Integrated Regional Water Management Plan Update – 2012)

Prepared by:

RMC Water and Environment

Geosyntec consultants

2M

Dr. Richard Ambrose

GreenInfo Network

Solution Strategies International Inc.

& Aubrey Dugger

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Figure 8. Habitat Linkages

For reference, these linkages are shown with critical habitat and land ownership in Figures 9 and 10)

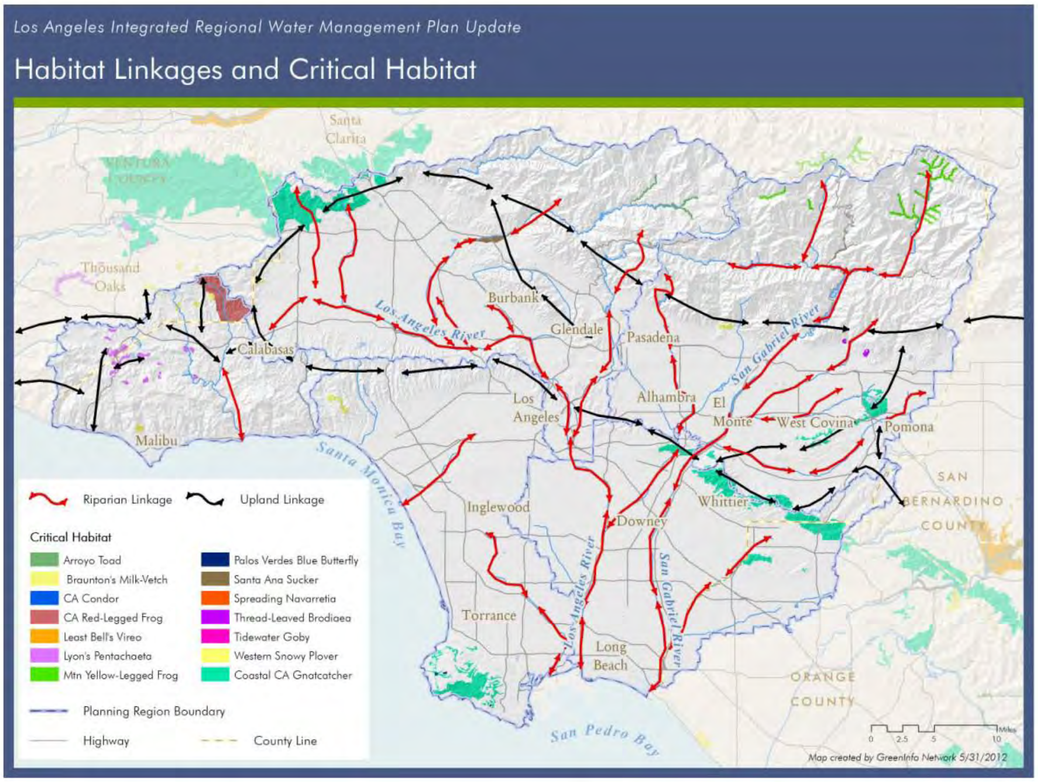

Figure 9. Habitat Linkages with USFWS Designated Critical Habitat Areas (May 2012)

Event ID,StreamId,Date,Season (W/D),Weather,Flow type,Water Clarity,Water Color,Water Odor,Floatables,Biological Floatables,Total Floating Algae Cover (%),% DT,% SP,% CH,Total Mat Algae Cover (%),% EN,% DT,%CL/RZ,Biological Floatables Notes,Trash Density,Trash Notes,Trash Type,% organics,% non-recyclable trash,% plastics,% recyclables,% large items,AirTemperature,WaterTemperature,pH,DO,Turbidity,Conductivity,Flow,Nitrate,Phosphate,Ammonia,Enterococcus,EColi,TotalColiform,IBIScore,Notes
1,1,11/7/1998,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,light,1 metal spoon,R=100%,,,,,,17.0,14.0,8.4,8.15,1.25,1875,NM,8.80,2.43,2.40,NM,NM,NM,,none
2,1,12/5/1998,W,clear,steady,clear,clear,none,none,other_foam,0,,,,NM,,,,Yellow-brown colored foam.,light,No description,R=50_P=50,,,,,,12.3,13.3,8.5,10.87,1.60,1800,NM,11.00,4.80,0.50,NM,NM,NM,,none
3,1,1/9/1999,W,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Brown algae,light,4 pieces,NM,,,,,,19.8,11.5,8.3,11.62,0.63,1665,NM,0.73,2.00,0.05,NM,NM,NM,,none
4,1,2/6/1999,W,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,15.0,15.0,8.3,10.66,4.75,1497,NM,10.00,1.97,0.27,NM,NM,NM,,none
5,1,3/6/1999,W,overcast,steady,clear,clear,musty_other_swampy,garbage,other_algae,0,,,,50-60,,,,Brown algae on bottom.,light,1 plastic bag,P=100,,,,,,13.0,14.0,8.3,13.81,1.85,1697,NM,10.33,2.02,0.04,NM,NM,NM,,50% + brown algae on bottom.
6,1,5/8/1999,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,light,3 items,P=50_R=50,,,,,,15.5,18.0,8.3,12.30,0.92,3690,NM,7.70,2.17,0.10,NM,NM,NM,,none
7,1,6/5/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,17.0,17.0,8.5,12.90,0.85,2620,NM,2.36,2.01,0.04,NM,NM,NM,,Bullfrog tadpoles observed
8,1,7/17/1999,D,clear,steady,clear,clear,none,other_pipe,other_algae,10-20,,,,NM,,,,Algae 15-20% cover,light,1 PVC pipe removed,R=100%,,,,,,20.0,20.0,7.8,4.97,1.20,1896,NM,0.07,0.67,0.005,NM,NM,NM,,Low flow under crossing subsur
9,1,8/7/1999,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,NM,,,,Algae 15-20% cover,none,none,none,,,,,,19.5,19.4,8.4,6.50,1.00,1915,NM,0.005,0.59,0.005,NM,NM,NM,,"Bullfrog tadpoles observed, La"
13,1,9/4/1999,D,overcast,steady,cloudy,clear,none,none,other_algae,10-20,,,,NM,,,,Algae 15% cover,none,none,none,,,,,,18.0,19.0,8.1,5.77,2.00,2330,NM,0.01,1.25,0.03,NM,NM,NM,,none
16,1,11/6/1999,D,overcast,steady,clear,clear,none,oily sheen,other_algae,0-10,,,,NM,,,,Algae 2% cover,none,none,none,,,,,,18.0,16.3,7.9,8.55,0.005,2350,NM,0.22,0.78,0.005,NM,NM,NM,,none
17,1,12/4/1999,W,clear,heavy,clear,clear,none,none,other_algae,0-10,,,,30-40,,,,30-40% bottom algae.,none,none,none,,,,,,18.4,12.0,8.4,NM,0.60,1788,NM,5.02,0.92,0.04,NM,NM,NM,,30-40% bottom algae.
19,1,2/5/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,light,Plastic cup tissue paper,P=75% R=25%,,,,,,18.5,15.5,8.1,10.32,0.55,1562,NM,13.05,4.72,0.14,30,NM,NM,,none
20,1,3/4/2000,W,overcast,heavy,muddy,brown,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,13.0,14.3,8.5,10.11,39.50,1407,NM,3.18,2.04,0.06,1236,NM,NM,,Rained on March 3 2000. Flow w
21,1,4/1/2000,W,clear,heavy,clear,clear,none,other_leaves and pollen,other_algae,0-10,,,,NM,,,,none,none,none,none,,,,,,26.8,16.4,8.6,15.20,0.75,1976,NM,4.05,2.11,0.16,10,NM,NM,,none
22,1,10/2/1999,D,overcast,steady,clear,clear,none,other_string_newspaper_wax pap,other_algae,0-10,,,,NM,,,,Algae 1% cover yellow duck wee,light,7 pieces of concrete,L=100%,,,,,,18.8,17.7,7.7,7.07,0.90,2285,NM,NM,1.10,7.05,NM,NM,NM,,Lots of duckweed up and down s
24,1,5/6/2000,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.5,18.7,8.4,13.91,0.40,1537,NM,0.53,0.97,0.005,5,NM,NM,,Water flowing steadily over th
25,1,6/3/2000,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,60-70,,,,Floating algae 10% cover Mat a,none,none,none,,,,,,19.0,20.5,8.2,11.27,1.25,1742,NM,0.05,0.54,0.02,74,NM,NM,,none
26,1,7/8/2000,D,clear,steady,clear,clear,none,none,other_algae,30-40,,,,NM,,,,none,none,none,none,,,,,,21.0,19.6,7.9,8.11,1.43,1862,NM,0.005,1.18,0.005,20,NM,NM,,none
27,1,8/5/2000,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,NM,,,,Floating algae 5%,none,none,none,,,,,,22.5,21.9,7.7,4.67,1.75,1862,NM,0.02,1.44,0.005,10,NM,NM,,none
28,1,9/9/2000,D,clear,intermittent,clear,clear,none,none,other_algae,0-10,,,,20-30,,,,Floating algae 5% cover Mat al,none,none,none,,,,,,20.0,19.3,7.9,6.21,0.40,2180,NM,0.01,1.32,0.005,10,NM,NM,,Water Depth 6-8inches
29,1,11/4/2000,D,clear,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,Mat algae 20-30% cover

brown,none,none,none,,,,,,21.0,15.2,8.0,10.38,1.30,1802,NM,3.70,3.16,0.07,98,NM,NM,,none
30,1,12/2/2000,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,Plastic
cup,P=100%,,,,,,14.0,12.7,8.0,10.04,0.04,1943,NM,2.61,1.96,0.13,10,NM,NM,,Tested pH field blank value 10
31,2,11/7/1998,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 1%
cover,none,none,none,,,,,,17.8,13.5,8.2,10.55,0.005,1095,0.8,0.07,0.03,0.97,NM,NM,NM,,none
32,2,12/5/1998,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,11.8,10.0,8.3,8.79,0.40,1200,3.4,0.09,0.08,0.13,NM,NM,NM,,none
33,2,1/9/1999,W,clear,steady,clear,clear,none,none,other_algae_foam,10-20,,,,20-30,,,,"Algae 15% floating cover,20-30",light,PVC pipe wooden plank,L=100%,,,,,,15.8,8.0,8.1,9.90,0.01,1010,2.8,0.14,0.005,0.005,NM,NM,NM,,2 ft long portion of a 2
34,2,2/6/1999,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,Algae 50-75%
cover,none,none,none,,,,,,15.7,11.5,8.0,10.72,0.40,1065,2.6,0.28,0.10,0.29,NM,NM,NM,,none
35,2,5/8/1999,D,overcast,steady,clear,clear,none,none,other_algae,10-20,,,,NM,,,,Algae 15% cover,light,1 cement block,L=100%,,,,,,16.3,14.8,8.1,11.37,0.005,1236,4.6,0.005,0.02,0.02,NM,NM,NM,,none
36,2,6/5/1999,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,NM,,,,Algae 2% cover,light,1 cement block,P=1%_L=99%,,,,,,16.8,14.8,8.0,9.52,0.02,6630,1.7,0.25,0.15,0.005,NM,NM,NM,,none
37,2,8/7/1999,D,clear,intermittent,clear,clear,none,none,other_algae,0-10,,,,NM,,,,Algae 10%
cover,none,none,none,,,,,,19.0,18.0,8.4,11.55,0.27,1247,0.4,0.005,0.14,0.005,NM,NM,NM,,none
38,2,12/4/1999,W,clear,trickle,clear,clear,none,none,other_algae,80-90,,,,NM,,,,Leaves 10%
cover,none,none,none,,,,,,17.5,10.1,7.9,9.80,2.10,1325,NM,0.22,0.18,0.005,NM,NM,NM,,90% light brownish green algae
40,2,3/6/1999,W,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,40-50,,,,Algae 5% cover inside pool. Mo,none,none,none,,,,,,15.5,11.3,8.1,11.72,0.45,1225,1.8,0.04,0.04,0.01,NM,NM,NM,,Large sediment build up instre
41,2,4/10/1999,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,50-60,,,,Floating algae 2% cover Signif,light,1 cement block,L=100%,,,,,,14.8,10.3,7.9,12.08,0.10,1140,4.7,0.14,0.17,0.005,NM,NM,NM,,Large pieces of construction w
42,2,1/20/2000,W,clear,steady,clear,clear,none,none,other_algae,60-70,,,,NM,,,,Algae 65%
cover,none,none,none,,,,,,20.3,13.0,7.8,10.56,0.005,1340,0.6,0.005,0.10,0.005,52,NM,NM,,Split Sample 5
43,2,7/17/1999,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leave 1% cover Much green gro,light,Old T-shirt and shorts,NRT=100%,,,,,,22.0,18.0,7.9,10.65,0.05,1274,0.1,0.18,0.25,0.005,NM,NM,NM,,tadpoles crayfish minnows lots
44,2,9/4/1999,D,overcast,trickle,clear,clear,none,none,mosquito larvae_other_algae,40-50,,,,NM,,,,"Algae 50% cover, 10% Insect la",none,none,none,,,,,,16.7,18.5,7.9,4.23,0.65,1252,NM,0.01,0.005,0.03,NM,NM,NM,,Creek trickles into a murky po
45,2,10/2/1999,D,clear,none,clear,clear,none,none,other_algae,90-100,,,,NM,,,,Algae 95%
cover,none,none,none,,,,,,21.5,17.5,7.6,3.95,0.68,1234,NM,NM,0.06,0.19,NM,NM,NM,,Not enough water in stream to
46,2,11/6/1999,D,clear,intermittent,clear,clear,none,none,other_algae,0-10,,,,NM,,,,none,light,2 Metal
bars,L=100%,,,,,,17.5,17.0,7.8,NM,15.00,1234,NM,0.005,0.11,0.05,NM,NM,NM,,Flow not measured because ther
47,2,2/5/2000,W,clear,steady,clear,brown,none,none,other_algae,30-40,,,,90-100,,,,"Algae 35% cover,full
coverage",none,none,none,,,,,,17.7,12.1,8.1,10.45,0.005,1098,0.5,0.12,0.19,0.03,122,NM,NM,,none
48,2,3/4/2000,W,overcast,heavy,clear,clear,none,garbage,none,0,,,,NM,,,,none,light,Wood PVC pipe styrofoam
cups,R=40%_L=60%,,,,,,13.5,12.8,8.1,11.68,0.52,1336,3.7,1.50,0.62,0.005,97,NM,NM,,Rain March 2000. Stream bank w
49,2,4/1/2000,W,clear,steady,clear,clear,none,none,other_pollen,0,,,,NM,,,,Pollen dust
surface,none,none,none,,,,,,28.0,15.2,8.3,11.21,0.11,1264,NM,0.95,0.09,0.09,20,NM,NM,,none
50,2,5/6/2000,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,17.8,16.1,8.1,9.58,3.00,2890,4.8,1.29,0.18,0.14,135,NM,NM,,none
51,2,6/3/2000,D,clear,steady,clear,clear,none,none,other_algae,50-60,,,,NM,,,,Algae 50-60%
cover,none,none,none,,,,,,20.8,20.8,8.3,11.08,1.10,1238,2.2,0.64,0.26,0.02,86,NM,NM,,none
52,2,7/8/2000,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,NM,,,,Algae 15-25% cover,light,1 plastic
bottle,R=100%,,,,,,20.5,17.1,8.1,8.84,1.55,1253,NM,0.83,0.49,0.14,216,NM,NM,,none
53,2,8/5/2000,D,clear,steady,clear,clear,none,none,other_algae,20-30,,,,NM,,,,Algae 25%
cover,none,none,none,,,,,,25.0,19.1,7.9,8.19,1.40,1244,0.2,0.18,0.31,0.01,135,NM,NM,,Alot of invasive vegetation al
54,2,11/4/2000,D,clear,trickle,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,20.5,13.1,7.8,9.11,0.005,1

289,0.2,0.53,0.33,0.005,298,NM,NM,,none
55,3,11/7/1998,D,overcast,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 2% cover,none,none,none,,,,,,15.5,13.8,8.2,9.65,0.60,675,0.2,0.19,0.12,0.80,NM,NM,NM,,none
56,3,12/5/1998,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,9.9,10.5,8.4,9.15,0.005,700,0.3,0.10,0.04,0.10,NM,NM,NM,,none
57,3,1/9/1999,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,0,,,,Leaves 1% cover,none,none,none,,,,,,17.0,9.8,8.3,8.45,0.20,600,0.4,0.10,0.03,0.005,NM,NM,NM,,none
58,3,2/6/1999,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,12.5,11.7,8.1,10.24,0.43,620,0.1,0.11,0.005,0.06,NM,NM,NM,,none
59,3,3/6/1999,W,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,15.1,11.6,8.3,10.28,0.65,670,0.5,0.11,0.04,0.01,NM,NM,NM,,none
60,2,9/9/2000,D,clear,steady_trickle,clear,clear,none,other_whitish film,other_algae,20-30,,,,NM,,,,Algae 25-35% cover half green,light,Shorts and carpet scrap,NRT=100%,,,,,,21.5,16.1,7.8,7.09,0.08,1325,NM,0.03,0.22,0.01,10,NM,NM,,"Slight whitish film, watercres"
61,2,12/2/2000,W,clear,steady,clear,clear,none,none,other_algae,10-20,,,,50-60,,,,Floating algae 20% cover. Brow,light,3 items,NM,,,,,,15.5,9.1,7.9,10.77,0.005,1366,1.4,0.32,0.17,0.04,216,NM,NM,,24 mosquito fish
62,3,4/10/1999,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,14.0,11.3,8.2,10.86,5.40,635,0.2,0.005,0.005,0.005,NM,NM,NM,,none
63,3,5/8/1999,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,16.9,15.8,8.1,9.56,0.005,685,0.3,0.005,0.005,0.02,NM,NM,NM,,none
64,3,6/5/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,16.9,15.3,8.1,8.83,0.10,546,0.3,0.02,0.07,0.005,NM,NM,NM,,none
65,3,7/17/1999,D,clear,steady,clear,clear,none,none,other_leaves_flowers_twigs,0,,,,NM,,,,Leaves flowers twigs 5%,none,none,none,,,,,,27.0,19.9,8.0,8.26,1.35,689,0.2,0.03,0.10,0.005,NM,NM,NM,,Water striders present
66,3,8/7/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,19.5,18.6,8.6,5.37,0.005,664,0.1,0.005,0.005,0.005,NM,NM,NM,,2 visible treefrog tadpoles
67,3,9/4/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.6,17.3,8.4,7.21,0.005,668,0.2,0.01,0.005,0.005,NM,NM,NM,,none
68,3,10/2/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,24.5,16.6,8.0,8.21,0.005,682,0.3,NM,0.005,3.25,NM,NM,NM,,none
69,3,11/6/1999,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.0,14.0,8.3,10.31,0.005,672,0.0,0.005,0.19,0.005,NM,NM,NM,,Several varieties of water bug
70,3,12/4/1999,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 10% cover,none,none,none,,,,,,16.8,10.3,8.2,10.46,0.005,693,0.1,0.005,0.04,0.01,NM,NM,NM,,"Leaves around margin;sycamore,"
72,3,1/20/2000,W,overcast,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 10% cover,none,none,none,,,,,,19.3,13.3,8.0,10.00,0.05,680,0.3,0.02,0.02,0.005,5,NM,NM,,Split sample 5. Leaves 10% of
73,3,2/5/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.3,12.9,8.2,9.83,1.65,686,0.2,0.005,0.05,0.005,10,NM,NM,,none
74,3,3/4/2000,W,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,12.0,11.4,8.1,11.14,0.12,668,0.4,0.04,0.49,0.005,5,NM,NM,,Rain March 3 2000
75,3,4/1/2000,W,clear,trickle,clear,clear,none,none,other_pollen,0,,,,NM,,,,Pollen dust on surface,none,none,none,,,,,,26.0,14.3,NM,9.80,0.89,701,NM,0.02,0.05,0.005,10,NM,NM,,none
76,3,5/6/2000,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,19.0,15.9,8.0,8.57,0.92,NM,NM,0.05,0.05,0.08,5,NM,NM,,none
77,3,6/3/2000,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,NM,,,,Algae 5% cover in one patch,none,none,none,,,,,,28.0,19.2,8.2,8.07,0.93,697,4.5,0.02,0.09,0.05,41,NM,NM,,none
78,3,7/8/2000,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,23.5,18.4,8.1,7.77,1.10,689,0.3,0.04,0.05,0.005,5,NM,NM,,none
79,3,8/5/2000,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,33.3,21.0,8.0,7.71,2.23,686,0.1,0.03,0.11,0.005,52,NM,NM,,none
80,3,9/9/2000,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,25.5,16.3,8.0,7.76,0.02,684,0.1,0.005,0.11,0.005,10,NM,NM,,none
81,3,11/4/2000,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,21.0,12.5,8.0,9.79,0.005,710,

0.2,0.005,0.06,0.005,5,NM,NM,,none
82,3,12/2/2000,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,15.8,10.9,8.1,10.21,0.005,75
0,0.2,0.005,0.10,0.02,5,NM,NM,,Tested pH field blank value 10
83,4,11/7/1998,D,overcast,steady,cloudy,brown_green,none,none,other_leaves,0,,,,NM,,,,Some
leaves,none,none,none,,,,,,15.5,14.5,8.2,7.89,13.00,2700,NM,0.09,0.005,0.13,NM,NM,NM,,none
84,4,12/5/1998,W,clear,steady,clear,clear,none,garbage,other_foam,0,,,,NM,,,,foam white .5in high@15%
cover,none,none,none,,,,,,13.0,12.2,8.1,9.53,6.30,1825,NM,0.07,0.08,0.23,NM,NM,NM,,Heavy flow recorded over the
d
85,4,1/9/1999,W,clear,steady,clear,clear,musty,none,other_algae_foam,0-10,,,,NM,,,,Algae 1% cover no info on
foa,light,3 pieces,P=100%,,,,,,21.0,10.7,8.1,11.05,5.30,1250,NM,0.04,0.03,0.03,NM,NM,NM,,none
86,4,2/6/1999,W,overcast,steady,clear,clear,none,none,mosquito larvae_other_foam,0,,,,NM,,,,Foam white 1in.
high.@2% cover,light,1 piece metal gear/crank
shaft,L=100%,,,,,,15.0,11.5,8.2,11.32,4.40,1500,NM,0.005,0.05,0.05,NM,NM,NM,,none
87,4,3/6/1999,W,overcast,steady,milky,brown_green,musty,none,other_foam,0,,,,NM,,,,Muddy colored
foam.,light,Trash near stream in
rocks,NRT=100%,,,,,,12.8,14.9,8.3,12.64,5.40,2200,NM,0.005,0.03,0.02,NM,NM,NM,,Muddy foam
88,4,4/10/1999,W,clear,trickle,cloudy,brown_green,none,none,other_leaves,0,,,,NM,,,,Small particles on
surface,light,A metal machine part,L=100%,,,,,,16.5,15.8,8.2,10.15,7.90,1525,NM,0.005,0.005,0.01,NM,NM,NM,,none
89,4,5/8/1999,D,clear,steady,clear,clear,other_stagnant,none,other_algae_foam,0-10,,,,NM,,,,Foam white,light,3
items,R=50%_L=50%,,,,,,17.3,19.1,8.2,8.98,2.50,4700,NM,0.005,0.005,0.02,NM,NM,NM,,none
90,4,6/5/1999,D,clear,steady,milky,brown_green,none,garbage,other_foam,0,,,,NM,,,,White foam.,light,Ball styrofoam
metal gear,NRT=40%_L=60%,,,,,,19.5,19.8,8.2,10.47,7.15,2225,NM,0.005,0.005,0.02,NM,NM,NM,,Dam was flowing
over both side
91,4,7/17/1999,D,clear,trickle,clear,green,none,none,none,0,,,,NM,,,,none,light,Metal Gear or Crank
shaft,L=100%,,,,,,27.5,25.3,8.2,8.72,8.00,2290,NM,0.005,0.38,0.05,NM,NM,NM,,Lots of debris up slope from w
92,4,8/7/1999,D,clear,steady,milky,clear,none,none,none,0,,,,NM,,,,none,none,Gear,L=100%,,,,,,25.0,23.9,8.4,9.76,8.00
,2478,NM,0.005,0.41,0.22,NM,NM,NM,,none
93,4,9/4/1999,D,clear,steady,milky,green,rotten_eggs,oily sheen,other_algae,0-10,,,,NM,,,,none,light,3
Pieces,P=50%_L=50%,,,,,,26.0,22.2,8.4,10.02,9.25,2810,NM,0.005,0.37,0.04,NM,NM,NM,,none
95,4,4/1/2000,W,clear,steady,cloudy,brown,none,none,none,0,,,,NM,,,,none,light,Metal Gear or Crank
shaft,L=100%,,,,,,25.3,18.2,8.4,10.87,6.20,2765,NM,0.005,0.01,0.49,5,NM,NM,,none
96,4,5/6/2000,D,clear,steady,cloudy,green,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,19.8,22.6,8.1,9.65,5.55,1
507,NM,0.09,0.09,0.01,5,NM,NM,,none
97,4,6/3/2000,D,clear,none,muddy,clear,none,none,other_algae,0,,,,90-100,,,,Algae below
water,none,none,none,,,,,,34.0,24.4,8.2,8.56,5.76,1756,NM,0.07,0.47,0.05,5,NM,NM,,A lot of ducks and snakes. One
98,4,7/8/2000,D,clear,steady,cloudy,green,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,24.0,23.8,8.4,9.62,6.75,2
320,NM,0.005,0.29,0.005,282,NM,NM,,none
99,4,11/4/2000,D,clear,steady,cloudy,brown_green,musty,garbage,other_foam,0,,,,0,,,,Foam white 1in. high.,light,5
pieces,R=50% P=50%,,,,,,22.9,15.4,8.3,11.89,8.35,2500,NM,0.005,0.22,0.005,5,NM,NM,,none
100,5,11/7/1998,D,overcast,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,none,light,1 Champagne
Flute,P=100%,,,,,,17.3,14.5,8.1,9.87,0.005,3050,3.5,9.10,0.34,1.19,NM,NM,NM,,none
101,4,10/2/1999,D,clear,steady,milky_muddy,brown_green,none,garbage,none,0,,,,NM,,,,none,light,plastic bottle
styrofoam glass,NRT=10%_P=10%_
R=10%_L=70%,,,,,,27.0,22.4,8.3,10.56,8.10,2820,NM,NM,0.38,0.89,NM,NM,NM,,none
102,4,11/6/1999,D,clear_overcast,none,cloudy,clear,none,none,none,0,,,,NM,,,,none,light,Metal Gear or Crank
shaft,L=100%,,,,,,20.5,17.5,8.1,6.73,6.95,2920,NM,0.005,0.18,0.04,NM,NM,NM,,none
103,4,12/4/1999,W,clear,steady,cloudy,brown_green,none,none,other_leaves,0,,,,NM,,,,leaves some plant
matter,moderate,3 Pieces styrofoam metal
gear,NRT=20%_L=80%,,,,,,18.5,11.7,8.4,NM,4.90,2665,NM,0.005,0.08,0.01,NM,NM,NM,,2 styrofoam
packages/boxes on
104,4,1/20/2000,W,overcast,steady,other_turbid,green,none,garbage,none,0,,,,NM,,,,none,moderate,50 items 10 tennis
balls 4 lar,NRT=30%_R=10%_P=10%_L=50%,,,,,,19.3,14.7,8.2,11.27,5.85,2760,NM,0.005,0.01,0.22,30,NM,NM,,split
sample 5
105,4,2/5/2000,W,clear,trickle,cloudy,brown,none,none,other_algae,0-10,,,,NM,,,,Small particles on

surface,light,ironing board cardboard box
me,R=10%_L=90%,,,,,,17.5,14.9,8.4,11.77,5.60,2190,NM,0.005,0.09,0.005,5,NM,NM,,none
106,4,3/4/2000,W,overcast,steady,clear,brown_green,none,garbage,other_foam,0,,,,NM,,,,Foam white 0.5in high.,light,10 plastic bags metal
gear,P=75%_L=25%,,,,,,13.0,13.5,8.3,10.35,7.10,1372,NM,0.90,0.14,0.005,216,NM,NM,,Rain March 3 2000. Dam was com
107,4,8/5/2000,D,clear,steady,cloudy,green,rotten_eggs,none,other_foam,0,,,,NM,,,,Foam 1% cover near vegetation,light,cardboard beer bottle plastic,P=50%;
R=50%,,,,,,36.5,26.9,8.2,9.11,4.75,2530,NM,0.005,0.38,0.005,231,NM,NM,,none
108,4,9/9/2000,D,clear,steady,cloudy,green,none,garbage,none,0,,,,0,,,,none,moderate,40 items wood gear styrofoam
b,NRT=35%_L=55%_R=10%,,,,,,26.5,21.6,8.2,10.23,5.10,2715,NM,0.005,0.32,0.03,85,NM,NM,,none
109,4,12/2/2000,W,clear,steady,cloudy,brown_green,musty,garbage,other_algae,0,,,,90-100,,,,Algae 90-100% mat,light,4 pieces aluminum cans,R=100%,,,,,,18.0,11.6,8.1,10.68,4.10,2490,NM,0.005,0.11,0.005,5,NM,NM,,fishy smell
110,5,12/5/1998,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Scattered floating leaves.,none,none,none,,,,,,13.5,12.2,7.8,10.50,16.00,1955,4.8,2.66,0.62,0.42,NM,NM,NM,,none
111,5,1/9/1999,W,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,40-50,,,,40-50% brown algae on bottom o,none,none,none,,,,,,22.5,10.6,8.1,12.57,0.18,3000,5.4,6.20,0.28,0.03,NM,NM,NM,,Brown algae 40-50%.
112,5,2/6/1999,W,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,14.5,13.2,7.9,9.34,2.25,2700,4.0,5.30,0.48,0.15,NM,NM,NM,,none
113,5,3/6/1999,W,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,20-30,,,,Algae on left side in pool and,none,none,none,,,,,,13.0,13.5,8.3,16.95,1.00,3200,3.1,6.73,0.19,0.01,NM,NM,NM,,low water level
114,5,4/10/1999,W,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,30-40,,,,30% + algae on stream bottom.,none,none,none,,,,,,18.3,13.3,8.0,12.65,0.005,2750,2.9,3.38,0.30,0.005,NM,NM,NM,,none
115,5,5/8/1999,D,overcast,steady,clear,clear,none,none,other_algae_leaves,0-10,,,,NM,,,,Algae 5-10% cover leaves in st,none,none,none,,,,,,18.5,NM,8.2,13.56,0.15,7700,1.9,3.80,0.14,0.08,NM,NM,NM,,none
116,5,6/5/1999,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 5% cover,none,none,none,,,,,,20.3,14.8,8.0,9.82,0.75,3530,3.6,3.20,0.45,0.03,NM,NM,NM,,none
117,5,9/4/1999,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,light,1 piece of paper,R=100%,,,,,,19.3,16.2,8.2,10.67,0.70,3500,2.5,4.95,0.37,0.01,NM,NM,NM,,Watercress growing along strea
118,5,11/6/1999,D,overcast,steady,clear,clear,none,sewage,other_leaves,0,,,,NM,,,,Leaves 50% cover,none,none,none,,,,,,21.0,13.0,8.0,8.46,0.73,3640,2.4,5.34,0.45,0.005,NM,NM,NM,,The leaves were preventing flo
121,5,1/20/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,19.0,12.8,8.1,11.73,0.40,3335,2.2,5.72,0.47,0.005,41,NM,NM,,split sample 5. Large willow d
122,5,7/17/1999,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,NM,,,,Algae 1% cover along margins,light,cardboard beer cans,R=100%,,,,,,28.8,19.8,8.2,10.46,1.85,3180,1.9,6.40,0.64,0.005,NM,NM,NM,,small fish .5in in length. Cor
123,5,8/7/1999,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,NM,,,,none,none,none,none,,,,,,20.3,16.9,8.4,10.64,0.53,3380,2.3,4.60,0.37,0.005,NM,NM,NM,,1' depth mosquito fish
124,5,10/2/1999,D,clear,steady,clear,clear,none,garbage,other_algae,0-10,,,,NM,,,,Algae 1% cover woody debris wi,light,large aluminum can and bag
of,NRT=33.3%_R=33.3%_L=33.3%,,,,,,19.0,15.1,8.0,11.36,0.25,3600,2.2,NM,0.39,0.16,NM,NM,NM,,"willow roots along edges, gamb"
125,5,2/5/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,20.0,15.0,8.3,14.46,1.30,3545,1.9,5.80,0.55,0.63,31,NM,NM,,none
126,5,3/4/2000,W,overcast,steady,muddy,brown,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,12.5,NM,8.1,10.24,72.50,1568,5.2,2.42,1.54,0.21,2909,NM,NM,,Rain March 3 2000
127,5,4/1/2000,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves,none,none,none,,,,,,28.0,15.0,8.2,NM,0.45,2965,2.7,4.72,0.44,0.35,20,NM,NM,,none
128,5,5/6/2000,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,22.0,18.2,8.0,11.18,10.50,3393,4.0,5.16,1.13,0.02,146,NM,NM,,none
129,5,6/3/2000,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,40-50,,,,Bottom algae@ 55%

cover.,none,none,none,,,,,,33.0,18.6,8.1,12.73,1.05,3650,12.9,4.76,0.62,0.51,31,NM,NM,,none
130,5,7/8/2000,D,clear,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,Algae 75% cover on substrate.,none,none,none,,,,,,27.0,18.0,8.1,11.34,2.45,3110,4.9,3.58,0.57,0.005,98,NM,NM,,none
131,5,8/5/2000,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,30-40,,,,Algae 45% cover,none,none,none,,,,,,33.5,21.3,8.0,11.23,2.04,3480,2.1,2.93,0.34,0.005,98,NM,NM,,Corrected NO3 NO2 N PPM data e
132,5,11/4/2000,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,28.5,12.0,8.1,11.69,0.33,3510,1.4,5.92,0.70,0.005,97,NM,NM,,none
133,5,9/9/2000,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,60-70,,,,Algae 70% cover brown matt 5%,none,none,none,,,,,,30.5,16.4,8.1,11.24,0.93,3180,2.3,4.64,1.40,0.03,1145,NM,NM,,Willow fell across stream rest
134,5,12/2/2000,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,22.5,9.6,8.0,11.52,0.005,3570,2.1,5.96,0.42,0.04,63,NM,NM,,Fallen tree slowing flow DS
135,6,11/7/1998,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 20% cover,light,Barbed wire,none,,,,,,17.3,12.0,7.8,8.55,0.10,NM,0.6,0.03,0.20,0.25,NM,NM,NM,,none
136,6,12/5/1998,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves,light,plastic bottle barbed wire,P=50%_R=50%,,,,,,11.5,10.0,7.8,10.36,0.005,2950,0.6,0.005,0.24,0.09,NM,NM,NM,,none
137,6,2/6/1999,W,overcast,steady,clear,clear,none,garbage,none,0,,,,NM,,,,none,light,Barbed wire fence post,R=100%,,,,,,13.8,11.8,8.1,9.97,0.005,2900,0.5,0.005,0.18,0.06,NM,NM,NM,,none
138,6,4/10/1999,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,15.5,11.5,7.9,9.82,0.005,2900,0.5,0.005,0.17,0.06,NM,NM,NM,,none
139,6,5/8/1999,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,16.8,14.2,8.1,8.95,0.005,8100,0.5,0.005,0.16,0.03,NM,NM,NM,,none
140,6,6/5/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,20.5,14.9,8.1,8.52,0.45,5455,0.4,0.005,0.18,0.005,NM,NM,NM,,none
141,6,7/17/1999,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,NM,,,,1% coverage,light,1 metal fence post,R=100%,,,,,,28.5,20.2,7.8,5.35,0.005,3345,0.1,0.01,0.30,0.05,NM,NM,NM,,none
142,6,8/7/1999,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,NM,,,,Leaves 10% cover on edges,none,none,none,,,,,,21.5,16.1,8.2,8.66,0.40,3510,0.2,0.005,0.19,0.005,NM,NM,NM,,willow roots growing on bottom
143,6,1/9/1999,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,light,Barbed wire fence post,R=100%,,,,,,20.8,11.5,7.8,6.81,0.03,2700,0.7,0.005,0.15,0.01,NM,NM,NM,,Substrate heavily sedimented 5
144,6,3/6/1999,W,overcast,steady,clear,clear,none,oily sheen,other_leaves,0,,,,NM,,,,Lots of leaves on bottom of st,light,"one trash bag, barbed wire",P=50%_R=50%,,,,,,11.4,11.9,7.9,10.03,0.005,3100,0.3,0.005,0.15,0.03,NM,NM,NM,,watch barbed wire in stream ab
145,6,9/4/1999,D,overcast,steady,clear,clear,rotten_eggs,none,none,0,,,,NM,,,,none,none,none,none,,,,,,17.3,15.3,8.1,9.35,0.005,3650,0.3,0.01,0.30,0.005,NM,NM,NM,,none
146,6,10/2/1999,D,overcast,steady,clear,clear,none,none,other_leaves_sticks,0,,,,NM,,,,Sticks and Leaves,none,none,none,,,,,,22.8,15.3,7.8,6.61,0.005,3380,0.2,NM,0.24,0.13,NM,NM,NM,,none
147,6,11/6/1999,D,overcast,steady,clear,clear,none,other_milky film,none,0,,,,NM,,,,none,light,Steel fence post,R=100%,,,,,,21.3,13.8,7.7,8.59,0.15,3405,0.1,0.005,0.29,0.005,NM,NM,NM,,milky film covering stream
148,6,12/4/1999,W,clear,intermittent,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.8,NM,7.7,9.00,0.005,3245,0.1,0.005,0.23,0.005,NM,NM,NM,,substantial portions of the st
150,6,1/20/2000,W,clear,steady,clear,clear,none,oily sheen,none,0,,,,NM,,,,none,none,none,none,,,,,,21.5,12.7,8.1,9.21,0.15,3350,0.2,0.01,0.24,0.005,5,NM,NM,,split sample 5
151,6,2/5/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.3,13.8,7.8,9.26,0.005,3180,0.2,0.005,0.15,0.005,5,NM,NM,,none
152,6,3/4/2000,W,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,12.3,12.4,8.0,8.91,0.08,3195,0.3,0.05,0.20,0.005,5,NM,NM,,Rain March 2000
153,6,4/1/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,Leaves,none,none,none,,,,,,24.0,15.7,7.8,9.33,0.48,3200,0.1,0.005,0.22,0.06,86,NM,NM,,none
154,6,5/6/2000,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,19.0,16.0,7.8,8.78,0.27,3215,0.1,0.005,0.29,0.005,158,NM,NM,,none

155,6,6/3/2000,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,25.8,16.7,8.0,9.11,0.85,3475,0.1,0.04,0.48,0.03,223,NM,NM,,none
156,6,7/8/2000,D,clear,trickle,clear,clear,none,oily sheen,other_foam,0,,,,NM,,,,Foam white 1in. high.,none,none,none,,,,,,23.0,16.8,8.0,7.50,8.30,3515,0.1,0.005,0.44,0.005,5,NM,NM,,none
157,6,8/5/2000,D,clear,none,clear,clear,none,oily sheen,none,0,,,,NM,,,,none,none,none,none,,,,,,29.0,20.9,8.0,7.41,5.40,4000,NM,0.02,0.40,0.005,4884,NM,NM,,none
158,6,10/7/2000,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,none
159,6,12/2/2000,W,clear,trickle,clear,clear,none,none,other_leaves,0,,,,0,,,,80-90% leaf cover,none,none,none,,,,,,20.1,8.9,7.8,9.20,1.50,3395,NM,0.005,0.42,0.03,31,NM,NM,,none
160,7,4/10/1999,W,clear,steady,clear,clear,none,garbage,none,0,,,,NM,,,,none,high,100+ items,O=0%_R=50%_P=40%_L=10%,,,,,,18.3,13.0,8.2,12.59,0.23,2550,8.9,0.40,0.14,0.14,NM,NM,NM,,none
161,7,6/5/1999,D,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,light,1 bottle lots of surrounding t,NRT=50%_R=10%_P=40%,,,,,,19.0,15.4,8.1,8.88,1.30,4335,NM,0.95,0.36,0.21,NM,NM,NM,,none
162,7,10/2/1999,D,clear,steady,clear,clear,rotten_eggs,none,mosquito larvae,0,,,,NM,,,,Very few Larvae,none,none,none,,,,,,24.3,17.2,8.0,7.20,0.55,3080,2.7,NM,0.28,0.08,NM,NM,NM,,none
163,7,11/6/1999,D,clear,trickle,clear,clear,none,garbage,none,0,,,,NM,,,,none,high,clothes blankets car speaker,NRT=15%_R= 85%,,,,,,23.0,16.3,8.0,9.90,2.30,2950,6.0,1.41,0.45,0.22,NM,NM,NM,,none
164,7,12/4/1999,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,19.0,10.5,7.8,8.83,1.40,3035,4.4,0.73,0.16,0.09,NM,NM,NM,,Lots of garbage along streamsi
166,6,9/9/2000,D,clear,steady,cloudy,clear,none,other_whitish film,other_leaves,0,,,,NM,,,,Lots of leaves,light,1 metal fence post barbed wire,R=100%,,,,,,26.5,16.2,7.8,7.81,0.61,3880,NM,0.02,0.43,0.03,537,NM,NM,,Stream very shallow flows incr
167,6,11/4/2000,D,clear,steady,clear,clear,rotten_eggs,none,other_leaves,0,,,,0,,,,willow leaves,none,none,none,,,,,,23.0,12.5,7.8,10.32,1.43,3640,NM,0.005,0.56,0.22,97,NM,NM,,very low flow rotten egg odor
168,7,11/7/1998,D,overcast,steady,clear,clear,rotten_eggs,none,other_leaves,0,,,,NM,,,,Leaves 5% cover,high,tires shopping cart debris.,O=5%_ R=20%_P=25%_L=50%,,,,,,16.0,14.0,8.0,9.50,0.77,NM,7.0,1.24,2.82,0.54,NM,NM,NM,,Dump site.
169,7,12/5/1998,W,clear,steady,cloudy,brown,rotten_eggs_sewage,none,none,0,,,,NM,,,,none,high,100+ items shopping cart,O=5%_R=10%_P=75%_L=10%,,,,,,14.0,11.5,7.9,9.74,2.70,2400,8.5,1.20,0.46,0.28,NM,NM,NM,,Trash included a shopping cart
170,7,1/9/1999,W,clear,steady,cloudy,clear,none,none,other_algae,0,,,,90-100,,,,100 % on bottom,high,20+ items tire bag clothes pla,O=0%_R=25%_P=50%_L=25%,,,,,,22.0,11.8,8.2,5.96,1.25,3050,4.8,1.13,0.15,0.05,NM,NM,NM,,"Trash tire, license plate, ba"
171,7,2/6/1999,W,overcast-clear,heavy,clear,clear,rotten_eggs_sewage,garbage,none,0,,,,NM,,,,none,high,1000+ items small-large,O=5%_ R=10%_ P=75%_ L=10%,,,,,,14.5,NM,8.3,11.91,0.82,2700,6.5,0.96,0.12,0.03,NM,NM,NM,,none
172,7,3/6/1999,W,overcast,steady,clear,clear,none,oily sheen,other_algae,0-10,,,,NM,,,,2% algae on margins,high,100-500 small-large couches sh,NRT=30%_P=40%_L=30%,,,,,,13.1,13.5,8.1,13.19,0.42,2970,5.3,0.70,0.12,0.06,NM,NM,NM,,"Dump site: old couches, plates"
173,7,5/8/1999,D,clear,steady,clear,clear,none,garbage,other_algae_leaves,0,,,,40-50,,,,Algae cover on bottom 40%.,high,No description,O=10%_R=40%_P=40%_L=10%,,,,,,20.0,17.5,8.3,10.70,0.80,3060,NM,0.58,0.09,0.12,NM,NM,NM,,Flow measurements scratched du
174,7,7/17/1999,D,clear,steady,clear,clear,rotten_eggs,none,other_algae_foam,0-10,,,,NM,,,,Foam white .5 in high 0-5% cov,high,50+ items & a tire,P=75%_L=25%,,,,,,28.0,20.9,8.0,9.34,1.55,2900,2.5,0.67,0.46,0.09,NM,NM,NM,,none
175,7,8/7/1999,D,clear,steady,clear,clear,none,garbage,other_algae,20-30,,,,NM,,,,Algae cover 25%,high,200+ items 2 shopping carts ma,NRT=50%_L=50%,,,,,,26.8,21.4,8.4,10.92,0.55,2910,NM,1.28,0.31,0.005,NM,NM,NM,,"mostly fast food trash, 2 shop"
176,7,9/4/1999,D,clear,steady,muddy,brown,rotten_eggs_musty,none,other_algae_foam,20-30,,,,NM,,,,Foam white .5 in high 0-5% cov,none,none,none,,,,,,21.8,18.8,8.2,10.40,0.95,3140,NM,0.52,0.23,0.08,NM,NM,NM,,Alternate Site due to Bees! Ne

177,7,2/5/2000,W,clear,steady,clear,clear,none,none,other_algae,NM,,,,NM,,,,No
Description,high,none,R=50%_P=50%,,,,,,19.0,14.3,8.2,NM,1.25,2855,5.7,0.49,0.58,0.19,41,NM,NM,,none
178,7,3/4/2000,W,overcast,steady,cloudy,gray_brown,none,none,none,0,,,,NM,,,,none,high,Many
items,NRT=50%_R=25%_P=25%,,,,,,13.0,13.6,8.2,9.73,7.90,1860,16.1,1.14,0.34,0.09,459,NM,NM,,Rain March 3
2000
179,7,7/8/2000,D,clear,steady,clear,clear,sewage,none,none,0,,,,NM,,,,none,high,Bee boxes trash on
streambank,P=60%_R=30%_L=10%,,,,,,24.0,20.5,8.2,8.91,2.05,2950,3.6,0.77,0.67,0.04,213,NM,NM,,none
180,7,8/5/2000,D,clear,steady,clear,clear,sewage,none,other_algae,0-10,,,,NM,,,,Algae 10%,high,Jack in the Box & bee
boxes,NRT=85%_R=15%,,,,,,31.5,22.0,7.9,7.03,2.20,2910,6.0,0.73,0.44,0.09,657,NM,NM,,none
181,1,1/6/2001,W,clear,steady,clear,clear,none,none,other_algae,0-
10,,,,0,,,,none,none,none,none,,,,,,18.0,12.8,8.2,10.66,0.18,1739,NM,3.98,5.46,0.20,10,NM,NM,,none
182,7,4/1/2000,W,clear,steady,clear,clear,none,none,other_algae_foam,20-30,,,,NM,,,,White foam.,light,plastic
styrofoam cloth
cement,NRT=50%_R=10%_P=40%,,,,,,25.5,16.4,8.0,8.29,0.75,2915,11.1,0.87,0.38,0.07,31,NM,NM,,none
183,7,5/6/2000,D,clear,steady,clear,clear,none,none,other_algae,NM,,,,40-50,,,,50% blue-green algae growing
o,high,Jack in the Box wrappers
plast,NRT=50%_R=10%_P=40%,,,,,,20.0,18.3,8.0,9.31,0.78,2850,7.1,0.89,0.34,0.15,122,NM,NM,,none
184,7,6/3/2000,D,clear,steady_heavy,clear,clear,none,garbage,other_algae,10-20,,,,NM,,,,Algae green
15%,moderate,20+ items plastic Bags
styrofo,NRT=20%_P=80%,,,,,,27.5,19.6,8.2,9.72,1.40,2880,6.0,0.71,0.54,0.06,84,NM,NM,,none
185,7,9/9/2000,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0-10,,,,70-80,,,,Algae 80-90% green float
brown,high,Food wrappers blankets yard wa,NRT= 50%_R=10%_ P=20%_
L=20%,,,,,,30.0,18.1,8.1,8.77,0.88,2970,4.5,0.75,0.55,0.005,218,NM,NM,,sulfer eating bacteria
186,7,11/4/2000,D,clear,steady,clear,clear,rotten_eggs,garbage,other_algae,0,,,,80-90,,,,Algae mat brown,high,100+
items,R=50% P=50%,,,,,,23.3,13.2,8.0,9.67,0.48,2950,3.7,0.83,0.92,0.03,185,NM,NM,,plastic bags snagged on roots
187,7,12/2/2000,W,clear,steady,clear,clear,rotten_eggs_other_salty,none,other_algae,0,,,,80-90,,,,Algae mat green and
brown,high,50+ items,R=50% P=50%,,,,,,21.7,10.9,7.9,9.50,0.26,3095,9.3,1.03,0.44,0.09,86,NM,NM,,Tested pH field
blank value 10
188,7,3/3/2001,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,none,high,El Pollo Loco cups and
many pl,NRT=50% P=50%,,,,,,16.0,13.8,7.9,10.68,3.08,2280,23.9,1.39,0.38,0.05,97,NM,NM,,none
189,2,5/5/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Green algal matt,light,none,P=50%
L=50%,,,,,,15.0,13.9,8.1,10.22,0.43,1181,3.5,1.08,0.24,0.005,292,NM,NM,,none
190,3,5/5/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,Green algal matt
cover,none,none,none,,,,,,22.0,14.4,8.1,9.24,0.06,719,0.7,0.005,0.07,0.005,10,NM,NM,,Large amount of poison oak on
191,4,4/7/2001,W,showers,heavy,clear,brown,other_fishy,none,other_foam,0,,,,0,,,,1in. high white foam @ 20-
30%,moderate,none,NM,,,,,,13.2,15.4,8.4,10.25,4.15,1460,NM,0.005,0.04,0.30,410,NM,NM,,none
192,3,6/16/2001,D,clear,steady,clear,NM,none,none,other_algae,0,,,,0-
10,,,,none,none,none,none,,,,,,29.0,18.0,7.8,8.14,0.29,708,NM,0.005,0.14,0.005,85,NM,NM,,+15 aborted attempts at
flow t
193,5,5/5/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,10-
20,,,,none,none,none,none,,,,,,23.3,16.3,7.8,12.25,0.64,3310,5.4,4.56,0.45,0.005,233,NM,NM,,Corrected NO3 NO2 N
PPM data e
194,4,1/6/2001,W,clear,steady,cloudy,brown,none,none,none,0,,,,0,,,,A few duck feathers,light,A bulldozer axle and a
small t,P=100%,,,,,,20.4,10.2,8.2,13.34,1.99,2500,NM,0.01,0.10,0.14,5,NM,NM,,Flow over top of dam. Apprx. 1
195,5,1/6/2001,W,clear,steady,clear,clear,none,other_watercress along
edge,none,0,,,,0,,,,none,none,none,none,,,,,,21.0,10.3,8.1,14.20,0.04,3460,2.4,5.80,0.44,0.09,30,NM,NM,,none
196,6,1/6/2001,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,0,,,,92% Leaf
cover,none,none,none,,,,,,18.0,10.1,7.8,8.99,1.20,3190,NM,0.05,0.52,0.10,31,NM,NM,,none
197,1,2/3/2001,W,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,none,none,none,none,,,,,,20.0,13.6,8.4,14.46,
0.71,1480,NM,4.62,3.58,0.83,10,NM,NM,,none
198,2,2/3/2001,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,24.0,10.5,8.1,11.52,1.05,131
8,2.0,1.26,0.24,0.05,31,NM,NM,,A stangnant pool of water was
199,4,2/3/2001,W,clear,heavy,cloudy,brown,none,none,none,0,,,,0,,,,none,moderate,Trash across the stream on
the,Large items,,,,,,23.0,11.9,8.4,11.90,4.20,1367,NM,0.07,0.07,0.04,5,NM,NM,,none

200,6,2/3/2001,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,Matt Algae was an iron-rust c,none,none,none,,,,,,22.0,12.0,7.7,9.60,0.65,3300,0.1,0.05,0.53,0.10,10,NM,NM,,none
201,1,3/3/2001,W,overcast,steady,clear_cloudy_muddy,brown_green,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,17.0,13.6,8.3,10.35,2.94,1204,NM,2.54,1.10,0.08,31,NM,NM,,none
202,2,3/3/2001,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,none,NRT=5% P=95%,,,,,,15.1,13.3,8.2,10.38,1.40,1045,18.0,2.51,0.32,0.005,41,NM,NM,,none
203,3,3/3/2001,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,"Thin, brown matt cover",none,none,none,,,,,,13.0,11.0,8.1,10.36,1.09,577,1.5,0.005,0.08,0.005,5,NM,NM,,none
204,4,3/3/2001,W,overcast,heavy,clear,brown,none,none,none,0,,,,0,,,,minor foam from falls,moderate,Wood debris,L=10% P=90%,,,,,,13.8,13.4,8.0,93.80,5.70,1192,NM,1.40,0.32,0.69,41,NM,NM,,Partly cloudy with a slight mi
205,5,3/3/2001,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,17.0,13.6,8.1,10.83,4.65,3230,8.3,4.04,0.72,0.12,203,NM,NM,,none
206,6,3/3/2001,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,Algae appeared to have been sc,none,none,none,,,,,,15.0,12.5,7.7,9.39,0.47,3360,0.3,0.005,0.72,0.13,52,NM,NM,,Orange bacteria present on str
207,1,4/7/2001,W,overcast,steady,muddy,brown,none,sewage,other_leaves,0,,,,0,,,,none,light,none,NM,,,,,,15.0,15.0,8.4,10.47,7.30,1500,NM,1.56,1.07,0.07,1210,NM,NM,,none
208,2,4/7/2001,W,showers,heavy,muddy,brown,none,none,other_foam,0,,,,0,,,,1/2 in. high white foam,light,none,P=70% NRT=30%,,,,,,12.0,12.8,8.2,10.10,16.00,939,NM,1.21,0.19,0.03,1690,NM,NM,,Checked calibration of conduct
209,3,4/7/2001,W,showers,heavy,muddy,brown,none,none,other_foam,0,,,,0,,,,1in. high white foam @ 0-10% c,none,none,none,,,,,,12.0,10.7,8.0,10.39,47.50,341,NM,0.23,0.04,0.005,845,NM,NM,,Calibration of turbidity meter
210,6,4/7/2001,W,rain,steady,clear,clear,none,none,other_algae,0,,,,80-90,,,,Long green strings of algae,none,none,none,,,,,,12.0,11.6,7.7,9.57,1.00,3060,NM,0.005,0.52,0.14,933,NM,NM,,none
211,6,5/5/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,Algal matt cover appeared to b,none,none,none,,,,,,23.0,14.2,NM,8.72,0.28,3470,0.2,0.005,0.63,0.005,243,NM,NM,,pH meter broken.
212,2,6/16/2001,D,clear,steady,clear,clear,none,none,Mosquito larvae_other_algae,0-10,,,,80-90,,,,none,light,none,NRT=20% P=80%,,,,,,22.0,16.5,7.9,9.32,0.08,1176,1.7,0.66,0.91,0.02,134,NM,NM,,Tadpoles observed on site.
213,4,6/16/2001,D,clear,none,muddy,green,none,none,other_algae,0,,,,90-100,,,,none,light,Fishing line & lure abandoned,R=50% NRT=50%,,,,,,31.8,25.6,8.1,9.58,4.80,1931,NM,0.005,0.41,0.32,10,NM,NM,,Snake siting
214,5,6/16/2001,D,clear,steady,clear,clear,none,NM,other_algae,10-20,,,,80-90,,,,Hairy algae. Floating algae al,none,none,none,,,,,,30.0,18.3,7.8,9.57,0.07,3330,4.4,4.08,0.37,2.53,158,NM,NM,,A blue damsel fly and many fro
215,6,6/16/2001,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,20,,,,20% gradual matt cover. Algae,none,none,none,,,,,,33.0,21.2,7.9,NM,0.20,3368,0.0,0.005,0.55,0.005,213,NM,NM,,none
216,7,6/16/2001,D,clear,NM,clear,Murky,rotten_eggs,none,other_algae,0,,,,90-100,,,,Algal matt found at edges and,high,"Whale picture, couch cushions,",R=5% P=50+pieces,,,,,,29.0,19.0,7.8,6.59,0.94,NM,5.6,1.20,0.78,0.01,345,NM,NM,,TDS conductivity meter reading
217,8,5/5/2001,D,clear,steady,clear,clear,none,other_leaves,none,0,,,,0,,,,none,none,none,none,,,,,,24.0,16.3,7.7,7.46,3.30,1800,NM,0.005,0.16,0.005,171,NM,NM,,Patches of gray sheen and tree
218,9,5/5/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,24.0,15.6,7.7,7.10,0.80,2766,NM,0.005,0.50,0.005,86,NM,NM,,none
219,10,5/5/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,25.0,15.6,7.2,NM,0.14,425,NM,0.02,0.16,0.005,5,NM,NM,,none
220,8,6/16/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,30.0,18.4,7.9,NM,0.07,1714,NM,0.005,0.14,0.02,369,NM,NM,,A white film was observed with
221,9,6/16/2001,D,clear,steady_trickle,clear,clear,none,oily sheen,none,0,,,,0,,,,none,none,none,none,,,,,,28.0,17.0,7.7,5.43,2.30,3110,NM,0.005,0.50,0.01,173,NM,NM,,none
222,9,7/7/2001,D,clear,none,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,27.0,18.2,7.5,5.46,1.60,3310,NM,0.005,0.61,0.005,74,NM,NM,,none
223,10,7/7/2001,D,clear,trickle,clear,clear,none,none,other_algae,10-20,,,,20-30,,,,none,none,none,none,,,,,,27.0,21.4,7.2,6.49,0.25,595,NM,0.005,0.09,0.005,10,NM,NM,,none
224,9,8/4/2001,D,clear,none,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,28.0,16.2,7.5,5.97,1.35,3655,NM,0.005,0.98,0.02,108,NM,NM,,Arundo donax identified on sit
225,7,5/5/2001,D,clear,steady,clear,clear,none,other_some tree debris,none,0,,,,0,,,,New and decaying algal matt

pr,high,Large amount of Carl's Junior,NM,,,,,,26.0,17.1,7.9,11.70,1.15,3040,4.5,0.83,0.30,0.03,135,NM,NM,,"Large amount of plastic bags,"
226,1,7/7/2001,D,clear,steady,clear,NM,none,none,other_algae,0-10,,,,30-40,,,,none,NM,NM,NM,,,,,,23.0,23.2,8.3,13.01,0.28,1873,NM,0.005,1.13,0.005,31,NM,NM,,none
227,2,7/7/2001,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,80-90,,,,none,none,none,none,,,,,,22.0,19.4,7.8,8.65,0.25,1196,0.3,0.68,0.44,0.005,384,NM,NM,,Watercress observed along stre
228,4,7/7/2001,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,28.0,25.5,8.0,9.78,6.15,2375,NM,0.005,0.60,0.005,74,NM,NM,,none
229,5,7/7/2001,D,overcast,steady,NM,clear,none,none,other_algae,0-10,,,,50-60,,,,none,none,none,none,,,,,,26.0,20.0,7.6,8.65,0.10,3310,3.6,5.60,0.51,0.005,309,NM,NM,,none
230,6,7/7/2001,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,none,none,none,none,,,,,,26.0,20.0,7.8,7.20,0.14,3468,NM,0.005,0.53,0.005,317,NM,NM,,none
231,7,7/7/2001,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,80-90,,,,none,high,200-500 trash items on site.,NRT=75% P=10% L=5% R=10%,,,,,,30.0,22.9,8.1,8.79,1.15,2899,0.4,0.92,0.61,0.07,323,NM,NM,,none
232,1,8/4/2001,D,clear,none,clear,clear,none,none,none,0,,,,0,,,,none,light,none,NRT=100%,,,,,,21.0,21.7,7.9,12.00,0.36,1962,NM,0.005,1.30,0.05,5,NM,NM,,none
233,2,8/4/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,none,none,none,none,,,,,,19.0,17.3,7.8,8.50,0.64,1220,NM,0.34,0.35,0.02,354,NM,NM,,"Mosquito fish, watercress and"
234,3,8/4/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,26.0,18.6,7.8,7.67,0.15,705,0.3,0.005,0.06,0.005,10,NM,NM,,Thin algae layer may have been
235,4,8/4/2001,D,clear,steady,Obscured greenish tint.,brown_green,rotten_eggs,none,none,0,,,,0,,,,none,none,none,none,,,,,,31.0,26.0,7.9,10.40,5.20,2600,NM,0.005,0.24,0.06,160,NM,NM,,none
236,7,8/4/2001,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0-10,,,,80-90,,,,none,high,none,R=25% NRT=45% P=25% L=5%,,,,,,28.0,19.8,8.1,NM,2.49,2810,7.6,0.77,0.61,0.26,183,NM,NM,,Possible homeless encampment.
243,10,8/4/2001,D,clear,intermittent,clear,clear,none,none,other_algae,0-10,,,,0-10,,,,none,light,none,NM,,,,,,25.0,20.1,7.4,4.79,2.60,708,NM,0.005,0.10,0.005,61,NM,NM,,none
244,1,4/10/1999,W,clear,trickle,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,13.3,13.0,8.2,11.47,0.45,1586,NM,6.95,1.47,0.32,NM,NM,NM,,none
245,3,9/8/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,none,none,none,none,,,,,,22.2,18.0,7.6,8.30,0.26,693,0.0,0.03,0.11,0.03,31,NM,NM,,none
246,5,9/8/2001,D,clear,steady,clear,clear,none,none,leaves=5%,0,,,,0,,,,none,none,none,none,,,,,,23.0,18.6,7.9,10.25,0.25,3330,1.4,4.52,0.82,0.03,108,NM,NM,,none
247,7,9/8/2001,D,clear,steady,clear,clear,other_sulfur,none,other_algae,0,,,,80-90,,,,chara on right margin.20-30% o,high,none,NRT=60%; P=25%; L=10%; Metal=5,,,,,,21.3,20.3,8.0,7.13,0.98,2968,NM,0.73,0.61,0.06,74,NM,NM,,excess trash noted along trail
248,10,9/8/2001,D,clear,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,none,none,none,none,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,not measured because site was
249,2,10/6/2001,D,overcast,trickle,clear,clear,none,none,other_algae,0,,,,90-100,,,,Cladophora matt algae,light,none,P=100%,,,,,,17.6,16.6,7.5,6.76,0.89,1212,NM,0.23,0.41,0.04,185,NM,NM,,none
250,5,10/6/2001,D,overcast,steady,clear,clear,rotten_eggs,garbage,other_algae,10-20,,,,60-70,,,,Mostly Rhizoclonium with some,light,none,NRT=100%,,,,,,18.0,16.6,7.9,9.79,0.03,3340,1.3,5.54,0.45,0.03,281,NM,NM,,none
251,7,10/6/2001,D,overcast,steady,clear,clear,slight musty odor accompanied,none,other_algae,0,,,,90-100,,,,"0-10% of matt green, 5% white",moderate,none,P=60%,,,,,,19.0,18.5,7.9,6.97,1.20,3014,7.8,0.71,0.62,0.09,583,NM,NM,,Flow measured in riffle just u
252,1,11/3/2001,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,50-60,,,,none,light,none,P=80%; NRT=20%,,,,,,20.5,19.2,8.0,14.76,0.39,2280,NM,0.35,1.39,0.09,31,NM,NM,,none
253,7,11/3/2001,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,50-60,,,,algae matt of diatoms,light,none,NRT=90%; P=10%,,,,,,23.2,16.0,8.0,7.58,0.51,3024,5.6,0.96,0.63,0.16,53,NM,NM,,Crayfish present at site
254,7,4/7/2001,W,overcast,heavy,muddy,clear,none,none,other_algae,0,,,,0-10,,,,Green matt cover,high,less than 50

items counted,NRT=50% P=50%,,,,,,12.0,13.7,7.8,10.02,9.80,1544,NM,0.005,0.44,0.25,4280,NM,NM,,Checked calibration of conduct
255,1,6/16/2001,D,clear,NM,clear,clear,none,none,other_algae,0-10,,,,10-20,,,,none,light,less than 10 items counted on,NM,,,,,,22.0,23.5,8.5,14.33,0.90,1773,NM,0.005,0.33,0.09,5,NM,NM,,Mosquito fish observed at site
256,10,12/1/2001,W,overcast,none,clear,clear,none,none,other_algae_leaves,0,,,,0-10,,,,0-10% dead algae and 15% leaf,none,none,none,,,,,,16.5,9.9,7.0,3.34,0.52,780,NM,0.10,0.17,0.005,0.005,NM,NM,,none
257,9,12/1/2001,W,clear,intermittent,clear,clear,none,NM,other_algae,0,,,,20-30,,,,Diatom matt.,none,none,none,,,,,,14.3,8.5,7.2,5.37,0.78,3730,NM,0.005,0.67,0.005,10,NM,NM,,none
258,9,11/3/2001,D,NM,trickle,clear _other_film,clear,none,oily sheen,other_algae,0,,,,60-70,,,,less than 10% of algae matt gr,none,none,none,,,,,,20.3,12.9,7.1,5.36,1.40,3510,NM,0.005,0.43,0.02,10,NM,NM,,none
259,9,10/6/2001,D,overcast,trickle,clear_other_film,clear,none,none,none,0,,,,0,,,,prevalent leaf litter,none,none,none,,,,,,17.8,16.2,7.1,4.82,3.40,3540,NM,0.005,0.69,0.02,359,NM,NM,,Large number and variety of fr
260,9,9/8/2001,D,"clear, with slight film on top",none,clear,NM,musty,none,none,0,,,,0,,,,none,none,none,none,,,,,,21.0,17.1,7.1,4.44,2.60,3540,NM,0.005,0.68,NM,31,NM,NM,,none
261,8,12/1/2001,W,clear,steady,clear,clear,musty,none,other_algae,0,,,,10-20,,,,none,none,none,none,,,,,,18.0,10.9,7.8,8.46,0.60,1388,NM,0.005,0.10,0.005,0.005,NM,NM,,none
262,8,11/3/2001,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0,,,,less than 5% of algae cover is,none,none,none,,,,,,24.5,14.9,7.8,8.34,0.20,1763,NM,0.005,0.10,0.03,87,NM,NM,,none
263,8,9/8/2001,D,clear,steady,clear_cloudy_milky,clear,none,none,other_algae,0-10,,,,0,,,,algae I.D. = Chara,none,none,none,,,,,,26.0,19.7,7.8,8.65,0.90,1724,NM,0.005,0.11,NM,63,NM,NM,,milky gray film covering surfa
264,8,7/7/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,28.0,20.0,7.8,6.76,0.19,1714,NM,0.005,0.11,0.005,201,NM,NM,,Tadpoles were observed on site
265,7,12/1/2001,W,overcast,steady,cloudy,yellow,none,none,none,0,,,,0,,,,none,high,none,NRT=40%; P=60%,,,,,,15.8,11.2,8.0,9.29,1.80,2537,4.2,0.78,0.34,0.005,124,NM,NM,,none
266,6,9/8/2001,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0,,,,none,none,none,none,,,,,,24.5,19.6,7.8,7.12,0.33,3622,NM,0.01,0.54,0.005,309,NM,NM,,none
267,6,10/6/2001,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,17.5,16.0,7.8,7.92,15.00,3701,NM,0.005,0.54,0.15,134,NM,NM,,creek level very shallow with
268,6,11/3/2001,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0,,,,less than 5% of algae is Chara,none,none,none,,,,,,23.3,13.2,7.8,9.24,0.67,3490,0.3,0.005,0.48,2.00,10,NM,NM,,none
269,6,12/1/2001,W,clear,steady_trickle,clear,clear,none,"other_leaves,sticks, and uprooted",other_algae,0-10,,,,0,,,,none,none,none,none,,,,,,15.8,8.2,7.9,8.98,0.08,2753,0.2,0.005,0.44,0.01,99,NM,NM,,"70% floating leaves, sticks, w"
270,5,12/1/2001,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,none,none,none,none,,,,,,15.5,11.1,7.8,10.50,0.55,2850,2.8,4.96,0.49,0.005,150,NM,NM,,Major sand deposits in stream.
271,5,8/4/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,26.5,19.4,8.0,10.18,0.14,3300,2.6,3.96,0.29,0.005,96,NM,NM,,none
272,4,9/8/2001,D,clear,none,clear_milky,NM,rotten_eggs,none,other_algae,0-10,,,,0,,,,green foam noted on site,light,none,L=100%,,,,,,22.2,24.4,8.0,10.10,4.20,2710,NM,0.005,0.60,0.12,108,NM,NM,,
273,4,10/6/2001,D,clear,heavy,cloudy,yellow_brown,none,garbage,NM,0,,,,0,,,,none,light,none,P=100%,,,,,,20.7,21.0,8.0,8.88,5.70,2860,NM,0.005,0.37,0.07,216,NM,NM,,none
274,4,12/1/2001,W,overcast,steady,milky_muddy,brown_green,none,none,other_algae,0,,,,80-90,,,,Medium diatom matt.,light,none,R=70%; P=30%,,,,,,14.5,11.0,7.8,10.49,15.70,1726,NM,0.26,0.33,0.005,124,NM,NM,,Several dead blue gill fish. P
275,3,7/7/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,27.0,19.6,7.7,7.84,0.28,730,0.3,0.005,0.10,0.005,41,NM,NM,,none
276,3,10/6/2001,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,17.4,16.1,7.6,8.29,0.005,686,0.0,0.005,0.19,0.005,10,NM,NM,,none
277,2,12/1/2001,W,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Diatom matt,none,none,P=50%; 50% building materials,,,,,,11.8,9.6,7.7,10.51,0.47,1332,0.4,0.52,0.29,0.005,238,NM,NM,,none
278,2,11/3/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,Brown algae matt.,none,none,none,,,,,,18.0,14.8,7.8,10.51,0.05,1220,NM,0.18,0.32,0.005,75,NM,NM,,none

279,2,9/8/2001,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,none,light,none,R=100%,,,,,,20.6,18.1,7.6,8.21,0.40,1226,NM,0.22,0.36,0.005,97,NM,NM,,none
280,1,12/1/2001,W,clear,steady,cloudy,clear,NM,none,other_algae,0-10,,,,90-100,,,,Algae matt of diatoms.,light,none,R=50%; P=50%,,,,,,17.8,15.2,8.3,12.04,1.65,1636,NM,7.84,3.44,0.005,20,NM,NM,,none
281,1,10/6/2001,D,clear,steady,clear,clear,none,none,other_algae,30-40,,,,30,,,,green algae matt cover. No flo,light,none,P=90%; NRT=10%,,,,,,20.8,20.6,8.1,12.11,0.20,2240,NM,0.005,1.42,0.005,30,NM,NM,,Large school of small fish and
282,1,9/8/2001,D,clear,steady,clear,clear,none,none,other_algae,30-40,,,,0,,,,none,none,none,none,,,,,,23.0,21.9,7.9,12.77,2.05,2356,NM,0.005,1.31,0.02,10,NM,NM,,none
283,1,5/5/2001,D,clear,none,clear,clear,none,none,other_algae,0,,,,0-10,,,,none,none,none,none,,,,,,21.0,21.0,8.8,16.41,0.50,1628,NM,0.005,0.65,0.005,5,NM,NM,,80-90% distribution of embedde
284,1,10/7/2000,D,overcast,steady,clear,clear,none,none,other_algae,50-60,,,,NM,,,,Algae 60-70% cover.,none,none,none,,,,,,20.3,20.1,7.9,6.28,0.56,2200,NM,0.01,1.48,0.03,313,NM,NM,,Slightly cloudy water
285,2,10/7/2000,D,overcast,steady_trickle,clear,clear,none,none,other_algae,20-30,,,,20-30,,,,Algae 50-60% cover 70% green &,light,Carpet scrap,NRT=100%,,,,,,20.0,17.7,7.8,6.40,0.05,1205,NM,0.16,0.29,0.02,638,NM,NM,,Watercress throughout stream &
286,3,10/7/2000,D,overcast,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,18.3,16.9,8.0,8.47,0.005,677,0.2,0.005,0.08,0.03,63,NM,NM,,none
287,4,10/7/2000,D,overcast,steady,cloudy,brown,none,garbage,other_algae,10-20,,,,70-80,,,,Algae 15% floating,light,2 pieces aluminum can plastic,R=100%,,,,,,20.5,20.5,8.2,8.58,5.90,2690,NM,0.005,0.17,0.03,282,NM,NM,,none
288,7,10/7/2000,D,overcast,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,60-70,,,,Algae mat brown,moderate,Food wrappers,NRT=15%_ R=5%_ P=80%,,,,,,20.0,19.0,8.0,7.07,0.75,3100,5.3,0.83,0.61,0.15,428,NM,NM,,sulfer eating bacteria lots of
289,5,10/7/2000,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,Algae 10-20% cover mat,light,oven grill top,L=100%,,,,,,22.1,18.0,8.1,10.06,0.18,3470,2.1,5.48,0.70,0.07,379,NM,NM,,none
290,1,1/20/2000,W,clear,steady,clear,clear,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,20.8,16.4,7.8,9.15,1.28,1550,NM,9.56,4.60,0.02,20,NM,NM,,Split sample 5
291,7,1/20/2000,W,overcast,heavy,clear,clear,none,none,none,0,,,,NM,,,,none,moderate,some trash on streambanks,R=74%_P=25%_L=1%,,,,,,20.5,13.9,8.3,9.72,1.45,3050,5.4,0.46,0.18,0.10,132,NM,NM,,split sample 5 looks great aft
292,7,1/6/2001,W,clear,steady,clear,clear,rotten_eggs,none,other_algae,10-20,,,,60-70,,,,Green AlgaeFLT. Brown AlgaeMT,moderate,"Pieces of broken down plastic,",P=80% L=10% NRT=10%,,,,,,21.0,11.6,7.9,9.14,0.59,2960,4.7,0.73,0.51,0.19,20,NM,NM,,none
293,7,2/3/2001,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,none,high,Removed three bags of trash,R=2% NRT=8% P=90%,,,,,,26.0,11.8,7.9,10.55,1.30,2700,10.0,1.13,0.10,0.005,63,NM,NM,,Jack in the Box food wrappers
294,5,2/3/2001,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,27.0,11.0,8.1,11.39,0.70,3500,1.5,6.32,0.64,0.06,86,NM,NM,,Conductivity meter was mis-cal
295,5,4/7/2001,W,showers,heavy,muddy,brown,none,none,other_foam,0,,,,0,,,,.25 in high foam @ 0-10% cover,light,2 socks hanging in a tree.,NM,,,,,,11.3,12.7,8.0,10.27,140.00,1191,NM,2.06,0.72,0.14,6840,NM,NM,,High muddy flow. Extension of
296,2,1/6/2001,W,clear,steady,clear,clear,none,none,other_algae,0,,,,50-60,,,,none,none,none,none,,,,,,17.0,9.5,7.9,12.54,0.005,1386,NM,0.37,0.22,0.07,20,NM,NM,,none
297,3,1/6/2001,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,19.0,10.4,8.1,10.23,0.005,699,0.2,0.01,0.17,0.08,5,NM,NM,,none
298,3,2/3/2001,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,21.0,10.4,8.1,10.94,0.005,683,NM,0.005,0.04,0.005,5,NM,NM,,none
299,3,11/3/2001,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,20.8,14.2,7.9,9.72,0.005,692,0.3,0.005,0.04,0.005,5,NM,NM,,none
300,4,11/3/2001,D,clear,steady,cloudy,yellow,none,none,other_algae,0,,,,90-100,,,,60% brown algae matt; 40% gree,none,none,none,,,,,,23.9,18.4,7.9,12.42,4.30,2920,NM,0.005,0.09,0.27,5,NM,NM,,none
301,5,11/3/2001,D,clear,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,Brown algae matt.,none,none,none,,,,,,21.5,14.6,7.9,10.28,0.17,3330,1.5,5.62,0.40,0.05,5,NM,NM,,none

302,3,12/1/2001,W,clear,steady,clear,clear,none,none,other_algae,0,,,,10-
20,,,,none,none,none,none,,,,,,13.0,10.8,7.7,9.90,0.005,721,NM,0.005,0.05,0.005,20,NM,NM,,none
303,1,1/5/2002,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,Thin Brown Diatoms and
Chara,none,none,none,,,,,,22.0,14.3,8.2,14.22,0.80,1621,NM,6.28,3.90,0.14,20,5,2359,,none
304,2,1/5/2002,W,clear,steady,clear,clear,none,other_leaves,none,0,,,,0,,,,none,none,none,none,,,,,,11.0,8.6,7.7,10.14,0.
02,1284,1.4,0.40,0.19,0.02,64,30,1313,,none
305,4,1/5/2002,W,clear,steady,cloudy,brown,other_fishy,none,other_algae,0,,,,90-100,,,,none,light,none,100 % Large
Items/Car parts,,,,,,15.3,12.6,7.8,11.23,3.80,1663,NM,0.01,0.10,0.03,10,20,624,,none
306,6,1/5/2002,W,overcast,steady,clear,clear,none,oily sheen,other_algae,0,,,,0,,,,"Diatom Film, 1% Chara, 1%
Iron",none,none,none,,,,,,16.0,8.0,7.8,9.64,0.01,3466,NM,0.01,0.47,0.02,42,5,789,,none
307,10,1/5/2002,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,Some duck weed
present,none,none,none,,,,,,15.0,10.0,7.2,10.37,0.01,518,0.5,0.01,0.12,0.03,31,85,538,,none
308,1,2/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,90-
100,,,,none,none,none,none,,,,,,20.0,13.0,8.2,17.44,0.80,1683,NM,8.00,4.02,0.17,10,41,528,,none
309,3,2/3/2002,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,16.0,8.0,7.7,11.73,0.36,715,0
.2,0.01,0.07,0.01,10,10,173,,none
310,6,2/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,"5% = Chara, 5% = Iron eating
b",none,none,none,,,,,,13.0,5.0,7.6,11.10,0.17,3293,NM,0.01,0.36,0.01,10,20,480,,none
311,7,2/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,50-60,,,,"90% = Diatoms, 10% =
Cladophor",moderate,"Grocery bags, El Pollo Loco wr","10% = Plastics, 90% =
NRT",,,,,,20.0,8.0,8.0,11.90,0.55,2749,NM,0.74,0.22,0.02,31,98,3255,,none
312,5,1/5/2002,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,21.0,11.0,7.8,11.20,0.02,280
0,1.6,5.20,0.44,0.14,31,52,1050,,Less than 1% algae matt presen
313,5,2/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,Diatoms,light,"Bottles, Plastics, and
Glass","50% =Plastics, 50% = R",,,,,,21.0,8.0,7.9,14.70,0.33,3360,2.3,5.22,0.33,0.03,10,31,860,,none
314,3,3/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,"95% = Cladophora, 5% =
Chara",none,none,none,,,,,,19.0,10.2,7.6,10.98,0.18,722,NM,0.01,0.06,0.12,10,5,63,,none
315,5,3/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,none,light,none,"90% = R, 10% =
NRT",,,,,,22.0,10.8,8.0,14.86,0.51,3255,3.0,5.10,0.21,0.68,20,10,1334,,none
316,6,3/3/2002,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,Slight amount of Fine
Diatoms.,none,none,none,,,,,,19.0,8.5,7.9,10.44,0.15,3278,0.1,0.01,0.40,0.01,53,41,1198,,none
317,7,3/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,"80% = Fine Diatoms, 20% =
Matt",high,100 items,90% = NRT,,,,,,21.0,11.0,8.0,12.60,0.78,2916,2.0,0.55,0.19,0.48,31,41,4106,,Cladophora algae
upstream in r
318,8,3/3/2002,W,NM,none,clear,clear,none,none,none,0,,,,0,,,,"Many small water beetles, no
a",none,none,none,,,,,,20.0,14.2,7.3,8.10,1.10,1752,NM,0.01,0.14,NM,20,10,404,,none
319,9,3/3/2002,W,clear,trickle,clear,clear,none,none,other_algae,0,,,,90-
100,,,,none,none,none,none,,,,,,19.0,12.2,7.2,7.20,1.85,3270,NM,0.01,0.48,0.03,20,5,1178,,none
320,3,1/5/2002,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,0,,,,none,none,none,none,,,,,,13.4,10.5,7.6,8.53,0.
01,713,0.4,0.01,0.05,0.01,5,5,309,,none
321,7,1/5/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,"95% of Algae Matt Diatom, 5%
i",moderate,"El Pollo Loco wrappers, Grocer","95% - NRT, 5% -
P",,,,,,21.0,11.0,7.8,9.23,0.40,2578,3.4,0.78,0.24,0.01,5,73,15531,,none
322,8,1/5/2002,W,clear,trickle,clear,clear,none,none,other_algae_leaves,0,,,,0,,,,"Less than 1% Diatom, 1-10%
lea",none,none,none,,,,,,17.0,10.0,7.6,7.12,0.79,1895,NM,0.01,0.04,0.07,5,5,631,,none
323,9,1/5/2002,W,overcast,none,clear,clear,rotten_eggs,oily sheen,other_algae,0,,,,90-100,,,,Thin
Diatoms,none,none,none,,,,,,18.0,10.0,7.2,3.03,0.99,3790,NM,0.01,0.71,0.48,5,5,1081,,none
324,2,2/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,Brown algae
(Diatoms),none,none,none,,,,,,15.0,6.0,7.4,12.46,0.15,1343,0.7,0.58,0.24,0.02,5,10,2481,,none
325,4,2/3/2002,W,clear,steady,cloudy,brown,other_fishy,none,other_algae,0-10,,,,NM,,,,Cloudiness of water made it
di,light,none,100% Plastics,,,,,,17.0,10.0,7.8,12.13,3.90,1833,NM,0.01,0.05,0.06,5,10,110,,none
326,8,2/3/2002,W,clear,trickle,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,14.0,8.0,7.6,8.53,0.18,1789,
NM,0.01,0.06,0.01,5,5,416,,none
327,9,2/3/2002,W,clear,trickle,clear,clear,none,oily sheen,other_algae,0,,,,40-50,,,,Lots of

detritus,none,none,none,,,,,,20.0,7.0,7.1,7.09,0.83,4310,NM,0.01,0.31,0.04,5,5,537,,none
328,10,2/3/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,none,light,none,100% = Plastics,,,,,,14.0,6.0,7.5,12.10,0.03,407,0.3,0.01,0.11,0.01,5,5,161,,none
329,1,3/3/2002,W,clear,trickle,clear,clear,none,none,other_algae,10-20,,,,90-100,,,,none,light,One glass bottle,100% = R,,,,,,22.0,16.0,8.3,19.68,0.33,1573,NM,7.96,2.92,NM,5,41,677,,none
330,4,3/3/2002,W,clear,steady,muddy,green,other_fishy,garbage,other_algae,0,,,,80-90,,,,"Diatoms along both margins, un",moderate,50 items,"75% = NRT, 25% = L",,,,,,20.0,15.1,7.8,10.85,4.75,2200,NM,0.01,0.05,0.14,5,10,275,,none
331,10,3/3/2002,W,clear,none,clear,clear,none,none,other_algae,20-30,,,,70-80,,,,none,none,none,none,,,,,,19.0,9.4,7.3,9.30,0.19,477,NM,0.01,0.12,0.03,5,5,74,,none
332,2,3/3/2002,W,clear,steady,clear,clear,none,none,other_algae,20-30,,,,70-80,,,,"30% Floating Diatoms, 70% Matt",light,One Cinder Block,"50% = L, 50% = NRT",,,,,,20.0,8.5,7.5,11.88,0.70,1382,0.7,0.38,0.15,0.20,10,10,2282,,none
333,4,4/8/2002,W,overcast,steady,muddy,brown_green,NM,garbage,other_algae,0,,,,90-100,,,,100% Thick Diatoms,light,"Truck gear,Bench, and Construn","R = 5%, NRT = 25%, L = 70%",,,,,,18.0,17.6,8.1,9.54,4.70,2540,NM,0.01,0.20,0.10,5,5,4352,,none
334,5,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,30-40,,,,"Cladophora, Diatom Matt",none,none,none,,,,,,15.0,14.8,8.1,12.60,0.03,3380,2.8,4.30,0.42,0.07,31,30,3448,,none
335,12,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,20-30,,,,70-80,,,,Spyrogyra and Thick Diatom Mat,light,none,NRT = 100%,,,,,,16.0,15.7,8.1,10.13,0.24,2280,NM,0.01,0.29,0.02,5,10,3448,,none
336,14,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,0,,,,Thin Film Diatom,none,none,none,,,,,,17.0,13.9,7.8,8.62,0.11,1256,0.0,0.07,0.13,0.10,20,5,554,,none
337,16,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,30-40,,,,50-60,,,,none,moderate,"Bottles, Condoms, Pads","R = 60%, NRT = 40%",,,,,,18.0,15.6,7.4,8.13,0.01,1562,0.1,0.76,0.43,0.06,64,5,3873,,none
338,17,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,80-90,,,,"Cladophora = 95%, Spyrogyra =",light,none,NM,,,,,,18.0,16.2,7.2,8.19,0.64,1426,0.3,0.07,0.32,0.02,20,175,2909,,Many crayfish present at site.
339,19,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,"Rhizoclonium = 25%, Chara = 50",none,none,none,,,,,,16.0,15.4,8.0,9.54,0.01,1130,0.9,0.01,0.23,0.01,5,5,816,,none
340,18,4/8/2002,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,Diatom Matt,light,none,Plastics = 100%,,,,,,15.0,14.6,8.0,9.50,0.03,1570,0.2,0.01,0.19,0.05,10,310,1354,,none
341,1,4/7/2002,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,none,none,Difficult to determine presenc,none,,,,,,17.0,16.4,8.4,12.71,0.54,1804,NM,2.48,2.66,0.07,5,158,NM,,none
342,2,4/7/2002,W,overcast,steady,clear,clear,none,none,other_algae,50-60,,,,70-80,,,,"Cladophora = 50%, Thick Diatom",none,none,none,,,,,,16.0,12.9,8.0,10.78,0.01,1341,NM,0.02,0.17,0.08,42,920,NM,,Watercress beginning to choke
343,3,4/7/2002,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,Cladophora = 100% with Diatom,none,none,none,,,,,,18.0,13.1,8.0,9.74,0.01,706,NM,0.01,0.09,0.03,5,5,NM,,none
344,6,4/7/2002,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,0,,,,100% df,light,none,Plastics = 100%,,,,,,15.0,12.5,8.1,8.78,0.01,3252,NM,0.01,0.62,0.03,20,5,NM,,Algae correction M.A. 02-02-03
345,7,4/7/2002,W,overcast,steady,clear,clear,sewage,none,none,0,,,,90-100,,,,none,high,More than 40 items. Among them,"NRT = 15%, Plastics = 75%, L =",,,,,,17.0,14.6,7.9,7.25,0.37,3110,9.7,0.43,0.28,0.09,20,410,NM,,none
346,8,4/7/2002,W,overcast,none,clear,clear,none,none,none,0,,,,0,,,,none,light,none,"Plastics = 50%, L = 50%",,,,,,15.0,12.6,7.7,NM,1.04,1761,NM,NM,NM,NM,NM,NM,NM,,Site was dry and testing was d
347,9,4/7/2002,W,overcast,steady,clear,clear,none,oily sheen,other_algae,30-40,,,,0,,,,Floating Green Diatoms and Dia,none,none,none,,,,,,15.0,13.0,7.4,5.23,0.17,4150,NM,0.01,0.45,0.05,30,NM,NM,,none
348,10,4/7/2002,W,overcast,none,clear,clear,none,none,other_algae,40-50,,,,60-70,,,,none,none,none,none,,,,,,15.0,12.1,7.8,7.16,0.65,552,NM,0.01,0.14,0.03,5,5,NM,,none
349,11,4/7/2002,W,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,10-20,,,,"Cladophora = 90%, Chara = 10%.",none,none,none,,,,,,17.0,13.8,8.1,10.71,0.01,1262,NM,0.01,0.19,0.01,10,5,NM,,none
350,13,4/7/2002,W,overcast,steady,clear,clear,rotten_eggs,NM,other_algae,10-20,,,,90-100,,,,10% Watercress coverage,moderate,10 items,"R = 20%, Plastics = 80%",,,,,,19.0,16.1,7.4,8.87,0.93,3760,1.4,1.16,0.61,0.08,110,64,NM,,Many crayfish and small fish p
351,2,6/2/2002,D,overcast,steady,clear,clear,none,none,other_algae_foam,0,,,,0,,,,"Diatom Matt = 99%, Chara = 1%.",light,One piece of PVC pipe.,Plastics = 100%,,,,,,17.0,15.8,8.0,7.17,0.31,1389,0.1,0.25,0.35,0.03,299,231,3873,,none

352,3,6/2/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-
10,,,,none,none,none,none,,,,,,18.0,16.2,7.7,8.19,0.01,744,NM,0.01,0.08,0.01,5,20,369,,none
353,4,6/2/2002,D,clear,steady,cloudy,brown,musty,none,other_algae,0-10,,,,90-100,,,,Thick Diatoms
present.,moderate,Garbage hidden in dense
willow,NM,,,,,,20.0,22.4,8.1,8.34,3.83,2760,NM,0.01,0.32,0.01,52,86,8664,,none
354,6,6/2/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,none,light,none,R =
100%,,,,,,20.0,16.8,7.9,7.26,0.08,3790,NM,0.01,0.53,0.01,148,41,2098,,none
355,9,6/2/2002,D,overcast,intermittent,NM,clear,rotten_eggs,oily sheen,other_algae,10-20,,,,20-30,,,,Chara present on
site.,none,none,none,,,,,,17.0,15.4,7.4,3.52,1.50,4280,NM,0.01,0.76,0.01,10,5,1354,,none
356,11,6/2/2002,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,0-
10,,,,none,none,none,none,,,,,,17.0,16.4,7.9,8.93,0.02,1396,0.0,0.01,0.23,0.01,20,20,2282,,none
357,12,6/2/2002,D,clear,steady,clear,clear,rotten_eggs,NM,other_algae,0,,,,40-50,,,,Thick
Diatoms,none,none,none,,,,,,20.0,20.5,8.3,8.40,0.55,2365,NM,0.01,0.28,0.01,63,10,12996,,none
358,13,6/2/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,80-90,,,,Brown Diatoms with 10%
watercr,light,none,"Plastics = 33%, R = 33%, NRT
=",,,,,,20.0,18.0,7.2,6.01,NM,3980,1.1,1.66,0.88,0.01,416,240,17329,,10-20 crayfish in pool.
359,10,6/2/2002,D,overcast,intermittent,clear,clear,musty,none,other_algae,0,,,,0-
10,,,,none,none,none,none,,,,,,19.0,17.6,7.3,4.25,0.19,666,NM,0.01,0.17,0.01,5,5,1789,,Many tadpoles present at site.
360,1,6/3/2002,D,clear,NM,clear,clear,none,none,other_algae,20-30,,,,90-100,,,,"Fine Diatom cover = 90%,
Enter",none,none,none,,,,,,20.0,19.1,8.1,13.62,3.39,2350,NM,0.01,1.11,0.19,10,288,11198,,none
361,5,6/3/2002,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,80-90,,,,"Cladophora = 85%,
Enteromorpha",none,none,none,,,,,,22.0,17.3,8.0,13.85,0.04,3350,0.8,5.14,0.49,0.10,10,20,2755,,none
362,7,6/3/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,"Floating algae = Cladophora,
M",moderate,"Recently cleaned site, small a","R = 10%, NRT =
90%",,,,,,21.0,17.7,7.7,8.63,0.37,3030,3.3,1.33,0.79,0.13,161,63,19863,,none
363,14,6/3/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,0,,,,Diatom
Film,none,none,none,,,,,,18.0,15.3,7.7,8.17,NM,1311,NM,0.01,0.11,0.01,10,135,683,,none
364,16,6/3/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,none,moderate,30 items on site,"O = 10%,
R = 10%, NRT = 40%, P",,,,,,21.0,17.0,7.7,8.13,0.22,1574,NM,0.83,0.38,0.05,439,31,6131,,5-10 mosquito fish on site.
365,17,6/3/2002,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,90-100,,,,none,moderate,none,"R = 10%, L =
40%, Plastics = 5",,,,,,22.0,17.4,6.8,4.63,0.93,1446,0.6,0.04,0.31,0.14,265,10,8664,,none
366,18,6/3/2002,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,0,,,,Fine Diatoms
present,light,none,Plastics = 100%,,,,,,17.0,15.7,7.8,9.67,0.03,1510,NM,0.01,0.13,0.02,41,10,512,,Data entry correction
02/03/03
367,19,6/3/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,"Thick Diatoms = 80%, Chara =
2",none,none,none,,,,,,17.0,20.0,7.9,9.48,0.01,1155,NM,0.01,0.27,0.16,31,51,842,,none
368,2,5/5/2002,D,overcast,steady,clear,clear,none,none,other_algae,30-40,,,,90-100,,,,Floating Algae = Diatoms
Algae,none,none,none,,,,,,16.0,13.0,8.0,10.05,1.36,1384,NM,0.13,0.15,0.08,164,1354,4611,,none
369,7,5/5/2002,D,clear,steady,clear,clear,rotten_eggs,NM,other_algae,20-30,,,,90-100,,,,Algae Matt =
Cladophora,high,Approximately 35 items at site,"NRT=15%, P=75%,
L=10%",,,,,,20.0,16.0,7.6,7.98,0.56,3340,5.7,0.76,0.28,0.14,42,121,12996,,none
370,8,5/5/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,N
M,NM,NM,NM,NM,NM,,Site was dry.
371,10,5/5/2002,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,20-
30,,,,none,none,none,none,,,,,,19.0,14.0,7.2,6.73,0.06,589,NM,0.005,0.12,0.11,10,10,3654,,Many tadpoles at site.
372,11,5/5/2002,D,overcast,steady,clear,clear,none,garbage,other_algae,0,,,,10-20,,,,80% of Algae Matt is Chara.
20,light,none,"NRT = 67%, P = 33%",,,,,,14.0,14.0,8.0,9.97,0.29,1366,NM,0.005,0.13,0.03,124,41,1935,,none
373,3,11/3/2002,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,23.0,13.0,8.1,9.12,0.01,699,
NM,0.02,0.04,0.08,5,5,789,,none
374,1,5/5/2002,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,Algae Matt = Thick
Diatoms,none,none,none,,,,,,18.0,17.0,8.2,11.42,2.30,2054,NM,0.48,1.04,0.01,5,171,10462,,none
375,3,5/5/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0,,,,Algae Matt = Diatom
Film,none,none,none,,,,,,18.0,14.0,7.9,8.90,0.40,719,NM,0.005,0.06,0.01,5,5,218,,none
376,6,5/5/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,0-

10,,,,none,none,none,none,,,,,,15.0,13.0,8.0,8.33,0.14,3364,NM,0.01,0.39,0.02,150,20,2187,,none
377,13,5/5/2002,D,clear,steady,clear,clear,rotten_eggs,NM,other_algae,0,,,,90-100,,,,Algae Matt = Diatoms,light,Less than 10 items in sample a,NM,,,,,,19.0,16.0,7.3,6.85,0.90,4070,1.8,0.005,0.58,0.05,111,52,12033,,none
378,5,5/6/2002,D,overcast,steady,clear,clear,none,none,other_algae,30-40,,,,80-90,,,,"Floating Algae = Enteromorpha,",none,none,none,,,,,,15.0,14.0,7.9,9.67,0.005,3490,1.3,5.32,0.33,0.005,31,41,3654,,none
379,12,5/6/2002,D,overcast,steady,clear,clear,none,none,other_algae,20-30,,,,90-100,,,,Algae Matt = Thick Diatoms,none,none,none,,,,,,14.0,17.0,8.1,8.98,0.59,2460,NM,0.05,0.28,0.04,5,52,8664,,none
380,14,5/6/2002,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,14.0,14.0,7.8,8.37,0.03,1255,0.2,0.07,0.14,0.06,31,20,547,,none
381,9,11/3/2002,D,clear,steady,clear,clear,rotten_eggs_other_sulfur,none,other_algae_invasive plants,0,,,,90-100,,,,20% algae cover = Chara;
100%,none,none,none,,,,,,24.0,14.0,7.0,5.37,0.24,3120,NM,0.005,0.48,0.15,74,63,601,,none
382,17,5/6/2002,D,overcast,steady,clear,clear,none,NM,other_algae,0-10,,,,90-100,,,,90% of Floating Algae is Spyro,light,none,"P=5%, L=95%",,,,,,16.0,16.0,7.1,4.93,0.58,1475,1.0,0.05,0.31,0.03,10,53,NM,,none
383,18,5/6/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,0,,,,Algae Matt is Diatom Film,light,Approximate number of items
=,P=100%,,,,,,15.0,15.0,8.2,7.06,0.005,1621,NM,0.005,0.19,0.09,42,5,675,,none
384,19,5/6/2002,D,overcast,steady,clear,clear,none,oily sheen,other_algae,0,,,,10-20,,,,"DF= 80-90%, CH= 0-10%",none,none,none,,,,,,15.0,15.0,8.1,8.88,0.23,1162,NM,0.005,0.19,0.005,10,5,743,,none
385,2,7/14/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,No green algae matt. A patch o,none,none,none,,,,,,21.0,19.0,7.8,5.88,0.74,1386,NM,0.17,0.38,0.11,111,5,9804,,Over 100 small snails present.
386,9,7/14/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0,,,,Algae Matt is Diatom Film,none,none,none,,,,,,28.0,18.0,7.1,3.00,0.10,3210,NM,0.005,0.45,0.02,238,97,699,,none
387,12,7/14/2002,D,clear,steady,clear,clear,musty,none,other_algae,0,,,,20-30,,,,Algae Matt consists of Thick D,light,More than 10 items present.,"R=40%, NRT=40%,
P=20%",,,,,,26.0,24.0,7.9,7.31,0.85,2403,NM,0.07,0.23,0.02,99,5,24193,,Many crayfish and large tadpol
388,13,7/14/2002,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,90-100,,,,Matt Diatoms,light,none,"R=50%, P=50%",,,,,,30.0,21.0,7.2,6.02,1.06,3927,0.5,1.64,0.83,0.05,945,413,24192,,Many crayfish at site.
389,14,7/14/2002,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,NM,none,none,none,,,,,,19.0,18.0,7.6,8.18,0.09,1268,NM,0.02,0.09,0.005,178,218,2932,,1 Pacific Tree Frog Identified
390,1,7/15/2002,D,clear,none,muddy,brown,none,none,none,0,,,,0,,,,0,none,none,none,,,,,,23.0,25.0,8.1,12.70,4.00,1938,NM,0.04,1.23,0.16,31,97,17329,,none
391,4,7/15/2002,D,clear,steady,cloudy,brown_green,none,garbage,other_algae,0,,,,50-60,,,,Algae Matt = Diatom Matt,light,Approximate number of items =,"P=40%,
NRT=60%",,,,,,30.0,27.0,8.2,9.49,7.75,3020,NM,0.01,0.70,0.01,64,256,24193,,none
392,5,7/15/2002,D,clear,steady,clear,clear,none,none,other_algae,20-30,,,,90-100,,,,20% of ALgae Matt is Cladophor,none,none,none,,,,,,28.0,20.0,7.9,10.98,0.57,3630,NM,4.20,0.31,0.005,124,122,9804,,3 Pacific Tree Frogs identifie
393,7,7/15/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,10% of Algae Matt is Rhizoclon,light,Light amount of trash along ac,"R=45%, P= 45%,
L=10%",,,,,,31.0,22.0,7.6,6.63,1.30,3230,6.3,0.59,0.70,0.06,344,132,24193,,none
394,16,7/15/2002,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,50-60,,,,Algae Matt is 100% Thick Diato,none,none,none,,,,,,29.0,20.0,7.6,8.34,0.24,1461,NM,1.02,0.38,0.04,384,10,4352,,Approximately 5 Mosquito Fish
395,17,7/15/2002,D,clear,trickle,clear,clear,none,none,other_algae,20-30,,,,90-100,,,,100% of Algae Matt is Thick Di,light,none,P=100%,,,,,,31.0,22.0,7.1,4.68,0.96,1576,NM,0.08,0.30,0.13,20,10,6131,,none
396,18,7/15/2002,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,22.0,18.5,7.8,8.77,0.36,1523,NM,0.005,0.05,0.02,10,20,1565,,none
397,2,8/4/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
398,3,8/4/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0,,,,Algae Matt is 100% Diatom Film,none,none,none,,,,,,27.0,18.0,7.5,7.31,0.01,714,NM,0.01,0.03,0.005,42,5,275,,none
399,9,8/4/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0,,,,Algae Matt is Diatom

Film.,none,none,none,,,,,,26.0,17.0,6.9,4.33,0.005,3265,NM,0.01,0.64,0.005,591,122,1274,,20% of margin vegetated with w
400,14,8/4/2002,D,overcast,steady,clear,clear,none,none,other_leaves,0,,,,0,,,,none,none,none,none,,,,,,17.0,17.0,7.8,8.15,0.02,1349,NM,0.005,0.07,0.005,20,10,1376,,none
401,16,8/4/2002,D,clear,steady,clear,clear,none,none,other_algae_foam,0,,,,90-100,,,,Algae Matt is Thick Diatoms. W,none,none,none,,,,,,26.0,18.0,8.0,7.84,0.05,1572,NM,0.78,0.46,0.08,478,63,5172,,none
402,4,8/5/2002,D,clear,steady,other_turbid,green,none,garbage,other_algae,0,,,,90-100,,,,none,NM,Trash type is large metal gear,L=100%,,,,,,30.0,25.0,8.0,9.67,5.95,2870,NM,0.005,0.57,0.10,10,84,24192,,none
403,1,8/5/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was Dry.
404,7,8/5/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,Algae Matt is 100% Thick Diato,moderate,Approximate number of items is,"NRT=95%, P=5%",,,,,,28.0,20.0,7.4,6.20,0.97,3250,3.7,0.08,0.40,0.04,222,134,24193,,none
405,19,8/5/2002,D,overcast,steady,clear,clear,none,none,other_algae,10-20,,,,40-50,,,,30% of Algae Matt is Chara. 30,none,none,none,,,,,,19.0,18.0,7.7,9.03,0.09,1122,NM,0.005,0.12,0.005,10,10,2359,,none
406,1,9/9/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,To low to measure
407,9,5/5/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,Chara Algae,none,none,none,,,,,,15.0,14.0,7.5,6.80,0.005,3010,NM,0.005,0.42,0.10,42,5,1616,,One Plastic PVC sticking out f
408,11,7/14/2002,D,clear,intermittent,clear,clear,none,none,other_algae,80-90,,,,10-20,,,,Algae Matt is 90% Thick Diatom,light,none,NM,,,,,,25.0,18.0,6.8,1.90,0.30,1452,NM,0.04,0.13,0.06,20,5,644,,Many tree frog tadpoles presen
409,12,8/4/2002,D,clear,trickle,cloudy,clear,none,none,other_algae,0-10,,,,90-100,,,,Floating Algae is 100% Enterom,none,none,none,,,,,,26.0,21.0,8.2,10.09,0.90,2385,NM,0.03,0.08,0.04,10,5,14136,,none
410,11,8/4/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,SIte was dry.
411,18,8/5/2002,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,none,"R=2%, NRT=75%, P=8%, L=2%",,,,,,19.0,17.0,7.8,9.68,0.005,1530,NM,0.005,0.09,0.005,222,573,2187,,none
412,4,9/9/2002,D,clear,none,muddy,green,none,garbage,other_algae,0,,,,60-70,,,,90% of Matt cover = DM; 10% =,light,Large orange styrofoam floats,R = 10%,,,,,,32.0,22.0,8.4,11.23,4.25,3195,NM,0.005,0.75,0.09,20,41,17329,,Debris less than 1in diameter
413,19,9/9/2002,D,clear,steady,clear,clear,none,none,other_algae,20-30,,,,60-70,,,,Algae Mat= CH and DT,none,none,none,,,,,,23.0,17.0,7.6,8.68,0.005,1145,NM,0.005,0.14,0.01,5,5,6867,,none
414,17,9/9/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Too low to measure
415,2,9/8/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
416,3,9/8/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0-10,,,,none,none,none,none,,,,,,29.0,18.0,7.4,7.79,0.23,715,NM,0.005,0.09,0.12,10,10,884,,Many water bug traps in water.
417,6,9/8/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
418,9,9/8/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,60-70,,,,Algae Matt = DT and CH,light,2,P = 100%,,,,,,28.0,17.0,6.8,5.04,0.72,3010,NM,0.005,0.58,0.02,207,135,988,,none
419,12,9/8/2002,D,clear,steady,clear,clear,none,garbage,other_algae,10-20,,,,90-100,,,,Algae type = DM and SP,light,Approx # items = 4,P = 100%,,,,,,27.0,26.0,7.7,9.49,0.57,2760,NM,0.005,0.15,0.09,20,5,8704,,none
420,6,10/13/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
421,4,10/14/2002,D,clear,steady,milky,brown,musty,sewage,other_algae,0,,,,90-100,,,,Algae type = DT,light,Appr # Items = 5 Two large ora,NM,,,,,,25.0,20.0,8.3,11.59,5.83,3350,NM,0.005,0.22,0.03,42,84,5172,,Tapia spill
422,17,10/14/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Tapia Spill
423,18,10/14/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,Algae type: CL = 50%; DF = 50%,light,Appr. # Items = 5,R = 50%; P = 50%,,,,,,17.0,18.0,7.6,8.88,0.37,1260,NM,0.26,0.25,0.05,5,5,1211,,Tapia Spill

424,19,10/14/2002,D,overcast,steady,clear,clear,none,none,other_algae,30-40,,,,70-80,,,,Algae type : CH = 30%; SP = 20,none,none,none,,,,,,17.0,15.0,7.5,9.37,0.005,1148,NM,0.005,0.12,0.01,5,5,2282,,Tapia spill
425,4,5/6/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,Algae Matt = Thick Diatoms,moderate,Approximately 50 items at site,"Organics = 5%, R = 20%, NRT =",,,,,,19.0,19.0,8.0,9.32,2.00,2630,NM,0.03,0.03,0.12,5,74,4352,,none
426,16,5/6/2002,D,overcast,steady,clear,clear,none,none,other_algae,10-20,,,,50-60,,,,90% of Floating Algae is Enter,light,none,R=90%,,,,,,15.0,15.0,7.5,8.18,0.01,1477,NM,0.71,0.35,0.005,137,31,7270,,none
427,3,7/14/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,75% of Algae Matt is Diatom Fi,none,none,none,,,,,,29.0,20.0,7.4,7.40,0.005,700,NM,0.005,0.08,0.005,10,20,816,,none
428,6,7/14/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
429,13,8/4/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,Algae Matt is Thick Diatoms.,none,none,none,,,,,,28.0,19.0,7.1,6.20,0.55,3980,1.6,1.52,0.77,0.04,659,203,24192,,Large debris sited upstream of
430,19,7/15/2002,D,clear,steady,clear,NM,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,23.0,21.0,7.8,9.36,0.18,1089,NM,0.02,0.14,0.06,31,5,1333,,none
431,5,8/5/2002,D,clear,steady,clear,clear,none,garbage,other_algae,0-10,,,,80-90,,,,80% of Algae Matt is is Cladop,light,none,R=100%,,,,,,24.0,17.0,7.8,10.63,0.49,3575,NM,4.64,0.21,0.02,53,31,8164,,Unable to measure flow due to
432,5,9/9/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,10% = EN; 90% = DT,moderate,Appr # Items = 12,R = 15%; P = 85%,,,,,,28.0,15.0,8.1,11.80,0.28,3570,NM,4.64,0.34,0.02,238,295,7270,,7in diameter pipe on site. Pic
433,18,9/9/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0-10,,,,none,none,none,none,,,,,,21.0,16.0,7.8,9.28,0.11,1590,NM,0.005,0.09,0.04,164,155,2143,,none
434,9,10/13/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Algae Matt : 30% = CH; 70% = D,none,none,none,,,,,,24.0,15.0,7.6,3.30,0.16,3190,NM,0.005,0.40,0.12,87,74,794,,none
435,14,10/13/2002,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,0,,,,none,none,none,none,,,,,,17.0,15.0,7.6,8.26,0.04,1372,NM,0.005,0.005,0.02,20,10,520,,none
436,16,10/13/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
437,11,9/8/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
438,13,9/8/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,Algae type = DT,light,"2 bags, 1 Baskin Robbins cup,",P = 100%,,,,,,29.0,18.0,7.1,7.16,1.09,3910,0.5,1.68,0.82,0.13,831,327,9139,,none
439,13,11/3/2002,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,80-90,,,,DT,light,none,NRT = 100%,,,,,,24.0,14.0,7.5,7.32,0.61,3940,NM,1.36,0.57,0.06,428,282,9804,,Single crayfish identified.
441,5,10/14/2002,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,0,none,none,none,,,,,,18.0,14.0,8.0,10.03,1.90,3650,0.6,5.12,0.28,0.18,1607,24193,24193,,Tapia spill
442,14,9/8/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,DT in sunlit stagnant glides.,none,none,none,,,,,,21.0,16.0,7.4,7.98,0.005,1356,NM,0.005,0.08,0.005,64,41,708,,none
443,16,9/8/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
444,2,10/13/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
445,3,10/13/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0,,,,DF,none,none,none,,,,,,27.0,16.0,8.1,9.28,0.005,711,NM,0.005,0.005,0.03,5,272,2909,,Data entry correction made 02/
446,11,10/13/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site was dry.
447,12,10/13/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,Algae Matt: DM,light,none,P = 99%; R = 1%,,,,,,19.0,16.0,8.1,9.01,0.29,2750,NM,0.005,0.18,0.02,5,5,4106,,none
448,13,10/13/2002,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,90-100,,,,Algae Matt: 90-100% DM,none,none,none,,,,,,22.0,17.0,7.2,6.70,0.32,4000,1.0,1.47,0.62,0.03,531,189,24192,,5 - 10 crayfish in lower pool.
449,1,10/14/2002,D,clear,steady,clear,clear,sewage,none,other_algae,30-40,,,,0,,,,AlgaeFLT = EN AlgaeMT = DF,light,none,none,,,,,,22.0,22.0,7.5,11.05,0.56,2520,NM,0.02,1.63,0.05,269,74,24193,,Tapia spill

450,7,10/14/2002,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,80-90,,,,Algar type = DT,light,Appr. # Items = 10,R = 90%; NRT = 10%,,,,,,18.0,17.0,7.7,7.25,0.90,3200,NM,0.49,0.37,0.06,42,161,10462,,Tapia spill
451,2,11/3/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,"Dry, no flow."
452,4,11/3/2002,D,clear,steady,cloudy,green,musty,none,other_algae,0,,,,90-100,,,,RZ; CL; and DT,light,2 large styrofoam floats and m,R=20%; NRT=30%; L=50%,,,,,,25.0,16.0,8.0,11.30,5.66,3081,NM,0.005,0.005,0.04,20,31,17329,,none
453,12,11/3/2002,D,clear,steady,clear,clear,musty,none,other_algae,0,,,,90-100,,,,SP=20-30%; DT=70-80%,light,4 items,R=25%; NRT=75%,,,,,,22.0,14.0,7.9,10.23,0.12,2852,NM,0.03,0.28,0.01,5,5,5794,,none
454,16,11/3/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,"Dry, no flow."
455,5,11/4/2002,D,clear,steady,clear,clear,rotten_eggs_sewage,none,other_algae,0,,,,90-100,,,,EN = 10%; DT = 90%,none,none,none,,,,,,19.0,10.0,8.1,11.76,0.02,3720,0.5,4.30,0.37,0.11,148,336,2613,,Lots of fine sediment that rel
456,17,11/4/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,"Dry, no flow."
457,18,11/4/2002,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,none,light,2 items,P = 100%,,,,,,19.0,14.0,7.7,10.01,0.005,1702,0.3,0.005,0.03,0.005,20,5,1187,,Litter at top of bank along ro
458,19,11/4/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,70-80,,,,Floating algae type = DM and R,light,2 items - glass bottles.,L = 100%,,,,,,19.0,13.0,7.6,9.86,0.005,1145,NM,0.05,0.02,0.01,10,5,2014,,none
459,3,12/1/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,Algae type = DT,none,none,none,,,,,,12.0,12.0,7.9,9.43,0.005,740,NM,0.005,0.01,0.005,20,5,1012,,none
460,6,12/1/2002,W,clear,steady,clear,clear,none,other_leaves,other_algae,0,,,,0-10,,,,Green algae on rocks. One patc,light,none,P = 100%,,,,,,16.0,11.0,7.5,8.19,0.05,3890,NM,0.04,0.48,0.07,109,10,906,,none
461,9,12/1/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Algae type = CH and DT,none,none,none,,,,,,17.0,13.0,7.1,4.59,0.28,3700,NM,0.04,0.51,0.02,63,20,581,,none
462,13,12/1/2002,W,NM,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,90-100,,,,Algae type = 100% DT,moderate,10 items,R = 30%; NRT = 50%; P = 20%,,,,,,18.0,14.0,7.1,5.83,0.48,3490,1.0,1.15,0.67,0.09,262,110,6131,,Found one milk jug full of syr
463,14,12/1/2002,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,0,,,,Sycamore and Alder leaves.,none,none,none,,,,,,18.0,14.0,7.5,8.20,0.005,1424,0.1,0.02,0.12,0.14,31,5,663,,none
464,18,12/2/2002,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,moderate,15 items,R = 10%; NRT = 40%; P = 50%,,,,,,19.0,15.0,7.6,9.55,0.005,1553,0.3,0.07,0.20,0.01,5,5,3873,,none
465,4,12/2/2002,W,NM,steady,muddy,green,none,NM,other_algae_leaves,0,,,,90-100,,,,Algae Type = DT,moderate,50 items,NRT = 33%; P = 33%; Metal debr,,,,,,19.0,14.0,NM,10.66,6.50,2490,NM,0.03,0.17,0.04,41,571,19863,,none
466,7,12/2/2002,W,clear,steady,clear,clear,musty,none,other_algae,0,,,,10-20,,,,none,high,30 items,NRT = 45%; P = 50%; L = 5%,,,,,,18.0,12.0,7.5,8.60,1.28,2875,4.8,0.69,0.46,0.05,1467,1039,19863,,none
467,17,12/2/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,60-70,,,,Algae type = DT,light,none,R = 50%; L = 50%,,,,,,23.0,14.0,6.9,6.70,0.05,1659,1.2,0.15,0.37,0.03,20,10,1664,,none
468,19,12/2/2002,W,clear,trickle,clear,clear,none,none,other_algae,20-30,,,,10-20,,,,Floating algae type = RZ/CL; A,none,none,none,,,,,,20.0,12.0,7.4,7.39,0.005,1086,NM,0.05,0.15,0.005,10,5,2359,,none
469,5,4/7/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,DT =84%_CL/RZ =16%,light,1 item,P=100%,,,,,,26.5,12.3,8.0,12.89,0.41,3480,3.7,3.98,0.41,0.005,20,98,5172,,none
470,4,1/13/2003,W,clear,steady,cloudy,brown,other_fishy,none,other_algae,0,,,,90-100,,,,100% DT,moderate,10-15 Items,P=90%; L=5%; NRT=5%,,,,,,13.0,12.0,8.2,11.50,3.83,1722,NM,0.005,0.07,0.01,41,20,1553,,none
471,17,1/13/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,DF=45%; DM=45%; CL/RZ=10%; 50%,NM,NM,NM,,,,,,35.0,12.0,7.0,7.71,0.29,1347,1.5,0.29,0.23,0.10,63,10,884,,Poor canopy cover.
472,19,1/13/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,CL/RZ=100%,light,1 Item,Wooden board,,,,,,16.0,13.0,7.6,9.90,0.005,950,NM,0.36,0.18,0.04,5,5,213,,none
475,7,4/7/2003,W,clear,steady,clear,clear,none,garbage,other_algae,0,,,,70-80,,,,Mat= CL/RZ =85%_DT=15%,high,Appoximately 100 items: mostly,NRT=80%_P=10%_R=10%,,,,,,19.5,13.2,7.7,9.64,0.93,3115,0.4,0.83,0.24,0.05,197,435,24192,,Canopy 50%
476,11,11/3/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,"Dry, no flow."
477,14,11/3/2002,D,clear,steady,clear,clear,none,oily sheen,other_algae,0,,,,0-

10,,,,DT,none,none,none,,,,,,18.0,14.0,7.6,8.63,0.005,1347,0.1,0.04,0.06,0.06,20,63,1793,,Flow is stagnating in glides a
478,1,11/4/2002,D,clear,trickle,clear,clear,sewage,none,other_algae,30-40,,,,0,,,,Enteromorpha and Duckweed,light,2 items,R=100%,,,,,,20.0,19.0,7.2,9.33,1.56,2770,NM,0.20,1.51,0.10,10,20,8164,,none
479,7,11/4/2002,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,70-80,,,,Algae type = 100% DT,light,10 items,NRT=100%,,,,,,20.0,13.0,7.6,9.84,0.56,3470,3.1,0.52,0.14,0.08,323,97,2755,,none
480,2,12/1/2002,W,clear,steady,clear,clear,none,none,other_algae,40-50,,,,80-90,,,,Algae matt type = RZ and CH co,light,3 items,R = 33%; P = 66%,,,,,,13.0,11.0,7.4,7.46,0.13,1507,NM,0.71,0.30,0.12,213,41,1723,,none
481,11,12/1/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0,,,,DF,none,none,none,,,,,,17.0,12.0,7.6,7.05,0.005,1720,NM,0.02,0.19,0.05,5,5,435,,none
482,12,12/1/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,Algae type = 100% DT,light,none,R = 100%,,,,,,16.0,12.0,8.1,10.66,1.45,2401,NM,0.14,0.37,0.06,63,63,2187,,none
483,1,12/2/2002,W,clear,trickle,clear,clear,none,none,other_algae,0,,,,90-100,,,,Algae Type = DT,none,none,none,,,,,,20.0,17.0,7.9,13.92,1.04,1848,NM,4.56,2.70,0.12,86,41,7701,,none
484,5,12/2/2002,W,clear,steady,clear,clear,none,none,other_algae,0,,,,50-60,,,,Algae type = DT,none,none,none,,,,,,15.0,10.0,8.0,10.73,0.13,3460,1.0,4.00,0.55,0.08,41,51,1664,,none
485,16,12/2/2002,W,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,"Dry, no flow."
486,5,1/13/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,DT 100%,none,none,none,,,,,,17.0,11.0,8.1,11.92,0.45,3780,1.5,4.62,0.39,0.03,52,52,1597,,none
488,2,5/17/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Cl/RZ=100%,light,Nylon rope dog bone stuck in t,NRT =100%,,,,,,19.5,16.1,7.9,9.65,0.11,1275,4.8,0.78,0.25,0.005,52,146,1968,,Canopy =35%. Fresh horse manu
489,3,5/17/2003,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,21.8,16.0,7.9,8.40,0.005,730,NM,0.005,0.11,0.03,122,20,556,,Poison Oak galore.
490,6,5/17/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,"Mat= Cl/RZ=50%_CH=50%, Iron-ea",none,none,none,,,,,,22.0,16.2,7.6,8.26,0.005,3620,NM,0.005,0.47,0.03,145,31,2014,,Canopy 70% 50+ small tadpoles_
491,8,5/17/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,SP=72%_CH=28%,none,none,none,,,,,,22.0,16.2,7.3,5.42,0.33,2045,NM,0.005,0.14,0.04,41,10,663,,Canopy = 70-80% Gopher Snake_5
492,9,5/17/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,50-60,,,,Cl/RZ =46%_DT=29%_CH=25%,none,none,none,,,,,,21.0,16.1,7.4,9.11,0.29,3140,NM,0.005,0.56,0.03,187,158,8164,,none
494,13,5/17/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,CL/RZ =81%_DT=19%,high,30-40 items_ including trashca,P=95%_L=5%,,,,,,22.5,18.3,7.3,7.56,0.77,3505,2.0,0.64,0.61,0.05,327,98,15531,,Canopy = 60-70%
496,4,5/18/2003,D,clear,steady,cloudy,clear,none,none,other_algae,0,,,,100,,,,MAT= CL/RZ 50% DT 50%,none,none,none,,,,,,20.0,20.6,8.0,9.25,3.90,1517,NM,0.005,0.28,0.005,31,52,24193,,none
498,16,5/18/2003,D,clear,steady,clear,clear,none,none,none,0,,,,20-30,,,,CL/RZ=100%,none,none,none,,,,,,20.0,17.1,7.5,9.27,0.05,1618,NM,0.33,0.35,0.06,84,20,1597,,Canopy = 90-100%
500,17,5/18/2003,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,80-90,,,,FLT: DT=100%. (In margins) MT,none,none,none,,,,,,21.5,18.1,7.0,8.44,0.06,1027,5.3,0.09,0.34,0.05,31,143,1860,,Canopy =50-60%. One crayfish C
502,18,5/18/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,"CL/RZ =100%, SP present, not i",light,10 items,L=50%_NRT=50%,,,,,,17.0,16.2,7.7,11.24,0.005,1553,NM,0.005,0.12,0.04,20,145,1076,,Canopy = 30-40%
503,19,5/18/2003,D,overcast,steady,clear,clear,none,none,none,0,,,,50-60,,,,CL/RZ =94%_DT=6%,none,none,none,,,,,,18.0,16.1,7.5,11.07,0.005,772,4.2,0.02,0.10,0.03,10,41,556,,Canopy =60-70%
509,6,6/1/2003,D,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,10-20,,,,Mat= CH 100%,none,none,none,,,,,,20.5,17.4,7.5,6.78,0.06,3730,NM,0.005,0.33,0.07,323,31,1576,,Tadpoles.
510,7,1/13/2003,W,clear,steady,clear,clear,none,garbage,other_algae,0,,,,60-70,,,,DT=90%; CL=10% (Mostly in Riff,high,100+ Items,P=10%; L=10%; R=5%; NRT=75%,,,,,,18.0,11.9,7.7,8.75,1.20,3280,2.9,0.65,0.23,0.07,253,121,4611,,Rotten egg smell when sediment
511,16,1/13/2003,W,clear,trickle,clear,clear,none,none,other_algae,0,,,,20-30,,,,DT=100%; 25% coverage of white,none,none,none,,,,,,18.0,12.0,7.6,7.23,0.37,1552,NM,0.17,0.43,0.08,31,5,933,,none

512,18,1/13/2003,W,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM
,0.01,0.28,0.01,98,5,1374,,Water samples only site not me
516,8,6/1/2003,D,clear,intermittent,clear,clear,none,none,other_algae,0,,,,10-
20,,,,CH=100%,none,none,none,,,,,,24.5,17.5,7.2,NM,0.49,2100,NM,0.005,0.08,0.03,86,31,3255,,1 tadpole_many flies.
530,1,6/2/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,50-
60,,,,CL/RZ=50%_EN=50%,none,none,none,,,,,,17.0,19.3,7.6,9.00,0.19,1644,NM,0.01,1.21,0.05,5,63,3873,,none
537,19,6/2/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,60-
70,,,,CL/RZ=100%,light,none,P=70%_NRT=30%,,,,,,18.0,16.8,7.4,9.64,0.005,817,NM,0.005,0.18,0.02,20,5,1076,,none
541,4,4/7/2003,W,clear,steady,cloudy,brown,none,none,other_algae,0,,,,90-100,,,,MAT= DT 50%_CL/RZ with DT cove,moderate,"20 items, canoe.",P=95%
L=5%,,,,,,22.0,16.5,8.1,9.62,2.92,1600,NM,0.04,0.14,0.01,31,5,24193,,Unusual Carp behavior noted.
543,7,3/3/2003,W,overcast,steady,clear,clear,rotten_eggs,garbage,other_algae,0,,,,40-50,,,,Mat= CL/RZ=60% in riffle_DT=40,high,Appoximately 100 items: soda c,NRT
=90%_P=5%_R=5%,,,,,,13.5,11.1,7.8,9.83,1.05,2860,4.7,0.70,0.25,0.005,52,20,6131,,70-80% Canopy Cover.
546,16,3/3/2003,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,DM=100%,light,"2 items: 1 aluminum can, 1 soc",R=50%_NRT=50%,,,,,,13.5,13.3,7.8,9.34,0.005,1633,NM,0.45,0.43,0.07,74,10,345,,none
548,16,4/7/2003,W,clear,steady,clear,clear,none,none,none,30-40,,,,30-40,,,,FLT: DT=100%_MT:
DT=100%,none,none,none,,,,,,19.0,16.3,7.7,11.04,0.16,1607,NM,0.61,0.36,0.05,109,31,3448,,Large area of stream bank cove
550,17,3/3/2003,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,Cl/RZ=100%,light,2-5 items: grocery bags.,NRT =100%,,,,,,12.9,16.0,7.3,8.92,0.78,994,8.8,0.43,0.30,0.05,52,52,1553,,none
551,17,4/7/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,50-60,,,,CL/RZ
=100%,none,none,none,,,,,,23.3,16.5,7.1,8.47,0.28,1020,4.7,0.30,0.24,0.005,5,20,2187,,more than 100 Bullfrog tadpole
552,19,4/7/2003,W,clear,steady,clear,clear,none,none,none,0,,,,30-40,,,,CL/RZ
=100%,light,none,none,,,,,,18.5,14.2,7.6,10.31,0.005,752,3.4,0.08,0.13,0.005,20,5,443,,none
554,11,5/17/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,MAT= CL/RZ 72%_CH
28%,none,none,none,,,,,,21.0,16.6,8.1,10.27,0.005,1344,1.5,0.15,0.19,0.03,30,52,1872,,Canopy = 50%
555,12,5/17/2003,D,overcast,steady,clear,clear,none,garbage,other_algae,0,,,,90-100,,,,MAT=CL/RZ 100%,light,rubber dingy,P=100%,,,,,,21.5,18.8,7.8,8.89,1.01,1402,NM,0.005,0.40,0.03,10,5,4352,,none
572,13,6/1/2003,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,60-70,,,,CL/RZ=72%_DT=28%,high,~200 items. Stream wash
debris,P=50%_NRT=45%_L=5%,,,,,,25.0,20.2,7.2,8.87,0.54,3700,0.6,0.69,0.53,0.07,197,132,8164,,Canopy = 80-90%. 50 crayfish.
574,16,6/2/2003,D,clear,trickle,clear,clear,none,garbage,other_algae_leaves,0,,,,60-
70,,,,CL/RZ=100%,moderate,none,P=40%_NRT=40%_R=20%,,,,,,21.8,18.1,7.4,9.06,0.23,1603,NM,0.29,0.43,0.04,350
,31,9208,,Canopy = 60-70%
591,2,1/12/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,80-90,,,,100%
DT,none,NM,NM,,,,,,12.0,11.5,7.9,9.56,0.005,1400,0.8,1.23,0.24,0.13,63,63,1539,,
592,3,1/12/2003,W,clear,steady,clear,none,none,none,0,0,,,,0-10,,,,100%
CL/RZ,none,none,none,,,,,,16.0,11.0,7.9,9.88,0.005,686,NM,0.02,0.05,0.12,5,5,226,,
593,9,1/12/2003,W,clear,trickle,steady,clear,none,none,other_leaves,0,,,,NM,,,,Diatoms and decompsed leaves,light,1 PVC pipe,Plastics=100%,,,,,,19.0,13.0,7.1,4.06,0.26,3040,NM,0.005,0.52,0.06,41,5,327,,Measurements taken in pool ver
594,10,1/12/2003,W,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,0-10,,,,Mat= DF 100% Moss or Lichen gr,light,3 Items: Cloth_ Metal_ Synth,25% Recyclables - not
plastic;,,,,,,14.0,10.0,7.3,10.52,0.11,475,0.1,0.03,0.18,0.005,5,5,97,,
595,11,1/12/2003,W,clear,steady,clear,clear,none,none,Algae_ Duckweed 0-10%,0,,,,10,,,,Matt = DF 100%,light,1 boken plastic bottle,100% Plastics,,,,,,17.0,11.4,8.0,10.00,0.02,1550,NM,0.03,0.16,0.02,10,5,317,,Gelatenous transparent beige f
596,1,1/13/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,100%DT,light,2
items,NM,,,,,,16.0,14.0,7.9,11.02,0.91,1664,NM,5.22,2.92,0.06,20,31,2851,,none
606,1,4/7/2003,W,clear,steady,clear,clear,none,other _Brown Scum,other_algae,0,,,,50-60,,,,50% =CL/RZ_50%=
DT,light,5-10 items,P =50%_NRT=50%,,,,,,20.0,16.9,8.1,10.65,0.33,1548,NM,5.64,2.68,0.04,10,10,1014,,none
607,13,1/12/2003,W,clear,steady,clear,clear,NM,none,other_algae_foam,0,,,,80-90,,,,"MAT = DT 100% Foam-

white/tan,",moderate,"Rubber hose, stuck in earth",5% large items_ 10% plastics_,,,,,,20.0,15.0,7.2,7.86,0.69,3825,1.1,1.81,0.85,0.04,161,31,1789,,
608,14,1/12/2003,W,overcast,steady,clear,clear,none,none,other_algae_leaves,0-10,,,,0,,,,DM + green lichen or moss on c,none,NM,NM,,,,,,15.0,12.6,7.6,7.85,0.005,1395,0.2,0.005,0.10,0.01,5,20,399,,brownish white sheen on surfac
609,6,2/2/2003,W,clear,steady,clear,clear,NM,none,other_algae_leaves,0,,,,0-10,,,,Mat= 100%CH; iron-eating bacte,light,1 item,NRT= 100%,,,,,,18.0,12.0,7.5,8.01,0.43,3810,NM,0.01,0.55,0.04,10,5,677,,none
610,10,2/2/2003,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0-10,,,,FLT: 100%DT; MAT: 100%CL/RZ,none,none,none,,,,,,16.0,10.0,7.2,9.55,0.05,502,NM,0.005,0.19,0.05,5,5,74,,none
611,13,2/2/2003,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,80-90,,,,FLT= DT100% MAT= 5%CL/RZ 95%,light,"2.5x18inch plastic panel, plas",100% plastic,,,,,,21.0,15.0,7.2,9.82,0.61,3970,0.7,1.15,0.65,0.05,278,74,3654,,none
612,14,2/2/2003,W,clear,steady,clear,clear,none,none,none,0,,,,0-10,,,,100% CL/RZ,light,"plastic bag, styrofoam cup",100% non-recyclable trash,,,,,,21.0,15.3,7.4,8.42,0.01,1354,NM,0.005,0.09,0.005,20,5,1119,,Canopy cover 30-40%
613,1,2/3/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,"35%EN, 65%CL/RZ",light,less than 10 items,NRT =100%,,,,,,21.5,15.2,8.4,14.30,0.20,1722,NM,7.12,4.10,0.12,5,5,2247,,"Largemouth bass, 20 ducks, san"
614,4,2/3/2003,W,clear,steady,cloudy,brown_green,none,none,other_algae,0,,,,90-100,,,,MAT= DT100%,moderate,"50 items: bottles, metal gear,",R =10%_L =15%_P= 25%_NRT =50%,,,,,,20.0,13.9,8.1,10.67,2.30,2340,NM,0.005,0.10,0.005,31,20,12033,,none
615,5,2/3/2003,W,clear,steady,clear,clear,none,none,other_algae_pollen_seeds_leaves,20-30,,,,70-80,,,,"FLT: DT100%, MAT: DT80%, CL/RZ",light,Abandoned pipe,L=100%,,,,,,19.5,9.4,8.0,14.25,0.33,3495,0.1,4.90,0.28,0.01,5,5,3076,,none
616,7,2/3/2003,W,clear,steady,clear,clear,none,garbage,other_algae,0,,,,80-90,,,,"38%DT, 62%CL/RZ",high,"200 items: shopping cart, ceme",L =5% _R =15%_P =30%_NRT =50%,,,,,,21.0,11.1,7.8,11.37,1.32,3550,2.1,0.66,0.21,0.04,158,292,15531,,none
617,19,2/3/2003,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,50-60,,,,"FLT- DT100%. MAT-CL60%, DT40%.",light,100% traffic cone,NRT = 100%,,,,,,20.5,13.6,7.3,11.11,0.07,1031,0.4,0.03,0.005,0.005,20,5,432,,Pacific Tree Frog Cape Ivy is
618,6,3/2/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,10-20,,,,Mat= 100% CL/RZ grpwing among,none,none,none,,,,,,NM,11.9,7.8,9.43,0.54,3490,NM,0.005,0.52,0.09,52,10,933,,Pacific Tree Frog
619,11,3/2/2003,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,0,,,,none,none,none,none,,,,,,19.3,10.7,8.2,11.60,0.005,1425,NM,0.11,0.14,0.02,10,20,428,,none
620,12,3/2/2003,W,clear,steady,cloudy,brown,none,none,other_foam,0,,,,none,,,,none,none,none,none,,,,,,19.0,12.9,7.7,9.96,2.43,1222,NM,0.005,0.08,0.03,5,10,581,,none
621,3,3/2/2003,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,16.5,11.2,8.0,10.23,0.005,708,NM,0.005,0.05,0.005,10,5,173,,none
622,13,3/2/2003,W,clear,steady,clear,brown,musty,none,other_algae,0,,,,0-10,,,,DT50% CL/RZ 50%,high,50 items,R10% NRT60% P30%,,,,,,18.5,13.8,7.4,9.42,0.86,3810,0.2,0.88,0.56,0.07,96,62,4352,,none
623,14,3/2/2003,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,NM,12.6,7.7,10.14,0.005,1192,0.2,0.03,0.06,0.005,30,10,933,,none
624,14,4/6/2003,W,clear,steady,clear,clear,none,none,none,0,,,,0-10,,,,100% CL/RZ,none,none,none,,,,,,17.3,14.2,7.7,8.56,0.005,1210,0.3,0.10,0.06,0.01,63,295,1223,,Pacific Tree frog
625,2,4/6/2003,W,clear,steady,clear,clear,none,none,none,0,,,,10-20,,,,"50%DT, 50% CL/RZ",light,2 items,P =100%,,,,,,16.0,11.1,7.8,7.14,0.07,1333,2.2,1.69,0.20,0.13,299,594,4352,,none
626,6,4/6/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,Mat= UMA 100%,light,2 metal poles,L =100%,,,,,,16.8,11.7,7.5,7.52,0.09,3545,NM,0.04,0.41,0.01,52,5,1722,,One Pacific tree frog and nume
627,8,4/6/2003,W,clear,trickle,clear,clear,none,none,mosquito larvae_other_algae,0,,,,10-20,,,,"Mat= UMA 100%, and Iron-eating",none,none,none,,,,,,15.5,11.8,7.1,3.99,0.05,2300,NM,0.005,0.18,0.05,74,5,855,,none
628,9,4/6/2003,W,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,70-80,,,,70% DT 30% CL/RZ,none,none,none,,,,,,17.0,12.1,7.5,9.14,0.33,3120,NM,0.03,0.34,0.02,10,131,1529,,none
629,10,4/6/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,Mat= 100% CL/RZ,none,none,none,,,,,,16.0,11.7,7.5,10.45,0.02,397,1.4,0.01,0.10,0.13,5,5,689,,Newt and Lizard present
630,11,4/6/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,MAT= 100% DT,light,1 item,P =100%,,,,,,16.5,12.0,8.2,11.35,0.07,1449,NM,0.24,0.15,0.04,52,5,624,,none

631,12,4/6/2003,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,70-80,,,,FLT=EN100% MAT= 100% CL/RZ wi,NM,NM,NM,,,,,,19.3,14.3,7.9,10.56,0.47,1574,NM,0.05,0.28,0.05,5,5,1421,,none
632,13,4/6/2003,W,clear,steady,clear,clear,none,garbage,other_algae,10-20,,,,90-100,,,,FLT=100%DT MAT=100%CL/RZ,high,500 items,60% NRT_ 20% P_ 20% R,,,,,,20.0,14.2,7.3,11.06,0.47,3700,NM,0.87,0.48,0.11,63,109,6488,,none
633,4,3/3/2003,W,overcast,steady,cloudy,brown,other_fishy,none,other_algae_foam,0,,,,90-100,,,,MAT= DT 100%. White foam =cov,high,90 items,P=90%_10%=NRT,,,,,,12.5,13.1,8.4,11.23,4.67,1370,NM,NM,0.08,0.005,31,20,749,,none
640,6,1/12/2003,W,clear,steady,clear,clear,none,oily sheen_garbage,other_leaves,0,,,,none,,,,none,light,1 plastic bag,P= 100%,,,,,,19.0,10.9,7.6,8.15,0.01,3475,NM,0.005,0.52,0.07,86,5,857,,
641,12,1/12/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,MAT= DT 50% CL/RZ 50%,light,2 pieces of 3in diam steel pip,100% recyclable,,,,,,15.0,11.0,7.8,11.39,1.60,1867,NM,0.005,0.27,0.005,30,41,860,,Canopy 10-20% CL/RZ dominates
643,8,2/2/2003,W,clear,intermittent,clear,clear,none,none,other_algae_leaves,0,,,,0-10,,,,100%CH,none,none,none,,,,,,16.0,12.0,7.1,NM,0.74,1944,NM,0.01,0.15,0.29,31,5,354,,Cardinal sticky monkey flower
644,9,2/2/2003,W,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,20-30,,,,100%CH,none,none,none,,,,,,19.0,13.0,7.0,5.24,0.005,3205,NM,0.005,0.65,0.12,96,332,683,,DO measured in stagnant flow
645,12,2/2/2003,W,NM,steady,clear,clear,none,garbage,other_algae,0-10,,,,80-90,,,,MAT & FLT= 100% DT,light,Wood with nail,NRT,,,,,,21.0,12.0,7.8,11.14,0.37,2107,NM,0.01,0.33,0.03,20,5,644,,none
646,16,2/3/2003,W,clear,trickle,clear,clear,none,none,other_leaves_pollen,70-80,,,,40-50,,,,"FLT-DT100%, MT-DM100%",none,none,none,,,,,,20.0,12.0,7.5,7.09,0.40,1629,NM,0.24,0.33,0.11,41,10,1236,,Surface water of Stokes Creek
647,17,2/3/2003,W,clear,steady,clear,clear,none,none,other_algae,20-30,,,,90-100,,,,"FLT-DT95%, EN5%. MAT-DT65%, CL",light,light trash along roadside,NRT =100%,,,,,,19.0,12.5,7.0,9.86,0.07,1407,1.9,0.14,0.18,0.005,10,41,907,,none
648,2,3/2/2003,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,1 plastic cup,P=100%,,,,,,17.5,10.5,8.0,11.67,0.70,1446,3.2,1.28,0.25,0.04,85,74,2613,,none
660,2,7/13/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,"Cl/RZ =100% Some CH noted, no",light,1 Bud Light aluminum can,R=100%,,,,,,25.5,18.6,7.7,8.30,0.005,1318,3.3,0.72,0.24,0.005,472,345,3255,,"Canopy = 40-50%. Tadpoles, sma"
661,5,7/1/2003,D,clear,steady,clear,clear,none,none,other_algae_leaves,20-30,,,,70-80,,,,FLT: EN=100%. MT: Cl/RZ=79%_EN,none,none,none,,,,,,25.0,18.7,7.8,11.52,0.12,3358,1.9,3.66,0.40,0.04,135,85,11198,,"70-80% Canopy, 100+ Mosquito f"
662,6,7/13/2003,D,clear,none,clear,clear,none,other_gray film,other_algae,0,,,,10-20,,,,CH=100%,none,none,none,,,,,,33.5,20.4,7.1,3.08,0.65,4170,NM,0.005,0.79,0.10,616,313,24193,,Lots of tadpoles.
663,12,7/13/2003,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,90-100,,,,MAT = DT 100%,light,Approx. 5 items: plastic bottl,NRT=75%_P=25%,,,,,,32.5,24.8,8.0,10.90,0.89,1935,NM,0.005,0.46,0.07,20,20,15531,,none
664,10,5/17/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,CL/RZ =100%,none,none,none,,,,,,22.5,16.2,7.5,9.06,0.35,319,NM,0.01,0.19,0.05,41,10,1789,,Newt seen
665,2,2/2/2003,W,clear,steady,clear,clear,none,none,other_algae,0-10,,,,none,,,,FLT= EN 100%,none,none,none,,,,,,20.0,11.2,7.8,9.96,0.06,1564,1.3,1.05,0.28,0.01,31,63,1313,,
666,3,2/2/2003,W,clear,steady,clear,clear,none,none,other_moss,0,,,,0,,,,2 small moss patches,none,none,none,,,,,,17.0,12.0,7.9,9.24,0.005,716,NM,0.01,0.10,0.01,10,5,249,,small frog
667,11,2/2/2003,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,17.5,11.0,8.0,10.72,0.005,1426,0.6,0.01,0.18,0.03,10,5,213,,none
668,18,2/3/2003,W,clear,steady,clear,clear,none,garbage,none,0,,,,0-10,,,,100% CL/RZ,high,"50 items, including appliances",L =10%_NRT =15%_P=25%_R=50%,,,,,,23.0,13.6,7.6,10.70,0.04,1575,0.2,0.005,0.14,0.005,10,10,759,,Clean up site. Post Fire: Deer
669,14,5/17/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,CL/RZ =100%,none,none,none,,,,,,18.0,16.4,7.8,11.40,0.37,1129,0.2,0.04,0.06,0.005,63,20,1483,,Canopy = 90-100%
670,9,6/1/2003,D,clear,steady,clear,clear,none,none,other_algae_leaves,0,,,,10-20,,,,CH=76%_DT=24%,none,none,none,,,,,,23.0,16.6,7.3,6.71,0.29,3020,NM,0.005,0.50,0.06,175,52,7270,,Tadpoles.

Canopy = 55-65%
671,12,6/1/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,80-90,,,,CL/RZ=90%_DT=10%,light,none,O=100%,,,,,,NM,23.8,7.8,11.44,0.03,1644,NM,0.005,0.51,0.07,10,20,12996,,none
672,18,6/2/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,CL/RZ=75%_SP=25%,light,Approximately 50 items.,NRT=85%_L=15%,,,,,,18.0,17.5,7.7,9.76,0.01,1529,NM,0.005,0.13,0.04,86,216,1935,,none
681,13,7/13/2003,D,clear,steady,clear,yellow,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,33.0,21.9,7.5,7.86,1.16,3410,0.7,1.74,0.78,0.09,813,301,24192,,"70-80% Canopy. Crayfish, Chub,"
682,14,7/13/2003,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,23.5,18.9,7.4,8.13,0.03,1160,NM,0.16,0.04,0.06,201,63,2909,,none
683,16,7/1/2003,D,clear,trickle,clear,clear,none,none,other_leaves,17,,,,50-60,,,,FLT: EN=100%_ MT: CL/RZ=100%,light,"Styrofoam cup, human feces.",O=50%_NRT=50%.,,,,,,25.5,18.3,7.4,9.40,0.80,1664,NM,0.17,0.33,0.04,145,298,12996,,Canopy = 85-95%
690,4,8/4/2003,D,clear,steady,cloudy,green,none,none,other_algae,0,,,,90-100,,,,MAT= DT 50% CL/RZ 50%,light,Concrete chunk_ metal,L=100%,,,,,,27.3,24.4,8.0,8.03,5.00,2410,NM,0.005,0.55,0.07,63,120,12996,,none
691,5,8/4/2003,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,70-80,,,,FLT: EN=100%. MT: CL/RZ=58%_DT,none,none,none,,,,,,27.5,18.5,7.8,9.96,0.27,3410,1.0,3.52,0.38,0.06,1019,73,6131,,Canopy = 70-80%
692,7,8/4/2003,D,clear,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,90-100,,,,Mat= DT=100%,moderate,50 items: including El Pollo L,NRT=90%_P=5%_R=5%,,,,,,29.0,20.5,7.6,7.60,1.33,3145,2.3,0.77,0.80,0.14,171,86,24193,,Canopy = 80-90%
693,10,8/3/2003,D,clear,trickle,clear,clear,none,none,mosquito larvae_other_algae,0,,,,80-90,,,,Mat= CL/RZ=50%_SP=25%_CH=25%,none,none,none,,,,,,27.5,20.4,7.4,6.92,0.005,562,NM,0.005,0.16,0.08,63,52,2143,,Canopy = 60%. Dragonflies_ sk
694,11,8/3/2003,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,40-50,,,,FLT: EN=100%. MT: CH=51%_EN=4,none,none,none,,,,,,24.8,18.9,7.8,8.35,0.005,1335,NM,0.005,0.15,0.07,161,20,4106,,Canopy = 60-70%. Baby frogs_
695,13,8/3/2003,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,moderate,10 items =including styrofoamm,P=40%_R=40%_NRT=20%,,,,,,28.0,20.6,7.2,7.56,0.87,3805,0.6,1.61,0.72,0.14,880,1187,24197,,none
696,16,8/4/2003,D,clear,steady,clear,clear,none,garbage,none,0,,,,0,,,,none,light,none,R=50%_NRT=50%,,,,,,29.0,19.2,7.4,7.25,0.33,1624,NM,0.32,0.38,0.10,987,1725,8664,,none
697,9,3/2/2003,W,clear,steady,clear,clear,none,none,other_algae,0,,,,40-50,,,,65% DT; 35% CL/RZ,light,PVC pipe,P=100%,,,,,,18.5,12.0,7.5,8.64,0.66,3190,NM,0.005,0.54,0.10,5,272,1081,,none
698,10,3/2/2003,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,16.0,9.9,7.4,11.82,0.005,282,3.0,0.005,0.08,0.02,63,20,262,,none
699,3,4/6/2003,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,16.0,12.1,8.0,9.49,0.01,748,NM,0.005,0.05,0.005,31,5,313,,none
700,1,3/3/2003,W,overcast,steady,clear,clear,none,none,other_algae_foam,0,,,,70-80,,,,MT = 100%DM. White foam,none,none,none,,,,,,17.0,14.0,8.0,10.83,1.30,1512,NM,5.82,2.98,0.11,10,5,2755,,"Arizona Crossing blown out, 1"
701,5,3/3/2003,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,DT=80%_CL/RZ=20%,light,"Picture Frame, Socks, Plastic",P=25%_NRT=75%,,,,,,15.0,11.1,8.1,11.69,0.15,3390,2.1,4.46,0.60,0.12,74,98,4352,,none
702,18,3/3/2003,W,overcast,steady,clear,clear,none,NM,other_leaves,0,,,,0,,,,none,moderate,50 items on bank only,R=80%_P=20%,,,,,,16.0,13.9,7.8,10.27,0.10,1597,NM,0.005,0.19,0.005,5,5,1250,,none
703,18,4/7/2003,W,clear,steady,clear,clear,none,none,,,,,,,,,,NM,moderate,50 items,NRT = 50%_R=40%_L=10%,,,,,,16.0,14.4,7.8,10.12,0.005,1551,NM,0.005,0.18,0.005,5,10,1145,,none
704,19,3/3/2003,W,overcast,steady,clear,clear,none,NM,other_algae,0,,,,30-40,,,,CL/RZ = 90%_DT=10%,light,"1 item: metal strip, plywood",R=100%,,,,,,15.0,12.8,7.5,10.36,0.005,801,2.6,0.01,0.21,0.005,10,5,419,,Canopy 50-60%.
706,19,8/4/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,CL/RZ = 100%. Some CH present,none,none,none,,,,,,23.0,18.5,7.6,9.81,0.005,939,NM,0.005,0.16,0.09,30,5,2224,,none
707,3,8/3/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0,,,,0,none,none,none,,,,,,17.5,20.3,7.4,7.50,0.12,738,NM,0.005,0.03,0.03,209,52,754,,none
709,7,9/9/2002,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,DT,high,Approx # items = 150,NRT = 95%; P = 5%,,,,,,29.0,17.0,7.6,7.15,0.86,3410,1.9,0.53,0.39,0.05,124,218,17329,,none
710,1,5/18/2003,D,clear,steady,clear,clear,none,none,other_algae,30-40,,,,60-70,,,,FLT: EN =100%_MT:

CL/RZ=100%,none,none,none,,,,,,19.0,18.6,8.2,14.53,0.19,1534,NM,0.06,0.74,0.02,5,10,1137,,none
711,5,5/18/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,30-40,,,,CL/RZ =92%_DT=8%,light,3 items,NRT=100%,,,,,,23.0,15.7,8.0,8.27,0.35,3500,2.1,3.08,0.47,0.02,97,52,2489,,Canopy = 90-100%
712,7,5/18/2003,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,80-90,,,,Mat= CL/RZ=100%. Algae strands,moderate,Approx. 50-100 items_Food cont,NRT=90%_R=10%,,,,,,24.0,16.8,7.6,9.22,0.60,2950,7.2,0.47,0.39,0.09,187,669,7701,,Canopy = 70-80% 2 ducks.
713,2,6/1/2003,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,50-60,,,,FLT: EN=100%_MT: CL/RZ=100%,light,Less than 10 items_3 oranges_,O=50%_P=50%,,,,,,19.5,16.9,7.8,10.13,0.005,1256,2.4,0.63,0.14,0.02,213,74,3654,,Canopy= 20-30%
714,3,6/1/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,M: CL/RZ100% few strands of Cl,none,none,none,,,,,,24.0,19.9,7.8,8.47,0.005,720,NM,0.005,0.03,0.005,41,5,457,,Blue dragonfly. Dragonfly lar
715,4,6/2/2003,D,clear,Heavy. (Dam is releasing.),muddy,brown_green,rotten_eggs,other_bubbles from turbulence,other_algae,0,,,,50-60,,,,MAT= DT 100%,light,Large metal gear,L=100%,,,,,,21.8,24.9,7.6,7.33,5.59,1778,NM,0.005,0.74,0.35,86,169,17329,,10+ Large Carp. Dam is releasi
717,1,7/1/2003,D,overcast,steady,clear,clear,none,none,other_algae,30-40,,,,60-70,,,,FLT: EN=50%_CL/RZ=50%. MT: CL,light,none,P=100%,,,,,,21.0,21.9,8.3,17.05,0.60,1780,NM,0.005,0.89,0.02,41,41,6131,,"Dead willows on left bank, ups"
718,10,7/13/2003,D,clear,trickle,clear,clear,none,none,other_algae,10,,,,60-70,,,,FLT: EN=100%. MT: DT=51%_CL/R,none,none,none,,,,,,32.5,21.7,7.1,9.54,5.17,506,NM,0.005,0.12,0.04,52,10,4611,,Canopy = 40-50%. Waterstriders
719,10,6/1/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,Cl/RZ =100%,none,none,none,,,,,,22.5,17.9,7.1,8.19,0.005,420,0.6,0.005,0.09,0.04,10,41,4611,,5 water striders present.
720,11,6/1/2003,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,90-100,,,,FLT: DT=60%_CL/RZ=40%_MT: CL/R,none,none,none,,,,,,21.8,19.3,8.1,12.10,0.005,1312,0.8,0.03,0.10,0.01,98,86,1515,,Canopy 50% Red and blue dragon
721,14,6/1/2003,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,30-40,,,,CL/RZ=100%,none,none,none,,,,,,19.5,17.8,7.8,11.33,0.005,1122,0.2,0.02,0.07,0.04,41,120,1829,,"1 tadpole, 1 California tree f"
722,5,6/2/2003,D,clear,steady,clear,clear,none,none,other_algae_leaves,10-20,,,,70-80,,,,FLT: EN=100%_MT: CL/RZ=100%,none,none,none,,,,,,22.3,19.1,7.8,13.14,0.005,3570,1.4,3.26,0.43,0.05,51,108,5475,,Canopy = 70-80%
723,7,6/2/2003,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,80-90,,,,Mat= CL/RZ = 100%,high,More than100 items,P=75%_R=20%_NRT=5%,,,,,,25.0,19.5,7.7,8.44,0.005,3060,5.7,0.85,0.86,0.12,318,1607,24193,,none
724,17,6/2/2003,D,clear,steady,clear,clear,none,none,other_algae,10-20,,,,40-50,,,,FLT: CL/RZ = 100%_MT: CL/RZ=90,none,none,none,,,,,,23.8,20.3,6.9,8.19,0.005,1101,1.5,0.06,0.41,0.08,63,52,7701,,Heard bullfrog croaking ~ 100
731,3,7/13/2003,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,Strands of white-colored CL/RZ,none,none,none,,,,,,32.5,23.0,7.6,6.83,0.09,736,NM,0.005,0.06,0.10,74,5,2143,,Patches of diatom-covered gree
732,4,7/1/2003,D,clear,steady,muddy,brown_green,rotten_eggs,none,other_algae,0,,,,80-90,,,,MAT= Cl/RZ 70% DT 30%.,light,Metal gear box.,L=100%,,,,,,25.0,24.0,7.8,8.51,4.97,2020,NM,0.005,0.60,0.02,30,5,8164,,none.
733,11,7/13/2003,D,clear,steady,clear,clear,none,none,other_algae,0-10,,,,10-20,,,,FLT: EN=100%. MAT: Cl/RZ=97%_,none,none,none,,,,,,29.0,23.1,7.8,7.87,0.17,1300,0.1,0.005,0.13,0.05,122,187,3654,,Canopy = 60-70%
734,17,7/1/2003,D,clear,steady,clear,clear,none,none,other_horse manure,0,,,,80-90,,,,CL/RZ=100%,none,none,none,,,,,,31.0,21.4,7.3,9.07,0.13,1182,2.8,0.01,0.35,0.06,189,110,5794,,"Killer bees, Bullfrog tadpoles"
735,19,7/1/2003,D,clear,steady,clear,clear,none,none,none,0,,,,70-80,,,,DT=54%_CL/RZ=46%,none,none,none,,,,,,19.0,18.4,7.8,10.15,0.01,846,0.4,0.005,0.12,0.07,10,10,1450,,Canopy = 60-70%.
739,12,8/3/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,MAT= CL/RZ with DT 100%,light,Crayfish remains_ picnic remai,NRT=90%_O=10%,,,,,,29.0,24.9,7.9,9.16,0.52,2058,NM,0.005,0.45,0.10,52,41,6867,,Canopy 80%
740,17,8/4/2003,D,clear,steady,clear,clear,sewage,none,other_algae,30-40,,,,90-100,,,,FLT: EN=100% MT: SP=70%_UMA b,light,Concrete debris_metal,L=100%,,,,,,29.0,21.7,6.9,4.48,0.10,1351,0.5,0.02,0.33,0.13,5,5,3255,,Canopy 50-60% Water is heavily
741,18,8/4/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,0-10,,,,UMA = 50%_CL/RZ =

50%,moderate,none,L=50%_NRT=50%,,,,,,21.5,19.0,7.8,9.91,0.03,1595,NM,0.04,0.21,0.10,122,84,2489,,none
748,7,7/1/2003,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,70-80,,,,Mat=
CL/RZ=100%,moderate,none,NRT=65%_P=30%_L=5%.,,,,,,23.0,19.5,7.9,7.83,0.78,3030,3.1,1.09,0.72,0.08,226,282,2
4192,,Canopy = 70-80%
749,9,7/13/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,20-
30,,,,CH=100%,none,none,none,,,,,,31.5,18.1,7.5,5.70,0.08,3050,NM,0.005,0.58,0.08,148,109,2613,,Canopy = 80-90%
750,18,7/1/2003,D,overcast,steady,clear,clear,none,none,other_algae,0-10,,,,20-30,,,,FLT: CL/RZ = 100%. MT:
CL/RZ,moderate,none,NRT=50%_P=25%_L=25%.,,,,,,18.0,17.9,7.9,9.65,0.01,1552,NM,0.005,0.10,0.04,52,41,1658,,C
anopy = 10%
757,1,8/4/2003,D,clear,steady,clear,clear,none,none,other_algae,30-40,,,,90-100,,,,FLT: EN=100%_MT:
EN=50%_DT=50%,light,Tail light_Fast food
cup,NRT=50%_P=50%,,,,,,25.0,21.6,7.6,9.00,0.55,1883,NM,0.02,1.26,0.09,63,41,8664,,none
758,2,8/3/2003,D,clear,steady,clear,clear,none,none,none,0,,,,20-30,,,,CL/RZ=100%,light,1 Plastic
Bottle,P=100%,,,,,,22.0,17.7,7.6,8.58,0.005,1351,NM,0.77,0.33,0.10,369,187,3873,,Canopy = 90-100%. Lots of tad
759,9,8/3/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,20-30,,,,CH
=100%,none,none,none,,,,,,26.5,18.3,7.4,5.86,0.01,3230,NM,0.005,0.63,0.05,161,249,1918,,Canopy =90-100%
760,14,8/3/2003,D,clear,steady,clear,clear,none,none,other_leaves_pollen,0,,,,1,,,,MAT: DT
100%,none,none,none,,,,,,22.0,18.9,7.6,8.62,0.01,1194,NM,0.13,0.02,0.06,145,63,2489,,More than 10 tree frogs_tadpol
764,8,1/12/2003,W,clear,Dry,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Site was dry
765,8,3/2/2003,W,clear,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Could not access the site. Gat
767,6,8/4/2002,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,N
M,NM,NM,NM,NM,NM,,DRY
768,17,8/5/2002,D,clear,none,clear,clear,none,none,other_algae,1,,,,90-100,,,,NM,light,,70% Plastics 30%
Wood,,,,,,26.3,21.0,6.9,NM,0.93,1593,NM,0.08,0.40,0.04,5,98,12996,,Too shallow for DO
769,8,7/13/2003,D,clear,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM
,NM,NM,NM,NM,NM,NM,,No flow_ no data recorded
770,6,8/3/2003,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,N
M,NM,NM,NM,NM,NM,,Dry channel. No data collected
771,8,8/3/2003,D,clear,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Site not measured dry
772,1,10/7/2003,D,overcast,steady,clear,clear,none,none,other_algae,15,,,,85,,,,FLT: DT 100% MAT: DT
100%,none,none,none,,,,,,19.5,19.9,7.7,8.64,0.28,2210,NM,0.10,1.48,0.06,52,122,6131,,Canopy 5%
774,2,10/5/2003,D,overcast,steady,clear,clear,none,none,other_algae,3,,,,61,,,,FLT=DT100% MAT=CH 19% CL./RZ
2,none,none,none,,,,,,17.5,15.1,7.5,8.76,0.005,1366,NM,0.32,0.29,0.09,52,30,2063,,Canopy 15%
775,3,10/5/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,3,,,,MAT= CL/RZ
100%,none,none,none,,,,,,22.0,17.0,7.7,9.80,0.005,714,NM,0.06,0.09,0.03,31,96,1106,,Canopy 80%
776,4,10/5/2003,D,clear,steady,clear,brown_green,none,none,other_algae_oily sheen,11,,,,100,,,,FLT=EN 100%
MAT=CL/RZ 28% DT 7,light,One large metal
machine,L=100%,,,,,,20.5,20.4,8.1,8.99,6.60,2740,NM,0.05,0.54,0.07,10,20,14136,,Canopy 20%_Cattails are starti
777,5,10/7/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,97,,,,MAT=CL/RZ 20% DT
80%,none,none,none,,,,,,21.5,17.0,8.0,10.36,0.23,3520,1.4,4.26,0.44,0.06,1050,959,5475,,Canopy 80%
778,7,10/5/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,80,,,,MAT=CH 14% DT 86%,moderate,20 Items:
Shopping cart_styrof,Plastics 60% Large items
40%,,,,,,23.0,17.4,7.6,7.11,1.10,2875,6.4,0.96,0.55,0.11,240,231,24193,,none
779,6,10/5/2003,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Dry channel. No data collected
780,8,10/5/2003,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Dry channel_ no data collected
781,9,10/5/2003,D,clear,intermittent,clear,clear,none,other_film,other_algae,1.40,,,,88.6,,,,FLT=DT 100% MAT= DT
56% CH 44,none,none,none,,,,,,24.0,16.6,7.2,3.55,0.53,3190,NM,0.03,0.67,0.005,278,108,1354,,Canopy 90%. Field
data was col
782,10,10/5/2003,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,N

M,NM,NM,NM,NM,NM,NM,,Dry channel_ no data collected
783,11,10/5/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,35,,,,MAT=DT 51% CH 30% CL/RZ 19%,light,2 Items: One aluminum can_ one,NRT 50%_ R 50%,,,,,,20.5,15.2,7.6,8.16,0.10,1329,NM,0.06,0.14,0.03,135,31,3873,,Canopy 20-30%
784,12,10/7/2003,D,overcast,steady,clear,clear,none,none,other_algae_leaves,0,,,,97,,,,MAT= CL/RZ with DT 100%,light,One paper plate,NRT 100%,,,,,,19.3,19.2,8.0,8.95,0.17,2530,NM,0.09,0.43,0.04,5,5,7701,,Canopy 90% Crayfish
785,13,10/5/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,5,,,,MAT= DT 100%,none,none,none,,,,,,19.0,16.9,7.2,7.34,2.05,3660,0.8,1.35,1.88,0.005,496,269,15531,,Canopy 80%
786,14,10/5/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,1,,,,MAT= DT 100%,light,1 Item,Plastics 100%,,,,,,18.0,16.5,7.8,9.85,0.005,1216,NM,0.07,0.05,0.03,5,30,364,,Canopy NM
787,16,10/5/2003,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,5,,,,MAT= CL/RZ 100%,moderate,20-25 Items: Paper plates_ nap,O 5%_ P 5%_ R 90%,,,,,,20.5,15.3,7.6,8.51,1.47,1671,NM,0.44,0.45,0.005,379,1178,6131,,Canopy 90%
788,17,10/5/2003,D,clear,intermittent,clear,clear,none,none,other_duckweed,0,,,,0,,,,Duckweed cover 100%,none,none,none,,,,,,20.0,17.8,6.8,2.55,0.90,1410,NM,0.12,0.33,0.13,10,20,3255,,Canopy 40%
791,18,10/7/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,9,,,,MAT=DT 100%,NM,NM,NM,,,,,,18.5,17.8,7.9,11.45,0.005,1567,NM,0.08,0.18,0.005,98,5,710,,Canopy 70%
792,19,10/7/2003,D,overcast,steady,clear,clear,none,none,other_algae,5,,,,68,,,,FLT= DT 100%_ MAT= DT 100%,light,none,Plastics 100%,,,,,,18.0,17.1,7.9,11.26,0.005,1030,NM,0.07,0.21,0.06,30,5,1850,,Canopy 60-70%
793,1,11/2/2003,D,clear,steady,clear,clear,none,none,other_algae,1,,,,100,,,,FLT=RZ/CL 100% MAT= DT 100%,light,none,P=100%,,,,,,19.3,16.7,8.0,9.94,1.17,2550,NM,0.34,1.10,0.08,145,601,10462,,Canopy 10%
794,2,11/2/2003,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,100,,,,MAT= SP 44% DT 56%,light,1 Item= Rope dog toy,NRT= 100%,,,,,,16.0,11.4,7.4,7.71,0.005,1316,NM,0.66,0.28,0.05,331,226,7270,,Canopy 75%
795,8,11/2/2003,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Dry Channel_ No data collected
796,3,11/2/2003,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,15.5,13.3,7.6,9.07,0.005,712,NM,0.005,0.05,0.05,31,292,1565,,Canopy= 15%
797,5,11/2/2003,D,clear_ Partly cloudy,steady,clear,red_brown,none,none,other_algae,0,,,,95,,,,MAT= DT 100%,light,1 Item= Aluminum can,R= 100%,,,,,,16.3,11.7,7.9,9.97,0.71,2802,3.5,3.92,0.61,0.32,3076,1210,24193,,Canopy 80% _Water Color may j
798,7,11/2/2003,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,23,,,,MAT= CL/RZ 100%,high,50 items,NRT= 45%_ P= 50%_ R=5%,,,,,,14.5,12.9,7.8,7.70,1.54,2875,NM,0.85,0.51,0.16,2602,1354,24193,,Canopy 80%
799,12,11/2/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,90-100,,,,MAT= DT 99% SP 1%,light,8 Items= Plastic water bottles,P= 50%_ R= 50%,,,,,,16.0,14.2,8.1,9.61,0.99,2520,NM,0.05,0.41,0.005,20,120,7270,,Low battery on turbidity meter
800,13,11/2/2003,D,clear,trickle,clear,brown_green,musty,other_ Bubbles/Soapy looking,other_algae_duckweed,0,,,,29,,,,MAT= DT 100%,light,4 Items,R= 100%,,,,,,18.5,14.5,NM,6.50,1.37,3040,NM,1.98,0.92,0.31,1414,389,19863,,Canopy=90%_ Conductivity redon
801,14,11/2/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,10,,,,MAT= 100% DT,none,none,none,,,,,,16.5,14.4,7.4,9.32,0.01,1256,NM,0.005,0.08,0.005,41,5,1785,,Canopy= 95% Floating Leaves an
802,17,11/2/2003,D,overcast,steady,clear,clear,none,none,other_algae_duckweed,0,,,,97,,,,MAT= CL/RZ 100%,none,none,none,,,,,,13.0,14.6,6.9,4.97,0.18,1554,NM,0.22,0.43,0.08,122,63,5794,,Canopy= 40%
803,18,11/2/2003,D,clear,steady,clear,clear,none,none,other_algae_watercress,0,,,,9,,,,MAT= DT 100%,none,none,none,,,,,,18.3,15.8,8.0,9.65,0.05,1611,NM,0.02,0.13,0.005,630,5,1918,,Canopy= 90%_ new growth
804,1,12/14/2003,W,rain,steady,clear,clear,none,none,other_algae,0,,,,95,,,,MAT= DT 100%,light,3 Items,NRT=100%,,,,,,12.5,13.2,7.7,11.06,0.82,1454,NM,6.24,4.52,0.06,30,10,2723,,
805,2,12/14/2003,W,overcast,trickle,clear,clear,none,other_ Leaves,other_algae,5,,,,100,,,,FLT= DT 100% MAT= DT 100%,light,2 Items_ old pipe,P= 100%,,,,,,12.5,7.8,7.5,9.76,0.03,1333,NM,0.58,0.25,0.01,31,5,173,,none
806,3,12/14/2003,W,showers,steady,clear,clear,none,other_ Leaves,none,0,,,,none,,,,none,none,none,none,,,,,,11.5,10.0,7.7,10.86,0.005,753,NM,0.005,0.05,0.005,20,10,448,,none
807,5,12/14/2003,W,rain,steady,clear,clear,none,none,other_algae,0,,,,80,,,,MAT= CL/RZ w/DT on top 100%,none,none,none,,,,,,12.3,8.2,7.9,12.34,0.19,3349,NM,5.10,0.43,0.02,52,52,591,,Canopy 80%

808,7,12/14/2003,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,53,,,,MAT= CL/RZ 100%,moderate,30 Items,NRT= 50%_ P=50%,,,,,,13.0,9.3,7.7,9.00,1.16,3180,NM,0.53,0.31,0.06,12,161,17329,,Canopy= 80%
809,8,12/14/2003,W,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Dry Channel_ No data collected
810,12,12/14/2003,W,rain,steady,clear,clear,none,none,other_algae,0,,,,70-80,,,,MAT= CL/RZ w/DT on top 100%,none,none,none,,,,,,12.5,8.6,8.0,11.42,0.09,2560,NM,0.07,0.31,0.03,20,52,565,,Canopy 70%
811,13,12/14/2003,W,showers,steady,cloudy,brown,none,other_ Leaves,other_algae,0,,,,80,,,,NM,light,5 Items_ Metal and rubber,NRT= 50%_ P= 50%,,,,,,11.3,11.5,7.4,9.26,1.90,3670,NM,1.69,0.83,0.08,134,63,1968,,
812,14,12/14/2003,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,20,,,,MAT= CL/RZ 100%,none,none,none,,,,,,12.5,11.6,7.6,9.25,0.01,1276,NM,0.005,0.09,0.03,5,5,2282,,Canopy= 95%
813,17,12/14/2003,W,showers,trickle,clear,clear,none,none,other_algae,12,,,,100,,,,FLT= EN 100% MAT= CL/RZ 100%,none,none,none,,,,,,12.0,11.9,7.6,5.94,0.18,1471,NM,0.32,0.32,0.005,31,10,512,,Canopy= 30%
814,18,12/18/2003,W,showers,intermittent,clear,clear,none,none,other_algae,0,,,,10,,,,MAT= CL/RZ 100%,light,6 Items,R= 50%_ L= 50%,,,,,,14.0,12.9,7.8,9.64,0.09,1597,NM,0.005,0.07,0.005,132,5,712,,Canopy= 70%
815,1,1/11/2004,W,clear,steady,clear,clear,none,garbage,other_algae,0,,,,84,,,,MAT= DT 100%,light,4 Items_NRT is paper,P=75% NRT=25%,,,,,,21.0,13.3,8.0,12.21,0.63,1735,NM,5.08,3.42,0.08,20,5,1515,,Canopy 5%
816,2,1/11/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,7,,,,MAT= DT 100%,none,none,none,,,,,,13.3,7.3,7.5,10.76,0.72,1453,NM,1.03,0.32,0.02,203,86,1872,,Canopy NM
817,3,1/11/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,15.0,9.4,7.6,10.32,0.04,742,NM,0.005,0.04,0.005,5,10,1017,,Canopy NM
818,5,1/11/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,17,,,,MAT= CL/RZ 100%,none,none,none,,,,,,23.0,9.1,7.7,11.18,0.65,3179,1.8,5.68,1.12,0.05,135,52,3076,,Canopy 70%
819,7,1/11/2004,W,clear,steady,clear,clear,none,garbage,other_algae,0,,,,17,,,,MAT= RZ/CL 100%,high,20% NRT= 10% sheetrock scraps_,P=80%_ NRT=20%,,,,,,28.0,10.0,7.6,8.82,1.85,2810,NM,0.75,0.41,0.08,243,389,24192,,Canopy 80%
820,8,1/11/2004,W,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Dry channel_ no data collected
821,12,1/11/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,77,,,,MAT= CL/RZ 100%,light,Two candy wrappers,NRT=100%,,,,,,10.0,7.7,7.8,11.94,1.41,1864,NM,0.005,0.23,0.04,20,10,1198,,Canopy 5%
822,13,1/11/2004,W,clear,steady,clear,clear,sewage,none,none,0,,,,none,,,,none,moderate,Garden hose,P=15% NRT=5% R=80%,,,,,,22.8,12.8,7.4,9.80,0.76,3780,NM,1.39,0.69,0.07,201,62,2755,,Canopy 50%
823,14,1/11/2004,W,clear,steady,clear,clear,none,other_leaves,other_algae,0,,,,32,,,,MAT= DT 100%,none,none,none,,,,,,20.5,12.8,7.3,9.58,0.02,1291,NM,0.005,0.05,0.005,5,5,857,,Canopy 80%
824,17,1/11/2004,W,clear,steady,clear,clear,none,garbage,other_algae,1.40,,,,86,,,,FLT= CL/RZ 100% MAT=CL/RZ 100%,light,NRT=paper,P=75% NRT=25%,,,,,,16.5,10.0,6.8,8.09,0.76,1477,NM,0.15,0.35,0.01,41,20,487,,Canopy 40%
825,18,1/11/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,9,,,,MAT= DT 100%,light,Two items total_ NRT is an aut,P= 50% NRT=50%,,,,,,19.0,13.8,7.7,8.67,0.005,1596,NM,0.005,0.13,0.01,309,5,2143,,Canopy 70%
826,1,2/8/2004,W,clear,steady,clear,clear,none,none,other_algae,1,,,,95,,,,FLT= DT 100% MAT= DT 100%,light,none,NRT=100%,,,,,,18.0,12.9,8.3,13.82,0.46,1694,NM,6.96,3.04,0.06,52,5,934,,Canopy 5% Five to ten ducks up
827,2,2/8/2004,W,clear,steady,clear,clear,none,none,other_algae,22,,,,65,,,,FLT= CL/RZ 73% DT27% MAT= CL/,none,none,none,,,,,,16.5,8.0,7.6,11.41,0.005,1438,NM,0.80,0.17,0.005,189,20,860,,Canopy 40%
828,3,2/8/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,16.5,8.5,7.7,11.34,0.005,730,NM,0.03,0.06,0.02,5,5,74,,Canopy NM CL/RZ at riffles out
829,5,2/8/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,19.5,8.6,8.1,13.13,0.44,3350,0.6,5.08,0.40,0.03,52,10,1607,,Canopy 65%
830,7,2/8/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,60,,,,MAT= CL/RZ 100%,high,Garbage from storm drain and,NRT=100%,,,,,,19.0,10.1,8.0,9.83,1.55,2900,NM,0.51,0.16,0.07,187,121,2613,,Canopy 70%
831,8,2/8/2004,W,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Dry channel no data recorded.
832,12,2/8/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,MAT= CL/RZ with DT on top 100%,none,none,none,,,,,,18.8,9.2,8.2,12.22,0.97,1830,NM,0.01,0.18,0.04,5,5,605,,Canopy 5%
833,13,2/8/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,29,,,,MAT= CL/RZ 100%,light,Three items,NRT=33% P=67%,,,,,,19.0,12.3,7.4,10.08,1.22,3660,NM,1.30,0.58,0.04,216,63,3654,,Canopy 100%

834,14,2/8/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,29,,,,MAT= CL/RZ with DT on top 100%,none,none,none,,,,,,20.0,13.5,7.9,9.55,0.01,1262,0.1,0.005,0.08,0.01,10,5,771,,Canopy 80%
835,17,2/8/2004,W,clear,steady,clear,clear,none,garbage,other_algae,0,,,,93,,,,MAT= RZ/CL 100%,light,Washed onto brush,P= 100%,,,,,,16.3,10.7,7.6,8.74,0.53,1413,NM,0.10,0.20,0.07,74,41,880,,Canopy 40%
836,18,2/8/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,moderate,12 Items including car_and_was,NRT=25% P=5% R=20% L= 50%,,,,,,20.0,13.3,8.2,9.33,0.02,1528,NM,0.005,0.13,0.005,146,5,860,,Canopy 60% Lots of large dried
837,1,3/7/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,90,,,,MAT= DT100%,light,Large items are 5 concrete sla,L=100%,,,,,,24.0,17.0,8.1,11.68,1.40,1473,NM,5.44,2.76,0.08,31,97,2755,,Canopy 1% Arizona Crossing is
838,2,3/7/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,Two items. NRT is a copper pla,NRT= 50% P= 50%,,,,,,23.5,12.1,7.8,10.29,0.36,1348,NM,1.79,0.32,0.14,63,341,2481,,Canopy 40% Lots of sedimentati
840,3,3/7/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,26.0,12.2,7.6,10.19,0.06, 688,NM,0.04,0.10,0.05,10,5,240,,Sediment/sand collapsed into s
841,5,3/7/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,Approx 6 items_ tennis balls_,NRT= 100%,,,,,,24.0,13.7,8.1,9.96,1.38,2502,3.7,4.18,0.49,0.05,74,98,2851,,Sediment has built up on right
842,7,3/7/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,88,,,,MAT= CL/RZ 100%,high,More than 300 items,Plastics= 75% R= 10% L=10% NRT,,,,,,28.5,13.8,7.8,11.06,1.83,2760,NM,0.64,0.17,0.02,233,187,17329,,Canopy 60%
843,8,3/7/2004,W,clear,intermittent,clear,clear,none,garbage,none,0,,,,none,,,,none,light,Two half-eaten apples,O= 100%,,,,,,27.0,13.4,7.0,NM,0.20,2210,NM,0.05,0.19,0.08,5,5,480,,Canopy 85%
844,12,3/7/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,36,,,,MAT= CL/RZ 100%,none,none,none,,,,,,25.5,13.4,8.3,10.24,2.60,1300,NM,0.03,0.09,0.07,5,5,404,,Canopy 10% Rocks only partiall
845,13,3/7/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,11,,,,MAT= DM 90% DT 10%,light,none,P=100%,,,,,,28.5,16.0,7.5,10.75,1.13,3625,NM,0.84,0.60,0.14,262,547,6131,,Canopy 40%
846,14,3/7/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,30.0,16.8,7.7,9.30,0.01, 1196,NM,0.19,0.13,0.04,31,5,627,,Recent storms scoured algae. F
847,17,3/7/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,5,,,,MAT= CL/RZ 100%,moderate,none,P= 75% R= 15% NRT= 10%,,,,,,26.5,14.0,7.2,9.45,1.67,961,NM,0.37,0.14,0.06,41,52,1723,,Canopy 5%. Lots of floating co
848,18,3/7/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,moderate,Approx 20 items. Car piece and,NRT= 95% L= 5%,,,,,,25.5,17.9,8.2,9.31,0.06,1319,NM,0.02,0.17,0.04,98,20,1860,,Canopy 40% One frog
849,1,4/4/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,15,,,,MAT= CL/RZ 34%_ DT 66%,light,Approx. 3 items_ orange traffi,P=100%,,,,,,19.5,17.5,8.0,12.53,0.35,1670,NM,3.08,2.78,0.04,5,10,1850,,Canopy 5%
850,2,4/4/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,1,,,,CL/RZ= 100%,none,none,none,,,,,,17.0,13.7,7.7,9.47,0.005,1350,NM,1.29,0.22,0.03,393,448,1723,,Canopy 15%
851,3,4/4/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,19.5,13.3,7.6,9.03,0.005, 721,NM,0.005,0.07,0.005,5,5,221,,Canopy 40% Four newts
852,5,4/4/2004,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,Shoes_ribbon_tennis ball,NRT= 100%,,,,,,20.5,14.5,8.2,9.94,0.74,3254,1.5,4.24,0.46,0.04,95,98,4352,,Canopy 85%
853,7,4/4/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,97,,,,MAT= RZ/CL 100%,high,Large items are concrete,P=45%_NRT_45%_L=10%,,,,,,19.7,15.6,7.7,7.54,1.55,2880,NM,0.44,0.37,0.15,173,480,24193,,Canopy 95%
854,12,4/4/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,68,,,,MAT= CL/RZ 100%,none,none,none,,,,,,19.3,16.2,8.3,9.25,0.78,1824,NM,0.02,0.29,0.005,52,20,2613,,Canopy 40%
855,13,4/4/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,37,,,,MAT= CL/RZ with diatoms 100%,light,1 plastic bottle_ 2 plastic ba,P= 50%_ NRT= 50%,,,,,,20.5,16.8,7.4,8.12,1.12,3540,NM,0.95,0.65,0.05,262,175,15531,,Canopy 60% crayfish present
856,14,4/4/2004,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,20,,,,MAT= CL/RZ with diatoms 100%,none,none,none,,,,,,17.8,14.9,7.5,9.44,0.005,1234,0.1,0.03,0.04,0.005,31,10,441,,Canopy 90% 1 California Newt_1
857,17,4/4/2004,W,clear,steady,clear,clear,none,none,other_algae,0,,,,84,,,,MAT= CL/RZ 100%,none,none,none,,,,,,19.7,16.0,7.0,6.53,0.13,1085,NM,0.23,0.31,0.03,52,63,4884,,Canopy 75%
858,18,4/4/2004,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,Approx. 10 items,NRT=25%_ R=25%_L= 50%,,,,,,17.8,16.5,8.3,9.65,0.15,1508,NM,0.01,0.12,0.005,265,5,4352,,Canopy 65%
859,8,4/4/2004,W,clear,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM, NM,NM,NM,NM,NM,NM,,No surface flow in channel_ no

860,1,5/2/2004,D,clear,steady,clear,clear,none,none,other_algae,7,,,,30,,,,MAT=RZ/CL75% EN25% FLT=EN100%,light,Paper Towel,NRT=100%,,,,,,32.0,20.2,7.8,14.33,0.50,1861,NM,0.21,1.21,0.05,10,41,1354,,Canopy 10% 15-20 Bullfrog Tadp
861,2,5/2/2004,D,clear,steady,clear,clear,none,none,none,0,,,,43,,,,MAT=CL/RZ100%,light,Approx. 2 items= 1 cigarette 1,NRT=100%,,,,,,22.0,15.0,7.7,9.63,0.03,1397,NM,0.97,0.23,0.01,169,292,2247,,Canopy 95%
862,3,5/2/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,2,,,,DT,none,none,none,,,,,,32.0,16.1,7.5,8.75,0.005,728,NM,0.01,0.10,0.02,95,5,4611,,Canopy 70%
863,5,5/2/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,11,,,,MAT=CLRZ93% EN7%,none,none,none,,,,,,31.0,16.8,8.2,12.08,0.20,3264,1.1,3.78,0.52,0.02,86,161,4611,,Canopy 75% Butterflies_Sedimen
864,7,5/2/2004,D,clear,steady,clear_cloudy,clear,none,none,other_algae,0,,,,66,,,,MAT=CL/RZ w/ DT,moderate,Approx. 20 Items Candy wrap,P=80%_NRT=10%_RT=10%,,,,,,26.0,17.1,7.5,7.60,3.47,2960,NM,0.61,0.56,0.27,98,246,3873,,Canopy 80%
865,12,5/2/2004,D,clear,steady,clear,clear,none,garbage,other_algae,2,,,,100,,,,FLT=EN100% _MAT=CLRZ98%_EN2%,light,1 Item= Baby Bottle,P=100%,,,,,,27.3,19.6,8.4,10.00,0.03,1974,NM,0.01,0.27,0.07,31,63,8664,,Canopy 45% Tadpoles_Butterflie
866,13,5/2/2004,D,clear,steady,milky,gray,none,none,other_algae,0,,,,7,,,,MAT=CL/RZ w/ DT 100%,light,Approx. 6 Items = 2 Plastic wr,NRT=100%,,,,,,35.0,18.8,7.4,8.69,1.85,3800,NM,1.00,0.78,0.06,148,74,11198,,Canopy 80%
867,14,5/2/2004,D,clear,steady,clear,clear,none,Other_leaves_flowers,none,0,,,,5,,,,MAT=DT100%,none,none,none,,,,,,26.5,16.5,7.6,8.19,0.04,1292,0.0,0.01,0.04,0.01,10,10,2602,,Canopy 80% Over ten tree frogs
868,17,5/2/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,MAT=CL/RZ100%,light,Approx. 5 Items,P=100%,,,,,,32.5,18.3,7.0,7.66,0.005,1203,NM,0.06,0.31,0.03,63,74,2909,,Canopy 50%
869,18,5/2/2004,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,Beer bottles off the highway a,none,,,,,,25.5,20.4,8.3,9.73,0.42,1593,NM,0.01,0.12,0.07,30,20,1050,,Canopy 90% Wierd Bug w/ wings
870,8,5/2/2004,D,clear,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Dry
871,1,6/6/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,95,,,,MAT= DT 95% CL/RZ 5%,none,none,none,,,,,,20.5,21.9,8.6,15.10,0.51,2155,NM,0.01,1.35,0.01,10,41,24192,,Canopy 5%
872,2,6/6/2004,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,13,,,,MAT= CL/RZ 100%,none,none,none,,,,,,19.0,16.7,7.6,7.90,0.13,1401,NM,0.79,0.33,0.02,156,109,3076,,Canopy 40-50% Watercress along
873,3,6/6/2004,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,21.5,17.5,7.6,7.75,0.005,722,NM,0.01,0.06,0.01,41,5,1793,,none
874,5,6/6/2004,D,clear,steady,clear,clear,none,none,other_algae,13,,,,75,,,,FLT= EN 100% CL/RZ= 100%,none,none,none,,,,,,23.0,17.9,8.3,10.93,0.25,3244,1.2,3.08,0.41,0.03,52,51,8664,,Canopy 80% Lots of treefrog ta
875,7,6/6/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,94,,,,MAT= CL/RZ 100%,moderate,none,P= 20% R=80%,,,,,,24.5,20.3,8.1,7.96,1.75,2870,NM,0.58,0.53,0.13,481,240,24193,,Canopy 60%
876,12,6/6/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,MAT= CL/RZ w/DT 100%,light,10 Items,NRT= 80% P=20%,,,,,,22.0,21.1,8.1,7.27,0.74,2194,NM,0.005,0.22,0.05,41,10,24193,,Canopy 40-50% Lots of Crayfish
877,13,6/6/2004,D,clear,steady,milky,gray,other_fishy,none,other_algae,0,,,,21,,,,MAT= CL/RZ w/DT 100%,light,2 Items= 1 plastic bottle 1,P=50% NRT=50%,,,,,,25.5,19.6,7.4,7.17,2.20,3540,NM,1.05,0.86,0.10,382,86,24193,,Canopy 70%
879,14,6/6/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,2,,,,MAT= DT 100%,none,none,none,,,,,,20.5,16.8,7.8,8.44,0.01,1278,0.1,0.01,0.05,0.01,31,31,1576,,Tree frog tadpoles 10+
880,17,6/6/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,99,,,,MAT= CL/RZ 100%,none,none,none,,,,,,25.0,20.8,7.7,11.42,0.31,1339,NM,0.08,0.27,0.01,132,108,11198,,Canopy 50%
882,18,6/6/2004,D,clear,steady,clear,clear,none,other_watercress,other_algae,8,,,,8,,,,FLT= EN 100% MAT= CL/RX 100,moderate,12 Items,R=80% NRT= 20%,,,,,,23.0,19.9,8.4,9.67,0.005,1594,NM,0.01,0.09,0.01,41,10,909,,80% Plant growth has obscured
883,1,7/15/2004,D,overcast,steady,clear,clear,none,none,other_algae,26,,,,90,,,,FLT= DT 14% CL/RZ w/DT 86%,none,none,none,,,,,,27.0,24.6,8.4,13.50,0.14,1950,NM,0.01,1.48,0.01,62,5,2489,,Canopy 40% Measured at upstrea
884,2,7/15/2004,D,overcast,trickle,clear,clear,none,none,none,0,,,,none,,,,none,light,1 Item,NRT= 100%,,,,,,23.8,17.7,7.8,5.67,0.07,1406,NM,0.34,0.37,0.01,419,552,3076,,none

885,3,7/15/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,1,,,,MAT= SP 100%,none,none,none,,,,,,29.0,18.7,8.0,8.23,0.01,725,NM,0.01,0.07,0.01,41,31,1785,,none
886,5,7/15/2004,D,clear,steady,clear,clear,none,garbage,other_algae,5,,,,85,,,,FLT= EN 100% MAT= CL/RZ w/DT,light,1 Item- 1 styrofoam food conta,NRT= 100%,,,,,,24.0,17.3,8.2,10.70,0.10,3460,0.0,2.80,0.39,0.01,272,119,3282,,Canopy 85%
887,7,7/15/2004,D,clear,steady,milky,gray,none,none,other_algae,0,,,,64,,,,MAT= CL/RZ w/ DT 100%,moderate,40 Items,NRT=80% O=10% P=10%,,,,,,26.5,19.9,7.9,6.78,3.18,3045,NM,0.59,0.58,0.10,249,410,24193,,Canopy 90-100%
888,12,7/15/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,MAT= DT 100%,none,none,none,,,,,,29.0,23.4,8.2,11.89,0.51,2325,NM,0.01,0.17,0.01,30,5,19863,,Canopy 80-90% Analyzed at the
889,13,7/15/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,76,,,,MAT= DT 100%,light,10 Items,NRT= 34% P=33% R=33%,,,,,,30.3,19.9,7.7,8.29,2.42,3530,NM,1.29,0.96,0.08,382,231,15531,,Canopy 92% Crayfish more than
890,14,7/15/2004,D,clear,steady,clear,clear,none,other_leaves,none,0,,,,none,,,,none,light,1 Item- Water bottle,P= 100%,,,,,,28.0,17.5,8.0,8.74,0.19,1314,0.1,0.01,0.07,0.04,20,10,907,,Canopy 80% Pacific tree frog
891,17,7/15/2004,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,94,,,,MAT= CL/RZ 100%,light,1 Item = plastic bag,P=100%,,,,,,26.0,19.5,7.4,8.04,0.81,1388,NM,0.01,0.26,0.01,160,1935,5172,,Canopy 70-80%
892,18,7/15/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,15,,,,MAT= CL/RZ 90% CH 10%,none,none,none,,,,,,24.5,19.5,8.3,10.46,0.55,1546,NM,0.02,0.08,0.01,275,10,1354,,10+ Pacific tree frogs w/limbs
893,1,8/8/2004,D,clear,intermittent,clear,clear,none_other_sulfur,none,other_algae_duckweed,0,,,,95,,,,RZ/CL with DT 100%,none,none,none,,,,,,23.0,19.5,7.3,2.81,1.50,1869,NM,0.22,1.33,0.04,20,20,7701,,Canopy 40% Data collected US o
894,2,8/8/2004,D,clear,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Dry channel. No data recorded.
895,3,8/8/2004,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,31.0,19.3,7.9,7.88,0.19,718,NM,0.01,0.08,0.01,74,74,1483,,
896,5,8/8/2004,D,clear,steady,clear,clear,none,none,other_algae_leaves,3,,,,93,,,,FLT=EN 100% MAT=CL/RZ with DT,light,2 items,NRT 100%,,,,,,30.0,18.1,8.0,11.03,0.54,3375,0.9,3.14,0.49,0.04,134,62,8664,,Canopy 80-90% 1 tree frog and
897,7,8/8/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,93,,,,MAT=DT 100%,light,none,NRT=90% R=10%,,,,,,29.5,19.9,7.9,6.98,0.22,2970,NM,0.65,0.57,0.13,160,119,24193,,Canopy 90-100% Palm trees and
898,12,8/8/2004,D,clear,intermittent,clear,clear,none,none,other_algae,0,,,,68,,,,MAT=RZ/CL with DT 100%,light,1 item,P=100%,,,,,,29.0,20.9,7.7,6.47,0.46,2335,NM,0.005,0.04,0.06,63,10,24193,,Canopy 70-80% 10+ tree frogs &
899,13,8/8/2004,D,clear,trickle,cloudy,gray,none,none,other_algae,0,,,,84,,,,MAT=DT 100%,none,none,none,,,,,,34.0,20.1,7.6,7.75,1.55,3395,NM,1.03,0.77,0.07,120,419,14136,,Canopy 60-80%
900,14,8/8/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,2,,,,MAT=CL/RZ100%,light,1 item,P=100%,,,,,,20.5,17.4,7.8,8.30,0.09,1305,0.1,0.02,0.09,0.03,85,63,1137,,Canopy 90-100%
901,17,8/8/2004,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,34,,,,MAT=SP100%,light,none,NRT 100%,,,,,,31.0,20.8,7.2,2.17,0.44,1390,NM,0.02,0.34,0.03,10,31,3255,,Data collected in pool upstrea
902,18,8/8/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,16,,,,MAT=CL/RZ with DT 100%,light,6 items,NRT=67% R=33%,,,,,,22.0,19.3,8.2,9.28,0.30,1557,NM,0.005,0.08,0.005,155,52,805,,Canopy 70-80% Tree frogs and t
903,1,9/12/2004,D,clear,intermittent,clear,clear,musty_other_decaying_algae,none,other_algae,16,,,,46,,,,FLT=EN100% MAT=SP75% RZ/CL25%,light,15 items: cans napkins paintba,NRT=60% R=40%,,,,,,26.5,24.3,7.8,11.04,2.62,2270,NM,0.01,1.68,0.11,5,5,24193,,Canopy 10-20%. 100+ arroyo chu
904,3,9/12/2004,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,26.0,18.4,7.8,7.65,0.005,720,NM,0.005,0.10,0.09,41,41,2014,,Canopy 60%
905,5,9/12/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,95,,,,MAT=CL/RZ with DT100%,none,none,none,,,,,,29.0,18.1,8.1,NM,0.55,3460,1.2,2.26,0.50,0.06,240,143,10462,,Canopy 90%
906,7,9/12/2004,D,clear,steady,cloudy,gray,musty,garbage,other_algae,0,,,,84,,,,MAT=RZ/CL 100%,moderate,12 items,P=50% R=50%,,,,,,25.0,20.4,7.8,6.00,2.08,2970,NM,0.60,0.68,0.14,120,81,17329,,Canopy 90%
907,12,9/12/2004,D,clear,intermittent,clear,clear,musty,none,none,0,,,,none,,,,none,light,2 items,NRT 100%,,,,,,28.0,20.2,7.7,5.88,1.23,2370,NM,0.07,0.23,0.21,10,5,24193,,Canopy 90%
908,13,9/12/2004,D,clear,steady,cloudy,gray_other_whitish,musty_other_chemical,none,other_algae,0,,,,65,,,,MAT= CL/RZ 90% DT 10%,moderate,13 items,P=20% NRT=

80%,,,,,,30.0,19.8,7.4,9.21,1.73,3740,NM,1.05,1.06,0.16,583,480,24193,,Canopy 90%
909,14,9/12/2004,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,1,,,,MAT= DT
100%,none,none,none,,,,,,24.0,18.3,7.8,7.23,0.02,1344,0.0,0.005,0.08,0.07,74,5,1211,,Canopy 95% Whitish film where
910,18,9/12/2004,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,46,,,,MAT= RZ/CL95% CH5%,high,~100
items,L=75% NRT=20% R=5%,,,,,,25.0,19.5,8.2,10.00,0.20,1509,NM,0.02,0.12,0.07,143,5,1246,,Canopy 70-80%
911,2,9/12/2004,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Dry channel No data recorded
912,8,9/12/2004,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,Dry channel No data recorded
913,17,9/12/2004,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,N
M,NM,NM,NM,NM,NM,NM,,No surface flow between pools.
973,1,11/7/2004,D,showers,steady,clear,clear,none,none,other_algae,5,,,,50-60,,,,FLT = DT 100% MAT = RZ/CL
w/,light,1 item = Glass beer bottle,R = 100%,,,,,,18.0,15.0,8.2,11.73,1.90,1965,NM,0.98,1.21,0.05,10,31,4352,,Canopy
10% Cape Ivy on the ups
974,2,11/7/2004,D,rain,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,10 items,P= 90% NRT=
10%,,,,,,12.0,12.0,8.1,7.46,0.25,1505,NM,1.19,0.36,0.03,86,63,2489,,Canopy 60-70% Extensive sedime
975,3,11/7/2004,D,rain,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,13.5,11.7,8.2,9.60,0.25,7
54,NM,0.02,0.06,0.01,5,10,601,,Canopy 60%
976,5,11/7/2004,D,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,diatoms less than a dime
thick,none,none,none,,,,,,13.0,10.8,8.1,9.51,1.40,3650,2.4,4.88,0.77,0.06,419,121,11198,,Canopy 80-90%
977,7,11/7/2004,D,showers,steady,clear,clear,rotten_eggs,none,none,0,,,,none,,,,none,high,~50 items,P 95% NRT 4% R
1%,,,,,,13.0,12.9,7.9,8.16,2.40,2880,NM,0.61,0.30,0.10,317,354,11198,,Canopy 70% Small amounts of DF
979,12,11/7/2004,D,showers,steady,clear,clear,none,none,other_algae,0,,,,100,,,,CL/RZ w/DT =
100%,none,none,none,,,,,,13.0,12.3,8.1,9.15,1.30,1693,NM,0.12,0.36,0.06,5,10,1313,,Canopy 30%
980,13,11/7/2004,D,overcast,steady,clear,clear,musty,other_leaves,other_algae,0,,,,14,,,,MAT= RZ/CL 77% DT
23%,moderate,~50 items,P=70% NRT=
30%,,,,,,13.7,14.0,7.6,8.84,1.40,3320,NM,1.13,0.70,0.06,278,10462,119,,Canopy 80-90%
981,14,11/7/2004,D,showers,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,15.0,13.9,7.8,8.26,0.
06,1362,0.6,0.01,0.08,0.02,31,5,933,,Canopy 90% Pacific tree frog.
982,17,11/7/2004,D,showers,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,2
items,NRT=100%,,,,,,14.2,14.0,7.2,6.87,0.45,1391,NM,0.36,0.34,0.04,109,63,2489,,Canopy 70% Algae scoured by re
983,18,11/7/2004,D,showers,steady,clear,clear,none,none,other_algae,0,,,,34,,,,MAT = RZ/CL 84% CH
16%,light,none,L= 90% NRT= 10%,,,,,,16.0,14.6,8.1,9.17,0.09,1596,NM,0.005,0.10,0.03,31,30,1014,,Canopy 70%
984,1,10/3/2004,D,overcast,steady,clear,clear,none,garbage,other_algae,22,,,,30,,,,FLT= EN100% MAT =
SP100%,none,none,none,,,,,,20.0,19.2,7.6,6.94,1.20,2390,NM,0.06,1.81,0.12,20,20,24192,,Canopy 15%
985,2,10/3/2004,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,
NM,NM,NM,NM,NM,NM,,NM
986,3,10/3/2004,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,20.5,15.7,8.0,12.51,0.01,
719,NM,0.005,0.005,0.005,10,10,650,,Canopy 60%
987,5,10/3/2004,D,clear,steady,clear,clear,none,none,other_algae_duckweed,0,,,,96,,,,MT =
RZ/CL100%,none,none,none,,,,,,23.5,14.9,8.1,10.38,0.02,3520,1.3,2.72,0.51,0.03,158,259,2613,,Canopy 90-95%
988,7,10/3/2004,D,clear,steady,clear,yellow,none,none,other_algae,0,,,,87,,,,MT= RZ/CL w/DT 100%,light,5
items,NRT=100%,,,,,,20.5,17.3,7.9,6.66,5.20,3140,NM,0.44,0.38,0.12,317,134,14136,,Canopy 80-90%
989,12,10/3/2004,D,clear,steady,clear,clear,none,none,other_algae,0,,,,1,,,,MT= RZ/CL100%,light,2 items - plastic
bottle and f,P= 50% NRT= 50%,,,,,,21.5,17.6,8.1,8.38,0.19,2510,NM,0.03,0.36,0.06,399,5,6131,,Canopy 75-80%
990,13,10/3/2004,D,clear,steady,cloudy,clear,musty,other_chemical overtones,other_algae,0,,,,39,,,,MT= RZ/CL89%
DT11%,light,1 item,NRT=100%,,,,,,24.5,17.6,7.5,10.16,1.45,3610,NM,1.04,1.05,0.10,,413,14136,,Canopy 80-90%
991,14,10/3/2004,D,overcast,trickle,clear,clear,none,none,other_algae,0,,,,1,,,,MT=DT100%,none,none,none,,,,,,17.5,15
.7,7.8,7.05,0.72,1389,0.1,0.005,0.06,0.02,41,41,2723,,none
992,17,10/3/2004,D,NM,none,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,N
M,NM,NM,NM,NM,NM,NM,,Stream is dry
993,18,10/3/2004,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,81,,,,MT= RZ/CL 100%,moderate,none,NRT
=90% L=9% R=1%,,,,,,18.5,16.8,8.1,13.28,0.01,1553,NM,0.005,0.11,0.005,86,30,1246,,Canopy 60%
994,1,12/5/2004,W,rain,steady,cloudy,gray,none,none,other_algae,0,,,,30-40,,,,MAT= CLRZ 90% SP

10%,none,none,none,,,,,,10.0,12.5,7.9,9.66,3.17,1681,NM,4.14,2.84,0.09,52,10,2909,,Boulder rip-rap still visible
995,1,2/13/2005,W,overcast,steady,muddy,brown_green,none,none,none,NM,,,,NM,,,,NM- could not see bottom of ch,light,2 Items - Candy bar wrapper,P=50% NRT=
50%,,,,,,18.5,15.5,8.5,11.94,7.10,1187,NM,1.94,0.71,0.12,85,327,14136,,Five ducks upstream
996,2,2/13/2005,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,17.0,13.4,8.3,9.82,2.18,1058,NM,1.44,0.21,0.07,63,41,2602,,Lots of sediment
997,3,2/13/2005,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,15.0,12.6,8.3,9.23,2.75,473,NM,0.06,0.07,0.08,5,5,591,,none
998,5,2/13/2005,W,overcast,steady,muddy,clear,none,none,other_algae,0,,,,12.8,,,,Mat= CL/RZ 100%,moderate,12 Items,NRT=80% P=15% L=5%,,,,,,18.0,14.1,8.2,9.91,6.30,2640,22.4,2.88,0.57,0.18,309,738,14136,,Canopy 90%
999,7,2/13/2005,W,overcast,steady,clear,clear,sewage,none,other_algae,0,,,,44,,,,Mat = CL/RZ 100%,high,Over 100 Items,P=70% R=20% NRT=10%,,,,,,16.5,14.7,7.6,10.63,5.20,2245,NM,1.20,0.39,0.13,959,1137,15531,,Canopy 70-80%
1000,12,2/13/2005,W,overcast,steady,muddy,clear,none,none,none,0,,,,NM,,,,Obscured by high flows,light,1 Item,NRT=100%,,,,,,17.0,14.0,8.3,10.24,7.80,903,NM,0.50,0.27,0.34,146,213,4106,,Canopy 25-35%
1001,13,2/13/2005,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,1,,,,Mat=CL/RZ 100%,light,"3 Items - Plastic bag, pipe an",NRT=66% L=34%,,,,,,17.0,14.0,8.0,9.32,3.30,2650,NM,0.85,0.67,0.18,246,246,4106,,CL/RZ at riffle NW of pool
1002,14,2/13/2005,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,1 Item - PVC Pipe,P=100%,,,,,,16.5,14.1,8.3,9.77,3.20,667,3.0,1.01,0.06,0.11,10,10,156,,Canopy 80-90% 1 CA Newt
1003,17,2/13/2005,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,none,R=100%,,,,,,17.5,14.4,7.8,9.44,3.13,781,NM,0.67,0.25,0.17,51,379,2187,,Site has cleared out due to re
1004,18,2/13/2005,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,none,NRT=100%,,,,,,18.0,16.1,8.4,10.68,0.28,1381,NM,0.01,0.09,0.07,20,5,288,,Canopy 60%
1005,1,3/6/2005,W,clear,steady,muddy,brown_green,none,none,other_algae,0,,,,37,,,,Mat= CL/RZ w/DT 100%,none,none,none,,,,,,17.5,16.3,8.4,10.38,4.90,1339,NM,1.85,0.61,0.05,10,63,2613,,Canopy 15% Rip Rap added to do
1007,2,3/6/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,moderate,1 Item,P=100%,,,,,,18.0,15.0,8.2,10.22,1.40,1077,NM,1.63,0.18,0.005,74,169,583,,50-60%
1008,3,3/6/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,21.0,14.5,8.3,9.19,3.40,554,NM,0.27,0.02,0.005,5,10,285,,Canopy 80%
1009,5,3/6/2005,W,clear,steady,clear,clear,none,none,other_algae,0,,,,11,,,,Mat=CL/RZ 100%,light,10 Items,NRT=100%,,,,,,22.5,14.7,8.1,10.28,5.00,3060,30.4,3.30,0.45,0.04,74,63,2909,,Canopy 90%
1011,7,3/6/2005,W,clear,steady,clear,clear,none,other_leaves,other_algae,0,,,,30,,,,Mat=CL/RZ 100%,high,"Over 100 Items- 4 tires, golf",NRT=40% R=25% L=25%
P=10%,,,,,,22.0,16.8,8.2,11.87,2.50,2740,NM,1.07,0.15,0.01,74,211,11198,,Canopy 60-70%
1012,12,3/6/2005,W,clear,steady,cloudy,clear,none,none,none,0,,,,NM,,,,bottom obscured,light,3 Items,NRT=100%,,,,,,19.5,15.2,8.3,10.38,5.70,1109,NM,0.86,0.30,0.07,52,86,2282,,Canopy 40-50%
1013,13,3/6/2005,W,clear,steady,clear,clear,other_weird_smell,none,other_algae,0,,,,1.70,,,,Mat= DT85% CL/RZ 15%,moderate,none,P=75% NRT=25%,,,,,,24.5,16.6,8.0,9.30,2.20,3140,NM,2.96,0.61,0.07,41,84,2755,,Almost all CL/RZ in riffle
1014,14,3/6/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,1 Item- electrical extension,NRT=100%,,,,,,16.0,14.2,8.2,10.16,0.58,872,5.1,1.58,0.005,0.005,5,20,243,,Canopy 80-90%
1015,17,3/6/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,"2 Items- Tire, rusted metal",L=100%,,,,,,19.0,15.7,7.9,9.88,4.08,691,NM,0.74,0.33,0.02,52,530,1421,,none
1016,18,3/6/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,20.0,16.1,8.4,10.43,1.14,1281,NM,0.59,0.20,0.005,30,31,3654,,none
1018,1,4/3/2005,W,overcast,steady,clear,brown_green,none,none,other_algae,5,,,,33,,,,Flt=EN100% Mat=CL/RZ w/DT100%,light,Broken glass from
alchohal,R=100%,,,,,,18.0,15.4,8.5,11.29,1.29,1483,NM,2.26,1.25,0.08,5,10,2014,,Canopy 15% Rip rap unburied.
1019,2,4/3/2005,W,overcast,steady,clear,clear,none,none,other_algae,0,,,,3,,,,Mat=CL/RZ 100%,light,3 Items,NRT=100%,,,,,,16.0,11.9,8.2,9.74,0.59,1112,NM,1.20,0.12,0.05,41,110,744,,Canopy 70%
1020,3,4/3/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,16.5,13.6,8.3,9.49,1.30,616,NM,0.15,0.04,0.005,10,10,187,,none

1021,5,4/3/2005,W,clear,steady,clear,clear,none,none,other_algae,0,,,,39,,,,Mat=CL/RZ 100%,moderate,11 Items,NRT=100%,,,,,,16.0,13.7,8.1,10.12,0.76,3100,12.9,3.62,0.37,0.06,86,146,3873,,Canopy 90-100% Some sediment i
1022,7,4/3/2005,W,clear,steady,clear,clear,none,none,other_algae,0,,,,73,,,,RZ/CL 100%,moderate,40-50 Items,P=50% NRT=40% R=10%,,,,,,16.0,13.9,8.2,10.06,1.05,3070,NM,0.85,0.14,0.08,98,173,4106,,Canopy 70-80%
1023,12,4/3/2005,W,clear,steady,clear,clear,none,none,other_algae,0,,,,85,,,,Mat = CL/RZ 100%,light,3 Items,NRT=100%,,,,,,15.5,15.7,8.4,9.67,1.01,1449,NM,0.005,0.10,0.07,10,5,213,,Canopy 20-25%
1024,13,4/3/2005,W,clear,steady,clear,clear,none,none_other_some bubbles on surface,other_algae,0,,,,23,,,,Mat=CL/RZ 100%,light,none,P=50% NRT=50%,,,,,,19.0,13.6,7.9,9.96,0.83,3360,NM,1.80,0.33,0.14,52,158,1467,,none
1025,14,4/3/2005,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,15.0,14.0,8.3,9.82,0.08,1010,2.8,2.70,0.01,0.06,10,20,556,,Canopy 85%
1026,17,4/3/2005,W,clear,steady,clear,clear,none,none,other_algae,0,,,,20,,,,Mat=CL/RZ 80% DT 20%,light,2 Items = cables,L= 100%,,,,,,18.0,16.6,7.9,9.14,0.35,857,NM,0.46,0.32,0.12,10,41,432,,Canopy 25%
1027,18,4/3/2005,W,clear,steady,clear,clear,none,none,other_algae,0,,,,11,,,,Mat=EN100%,none,none,none,,,,,,17.5,15.9,8.3,9.92,0.005,1550,NM,0.05,0.09,0.06,20,20,441,,Canopy 5-10%
1028,2,9/7/2003,D,clear,trickle,clear,clear,none,none _other_whitish film,other_algae,0,,,,10,,,,Mat=DT100%,light,7 Items - plastic bag filled w,R=80% P=20%,,,,,,24.0,18.2,7.7,7.40,0.72,1360,NM,0.30,0.38,0.03,521,20,5794,,none
1029,3,9/7/2003,D,clear,steady,clear,clear,none,none,other_algae,0,,,,10,,,,Mat=CL/RZ 100%,none,none,none,,,,,,27.0,20.8,7.7,7.67,0.26,720,NM,0.04,0.09,0.005,86,31,670,,Leaves (mainly live oak) have
1030,4,9/7/2003,D,clear,steady,milky,green,none,none,other_algae,0,,,,100,,,,Mat= CL/RZ w/DT100%,none,none,none,,,,,,31.0,25.3,8.0,9.24,6.40,2680,NM,0.03,0.74,0.12,10,10,24192,,Canopy 20-30%
1031,9,9/7/2003,D,clear,trickle,clear,clear,none,other_thin milky film,other_algae_leaves_sticks,0,,,,100,,,,Mat=CH w/DT 100%,none,none,none,,,,,,31.0,18.0,7.2,2.92,1.30,3175,NM,0.02,0.81,0.005,369,213,1860,,none
1032,11,9/7/2003,D,clear,trickle,clear,clear,none,none,other_algae_whitish sheem,0,,,,53,,,,Mat= CH66% DT20% CL/RZ14%,none,none,none,,,,,,30.0,19.1,7.7,5.84,0.44,1367,NM,0.01,0.19,0.01,161,201,3255,,Canopy 60-70% Spearmint growin
1033,13,9/7/2003,D,clear,trickle,clear,clear,sewage_musty,none,other_algae,0,,,,92,,,,Mat= DT 100%,light,none,P=100%,,,,,,28.0,19.8,7.3,6.50,1.30,3530,NM,1.73,0.93,0.13,521,211,24192,,none
1034,14,9/7/2003,D,clear,steady,clear,clear,none,none,other_leaves,0,,,,none,,,,NM,light,1 Item,P=100%,,,,,,27.5,19.2,7.6,9.44,0.03,1215,NM,0.10,0.06,0.03,132,52,2613,,Canopy 80-90%
1035,16,9/7/2003,D,clear,steady,clear,clear,none,garbage,other_algae,4,,,,62,,,,Flt=RZ/CL100% Mat=DT89% RZ/,light,none,P=50% NRT=40% R=10%,,,,,,27.0,18.3,7.5,7.63,0.05,1615,NM,0.46,0.36,0.06,368,238,3654,,Canopy 60-70%
1036,1,9/9/2003,D,overcast,steady,clear,clear,musty,none,other_algae,0,,,,100,,,,Mat= EN w/DT100%,none,none,none,,,,,,25.0,22.6,8.1,14.32,0.01,1858,NM,0.01,1.62,0.005,10,5,4611,,Canopy 0-10%
1037,5,9/7/2003,D,clear,steady,clear,clear,none,other_leaves,other_algae,0,,,,73,,,,Mat=CL/RZw/DT88% DT12%,none,none,none,,,,,,21.5,17.2,7.8,103.50,1.10,3430,1.7,3.90,0.36,0.03,246,134,7270,,Canopy 80-90%
1038,7,9/9/2003,D,overcast,steady,clear,clear,rotten_eggs,none,other_algae_duckweed,0,,,,82.70,,,,Mat=CL/RZ44% DT56%,high,"Over 100 Items- Beer cans, new",NRT=50% R=25% P=15% L=10%,,,,,,22.5,19.5,7.7,7.09,1.18,3130,3.5,1.15,0.52,0.21,620,738,24193,,Canopy 70-80%
1039,12,9/9/2003,D,clear,steady,clear,clear,rotten_eggs,garbage,other_algae,0,,,,93,,,,Mat=CL/RZ w/DT 100%,light,2 Items,NRT=100%,,,,,,23.0,22.2,8.0,10.17,0.29,1915,NM,0.07,0.43,0.04,5,14136,10,,Canopy 70-80%
1040,17,9/9/2003,D,overcast,steady,clear,clear,none,none,other_algae_duckweed,12.60,,,,100,,,,Flt= RZ/CL 100% Mat= RZ/CL 6,none,none,none,,,,,,22.8,19.5,6.8,6.15,0.005,1323,NM,0.12,0.34,0.04,NM,52,8164,,Canopy 60-70%
1042,18,9/9/2003,D,overcast,steady,clear,clear,none,none,other_algae,5,,,,5,,,,NM,light,15 Items,L=75% P=25%,,,,,,20.0,18.6,7.7,9.70,0.005,1523,NM,0.02,0.10,0.005,74,41,1467,,none
1043,19,9/9/2003,D,overcast,steady,clear,clear,none,none,other_algae,5,,,,5,,,,NM,none,none,none,,,,,,20.0,17.8,7.6,9.98,0.005,918,NM,0.05,0.14,0.03,20,5,2400,,none
1044,2,12/5/2004,W,rain,heavy,clear,Muddy,none,none,other_algae,0,,,,53,,,,Mat= DT100%,none,none,none,,,,,,8.0,9.5,7.8,9.75,30.00,1286,NM,0.87,0.34,0.10,1374,933,17329,,Site was retested later in the
1045,3,12/5/2004,W,rain,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,7.0,8.5,8.0,10.80,0.86,697,NM,0.005,0.06,0.10,52,5,487,,none

1046,5,12/5/2004,W,rain,steady,muddy,brown,none,none,none,0,,,,none,,,,NM,light,2 Items,NRT=50%
R=50%,,,,,,9.5,8.9,8.1,9.76,8.30,3430,14.9,3.30,0.63,0.23,243,327,8664,,Canopy 70-80% Algae scoured by
1047,7,12/5/2004,W,rain,heavy,cloudy,clear,none,garbage,none,0,,,,none,,,,NM- Water is too cloudy to
see,moderate,40-50 Items,R=75%
P=25%,,,,,,8.0,10.1,7.8,11.92,11.00,2470,NM,1.18,0.60,0.79,4106,12033,24193,,Canopy 80%
1048,12,12/5/2004,W,rain,steady,clear,clear,none,none,none,0,,,,none,,,,"NM- too obscured to see
algae,",none,none,none,,,,,,8.0,8.2,8.2,10.08,1.50,2080,NM,0.01,0.27,0.08,10,10,706,,Canopy 32%
1049,13,12/5/2004,W,rain,steady,muddy,brown,none,other_white foam,none,0,,,,none,,,,NM,light,none,NRT=50%
P=50%,,,,,,8.0,9.7,7.7,9.96,27.50,1340,NM,0.96,0.91,0.80,6131,2851,24193,,none
1050,14,12/5/2004,W,rain,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,9.0,11.9,7.8,8.12,0.60,1
320,NM,0.005,0.03,0.09,231,30,1515,,none
1051,17,12/5/2004,W,rain,steady,clear,clear,none,none,other_algae,0,,,,21.60,,,,Mat= RZ/CL
100%,none,none,none,,,,,,8.0,10.5,7.3,9.76,0.70,1342,NM,0.18,0.30,0.16,2035,31,2143,,Canopy 50%
1052,18,12/5/2004,W,rain,steady,clear,clear,none,none,other_algae,0,,,,36.80,,,,Mat= RZ/CL
100%,none,none,none,,,,,,9.0,11.7,7.8,10.03,3.10,1531,NM,0.03,0.45,0.13,683,218,8164,,Canopy 55%
1053,1,5/8/2005,D,clear,steady,clear,clear_green,none,none,other_algae,22,,,,62,,,,Flt= EN 100% Mat= CL/RZ
100%,none,none,none,,,,,,19.0,19.1,8.6,14.88,0.27,1559,NM,2.30,1.98,0.15,30,5,958,,Canopy 10% 3 carp sighted (16
1054,2,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,59,,,,Mat = CL/RZ
100%,none,none,none,,,,,,17.5,13.7,8.1,10.08,0.80,1138,NM,0.47,0.19,0.05,135,109,2014,,Canopy 50-60%
1055,3,5/8/2005,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,18.0,14.5,8.3,9.53,1.09,6
51,NM,0.10,0.07,0.005,5,5,240,,none
1056,5,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,34,,,,Mat= CL/RZ 100%,light,6
Items,NRT=100%,,,,,,19.5,15.6,8.0,10.21,0.71,2930,5.7,3.44,0.49,0.07,122,98,2481,,Canopy 75-80% Broken tree bran
1057,7,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,75,,,,Mat= RZ/CL 100%,light,none,P= 90%
BRT= 10%,,,,,,18.0,16.2,7.6,9.96,1.09,3020,NM,0.55,0.35,0.14,161,259,5794,,Canopy 80%
1058,12,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,87,,,,Mat= CL/RZ 100%,light,1 Item,NRT=
100%,,,,,,19.0,18.2,8.3,9.66,0.78,1629,NM,0.07,0.36,0.07,5,10,743,,Canopy 20-30%
1059,13,5/8/2005,D,clear,steady,clear,clear,sewage,none,other_algae,0,,,,56,,,,Mat= CL/RZ 100%,light,2 Items water
bottles,P= 100%,,,,,,21.0,15.6,7.7,9.77,0.97,3320,NM,1.51,0.61,0.05,199,145,3130,,Canopy 80-85%
1060,14,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,43,,,,Mat= CL/RZ
100%,none,none,none,,,,,,18.0,15.4,8.2,9.71,0.12,1065,NM,2.68,0.06,0.005,10,52,601,,Canopy 80-90%
1061,17,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,53,,,,Mat= RZCL 100%,light,3 Items,P=66%
R=34%,,,,,,19.5,18.8,7.5,9.94,0.06,1022,NM,0.20,0.36,0.05,20,20,1296,,Canopy 40%
1062,18,5/8/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,Mat = CL/RZ 100%,light,none,NRT=
100%,,,,,,20.0,19.5,8.3,10.96,0.15,1488,NM,0.005,0.18,0.01,20,5,537,,Canopy 30-40%
1063,2,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,8.30,,,,52.90,,,,Flt= DT 100% Mat= CL/RZ
99%,none,none,none,,,,,,17.0,16.4,8.0,8.96,0.18,1101,NM,0.15,0.15,0.07,52,63,1723,,Canopy 70-80%
1064,1,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,62,,,,72,,,,Flt=62%
Mat=72%,none,none,none,,,,,,22.5,20.1,8.4,14.22,0.38,1764,NM,0.08,0.49,0.03,5,10,1515,,Canopy 15-20%
1066,3,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,3.20,,,,33.30,,,,Flt=DT 100% Mat=CL/RZ
74%,none,none,none,,,,,,16.5,15.5,8.2,9.11,0.31,660,NM,0.04,0.12,0.04,10,10,754,,Canopy 50-60%
1067,5,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,96,,,,Mat= CL/RZ 100%,light,5
Items,NRT=100%,,,,,,19.0,17.2,7.9,9.25,0.72,2960,9.6,3.28,0.48,0.08,72,41,2602,,Canopy 90%
1069,7,6/5/2005,D,overcast,steady,clear,clear,musty,none,other_algae,0,,,,76,,,,Mat=RZ/CL w/DT
100%,moderate,none,P=90% R=10%,,,,,,17.5,18.6,8.0,7.81,0.82,3150,NM,0.93,0.46,0.09,364,345,24193,,Canopy 80-
85%
1070,12,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,95,,,,Mat= CL/RZ w/DT 100%,moderate,30
Items,NRT=75% R=25% P=5%,,,,,,19.0,20.2,8.2,8.31,1.10,1861,NM,0.03,0.43,0.04,5,20,3448,,Canopy 30-40%
1071,13,6/5/2005,D,overcast,steady,clear,clear,other_oil_paints,"other_foam, leaves",other_algae,0,,,,66.20,,,,Mat=
CL/RZ 100%,moderate,20 Items,P= 50% NRT=30%
R=20%,,,,,,19.0,18.3,7.6,7.84,0.40,3530,NM,1.26,0.65,0.04,175,98,8164,,Canopy 65-70%
1072,14,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,16,,,,47,,,,Flt=EN 100% Mat= CL/RZ
100%,none,none,none,,,,,,18.5,16.5,8.2,9.57,0.10,1070,0.8,1.42,0.07,0.03,31,62,3325,,Canopy 90-95%
1073,17,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,25,,,,73,,,,Flt=RZ/CL 100% Mat=RZ/CL

100%,light,4 Items,NRT=50% L=50%,,,,,,19.0,19.9,7.3,6.09,0.23,1145,NM,0.06,0.42,0.10,10,52,24192,,Canopy 10-15%
1075,18,6/5/2005,D,overcast,steady,clear,clear,rotten_eggs,none,other_algae,0,,,,90,,,,Mat= RZ/CL 100%,light,7 Items,NRT=100%,,,,,,19.0,18.1,8.2,9.95,0.03,1524,NM,0.01,0.16,0.09,20,5,301,,Canopy 40-50%
1076,21,6/5/2005,D,overcast,trickle,clear,clear,none,none,other_algae,0,,,,50,,,,CL/RZ= 100%,none,none,none,,,,,,NM,18.6,7.8,7.60,0.29,3040,NM,0.12,0.31,0.07,295,97,19863,,Salinity= 0.90
1077,22,6/5/2005,D,overcast,NM,clear,clear,none,none,none,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,23.2,7.9,8.01,4.62,1881,NM,0.01,0.38,0.02,98,41,12033,,Salinity= .90
1078,23,6/5/2005,D,overcast,NM,clear,clear,none,none,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,22.5,7.8,7.73,6.50,1801,NM,0.01,0.36,0.06,31,20,11198,,Salinity= 0.90
1079,24,6/5/2005,D,overcast,NM,cloudy,clear,none,none,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,22.2,7.7,5.75,7.30,1731,NM,0.01,0.37,0.06,86,109,24193,,Salinity= .90
1080,25,6/5/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,95,,,,Mat= CL/RZ 100%,light,none,none,,,,,,NM,20.1,7.7,8.15,0.03,1191,NM,0.01,0.36,0.04,30,10,5475,,Salinity= 1.3
1081,26,6/5/2005,D,overcast,lake,cloudy,clear,none,none,NM,NM,,,,NM,,,,NM,light,1 item,P=100%,,,,,,NM,21.9,7.7,7.32,7.40,1678,NM,0.01,0.34,0.02,158,185,24192,,Salinity= 1.0
1082,27,6/5/2005,D,overcast,lake,cloudy,clear,none,none,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,22.6,7.8,7.00,7.00,1828,NM,0.005,0.35,0.03,74,41,24193,,Salinity= .90
1083,21,7/10/2005,D,clear,none,clear,clear,none,none,none,0,,,,none,,,,NM,light,NM,R=100%,,,,,,NM,21.2,7.7,5.27,3.27,2980,NM,0.01,0.11,0.05,148,231,24192,,Salinity= 1.50 30ft downstrea
1084,22,7/10/2005,D,clear,lake,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,25.7,8.2,8.62,5.40,2300,NM,0.005,0.25,0.01,5,5,52,,none
1085,23,7/10/2005,D,clear,lake,cloudy,green,none,none,other_algae,0,,,,80,,,,Mat= CL/RZ 100%,NM,NM,NM,,,,,,NM,25.8,8.1,7.87,10.13,2117,NM,0.005,0.29,0.04,10,5,2359,,none
1086,24,7/10/2005,D,clear,lake,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,25.8,8.1,7.54,9.13,2170,NM,0.01,0.26,0.02,52,63,2909,,none
1087,25,7/10/2005,D,clear,steady,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,25.2,7.5,6.67,1.21,1465,NM,0.005,0.30,0.01,5,10,6131,,Salinity= .70 Mat Algae prese
1088,26,7/10/2005,D,clear,lake,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,light,1 item= Raquet ball,NRT= 100%,,,,,,NM,25.9,8.0,7.65,9.90,1947,NM,0.01,0.25,0.05,10,41,1793,,none
1089,27,7/10/2005,D,clear,lake,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,26.3,8.1,7.22,8.52,2205,NM,0.005,0.28,0.09,10,41,1956,,Salinity= 1.10
1090,28,7/10/2005,D,clear,lake,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,25.9,8.2,9.77,5.13,2390,NM,0.005,0.16,0.02,41,5,122,,Salinity= 1.20
1091,21,8/7/2005,D,clear,steady,cloudy,brown_green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,24.9,7.7,4.49,1.53,3100,NM,0.04,0.30,0.07,121,120,24192,,Salinity= 1.5
1093,22,8/7/2005,D,clear,lake,cloudy,green,rotten_eggs,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,27.9,8.0,6.38,9.43,2605,NM,0.01,0.60,0.12,142,41,17329,,Salinity= 1.30
1094,23,8/7/2005,D,clear,lake,muddy,yellow_brown,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,28.0,7.9,6.65,12.83,2580,NM,0.005,0.69,0.05,51,10,17329,,Salinity= 1.30
1095,24,8/7/2005,D,clear,lake,cloudy,yellow_brown,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,27.7,7.9,6.49,12.00,2550,NM,0.01,0.66,0.005,97,74,15531,,Salinity= 1.25
1096,25,8/7/2005,D,clear,steady,clear,clear,none,none,other_algae,1,,,,70,,,,Flt= CL/RZ 100% Mat= CL/RZ 10,none,none,none,,,,,,NM,25.4,7.3,3.37,0.67,1328,NM,0.08,0.55,0.06,52,314,19863,,Salinity= 0.70
1097,26,8/7/2005,D,clear,lake,cloudy,yellow_brown,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,28.5,8.0,7.57,11.17,2550,NM,0.005,0.68,0.05,52,10,12033,,Salinity= 1.20
1098,27,8/7/2005,D,clear,lake,cloudy,yellow_brown,musty,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,28.9,8.0,7.80,10.66,2645,NM,0.005,0.60,0.03,97,20,14136,,Salinity=1.3
1100,28,8/7/2005,D,clear,lake,cloudy,yellow_brown,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,29.2,8.2,8.83,10.50,2685,NM,0.07,0.55,0.04,20,20,12996,,Salinity= 1.3
1102,1,7/10/2005,D,clear,steady,cloudy,clear,none,garbage,other_algae,67,,,,90,,,,Flt= EN 100% Mat= CL/RZ 100%,light,"2 items- Coke can, shopping ba",NRT 50% R 50%,,,,,,22.0,20.7,8.0,8.48,0.41,1895,NM,0.005,0.54,0.05,5,5,6867,,Canopy 5-10% Native tadpoles
1103,2,7/10/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,78,,,,Mat = CL/RZ 100%,light,1 item,R

100%,,,,,,20.0,17.6,8.0,9.02,0.21,1132,NM,0.18,0.23,0.08,384,240,1725,,Canopy 80%
1104,3,7/10/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,17,,,,Mat= CL/RZ
100%,none,none,none,,,,,,20.5,17.5,8.2,8.92,0.28,673,NM,0.07,0.13,0.03,31,10,1313,,Canopy 0-10%
1105,5,7/10/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,58,,,,CL/RZ w/DT
100%,none,none,none,,,,,,24.0,18.7,8.0,9.32,0.78,2930,3.8,3.42,0.37,0.08,350,132,6488,,Canopy 75-85% Lots of mosquit
1106,7,7/10/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,94,,,,DT 100%,moderate,~25 items,P=90%
NRT=10%,,,,,,22.5,20.0,7.9,7.91,1.12,3240,NM,0.53,0.32,0.12,547,313,24193,,Canopy 75-80%
1107,12,7/10/2005,D,clear,steady,clear,clear,Decaying algae,none,other_algae,0,,,,100,,,,100% decaying CL/RZ w/DT,light,2 items,NRT 100%,,,,,,22.0,22.4,8.2,8.32,0.78,2140,NM,0.005,0.29,0.09,20,5,11198,,Canopy 45-50% Three large mout
1108,13,7/10/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,DT 100%,light,1 items,P=50%
NRT=50%,,,,,,27.0,19.9,7.8,9.77,0.82,3435,NM,1.18,0.64,0.10,249,878,4374,,Canopy 90-100%
1109,14,7/10/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,52,,,,CL/RZ 100%,light,1 item,NRT
100%,,,,,,19.5,17.2,8.1,8.60,0.01,1120,NM,1.07,0.10,0.03,20,20,1374,,Canopy 90-95%
1111,17,7/10/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,85,,,,RZ/CL w/DT 100%,light,6 items,NRT=40% R=30% L=30%,,,,,,24.0,21.2,7.3,10.62,0.23,1275,NM,0.08,0.29,0.10,41,691,15531,,~7 large mouth bass
1112,18,7/10/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,72,,,,RZ/CL w/DT
100%,none,none,none,,,,,,21.5,19.3,8.2,11.61,0.25,1516,NM,0.01,0.14,0.09,52,20,1726,,Canopy 70%
1113,1,8/7/2005,D,clear,steady,clear,clear,none,none,other_algae,50,,,,67,,,,Flt=EN 100% Mat=EN 100%,light,1 item= broken bottle,R=100%,,,,,,21.0,22.3,7.9,8.68,1.14,1774,NM,0.03,0.83,0.09,20,20,11198,,"Canopy 5-10% Crayfish, Stagna"
1114,2,8/7/2005,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,52,,,,"Mat=SP 40%, DT 60%",light,6 Items,"N 17%, R 83%",,,,,,21.5,19.1,8.0,8.77,0.30,1115,NM,0.17,0.19,0.03,294,160,3654,,"Losts of crayfish, tons of wat"
1115,3,8/7/2005,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,27.0,19.4,8.2,8.83,0.39,638,NM,0.05,0.08,0.06,63,10,1354,,none
1117,5,8/7/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,CL/RZw/DT 100%,light,1 item,R
100%,,,,,,29.5,20.5,8.0,10.11,0.79,3060,2.3,3.20,0.23,0.01,317,175,11198,,"Canopy 90%, Striped Bass, Mosq"
1118,7,8/7/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,89.90,,,,Mat=100% CL/RZ w/ DT on Top,moderate,12 Items,"P 25%, N 75%",,,,,,25.0,22.3,7.5,7.21,1.35,3180,NM,0.48,0.32,0.19,213,529,24193,,Canopy 78%
1119,12,8/7/2005,D,clear,steady,clear,clear,musty,none,other_algae,0,,,,100,,,,Mat=CL/RZ w/DT,moderate,14 Items,"P 5%, N 90%, R 5%",,,,,,27.5,24.7,8.2,7.57,2.30,1934,NM,0.31,0.31,0.07,41,5,8164,,"3 Crayfish, 1 Striped Bass, Fl"
1120,13,8/7/2005,D,clear,steady,milky,yellow,musty_other_chemical,none,other_algae,0,,,,98,,,,Mat=CL/RZ w/DT,light,10 Items,"P 75%, N 15%, R
10%",,,,,,30.0,22.2,7.6,8.94,1.03,3420,NM,1.57,0.71,0.08,563,571,24192,,"Canopy 83%, Foam in stream, lo"
1121,14,8/7/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,46,,,,Mat=CL/RZ,none,none,none,,,,,,20.5,18.8,8.0,8.65,0.01,1065,0.4,0.88,0.09,0.08,20,20,2723,,"Canopy 92.5, 2 Tree Frog Tadpo"
1122,17,8/7/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,Mat=CL/RZ,none,none,none,,,,,,31.0,21.7,7.2,10.22,0.30,1278,NM,0.10,0.34,0.05,20,30,5172,,23% Canopy
1123,18,8/7/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,39.40,,,,Mat=CL/RZ,none,none,none,,,,,,21.0,19.5,8.2,11.27,0.61,1433,NM,0.07,0.10,0.05,20,4352,4352,,Canopy 80%
1124,21,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,14,,,,none,,,,Flt= DT 100%,light,1 Item,P
100%,,,,,,NM,18.6,8.0,9.10,5.00,3030,NM,0.01,0.24,0.09,20,74,15531,,Salinity=1.5
1125,22,9/11/2005,D,clear,NM,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,21.4,8.1,5.46,8.10,2865,NM,0.005,0.38,0.08,52,5,4352,,Salinity=1.4
1126,23,9/11/2005,D,clear,NM,milky_other_surface_scum,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,21.0,8.5,7.20,14.10,2830,NM,0.01,0.45,0.10,20,10,4884,,Salinity=1.5
1127,24,9/11/2005,D,clear,NM,milky_other_surface_scum,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,21.8,8.0,6.50,8.20,2820,NM,0.005,0.40,0.11,74,20,7270,,Salinity=1.4
1128,25,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,75,,,,Mat=CL/RZ,light,1 Item,P
100%,,,,,,NM,22.8,7.3,5.52,5.30,1521,NM,0.005,0.26,0.04,10,10,8664,,Salinity .8
1129,26,9/11/2005,D,clear,NM,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,22.2,8.0,6.36,9.10,2

820,NM,0.005,0.34,0.10,160,98,6867,,Salinity=1.4
1130,27,9/11/2005,D,clear,NM,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,22.0,8.0,7.13,7.50,2870,NM,0.005,0.39,0.13,10,86,10462,,Salinity=1.5
1131,28,9/11/2005,D,clear,NM,clear,clear_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,21.9,8.1,7.39,7.20,2880,NM,0.005,0.35,0.10,20,10,4884,,Salinity=1.5
1132,28,6/5/2005,D,NM,NM,NM,NM,NM,NM,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,,Site Added July 2005
1133,1,9/11/2005,D,clear,steady,other_Darkblack(mucky),clear,other_sulfur,none,other_algae,44,,,,96,,,,Flt= EN 100% Mat=DT 100%,light,3 items (water bottles),P=
100%,,,,,,21.0,20.8,8.1,9.69,0.43,2260,NM,0.01,0.80,0.03,5,20,5172,,"Canopy 5-10% Crayfish 13+, wa"
1134,2,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,29,,,,Mat= CL/RZ 73% DT 27%,light,1 item (can),R=100%,,,,,,22.5,17.3,8.3,10.37,0.34,1181,NM,0.04,0.14,0.01,122,146,4106,,Canopy 50%
1135,3,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,23,,,,none,,,,Flt = DT
100%,none,none,none,,,,,,22.0,16.1,8.2,7.40,0.23,6775,NM,0.005,0.08,0.02,5,20,538,,Algae was removed by Stream Te
1136,5,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,Mat = DT 100% (CL/RZ traces dy,light,4 items,NRT=100%,,,,,,21.5,16.5,8.0,8.54,0.49,3130,4.2,3.38,0.34,0.09,265,145,8164,,100+ mosquito fish
1137,7,9/11/2005,D,clear,steady,cloudy,brown,none,none,NM,NM,,,,NM,,,,NM,light,none,P=50%
NRT=50%,,,,,,20.5,17.8,7.9,7.21,7.00,3210,NM,0.74,0.39,0.11,612,265,24193,,none
1138,12,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,100,,,,Mat= CL/RZ w/DT 100%,light,3 items,NRT=100%,,,,,,20.5,19.3,8.2,7.30,0.61,2520,NM,0.01,0.37,0.04,30,20,9804,,none
1139,13,9/11/2005,D,clear,steady,cloudy_other_whitish_cast,clear,musty_other_chemical,other_foam and duckweed,other_algae,0,,,,100,,,,Mat= DT
100%,none,none,none,,,,,,20.0,17.7,7.5,6.05,1.60,3445,NM,1.25,0.83,0.09,1178,195,24193,,none
1140,14,9/11/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,22,,,,CL/RZ w/DT 100%,light,3 items,NRT=66% P=34%,,,,,,19.5,16.9,8.1,8.99,0.02,1179,,0.71,0.08,0.05,52,97,1126,,Canopy 90-95% 1 newt 1 tadpol
1141,17,9/11/2005,D,clear,trickle,clear,green,none,none,other_algae,0,,,,100,,,,DT
100%,none,none,none,,,,,,18.0,18.4,7.2,8.16,0.01,1418,NM,0.10,0.37,0.06,5,20,5794,,none
1142,18,9/11/2005,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,20.0,18.9,8.1,10.21,0.15,1537,NM,0.02,0.08,0.01,20,31,2098,,Canopy 80%
1143,1,10/16/2005,D,showers,steady,clear,clear,none,none,other_algae,39,,,,36,,,,Flt=EN 100% Mat= CL/RZ 95% S,none,none,none,,,,,,20.5,17.4,8.0,9.33,0.55,2420,NM,0.07,0.75,0.005,5,5,3873,,Canopy 13%
1144,2,10/16/2005,D,clear,trickle,clear,clear,none,none,other_algae,0,,,,21.80,,,,CL/RZ w/DT 100%,light,4 items,P=75% NRT 25%,,,,,,20.0,13.3,8.0,9.78,0.52,1210,NM,0.11,0.11,0.005,10,122,2755,,"Canopy 30-40% little fish, ta"
1145,3,10/16/2005,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NM,none,none,none,,,,,,17.5,14.5,8.2,8.64,0.49,681,NM,0.06,0.005,0.005,5,5,706,,none
1146,5,10/16/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,100,,,,DT 60% CL/RZ w/DT 40%,light,5 items,NRT 100%,,,,,,20.5,14.2,8.1,10.49,1.37,3300,2.2,5.46,0.44,0.005,331,269,4106,,Canopy 90%
1147,7,10/16/2005,D,clear,steady,cloudy,yellow,musty_sulfur,none,other_algae,0,,,,81,,,,CL/RZ
100%,moderate,none,NRT 100%,,,,,,18.5,16.1,7.7,6.45,3.40,3195,NM,0.77,0.29,0.24,201,354,9804,,Canopy 50-60%
1148,12,10/16/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,100,,,,CL/RZ w/DT 100%,light,1 item,NRT 100%,,,,,,19.0,15.7,8.2,9.08,0.47,2720,NM,0.04,0.33,0.03,10,10,4611,,Canopy 50-60%
1149,13,10/16/2005,D,overcast,steady,clear,clear,none,"other_duckweed, foam, watercress",other_algae,0,,,,32,,,,DT 87% CL/RZ 13%,light,8 items,P=60%
NRT=40%,,,,,,19.5,16.6,7.6,7.38,1.90,3510,NM,2.27,0.69,0.19,504,426,19862,,Canopy 80-90%
1150,14,10/16/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,42,,,,CL/RZ
100%,none,none,none,,,,,,19.5,15.4,8.0,8.64,0.07,1245,0.2,0.68,0.10,0.03,10,30,1935,,Canopy 30-40% 1 pacific tree f
1151,17,10/16/2005,D,clear,steady,clear,clear,rotten_eggs,none,other_algae_duckweed,0,,,,91,,,,CL/RZ
100%,light,none,NRT 100%,,,,,,22.0,15.5,7.3,6.62,0.45,1485,NM,0.21,0.31,0.11,20,5,1169,,Canopy 30-40%
1152,18,10/16/2005,D,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,none,P=50%
NRT=50%,,,,,,20.0,16.9,8.1,10.23,0.33,1566,NM,0.06,0.10,NM,20,20,2143,,Canopy 40-50%
1154,21,10/16/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,50,,,,CL/RZ 100%,light,3 items,NRT 100%,,,,,,NM,15.7,7.9,7.43,1.40,3100,NM,0.27,0.29,0.09,146,173,4884,,Canopy 5% Salinity 1.6ppt
1155,22,10/16/2005,D,overcast,lake,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,18.8,8.1,7.71,5

.20,2960,NM,0.005,0.14,0.06,20,20,187,,Salinity 1.5
1156,23,10/16/2005,D,overcast,lake,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,18.7,8.0,8.82,5.50,2940,NM,0.01,0.15,0.09,10,10,226,,Salinity 1.5
1157,24,10/16/2005,D,overcast,lake,Greenish,brown,none,garbage,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,18.5,8.0,8.09,6.90,2910,NM,0.02,0.17,0.12,74,41,1187,,none
1158,25,10/16/2005,D,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,19.9,7.3,8.71,1.10,1782,NM,0.08,0.26,0.11,5,122,7701,,Salinity 1.0
1159,26,10/16/2005,D,overcast,lake,Olive Green,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,18.8,8.0,8.20,6.60,2900,NM,0.04,0.21,0.11,31,5,857,,Salinity 1.5
1160,27,10/16/2005,D,overcast,lake,Light Green,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,19.0,8.1,8.88,6.00,2950,NM,0.02,0.20,0.13,109,5,1374,,Salinity 1.5
1161,28,10/16/2005,D,overcast,lake,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,18.9,8.1,9.07,5.30,2970,NM,0.01,0.19,0.05,5,5,345,,Salinity 1.5
1162,1,11/6/2005,D,clear,steady,clear,clear,none,none,other_algae,15,,,,60,,,,Flt=DT 100% Mat=DT 100%,none,none,none,,,,,,21.0,15.6,8.3,14.19,1.27,2500,NM,0.43,0.80,0.05,10,5,4106,,"10+ Crayfish, 100+ Mosquito fi"
1163,2,11/6/2005,D,overcast,steady,clear,clear,none,none,other_algae,0,,,,13,,,,Mat= DT 23% SpiroGyro 77%,light,10 items,P=90% R=10%,,,,,,19.0,13.0,8.1,11.16,0.15,1201,NM,0.05,0.16,0.01,52,41,2282,,Canopy 70-80%
1164,3,11/6/2005,D,clear,steady,clear,clear,none,none,other_DT film on surface,0,,,,none,,,,NM,none,none,none,,,,,,20.0,13.7,8.0,9.47,0.46,685,NM,0.03,0.08,0.03,5,5,771,,Caddis fly larvae
1165,5,11/6/2005,D,clear,steady,clear,clear,none,none,other_algae,0,,,,96,,,,CL/RZ w/DT 100%,light,2 items,NRT=100%,,,,,,22.0,12.7,8.1,11.24,1.60,3400,3.3,4.62,0.53,0.06,223,173,7270,,Canopy 85%
1166,7,11/6/2005,D,overcast,steady,clear,clear,musty,none,other_algae,0,,,,15,,,,CL/RZ 100%,high,Construction materials- cinder,P=75% NRT=10% L=10% R=5%,,,,,,19.5,13.6,8.0,7.91,2.35,3130,NM,0.59,0.27,0.25,313,327,15531,,Canopy 90-95%
1167,12,11/6/2005,D,clear,steady,clear,clear,none,garbage,other_algae,0,,,,95,,,,CL/RZ w/DT,light,3 items,NRT=67% P=33%,,,,,,17.0,13.9,8.2,10.02,1.15,2470,NM,0.05,0.32,0.05,20,20,4884,,Canopy 50%
1168,13,11/6/2005,D,overcast,steady,clear,clear,musty_other_chemical,"other_5 inch high foam, rainbow colored",other_algae,0,,,,28,,,,DT 100%,moderate,none,P=50% R=50%,,,,,,19.0,14.5,7.5,9.20,3.09,3600,NM,1.95,0.89,0.16,1106,3448,24193,,Canopy 90%
1169,14,11/6/2005,D,overcast,steady,clear,clear,none,other_leaves and organic matter,other_algae,0,,,,1,,,,CL/RZ 100%,light,1 item- can,R= 100%,,,,,,19.0,14.6,8.0,9.17,0.01,1256,0.3,0.52,0.09,0.01,20,20,1624,,Canopy 90% Four pacific tree
1170,17,11/6/2005,D,clear,steady,clear,clear,none,none,other_algae,14,,,,100,,,,Flt=SP 100% Mat= CL/RZ 86% DT,none,none,none,,,,,,23.0,16.0,7.4,8.32,0.49,1576,NM,0.03,0.36,0.01,74,262,3654,,Canopy 5% Looks like CL/RZ is
1171,18,11/6/2005,D,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NM,light,8 items,P= 75% R= 25%,,,,,,19.0,16.4,8.3,10.87,0.04,1563,NM,0.03,0.14,0.04,10,5,2359,,none
1172,1,12/4/2005,W,clear,steady,cloudy,brown,none,none,other_leaves,0,,,,91,,,,DT=100%,light,2 beer bottles,R=100%,,,,,,19.0,13.0,8.4,13.69,3.05,1844,NM,5.68,3.64,0.04,5,20,4352,,average canopy=17%
1173,2,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,20,,,,DT=100%,light,plastic bottles and bags,P=100%,,,,,,16.3,8.8,8.0,10.74,0.01,1254,NM,0.15,0.11,0.005,95,52,689,,canopy=50%
1174,3,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,13.0,10.4,8.1,10.30,0.18,694,NM,0.01,0.03,0.005,10,5,161,,none
1175,5,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,100,,,,DT=100%,none,none,none,,,,,,17.5,10.9,8.1,10.81,1.45,3230,2.2,3.76,0.50,0.05,132,96,5475,,canopy=80-90%
1176,7,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,24.80,,,,DT=100%,moderate,none,"P=10%, NRT=90%",,,,,,16.0,10.7,7.6,80.80,1.22,3090,NM,0.63,0.39,0.15,135,213,6488,,canopy=40%
1177,12,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,100,,,,CL/RZ w/DT=100%,none,none,none,,,,,,18.5,10.6,8.2,10.41,1.30,2360,NM,0.03,0.26,0.01,20,5,2481,,canopy=40-50%
1178,13,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,58,,,,DT=100%,none,none,none,,,,,,14.0,12.8,7.7,9.07,0.87,3550,NM,2.48,0.76,0.04,292,108,8164,,canopy=70%
1179,14,12/4/2005,W,clear,steady,clear,clear,none,none,other_leaves,0,,,,1,,,,DT=100%,none,none,none,,,,,,18.5,11.2,7.

9,9.04,0.58,1307,0.2,0.33,0.03,0.005,20,5,959,,canopy=85%
1180,17,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,66,,,,Cl/RZwDT=100%,light,none,NRT=100%,,,,,,14.8,12.8,7.3,6.38,0.48,1572,NM,0.13,0.31,0.005,20,63,1081,,canopy=20%
1181,18,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,25,,,,CL/RZwDT=100%,light,none,NRT=100%,,,,,,20.0,13.2,7.9,10.79,0.15,1598,NM,0.01,0.07,NM,10,5,2909,,canopy=80%
1182,21,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,44,,,,CL/RZwDT=100%,none,none,none,,,,,,NM,11.4,7.7,12.13,1.90,2705,NM,0.29,0.33,0.05,233,161,2046,,salinity=1.3
1183,22,12/4/2005,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,12.7,7.7,11.00,4.12,2325,NM,0.02,0.18,0.02,10,20,1450,,salinity=1.2
1184,23,12/4/2005,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,12.4,7.7,8.10,7.22,2300,NM,0.04,0.18,0.04,411,74,8164,,salinity=1.1
1185,24,12/4/2005,W,clear,none,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,12.3,7.6,8.67,5.70,2145,NM,0.04,0.14,0.11,62,96,1789,,salinity=1.1
1186,25,12/4/2005,W,clear,steady,clear,clear,none,none,none,0,,,,72.70,,,,CL/RZ=100%,none,none,none,,,,,,NM,13.9,7.5,9.88,0.14,1607,NM,0.03,0.19,0.005,63,5,1607,,salinity=1.1
1187,26,12/4/2005,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,13.0,7.7,9.32,6.45,2210,NM,0.02,0.12,0.05,30,31,2481,,salinity=1.1
1188,1,1/8/2006,W,clear,steady,cloudy,clear,none,none,none,0,,,,11,,,,CL/RZ=100%,light,2 grocery bags,NRT=100%,,,,,,17.5,13.7,8.2,10.88,2.02,1618,NM,6.56,2.80,0.11,97,86,5172,,"canopy=10%, 1 crayfish, 6 coot"
1189,2,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,none,"P=50%, NRT=50%",,,,,,12.0,8.3,8.1,11.94,0.19,1236,NM,0.62,0.20,0.04,132,73,3873,,none
1190,3,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,13.5,10.7,8.1,10.43,0.78,658,NM,0.05,0.08,0.04,10,20,416,,none
1191,5,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,2 items,NRT=100%,,,,,,19.5,10.4,8.2,10.47,3.46,3480,3.5,3.96,0.69,0.11,381,185,12033,,"canopy=85-90%, Stream bottom i"
1193,7,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,4.60,,,,none,high,too many plastic bags/bottles,"NRT=60%, R=40%",,,,,,21.0,11.1,7.8,9.98,1.71,2815,NM,0.92,0.42,0.12,448,359,12033,,canopy=20%
1194,12,1/8/2006,W,clear,steady,clear,clear,none,other_slightly foamy,none,0,,,,3-5,,,,CL/RZ=100%,light,4 items,"NRT=75%, R=25%",,,,,,13.0,10.5,8.2,10.54,1.68,1350,NM,0.55,0.50,0.10,31,20,1439,,algae scoured out except on ro
1195,13,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,1,,,,CL/RZ=100%,moderate,appr. 25 items,"NRT=25%, P=75%",,,,,,21.0,11.6,7.6,9.48,3.50,3730,NM,1.56,0.78,0.16,309,156,11198,,stream channel altered by prev
1196,14,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,18.0,13.0,8.1,9.82,0.05,1205,0.3,0.42,0.08,0.05,5,10,2143,,canopy=75%
1197,17,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,appr. 5 items,NRT=100%,,,,,,19.5,12.1,7.2,8.74,2.80,1185,NM,0.57,0.47,0.01,52,41,2187,,canopy=40%
1198,18,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,light,1 tire w/rim,L=100%,,,,,,16.0,13.6,8.0,9.84,0.05,1565,NM,0.03,0.10,0.06,110,10,3076,,canopy=40%
1200,21,1/8/2006,W,clear,intermittent,clear,clear,none,none,none,0,,,,12,,,,CL/RZ=100%,light,none,P=100%,,,,,,NM,11.8,8.0,11.33,1.08,2750,NM,0.66,0.38,0.005,303,185,15531,,canopy=5%
1201,22,1/8/2006,W,clear,none,cloudy,clear,none,other_natural debris,none,0,,,,none,,,,none,light,1 item,R=100%,,,,,,NM,11.4,7.7,9.07,3.90,1370,NM,0.70,0.49,0.06,30,10,689,,average salinity=0.75ppt
1202,23,1/8/2006,W,clear,none,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,11.2,7.7,8.35,2.97,1354,NM,0.64,0.38,0.06,20,5,749,,salinity=0.8ppt
1203,24,1/8/2006,W,clear,none,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,11.6,7.7,7.87,3.48,1340,NM,0.54,0.36,0.005,80,20,1274,,average salinity=0.75
1204,25,1/8/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,13.7,7.5,10.59,1.00,1248,NM,0.43,0.32,0.04,52,52,1515,,canopy=10%
1205,26,1/8/2006,W,clear,none,clear,clear,none,other_sticks and leaves,none,0,,,,none,,,,none,none,none,none,,,,,,NM,12.1,7.6,8.08,2.63,1350,NM,0.55,0.36,0.08,31,10,988,,average salinity= 0.75ppt
1206,27,1/8/2006,W,clear,none,clear,clear,none,other_leaves,none,0,,,,none,,,,none,none,none,none,,,,,,NM,11.8,7.8,8.9

3,2.67,1357,NM,0.57,0.37,0.08,31,10,638,,average salinity=0.7ppt
1207,28,1/8/2006,W,clear,none,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,11.7,7.8,8.66,2.38,1385,NM,0.61,0.40,0.06,10,5,1092,,average salinity=0.75ppt
1208,21,11/6/2005,D,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,13.7,7.9,9.99,1.98,3100,NM,0.25,0.32,0.09,74,98,6131,,average salinity=1.5
1209,22,11/6/2005,D,clear,none,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,15.8,8.2,9.68,4.33,2350,NM,0.005,0.15,0.08,5,52,226,,average salinity=1.2ppt
1210,23,11/6/2005,D,clear,none,milky,gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,16.0,8.1,9.65,10.14,2400,NM,0.005,0.12,0.12,51,10,556,,salnity=1.2ppt
1211,24,11/6/2005,D,clear,none,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,16.4,7.9,6.84,5.45,2340,NM,0.03,0.15,0.28,50,10,605,,average salinity=1.2ppt
1212,25,11/6/2005,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,17.2,7.3,7.75,0.21,1634,NM,0.05,0.26,0.08,10,10,4352,,average salinity=0.85ppt
1213,26,11/6/2005,D,clear,none,clear,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,16.3,7.9,7.17,6.90,2355,NM,0.02,0.19,0.23,60,20,933,,average salinity=1.2ppt
1214,27,11/6/2005,D,clear,none,clear,brown,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,16.2,8.1,9.14,7.19,2475,NM,0.005,0.15,0.07,51,31,1376,,average salinity=1.2ppt
1215,28,11/6/2005,D,NM,none,none,none,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,16.7,8.2,11.57,8.50,2525,NM,0.005,0.11,0.09,30,30,294,,average salinity=1.25ppt
1216,1,2/12/2006,W,clear,steady,clear,clear,none,none,,16.6,,,,83.37,,,,10-20 mosquito fish,light,plastic caution tape,100% plastics,,,,,,24.5,13.8,8.5,16.34,0.96,1652,NM,2.62,1.66,0.02,5,8,1619,,
1217,21,3/5/2006,W,clear,steady,clear,clear,none,none,none,0,,,,19.2,,,,none,none,none,none,,,,,,NM,13.1,8.0,9.87,1.70,2325,NM,0.54,0.27,0.12,253,416,6774,,none
1218,2,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,80.4,,,,none,none,none,none,,,,,,17.3,9.0,8.1,11.18,0.02,1112,NM,0.22,0.14,0.01,20,63,1187,,
1219,3,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,0,none,none,none,,,,,,20.4,11.0,8.1,9.06,0.39,580,NM,0.02,0.08,0.005,5,5,723,,
1220,5,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,40,,,,none,light,none,100% non recyclable,,,,,,24.5,10.9,8.1,12.09,1.10,3490,1.7,4.73,0.44,0.11,58,57,4482,,
1221,7,2/12/2006,W,clear,steady,clear,clear,ammonia,none,none,0,,,,61.2,,,,none,moderate,none,75% plastics 20% non recyclabl,,,,,,23.3,11.5,8.0,9.59,1.70,3260,NM,0.44,0.25,0.08,288,160,5475,,
1222,22,3/5/2006,W,overcast,lake,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,13.6,8.1,15.99,6.27,1154,NM,0.03,0.09,0.03,5,86,10462,,salinity=0.65ppt at 12.95 Celc
1223,12,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,100,,,,none,light,none,50% plastics 50% non-recyclabl,,,,,,15.0,10.9,8.3,10.28,1.50,1729,NM,0.03,0.31,0.08,31,10,1198,,
1224,13,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,9.09,,,,none,none,none,none,,,,,,26.5,13.1,7.7,9.22,1.75,3425,NM,1.67,0.47,0.04,109,256,4611,,
1225,23,3/5/2006,W,overcast,NM,clear,clear,none,other_pollen,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,13.6,8.1,12.90,3.40,1044,NM,0.005,0.12,0.04,41,74,3609,,salinity=0.5ppt at 13.4 Celciu
1226,14,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,6.4,,,,NM,none,NM,NM,,,,,,26.0,14.7,7.9,9.74,0.005,1092,0.2,0.29,0.08,0.06,20,20,1145,,
1227,24,3/5/2006,W,overcast,NM,clear,clear,none,other_pollen,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,13.5,8.1,12.04,4.40,1045,NM,0.005,0.13,0.05,20,41,2909,,none
1228,17,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,100,,,,none,light,none,100% plastics,,,,,,20.8,11.9,7.3,8.69,2.80,1055,NM,0.12,0.24,0.04,41,85,959,,
1230,18,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,3,,,,none,light,none,100 non-reclyable,,,,,,24.8,15.4,8.0,10.10,0.51,1346,NM,0.02,0.11,0.07,41,5,2851,,
1231,25,3/5/2006,W,overcast,NM,clear,clear,none,none,none,0,,,,37,,,,none,light,2 items,"50 plastics,50 recyclables",,,,,,NM,14.8,8.2,10.65,1.08,1012,NM,0.11,0.20,0.10,52,25,1553,,none
1232,21,2/12/2006,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,none,100% plastics,,,,,,NM,12.3,7.9,14.14,0.73,3125,NM,0.15,0.14,0.02,36,31,1882,,salinity 1.3 ppt 12.45 degrees
1233,26,3/5/2006,W,overcast,NM,clear,clear,none,none,other_damselfly larvae,NM,,,,NM,,,,none,none,none,none,,,,,,NM,14.3,8.1,12.20,3.50,1044,NM,0.005,0.10,0.04,10,41,3654,,salinity=0.5 ppt at 14.2 Celciu

1234,22,2/12/2006,W,clear,lake,clear,clear,none,other_leaves and woody debris,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,13.0,7.9,12.78,5.25,1740,NM,0.01,0.05,0.09,10,5,1259,,salinity 0.9 ppt at 12.6 degre
1235,27,3/5/2006,W,overcast,NM,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,14.3,8.1,13.31,5.23,1076,NM,0.005,0.14,0.07,30,62,2851,,salinity=0.55ppt at 13.9 Celci
1236,23,2/12/2006,W,clear,clear,clear,clear,none,none,,,,,,,,,NM,none,NM,NM,,,,,,,13.2,7.7,11.20,5.36,1625,NM,0.03,0.06,0.005,10,5,624,,
1237,28,3/5/2006,W,overcast,NM,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,14.2,7.9,13.26,3.63,1128,NM,0.04,0.08,0.005,10,62,3448,,salinity=0.6ppt at 14 Celcius
1238,1,3/5/2006,W,clear,steady,milky,brown,none,none,none,0,,,,32,,,,NM,light,plastic bottle,100 plastic,,,,,,15.5,14.1,8.3,11.37,3.90,1423,NM,3.87,2.16,0.09,87,74,4762,,
1239,2,3/5/2006,W,clear,intermittent,clear,clear,none,none,none,0,,,,40,,,,none,light,4 items,"50plastics,50recyclables",,,,,,17.0,11.4,7.9,11.96,1.22,1189,NM,0.37,0.13,0.07,187,97,3448,,none
1240,24,2/12/2006,W,clear,none,clear,clear,none,none,,,,,,,,,NM,none,NM,NM,,,,,,,13.2,7.6,10.75,5.57,1607,NM,0.005,0.11,0.03,31,10,1236,,salinity .85 ppt at 12.85 degr
1241,3,3/5/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,15.5,10.4,8.1,10.95,0.99,626,NM,0.02,0.04,0.02,10,10,443,,
1242,25,2/12/2006,W,clear,,clear,clear,none,none,,0,,,,100,,,,NM,light,NM,33% glass 66% plastic,,,,,,,14.4,7.7,12.59,0.29,1114,NM,0.04,0.22,0.005,8,5,530,,Salinity 0.5 at 13.85 degrees
1243,5,3/5/2006,W,clear,steady,clear,none,none,none,none,0,,,,none,,,,none,none,NM,none,,,,,,16.0,11.1,8.1,11.28,2.95,3150,4.8,3.96,0.58,0.09,303,704,15732,,none
1244,26,2/12/2006,W,clear,none,clear,clear,none,garbage,,,,,,,,,NM,light,NM,75% non-recyclable 25% plastic,,,,,,,13.7,7.6,10.72,4.75,1608,NM,0.005,0.10,0.005,10,5,556,,salinity 0.85 ppt at 13.8 degr
1245,7,3/5/2006,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,14.5,10.5,8.0,10.24,3.25,2615,NM,0.81,0.31,0.07,487,211,9804,,none
1246,12,3/5/2006,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,13.0,12.1,8.2,11.25,3.25,1245,NM,0.03,0.17,0.03,10,31,3255,,none
1247,27,2/12/2006,W,clear,,clear,clear,none,none,,,,,,,,,NM,none,NM,NM,,,,,,,13.3,7.7,11.64,5.40,1703,NM,0.005,0.80,0.005,52,41,1210,,Salinity 0.9 ppt at 13.1 degre
1248,13,3/5/2006,W,overcast,steady,clear,clear,none,none,none,0,,,,1,,,,none,moderate,"wrappers,styrofoam,plastic bag","10plastics, 90non-recyclables",,,,,,16.0,10.9,7.7,10.18,2.51,3495,NM,1.43,0.65,0.05,393,373,9208,,none
1249,14,3/5/2006,W,overcast,steady,clear,clear,none,none,none,0,,,,5,,,,none,light,one grocery bag,100 non-recyclables,,,,,,14.0,11.9,8.0,10.58,0.44,1201,0.3,0.29,0.08,0.005,31,31,3654,,none
1250,28,2/12/2006,W,clear,,clear,clear,none,none,none,,,,,,,,NM,,NM,NM,,,,,,NM,13.2,7.8,11.94,4.33,1732,NM,0.005,0.11,0.005,5,30,738,,salinity is 1.1 ppt at 12.3
1251,17,3/5/2006,W,overcast,steady,cloudy,clear,none,none,none,0,,,,none,,,,none,light,"cell phone, tire","10 plastic, 90 large items",,,,,,16.0,13.2,7.7,9.72,0.43,985,NM,0.16,0.22,0.10,52,63,2046,,none
1252,18,3/5/2006,W,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,16.7,14.1,8.1,10.68,1.37,1560,NM,0.03,0.08,0.005,10,171,2481,,none
1253,1,5/14/2006,D,overcast,steady,clear,clear,none,none,none,6.8,,,,78.8,,,,none,light,"glass/plastic bottle, styrofoa","40 plastics, .40 non-recyclabl",,,,,,21.5,18.3,8.2,10.52,0.60,1725,NM,0.08,0.60,0.09,5,8,1375,,
1254,2,5/14/2006,D,clear,steady,clear,clear,none,none,none,0,,,,41.2,,,,none,none,none,none,,,,,,21.0,17.7,8.0,11.40,0.30,1201,NM,0.35,0.22,0.04,74,110,5475,,none
1255,1,4/23/2006,D,overcast,steady,clear,clear,none,garbage,none,0,,,,65,,,,none,light,none,100 plastic,,,,,,18.0,16.5,8.6,14.49,0.57,1375,NM,0.12,0.53,0.02,5,10,1644,,
1256,3,5/14/2006,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,23.0,16.4,7.9,9.01,0.47,705,NM,0.01,0.08,0.04,31,20,1014,,none
1257,2,4/23/2006,D,overcast,steady,cloudy,clear,none,none,none,0,,,,31,,,,none,light,none,20% plastics 5% recyclables 75,,,,,,13.5,13.1,8.1,11.18,0.38,1098,NM,0.36,0.30,0.005,97,148,2382,,
1258,5,5/14/2006,D,clear,steady,clear,clear,none,none,none,0,,,,77.5,,,,none,light,2 items,"50 plastics, 50non-recyclable",,,,,,21.5,18.0,8.0,12.27,0.50,299,3.1,3.90,0.72,0.06,120,141,7270,,none
1259,3,4/23/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,15.0,11.8,8.0,10.61,0.56,641,NM,0.02,0.03,0.01,5,41,554,,
1260,7,5/14/2006,D,clear,steady,clear,green,none,none,none,0,,,,69.6,,,,none,light,4 items,100 non-

recyclables,,,,,,21.0,17.8,7.6,7.24,1.85,293,NM,0.44,0.49,0.14,441,480,19863,,none
1261,12,5/14/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,95,,,,none,light,"plastic bottle, 55 gallon tras","5 plastics, 95 large items",,,,,,19.5,20.3,8.1,9.84,0.46,1645,NM,0.05,0.42,0.07,5,5,8164,,none
1262,13,5/14/2006,D,clear,steady,clear,clear,none,none,none,0,,,,5,,,,none,light,4-5 items,"70 non-recyclables, 30plastics",,,,,,20.5,17.8,7.5,8.33,1.38,346,NM,1.16,0.74,0.15,411,776,12997,,none
1263,5,4/23/2006,D,overcast,steady,clear,clear,none,other_leaves,none,0,,,,86,,,,none,light,none,90% plastics 10% large items,,,,,,14.5,14.2,8.1,10.78,1.14,3250,4.4,3.50,0.46,0.01,64,135,8686,,
1264,14,5/14/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,1 hand trowel,100 recyclables,,,,,,16.0,15.2,8.1,9.42,0.43,1099,0.2,0.09,0.11,0.06,52,41,2014,,none
1265,7,4/23/2006,D,overcast,heavy,clear,clear,rotten_eggs_musty,none,none,0,,,,25.7,,,,none,high,human waste observed,90% non-recylable 10% plastics,,,,,,13.5,13.6,7.9,9.37,1.50,3,NM,1.71,0.46,0.05,158,292,4106,,
1266,12,4/23/2006,D,overcast,heavy,clear,clear,none,none,none,0,,,,82,,,,none,light,none,100% plastic,,,,,,15.0,16.5,8.3,9.26,0.78,1395,NM,0.12,0.25,0.03,20,5,2187,,
1267,13,4/23/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,2.6,,,,none,light,none,90% plastics 10%recylables,,,,,,15.0,13.5,7.6,9.35,1.48,3530,NM,0.04,0.56,0.04,187,959,14136,,
1268,14,4/23/2006,D,clear,steady,clear,none,none,none,none,0,,,,4.47,,,,none,none,none,none,,,,,,14.5,13.1,8.1,10.48,0.24,954,0.5,0.33,0.04,0.01,5,10,2143,,
1269,17,5/14/2006,D,clear,steady,clear,clear,none,none,none,0,,,,41,,,,none,light,"car door, bags","50 non-recyclables, 50 large i",,,,,,22.5,20.1,7.3,7.62,0.55,1008,NM,0.36,0.40,0.06,41,63,1918,,none
1270,18,5/14/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,1,,,,none,light,"paper cup, chip bag, broken mi","66 non-recyclables, 34 recycla",,,,,,18.8,16.8,7.9,9.46,0.28,1452,NM,0.02,0.15,0.02,98,10,2310,,none
1271,17,4/23/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,19,,,,none,light,1 tire 5 envelopes,100% non-recyclables,,,,,,14.8,15.9,7.7,9.44,0.50,923,NM,0.15,0.36,0.03,20,51,2602,,
1272,21,5/14/2006,D,clear,NM,clear,brown,none,none,none,0,,,,94.5,,,,none,none,none,none,,,,,,NM,19.4,7.9,10.93,0.86,2775,NM,0.07,0.48,0.10,122,152,5324,,
1273,18,4/23/2006,D,clear,steady,clear,clear,none,none,none,0,,,,4.9,,,,none,light,styrofoam,100% non-recyclables,,,,,,17.3,17.0,8.1,9.69,0.16,1422,NM,0.04,0.16,0.005,30,5,8664,,
1274,22,5/14/2006,D,clear,NM,clear,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,23.5,8.0,9.74,2.23,1843,none,0.03,0.42,0.005,10,5,8164,,none
1275,23,5/14/2006,D,clear,NM,clear,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,23.3,8.0,8.96,2.75,1567,NM,0.01,0.43,0.01,20,10,6131,,none
1276,24,5/14/2006,D,clear,NM,clear,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,23.1,7.8,7.92,2.90,1394,NM,0.01,0.27,0.02,41,52,7701,,none
1277,21,4/23/2006,D,overcast,steady,clear,clear,none,none,none,0,,,,50,,,,none,light,none,100% non-recyclable,,,,,,NM,14.4,8.0,8.17,0.54,2620,NM,0.30,0.23,0.07,152,148,3255,,
1278,22,4/23/2006,D,clear,lake,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,18.5,8.1,8.86,4.95,1469,NM,0.01,0.21,0.05,10,20,638,,Salinity = 0.8 ppt at 18.35 de
1279,25,5/14/2006,D,clear,steady,clear,clear,none,none,other_leaves_pollen,0,,,,81.3,,,,none,none,none,none,,,,,,NM,21.0,7.9,9.33,0.75,1068,NM,0.02,0.36,0.07,10,36,3415,,none
1280,23,4/23/2006,D,overcast,lake,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,18.3,7.9,8.62,3.00,1238,NM,0.01,0.20,0.02,120,31,683,,salinity = 0.6 ppt at 18.3 deg
1281,26,5/14/2006,D,clear,NM,clear,clear,none,none,other_leaves_pollen,0,,,,none,,,,none,none,none,none,,,,,,NM,23.2,7.7,7.47,3.30,1338,NM,0.005,0.45,0.04,31,10,6867,,none
1282,27,5/14/2006,D,clear,NM,cloudy,clear,none,none,other_leaves,NM,,,,NM,,,,none,none,none,none,,,,,,NM,23.6,8.0,8.79,5.20,1553,NM,0.01,0.43,0.06,20,51,7270,,none
1283,28,5/14/2006,D,clear,NM,cloudy,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,NM,23.6,8.0,8.91,3.40,1800,NM,0.01,0.47,0.08,5,10,5475,,none
1284,24,4/23/2006,D,overcast,lake,other_bubbles,NM,none,none,mosquito larvae,NM,,,,NM,,,,none,none,none,none,,,,,,NM,17.9,7.8,7.52,4.15,1136,NM,0.005,0.18,0.03,591,201,1259,,Salinity= 0.6 ppt at 17.95 deg
1285,25,4/23/2006,D,overcast,lake,clear,clear,none,none,none,0,,,,63,,,,none,none,none,none,,,,,,NM,16.5,8.2,8.91,0.12,936,NM,0.06,0.37,0.10,20,8,2732,,
1286,26,4/23/2006,D,overcast,lake,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,18.3,7.9,7.85,5.60,1190,NM,0.01,0.28,0.01,354,5,1233,,salinity = .06 ppt at 18.35 de

1287,27,4/23/2006,D,overcast,lake,clear,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,18.3,8.0,8.34,
3.10,1215,NM,0.005,0.35,0.01,73,5,1050,,Salinity = 0.7 ppt at 18.4 deg
1288,28,4/23/2006,D,overcast,lake,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,17.9,8.1,9.20,
3.70,1267,NM,0.01,0.16,0.005,52,20,697,,salinity = .65 ppt at 17.95 de
1289,28,5/10/2005,D,clear,lake,cloudy,brown,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,NM,2.8,8.0,9.54,2.70,
1535,NM,0.01,0.22,0.01,5,20,1860,,
1290,22,5/10/2005,D,clear,lake,cloudy,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,21.0,8.0,9.73,4.
05,1566,NM,0.01,0.17,0.06,5,10,1201,,
1291,23,5/10/2005,D,clear,lake,cloudy,brown,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.3,7.9,7.92,
3.75,1331,NM,0.01,0.23,0.02,148,31,10462,,
1292,24,5/10/2005,D,clear,lake,cloudy,NM,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,NM,20.6,7.9,8.72,6.10,1
192,NM,0.01,0.25,0.03,31,10,19863,,
1293,25,5/10/2005,D,clear,lake,clear,clear,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,19.8,8.0,11.20,0.6
9,1069,NM,0.01,0.28,0.02,52,31,17329,,
1294,26,5/10/2005,D,clear,lake,cloudy,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,21.8,7.9,9.01,2.
08,1219,NM,0.01,0.23,0.02,5,5,5475,,
1295,27,5/10/2005,D,clear,lake,cloudy,brown,none,none,none,0,,,,NM,,,,none,none,none,none,,,,,,NM,21.6,8.0,9.57,3.7
3,1412,NM,0.01,0.23,0.03,20,10,5475,,
1297,21,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,16.3,8.0,7.44,1.10,2790,NM,,,,NM,63,4106,,
1298,22,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,17.5,8.4,10.61,1.40,2660,NM,,,,NM,5,2909,,
1299,23,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,17.0,8.4,8.63,1.40,2700,NM,,,,NM,5,5475,,
1300,24,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,17.0,8.3,8.57,NM,2670,NM,,,,NM,5,7270,,
1301,25,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,16.3,2.6,4.80,1.10,8120,,,,,NM,5,6131,,
1302,26,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,17.3,8.3,8.82,1.57,2700,NM,,,,NM,5,10462,,
1303,27,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,17.3,8.4,9.09,1.30,2760,NM,,,,NM,5,5172,,
1304,28,10/30/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,17.5,8.4,NM,1.40,2750,none,NM,,,NM,20,2613,,
1305,21,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,22.1,8.3,N
M,10.20,2565,,,,,10,31,724192,,
1306,22,7/19/2007,D,clear,none,cloudy,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,26.9,8.3,
NM,12.35,2367,,,,,5,5,14136,,
1307,23,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,25.9,7.9,N
M,10.00,2323,NM,,,,20,41,24191,,
1308,24,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,12.0,8.0,N
M,10.80,2315,NM,,,,10,30,724192,,
1309,25,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,24.1,7.8,N
M,7.00,2204,NM,,,,10,10,724192,,
1310,26,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,25.2,8.2,N
M,9.90,2271,NM,,,,5,30,24192,,
1311,27,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,26.9,8.4,N
M,10.00,2305,NM,,,,5,5,19863,,
1312,28,7/19/2007,D,clear,none,cloudy,green_gray,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,NM,27.6,8.6,N
M,9.85,2316,NM,,,,5,5,19863,,
1313,21,9/25/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,18.5,7.8,11.30,NM,2580,NM,,,,5,373,19863,,
1314,22,9/25/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae
100%,none,none,none,,,,,,NM,19.9,8.3,9.98,NM,NM,NM,,,,10,638,24192,,

1315,23,9/25/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae 100%,none,none,none,,,,,,NM,19.8,8.3,8.45,NM,2460,NM,,,,41,504,24192,,
1316,24,9/25/2007,D,clear,none,cloudy,gree,none,none,other_algae,NM,,,,NM,,,,algae 100%,none,none,none,,,,,,NM,20.1,8.3,6.09,NM,2600,NM,,,,10,836,24192,,
1317,25,9/25/2007,D,clear,none,cloudy,none,none,none,other_algae,NM,,,,NM,,,,algae 100%,none,none,none,,,,,,NM,19.7,8.2,5.35,NM,2680,NM,,,,10,448,24192,,
1318,26,9/25/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae 100%,none,none,none,,,,,,NM,20.6,8.5,10.20,NM,2710,NM,,,,10,839,24192,,
1319,27,9/25/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae 100%,none,none,none,,,,,,NM,20.3,8.4,9.91,NM,2610,NM,,,,10,512,15531,,
1320,28,9/25/2007,D,clear,none,cloudy,green,none,none,other_algae,NM,,,,NM,,,,algae 100%,none,none,none,,,,,,NM,20.2,8.3,12.51,NM,2590,NM,,,,10,464,24192,,
1321,21,8/22/2007,D,clear,none,none,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,24.5,8.1,6.32,11.00,2685,NM,,,,10,20,24192,,
1322,22,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,25.5,8.3,6.25,11.00,2700,NM,,,,5,20,14136,,
1324,23,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,25.7,8.3,7.51,11.00,2670,NM,,,,10,20,15531,,
1325,24,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,25.6,8.2,5.65,10.80,2650,NM,,,,41,10,24192,,
1326,25,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,25.2,8.3,6.75,10.10,2590,NM,,,,10,5,24192,,
1327,26,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,26.7,8.4,7.38,8.50,2680,NM,,,,10,10,24192,,
1328,27,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,26.7,8.4,8.65,10.70,2700,NM,,,,10,10,24192,,
1329,28,8/22/2007,D,clear,none,none,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,27.0,8.5,9.54,10.60,2750,NM,,,,5,5,19863,,
1330,2,4/11/2008,W,clear,trickle,clear,yellow,none,none,other_algae,NM,,,,NM,,,,CLRZ= 20%,light,2 items (plastic lid/pipe),P=100%,,,,,,20.9,12.1,8.3,10.11,0.23,13,NM,2.28,0.60,NM,74,52,754,,
1331,3,4/11/2008,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,15.5,11.4,8.3,8.60,0.00,740,NM,0.00,0.26,NM,0,0,265,,
1332,5,4/11/2008,W,clear,steady,clear,yellow,none,other_veg-watercress,other_algae,NM,,,,NM,,,,algae 95%,light,2 items (aluminum can/ cigarette butt),R=50%
NRT=50%,,,,,,24.8,13.0,8.3,11.99,0.42,5135,NM,3.98,1.12,NM,20,63,4884,,"tree frog, thistle, pp downstream, willow fur"
1333,15,3/6/2008,W,clear,heavy,milky,brown,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,22.3,15.7,7.8,NM,1.90,1393,NM,,,,,,,,
1334,30,4/11/2008,W,clear,steady,clear,clear,none,none,other_algae_foam,NM,,,,NM,,,,"algae=60%, white foam (less than 1",light,none,none,,,,,,NM,NM,NM,NM,NM,NM,NM,5.88,1.14,NM,52,30,8164,,"car issues, no data recorded"
1335,1,3/6/2008,W,clear,heavy,clear,yellow_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,22.5,13.3,7.4,9.57,1.50,13,NM,NM,NM,NM,NM,NM,NM,,
1336,14,3/6/2008,W,clear,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,17.5,13.4,8.3,9.07,0.00,956,NM,,,,,,,,
1337,1,5/4/2008,D,overcast,heavy,clear,clear,none,none,other_algae,95,,,,45,,,,none,none,none,none,,,,,,20.0,17.6,8.3,11.46,NM,1835,NM,0.02,0.55,NM,20,5,8164,,dead batteries in turbidity meter
1338,2,5/4/2008,D,overcast,steady,other,green,none,none,other_algae,NM,,,,NM,,,,none,light,1 iten (PVC pipe),NRT=100%,,,,,,15.0,13.8,7.9,11.28,0.17,1284,NM,0.63,0.09,NM,41,20,2247,,
1339,3,5/4/2008,D,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,15.5,14.0,7.8,8.32,0.07,718,NM,0.00,0.00,NM,0,10,605,,
1340,5,5/4/2008,D,clear,trickle,clear,clear,none,,other_algae_leaves,NM,,,,NM,,,,none,none,none,none,,,,,,19.0,15.5,8.1,14.56,0.70,3330,NM,2.32,0.37,NM,52,31,3448,,
1341,14,5/4/2008,D,overcast,steady,clear,clear,none,none,other_algae,80,,,,none,,,,filament algae= 40%,none,none,none,,,,,,16.1,16.9,8.4,9.36,0.08,1026,NM,0.00,0.00,NM,75,63,3654,,fire area

1342,19,5/4/2008,D,overcast,steady,clear,clear,none,none,mosquito larvae_other_algae,95,,,,30,,,,CLRZ,light,3 items,P=30% NRT=70%,,,,,,14.8,14.4,7.8,8.33,0.10,861,NM,0.00,0.00,NM,10,10,1594,,
1343,30,5/4/2008,D,clear,steady,clear,clear,none,none,other_leaves,NM,,,,NM,,,,none,none,none,none,,,,,,19.0,15.2,7.8,9.99,0.33,3640,NM,5.48,0.69,NM,374,98,6131,,
1344,21,5/4/2008,D,clear,steady,clear,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,17.6,7.7,3.90,4.30,2640,NM,0.35,0.28,NM,10,10,7701,,
1345,22,5/4/2008,D,clear,steady,cloudy,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.5,7.9,2.78,2.80,2030,NM,0.02,0.27,NM,0,20,24196,,
1346,23,5/4/2008,D,clear,trickle,clear,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.7,8.0,3.32,4.60,1740,NM,0.02,0.28,NM,10,41,24196,,
1347,24,5/4/2008,D,clear,none,clear_muddy,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.7,7.9,3.95,4.50,1470,NM,0.01,0.14,NM,20,5,19863,,
1348,25,5/4/2008,D,NM,steady,clear,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,18.8,7.9,5.37,3.90,1330,NM,0.11,0.07,NM,0,5,3076,,
1349,26,5/4/2008,D,overcast,steady,none,green,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.2,7.9,4.61,NM,1390,NM,0.00,0.13,NM,20,5,16462,,
1350,27,5/4/2008,D,clear,trickle,clear,none,none,oily sheen,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.7,7.9,3.68,4.90,1560,NM,0.00,0.25,NM,32,10,17329,,
1351,28,5/4/2008,D,overcast,steady,clear,none,none,none,none,NM,,,,NM,,,,none,none,none,none,,,,,,NM,20.1,7.9,3.30,4.90,2217,NM,0.00,0.16,NM,32,10,19863,,
1352,31,5/4/2008,D,overcast,trickle,clear,clear,none,none,none,0,,,,0,,,,none,light,none,R=100%,,,,,,22.0,13.7,7.4,8.83,NM,4763,NM,0.00,0.00,NM,120,131,3448,,
1353,32,5/4/2008,D,overcast,steady,clear,clear,none,none,none,0,,,,65,,,,none,light,large item: 2x4 board,P=95% L=5%,,,,,,22.0,15.1,7.7,15.66,NM,4283,NM,0.00,0.00,NM,41,10,833,,
1354,1,6/8/2008,D,overcast,NM,clear,clear,musty,other_algae,none,5,,,,40,,,,spiro,none,none,none,,,,,,20.1,19.6,8.0,14.16,0.04,1792,NM,0.02,0.78,0.05,0,5,5475,,NZMS present
1355,2,6/8/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,plastic bottles,100% plastic,,,,,,19.0,15.6,7.9,8.96,0.77,1306,NM,0.58,0.21,0.04,135,75,2755,,
1356,3,6/8/2008,D,clear,steady,clear,clear,none,none,mosquito larvae,NM,,,,NM,,,,NM,none,none,none,,,,,,20.0,16.0,7.8,7.01,0.00,706,NM,0.01,0.04,0.01,10,10,1467,,
1357,5,6/8/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,moderate,NM,100% non-recyclable trash,,,,,,24.0,17.8,8.1,12.50,0.11,3245,NM,2.50,0.45,0.05,31,31,5172,,
1358,21,6/8/2008,D,clear,none,cloudy,green,none,none,none,NM,,,,NM,,,,NM,none,none,none,,,,,,18.8,20.7,4.1,7.27,4.10,2385,NM,0.01,0.35,0.11,5,75,4245,,salinity 1.26 ppt
1359,22,6/8/2008,D,clear,none,milky,green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,20.6,23.9,7.5,8.73,3.70,2245,NM,0.00,0.36,0.05,10,10,3725,,salinity 1.12 ppt
1360,23,6/8/2008,D,clear,none,cloudy,green,none,none,NM,NM,,,,NM,,,,none,none,none,none,,,,,,22.5,24.4,7.1,8.22,5.40,1885,NM,0.00,0.34,0.06,10,5,6130,,salinity 0.941 ppt
1361,24,6/8/2008,D,clear,none,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,23.0,24.2,7.4,8.97,5.40,1840,NM,0.00,0.38,0.05,30,5,9804,,salinity 0.92 ppt
1362,25,6/8/2008,D,clear,none,clear,green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,23.0,23.4,7.3,12.32,2.30,1430,none,0.01,0.25,0.04,5,5,6130,,"salinity 0.7 ppt, Samples taken about 250 feet uptream of usual spot"
1363,26,6/8/2008,D,clear,none,cloudy,green,none,NM,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,25.5,24.3,7.4,9.84,5.60,1740,none,0.00,0.35,0.06,20,10,7270,,salinity 0.87 ppt
1364,27,6/8/2008,D,clear,none,cloudy,green,none,none,NM,NM,,,,NM,,,,none,none,none,none,,,,,,25.5,25.1,7.4,8.60,4.20,1910,none,0.00,0.35,0.10,10,41,2812,,saliniity 0.96 ppt
1365,28,6/8/2008,D,clear,none,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,none,none,none,,,,,,19.5,22.3,7.1,9.05,4.80,2355,none,0.00,0.33,0.11,10,31,24196,,salinity 1.18 ppt
1366,14,6/8/2008,D,overcast,steady,clear,clear,none,none,none,NM,,,,80,,,,none,none,none,none,,,,,,19.8,19.1,8.3,16.17,0.00,1053,NM,0.01,0.03,0.00,10,5,3255,,
1367,15,6/8/2008,D,clear,steady,clear,clear,none,garbage,none,5,,,,95,,,,none,light,trash downstream,"plates, plastics, bags, bottles",,,,,,21.4,20.4,7.3,18.14,0.21,2260,NM,0.19,0.18,0.00,30,41,5172,,
1368,19,6/8/2008,D,clear,steady,clear,clear,none,none,none,0,,,,95,,,,none,none,none,none,,,,,,17.5,15.7,7.9,15.06,0.12,914,NM,0.02,0.21,0.04,41,5,2603,,

1369,30,6/8/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,none,none,,,,,,24.0,17.5,7.9,9.12,1.10
,3525,NM,5.96,0.76,0.05,160,122,7701,,
1370,1,7/13/2008,D,clear,steady,clear,NM,musty,other_algae,none,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,22.0,7.6,7.34
,0.38,2230,NM,0.01,1.35,0.00,0,5,7701,,NZMS Present
1371,2,7/13/2008,D,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,none,100%
plastics,,,,,,23.8,18.6,7.6,7.58,0.43,1364,NM,0.29,0.38,0.06,906,86,2809,,
1372,3,7/13/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,none,none,,,,,,25.0,20.2,7.6,5.36,0.0
0,725,NM,0.04,0.09,0.04,122,5,2809,,
1373,5,7/13/2008,D,clear,steady,clear,clear,rotten_eggs,none,none,NM,,,,NM,,,,NM,light,"paper towels, wipes",100%
non-recylable trash,,,,,,28.0,21.2,8.0,11.35,0.40,3375,NM,3.74,0.35,0.04,197,305,10462,,
1374,14,7/13/2008,D,NM,steady,clear,clear,none,none,none,NM,,,,40,,,,none,none,none,none,,,,,,27.8,21.8,8.2,8.36,0.45
,1070,NM,0.01,0.08,0.02,41,20,3609,,
1375,15,7/13/2008,D,NM,NM,cloudy,green,none,none,none,10,,,,100,,,,none,NM,NM,NM,,,,,,NM,21.7,7.8,9.03,5.85,2
560,NM,0.15,0.33,0.02,20,41,19863,,swimmers upstream causing water to become very turbid
1376,19,7/13/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,100,,,,none,light,metal frame,100% Non-recyclable
trash,,,,,,22.5,17.7,7.8,8.65,0.54,962,NM,0.02,0.14,0.04,52,5,488,,
1377,30,7/13/2008,D,clear,steady,cloudy,clear,none,none,none,NM,,,,80,,,,none,none,none,none,,,,,,26.8,21.1,7.8,8.29,1
.20,3630,NM,5.04,0.64,0.01,228,52,17329,,
1378,21,7/13/2008,D,overcast,none,cloudy,green,none,none,none,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,25.5,25.6,7.2,13.21
,17.80,2770,NM,0.00,0.10,0.08,10,5,19863,,salinity 1.39 ppt
1379,22,7/13/2008,D,overcast,none,cloudy,green,none,none,none,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,26.8,26.5,8.1,13.02
,22.40,2415,NM,0.00,0.31,0.08,5,10,10462,,salinity 1.21
1380,24,7/13/2008,D,overcast,none,cloudy,green,none,none,none,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,27.2,7.5,10.05
,16.00,2220,NM,0.00,0.32,0.05,10,5,6131,,salinity 1.10 ppt
1381,25,7/13/2008,D,overcast,NM,clear,green,none,none,none,75,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,25.7,7.0,8.81,3.20,
1454,NM,0.00,0.16,0.05,5,20,17359,,salinity 0.726 ppt
1382,28,7/13/2008,D,overcast,none,cloudy,green,none,none,none,NM,,,,NM,,,,NM,light,NM,NM,,,,,,22.5,26.1,7.4,15.5
0,15.00,2550,NM,0.00,0.08,0.10,5,5,1120,,salinity 1.27 ppt
1383,21,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,29.8,27.7,7.4,12.26,33.20,2650,NM,0.00,0.00,0.00,0,0,24192,,salinity 1.35
1384,22,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,25.5,26.5,6.4,5.68,31.00,2550,NM,0.00,0.00,0.03,20,10,24192,,salinity
1.28
1385,23,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,25.5,25.5,6.8,5.29,37.80,2600,NM,0.00,0.00,0.00,10,0,24192,,salinity 1.28
1386,24,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,26.5,25.2,6.7,5.54,35.00,2490,NM,0.00,0.00,0.01,63,52,24192,,salinity
1.30 ppt
1387,25,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,28.5,25.1,6.7,5.54,33.80,2490,NM,0.00,0.06,0.03,10,41,24192,,salinity
1.25
1388,26,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,29.3,24.8,6.9,9.06,34.30,2540,NM,0.00,0.00,0.00,10,52,24192,,salinity
1.27
1389,27,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,29.5,26.7,7.1,8.84,31.20,2580,NM,0.00,0.01,0.01,41,41,24192,,salinity
1.29 ppt
1390,28,8/10/2008,D,,,,,,,,,,,,,,,,NM,NM,,,,,,32.5,28.1,7.7,13.43,32.50,2570,NM,0.00,0.00,0.06,20,0,24192,,salinity
1.29 ppt
1391,1,8/10/2008,D,clear,steady,cloudy,green,musty,NM,NM,10,,,,60,,,,NA,light,NA,NA,,,,,,29.5,21.8,7.5,7.11,0.90,23
00,NM,0.04,1.38,0.06,30,20,19863,,
1392,2,8/10/2008,D,clear,none,clear,clear,none,none,none,NA,,,,NA,,,,NA,light,light,50% non-recyclable trash 50%
recyclable,,,,,,22.3,16.4,7.5,5.59,1.40,1310,NM,0.04,0.20,0.05,30,1467,9208,,
1393,3,8/10/2008,D,clear,steady,clear,clear,none,none,none,NA,,,,NA,,,,NA,none,NA,none,,,,,,24.0,18.8,7.7,4.99,0.00,7
03,NM,0.02,0.06,0.08,98,20,12282,,
1394,14,8/10/2008,D,clear,steady,clear,clear,none,none,none,0,,,,60,,,,NM,NM,NA,NA,,,,,,26.0,21.7,8.1,8.70,0.10,1062
,NM,0.04,0.09,0.03,160,0,2382,,
1395,5,8/10/2008,D,clear,steady,clear,clear,none,none,none,NA,,,,NA,,,,NA,light,NA,100%
plastics,,,,,,28.5,19.0,8.0,10.72,0.30,3450,NM,3.80,0.30,0.04,86,85,10111,,
1396,15,8/10/2008,D,clear,steady,clear,green,none,other_algae,none,NA,,,,NA,,,,NA,light,NA,50% non-recyclable 50%
recyclable,,,,,,32.5,21.0,7.8,10.03,0.70,2730,NM,0.09,0.44,0.06,52,41,29192,,

1397,19,8/10/2008,D,clear,steady,clear,clear,none,none,none,,,,,20,,,,NM,none,NA,NM,,,,,,22.5,16.4,7.7,8.41,0.00,980,
NM,NM,0.08,0.05,31,10,6488,,
1398,30,8/10/2008,D,clear,steady,clear,clear,none,none,none,NA,,,,NA,,,,NA,light,NA,100% non-
recyclable,,,,,,27.0,19.3,7.9,8.80,0.70,3800,NM,5.64,0.58,0.05,537,330,24198,,
1399,1,9/14/2008,D,overcast,steady,clear,clear,none,none,none,,,,,,,,,NM,none,NA,NM,,,,,,20.0,19.7,7.4,3.60,0.70,2410,
NM,0.05,1.42,0.01,31,10,14136,,
1400,5,9/14/2008,D,overcast,steady,clear,clear,none,none,,,,,,,,,,NM,,NA,NM,,,,,,17.0,16.7,8.0,6.69,0.12,3440,NM,4.74,
0.39,0.00,201,203,14136,,
1401,12,9/14/2008,D,overcast,steady,clear,clear,none,other_film on surface,,,,,,,,,NM,light,NA,100% non recyclable
plastic,,,,,,16.8,20.4,7.9,6.24,1.40,2300,NM,0.01,0.24,0.02,10,5,4352,,
1402,15,9/15/2008,D,clear,steady,cloudy,clear,none,none,none,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,21.5,20.5,6.8,9.40,1.00,
2760,NM,1.38,1.05,0.06,121,10,17329,,
1403,30,9/12/2008,D,clear,steady,clear,clear,none,none,none,NA,,,,NA,,,,NA,light,NA,NM,,,,,,27.0,18.4,7.0,8.78,0.80,3
350,NM,7.24,0.87,0.02,426,428,24196,,
1404,21,9/14/2008,D,overcast,none,milky,green,none,none,none,,,,,,,,,NM,none,NA,NM,,,,,,,21.9,7.3,5.30,6.80,2930,N
M,0.00,0.16,0.08,5,10,24196,,salinity 1.46
1405,22,9/14/2008,D,overcast,none,milky,green,none,none,none,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,15.0,23.6,7.7,1.73,7.2
0,2890,NM,0.00,0.22,0.08,10,10,24196,,salinity 1.44
1406,23,9/14/2008,D,overcast,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,16.5,22.9,7.9,4.89,7.2
0,2910,NM,0.00,0.11,0.05,31,20,24196,,salinity 1.44
1407,24,9/14/2008,D,overcast,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,17.3,23.1,7.9,6.04,8.7
0,2890,NM,0.00,0.12,0.09,20,31,24196,,salinity 1.43
1408,25,9/14/2008,D,clear,none,cloudy,NM,none,NM,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,19.8,23.0,7.0,1.30,9.00,279
0,NM,0.00,0.19,0.17,5,5,24196,,salinity 1.42
1409,26,9/14/2008,D,clear,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,19.8,23.4,7.0,4.00,8.10,2
860,NM,0.00,0.14,0.09,10,5,24196,,salinity 1.43
1410,27,9/14/2008,D,clear,none,cloudy,NM,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,20.0,23.8,7.2,5.93,7.30,28
90,NM,0.00,0.15,0.09,10,5,24196,,salinity 1.44
1411,28,9/14/2008,D,overcast,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,15.3,22.8,6.8,6.15,7.2
0,2880,NM,0.00,0.07,0.05,10,85,24196,,salinity 1.44
1412,21,10/5/2008,D,overcast,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,17.5,20.2,7.8,6.32,8.3
0,3000,NM,0.00,0.14,0.13,10,10,12003,,salinity 1.52
1413,22,10/5/2008,D,overcast,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,16.8,21.4,7.7,2.00,9.5
0,2960,NM,0.00,0.13,0.77,20,5,8664,,salinity 1.49
1414,23,10/5/2008,D,clear,none,clear,green,none,NM,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,17.3,21.0,7.8,6.22,10.80,29
70,NM,0.00,0.09,0.17,5,31,24196,,Salinity 1.49
1415,24,10/5/2008,D,clear,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,18.3,21.1,7.8,5.98,10.80,
2960,NM,0.00,0.08,0.20,10,41,24196,,salinity 1.50
1416,25,10/5/2008,D,clear,none,cloudy,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,19.5,21.2,7.6,3.06,8.90,2
870,NM,0.00,0.08,0.28,10,5,24196,,salinity 1.41
1417,26,10/5/2008,D,clear,none,clear,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,20.3,21.8,7.9,8.01,9.80,289
0,NM,0.00,0.08,0.11,20,31,11199,,salinity 1.40
1418,27,10/5/2008,D,clear,none,clear,green,none,none,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,21.5,21.5,7.9,5.86,8.40,285
0,none,0.00,0.07,0.18,10,10,24196,,salinity 1.45
1419,28,10/5/2008,D,overcast,none,cloudy,NM,NM,NM,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,16.0,20.7,7.3,5.47,8.50,3
000,NM,0.00,0.12,0.11,10,5,12033,,salinity 1.50
1420,1,10/5/2008,D,clear,steady,clear,clear,none,none,NM,NA,,,,NA,,,,NA,none,NA,NA,,,,,,22.0,19.3,7.4,4.03,2.10,25
10,NM,0.06,1.44,0.04,20,52,15531,,
1421,5,10/5/2008,D,clear,steady,clear,clear,none,none,none,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,16.0,15.4,8.0,6.60,0.30,35
70,NM,4.68,0.35,0.02,109,243,8664,,
1422,12,10/5/2008,D,overcast,intermittent,clear,clear,none,oily
sheen,NM,NA,,,,NA,,,,NA,NM,NA,NA,,,,,,15.5,17.7,7.8,5.41,0.38,2390,NM,0.00,0.26,0.00,63,282,5475,,
1423,15,10/5/2008,D,clear,steady,clear,clear,none,other_dead algea?
,NM,NA,,,,NA,,,,light,NM,NA,NA,,,,,,20.5,18.2,7.9,9.45,1.00,3040,NM,0.44,0.45,0.03,10,10,24196,,

1424,3,11/9/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,NM,12.9,7.7,8.91,0.00,722,NM,0.01,0.02,0.13,5,5,332,,
1425,5,11/9/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,NM,13.5,7.9,9.93,0.30,3430,NM,4.96,0.58,0.00,109,5475,63,,
1426,13,11/9/2008,D,clear,steady,clear,NM,none,none,NM,NM,,,,NM,,,,NM,light,NM,%100 plastics,,,,,,NM,15.3,7.5,7.65,1.40,3610,NM,1.48,0.82,0.00,452,20,15531,,
1427,30,11/9/2008,D,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,NM,%100 plastics,,,,,,NM,13.7,7.9,8.70,0.90,3850,NM,1.48,0.70,0.00,332,233,12997,,
1428,15,11/6/2008,D,clear,steady,green,gray,none,none,none,NM,,,,NM,,,,NM,moderate,NM,%50 plastic %50 non recyclable trash,,,,,,25.0,13.4,7.6,10.01,0.80,2940,NM,1.85,0.51,0.12,20,52,5712,,
1429,1,11/6/2008,D,NM,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,NM,NM,,,,,,23.5,18.5,7.4,9.15,0.90,2760,NM,0.13,1.07,0.05,31,203,8664,,
1430,12,11/6/2008,D,clear,steady,clear,green,none,none,NM,NM,,,,NM,,,,NM,none,NM,NM,,,,,,26.0,14.0,8.0,9.56,1.60,2970,NM,0.00,0.25,0.08,52,75,4884,,
1431,14,11/6/2008,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,26.5,18.2,7.9,9.25,0.00,1211,NM,0.00,0.25,0.08,10,20,2613,,
1432,21,11/9/2008,D,clear,NM,cloudy,green,none,none,NM,,,,,,,,,NM,none,NM,NM,,,,,,18.0,14.9,7.2,NM,6.70,2960,NM,0.00,0.09,0.00,10,110,6867,,salinity 1.47 ppt
1433,22,11/9/2008,D,clear,NM,clear,brown,none,none,none,,,,,,,,,NM,none,NM,NM,,,,,,16.0,15.7,7.9,NM,7.40,2970,NM,0.00,0.10,0.00,5,74,6488,,salinity 1.49 ppt
1434,23,11/9/2008,D,clear,NM,clear,brown,none,none,NM,,,,,,,,,NM,,none,NM,,,,,,16.0,15.4,7.3,NM,10.50,2980,NM,0.00,0.05,0.00,5,97,9208,,salinity 1.49 ppt
1435,24,11/9/2008,D,clear,NM,clear,green,NM,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,16.0,15.6,7.5,NM,9.10,3020,NM,0.00,0.05,0.00,10,31,7270,,salinity 1.51
1436,25,11/8/2008,D,clear,NM,clear,green,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.8,15.4,17.2,NM,8.50,3040,NM,0.00,0.10,0.00,20,63,6131,,salinity 1.51 ppt
1437,26,11/9/2008,D,clear,NM,clear,green,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.0,16.1,7.5,NM,9.10,3060,NM,0.00,0.03,0.00,5,30,7701,,salinity 1.52 ppt
1438,27,11/9/2008,D,clear,NM,clear,green,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.0,16.0,7.6,NM,9.00,3000,NM,0.00,0.10,0.03,20,160,10462,,salinity 1.49
1439,28,11/9/2008,D,clear,NM,clear,green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,16.5,15.9,7.2,NM,7.80,2940,NM,0.00,0.10,0.00,31,121,8164,,salinity 1.47
1440,1,12/7/2008,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,20.5,15.5,8.0,9.98,0.50,1835,NM,6.24,3.54,NM,30,63,3076,,
1441,2,12/7/2008,W,overcast,intermittent,clear,brown,none,oily sheen,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,18.5,12.0,7.2,4.39,0.70,1360,NM,0.80,0.35,NM,199,52,9208,,
1442,3,12/7/2008,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,16.8,11.8,7.8,7.09,0.00,762,NM,0.00,0.10,NM,5,5,98,,
1443,5,12/7/2008,W,clear,nm,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,1,%100 large items (NET),,,,,,17.5,12.4,8.0,7.60,0.90,3500,NM,4.00,0.56,NM,185,41,2987,,
1444,12,12/7/2008,W,overcast,steady,clear,clear,musty,other_bubbles,none,NM,,,,NM,,,,NM,light,5,%100 plastics,,,,,,16.0,11.8,8.0,9.30,0.70,2650,NM,0.09,0.09,NM,20,20,933,,
1445,13,12/7/2008,W,overcast,NM,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,NM,%50 plastics %50 non-reclclable,,,,,,19.8,15.0,7.4,5.91,0.70,3750,NM,1.25,0.00,NM,408,20,5794,,
1446,15,12/7/2008,W,overcast,steady,clear,clear,none,none,NM,NA,,,,NA,,,,NA,none,NA,NA,,,,,,19.5,20.4,7.3,7.76,1.10,1603,NM,6.84,4.12,,20,20,3654,,
1447,30,12/7/2008,W,overcast,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,20.0,12.6,7.8,7.06,6.63,3950,NM,5.12,0.76,NM,213,41,5172,,
1448,19,12/9/2008,W,clear,trickle,clear,clear,none,none,other_algae,NM,,,,NM,,,,NM,light,rebar,%100 non-recyclable,,,,,,18.3,10.2,7.8,5.53,0.05,1051,NM,0.00,0.05,NM,20,5,73,,
1449,21,12/7/2008,W,overcast,NM,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NM,NM,,,,,,20.0,13.0,7.1,6.14,5.70,2690,NM,0.00,0.08,0.04,5,10,1450,,salinity 1.36
1450,22,12/7/2008,W,overcast,NM,cloudy,brown,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.0,13.4,7.7,7.56,6.80,2570,NM,0.00,0.06,0.00,10,5,1500,,salinity 1.27

1451,23,12/7/2008,W,overcast,NM,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.5
,13.5,7.8,7.26,6.70,2550,NM,0.00,0.06,0.26,5,10,3448,,salinity 1.27
1452,24,12/7/2008,W,overcast,NM,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.3
,13.4,7.8,6.61,7.30,2520,NM,0.00,0.16,0.00,10,5,6131,,salinity 1.26
1453,25,12/7/2008,W,overcast,NM,cloudy,brown_green,none,NM,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.0,
13.0,7.3,5.03,4.40,2410,NM,0.01,0.10,0.00,41,5,4353,,salinity 1.21
1454,26,12/7/2008,W,overcast,NM,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.5
,13.6,7.8,6.83,6.80,2520,NM,0.00,0.08,0.17,5,5,8664,,salinity 1.25
1455,27,12/7/2008,W,overcast,NM,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,18.0
,14.0,7.7,6.27,7.10,2620,NM,0.00,0.06,0.00,5,52,11199,,salinity 1.30 ppt
1456,28,12/7/2008,W,overcast,NM,cloudy,brown,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,19.0,13.6,
7.6,6.88,6.20,2620,NM,0.00,0.06,0.00,10,5,1314,,salinity 1.31
1457,1,1/11/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,%100
recyclables,,,,,,30.0,14.3,7.8,11.68,1.20,1790,NM,4.96,3.26,0.07,10,10,2382,,
1458,2,1/11/2009,W,clear,intermittent,cloudy,NM,none,oily
sheen,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,24.0,10.2,6.6,9.59,1.80,1500,NM,0.77,0.31,0.00,52,52,703,,
1459,3,1/11/2009,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,15.8,9.3,7.6,9.90,0.20,72
2,NM,0.00,0.07,0.00,5,5,110,,
1460,5,1/11/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,%100 non
recylable,,,,,,21.0,10.2,7.7,12.21,0.90,3550,NM,5.64,0.48,0.02,63,75,1658,,
1461,12,1/11/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,24.0,8.9,7.9,11.54,1.90
,1950,NM,0.03,0.21,0.00,10,10,201,,
1462,13,1/11/2009,W,clear,steady,clear,clear,none,"other_light film, foam (light
brown)",none,NM,,,,NM,,,,NM,light,7,%14 non reclclable %28 plastics %57
reclyclables,,,,,,28.3,14.1,7.2,8.11,0.50,3710,NM,1.15,0.66,0.01,96,767,2382,,
1463,15,1/11/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,moderate,11,%60 plasics %40
recyclables not plastic,,,,,,28.5,13.6,7.5,10.77,1.90,2400,NM,1.12,0.70,0.00,10,41,1497,,
1464,18,1/11/2009,W,clear,trickle,clear,clear,none,none,other_leaves,NM,,,,NM,,,,none,none,NA,NA,,,,,,25.0,13.0,7.7,
8.78,0.40,1520,NM,0.00,0.10,0.00,10,5,295,,
1465,19,1/11/2009,W,clear,trickle,clear,clear,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,24.5,10.7,7.6,7.
59,0.30,1114,NM,0.00,0.10,0.01,5,5,1421,,
1466,30,1/11/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,29.3,11.7,7.6,9.65,0.60
,3920,NM,8.64,0.68,0.00,121,85,2187,,
1467,21,1/11/2009,W,clear,none,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,23.6,9.
6,7.8,10.53,4.50,2830,NM,0.00,0.15,0.04,5,10,1723,,salinity 1.37 ppt
1468,22,1/11/2009,W,clear,none,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,23.0,1
0.4,8.1,11.75,5.60,1980,NM,0.00,0.23,0.02,5,10,336,,salinity 0.99 ppt
1469,23,1/11/2009,W,clear,none,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NM,NM,,,,,,24.0,
9.8,8.0,10.70,6.10,1970,NM,0.00,0.09,0.04,10,5,2382,,salinity .99 ppt
1470,24,1/11/2009,W,clear,none,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,24.5,1
0.0,8.0,8.53,5.70,1920,NM,0.00,0.11,0.02,10,20,3255,,0.96
1471,25,1/11/2009,W,clear,NM,cloudy,brown_green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,25.0,10.5,7.7,1
0.40,3.20,1820,NM,0.00,0.11,0.06,20,20,1956,,salinity 0.91
1472,26,1/11/2009,W,clear,NM,cloudy,brown_green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,24.8,10.8,8.0,1
2.02,5.90,1900,NM,0.00,0.09,0.02,5,5,1500,,salinty 0.95 ppt
1473,27,1/11/2009,W,clear,NM,cloudy,brown_green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,25.0,10.4,8.0,1
2.34,5.80,1920,NM,0.00,0.12,0.02,5,52,2046,,salinity 0.96
1474,28,1/11/2009,W,clear,NM,cloudy,brown_green,none,none,other_leaves,NM,,,,NM,,,,NM,none,NA,NA,,,,,,21.8,9.
6,7.8,11.83,5.80,2220,NM,0.00,0.13,0.06,10,5,1187,,salinity 1.12
1475,1,2/17/2009,W,overcast,heavy,muddy,brown,NM,NM,NM,NM,,,,NM,,,,NM,nm,NM,NM,,,,,,NM,11.9,7.8,12.81,4
0.00,1094,NM,1.24,0.88,0.00,6867,5475,>24198,,measured after rain event
1476,2,2/17/2009,W,overcast,heavy,cloudy,brown,none,none,none,NM,,,,NM,,,,NM,light,5,NM,,,,,,12.3,10.4,8.1,10.80,
32.20,886,NM,0.81,0.14,0.00,7,155,11199,,measured after rain event
1477,3,2/17/2009,W,rain,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,9.0,8.9,7.4,10.99,4.20,230

,NM,0.08,0.01,0.17,85,52,461,,measured after rain event
1478,5,2/17/2009,W,overcast,heavy,muddy,brown,none,none,none,NM,,,,NM,,,,NM,light,2,%100 plastics,,,,,,13.0,9.5,7.6,11.58,170.00,1100,NM,0.65,1.63,0.01,24198,24198,24198,,measured after rain event
1479,12,2/17/2009,W,overcast,heavy,cloudy,brown_green,none,other_foam,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,12.0,11.0,7.9,11.07,14.90,943,NM,0.83,0.44,0.02,4569,551,24198,,measured after rain event
1480,13,2/17/2009,W,clear,heavy,cloudy,brown,none,none,none,NM,,,,NM,,,,NM,light,NM,NM,,,,,,15.5,10.5,7.1,10.31,20.30,1280,NM,0.90,0.92,0.00,2613,1354,17329,,shortly after rain event
1481,14,2/17/2009,W,overcast,heavy,muddy,brown,NM,NM,NM,NM,,,,NM,,,,NM,nm,NM,NM,,,,,,NM,10.9,7.3,13.11,39.50,368,NM,1.66,0.10,0.17,364,52,4352,,measured shortly after rain event
1482,15,2/17/2009,W,overcast,heavy,cloudy,clear,none,other_foam,NM,NM,,,,NM,,,,NM,moderate,NM,%75 plastics %25 reclyables,,,,,,13.5,11.8,7.7,10.58,35.50,1030,NM,1.27,1.07,0.02,6131,3282,>24198,,measured post rain event
1483,1,3/1/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,30.0,15.5,8.3,11.64,2.60,1580,NM,8.44,3.12,0.22,31,10,1789,,
1484,2,3/1/2009,W,clear,steady,clear,brown_green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,22.5,11.5,7.9,NM,0.90,1370,NM,0.93,0.29,0.19,52,10,1664,,
1485,3,3/1/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,17.8,11.3,7.8,NM,0.20,710,NM,0.02,0.12,0.17,10,5,350,,
1486,5,3/1/2009,W,clear,trickle,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,5,100% plastics,,,,,,17.5,11.8,7.9,11.24,0.71,3510,NM,4.36,0.41,0.16,75,84,6488,,
1487,12,3/1/2009,W,clear,steady,clear,clear,none,other_foam,none,NM,,,,NM,,,,NM,light,NM,100% non recyclable,,,,,,21.0,13.4,8.1,10.50,1.50,1520,NM,0.02,0.16,0.17,40,5,1259,,
1488,13,3/1/2009,W,clear,steady,clear,brown,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,26.3,14.5,7.4,NM,2.00,3630,NM,1.02,0.66,0.15,74,5,1259,,
1489,14,3/1/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,none,NA,,,,,,24.3,17.3,7.9,NM,0.50,1100,NM,0.30,0.17,0.13,63,5,2613,,
1490,17,3/1/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,high,50,%50 plastics,,,,,,24.5,19.3,6.5,NM,16.00,1020,NM,0.41,0.24,0.20,20,10,1414,,
1491,18,3/1/2009,W,clear,steady,clear,clear,none,none,mosquito larvae,NM,,,,NM,,,,NM,none,NA,NA,,,,,,23.5,14.7,7.8,NM,0.26,1540,NM,0.03,0.14,0.14,31,5,331,,
1492,19,3/1/2009,W,clear,steady,clear,clear,none,none,mosquito larvae,NM,,,,NM,,,,NM,none,NA,NA,,,,,,25.5,14.3,7.8,NM,0.50,860,NM,0.04,0.17,0.16,20,5,933,,
1493,30,3/1/2009,W,clear,steady,clear,red_gray,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,28.5,13.3,7.2,NM,0.90,3800,NM,5.72,0.61,0.19,169,98,12033,,
1494,21,3/1/2009,W,clear,none,cloudy,brown_green,none,other_algae,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,NM,14.7,8.0,10.59,2.90,1610,NM,0.00,0.10,0.04,41,10,1467,,.800 ppt
1495,22,3/1/2009,W,clear,none,clear,brown_green,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,NM,15.1,8.4,11.63,4.70,1490,NM,0.00,0.14,0.00,5,5,520,,.747 ppt
1496,23,3/1/2009,W,clear,none,cloudy,brown_green,none,none,other_algae,NM,,,,NM,,,,NM,none,NA,NA,,,,,,NM,15.0,8.2,11.19,2.30,1340,NM,0.02,0.11,0.00,5,5,882,,.671 ppt
1497,24,3/1/2009,W,clear,none,cloudy,brown_green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,NM,NM,15.1,11.02,2.90,1290,NM,0.03,0.12,0.03,5,5,2187,,0.640 ppt
1498,25,3/1/2009,W,clear,none,cloudy,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,NM,13.5,7.6,8.12,7.20,1140,NM,0.11,0.19,0.11,41,5,1354,,0.569 ppt
1500,26,3/1/2009,W,clear,none,cloudy,brown_green,none,none,none,NM,,,,NM,,,,NM,none,none,none,,,,,,NM,15.5,8.2,11.00,2.40,1640,NM,0.01,0.10,0.01,5,5,414,,0.669 ppt
1501,28,3/1/2009,W,clear,none,clear,brown_green,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,NM,14.5,8.3,11.11,2.80,1430,NM,0.00,0.09,0.03,5,5,759,,0.714 ppt
1502,15,3/1/2009,W,clear,steady,clear,clear,none,oily sheen,none,NM,,,,NM,,,,NM,moderate,50,50% Plastics 50% non recyclable trash,,,,,,27.5,17.2,7.7,11.21,1.20,1560,NM,5.40,3.16,0.31,5,5,1658,,
1503,27,3/1/2009,W,clear,none,cloudy,brown_green,none,none,NM,0,,,,NM,,,,NM,none,none,none,,,,,,NM,15.0,8.2,10.71,3.00,1470,NM,0.01,0.10,0.01,5,5,414,,salinity .731 ppt
1504,1,4/5/2009,W,clear,steady,clear,clear,none,none,none,,,,,100,,,,mat=100 % CLRZ,none,none,none,,,,,,25.0,15.6,NM,16.04,0.60,1400,NM,3.56,2.26,0.07,20,5,2046,,
1505,2,4/5/2009,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,21.5,10.8,8.3,NM,1.00,14

00,NM,0.67,0.22,0.04,75,153,3873,,
1506,3,4/5/2009,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,16.3,NM,8.5,NM,0.20,730,NM,0.00,0.04,0.07,5,5,426,,
1507,5,4/5/2009,W,clear,steady,clear,clear,none,none,NM,,,,,80,,,,mat=CLRZ,light,NM,100% trash,,,,,,22.0,11.9,NM,10.79,0.70,2,NM,4.00,0.34,0.00,175,197,24196,,
1508,12,4/5/2009,W,clear,steady,clear,clear,none,none,NM,,,,,100,,,,mat=100 % CLRZ,light,2,100% plastics,,,,,,15.5,14.1,8.7,9.37,0.70,1800,NM,0.01,0.22,0.04,5,20,987,,
1509,13,4/5/2009,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,2 to 3 items,"20% organics, 80% plastics",,,,,,23.0,14.6,7.8,NM,1.10,3500,NM,0.93,0.60,0.04,262,75,5794,,
1510,14,4/5/2009,W,clear,steady,clear,clear,none,none,other_leaves,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,21.5,13.9,8.8,NM,0.30,1200,NM,0.00,0.08,0.07,10,31,4106,,
1511,15,4/5/2009,W,clear,steady,clear,clear,ammonia_chlorine,none,NM,NM,,,,100,,,,mat=100 % CLRZ,light,broken glass,100% reclyclables non-plastics,,,,,,25.0,18.2,NM,11.22,0.70,1300,NM,5.16,3.56,0.16,10,63,2987,,
1512,17,4/5/2009,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,moderate,NM,NM,,,,,,23.0,14.4,8.0,NM,0.35,1300,NM,0.23,0.21,0.00,5,63,2755,,
1513,18,4/5/2009,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,22.0,14.0,8.6,NM,0.20,1600,NM,0.07,0.13,0.15,5,5,691,,
1514,30,4/5/2009,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NM,NM,,,,,,25.5,12.7,8.2,NM,0.70,3600,NM,5.12,0.50,0.06,98,30,6488,,
1515,21,4/5/2009,W,clear,NM,clear,brown_green,none,other_leaves,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,16.3,16.2,8.2,6.80,3.40,2170,NM,0.00,0.07,0.03,10,10,17329,,salinity = 1.01 ppt
1516,22,4/5/2009,W,clear,NM,clear,brown_green,none,other_leaves,NM,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,19.0,17.9,8.2,6.96,3.30,2110,NM,0.00,0.14,0.05,41,10,9204,,salinity = .974 ppt
1517,23,4/5/2009,W,clear,none,clear,brown_green,none,NM,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,20.0,18.5,8.3,7.31,4.00,1960,NM,0.00,0.00,0.00,5,5,2359,,salinity = .902 ppt
1518,24,4/5/2009,W,clear,none,clear,brown_green,NM,NM,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,21.0,17.9,8.3,7.66,3.20,1840,NM,0.01,0.07,0.06,10,10,3448,,salinity = 0.842 ppt
1519,25,4/5/2009,W,clear,none,clear,brown_green,none,NM,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,22.0,16.1,7.9,6.93,0.80,1450,NM,0.00,0.15,0.04,10,5,1430,,salinity = .655 ppt
1520,26,4/5/2009,W,clear,none,clear,brown_green,none,NM,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,23.3,18.6,8.3,7.56,8.30,11830,NM,0.00,0.07,0.00,5,5,4884,,salinity = .841 ppt
1521,27,4/5/2009,W,clear,none,clear,brown_green,none,NM,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,23.8,18.8,8.3,7.39,3.50,2030,NM,0.00,0.08,0.00,20,5,3448,,salinity = .933 ppt
1522,28,4/5/2009,W,clear,none,NM,brown_green,none,NM,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,15.0,16.6,8.3,6.87,3.80,2130,NM,0.01,0.11,0.06,10,5,8164,,salinity = 1.25 ppt
1523,1,5/3/2009,D,clear,steady,clear,clear,none,none,none,0,,,,75,,,,Mat=%75 CLRZ,none,NA,NA,,,,,,26.8,17.9,8.4,11.57,8.40,1960,NM,0.19,0.82,0.00,5,20,14136,,
1524,2,5/3/2009,D,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,PVC pipe,100% plastics,,,,,,22.0,15.7,7.8,10.30,1.10,1386,NM,0.35,0.31,0.00,145,146,1366,,
1525,3,5/3/2009,D,clear,steady,clear,NM,none,none,none,0,,,,0,,,,0,0,none,NA,,,,,,24.0,15.0,7.8,9.04,0.75,720,NM,0.01,0.08,0.00,20,10,345,,
1526,5,5/3/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,2.90,0.35,0.00,20,74,2909,,
1527,12,5/3/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,0.05,0.31,0.11,5,10,3784,,
1528,13,5/3/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,0.12,0.68,0.02,5,5,12033,,
1529,17,5/3/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,0.26,0.35,0.00,41,NM,3255,,
1530,30,5/3/2009,D,clear,steady,clear,clear,none,none,none,NA,,,,NA,,,,NA,none,NA,NA,,,,,,23.0,16.0,7.8,9.91,1.00,3790,NM,5.14,0.59,0.00,5,175,15531,,
1531,14,5/5/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,0.04,0.07,0.06,86,650,5475,,
1532,18,5/5/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,0.07,0.08,0.04,85,5,2613,,
1533,19,5/5/2009,D,,,,,,,,,,,,,,,,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,0.05,0.19,0.00,86,75,2755,,
1534,21,5/3/2009,D,overcast,NM,cloudy,green,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,22.0,18.7,7.6,7.66,9.70,2310,NM,0.00,0.04,0.00,5,5,5784,,salinity 1.18 ppt
1535,22,5/3/2009,D,overcast,none,cloudy,green,none,none,none,100,,,,0,,,,none,none,NA,NA,,,,,,22.0,20.8,7.9,8.60,6.00,2220,NM,0.02,0.06,0.00,10,5,5012,,salinity 1.11 ppt

1536,23,5/3/2009,D,overcast,none,cloudy,green,none,none,NM,100,,,,0,,,,NM,none,NA,NA,,,,,,23.3,21.0,7.7,10.12,11.9
0,1950,NM,0.02,0.08,0.00,5,5,4611,,salinity = 0.974
1537,24,5/3/2009,D,cloudy,none,cloudy,green,none,none,NM,100,,,,0,,,,NM,none,none,NA,,,,,,24.0,21.3,7.9,11.17,7.00
,1890,NM,0.00,0.08,0.00,5,5,4611,,salinity = 0.946
1538,25,5/3/2009,D,overcast,none,cloudy,green,none,none,NM,100,,,,0,,,,NM,NM,NM,NM,,,,,,26.0,19.1,7.6,10.07,3.30
,1480,NM,0.05,0.18,0.00,10,5,2613,,salinity = 0.741
1539,26,5/3/2009,D,overcast,NM,cloudy,green,none,none,NM,100,,,,0,,,,NM,NM,NM,NM,,,,,,26.0,22.0,7.9,11.46,4.30,
1830,NM,0.00,0.13,0.00,20,5,2187,,salinity = 0.914
1540,27,5/3/2009,D,overcast,NM,cloudy,green,none,none,NM,100,,,,0,,,,NM,light,"plastic bottle, plastic bag",100%
plastics,,,,,,25.5,21.6,8.0,11.95,9.90,1970,NM,0.00,0.04,0.14,134,10,12997,,salinity = 1.01 ppt
1541,28,5/3/2009,D,overcast,NM,cloudy,green,none,NM,,100,,,,0,,,,NM,none,none,NA,,,,,,20.0,19.6,7.9,11.10,11.10,22
10,NM,0.00,0.01,0.00,10,5,6131,,salinity 1.11 ppt
1542,1,6/7/2009,D,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,23.3,20.0,8.1,3.29,1.70,23
20,NM,0.06,0.89,0.00,5,41,>24196,,
1543,1,7/12/2009,D,clear,trickle,clear,red,sewage,none,NM,60,,,,none,,,,Flt=Spirogyra,0,NA,NA,,,,,,27.0,20.4,7.8,5.50,
1.70,2160,NM,0.01,1.41,0.00,122,20,>24196,,
1544,28,7/12/2009,D,clear,none,cloudy,brown,NM,NM,NM,NM,,,,NM,,,,NM,nm,NM,NM,,,,,,28.5,25.5,8.2,8.10,10.90,
2235,NM,0.00,0.10,0.18,5,10,15531,,AVG Salinity PPT 1.12
1545,27,7/12/2009,D,clear,none,cloudy,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,34.5,27.9,8.3,10.10,1
1.30,2480,NM,0.00,0.04,0.13,31,5,6131,,AVG Salinity PPT 1.24
1546,26,7/12/2009,D,clear,none,cloudy,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,33.8,26.5,7.9,6.80,11
.30,2420,NM,0.00,0.02,0.14,10,5,14136,,AVG Salinity PPT 1.20
1547,25,7/12/2009,D,clear,none,cloudy,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,33.0,26.0,8.1,7.00,14
.10,2,NM,0.00,0.07,0.14,10,20,9208,,AVG Salinity PPT 1.13
1548,24,7/12/2009,D,clear,none,clear,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,33.0,26.0,8.1,7.00,14.1
0,2430,NM,0.00,0.04,0.13,41,5,9804,,AVG Salinity PPT1.21
1549,23,7/12/2009,D,clear,none,cloudy,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,33.5,26.6,8.0,8.70,10
.90,2480,NM,0.00,0.01,0.19,5,5,10462,,AVG Salinity PPT 1.24
1550,22,7/12/2009,D,clear,none,cloudy,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,31.0,26.3,8.3,10.80,1
0.00,2440,NM,0.00,0.08,0.17,10,10,2014,,AVG Salinity PPT 1.22
1551,21,7/12/2009,D,clear,none,clear,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,31.0,25.2,8.0,6.00,11.6
0,2420,NM,0.00,0.06,0.27,122,5,24196,,AVG Salinity PPT 1.21
1552,17,7/12/2009,D,clear,trickle,clear,brown_green,none,none,none,0,,,,30-
40,,,,CLRZ,light,2,NM,,,,,,NM,18.9,7.3,3.42,0.10,1490,NM,0.10,0.29,0.00,158,231,4611,,
1553,19,7/12/2009,D,clear,steady,clear,clear,none,none,none,0,,,,5,,,,NM,none,NA,NA,,,,,,NM,18.0,8.2,10.50,0.00,1020
,NM,0.01,0.15,0.00,5,63,1935,,
1554,14,7/12/2009,D,clear,steady,clear,clear,other_mint,none,none,0,,,,small,,,,small,none,NA,NA,,,,,,NM,22.1,8.2,9.70
,0.10,1200,NM,0.03,0.09,0.00,546,173,5794,,
1555,12,7/12/2009,D,clear,trickle,clear,clear,none,none,none,,,,,,,,,filamentous algae,moderate,NM,15%-organic 35%-
plastic 50%nonrecyclable,,,,,,28.5,20.3,7.7,4.10,0.50,2170,NM,0.10,0.03,0.50,31,5,17329,,
1556,5,7/12/2009,D,clear,steady,clear,clear,sewage,none,none,NA,,,,NA,,,,NA,none,NA,NA,,,,,,29.6,17.8,8.1,9.40,23.8
0,3500,NM,3.20,0.30,0.00,1421,41,9804,,
1557,15,7/12/2009,D,clear,steady,clear,clear,none,none,none,15,,,,none,,,,NA,light,5,90%-recycle 5%-plastic 5%-
nonrecyclable,,,,,,28.0,19.5,7.8,7.50,0.80,2530,NM,0.04,0.60,0.02,31,41,24196,,
1558,13,7/12/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,26.5,19.0,7.7,6.70,1.80,37
70,NM,1.09,0.79,0.00,613,98,14136,,
1559,30,7/12/2009,D,clear,steady,clear,yellow_brown,none,none,mosquito
larvae,0,,,,none,,,,NA,none,NA,NA,,,,,,31.0,18.9,8.1,7.20,0.50,4090,NM,4.72,0.59,0.04,1119,31,14136,,
1560,2,7/12/2009,D,clear,intermittent,cloudy,clear_other_sheen,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,24.5,1
6.4,7.8,5.20,1.70,14180,NM,0.11,0.38,0.00,2909,9804,24196,,
1561,3,7/12/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,26.0,18.4,7.7,7.00,0.20,729
0,NM,0.01,0.13,0.00,132,5,1785,,
1562,2,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,light,100% plastics,"pen, ppc pipe, plastic
bag",,,,,,20.3,15.4,8.0,8.73,2.10,1490,NM,0.43,0.36,0.00,288,201,2014,,

1563,3,6/7/2009,D,overcast,steady,clear,clear,none,none,mosquito larvae,0,,,,none,,,,NA,none,NA,NA,,,,,,18.0,14.9,8.1,8.91,0.40,740,NM,0.00,0.04,0.00,5,5,591,,
1564,5,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,75,,,,CLRZ 100%,light,2,100% nonrecyclable,,,,,,20.3,16.5,7.8,2.57,1.00,3150,NM,3.16,0.55,0.34,295,197,9804,,
1565,12,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,40,,,,CLRZ with diatoms,light,9,"25% plastics, 75% nonrecyclable",,,,,,19.5,19.1,8.3,2.60,1.60,2200,NM,0.01,0.45,0.08,86,75,9804,,
1566,13,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,light,NM,"papers, small piece of carpet",,,,,,22.5,17.5,7.5,7.40,1.50,3500,NM,1.23,0.77,0.25,496,161,12997,,
1567,14,6/7/2009,D,"clear, overcast",steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,NA,19.2,8.5,10.10,0.70,1200,NM,0.04,0.10,0.03,311,108,4160,,
1568,15,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,light,10,"10% plastic, 50% nonrecyclable, 40% recyclable",,,,,,19.8,17.6,7.8,2.80,2.00,2800,NM,1.18,0.38,0.01,41,197,12033,,
1569,17,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,20,,,,NM,moderate,NM,"25% plastics, 25% nonrecyclable, 25% recyclable, 25% large items",,,,,,NM,18.3,7.9,5.20,1.70,1160,NM,0.10,0.32,0.01,336,110,8664,,
1570,18,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,moderate,NM,100% nonrecyclable,,,,,,NM,16.9,8.4,8.86,1.30,1560,NM,0.03,0.15,0.07,75,5,3873,,
1571,30,6/7/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,21.5,17.0,7.9,7.70,1.10,3380,NM,5.88,0.63,0.38,1314,616,>24196,,
1572,21,6/7/2009,D,overcast,NM,cloudy,green,none,none,other_planktonic algae,NM,,,,NM,,,,none,NM,NM,NM,,,,,,19.5,19.3,8.1,3.67,8.80,2740,NM,NM,0.12,0.04,5,52,6131,,AVG Salinity PPT 1.37
1573,22,6/7/2009,D,overcast,none,cloudy,green,none,other_planktonic algae,none,0,,,,NA,,,,NA,NM,NM,NM,,,,,,17.5,21.6,8.3,8.75,10.30,2620,NM,NM,0.14,0.14,20,5,3255,,AVG Salinity PPT 1.30
1574,23,6/7/2009,D,overcast,none,cloudy,green,none,none,other_planktonic algae,NM,,,,NM,,,,NA,NM,NM,NM,,,,,,18.5,21.7,8.3,8.40,12.20,2570,NM,NM,0.20,0.20,5,10,2603,,AVG Salinity PPT 1.29
1575,24,6/7/2009,D,overcast,none,cloudy,green,none,none,other_planktonic algae,NM,,,,NM,,,,NA,NM,NM,NM,,,,,,20.0,21.7,8.3,8.55,9.10,2530,NM,NM,0.37,0.05,41,31,4884,,AVG Salinity PPT 1.26
1577,25,6/7/2009,D,overcast,none,cloudy,green,none,none,other_planktonic algae,NM,,,,NM,,,,NA,NM,NM,NM,,,,,,20.5,20.7,7.5,2.92,3.10,1860,NM,NM,0.53,0.16,10,5,1467,,AVG Salinity PPT .932
1578,26,6/7/2009,D,overcast,none,cloudy,green,none,none,other_planktonic algae,NM,,,,NM,,,,NA,NM,NM,NM,,,,,,19.9,22.2,8.3,8.29,9.80,994,NM,NM,0.33,0.06,5,5,4352,,AVG Salinity PPT .988
1579,27,6/7/2009,D,overcast,none,cloudy,green,none,none,other_planktonic algae,NM,,,,NM,,,,NA,NM,NM,NM,,,,,,19.0,22.5,8.6,11.49,12.30,2620,NM,NM,0.20,0.00,5,5,5172,,AVG Salinity PPT 1.31
1580,28,6/7/2009,D,overcast,none,cloudy,green,none,none,other_planktonic algae (100%),NM,,,,NM,,,,NA,none,NM,NM,,,,,,18.3,21.0,8.4,12.25,9.90,2610,NM,NM,0.09,0.02,10,52,3076,,AVG Salinity PPT 1.30
1581,3,8/2/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,19.9,19.9,8.1,7.20,0.00,720,NM,0.00,0.12,0.01,86,5,4106,,
1582,13,8/2/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,24.0,19.6,7.6,6.90,0.50,3790,NM,1.52,0.84,0.03,749,1178,>24196,,
1583,21,8/2/2009,D,overcast,none,cloudy,green,NM,none,none,0,,,,"planktonic algae, some bubbly stuff",,,,"planktonic algae, some bubbly stuff",NM,NA,NA,,,,,,18.5,24.9,7.9,3.06,33.80,2580,NM,0.00,0.00,0.11,160,98,>24196,,AVG Salinity PPT 1.29
1584,28,8/2/2009,D,overcast,none,clear,green,none,none,none,0,,,,total planktonic,,,,total planktonic,NM,NA,NA,,,,,,19.0,25.4,7.8,3.17,23.30,2560,NM,0.00,0.00,0.17,16,52,>24196,,AVG Salinity PPT 1.27
1585,27,8/2/2009,D,clear,none,clear,green,none,none,none,0,,,,total planktonic,,,,total planktonic,NM,NA,NA,,,,,,28.0,25.5,8.1,3.18,34.20,2330,NM,0.00,0.00,0.11,20,31,>24196,,AVG Salinity PPT 1.25

1586,26,8/2/2009,D,clear,none,clear,green,NM,none,none,0,,,,total planktonic,,,,total planktonic,NM,NM,NM,,,,,,26.5,25.7,8.0,3.18,32.80,2520,NM,0.00,0.00,0.16,20,31,>24196,,AVG Salinity PPT 1.25
1587,25,8/2/2009,D,clear,none,cloudy,green,none,none,none,0,,,,total planktonic,,,,total planktonic,none,NA,NA,,,,,,25.0,25.0,7.6,1.15,21.00,2410,NM,0.00,0.00,0.37,75,5,>24196,,AVG Salinity PPT 1.21
1588,24,8/2/2009,D,clear,none,cloudy,green,none,none,none,0,,,,all planktonic,,,,all planktonic,NM,NA,NA,,,,,,22.5,25.7,8.1,3.86,27.90,2470,NM,0.00,0.00,0.13,84,31,>24196,,AVG Salinity PPT 1.24
1589,23,8/2/2009,D,clear,none,cloudy,green,none,none,none,0,,,,total planktonic,,,,total planktonic,NM,NA,NA,,,,,,21.5,25.7,8.0,3.23,33.50,2500,NM,0.00,0.00,0.12,41,63,>24196,,AVG Salinity PPT 1.25
1590,22,8/2/2009,D,overcast,none,cloudy,green,none,none,none,0,,,,all planktonic,,,,all planktonic,NM,NM,NM,,,,,,21.0,26.1,8.0,5.30,37.50,2550,NM,0.00,0.00,0.14,31,52,>24196,,AVG Salinity PPT 1.26
1591,17,8/2/2009,D,overcast,none,cloudy,gray,none,none,none,0,,,,none,,,,NA,light,5,100% plastics,,,,,,21.0,19.8,7.2,0.70,0.17,1610,NM,0.01,0.51,0.01,644,3654,11199,,
1592,19,8/2/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,20.0,19.0,8.2,10.42,0.00,1060,NM,0.01,0.11,0.02,63,31,2382,,
1593,14,8/2/2009,D,overcast,steady,clear,clear,none,none,none,0,,,,none,,,,NA,light,1,100% plastics,,,,,,20.0,20.0,8.3,10.40,0.00,1220,NM,0.00,0.05,0.01,933,84,3884,,
1594,15,8/2/2009,D,clear,steady,clear,clear,none,none_oily sheen(streaks),none,3,,,,80,,,,EN,none,NA,NA,,,,,,27.0,20.1,7.7,6.80,1.30,2670,NM,0.04,0.77,0.09,292,31,>24196,,
1595,5,8/2/2009,D,overcast,steady,clear,clear,none,none,none,0,,,,80,,,,CLRZ,none,NA,NA,,,,,,24.0,18.9,8.0,8.60,0.32,3600,NM,4.28,0.20,0.03,882,63,14136,,
1596,1,8/2/2009,D,overcast,none,clear,clear,none_other_swampy,none,none,75,,,,95,,,,spyrogyra,none,NA,NA,,,,,,23.0,20.5,7.5,3.80,1.03,2280,NM,0.04,1.29,0.13,189,5,>24196,,
1597,30,8/2/2009,D,clear,steady,clear,clear,none,none,none,0,,,,none,,,,NA,none,NA,NA,,,,,,25.0,20.1,8.0,7.70,0.80,4080,NM,9.24,0.51,0.13,1274,61,>24196,,
1598,2,8/2/2009,D,clear,none,milky,clear,none,none_other_light surface film,none,0,,,,none,,,,NA,none,NA,NA,,,,,,21.0,NM,NM,NM,NM,NM,NM,0.00,0.48,0.23,3873,1935,15531,,Samples taken in shallow water. Water was too shallow for other measurements.
1599,1,9/13/2009,D,overcast,none,clear,clear,none,none,,0,,,,0,,,,NM,none,NA,NA,,,,,,23.4,21.1,7.6,6.45,2.80,2300,NM,0.02,1.02,1.06,10,5,>24196,,
1600,3,9/13/2009,D,overcast,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,18.0,18.3,7.9,7.83,0.00,710,NM,0.00,0.00,0.00,41,5,1017,,
1601,5,9/13/2009,D,clear,trickle,clear,clear,none,none,none,0,,,,0,,,,NM,none,NA,NA,,,,,,NM,18.4,7.8,9.70,0.20,9240,NM,4.40,0.23,0.02,323,216,14136,,
1602,12,9/13/2009,D,clear,none,clear,clear,none,oily sheen,mosquito larvae,30,,,,30,,,,NM,light,NM,100% plastic,,,,,,NM,20.5,7.1,NM,1.30,6020,NM,0.02,0.28,0.27,2014,98,17329,,samples taken upstream from usual sampling location due to creek being dry
1603,13,9/13/2009,D,clear,trickle,clear,clear,none,none,NM,NM,,,,NM,,,,NM,light,NM,100% plastics,,,,,,22.5,19.6,7.5,7.25,0.70,3740,NM,1.22,0.88,0.06,1421,40,2143,,
1604,14,9/13/2009,D,overcast,trickle,clear,clear,none,other_pollen,none,NM,,,,NM,,,,NM,none,NM,NA,,,,,,23.5,21.0,8.1,8.99,0.90,1230,NM,0.01,0.06,0.00,495,249,2143,,
1605,15,9/13/2009,D,overcast,steady,clear,clear,rotten_eggs,none,NM,NM,,,,NM,,,,NM,light,NM,NM,,,,,,23.5,20.0,7.6,8.68,1.30,2420,NM,0.89,0.19,2.57,249,52,>24196,,
1606,18,9/13/2009,D,overcast,steady,clear,clear,none,other_brown sheen,NM,NM,,,,NM,,,,NM,light,NM,car tire,,,,,,21.5,18.5,8.0,8.60,0.00,16,NM,0.00,0.09,0.03,146,5,1607,,
1607,19,9/13/2009,D,overcast,trickle,clear,clear,none,garbage,none,NM,,,,NM,,,,NM,light,NM,50% plastics 50% non reclyclable trash,,,,,,21.8,18.3,7.9,7.21,0.70,1070,NM,0.00,0.08,0.04,134,10,5475,,
1608,30,9/13/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,23.0,19.0,8.0,9.07,0.70,3960,NM,7.44,0.67,0.07,1259,98,24196,,
1609,1,10/4/2009,D,clear,none,clear,clear,none,none,none,10,,,,100,,,,NM,none,NA,NA,,,,,,24.5,18.8,7.6,8.33,0.80,2300,NM,0.03,1.25,0.13,75,10,7701,,
1610,3,10/4/2009,D,clear,trickle,clear,clear,none,none,NM,0,,,,0,,,,NM,none,NA,NA,,,,,,15.0,14.8,8.0,8.50,0.00,660,NM,0.21,0.37,0.00,31,776,31,,
1611,5,10/4/2009,D,steady,steady,clear,clear,none,none,none,0,,,,95,,,,none,none,NA,NA,,,,,,17.0,12.7,8.1,10.73,0.30,3720,NM,4.36,0.42,0.33,173,63,4106,,

1612,12,10/4/2009,D,clear,none,clear,clear,none,none,bibe,0,,,,100,,,,none,light,NM,100% non-recyclable,,,,,,17.3,17.4,7.7,9.80,1.30,2400,NM,0.05,0.15,0.12,5,5,4106,,
1613,13,10/4/2009,D,clear,trickle,clear,clear,none,none,none,0,,,,80,,,,none,none,NA,NA,,,,,,19.3,16.0,7.5,7.65,0.60,3840,NM,1.82,0.97,0.34,1450,259,12033,,
1614,14,10/4/2009,D,clear,trickle,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,19.3,17.2,7.9,9.69,0.00,1270,NM,0.17,0.34,0.11,173,10,1664,,
1615,15,10/4/2009,D,clear,steady,clear,clear,none,none,none,0,,,,100,,,,none,moderate,NM,10% organics 20%plastics 60%non recyclable 10% recyclable (not plastic),,,,,,24.0,16.1,7.6,7.60,1.10,2390,NM,1.87,2.31,0.16,121,41,>24196,,
1616,18,10/4/2009,D,clear,trickle,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,100% plastics,,,,,,19.0,15.7,7.9,10.00,0.02,1570,NM,0.05,0.14,0.16,160,135,1054,,
1617,19,10/4/2009,D,clear,trickle,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NM,NA,,,,,,19.5,14.3,7.7,8.90,1.10,1100,NM,0.01,0.13,0.03,20,20,2481,,
1618,30,10/4/2009,D,clear,steady,clear,clear,none,none,none,0,,,,90,,,,none,none,NA,NA,,,,,,17.5,13.8,8.0,NM,0.60,4120,NM,11.28,0.80,0.08,5,52,12997,,
1619,1,11/8/2009,D,clear,steady,clear,clear,none,none,mosquito larvae,50,,,,NM,,,,NM,none,NA,NA,,,,,,19.0,18.0,7.3,NM,0.40,2550,NM,0.01,1.13,0.00,41,41,4611,,
1620,2,11/8/2009,D,clear,trickle,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,16.0,11.1,7.4,5.96,0.30,NM,NM,0.06,0.39,0.00,487,197,17329,,
1621,3,11/8/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,14.0,12.3,7.8,9.30,0.00,788,NM,0.00,0.08,0.21,5,10,331,,
1622,5,11/8/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,NM,,,,,,13.4,11.3,7.9,NM,0.50,3700,NM,5.40,0.01,0.51,410,31,4884,,
1623,12,11/8/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,75% plastics,25% recylables (not plastic),,,,,,16.3,12.3,7.7,NM,0.10,2750,NM,0.04,0.30,0.10,41,10,1607,,
1624,13,11/8/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,19.0,14.8,7.5,7.87,0.50,4000,NM,1.14,0.84,0.03,697,471,24196,,
1625,14,11/8/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,20.0,16.6,8.2,10.15,0.00,1340,NM,0.00,0.10,0.02,86,10,2046,,
1626,15,11/8/2009,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,high,100 + items,70% Plastics 15% Non-recltclable trash 15% Large Items,,,,,,20.0,14.8,7.7,NM,0.40,3080,NM,0.46,0.54,0.29,86,10,3448,,
1627,17,11/8/2009,D,clear,trickle,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,NM,,,,,,23.5,14.6,7.2,5.53,0.03,1830,NM,0.23,0.34,0.03,20,75,1956,,
1628,19,11/8/2009,D,clear,trickle,clear,clear,none,other_silty/ gritty film (algae most likely),none,NM,,,,NM,,,,NM,light,NM,NM,,,,,,17.0,12.2,7.9,10.05,0.80,1170,NM,0.00,0.23,0.04,10,5,2755,,
1629,30,11/8/2009,D,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,18.5,12.5,7.9,10.80,0.50,4160,NM,4.84,0.82,0.02,399,30,5794,,
1630,21,11/8/2009,D,clear,NM,clear,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,21.5,15.8,7.6,6.80,3.00,2550,NM,0.17,0.40,0.79,122,31,2613,,
1631,22,11/8/2009,D,clear,none,clear,green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,20.5,15.8,7.7,5.61,1.20,2510,NM,0.18,0.53,0.97,148,20,2909,,
1632,23,11/8/2009,D,clear,none,clear,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,20.5,16.1,7.6,6.59,1.80,2490,NM,0.17,0.43,1.04,459,20,3873,,
1633,24,11/8/2009,D,clear,none,clear,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,22.0,16.3,7.6,5.57,2.30,2430,NM,0.27,0.45,0.98,41,52,3874,,
1634,25,11/8/2009,D,clear,none,clear,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,25.0,15.4,7.5,4.90,1.60,2350,NM,0.24,0.41,0.72,243,20,8664,,
1635,26,11/8/2009,D,clear,none,clear,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,23.0,16.3,7.6,4.92,2.90,2430,NM,0.58,0.56,0.88,30,31,6131,,
1636,27,11/8/2009,D,clear,none,clear,clear,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,23.3,16.3,7.8,7.78,2.60,2630,NM,0.16,0.46,0.87,120,52,3448,,
1637,28,11/8/2009,D,clear,none,clear,brown_green,none,none,none,0,,,,none,,,,none,none,none,none,,,,,,18.5,15.2,7.7,6.68,2.00,2540,NM,0.20,0.47,0.77,173,41,2613,,
1638,1,12/6/2009,W,overcast,steady,clear,clear,none,none,none,0,,,,75,,,,NM,none,NA,NA,,,,,,14.0,12.9,8.2,10.73,0.40,2160,NM,3.56,3.48,0.06,108,41,6131,,

1639,2,12/6/2009,W,overcast,intermittent,clear,clear,none,other_film (not oily),none,0,,,,0,,,,NM,none,none,none,,,,,,11.0,8.5,7.4,8.85,0.30,NM,NM,0.98,0.31,0.06,146,74,2909,,
1640,3,12/6/2009,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,none,none,,,,,,11.5,9.3,7.8,10.25,0.00,780,NM,0.00,0.01,0.00,5,5,315,,
1641,5,12/6/2009,W,overcast,steady,clear,clear,none,none,none,0,,,,100,,,,none,none,NA,NA,,,,,,11.0,8.0,8.1,11.74,0.06,3920,NM,5.48,0.41,0.00,5,40,2359,,
1642,12,12/6/2009,W,overcast,trickle,clear,clear,none,other_leaves,none,0,,,,100,,,,NM,none,NA,NA,,,,,,9.0,7.8,8.0,11.13,0.04,3070,NM,0.00,0.27,0.00,10,5,1081,,
1643,13,12/6/2009,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,none,light,none,recyclables,,,,,,12.0,12.5,7.5,8.29,0.20,3930,NM,0.97,0.75,0.00,10,75,3076,,
1644,14,12/6/2009,W,overcast,steady,clear,clear,none,none,none,0,,,,10,,,,none,none,NA,NA,,,,,,13.0,13.0,8.1,10.57,0.00,1390,NM,0.03,0.00,0.07,121,52,2481,,
1645,15,12/6/2009,W,overcast,steady,clear,clear,none,none,none,0,,,,100,,,,none,light,NM,25% Plastics 25% recyclables (non plastic) 50% Non-Recyclable,,,,,,14.5,18.2,7.4,7.41,0.90,1720,NM,4.48,5.12,0.12,173,20,6867,,
1646,18,12/6/2009,W,overcast,steady,clear,clear,none,other_leaves,none,0,,,,20,,,,NM,light,light,NM,,,,,,14.6,12.7,8.0,10.48,0.00,1650,NM,0.01,0.10,0.00,31,5,591,,
1647,19,12/6/2009,W,overcast,trickle,cloudy,clear,none,none,none,90,,,,0,,,,none,none,none,none,,,,,,13.0,9.8,7.6,5.43,0.60,1180,NM,0.00,0.14,0.00,5,5,1782,,
1648,30,12/6/2009,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,none,100% plastics,,,,,,12.3,8.9,8.0,11.80,0.08,4140,NM,5.80,0.65,0.00,158,10,5,,
1649,1,1/10/2010,W,clear,steady,clear,clear,clear,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,22.0,13.4,8.0,10.55,0.35,1810,NM,5.80,3.20,0.15,20,5,5475,,
1650,2,1/10/2010,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,100% plastics,,,,,,14.0,9.2,7.9,10.97,0.10,1620,NM,0.93,0.29,0.00,20,63,2247,,
1651,3,1/10/2010,W,clear,trickle,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,13.5,10.0,8.0,10.02,0.00,740,NM,0.00,0.35,0.01,5,5,243,,
1652,5,1/10/2010,W,clear,trickle,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,15.5,8.8,7.4,13.20,0.40,3510,NM,4.44,0.45,0.05,122,52,4353,,
1653,12,1/10/2010,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,moderate,NM,50% plastics 25% non recyclable trash 25% recyclables,,,,,,10.0,8.4,7.9,12.92,1.00,2060,NM,0.01,0.20,0.09,10,5,1309,,
1654,13,1/10/2010,W,clear,steady,clear,clear,none,none,none,5,,,,20,,,,NM,light,NM,100% plastics,,,,,,20.0,13.0,7.5,8.44,0.30,3770,NM,1.24,0.62,0.01,816,158,2613,,
1655,14,1/10/2010,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,NM,none,NM,NA,,,,,,19.8,14.6,8.0,9.94,0.00,1300,NM,0.00,0.10,0.00,86,5,1850,,
1656,15,1/10/2010,W,clear,steady,clear,clear,NM,NM,NM,NM,,,,NM,,,,NM,high,approx 100 items,40% plastics 50% non recyclable trash 10% recyclables non plastics,,,,,,22.3,16.3,7.5,10.30,0.20,1840,NM,4.72,3.52,0.22,52,31,2354,,
1657,17,1/10/2010,W,clear,steady,cloudy,clear,none,none,none,0,,,,40,,,,NM,moderate,NM,NM,,,,,,22.0,11.8,7.3,10.00,0.35,1520,NM,0.19,0.24,0.01,20,10,1401,,
1658,19,1/10/2010,W,clear,trickle,clear,clear,none,none,none,0,,,,10,,,,NM,none,NM,NM,,,,,,16.0,9.8,7.9,10.67,0.40,1150,NM,0.00,0.12,0.00,10,5,2755,,
1659,30,1/10/2010,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,0,light,NM,50% plastics 50% recyclables not plastic,,,,,,21.0,10.2,7.9,11.42,0.20,3930,NM,7.16,0.72,0.00,243,51,12997,,
1660,1,3/7/2010,W,clear,steady,cloudy,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,24.0,14.7,8.4,10.58,1.10,1330,NM,1.68,1.66,0.14,30,52,3654,,
1661,2,3/7/2010,W,clear,steady,clear,clear,other_horse_manure,none,none,0,,,,0,,,,NM,none,NA,NA,,,,,,16.5,12.2,8.2,10.61,0.10,1210,NM,0.86,0.14,0.03,31,132,2489,,
1662,3,3/7/2010,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,none,none,NA,NA,,,,,,11.0,10.1,8.0,10.16,0.00,580,NM,0.01,0.03,0.08,10,5,465,,
1663,5,3/7/2010,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,none,light,4 items,25% plastics 75% recyclables non plastics,,,,,,14.8,12.3,8.1,10.80,0.60,3380,NM,2.39,0.35,0.04,199,272,6488,,
1664,12,3/7/2010,W,overcast,heavy,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,15.5,13.6,8.3,10.72,1.30,1150,NM,0.15,0.10,0.31,52,31,2359,,
1665,13,3/7/2010,W,clear,steady,clear,yellow_green,none,none,none,0,,,,0,,,,NM,moderate,NM,NM,,,,,,19.0,13.7,7.7,9.95,1.10,3330,NM,0.59,0.48,0.10,336,52,6131,,

1666,14,3/7/2010,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NA,NA,,,,,,19.5,14.7,8.1,NM,0.00,8
20,NM,0.17,0.07,0.35,31,10,2247,,
1667,15,3/7/2010,W,clear,heavy,clear,clear,none,none,none,0,,,,60,,,,NM,light,,50% plastics 50% non-recyclable
trash,,,,,,21.0,15.7,7.9,10.15,1.00,1360,NM,1.58,0.17,2.23,85,41,2613,,
1668,17,3/7/2010,W,clear,steady,clear,clear,sewage_faint,none,none,0,,,,10,,,,NM,light,,100%
plastics,,,,,,15.0,14.3,8.0,10.96,0.50,870,NM,0.22,0.35,0.15,20,41,4106,,
1669,18,3/7/2010,W,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,moderate,25 items,25% plastics 75%
recyclables non plastics,,,,,,16.5,14.8,8.0,NM,1.30,1470,NM,0.03,0.12,0.04,20,1250,5,,
1670,19,3/7/2010,W,clear,heavy,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NA,NA,,,,,,15.5,12.4,7.9,NM,0.60,61
0,NM,0.10,0.10,0.10,41,75,1664,,
1671,30,3/7/2010,W,clear,steady,clear,green,musty,none,none,5,,,,0,,,,none,light,NM,30% plastics 50% recyclables (not
plastic) 20% large items,,,,,,19.7,13.3,8.1,10.96,0.80,3160,NM,2.88,0.34,0.11,1198,336,14136,,
1672,1,2/4/2010,W,overcast,steady,clear,clear,none,other_seeds/ foilage,,NM,,,,NM,,,,NM,moderate,100%
plastics,NM,,,,,,17.3,14.1,8.4,NM,0.80,1500,NM,5.40,2.88,0.06,134,63,15531,,
1673,2,2/4/2010,W,overcast,steady,clear,NM,none,none,NM,0,,,,80,,,,mat=DT,light,NM,100% recyclable
plastic,,,,,,NM,11.3,8.1,4.75,1.70,1410,NM,0.85,0.30,0.06,110,52,4106,,
1674,3,2/4/2010,W,overcast,steady,clear,clear,none,none,,0,,,,0,,,,NM,none,NA,NA,,,,,,NM,10.3,7.9,9.86,0.00,720,NM,
0.01,0.08,0.00,20,<10,309,,
1675,5,2/4/2010,W,overcast,steady,clear,clear,none,other_pollen,,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,NM,11.2,8.1,4.38,1
.30,3700,NM,4.16,0.60,0.00,199,97,5794,,
1676,12,2/4/2010,W,overcast,heavy,clear,clear,none,none,NM,10,,,,60,,,,mat=LL +
DT,none,NM,NA,,,,,,11.3,4.2,8.4,4.17,1.30,1410,NM,0.35,0.34,0.04,75,52,2909,,
1677,13,2/4/2010,W,overcast,steady,clear,NM,musty,none,none,0,,,,0,,,,NM,moderate,NM,NM,,,,,,16.0,13.6,7.5,9.62,0.
90,3790,NM,0.92,0.64,0.02,586,31,4884,,
1679,14,2/4/2010,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,16.8,14.6,8.2,NM,0.
00,1130,NM,0.02,0.07,0.00,41,<10,679,,
1680,15,2/4/2010,W,overcast,steady,clear,clear,none,,,,,,,,,,NM,,NM,NM,,,,,,NM,15.1,7.8,4.73,1.20,1530,NM,5.84,3.40
,0.19,74,10,2755,,
1681,17,2/4/2010,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,NM,moderate,NM,NM,,,,,,15.0,11.8,7.5,10.39,7
.50,1010,,0.75,0.42,0.10,119,20,2723,,
1682,18,2/4/2010,W,overcast,steady,clear,clear,none,other_bubbles,none,NM,,,,NM,,,,,moderate,,,0,30,70,0,0,17,14.25,
8.05,NM,0.021666666666667,1483,NM,0.04,0.00,0.07,< 10,63,2613,,
1683,19,2/4/2010,W,clear,steady,clear,clear,none,none,none,0,,,,0,,,,,none,,,0,0,0,0,0,18,13.05,7.75,NM,0,795.5,NM,0.0
7,0.00,0.73,10,<10,723,,
1684,30,2/4/2010,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,,moderate,40
items,NM,,,,,,18,11.45,7.975,10.55,1.95,3960,NM,6.04,0.73,0.02,364,20,19863,,
1685,1,4/11/2010,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,NM,NM,NM,,,,,,14.5,14.9,8.3,NM,0.
10,1700,NM,0.30,1.04,0.05,10,10,3448,,
1686,2,4/11/2010,W,overcast,heavy,clear,clear,none,none,none,0,,,,10,,,,,none,,,0,0,0,0,0,14.15,12.825,7.98,11.345,0.17
5,1322,NM,0.67,0.28,0.05,529,441,6867,,
1687,3,4/11/2010,W,overcast,steady,clear,clear,none,none,none,0,0,0,0,0,0,0,0,0,,none,,,0,0,0,0,0,12.95,11.4,7.81,10.33,0,
743,NM,0.00,0.12,0.04,10,5,393,,
1688,5,4/11/2010,W,overcast,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,light,NM,NM,,,,,,13.0,13.4,7.8,6.56,0.
20,3430,NM,3.88,0.51,0.12,199,158,19863,,
1689,12,4/11/2010,W,overcast,steady,clear,clear,none,other_foam,none,NM,,,,NM,,,,NM,light,NM,50% plastics 50%
reclyclables not plastic,,,,,,13.0,15.1,8.0,6.50,0.30,15500,NM,0.09,0.27,0.09,97,31,3255,,
1690,13,4/11/2010,W,clear,steady,clear,clear,none,none,NM,0,,,,80,,,,NM,light,NM,NM,,,,,,14.5,14.7,7.5,9.29,0.60,366
0,NM,1.03,0.65,0.12,487,122,24196,,
1691,14,4/11/2010,W,overcast,steady,clear,clear,none,none,,0,,,,30,,,,NM,none,NM,NM,,,,,,15.8,14.5,8.0,9.35,0.00,107
0,NM,0.00,0.10,0.63,121,20,4106,,
1692,15,4/11/2010,W,overcast,steady,clear,clear,musty,none,none,NM,,,,NM,,,,NM,high,NM,50% plastics 24% non
recyclable 25% recyclables,,,,,,14.0,17.2,7.6,NM,0.70,1560,NM,5.04,3.04,0.10,97,10,3873,,
1693,18,4/11/2010,W,overcast,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,NM,NM,,,,,,17.0,14.8,7.9,9.05,0
.00,1510,NM,0.00,0.08,0.00,41,10,990,,

1694,19,4/11/2010,W,overcast,steady,clear,clear,none,none,,0,,,,75,,,,NM,none,NM,NM,,,,,,15.0,14.2,7.9,9.34,0.00,760,
NM,0.00,0.08,0.00,41,41,1178,,
1695,30,4/11/2010,W,overcast,steady,clear,clear,none,,,,,,,80,,,,NM,moderate,NM,66% plastics 33% large
items,,,,,,12.9,13.7,8.0,8.86,0.50,3730,NM,5.68,0.70,0.10,798,41,15531,,
1696,1,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,100,,,,mat=100 %
CLRZ,none,NM,NM,,,,,,25.5,17.2,8.5,7.48,0.00,NM,NM,0.05,0.78,0.04,5,10,1500,,
1697,2,5/2/2010,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,14.5,13.5,8.0,10.03,0.00,
1330,NM,0.24,0.33,0.09,121,84,2909,,
1698,3,5/2/2010,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,14.5,12.6,7.9,NM,0.00,7
40,NM,0.04,0.13,0.06,10,31,697,,
1699,5,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,60,,,,mat=CLRZ,light,NM,100% recyclable not-
plastic,,,,,,14.5,12.6,8.2,7.77,0.05,3590,NM,1.72,0.35,0.03,52,249,8664,,
1700,7,5/2/2010,D,,,,,,,,,,,,,,,NM,,NM,NM,,,,,,NM,NM,NM,NM,NM,NM,NM,NM,NM,NM,809,63,4352,,
1701,12,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,100,,,,mat=100 %
CLRZ,none,NM,NM,,,,,,20.3,16.6,8.3,11.33,0.20,1540,NM,0.01,0.26,0.08,10,63,2659,,
1702,13,5/2/2010,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,20.0,15.6,7.5,10.01,0.30
,3730,NM,0.71,0.54,0.08,520,96,4884,,
1703,14,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,30,,,,mat=CLRZ,none,NM,NM,,,,,,21.0,17.7,8.2,9.48,0.
60,1070,NM,0.02,0.09,0.06,97,98,3255,,
1704,15,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,95,,,,mat=CLRZ,light,30% plastics 30%non-recylclable
trash 40% recylcables not plastic,NM,,,,,,26.0,17.0,8.3,7.37,0.00,NM,NM,0.09,0.30,0.06,20,10,1483,,
1705,17,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,10,,,,NM,none,NM,NM,,,,,,18.0,17.6,7.5,9.78,0.10,1120
,NM,0.17,0.33,0.07,233,153,3448,,
1706,18,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,,,,,NM,light,NM,NM,,,,,,18.5,15.2,7.9,10.71,NM,1530,
NM,0.02,0.15,0.09,62,5,2613,,
1707,19,5/2/2010,D,clear,steady,clear,clear,none,none,none,0,,,,90,,,,mat=CLRZ,none,NM,NM,,,,,,18.0,14.4,7.9,10.38,0
.10,830,NM,0.07,0.15,0.04,10,5,833,,
1708,30,5/2/2010,D,clear,steady,clear,clear,none,none,none,NM,,,,NM,,,,NM,none,NM,NM,,,,,,19.5,14.6,8.0,10.07,0.20
,3850,NM,4.00,0.45,0.07,355,211,8164,,
1709,1,6/6/2010,D,clear,steady,clear,clear,none,none,none,,,,,80,,,,clrz,light,NM,100%
plastics,,,,,,22.0,18.9,7.8,7.10,0.90,1770,NM,0.00,0.98,0.09,20,5,24196,,
1710,2,6/6/2010,D,,,,,,,,,,,0,0,100,,,,,,,,,,,,,,NM,0.43,0.23,0.10,309,52,17329,,
1711,3,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.00,0.00,0.25,62,5,4611,,
1712,5,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,2.65,0.33,0.11,146,5,24196,,
1713,12,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.00,0.19,0.02,108,41,9804,,
1714,13,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.98,0.68,0.09,683,292,10462,,
1715,14,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.00,0.11,0.12,249,5,3076,,
1716,15,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.00,0.21,0.00,41,31,15531,,
1717,17,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.25,0.28,0.04,149,318,17329,,
1718,19,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,0.05,0.07,0.17,189,10,9804,,
1719,30,6/6/2010,D,,,,,,,,,,,,,,,,,,,,,,,,,,,NM,2.58,0.82,0.15,189,41,9804,,
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1728,1,7/11/2010,D,overcast,steady,clear,NM,musty,none,NM,,,,,,,,,,dead
algae,,,,,,,,20,18.5,7.4,2.8,0.7,1940,,,,,85,510,25000,,
1729,2,7/11/2010,D,clear,steady,clear,clear,none,none,NM,,,,,,,,,,none,,,0,0,0,0,0,20,26.7,7.76,,0.4,1380,,,,,959,295,461
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1730,3,7/11/2010,D,overcast,steady,clear,clear,none,none,NM,,,,,,,,,,none,,,0,0,0,0,0,19,17.3,7.9,,0,720,,,,,211,185,2247,
,
1731,5,7/11/2010,D,clear,steady,clear,clear,none,none,NM,,,,,30,,,100,,light,5
items,,0,100,0,0,0,24,19.1,8,10.32,0.3,3600,,,,,315,110,7270,,
1732,12,7/11/2010,D,clear,steady,clear,clear,none,none,NM,,,,,100,,,100,dead
clrz,light,NM,NM,,,,,,24,23.1,8.1,10.59,0.4,1890,,,,,185,10,7270,,
1733,13,7/11/2010,D,clear,NM,NM,NM,other _sour,NM,NM,,,,,,,,,,,,,,,,,,25,18.7,7.5,,1.2,3680,,,,,839,173,12033,,
1734,15,7/11/2010,D,clear,steady,cloudy,green,musty,none,,,,,,70,,75,25,,moderate,30-40

items,plastics,0,0,100,0,0,20,18.5,7.6,7.28,2.4,2400,,,,,52,63,10462,,
1735,30,7/11/2010,D,clear,steady,clear,clear,none,none,,,,,,,,,,light,NM,plastics,0,0,100,0,0,23,18.9,7.9,,1.1,3860,,,,,305
,988,24196,,
1736,21,7/11/2010,D,overcast,none,cloudy,brown_green,none,NM,,100,,,,,,,,planktonic and poop type,,dead
fish,,,,,,,20,25.6,7.8,5.71,3.4,2440,,,,,5,20,1935,,
1737,22,7/11/2010,D,overcast,none,clear_cloudy,brown_green,none,none,none,0,0,0,0,0,0,0,0,,none,,,0,0,0,0,0,20,25.1,
7.86,5.12,2.72,2400,,,,,5,5,556,,
1738,23,7/11/2010,D,clear,none,cloudy,brown_green,NM,none,,100,,,,,,,,planktonic and poop
type,,,,,,,,21,24.8,8.02,7.15,5.12,2380,,,,,5,5,1178,,
1739,24,7/11/2010,D,clear,none,cloudy,brown_green,NM,none,,100,,,,,,,,planktonic and poop
type,,,,,,,,21,24.9,8.12,8.8,5.72,2290,,,,,5,20,8164,,
1740,25,7/11/2010,D,clear,none,cloudy,brown_green,NM,none,,100,,,,,,,,planktonic and poop type,,dead
bird,,,,,,,26,23.6,8.06,9.23,5.62,2200,,,,,31,21,9804,,
1741,26,7/11/2010,D,clear,none,cloudy,brown_green,NM,none,,100,,,,,,,,planktonic,,,,,,,,,23,25.4,8.16,9.41,6.63,2260,,,,
,10,10,4352,,
1742,27,7/11/2010,D,clear,none,cloudy,brown_green,none,none,,100,,,,,,,,planktonic and poop
type,,,,,,,,23,23.3,8,7.5,4.7,2360,,,,,10,5,4611,,
1743,28,7/11/2010,D,overcast,NM,cloudy,brown_green,none,NM,,100,,,,,,,,planktonic and poop
type,,,,,,,,20,24.6,7.8,5.2,4.3,2430,,,,,20,5,2481,,
1744,1,8/8/2010,D,clear,steady,clear,clear,none,none,NM,,,,,,,,,none,,,0,0,0,0,0,22.5,19.4,7.6,5.01,1.7,2130,,0,1.41,0,13
2,30,25000,,
1745,2,8/8/2010,D,clear,intermittent,clear,clear,none,none,NM,,,,,,,,,none,,,0,0,0,0,0,20.5,15.6,7.5,8.16,0.7,1380,,0.05,0
.26,0,1162,218,15331,,
1746,3,8/8/2010,D,clear,trickle,clear,clear,none,none,NM,,,,,,,,,none,,,0,0,0,0,0,19,16.8,7.9,9.07,0,710,,0,0.03,0.12,41,5
,1317,,
1747,5,8/8/2010,D,clear,steady,clear,clear,none,none,NM,0,0,0,0,90,,,,CLRZ with diatoms,light,1
item,non,0,100,0,0,0,22.5,17.2,8.13,8.43,0.5,3670,,0.18,0.08,0,410,218,25000,,
1748,12,8/8/2010,D,clear,intermittent,clear,clear,none,none,NM,0,0,0,0,100,0,0,100,CLRZ with diatoms,light,5
items,non,0,100,0,0,0,23,20.6,8.02,6.2,0.4,1920,,0.11,0.19,0,52,20,11199,,
1749,13,8/8/2010,D,clear,steady,clear,clear,none,none,NM,,,,,100,,,,dark brown
underwater,none,,,0,0,0,0,0,24.5,18.4,7.5,9.17,0.6,3830,,1.01,0.82,0,528,135,11199,,
1750,14,8/8/2010,D,clear,steady,clear,clear,none,none,NM,0,0,0,0,70,0,100,0,,none,,,0,0,0,0,0,19.5,17.6,8.1,7.09,0,114
0,,0,0.04,0,223,86,9804,,
1751,17,8/8/2010,D,clear,trickle,clear,clear,none,none,NM,0,0,0,0,20,0,100,0,,none,,,0,0,0,0,0,,19.5,7.4,1.73,0.1,1410,,
0,0.27,0,20,20,7270,,
1752,30,8/8/2010,D,clear,steady,clear,clear,none,none,NM,,,,,,,,,light,NM,,0,0,100,0,0,21.5,18.3,7.9,9.28,0.4,3980,,7.3
6,0.52,0,556,74,19863,,
1753,3,9/29/2010,D,clear,trickle,clear,clear,none,none,NM,0,0,0,0,0,0,0,0,,none,,,0,0,0,0,0,26,18.07,7.74,5.96,0,738.5,,
0,0,0.13,41,5,1789,,
1754,5,9/29/2010,D,clear,trickle,clear,clear,none,none,,0,0,0,0,100,0,0,100,dead clrz,moderate,20
items,NM,,,,,,29.5,19.55,8.09,10.22,,3495,,4.14,0.13,0,85,97,15531,,
1755,12,9/29/2010,D,clear,trickle,clear,green,none,none,NM,,,,,60,,,,NM,moderate,NM,plastics and
non,0,50,50,0,0,31,20.4,7.85,7.59,2.5,2034,,0,0,0,52,10,15531,,
1756,13,9/29/2010,D,clear,steady,clear,green,musty,none,NM,0,0,0,0,0,0,0,0,,moderate,30
items,,0,50,25,25,0,,19.65,7.4,5.1,1.4,3715,,,,,,,,,
1757,14,9/29/2010,D,clear,steady,clear,clear,none,none,,,,,,50,0,100,0,,none,,,0,0,0,0,0,24.5,19.28,7.87,6.89,0.03,1184.5
,,,,,,,,
1758,15,9/29/2010,D,clear,steady,clear,green,other_sulfur,none,NM,0,0,0,0,20,0,100,0,,moderate,50
items,,0,25,50,25,0,,18.35,7.68,5.87,1,2650,,,,,,,,,
1759,1,10/10/2010,D,clear,NM,cloudy,NM,NM,NM,NM,,,,,,,,,light,1,plastic,,0,100,,,27,18.58,7.53,5.37,9.4,,,0.22,1.13,
0.06,730.5,303,25000,,
1760,2,10/10/2010,D,clear,none,milky,brown,none,none,NM,,,,,,,,,light,1,non-
recyclable,,100,,,,24,14.5,7.27,2.17,2.13,1627.5,,0,0.12,0.05,5472,932,25000,,
1761,3,10/10/2010,D,clear,trickle,clear,clear,none,none,NM,,,,,,,,,none,,,,,,,,22,15.33,8.02,8.79,0,799,,0.04,0.45,0.25,41

,20,908,,
1762,5,10/10/2010,D,clear,NM,NM,NM,none,none,NM,,,,,,,,,light,,,,,,,20.5,14.15,8.02,9.34,1.43,,,4.77,0.5,0.1,1444,24
5.5,22029.5,,
1763,12,10/10/2010,D,clear,trickle,clear,NM,NM,none,NM,,,,,,,,,none,,,,,,,17,16.9,7.7,7.82,3.08,,,0.29,0.29,0,243,73,2
5000,,
1764,13,10/10/2010,D,NM,none,milky,brown,musty,none,NM,,,,,,,,,light,2,,,100,,,,25,17.53,7.2,4.82,1.3,3560,,1.26,1.0
1,0.2,2755,855,25000,,
1765,14,10/10/2010,D,clear,steady,clear,none,none,none,NM,,,,,,,,,none,,,,,,,22.5,17.55,7.94,8.98,0,1240.5,,0,0.13,0.03
,109,63,932,,
1766,17,10/10/2010,D,clear,trickle,clear,clear,none,none,NM,,,,,,,,,light,,,,,,,31,18.93,7.06,3.35,0.35,1592,,0.19,0.33,0.
1,809,75,25000,,
1767,19,10/10/2010,D,clear,steady,clear,clear,none,none,mosquito
larvae,,,,,,,,,none,,,,,,,22,15.05,7.75,8.5,0.18,1057,,0,0.1,0,85,10,2613,,
1768,21,10/10/2010,D,clear,none,cloudy,brown/green,none,none,NM,,,,,,,,all dispersed
alga,none,,,,,,,20.5,18.73,8.23,8.59,10,2140,,0,0.18,0.32,57,63,10462,,
1769,22,10/10/2010,D,clear,none,cloudy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,21.5,19.3,8.32,9.5,10.7,1930,,0,0.15,0.27,20,41,12667,,
1770,23,10/10/2010,D,clear,none,cloudy,brown/green,none,none,none,o,,,,,,,,total algal
cover,none,,,,,,,22,18.7,7.62,5.3,10.1,2380,,0.08,0.15,0.33,259,122,12667,,
1771,24,10/10/2010,D,clear,none,cloudy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,24,18.9,8.05,6.3,8.9,2220,,0.01,0.21,0.32,85,119,17329,,
1772,25,10/10/2010,D,clear,none,couldy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,25.5,18.9,7.66,4.5,6.6,2360,,0.05,0.33,0.12,92.5,31,24196,,
1773,26,10/10/2010,D,clear,none,cloudy,brown/green,none,none,none,o,,,,,,,,dispersed algae
(NM),none,,,,,,,28.5,19.5,8.18,7.54,7.6,2290,,0.06,0.21,0.28,110,86,15531,,
1774,27,10/10/2010,D,clear,none,cloudy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,32,20.3,8.25,7.4,8.2,2120,,0.02,0.13,0.12,10,30,11199,,
1775,28,10/10/2010,D,clear,none,cloudy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,20,18.7,8.1,7.7,9.3,2130,,0.01,0.22,0.38,51,98,12997,,
1776,30,10/10/2010,D,NM,trickle,cloudy,clear,none,none,NM,,,,,,,,,NM,none,,,,,,,26,15.7,7.96,8.74,1.26,3590,,7.77,0.7
,0.09,1014,5,25000,,
1777,15,10/10/2010,D,clear,NM,clear,clear,NM,NM,NM,,,,,,,,NM,moderate,NM,plastics non
recyclable,,,,,,29,17.1,7.62,8.7,1.26,,,0.58,0.58,0.12,331,309,25000,,
1778,1,11/7/2010,D,overcast,intermittent,clear,clear,none,oily
sheen,NM,,,,,,,,NM,none,,,,,,,22,17.5,7.57,6.08,1.85,2460,,0.08,1.25,0.02,30.5,46.5,25000,,
1779,3,11/7/2010,D,overcast,steady,clear,clear,none,none,algae,0,,,,0,,,,,none,,,,,,,16.5,13.43,7.64,9.01,0,714.5,,0,0.05,0
,31,5,173,,
1780,5,11/7/2010,D,overcast,trickle,clear,clear,none,none,NM,,,,,,,,,light,4
items,,,25,75,,,18,12.1,8.25,10.86,0.45,3595,,4.46,0.45,0.03,602,148,5686,,
1781,12,11/7/2010,D,overcast,steady,clear,clear,none,none,NM,,,,,,,,NM,light,1
item,,,,,100,,18,14.03,8.26,9.57,4.87,2405,,0.1,0.27,0.04,31,30,5475,,
1782,13,11/7/2010,D,overcast,steady,clear,clear,sewage,none,none,0,,,,0,,,,,light,5
items,,,100,,,,19,15.58,7.31,7.67,0.96,3610,,1.48,0.86,0.06,2187,784,9804,,
1783,15,11/7/2010,D,overcast,NM,clear,brown,none,other_leaves,NM,,,,,,,,NM,light,,,,50,50,,,20.5,14.6,7.92,10.29,0.5
3,2725,,0.3,0.28,0,41,20,9208,,
1784,17,11/7/2010,D,overcast,trickle,clear,clear,none,none,algae,10,,,,90,,,100,,light,10
items,,,100,,,,16,15.98,6.91,6.4,0.06,1446,,0.3,0.3,0.03,110,20,5794,,
1785,21,11/7/2010,D,overcast,none,cloudy,brown/green,none,oily sheen,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,18,16.6,8.19,7.08,12.3,2330,,0,0.08,0.06,30.5,15,1475,,
1786,22,11/7/2010,D,overcast,intermittent,cloudy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),,,,,,,,17.5,16.5,8.21,4.78,8.3,2300,,0,0.07,0.06,5,10,754,,
1787,23,11/7/2010,D,overcast,none,cloudy,green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,17,16.7,8.4,7.04,13,2230,,0,0,0.14,41,20,1250,,
1788,24,11/7/2010,D,overcast,none,cloudy,brown/green,none,oily sheen,NM,,,,,,,,dispersed algae

(NM),none,,,,,,,17,16.7,8.24,6.6,9.4,2190,,0,0,0.04,10,31,1850,,
1789,25,11/7/2010,D,overcast,none,cloudy,brown/green,none,none,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,17,16,7.7,4.68,7.8,1950,,0,0.07,0.04,36.5,25,4845,,
1790,26,11/7/2010,D,overcast,none,cloudy,brown/green,other_urine,oily sheen,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,17,16.6,8.2,6.08,11.3,2200,,0,0,0.07,63,10,2098,,
1791,27,11/7/2010,D,overcast,none,cloudy,green,none,oily sheen,NM,,,,,,,,dispersed algae
(NM),none,,,,,,,17,16.4,8.4,7.38,11.5,2270,,0,0.01,0.06,327,171,4106,,
1792,28,11/7/2010,D,overcast,none,cloudy,brown/green,none,oily sheen,NM,,,,,,,,dispersed algae
cover,none,,,,,,,16.5,16.3,8.3,7.26,12.5,2300,,0,0.06,0.03,10,20,1274,,
1793,1,12/5/2010,W,overcast,steady,clear,clear,none,other_reeds,NM,,,,,,,,NM,,,,,,,,14.4,13.4,8.18,10.72,1.47,1811,,6.
54,3.36,0.09,25,10,3900,,
1794,2,12/5/2010,W,overcast,trickle,clear,clear,none,oily
sheen,algae,100,100,,,100,,100,,,light,1,,,,100,,,14,9.5,7.05,7.94,1.22,1492,,0.55,0.33,0.02,275,41,4611,,
1795,3,12/5/2010,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,,13,9.6,7.45,10.25,0.05,736,,0,0.06,0.0
2,5,5,63,,
1796,5,12/5/2010,W,overcast,steady,clear,clear,none,other_leaves,NM,,,,,,,,,none,,,,,,,,12.6,8.9,7.88,,0.13,3800,,7.12,0.
59,0.08,121.5,63.5,2218.5,,
1797,12,12/5/2010,W,overcast,trickle,cloudy,brown/clear,none,none,NM,,,,,,,,,,,,,,,,11,8.5,8.19,,4.18,2440,,0,0.21,0.01,
10,5,2046,,
1798,13,12/5/2010,W,overcast,steady,clear,clear,musty,NM,algae,,,,,80,,100,,,moderate,,,,,50,50,,17,12.8,7.25,8.16,1.23
,3810,,1.26,0.68,0.02,275,52,3654,,
1799,14,12/5/2010,W,overcast,trickle,clear,clear,none,none,NM,,,,,,,,,NM,none,,,,,,,,16.5,12.6,7.83,9.79,0.37,1271,,0.03
,0.06,0.07,20,10,767,,
1800,15,12/5/2010,W,overcast,steady,clear,clear,ammonia_algae,none,NM,,,,,,,,NM,light,2 items. 1
clothing,,,50,50,,,18,18.4,7.48,8.87,0.75,1673,,6,3.64,0.29,63,31,2909,,
1801,17,12/5/2010,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,NM,light,10
items,,,50,50,,,16,13,7,7.63,0.33,1509,,0.35,0.27,0.06,41,10,2755,,
1802,19,12/5/2010,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,,NM,none,,,,,,,,15,9.3,7.92,9.22,0.05,1087,,0,0.11,
0.07,5,5,583,,
1803,30,12/5/2010,W,overcast,NM,clear,clear,NM,NM,algae,,,,,50,,100,,,none,,,,,,,,15,9.9,7.8,10.38,0.4,4020,,10.64,0.6
9,0.03,10462,909,3654,,
1804,21,12/5/2010,W,overcast,none,cloudy,green,none,none,NM,,,,,,,,dispersed planktonic
algae,none,,,,,,,12.5,9.1,8.14,7.86,10.47,2119,,0.02,0.03,0.1,5,5,121.5,,
1805,22,12/5/2010,W,overcast,none,cloudy,green,none,NM,NM,,,,,,,,planktonic algae,light,1
item,,,,,100,,10,8.7,8,7.68,11.7,2150,,0,0.01,0.03,5,5,594,,
1806,23,12/5/2010,W,overcast,none,cloudy,green,none,other_leaves,NM,,,,,,,,dispersed planktonic
algae,,,,,,,,,13.5,9.2,8.1,6.45,11.9,2160,,0,0.05,0.09,10,10,426,,
1807,24,12/5/2010,W,overcast,none,cloudy,green,none,other_leaves,NM,,,,,,,,dispersed planktonic
algae,,,,,,,,,13,9.2,8.04,6.8,11.2,2020,,0,0.08,0.06,5,10,243,,
1808,25,12/5/2010,W,overcast,none,cloudy,green,none,NM,NM,,,,,,,,dispersed planktonic
algae,none,,,,,,,13.5,9.8,7.7,6.04,10,2120,,0.05,0.13,0.11,20,15,638.5,,
1809,26,12/5/2010,W,overcast,none,cloudy,green,none,other_leaves,NM,,,,,,,,dispersed planktonic
algae,none,,,,,,,15.5,9.58,7.72,6.97,9,1990,,0,0.09,0.05,10,31,313,,
1810,27,12/5/2010,W,overcast,none,cloudy,green,none,none,NM,,,,,,,,dispersed planktonic algae
(NM),none,,,,,,,15,9.55,7.5,7.25,9.7,2180,,0,0.03,0.05,20,10,134,,
1811,28,12/5/2010,W,overcast,none,cloudy,green,none,other_leaves,NM,,,,,,,,dispersed planktonic algae
(NM),none,,,,,,,11,9,8.1,8.12,10.4,2220,,0.02,0.07,0.02,5,5,86,,
1812,1,1/9/2011,W,overcast,steady,clear,clear,none,NM,NM,,,,,,,,,NM,none,,,,,,,,11.8,8.22,10.86,0.82,1327.5,,2.9,2,0.0
7,31,20,2382,,
1813,2,1/9/2011,W,overcast,heavy,clear,clear,none,none,NM,,,,,,,,NM,light,1
item,,,,100,,,8,9.9,8.13,10.96,0.67,1124.5,,1.31,0.14,0.03,52,63,2613,,
1814,3,1/9/2011,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,NM,none,,,,,,,10,8.7,7.95,10.71,0.25,626,,0.02,0.04,
0.09,187,5,369,,
1815,5,1/9/2011,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,,NM,none,,,,,,,,,9.25,7.98,11.08,0.86,3700,,2.36,0.53,

0.11,10,63,5127,,
1816,12,1/9/2011,W,overcast,heavy,clear,clear,none,other_foam,NM,,,,,,,,NM,light,,,,,,100,,13,9.5,7.88,11.32,1.07,1117,,0.5,0.4,0.16,173,41,1106,,
1817,13,1/9/2011,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,NM,moderate,,,,20,80,,,11,11.2,7.62,9.14,0.81,4060,,0.96,0.62,0.11,51,110,4611,,
1818,15,1/9/2011,W,overcast,heavy,clear,clear,none,NM,NM,,,,,,,,NM,none,,,,,,,,12.8,7.65,10.07,0.76,1412,,1.97,1.83,0.2,259,10,2613,,
1819,30,1/9/2011,W,overcast,steady,clear,clear,none,none,NM,,,,,10,,,100,,light,1 item,,,100,,,,11.25,10.35,7.34,10.6,0.85,4080,,2.91,0.61,0.07,5,85,4106,,
1820,21,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,5,9.3,7.56,7.75,1.35,1080,,0.59,0.46,0,10,10,1552.5,,
1821,22,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,4.5,9.55,7.62,7.49,1.43,1061.5,,0.57,0.4,0,5,41,1616,,
1822,23,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,5,9.9,7.7,7.35,1.15,1020,,0.63,0.43,0,5,52,2098,,
1823,24,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,4,9.9,7.63,7.25,1.5,1010,,0.56,0.43,0,41,20,1860,,
1824,25,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,5.5,10,7.63,7.34,0.5,940,,0.62,0.41,0,41,46.5,1372,,
1825,26,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,8,9.98,7.71,7.4,1.7,1020,,0.64,0.38,0,30,30,1439,,
1826,27,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,6,10,7.69,7.36,1.8,1040,,0.55,0.43,0,31,30,1515,,
1827,28,1/9/2011,W,overcast,none,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,5,9.4,7.04,7.7,1.6,1041,,0.62,0.4,0,20,63,1153,,
1828,1,2/13/2011,W,clear,steady,clear,clear,none,none,none,,,,,25,,,,none,none,,,,,,,,12.48,7.74,12.01,0.3,1591,,1.07,1.81,0.06,20,20,3067.5,,
1829,2,2/13/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,13.5,9.4,8,11.82,0.46,1332,,0.95,0.05,0.09,41,41,4106,,
1830,3,2/13/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,none,none,,,,,,,13.5,9,7.7,10.58,0.83,762,,0,0,0.05,5,5,279,,
1831,5,2/13/2011,W,clear,NM,clear,clear,none,none,NM,,,,,,,,NM,none,,,,,,,18.01,8.9,7.89,13.38,0.83,3560,,3.02,0.23,0.04,52,98,4611,,
1832,12,2/13/2011,W,clear,steady,clear,clear,none,none,NM,,,,,,,,NM,none,,,,,,,,9.58,,11.09,1.45,1660,,0,0.1,0.04,98,5,2613,,
1833,13,2/13/2011,W,clear,steady,clear,clear,none,none,NM,,,,,45,,,,NM,light,,,,,,,,12.35,7.27,9.59,0.85,3704,,0.5,0.37,0.04,243,448,5794,,
1834,15,2/13/2011,W,NM,steady,clear,clear,none,none,NM,,,,,,,,NM,,,,,,,,26,16.13,7.34,10.42,0.67,1496,,2.42,0.64,0.22,20,20,7701,,
1835,30,2/13/2011,W,clear,steady,clear,clear,NM,none,NM,15,,,,90,,85,15,NM,light,,,,,,,,10.1,7.83,12.85,0.68,3870,,6.22,0.32,0.05,158,63,4884,,
1836,21,2/13/2011,W,clear,none,NM,NM,none,NM,NM,,,,,,,,NM,,,,,,,,14.5,11.6,8.1,9.77,3,,,0,0.13,0.07,5,5,876,,
1837,22,2/13/2011,W,clear,NM,clear,clear,none,other_reeds,NM,,,,,,,,NM,,,,,,,,14.4,11.35,8.13,10.13,3.7,,,0,0.17,0.06,5,5,717,,
1838,23,2/13/2011,W,clear,NM,clear,clear,none,none,NM,,,,,,,,NM,,,,,,,,17.5,11.65,8,8.8,3,,,0.06,0.11,0.1,5,5,160,,
1839,24,2/13/2011,W,clear,none,clear,clear,none,NM,NM,,,,,,,,NM,,,,,,,,20,11.5,7.94,8.95,4,,,0,0.02,0.08,5,20,1274,,
1840,25,2/13/2011,W,clear,none,clear,clear,none,none,NM,,,,,,,,NM,,,,,,,,21,12.17,7.5,8.59,1.4,,,0.14,0.07,0.04,5,5,437,,
1841,26,2/13/2011,W,clear,none,clear,clear,none,NM,NM,,,,,,,,NM,,,,,,,,23,11.55,8.1,9.09,3.4,,,0.01,0.06,0.05,5,5,211,,
1842,27,2/13/2011,W,clear,none,clear,NM,none,NM,NM,,,,,,,,NM,,,,,,,,20,12.5,8.04,9.96,3,,,0,0.02,0.05,5,5,528,,
1843,28,2/13/2011,W,clear,NM,clear,brown,none,NM,none,,,,,,,,none,none,,,,,,,15.1,11.4,8.04,9.45,2.9,,,0,0.02,0.09,52,5,1956,,
1844,2,3/6/2011,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,,,,,,,17.5,14.25,7.72,10.98,0.66,1098.5,,0.74,0.16,0,63,733,2909,,

1845,3,3/6/2011,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,none,,,,,,,14,10.1,8.6,10.46,0.57,657,,0.01,
0.05,0.03,31,266,7309,,
1846,13,3/6/2011,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,NM,,,,,,,,21.25,13.7,7.21,9.5,0.98,3500,,0.69,0
.44,0.22,61,292,9208,,
1847,14,3/6/2011,W,clear,steady,clear,clear,none,none,NM,NM,,,,5,,,100,NM,none,,,,,,,14,13.2,8.12,10.5,0.17,868.5,,0.
27,0,0,31,41,1700,,
1848,17,3/6/2011,W,overcast,steady,clear,clear,none,foam,NM,,,,,,,,,moderate,,,,50,,50,,18.5,14.6,7.73,10.08,0.53,893.
5,,0.18,0.24,0.05,20,20,2613,,
1849,19,3/6/2011,W,clear,heavy,clear,clear,none,none,NM,,,,,20,,,,none,none,,,,,,,16,12.3,8.01,10.91,0.38,678,,0.01,0.0
6,0,5,5,959,,
1850,30,3/6/2011,W,clear,steady,clear,clear,none,none,NM,,,,,,,,,,,,,,,,19.75,13.25,7.42,10.95,0.4,3330,,5.76,0.6,0.07,7
4,52,17329,,
1851,1,4/3/2011,W,overcast,steady,cloudy,yellow,none,leaves,NM,,,,,,,,,NM,none,,,,,,,29,17.35,8.46,9.76,1.02,1265,,1.
17,1.18,0.09,135,20,25000,,
1852,2,4/3/2011,W,clear,steady,clear,clear,none,none,NM,,,,,,,,,NM,high,yard
waste,,,,5,,,17.75,14.8,8.08,10.34,0.37,1087,,0.87,0.15,0.03,41,199,1235,,
1853,3,4/3/2011,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,,NM,light,,,,,,100,,13.5,13,8.04,10.2,0.07,686,,0.06,0.
07,0.08,20,10,878,,
1853,5,4/3/2011,W,overcast,steady,clear,clear,none,none,NM,,,,,,,,,NM,none,,,,,,,17,15.8,8.09,9.71,0.83,3395,,2.41,0.5
3,0.12,495,160,6910,,
1854,12,4/3/2011,W,overcast,heavy,other,brown,none,none,NM,,,,,,,,,NM,light,,,,,,100,,17,17.9,8.27,9.4,1.38,1247.5,,0.
28,0.51,0.32,213,5,1162,,
1855,13,4/3/2011,W,overcast,steady,clear,yellow,musty,NM,NM,,,,,,,,,NM,high,,,,,100,,,19.25,16.7,7.6,9.14,1.34,3540,,
0.54,0.55,0.18,988,63,3724,,
1856,15,4/3/2011,W,overcast,heavy,cloudy,yellow,none,none,NM,,,,,80,,,,NM,,,,,,,,18.5,18.15,7.83,9.01,1.08,1291,,0.9
6,1.35,0.09,96,20,2631,,
1857,30,4/3/2011,W,NM,steady,clear,yellow,none,none,NM,,,,,30,,,100,NM,light,,,,,100,,,18.5,16.75,7.87,9.4,0.67,3570
,,3.6,0.67,0.05,663,86,6653,,
1858,21,4/3/2011,W,overcast,NM,cloudy,brown,NM,none,NM,,,,,,,,,NM,none,,,,,,,16.5,18.65,7.94,7.85,2.2,1111,,0.26,
0.26,0.07,749,63,1723,,
1859,22,4/3/2011,W,overcast,none,cloudy,brown,none,none,none,,,,,,,,,NM,none,,,,,,,16,18.9,7.99,8.44,3.55,1161,,0.19,
0.18,0,1046,10,3076,,
1860,23,4/3/2011,W,NM,none,cloudy,green/brown,none,none,none,,,,,,,,,NM,,,,,,,,,18,18.48,7.73,6.13,3.94,867,,0.36,0.4
1,0.1,158,20,770,,
1861,24,4/3/2011,W,overcast,none,cloudy,green/brown,none,none,NM,,,,,,,,,NM,none,,,,,,,20,18.4,7.72,5.98,2.2,1718,,
0.43,0.38,0.09,448,52,5794,,
1862,25,4/3/2011,W,overcast,none,clear,green/brown,none,none,NM,,,,,,,,,NM,none,,,,,,,18,17.26,7.76,5.98,0.55,828.5,
,0.48,0.33,0.09,158,171,24196,,
1863,26,4/3/2011,W,overcast,none,cloudy,green/brown,none,none,NM,,,,,,,,,NM,,,,,,,,,17.5,18.53,7.76,5.67,1.76,849,,0.
45,0.41,0.12,933,63,5475,,
1864,27,4/3/2011,W,overcast,none,clear,green/brown,none,NM,NM,,,,,,,,,NM,,,,,,,,,18,18.85,7.69,5.7,2.88,905.5,,0.39,0.
34,0.1,771,41,3654,,
1865,28,4/3/2011,W,overcast,none,clear,green/brown,NM,none,none,,,,,,,,,NM,none,,,,,,,15,18.48,7.77,7,2.45,1012.5,,0
.34,0.35,0.2,794,31,3654,,
1866,1,6/5/2011,D,overcast,steady,clear,clear,none,none,NM,30,,100,,100,,,100,NM,,,,,,,,,21.5,17.78,7.91,11.3,0.04,185
4,,0,0.62,0,20,5,25000,,
1867,2,6/5/2011,D,clear,steady,clear,clear,musty,none,NM,,,,,80,,,100,none,light,yard
waste,,,,,,100,18,14.4,7.88,10.51,0.03,1243.5,,0.36,0.22,0.02,156,31,2489,,
1868,3,6/5/2011,D,overcast,steady,clear,clear,none,none,NM,,,,,,,,,none,none,,,,,,,16,13.87,7.78,9.07,0,765,,0,0.06,0,5,1
0,697,,
1869,5,6/5/2011,D,overcast,steady,clear,clear,none,none,NM,,,,,100,,,100,none,light,2
items,,,,100,,,19,14.88,7.78,12.44,0.03,3520,,3.42,0.4,0.04,120,68.5,17329,,
1870,12,6/5/2011,D,overcast,steady,cloudy,brown,none,none,NM,,,,,90,,100,,Dead
DT,none,,,,,,,,19,17.4,7.82,9.47,2.78,,,0,0.12,0.06,31,5,667,,

1871,13,6/5/2011,D,overcast,steady,clear,clear,faint sewage,none,NM,,,,,80,,,100,none,light,9 items,,,,90,10,,,16.48,7.29,6.76,0.75,3445,,0.81,0.62,0,408,134,17329,,
1872,15,6/5/2011,D,overcast,steady,clear,clear,none,none,NM,,,,,80,,90,10,none,light,,,,100,,,,22,16.78,7.71,11.16,0.46,2023.5,,0.23,0.23,0.03,109,63,12997,,
1873,17,6/5/2011,D,overcast,steady,clear,green,none,none,NM,,,,,50,,,100,none,moderate,,,,,,,,21,17.8,7.32,8.82,0.19,1226,,0.31,0.29,0,86,30,17329,,
1874,19,6/5/2011,D,clear,steady,clear,clear,none,none,NM,,,,,30,,,100,none,none,,,,,,,,18.5,15.9,7.8,9.97,0,847,,0,0.06,0.07,31,20,1236,,
1875,30,6/5/2011,D,overcast,steady,clear,clear,none,none,none,10,,,,80,,,100,Ttl fltng: brown algae,light,7 items,,,,100,,,,15.72,7.95,10.62,0.28,3885,,5.94,0.52,0.04,223,10,6131,,
1876,21,6/5/2011,D,overcast,none,cloudy,green,none,none,none,,,,,,,,,NM,,,,,,,,,18,20,8.35,,21.17,1925,,0,0,0.13,10,10,1539,,
1877,22,6/5/2011,D,overcast,none,cloudy,green,none,none,none,100,,,,,,,,plankton,none,,,,,,,,19,20.15,7.93,,8.15,1970.5,,0,0,0.44,63,10,4352,,
1878,23,6/5/2011,D,overcast,none,cloudy,green,none,none,none,100,,,,,,,,plankton,none,,,,,,,,18.5,20.8,8.26,,16.67,1764.5,,0,0,0.29,5,20,2359,,
1879,24,6/5/2011,D,overcast,none,cloudy,green,NM,none,none,100,,,,,,,,NM,none,,,,,,,,18.5,20.55,8.04,,16.33,1678.5,,0,0,0.2,10,10,2359,,
1880,25,6/5/2011,D,overcast,none,cloudy,green,none,none,none,100,,,,,,,,NM,,,,,,,,,20,20.6,8.24,,13.38,1569,,0,0,0.09,20,41,3076,,
1881,26,6/5/2011,D,overcast,none,cloudy,green,none,none,none,100,,,,,,,,none,none,,,,,,,,20,21.1,8.4,,19.66,1656.5,,0,0,0.25,10,10,6131,,
1882,27,6/5/2011,D,overcast,none,cloudy,green,none,none,none,100,,,,,,,,none,none,,,,,,,,20,21.1,8.17,,12.79,1819,,0,0,0.26,52,20,2359,,
1883,28,6/5/2011,D,overcast,none,cloudy,green/gray,other,none,none,100,,,,,,,,NM,none,,,,,,,,17,20,8.12,,21.83,1908,,0,0,0.05,31,10,3452,,
1884,14,6/5/2011,D,overcast,steady,clear,clear,none,none,algae,,,,,30,,,100,,none,,,,,,,,17,15.8,8.05,10.29,0,1026,,0.35,0.01,0,74,5,2247,,
1885,1,7/10/2011,D,overcast,steady,clear,clear,musty/sewage,none,algae,,,,,100,,100,,,none,,,,,,,,20.5,19.4,7.7,7.3,4.1,1810,,0,1.03,0.04,15,35.5,6356,,
1886,2,7/10/2011,D,clear,steady,clear,clear,none,none,algae,,,,,15,,,100,,light,4,,,25,,75,,21.5,18,7.71,8.07,1.1,1270,,0.6,0.27,0.13,3873,51,25000,,
1887,3,7/10/2011,D,clear,steady,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,22.1,18.8,7.7,7.91,0,730,,0,0.06,0.8,364,41,2613,,
1888,5,7/10/2011,D,clear,steady,clear,clear,none,algae,algae,50,100,,,,,,,,light,,,,50,50,,,22,19.5,8,9.8,0.1,3700,,2.96,0.11,0,776,109,25000,,
1889,12,7/10/2011,D,clear,steady,clear,green,none,algae,algae,1,100,,,,,,,,light,,,,,,100,,22.5,23.4,8,7.78,2.7,1790,,0.03,0.34,0.11,218,110,19863,,
1890,13,7/10/2011,D,clear,steady,clear,clear,none,none,algae,5,,,,50,,100,,,light,5,,,,50,50,,24.5,20.4,7.2,6.77,0.5,4110,,0.89,0.6,0.05,554,235,2481,,
1891,14,7/10/2011,D,overcast,steady,clear,clear,NM,none,mosquito larvae,30,100,,,5,100,,,,,none,,,,,,,,21,18.8,8,8.77,0.1,950,,0.29,0.07,0.13,183,10,2481,,
1892,15,7/10/2011,D,clear,steady,clear,clear,none,none,algae,5,100,,,100,,50,50,,none,,,,,,,,23,20.4,7.9,9.6,1.5,2310,,0.17,0.32,0.03,110,41,15531,,
1893,17,7/10/2011,D,clear,none,clear,clear,musty,none,algae,5,,,,,,,,,light,10,,,,,,,27,21.4,7,6.24,0,1200,,0.42,0.32,0.26,135,52,8164,,
1894,19,7/10/2011,D,overcast,steady,clear,clear,none,none,algae,,,,,40,,,,,none,,,,,,,,19,16.6,7.92,7.92,0.1,830,,0,0.13,0,52,52,5794,,
1895,30,7/10/2011,D,clear,steady,clear,clear,none,none,algae,25,,,,95,,100,,,none,,,,,,,,24,21.1,7.8,9.37,0.6,4210,,6.04,0.47,0.07,,,,,
1896,1,8/7/2011,D,overcast,steady,clear,clear,rotten_eggs,oily sheen,NM,,,,,,,,,light,1,,,,100,,,22,18.7,7.82,8.01,0.29,1848,,0,1.45,0,41,5,10112,,
1897,2,8/7/2011,D,clear,trickle,clear,clear,musty,none,algae,,,,,30,,,100,YARD WASTE,light,5,,,,100,,,18,16.3,7.68,8.27,0.53,1322,,0.23,0.54,0,1860,1483,6131,,

1898,3,8/7/2011,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,,24,17.3,7.83,8.2,0.19,717,,0,0.21,0,52,5,14
83,,
1899,5,8/7/2011,D,clear,steady,clear,clear,none,none,NM,,,,,,,,,,light,,,,,,,23.5,17.5,8.09,10.25,0.42,3780,,3.4,0.29,0,676
,272,19863,,
1900,12,8/7/2011,D,clear,trickle,clear,clear,none,none,algae,,,,,40,,,100,,light,10,,,50,50,,,23.3,20.5,7.95,7.4,1.1,1801,,0.
04,0.38,0,97,10,25000,,
1901,13,8/7/2011,D,clear,steady,clear,NM,musty,NM,algae,,,,,100,,,,,moderate,50,,,50,50,,,28,19.3,7.52,8.59,0.75,3840,
,0.83,0.94,0,733,31,17329,,
1902,15,8/7/2011,D,clear,steady,cloudy,clear,none,none,algae,,,,,10,,,,,light,1,,,,,100,,20.5,18.8,7.9,9.56,1.65,2570,,0.1,0
.45,0,63,52,25000,,
1904,21,8/7/2011,D,clear,none,cloudy,brown,none,none,algae,100,,,,,,,,,none,,,,,,,,24,24.3,8.07,8.56,8.4,2640,,0,0.16,0,2
5,20,25000,,
1905,22,8/7/2011,D,clear,none,cloudy,brown,none,none,algae,100,,,,,,,,,none,,,,,,,,24.5,25.1,8.1,7.88,7.7,2600,,0,0.26,0.
09,10,5,25000,,
1906,23,8/7/2011,D,clear,none,clear,brown,none,none,algae,100,,,,,,,,,none,,,,,,,,25.5,24.9,8.15,8.97,13.2,2570,,0,0.17,0.
11,10,10,25000,,
1907,24,8/7/2011,D,clear,none,cloudy,brown,none,none,algae,100,,,,,,,,,none,,,,,,,,26,24.3,8,7.03,14.5,2520,,0,0.23,0.11,
20,5,25000,,
1908,25,8/7/2011,D,clear,none,cloudy,brown,NM,none,algae,100,,,,,,,,,none,,,,,,,,24.2,27,8.1,7.45,8.5,2440,,0,0.18,0.16,
5,10,25000,,
1909,26,8/7/2011,D,clear,none,cloudy,brown,none,none,algae,100,,,,,,,,,,,,,,,,,29,25.2,8.2,8.16,11.5,2500,,0,0.18,0.08,20,
10,25000,,
1910,27,8/7/2011,D,clear,none,cloudy,brown,none,none,algae,100,,,,,,,,,,,,,,,,,28,25.6,8.1,8.55,8.5,2610,,0,0.11,0,5,5,250
00,,
1911,28,8/7/2011,D,clear,none,cloudy,brown,none,none,algae,100,,,,,,,,,none,,,,,,,,22,24.2,8.02,8.83,11.7,2600,,0,0.16,0,
5,5,25000,,
1912,30,8/7/2011,D,clear,steady,clear,clear,none,none,none,0,,,,90,,,100,,light,10
items,,,,100,,,25,19.02,7.9,10.02,2.82,4260,,6.64,0.53,0,379,,25000,,
1913,1,9/29/2011,D,overcast,steady,clear,clear,none,none,algae,,,,,90,,100,,,moderate,2
items,,,,,100,,19,19,7.75,,5.45,1962,,0,1.38,0,,,,,
1914,5,9/29/2011,D,clear,setady,clear,clear,none,none,algae,,,,,60,,,100,dead
CL/RZ,none,,,,,,,28,19.2,8.12,,0.91,3680,,5.68,0.27,0.05,,,,,
1915,12,9/29/2011,D,clear,steady,clear,clear,horses,none,algae,50,100,,,20,,,100,dead CL/RZ,moderate,5
items,,,50,,50,,28,22.9,7.47,,2.45,1758,,0.08,0.19,0.07,,,,,
1916,13,9/29/2011,D,clear,steady,clear,clear,musty,none,algae,,,,,90,,,100,,light,10
items,,,,100,,,,,7.49,7.98,0.82,3760,,1.1,0.73,0.03,,,,,
1917,15,9/29/2011,D,clear,steady,clear,clear,none,none,algae,40,100,,,50,,,100,dead
CL/RZ,none,,,,,,,22,18.8,7.64,,0.88,2840,,0.21,0.57,0.05,,,,,
1918,17,9/29/2011,D,clear,trickle,clear,clear,none,none,none,,,,,,,,,,light,5
items,,,,100,,,29,20.2,6.8,4.23,0,1384,,0,0.3,0,,,,,
1919,30,9/29/2011,D,clear,steady,clear,NM,none,none,algae,,,,,100,,,100,dead
CL/RZ,none,,,,,,,24,19.2,7.99,,0.5,4010,,5.16,0.51,0.02,,,,,
1920,1,10/19/2011,D,overcast,steady,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,16,18.18,7.6,7.79,1.35,2365,,0.09,1.27,
0,52,10,25000,,
1921,2,10/19/2011,D,overcast,trickle,clear,clear,none,none,algae,,,,,90,,100,,,none,10,yardwaste,,,,,,15,14.38,7.41,6.87,0
.08,1356,,0.27,0.39,0.01,275,171,5475,,
1922,5,10/19/2011,D,clear,steady,clear,clear,none,none,algae,,,,,30,,100,,,light,,,,100,,,,19.5,15.55,8.08,11.08,0.8,3710,,
1.27,0.43,0,435,168,14136,,
1923,12,10/19/2011,D,clear,steady,clear,clear,none,none,algae,,,,,5,,100,,at water
edge,light,,,,,100,,,20,17.18,7.77,9.15,2.18,2660,,5.08,0.38,0.03,52,30,6131,,
1924,13,10/19/2011,D,clear,steady,clear,clear,none,none,algae,,,,,75,,,100,dead
CL/RZ,light,,,,,100,,,21,17.38,7.45,6.67,0.97,4085,,1.36,0.8,0,154,327,6131,,
1925,15,10/19/2011,D,clear,steady,clear,clear,none,none,algae,,,,,75,,5,100,,light,,,,100,,,,22.5,16.45,7.67,8.86,0.9,2860,
,0.7,0.51,0.03,110,31,19836,,

1926,30,10/19/2011,D,clear,steady,clear,clear,none,none,algae,,,,,70,,100,,,none,,,,,,,21.25,16.25,7.94,8.07,0.49,4260,,8
.48,0.65,0,295,85,19836,,
1927,1,11/15/2011,D,clear,steady,cloudy,green,none,none,mosquito
larvae,,,,,,,,,none,,,,,,,19,14.6,8.04,9.83,3.37,2405,,0.17,0.62,0.01,41,75,6488,,
1928,5,11/15/2011,D,clear,steady,clear,clear,none,none,none,,,,,,,,,none,,,,,,,22,12.93,8.16,10.09,0.8,3105,,4.75,0.53,0.
06,581,209,4884,,
1929,12,11/15/2011,D,clear,steady,cloudy,green,none,none,algae,,,,,70,,100,,,none,,,,,,,18,12.73,8.15,10.14,8.22,2310,,
0.07,0.17,0.1,495,63,3873,,
1930,15,11/15/2011,D,clear,steady,cloudy,green,none,none,algae,,,,,5,,50,50,,none,,,,,,,21,15.75,7.66,8.67,4.58,2175,,3.
95,2.98,0.18,422,350,7270,,
1931,2,11/22/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,,light,3
items,,,100,,,,,10.8,8.08,,0.3,1225,,0.26,0.19,0,1187,148,9208,,
1932,13,11/22/2011,W,clear,clear,clear,clear,musty,none,algae,,,,,5,,,100,,none,,,,,,,20,13.5,7.61,7.29,0.89,3295,,1.39,0.
62,0.03,2282,908,8664,,
1933,15,11/22/2011,W,NM,NM,NM,NM,NM,NM,NM,,,,,,,,,,,,,,,,,12,17.4,7.57,,,1461,,,,,,,,
1934,T,11/22/2011,W,clear,NM,NM,NM,NM,NM,NM,,,,,,,,,,,,,,,,,17.6,7.61,,,2740,,0.71,0.6,0.01,10,10,10,,
1935,30,11/22/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,,light,10
items,,,100,,,,18,11.8,7.97,8.88,1.08,2945,,5,0.66,0.07,1989,1086,24196,,
1936,2,12/4/2011,W,clear,steady,clear,clear,horses,none,algae,,,,,60,,100,,,light,5
items,,,,,,,13.25,6.85,7.05,10.38,0,1449.5,,0.39,0.28,0.02,75,169,1085,,
1937,3,12/4/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,,none,,,,,,,7.5,7.85,7.71,10.94,0,757,,0,0.04,0,10,5,13
5,,
1938,1,12/4/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,,,,,,,,,,14,11.65,7.81,11.47,1.07,1707.5,,5.08,3.2,0.07,1
0,31,3285,,
1939,5,12/4/2011,W,clear,steady,clear,clear,none,none,algae,,,,,30,,,,,,,,,,,,10.5,7.25,7.95,11.77,0.08,3825,,7.2,0.5,0.01,
20,5,1236,,
1940,12,12/4/2011,W,clear,steady,clear,brown,none,none,none,,,,,,,,,,,,,,,,,14,7.88,7.28,11.06,3,1996.5,,0.12,0.28,0.05,,
30,2909,,
1941,13,12/4/2011,W,clear,clear,clear,clear,musty,none,algae,,,,,5,,,100,,light,,,,100,,,,19,11.76,7.2,8.5,0.66,3875,,1.21,
0.75,0.04,41,20,2909,,
1942,14,12/4/2011,W,clear,steady,clear,clear,none,none,none,,,,,,,,,none,,,,,,,,11.23,7.34,10.51,0.08,1148,,,,,31,5,529,,
1943,15,12/4/2011,W,clear,steady,clear,clear,none,none,algae,,,,,85,,,,,light,,,,100,,,,17.5,16.4,7.39,8.91,0.41,1656,,4.12,
3.36,0.19,203,63,17329,,
1944,19,12/4/2011,W,clear,steady,clear,clear,none,none,algae,,,,,10,100,,,,none,,,,,,,13,8.5,7.3,10.36,0,1072.5,,,,,5,5,5,,
1945,30,12/4/2011,W,clear,steady,clear,clear,clear,none,algae,,,,,85,,80,5,,,,,,,,,19,8.98,7.46,11.01,0.17,4050,,8.16,0.65,
0,134,63,2755,,
1946,21,12/4/2011,W,clear,NM,cloudy,green,none,none,leaves,,,,,,,,,none,,,,,,,15,9.55,7.23,11.12,9.08,1932,,0,0.04,0.0
8,5,10,1215,,
1947,22,12/4/2011,W,clear,none,cloudy,green,none,NM,NM,,,,,,,,,,,,,,,,,15.5,11,8.1,9.45,9.6,1990,,0,0,0.09,5,20,1658,,
1948,23,12/4/2011,W,clear,none,cloudy,green,none,none,leaves,,,,,,,,,none,,,,,,,14,10,7.5,9.9,9.8,1870,,0,0.03,0.11,31,2
0,2909,,
1949,24,12/4/2011,W,clear,none,cloudy,green,none,none,leaves,,,,,,,,,none,,,,,,,12,10.3,8.21,11.46,9.8,1850,,0,0.06,0.1
2,20,51,2247,,
1950,25,12/4/2011,W,clear,NM,cloudy,green,none,none,leaves,,,,,,,,,none,,,,,,,16,10.3,6.6,8.3,4.7,1728,,0,0.02,0.05,26,
10,367,,
1951,26,12/4/2011,W,clear,none,cloudy,green,none,none,leaves,,,,,,,,,none,,,,,,,18,10.6,7.44,13.6,13.7,1820,,0,0.01,0.1
1,5,10,1408,,
1952,27,12/4/2011,W,clear,none,clear,green,none,none,leaves,,,,,,,,,none,,,,,,,17,10.8,7.8,,8.8,1850,,0,0.01,0.1,5,10,195
6,,
1953,28,12/4/2011,W,clear,none,cloudy,green,none,none,leaves,,,,,,,,,none,,,,,,,8.1,9.2,7.5,11.2,8.1,1960,,0,0.04,0.09,5,
31,1462,,
1954,1,1/8/2012,W,clear,steady,clear,clear,none,none,algae,10,,,,80,,50,50,,,,,,,,,23,12.1,8.27,11.01,0.62,1913,,2.78,2.7
8,0.03,5,15,4203,,
1955,2,1/8/2012,W,clear,trickle,clear,clear,none,none,algae,5,,,,NM,,,,,light,,,,10,10,,80,23,8.85,7.87,10.8,0.43,1432.5,,

3.23,0.29,0.08,41,10,373,,
1956,3,1/8/2012,W,clear,steady,clear,clear,none,none,NM,NM,,,,NM,,,,,none,,,,,,,,19,9.1,7.8,,0.6,7580,,0,0.28,0,5,5,218,
,
1957,5,1/8/2012,W,clear,steady,clear,clear,none,none,algae,0,,,,80,,,100,,light,3,,,100,,,,19.3,9.48,7.85,12.44,0.3,3620,,5
.03,0.45,0.02,47,308,3430.5,,
1958,12,1/8/2012,W,clear,steady,clear,clear,none,none,algae,0,,,,100,,,100,,light,2,,,100,,,,18.5,7.8,7.71,11.45,2.25,2100
,,0,0.26,0,5,20,3873,,
1959,13,1/8/2012,W,clear,steady,clear,clear,none,none,algae,0,,,,60,,,100,,light,,,,100,,,,25.5,12.8,7.46,9.48,0.4,3825,,1.
17,0.81,0.03,548,41,2359,,
1960,15,1/8/2012,W,clear,steady,clear,clear,none,none,algae,0,,,,85,,,,,light,,,,,50,50,,25.5,12.2,7.69,10.84,1.07,2430,,1.
45,1.23,0.06,20,10,3255,,
1961,19,1/8/2012,W,clear,trickle,clear,clear,none,none,algae,0,,,,80,,,,,none,,,,,,,,,10.25,7.06,9.58,0,1065.5,,0,0.14,0.04,
10,10,767,,
1962,30,1/8/2012,W,clear,steady,clear,clear,none,none,leaves,0,,,,100,,100,,,light,5,,,,,,100,24.5,10.53,7.81,12.43,0.64,4
035,,7.79,0.68,0.01,20,20,3448,,
1963,21,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,20,9.9,8,10.72,8.5,2210,,0,0.07,0
.01,20,5,1872,,
1964,22,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,19.5,9.75,8,10.53,8.3,2190,,0,0.1
,0.01,10,5,1585,,
1965,23,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,19,9.6,8.8,7.9,10.4,2180,,0,0.1,0.
03,41,20,2613,,
1966,24,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,19,9.4,7.6,8.7,20,1980,,0,0.15,0.
03,5,5,1333,,
1967,25,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,20.8,9.9,7.53,7.67,4.2,1680,,0,0.
18,0.04,,86,1401,,
1968,26,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,22,9.9,8.2,9.65,9.7,1980,,0,0.86,
0.05,,10,2046,,
1969,27,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,20.3,10.4,7.9,10.21,9.6,2190,,0,0
.1,0.03,,10,1464,,
1970,28,1/8/2012,W,clear,none,cloudy,green,none,none,leaves,NM,,,,NM,,,,,none,,,,,,,,20,9.6,7.7,10.18,8,2240,,0,0.11,0
.1,,10,2631,,
1971,1,2/15/2012,W,overcast,steady,clear,clear,none,none,algae,NM,,,,NM,,,,,none,,,,,,,,13,12.7,8.09,11.29,0.22,1868,,2
.52,2.56,0.05,10,10,1465,,
1972,2,2/15/2012,W,overcast,steady,clear,clear,none,none,algae,0,,,,80,,100,,,light,,,,100,,,,12,9.35,8,,0.04,1663.5,,0.41,
0.24,0.02,30,10,763,,
1973,3,2/15/2012,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,,10,8.75,8.13,,0.11,721.5,,0,0.06,0.02,
5,5,109,,
1974,5,2/15/2012,W,overcast,steady,clear,clear,none,none,none,0,,,,0,,,,,light,5,,,100,,,,14,9.5,8.31,15.17,0.63,1999,,3.2
9,0.26,0.02,85,243,1909,,
1975,12,2/15/2012,W,showers,steady,clear,clear,none,foam,none,0,,,,0,,,,,none,,,,,,,,12,9.8,8.31,11.99,2.15,1930,,0,0.2,0
.09,10,20,25000,,
1976,13,2/15/2012,W,overcast,steady,clear,clear/brown,none,none,algae,0,,,,80,,90,10,,light,4,,,50,50,,,17,12.05,7.52,,0.
8,3480,,1.02,0.65,0.16,206,135,25000,,
1977,14,2/15/2012,W,overcast,trickle,clear,clear,none,none,algae,0,,,,10,,,100,,none,,,,,,,,13.5,12.75,,9.71,0.03,,,0,0.05,0
.04,10,5,1164.5,,
1978,15,2/15/2012,W,showers,steady,clear,clear,none,none,none,0,,,,0,,,,,light,10,,,75,25,,,12.5,11.9,8,11.02,0.49,1999,,
1.16,0.85,0.16,41,110,2851,,
1979,17,2/15/2012,W,showers,steady,clear,clear,none,none,algae,0,,,,80,,50,50,,light,,,,,100,,,12,12,6.76,8.83,1.29,1452,
,0.06,0.26,0.06,63,75,3448,,
1980,18,2/15/2012,W,showers,steady,clear,clear,none,none,algae,0,,,,20,,,,,moderate,20,,,,100,,,14,12.65,8.25,10.39,0.6
3,1599,,0,0.11,0,5,5,1314,,
1981,19,2/15/2012,W,overcast,trickle,clear,clear,none,none,algae,0,,,,40,,,100,,none,,,,,,,,12.75,10.25,8.22,10.38,0.86,10
97,,0,0.17,0.05,5,5,717,,
1982,30,2/15/2012,W,overcast,steady,clear,clear,none,none,algae,0,,,,80,,85,15,,light,2,,,,100,,,13.5,9.75,8.09,,0.97,404

0,,6.01,0.56,0.13,148,98,3873,,
1983,1,3/4/2012,W,clear,steady,clear,clear,none,none,algae,70,,,,15,,,,,none,,,,,,,,28,13.48,8.27,12.5,1.58,1744,,4.32,3.3,0.17,10,10,1223,,
1984,2,3/4/2012,W,clear,trickle,clear,clear,musty,NM,algae,35,,100,,,,,,,light,,,,,,,,24.5,9.38,8.09,,0.18,1438,,0.32,0.35,0.08,31,119,620,,
1985,3,3/4/2012,W,clear,intermittent,clear,clear,clear,none,algae,0,,,,0,,,,,none,,,,,,,,19,9.1,8.08,,0.01,757,,0,0.14,0.08,5,5,31,,
1986,5,3/4/2012,W,clear,steady,clear,NM,none,NM,algae,,,,,95,,,,,none,,,,,,,,24.5,10.4,8.07,13.84,0.16,3650,,3.9,0.31,0.14,96,37,2143,,
1987,12,3/4/2012,W,clear,steady,clear,clear,none,sewage,algae,0,,,,95,,,,,light,,,,50,,50,,23,10.45,8.03,10.67,0.82,2120,,0.02,0.32,0.14,20,31,25000,,
1988,13,3/4/2012,W,clear,steady,clear,clear/brown,rotten_eggs,none,algae,0,,,,95,,,,,none,,,,,,,,31,12.9,7.44,,1.77,3960,,1.03,0.65,0.11,448,185,4352,,
1989,15,3/4/2012,W,clear,NM,clear,clear,none,none,algae,0,,,,65,,,,,none,,,,,,,,35.5,14.8,7.83,12.38,0.27,2443.5,,0.96,1.06,0.25,5,121,4352,,
1990,30,3/4/2012,W,clear,steady,clear,clear,none,none,algae,10,,,,80,,,,,none,,,,,,,,31,11.2,7.92,,0.32,2040,,5.8,0.42,0.1,20,10,4352,,
1991,21,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,21,13.1,,10.67,6.58,,,0,0.02,0.12,97,5,1541,,
1992,22,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,22.5,14.3,,10.92,6.07,,,0,0.04,0.15,10,20,816,,
1993,23,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,24,13.75,,10.35,7.83,,,0,0.04,0.12,5,5,934,,
1994,24,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,26,13.85,,10.53,7.33,,,0,0.03,0.11,69,20,2187,,
1995,25,3/4/2012,W,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,,26.5,13.3,,9.51,5.48,,,0,0.09,0.11,41,20,1789,,
1996,26,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,28,14.3,,10.72,7.1,,,0,0.03,0.12,20,10,1086,,
1997,27,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,29,14.2,,11.17,8.18,,,0,0.05,0.15,63,31,1439,,
1998,28,3/4/2012,W,clear,none,cloudy,green/brown,none,NM,algae,NM,,,,NM,,,,,none,,,,,,,,20,13,,10.78,6.8,,,0,0.02,0.13,145,5,2359,,
1999,1,4/15/2012,D,clear,NM,clear,clear,none,none,algae,,,,,75,,100,,,none,,,,,,,,20,16.78,8.17,11.1,0.66,1539,,2.4,2.89,0.07,10,10,2382,,
2000,2,4/15/2012,D,clear,steady,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,18.5,13.48,7.12,9.72,0.26,1329,,0.78,0.35,0.08,197,63,2909,,
2001,3,4/15/2012,D,steady,steady,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,15.5,11,7.93,9.95,0.48,730,,0.06,0.09,0.07,20,5,1112,,
2002,5,4/15/2012,D,clear,steady,muddy,brown,none,NM,NM,,,,,,,,,,light,,,,,100,,,21.5,16.45,7.87,9.18,0.8,1342,,0.07,0.27,0.09,10,246,2359,,
2003,12,4/15/2012,D,clear,steady,clear,clear,none,none,algae,,,,,20,,100,,submerged diatoms,none,,,,,,,,20.5,14.9,8.15,10.14,0.87,1343,,0.02,0.27,0.06,119,5,3255,,
2004,13,4/15/2012,D,clear,steady,clear,clear,none,none,algae,,,,,5,,,,,light,,,,,100,,,19.25,14.45,7.6,7.92,0.85,3820,,0.96,0.75,0.11,414,246,7701,,
2005,14,4/15/2012,D,clear,trickle,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,19.5,14.75,7.88,9.46,2.48,1171,,0.02,0.09,0,20,5,1467,,
2006,15,4/15/2012,D,clear,steady,clear,clear,none,none,none,,,,,35,,100,,submerged diatoms,light,1 bag,,,,100,,,19,14.38,7.85,9.52,0.79,1815,,0.67,0.52,0.07,97,108,9208,,
2007,17,4/15/2012,D,clear,steady,clear,clear,none,none,algae,,,,,75,,,,,light,,,,100,,,,19.5,14.5,7.39,8.62,0.72,1232,,0.14,0.2,0.21,97,145,2613,,
2008,18,4/15/2012,D,NM,trickle,clear,clear,none,none,none,,,,,,,,,,light,,,,,25,75,,20.5,13.95,8.02,10,0.38,1562,,0.04,0.09,0.11,5,5,2755,,
2009,19,4/15/2012,D,clear,NM,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,20.5,12.95,7.64,9.35,3.39,1118,,0.04,0.17,0.0

4,10,5,1314,,
2010,30,4/15/2012,D,clear,steady,clear,clear,none,none,none,,,,,100,,,,,light,,,,100,,,,20,14.58,8.04,10.23,0.64,3840,,7.9,0.91,0.12,307,106,19863,,
2011,1,5/20/2012,D,clear,steady,clear,clear,none,none,none,,,,,100,,,100,benthic brown fuzz rhizodieim,none,,,,,,,,28.5,18.93,7.94,8.69,0.44,1027,,0.15,0.94,0.16,31,31,7701,,
2012,2,5/20/2012,D,clear,steady,clear,none,none,none,none,,,,,,,,,,none,,,,,,,,22,15.43,8.13,9.02,0.61,1389,,0.28,0.35,0.06,249,388,3968,,
2013,3,5/20/2012,D,clear,steady,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,,15.3,8.12,8.59,0,764,,0,0.08,0.03,40,85,754,,
2014,5,5/20/2012,D,clear,steady,clear,clear,none,garbage,none,,,,,10,,,100,,light,,,,,100,,,27.5,20.6,7.54,6.62,0.7,1617,,0,0.3,0.03,31,85,4611,,
2015,12,5/20/2012,D,clear,steady,clear,clear,none,none,none,,,,,5,,,50/50,,none,,,,,,,,23,20.1,8.05,8.87,0.63,1676,,0.02,0.34,0.7,41,5,295,,
2016,13,5/20/2012,D,clear,trickle,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,26,17.48,7.5,6.78,0.83,3805,,1.06,0.79,1.25,301,345,9208,,
2017,14,5/20/2012,D,clear,trickle,clear,clear,none,none,none,,,,,,,,,,none,,,,,,,,20.5,16.25,7.85,8.82,0.35,1233,,0.28,0.35,0,110,20,1296,,
2018,15,5/20/2012,D,clear,steady,clear,clear,none,garbage,none,,,,,30,,30,70,,light,,,,50,50,,,23.5,18.45,7.72,4.69,0.82,2145,,0,0.1,0.09,52,5,19863,,
2019,17,5/20/2012,D,clear,steady,cloudy,clear,none,none,none,,,,,,,,,,none,,,,,,,,27,19.2,7.2,6.22,6.7,1321,,0.15,0.32,0.05,3050,1480,5,,
2020,18,5/20/2012,D,overcast,trickle,clear,clear,none,none,none,,,,,,,,,,light,1,,,,,,,19,15.8,7.93,9.26,0.02,1628,,0,0.09,0,20,10,7270,,
2021,19,5/20/2012,D,clear,steady,clear,clear,none,none,none,10,,100,,,,,,,none,,,,,,,,18.5,16.28,7.96,10.24,0.24,1216,,0,0.05,0.05,31,31,2769,,
2022,30,5/20/2012,D,clear,steady,clear,clear,none,none,none,,,,,75,,,,,light,,,,,,,,31.3,17.73,8.08,8.98,0.04,3880,,6.1,0.68,0.05,311,148,15531,,
2023,21,5/20/2012,D,clear,none,cloudy,green,none,none,algae,100,,,,,,,,lots of fry,,,,,,,,,23,23.58,,6.44,2.6,1793,,0,0.08,0.08,200,100,25000,,
2024,22,5/20/2012,D,NM,none,cloudy,green,none,none,none,,,,,100,,,,lots of fry,,,,,,,,,24,24.38,,5.8,2.58,1753,,0,0.26,0.1,5,5,25000,,
2025,23,5/20/2012,D,clear,none,cloudy,green,none,none,algae,100,,,,,,,,lots of fry,,,,,,,,,26,24.5,,6.41,2.85,1653,,0,0.3,0.18,5,5,15551,,
2026,24,5/20/2012,D,clear,none,cloudy,green,none,none,algae,100,,,,,,,,lots of fry,,,,,,,,,27,24.28,,5.91,27.2,1586,,0,0.26,0.18,10,10,24196,,
2027,25,5/20/2012,D,clear,none,cloudy,green,none,NM,algae,100,,,,,,,,lots of fry,,,,,,,,,29.5,23.05,,6.54,1.97,1458,,0,0.22,0.08,20,5,11100,,
2028,26,5/20/2012,D,clear,none,cloudy,green,none,none,algae,100,,,,,,,,lots of fry,,,,,,,,,29,24.4,,5.71,3.52,1565,,0,0.17,0.07,5,20,24196,,
2029,27,5/20/2012,D,NM,NM,cloudy,green,none,none,algae,100,,,,,,,,lots of fry,,,,,,,,,30,24.6,,7.92,2,1670,,0,0.26,0.03,5,10,12997,,
2030,28,5/20/2012,D,clear,none,cloudy,green,none,none,algae,100,,,,,,,,lots of fry,none,,,,,,,,22,23.18,,5.65,2.38,1775,,0,0.26,0.07,30,5,7220,,
2031,1,6/10/2012,D,overcast,trickle,clear,green,none,none,none,0,,,,50,,,,,none,,,,,,,,18,17.9,7.87,7.73,1.59,1866,,0.09,1.31,0.04,15,10,20762.5,,
2032,2,6/10/2012,D,clear,intermittent,clear,clear,none,none,none,0,,,,90,,,,,light,1,,,,100,,,20.5,16.03,8.05,8.96,1.39,1326,,0.15,0.33,0.08,145,97,2595,,
2033,3,6/10/2012,D,overcast,intermittent,clear,NM,none,none,none,0,,,,0,,,,,none,,,,,,,,19.8,15.9,8.16,8.46,0.11,734,,0,0.06,0.03,85,5,1565,,
2034,5,6/10/2012,D,clear,steady,clear,clear,none,none,algae,5,,,,0,,,,,none,,,,,,,,19.5,16.7,8.1,10.1,0.38,3540,,2.88,0.48,0.09,211,74,24196,,
2035,12,6/20/2012,D,overcast,trickle,clear,clear,none,none,mosquito larvae,0,,,,10,,,,,none,,,,,,,,20.5,20.3,8.06,8.61,1.37,1738.5,,0.01,0.38,0.24,10,63,24196,,
2036,13,6/10/2012,D,NM,none,clear,clear,sulphur,NM,none,0,,,,0,,,,,none,,,,,,,,25,18.4,7.45,6.62,1.5,3730,,0.85,0.8,0.07

,122,122,8164,,
2037,14,6/10/2012,D,overcast,intermittent,clear,clear,none,none,none,0,,,,10,,100,,,none,,,,,,,18,16.6,7.82,8.61,0.01,1158,,0,0.08,0.02,216,465,3076,,
2038,15,6/10/2012,D,clear,trickle,clear,clear,none,none,none,0,,,,50,,,,,none,,,,,,,19,18.1,7.87,8.7,0.81,2215,,0.19,0.4,0.04,10,63,25000,,
2039,17,6/10/2012,D,clear,steady,clear,clear,none,none,none,0,,,,10,,40,60,,moderate,,,,,60,,40,24,19.8,7.14,6.36,0.38,1313,,0.15,0.29,0.05,31,63,7270,,
2040,18,6/10/2012,D,overcast,steady,clear,clear,none,garbage,none,0,,,,5,,100,,,light,,,,,100,,,18.5,16.45,8.07,8.78,2.27,1527,,0,0.12,0.04,31,5,2489,,
2041,19,6/10/2012,D,overcast,steady,clear,clear,none,none,none,0,,,,70,,90,10,,none,,,,,,,21,16.2,7.87,9.41,0,1127.5,,0,0.11,0.01,63,41,1918,,
2042,30,6/10/2012,D,clear,trickle,clear,clear,none,garbage,none,5,100,,,75,,100,,,light,3,,,,100,,,21,18.2,8.03,8.9,0.7,3865,,5,0.6,0.06,197,75,14136,,
2043,9,6/13/2012,D,overcast,intermittent,clear,clear,none,leaves,none,0,,,,0,,,,,none,,,,,,,21.5,17.1,7.65,6,0.7,2685,,0,0.42,0.1,,31,2282,,
2044,11,6/12/2012,D,clear,steady,clear,clear,none,none,none,0,,,,5,,50,50,snails and
tadpoles,light,1,,,,,,100,22.5,16.55,8.03,9.36,0.08,1222,,0,0.13,0.06,,20,1259,,
2045,SC22,6/13/2012,D,overcast,intermittent,clear,clear,none,none,leaves,5,100,,,80,,75,25,snails,light,,,10,,90,,,21,17.4,8.15,10.56,0.03,1498.5,,0,0.16,0.08,,20,1515,,
2046,1,7/8/2012,D,clear,none,clear,clear,none,none,none,5,100,,,95,,100,,,none,,,,,,,26.5,18.5,7.45,5.25,0.33,1897,,0.1,1.65,0.05,20,10,24196,,
2047,2,7/8/2012,D,clear,trickle,clear,clear,none,none,none,0,,,,30,,100,,,none,,,,,,,20,15.08,7.95,7.8,2.12,1343.5,,0.11,0.51,0.1,279,379,10467,,
2048,3,7/8/2012,D,clear,intermittent,clear,clear,none,none,none,0,,,,5,,,,,none,,,,,,,22.15,16.83,8.09,7.75,1.48,7050,,0,0.11,0.04,10,5,886,,
2049,12,7/8/2012,D,clear,trickle,clear,clear,none,garbage,none,0,,,,100,,,,,light,2,,100,,,,,23.75,19.43,7.84,6.46,1.15,1765.5,,0.14,0.3,0.36,173,5,24196,,
2050,13,7/8/2012,D,clear,trickle,clear,clear,none,none,none,30,,,,75,,,,,none,,,,,,,27.5,17.9,7.9,9.74,1.13,3690,,2.02,1.26,0.15,637,173,24196,,
2051,14,7/8/2012,D,clear,trickle,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,22,17.25,8,8.44,0.19,1174,,0,0.11,0.05,75,10,2359,,
2052,15,7/8/2012,D,clear,steady,clear,clear,none,leaves,none,0,,,,70,,100,,,none,,,,,,,22.5,18.25,7.7,8.2,1.77,2570,,0.13,0.62,0.1,10,5,25000,,
2053,17,7/8/2012,D,clear,intermittent,clear,clear,sewage,none,none,0,,,,50,,100,,,light,,,,50,50,,,29,20,7.27,4.23,0.82,1381.5,,0.06,0.37,0.09,148,110,4352,,
2054,18,7/8/2012,D,overcast,trickle,clear,clear,burned
rubber,none,none,0,,,,50,,100,,,light,5,,,,20,80,,20,16.05,8.1,9.13,0.05,1530.5,,0,0.14,0.12,5,5,1005,,
2055,19,7/8/2012,D,clear,trickle,clear,clear,none,none,none,0,,,,50,,100,,,none,,,,,,,20.75,16.5,8.04,9.54,0.15,1112,,0,0.2,0.05,10,5,906,,
2056,30,7/8/2012,D,clear,steady,clear,NM,NM,NM,none,0,,,,90,,80,20,,light,,,,60,20,20,,28.5,18.5,8.08,9.1,0.86,3870,,6.7,0.59,0.09,272,98,19863,,
2057,21,7/8/2012,D,clear,none,cloudy,green/brown,none,wood,algae,NM,,,,NM,,,,,none,,,,,,,24,24.88,8.79,12.4,19.5,2250,,0,0.15,0.27,52,10,15531,,
2058,22,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,27,25.83,8.86,11.11,12.5,2245,,0,0.5,0.25,5,10,19683,,
2059,23,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,28,25.23,8.81,11.19,6.96,2225,,0,0.14,0.28,10,5,25000,,
2060,24,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,light,,,,,,,,30,25.1,8.83,10.92,14.5,1977.5,,0,0.14,0.32,20,5,25000,,
2061,25,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,30,24.55,8.65,9.25,10.78,1944.5,,0,0.11,0.28,5,5,25000,,
2062,26,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,30,26,8.98,15.58,26.1,1946,,0,0.09,0.37,5,5,25000,,
2063,27,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,30,25.97,8.91,13.48,12.33,

2230,,0,0.12,0.27,10,10,25000,,
2064,28,7/8/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,NM,,,,,none,,,,,,,,25,24.6,8.8,10.13,10.2,2215,,0,0,0.23,5,10,24196,,
2065,1,8/5/2012,D,clear,none,clear,clear,none,none,none,0,,,,100,,100,,,none,,,,,,,,21.5,19.75,7.42,5.49,1.45,1913.5,,0.02,1.38,0.03,10,5,25000,,
2066,2,8/5/2012,D,clear,none,clear,clear,none,garbage,none,0,,,,0,,,,,light,2,,,100,,,,21.5,18.5,7.59,4.57,15.6,1320.5,,0,0.56,0.03,146,31,3873,,
2067,3,8/5/2012,D,clear,steady,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,,24,18.3,7.85,7.47,1.3,7135,,0,0.11,0,20,41,816,,
2068,13,8/5/2012,D,clear,steady,clear,clear,none,none,none,0,,,,95,,,,,light,,,,25,50,25,,28.5,20.45,7.4,6.04,0.77,3625,,0.99,0.99,0.16,860,275,19863,,
2069,14,8/5/2012,D,clear,intermittent,clear,clear,NM,NM,none,0,,,,50,,100,,,none,,,,,,,,23.5,18.2,7.5,8.22,0,1156,,0,0.07,0.01,98,41,2098,,
2070,15,8/5/2012,D,clear,steady,clear,clear,none,NM,none,0,,,,60,,100,,,none,,,,,,,,24,18.55,7.6,7.43,1.08,2565,,0.08,0.71,0.05,31,30,25000,,
2071,17,8/5/2012,D,clear,none,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,,28,20.5,7.06,7.2,1.33,1440.5,,0,0.34,0.09,62,5,3654,,
2072,18,8/5/2012,D,clear,steady,clear,clear,none,none,none,0,,,,60,,100,,,light,,,,,,100,,21,17.17,7.85,8.86,0,1481,,0.09,0.15,0,15,20,1694,,
2073,19,8/5/2012,D,overcast,steady,clear,clear,none,none,none,20,100,,,60,,,100,,none,,,,,,,,22.5,16.9,7.99,9.41,0.03,1074,,0,0.03,0,5,5,1850,,
2074,30,8/5/2012,D,clear,trickle,clear,clear,none,none,none,0,,,,80,,,,,light,3,,,,100,,,29.5,19.95,7.93,8.63,0.88,3925,,6.5,0.68,0.04,252,1323,15531,,
2075,21,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,25,25.1,8.41,6.7,11,2440,,0,0.4,0.26,110,5,7701,,
2076,22,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,28,25.98,8.48,7.14,9.45,2410,,0,0.45,0.25,10,5,24196,,
2077,23,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,28.5,25.75,8.56,8.11,13.33,2400,,0,0.26,0.23,31,5,6488,,
2078,24,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,29,25.88,8.49,7.68,14.33,2375,,0,0.4,0.33,75,5,9804,,
2079,25,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,30,25.4,8.44,6.83,12.17,2355,,0,0.37,0.25,75,5,3255,,
2080,26,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,30,25.98,8.49,6.58,12,2370,,0,0.42,0.26,495,5,8164,,
2081,27,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,31,26.06,8.54,7.34,11.67,2405,,0,0.44,0.22,161,10,9804,,
2082,28,8/5/2012,D,clear,none,cloudy,green/brown,none,none,algae,NM,,,,,,,,,none,,,,,,,,25,25.25,8.39,6.29,10.18,2425,,0,0.49,0.17,313,5,7270,,
2083,2,9/9/2012,D,clear,intermittent,clear,clear,none,none,none,0,,,,0,,,,,none,,,,,,,,29,19.85,7.96,7.41,0.04,7040,,0.01,1.01,0.17,10,5,19863,,
2084,3,9/9/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,,,,,,,,,27,19.3,7.59,5.12,2.33,2400,,0,0.1,0.03,31,5,1169,,
2085,5,9/9/2012,D,clear,steady,clear,clear,none,none,none,0,,,,95,,100,,,light,1,,,,100,,,26.5,19.85,7.93,9.43,0.42,1340,,4.37,0.37,0.11,309,561,24196,,
2086,13,9/9/2012,D,clear,intermittent,cloudy,green,none,oily sheen,crayfish,NM,,,,NM,,,,,light,,,,,100,,,30,20.25,7.23,5.31,1.04,3740,,0.98,0.94,0.07,288,201,24196,,
2087,14,9/9/2012,D,clear,trickle,clear,clear,none,none,yes,0,,,,60,,100,,,none,,,,,,,,26.25,19.5,8.22,7.96,0.8,1207,,0.01,0.1,0.07,173,134,1850,,
2088,15,9/9/2012,D,clear,intermittent,clear,clear,none,none,none,10,,,100,0,,,,,light,2,,,50,50,,,29,20.7,7.54,8.46,1.04,2870,,0.04,0.94,0.06,10,20,24196,,
2089,18,9/9/2012,D,clear,steady,clear,clear,none,none,leaves,0,,,,90,,,100,,light,,,,100,,,,22,18.5,8.36,8.7,0,1523,,0,0.1,0,20,10,1607,,
2090,19,9/9/2012,D,clear,trickle,clear,clear,none,none,yes,25,100,,,65,,95,5,,none,,,,,,,,25,18.75,8.22,7.93,0,1105.5,,0,0.

21,0.05,5,5,3314,,
2091,30,9/9/2012,D,clear,steady,clear,clear,none,none,yes,0,,,,95,5,95,,crayfish
fish,moderate,,,,90,10,,,32.5,20.85,8.13,8.83,0.69,3885,,8.22,0.8,0.08,160,31,3873,,
2092,3,10/7/2012,D,clear,trickle,clear,clear,none,none,none,0,,,,5,,,100,,none,,,,,,,,20,16.05,8.25,8.3,0,5995,,0.05,0.32,0.09,10,5,657,,
2093,13,10/7/2012,D,clear,trickle,clear,clear,rotten food,garbage,yes,0,,,,10,,100,,crayfish
fish,moderate,,,,10,90,,,25,17.45,8.28,6.8,3.78,3890,,0.99,1.36,0.12,1565,2613,25000,,
2094,14,10/7/2012,D,clear,trickle,clear,clear,none,none,leaves,0,,,,75,,100,,insects,none,,,,,,,,22.5,16.75,7.93,8.48,0,1212,,0.01,0.18,0.07,85,63,1314,,
2095,15,10/7/2012,D,clear,steady,clear,clear,none,none,yes,10,,,,80,,80,20,crayfish
fish,moderate,,,,15,80,5,,25.5,18.4,7.83,7.47,0,3250,,0.04,0.98,0.06,52,63,25000,,
2096,18,10/7/2012,D,overcast,intermittent,clear,clear,musty,none,leaves,0,,,,100,,100,,other human
influence,light,,,,20,30,50,,22.5,17.6,8.2,,1.5,1415,,0.04,0.26,0.05,46.5,20,5500.5,,
2097,19,10/7/2012,D,clear,trickle,clear,clear,none,none,yes,65,100,,,65,,100,,frog,none,,,,,,,,23,15.75,7.89,7.93,0.11,1023,,0,0.39,0.08,10,208,3654,,
2098,30,10/7/2012,D,clear,steady,clear,clear,musty,none,yes,0,,,,95,,100,,crayfish,light,,,,,100,,,26,16.3,8.54,8.45,0.41,4020,,1.7,1.09,0.11,209,41,19863,,
2099,21,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,22,20.9,7.45,5.63,38.83,2870,,0,0.23,0.17,20,20,6131,,
2100,22,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,23,21.95,8.22,5.48,35.5,2830,,0,0.05,0.16,5,5,2247,,
2101,23,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,22.5,21.3,8.46,8.73,46.67,2820,,0,0.23,0.17,10,20,2489,,
2102,24,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,24,20.95,8.36,7.23,45.83,2820,,0,0.24,1.22,41,31,4884,,
2103,25,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,25,20.15,8.06,4.8,42,2790,,0,0.06,0.15,69,69,4381,,
2104,26,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,25,21.5,8.4,8.38,49.17,2830,,0,0.28,0.14,10,41,3873,,
2105,27,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,25.5,23.85,8.47,9.31,43.83,2850,,0,0.2,0.12,10,10,4611,,
2106,28,10/7/2012,D,clear,none,cloudy,green,none,none,none,0,,,,0,,,,,none,,,,,,,,23,20.9,8.23,6.93,36.83,2850,,0,0.21,0.16,7270,20,2987,,
2107,2,11/4/2012,D,clear,none,cloudy,yellow,none,oily
sheen,alage,0,,,,10,,100,,,none,,,,,,,,21.75,12.65,7.65,8.18,17.5,3260,,0.13,0.48,0,98,41,6867,,
2108,3,11/4/2012,D,clear,trickle,clear,clear,none,none,leaves,0,,,,0,,,,,none,,,,,,,,18.5,12.5,8.03,9.41,0,5503.5,,0,0.08,0,30,5,473,,
2109,13,11/4/2012,D,clear,trickle,cloudy,brown,none,oily sheen
garbage,algae,25,100,,,0,,,,,moderate,,,,,100,,,,15.35,7.51,6.46,0.65,3970,,0.86,0.77,0.04,1789,158,7270,,
2110,14,11/4/2012,D,clear,intermittent,clear,clear,none,none,yes,0,,,,10,,100,,,none,,,,,,,,23.5,16.3,7.99,8.52,0.24,858,,0.86,0.12,0.02,158,108,2187,,
2111,15,11/4/2012,D,clear,steady,clear,clear,none,garbage,yes,3,,,,90,,80,20,,light,,,,35,15,55,,24.5,15.1,7.56,8.11,0,3395,,0.86,0.68,0.08,31,20,3255,,
2112,18,11/4/2012,D,clear,trickle,clear,clear,none,leaves/sticks,yes,0,,,,90,,,95,,moderate,,,,50,50,,,26.25,15.7,8.19,9.23,0.02,1136.5,,0.86,0.13,0.04,20,20,1658,,
2113,19,11/4/2012,D,clear,trickle,celar,clear,none,leaves sticks algae
pollen,yes,20,100,,,60,,100,,,none,,,,,,,,23.5,12.5,7.75,8.01,0.21,834.5,,0.86,0.12,0,5,31,1664,,
2114,30,11/4/2012,D,clear,steady,clear,clear,none,leaves,yes,0,,,,98,,100,,,light,,,,100,,,,,29.5,13,8.16,9.72,0.19,4040,,0.86,1.1,0,2316,581,14136,,
2115,21,11/4/2012,D,clear,none,muddy,green/brown,none,none,none,100,,,,0,,,,planktonic,none,,,,,,,,19,15.85,8.52,9.43,45.63,1800.5,,0.1,0,0,52,20,3448,,
2116,22,11/4/2012,D,clear,none,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,20,17.1,8.56,7.51,50.83,1773,,0,0,0,20,10,1850,,
2117,23,11/4/2012,D,clear,none,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,22,15.8,8.73,10.12,5

2.5,1782,,0,0,0,63,146,3076,,
2118,24,11/4/2012,D,clear,none,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,22.5,16.15,8.52,8.59
,54.17,1776.5,,0,0,0,51,52,4352,,
2119,25,11/4/2012,D,clear,none,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,24.5,15.15,8.16,7.05
,47.5,1768,,0,0,0,20,52,4106,,
2120,26,11/4/2012,D,clear,none,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,28.5,16.75,8.53,9.42
,55,1771,,0,0,0.04,20,63,2481,,
2121,27,11/4/2012,D,clear,none,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,28.5,16.75,8.31,10.1
9,47.5,1780.5,,0,0,0.02,75,30,2247,,
2122,28,11/4/2012,D,clear,NM,muddy,green/brown,none,none,yes,100,,,,0,,,,planktonic,none,,,,,,,,19,15.75,8.72,10.75,4
7.5,1788.5,,0,0,0.03,134,41,2613,,
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4.5,,1.77,2.12,0.13,199,98,7215,,
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Malibu Creek Watershed Monitoring Program Baseline Report
Executive Summary

September 18, 2005
Prepared by:
Malibu Creek Watershed Monitoring Coordinator, James Medlen

Purpose and Scope

The Malibu Creek Watershed Monitoring Program (MCWMP) is a cooperative effort aimed at determining baseline water quality throughout the entire Malibu Creek Watershed. The Monitoring Program's lead agency is the City of Calabasas. The funding for the project is provided by a Californian Proposition 13 grant and administered through the Los Angeles Regional Water Quality Control Board, (region 4). In addition stakeholders throughout the watershed including the County of Los Angeles, cities of Calabasas, Westlake Village, and Agoura Hills each contributed $30,000 dollars to the project.

The MCWMP is intended to provide information for the use of policy makers, regulatory agencies, and the public. Water quality in this watershed is integral in current and future public policies. The primary goal of the MCWMP is to collect data and information on pollutants and other problems that impair beneficial uses of Malibu Creek and its tributary streams. The monitored sites were chosen to represent a variety of land uses so that data collected would lead to a comprehensive picture of how pollutants are affecting basic health and beneficial uses of the watershed.

The monitoring program is coordinated by Jim Medlen and employs four interns: Chris Hardenbrook, John Hess, Sung Lee, and Greg Lyon. These interns monitor water quality in the field by taking samples from the field, analyzing data, and working on other portions of the MCWMP. The data that the project is collecting is being used to fill in data gaps missing for the Malibu Creek Watershed. This much needed data will create a more complete understanding of the watershed's present baseline condition.

The MCWMP consists of 13 sites on 10 streams spread among both Los Angeles and Ventura County. The program tests for a variety of parameters discussed in the main body of this report, and will expand monitoring of additional parameters at monitoring sites according to water quality conditions.

Methods

All baseline monitoring samples were taken by the project's coordinator and interns in the field. Methods used in the collection of baseline data for the project were approved by the state, and followed the State Water Resource Control Board's (SWRCB) Surface Water Ambient Water Moniotoring Program (SWAMP) protocal. Methods can be found in the main body of the baseline report, or the project's Quality Assurance Project Plan (QAPP).

Findings

Below is a water quality summary of creeks monitored in the watershed:

Las Virgenes Creek- LV1 and LV2

The project monitors at two sites along the Las Virgenes Creek; the upper site (LV1) receives run-off primarily from open space, while the lower site (LV2) receives urban run-off from residential and commercial use areas located in the city of Calabasas.

Bacteria levels at the two different sites differed. Bacterial levels at the upper Las Virgenes site LV1 consistently had lower bacterial levels than the downstream site LV2. Enterococcus levels at both sites did not meet the California State Department of Health Services recommended levels. The creek's lower site also had high fecal coliform levels on 4 out of 6 sampling events.

Nutrient levels at both of the project's sites on Las Virgenes Creek did not meet EPA water quality criteria summer limits twice for Total Nitrogen and twice for Total Phosphorous.

Chlorophyll-a levels remained low in the creek during all sampling events. Algae at the the LV1 site grew thicker as warmer weather moved in towards the beginning of summer. Algal growth at LV2 was limited due to tree canopy coverage at the site.

Lindero Creek - Lin1 and Lin2

The project monitors two sites along Lindero Creek; the upper site receives run-off from residential, urban built-up, cropland, and recreational-use, while the lower site receives run-off from Lake Lindero, which contains all the run-off listed above.

Enterococcus levels for both sites did not meet California State Department of Health Services recommended levels for the majority of all sampling events. Fecal coliform for both sites exceeded EPA TMDL limits on two occasions, and e.coli on three occasions.

Nutrient levels at the upper Lindero Creek (Lin1) site did not meet EPA water quality criteria summer limits twice for Total nitrogen and twice for Total phosphorous. The lower site Lin 1 did not meet EPA's summer limits for Total Nitrogen once and Total Phosphorous twice.

Chlorophyll-a levels were fairly low at the Lin1 site in the upper watershed, while levels at the lower site Lin2 had some very high spikes. Lin2 consistently had a coating of algae on the sampling site substrate.

Trash was commonly found at this site in the water and on the banks.

Conductivity levels at the upper site Lin1 were consistently high.

Medea Creek- Med1 and Med2

The project monitors two sites located on Medea Creek. The upper site Med1 receives run-off from cropland, residential, commercial, and shrub and brush areas, while the lower site receives run-off primarily from open space parkland.

Bacterial levels at the Med 1 site consistently exceed EPA TMDLs and WQOs for both Fecal Coliform and E.coli. Enterococcus levels did not meet California Department of Health Services recommended levels 5 times out of 6.
The lower Med2 site consistently exceeded EPA TMDLs and WQOs for E.coli. Fecal Coliform levels exceeded TMDL/WQOs standards twice. Enterococcus levels did not meet the California State Department of Health Services limits on five separate occasions.

Nutrient levels at the upper Medea Creek site (Med1) did not meet EPA water quality criteria summer limits twice for total phosphorous. The lower site Med2 did not meet EPA's summer limits for Total Nitrogen once and Total Phosphorous twice.

Chlorophyll-a levels at both sites remained low during all sampling events. The upper Medea Creek site was noted too have high levels of nuisance algae coating the substrate of the site and floating in the waterbody.

Conductivity levels at the upper site Med 1 were high on several sampling events.

Liberty Canyon Creek LC

Liberty Canyon Creek receives run-off primarily form evergreen forest, residential, and rangeland land uses.

This site had some of the highest Fecal Coliform and E.coli levels of all the sites. Both indicators had extremely high spikes within the sampling period (e.g., 5000/100 ml (twice) and 3609/100 ml respectively). Total Coliform levels were also very high twice. Enterococcus levels had extremely high spikes of 4884/100 ml, 2359/100 ml, and 1376/100 ml. There are no legal bacterial limits for this site because no beneficial uses have been designated.

Nutrient levels at the Liberty canyon site exceeded EPA's water quality criteria summer limits for Total Nitrogen twice.

Chlorophyll-a levels were some of the highest levels found out of all of the sites. Algae mats and a thin coat of algae on the substrate of this site's concrete channel were commonly found.

Liberty Canyon was observed to have high concentrations of trash in the channel during all sampling events.

Conductivity levels at the site are higher than average in comparison to other sites in the watershed.

Russell Creek- RUS

Russell Creek receives run-off from shrub and brush, residential, and commercial areas in Westlake Village. The creek drains into the southeastern section of Westlake Lake.

Both E.coli and Enterococcus levels were high two and three times. There are no bacterial limits for this site because no beneficial uses have been designated.

Nutrient levels at the site did not meet EPA water quality criteria summer limits twice for Total Nitrogen and twice for Total Phosphorous.

Chlorophyll-a levels remained low in the creek during all sampling events.

Trash in the channel has been found commonly on all sample events.

Triunfo Creek- Tri

Triunfo Creek receives run-off from 95% shrub and 5% residential land use. The creek also receives run-off from Lake Sherwood located upstream.

Bacterial levels at Triunfo Creek exceeded EPA TMDLs and Basin Plan Water Quality Objectives (WQOs) for both Fecal Coliform and E.coli on the majority of sampling dates.

Ammonia-N levels at the sites were higher on average than other sites throughout the watershed. The site did not meet EPA quality criteria summer limits for Total Nitrogen and Total Phosphorous once each.

In comparison to other sites tested, Chlorophyll-a levels were average. Algae was commonly found throughout the site's downstream and upstream substrate.

Hidden Valley Creek-HV

Hidden Valley Creek receives the majority of its run-off from cropland and pasture land uses.

Hidden Valley's bacterial levels exceeded EPA TMDLs WQOs for both Fecal Coliform and E.coli. Total Coliform exceeded limits once. Enterococcus levels exceeded the California State Department of Health Services recommended levels five times.

Nutrient levels at this site did not meet EPA water quality criteria summer limits twice for Total Nitrogen and twice for Total Phosphorous. Total Nitrogen levels at the site were higher on average than other sites sampled by the project.

Chlorophyll-a levels remained low in the creek during all sampling events. Nuisance algal blooms could be located at the culvert at the end of the creek before it heads into Lake Sherwood, but could not be found on the loose sandy substrate.

Malibu Creek- Mal

The Malibu Creek site is the lowest site in the Malibu Creek Watershed. This site receives run-off from a majority of rangeland and some commercial services land use.

Malibu Creek met bacterial standards and recommended levels on all sampling events.

Nutrient levels at the Malibu Creek site did not meet the EPA's water quality criteria summertime limits for Total Phosphorous twice.

Chlorophyll-a levels at the site were higher on average than other sites in the watershed. Algae at this site had completely taken over most of the stream's substrate by May.

Cold Creek Reference Site- CC

The project used Cold Creek as a natural backgrounds level site due to the creek's pristine location in the Santa Monica Mountains.

The creek consistently had lower levels of pollutants than any other creek in the watershed, and met all recommended levels and standards on almost all sampling events. On one event, Total Phosphorous levels did not meet the EPA's water quality criteria summer limits.

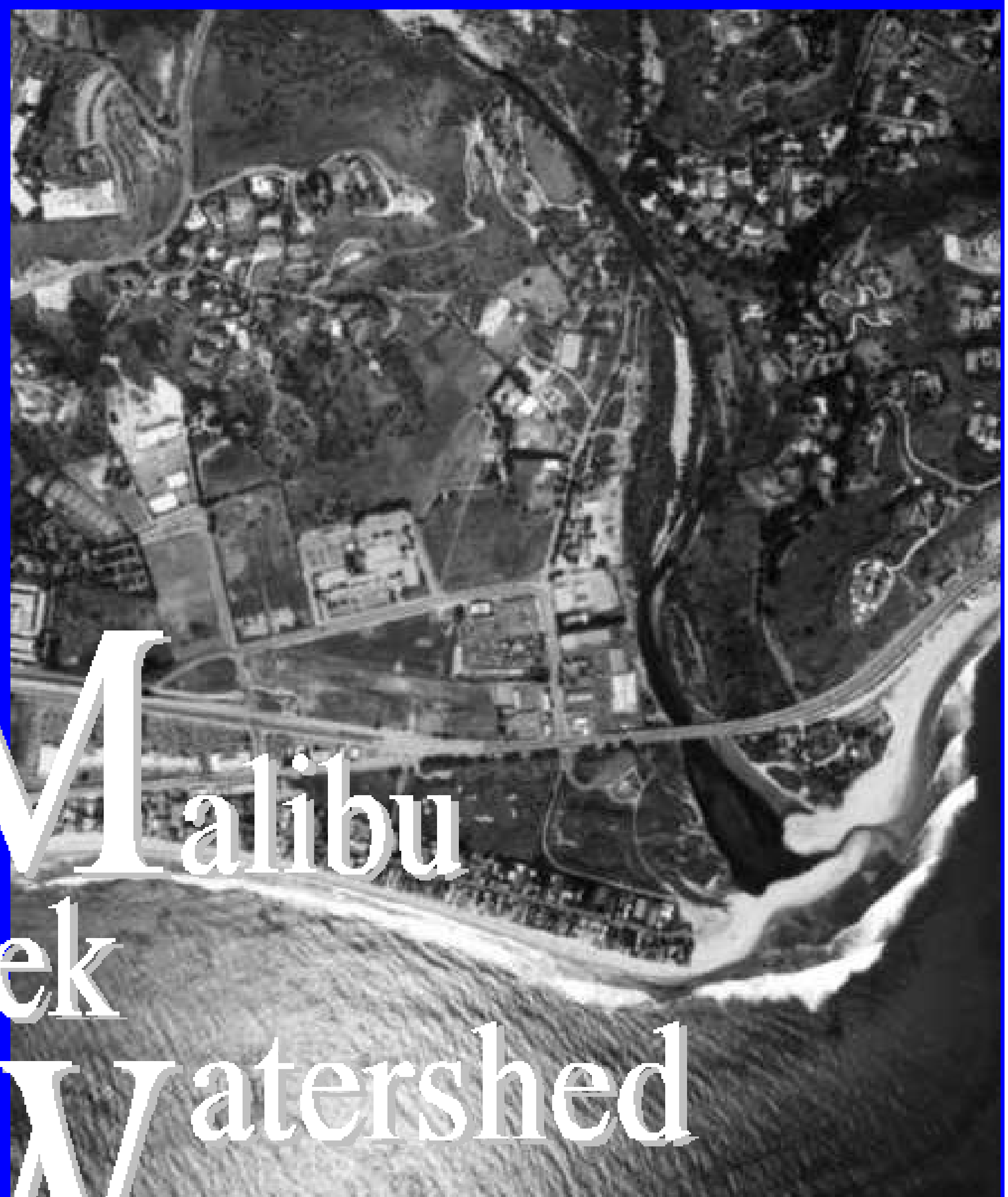
Conclusion

The purpose of this report is to provide watershed stakeholders and the public information on problematic areas that threaten the watershed's current beneficial uses due to poor water quality. Many sites throughout the watershed shared similar impairments such as high bacterial and nutrient levels, nuisance algal blooms (eutrophication), and trash along the creek's banks.

The only site monitored that could be considered free of water quality impairments was the project's reference background site Cold Creek, which is located high up in the Santa Monica Mountains, far removed from anthropogenic sources of run-off.

Further data collected in the following months will give a better representation of water quality at these sites. The program has only collected data in the late winter and spring months from February 2005 to June 2005. When more data is collected over a longer time period (encompassing all seasons) additional "Hot Spot" monitoring will test for EPA priority pollutants.

Making Progress: Restoration of the



Malibu Creek Watershed

Santa Monica Bay Restoration Project
Malibu Creek Watershed Executive Advisory Council

Final Report
January, 2001

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MALIBU CREEK WATERSHED

Introduction

The 109 mi^2 Malibu Creek watershed is the second largest subwatershed within the larger 414 mi^2 Santa Monica Bay watershed. It provides a wide variety of habitats for countless species (marine, animal and plant) and has long been a popular place for surfers, hikers and other outdoor enthusiasts. Surfrider Beach, famous for its surfing break and visited by 1.2 million people annually, is one of the most popular tourist destinations in the area. The watershed is also home to two federally listed endangered species – the tidewater goby and steelhead trout. As one of the few remaining coastal wetlands in Southern California, Malibu Lagoon is a critical stop-over for migrating birds along the Pacific flyway.

While open space predominates the region, residential and light commercial land uses, orchards, pastures, crops, natural areas and golf courses account for approximately 19% of the area. The watershed encompasses unincorporated portions of Ventura[1] and Los Angeles Counties, and seven cities -- Malibu, Calabasas, Agoura Hills, Thousand Oaks and Westlake Village and small portions of Simi Valley and Hidden Hills. Combined, these communities are home to more than 90,000 residents. Population growth within this region increased at a significant rate during the 1980s (10%), but slowed somewhat during the 1990s (2%). The current growth trend is expected to continue (see Figure 1).

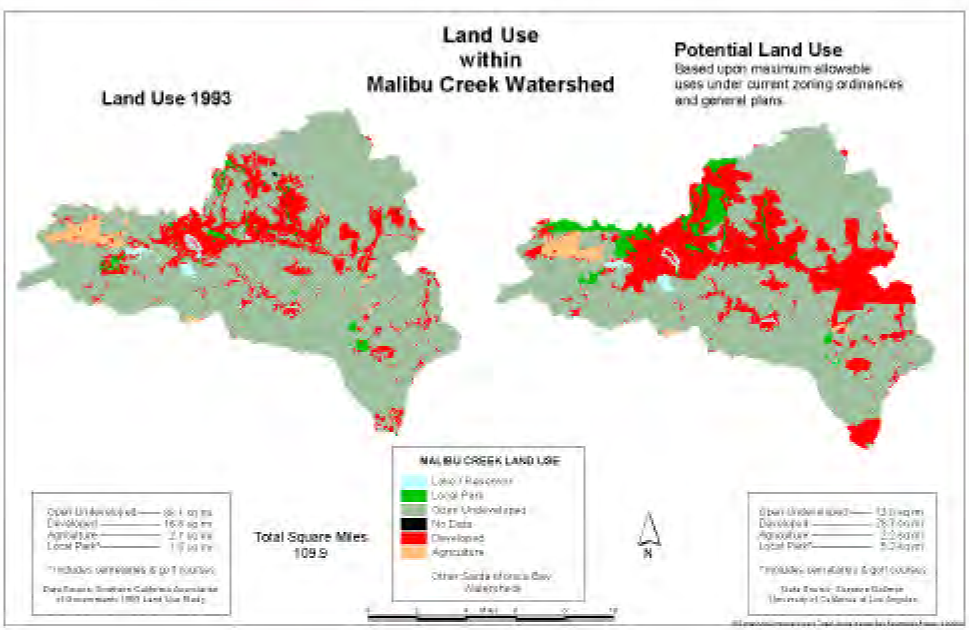

Figure 1. Past and projected land uses in the Malibu Creek Watershed.

[1] Ventura's unincorporated communities include Oak Park, Lake Sherwood and Hidden Valley.

In 1995, the Santa Monica Bay Restoration Project (SMBRP) completed the *Bay Restoration Plan* (BRP) which, among other elements, included a draft action plan for the Malibu Creek Watershed (MCW). The *Malibu Creek Watershed Natural Resource Plan*, released soon afterward by the Natural Resources Conservation Service, addressed watershed resources, water quality and quantity issues, and pollution reduction strategies. It also contained an appendix of 44 action items which paralleled the actions identified in the BRP.

A partial view of the Malibu Creek Watershed and the Pacific Ocean.

These 44 actions, consolidated down from an original list of 111 actions, were developed and agreed upon by watershed stakeholders through a consensus approach organized by the SMBRP. These 44 actions now provide the framework of guiding principles for restoration of the Malibu Creek watershed and comprise the Bay Restoration Plan's Malibu Creek Watershed Action Plan. They focus on six key areas of concern:

- Overall water quality and quantity
- Malibu Lagoon and surfzone
- Solid wastes and other wastes
- Land use
- Habitat protection and restoration
- Coordination and outreach

The entire process undertaken to guide restoration activities in the Malibu Creek watershed served as a subwatershed "pilot program" for Santa Monica Bay and could also serve as a model for other watersheds considering similar efforts. Key elements of this model include convening a stakeholder group, reaching consensus on the issues through stakeholder involvement, identifying the most significant pollutants of concern impacting the watershed's habitats and resources, developing restoration/protection management options, securing funding and ultimately, taking action.

The following report highlights the successes and challenges of this pilot program over the past six years, although some elements began before 1994. It contains four sections:

- ***Section One: Overview***, highlights the structure of stakeholder involvement in the watershed and provides brief summaries on: 1) sources of impairments to water quality, 2) other problematic issues, 3) human health risks and habitat degradation and 4) watershed studies and projects.

- ***Section Two: Action Plan Updat****e*, provides an in-depth update and assessment of the Natural Resource Plan's 44 action items (BRP actions).
- ***Section Three: Key Findings,*** summarizes the key findings of the data presented in Section Two.

- ***Section Four: Moving Forward - Watershed Restoration Priorities***, addresses future restoration priorities and objectives.

Implementation and Oversight Structure

The Malibu Creek Watershed Advisory Board, now called the Executive Advisory Council, was established in the early 1990s to address watershed pollution and restoration issues. Members of the Council include representatives of several local and state agencies, five municipalities, various other organizations and stakeholders, and the public at large (see Table 1.1). Throughout its tenure, the role of this Council has been to oversee, instigate and implement both upper and lower watershed restoration activities. More specifically, the group's role has been to:

- Call attention to watershed service opportunities (including grants, studies, pilot demonstration projects, partnerships, events, etc.);
- Promote/implement watershed protection and restoration projects;
- Help secure funding opportunities such as Proposition A bond funds and US EPA/State 205(j) grants and 319(h)[2]; and
- Oversee subcommittee activities (subcommittees identified below);
- Serve as an information sharing and clearinghouse outlet.

The committee is also a Watershed Implementation Committee that advises the Bay Watershed Council on matters pertinent to this watershed.

To better focus on key watershed issues and to help carry out the mission of the Executive Advisory Council, eight subcommittees have been formed. These subcommittees report back to the Council about their activities/progress during the Council's regularly scheduled bi-monthly meetings.

Malibu Creek Watershed Executive Advisory Council

Army Corp of Engineers
CA Coastal Commission
CA Department of Fish and Game
CA Department of Parks and Recreation
CA State Coastal Conservancy
CalTrout
City of Agoura Hills
City of Calabasas
City of Malibu
City of Thousand Oaks
City of Westlake Village
Heal the Bay
Las Virgenes Municipal Water District
Los Angeles County Department of Public Works
Los Angeles County Fire Department
Los Angeles County 3rd Supervisoral District
Los Angeles Regional Water Quality Control Board
Malibu Land Coastal Conservancy
Malibu Surfrider/Surfrider Foundation
National Parks Service/Santa Monica Mountains National Recreation Area
Natural Resources Defense Council
Resource Conservation District of the Santa Monica Mountains
Santa Monica Bay Restoration Project
Santa Monica Bay Audubon Society
Santa Monica Mountains Conservancy
Sierra Club
Triunfo Sanitation District
US Environmental Protection Agency
Ventura County
Watershed Community Residents/Stakeholders

* Active members, those organizations with consistent representation at stakeholder meetings, are bolded.

Table 1.1. Malibu Creek Watershed Executive Advisory Council.

1. Volunteer Water Quality Monitoring Task Force

The role of this subcommittee is to encourage volunteers to become involved in water quality and habitat monitoring activities. They meet every other month to discuss the latest methods and techniques for providing high quality, reliable data that can be used by stakeholders and decision-makers. The task

[2] US Environmental Protection Agency (EPA)/State grants are provided for water quality planning and implementation activities, respectively.

force has developed a volunteer monitoring program called "*The Stream Team,"* which is now coordinated by Heal the Bay (a local environmental organization), to assess the health of and impacts to stream reaches throughout the watershed**.** Currently, three volunteer groups are monitoring over 16 fixed locations throughout the watershed.

2. ***Steelhead Recovery Task Force***
   Originally called the "Rindge Dam" subcommittee, this group's focus has shifted from simply addressing the feasibility of removing Rindge Dam to now looking at all potential/existing barriers impeding steelhead migration to the upper reaches of Malibu, Topanga, Solstice and Arroyo Sequit creeks and their tributary streams.

3. ***Human Health***
   The role of this sub-committee is to identify and reduce health risks in the watershed, specifically those associated with recreational use of the creek, lagoon and surfzone. Most recently, they helped design a portion of the Coastal Conservancy/ UCLA study[3] which addressed pathogens.

   [This committee's membership overlaps with the *Monitoring and Modeling* and *Lower Malibu Creek and Lagoon Task Force* subcommittees and its activities have been scaled down somewhat as a result.]

4. ***Monitoring and Modeling Sub-committee***
   The role of this subcommittee is to design, coordinate and oversee monitoring efforts in the watershed. In April 1999, the subcommittee released the draft *Malibu Creek Watershed Monitoring Program* which has the primary objective of "collecting data and information on pollutants and other problems that impair the formally designated beneficial uses of Malibu Creek and its tributary streams." The report was reviewed by the SMBRP's Technical Advisory Committee and funds are now being sought to implement the plan.

5. ***Lower Malibu Creek and Lagoon Task Force***
   The role of the Lower Malibu Creek and Lagoon Task Force has been to: 1) oversee lagoon monitoring and restoration efforts, 2) address the impacts of high water levels, breaching and septic system influences to the lower creek and lagoon and 3) serve as the review committee for the long-awaited Coastal Conservancy/UCLA study. Following the release of the report, the committee has started the process of selecting which creek/lagoon management options to pursue and implement.

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[3] *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management.* Draft Final Report. California State Coastal Conservancy and UCLA, February 1999.

6. ***Invasive Species Task Force***
The Invasive Species Task Force was established in the later part of 1999 and its mission is to identify, assess and initiate removal of invasive plant and animal species in the watershed. Because many exotics are discovered through the efforts of other task forces, members of this task force work closely with them. The group has prioritized two actions: 1) to consult with the Los Angeles County Agriculture Commissioner about making Los Angeles County a "weed management zone" to become eligible for funding, and 2) to contact the Los Angeles County Department of Public Works about eliminating weeds in soil stockpile areas.

7. ***Flow Reduction Task Force***
The Flow Reduction Task Force was formed during the Winter 1999/00. Initial meetings have addressed developing a mission statement and set of goals. The focus of the task force will be on reducing stream flows into impacted streams within the watershed and on reducing residential/community demands for imported water through conservation.

8. ***Education Task Force***
This Task Force was formed in January 2000. At their first scheduled meeting, members began development of a mission statement, goals and a future plan of action. The primary focus of the Task Force will be on educating local residents and stakeholders about the restoration and preservation activities occurring in the Malibu Creek Watershed.

Watershed Impairments and Problematic Issues

The 1994 Water Quality Control Plan (i.e., the Basin Plan) developed by the Los Angeles Regional Water Quality Control Board (LARWQCB or Regional Board) identifies the entire Malibu coastline and Malibu Canyon and Lagoon as "Significant Ecological Areas" (SEAs), and documents 19 existing, intermittent and potential "Beneficial Uses" within the Malibu Creek watershed. However, various causes of impairments (Table 1.2) to this watershed threaten both its SEAs and beneficial uses. Some of the causes are well documented in several publications, including: 1) the Soil Conservation Service's *1995 Malibu Creek Watershed Natural Resources Plan*, 2) the Regional Board's *1997 Santa Monica Bay: State of the Watershed* report and *1994 Water Quality Control Plan*, and 3) the Coastal Conservancy's *1999 Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management* report.

Watershed Impairments
Urbanization and Development
Sedimentation and Erosion
Invasive Species
Nutrients
Pathogens and Bacteria
Excess Flows
Problematic Issues
Land Acquisition
Shortfalls in Funding
Inspections and Enforcement

Table 1.2. Watershed impairments and other problematic issues.

Watershed impairments, such as urban runoff, excess nutrients, pathogens and bacteria, sedimentation and erosion, invasive species, and excess freshwater flows adversely affect habitats, endangered species and human health. A quick summary of these impairments and the issues associated with them are provided here.

Urbanization and Development

As mentioned in the introduction, Malibu Creek watershed's population is growing at a significant rate (as much as 2 percent/year). This rapid growth is concurrent with development activities which contribute pollutant loads (heavy metals, nutrients, bacteria, trash and other inorganic compounds) through contaminated urban runoff, household waste, animal waste, on-site sewage disposal system discharges, illegal dumping and pesticide use. It also leads to greater demand for imported water, resulting in increased subsurface and creek flows and elevated groundwater tables, and ultimately impacting Malibu Lagoon and surfzone.

Sedimentation and Erosion

Much of the Malibu Creek watershed's soils are considered highly erodible. Increased dry weather flows, unstable streambanks, fires, construction sites not properly maintained and poorly-graded hillsides all contribute to the watershed's existing sedimentation and erosion problems. Brush clearing practices and roadside maintenance activities where dirt and debris are left on the side of the road and/or up-slope of creeks also increase sediment loads to receiving waters. These sources eventually reach the lower creek and lagoon and can adversely impact species and spawning grounds sensitive to high turbidity. Sediments also transport particle-binding pollutants, which in turn can affect many of the watersheds habitats and organisms. During seasonal high flow conditions (primarily during the rainy season), the impacts of sedimentation and erosion are especially pronounced.

Invasive Species

Both non-native plant and animal species in the Malibu Creek watershed have the potential to severely disrupt the natural ecosystem. The presence of non-native species can also be indicators of poor ecosystem health and represent competition for natural resources with native species.

The most significant non-native plant species include the giant reed, castor bean and wild tree tobacco (see Table 2.4 on page 67 for a more complete list of exotic plant species). The most significant non-native aquatic species include the western mosquito fish, yellowfin goby, oriental shrimp and polychaete worms.[4] Bullfrogs, crayfish and large-mouthed bass are also problematic and can be detrimental to southwestern pond turtles, California newts (both considered

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[4] *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management*. Draft Final Report. California State Coastal Conservancy/UCLA, February 1999.

special species of concern in California) and Arroyo Chub.

Nutrients

Nutrient entering Malibu Creek watershed's lakes, creeks and streams stem from a variety of point and nonpoint sources including animal waste, surface and groundwater flows, storm drain discharges, septic systems and Tapia Treatment Plant discharges. An overabundance of nutrients from these sources contributes to eutrophication problems in the watershed. Although evidence of eutrophication, specifically low dissolved oxygen and algal mats, is observed in some areas of Malibu Lagoon (Ambrose, et.al., 1999), the Las Virgenes Municipal Water District's (LVMWD or the District) monthly water quality data suggest a significant downward trend in the amount of nutrients present in the watershed's creeks and streams over the past ten years. Although little data has been collected on the watershed's upstream lakes and some reaches of Medea Creek, they also show signs nuisance algae and have been listed on the Regional Board's list of impaired waterbodies.

Pathogens and Bacteria

The presence of pathogens and bacteria in the watershed's creeks, lagoon and surfzone is a significant human health concern. These pollutants come from sources such as:

- Septic systems:[5] Systems not properly maintained and leach fields without adequate filter materials and distance are potential contributors of bacteria and pathogens to groundwater, creeks and the lagoon and surfzone.

- The Tapia Water Reclamation Facility: This facility, jointly owned by the Las Virgenes Municipal Water District and Triunfo Sanitation District, is located adjacent to Malibu Creek approximately 4.5 miles upstream from Malibu Lagoon. This facility treats municipal wastewater primarily from the cities and unincorporated areas of the upper watershed. Tapia has a processing capacity of 16 million gallons per day (mgd), but currently operates at 9 mgd. The tertiary-treated wastewater generated from this facility is either recycled or discharged into the creek, depending on the time of year, demand and/or other circumstances. Concerns have been raised for many years about both the quality and quantity of Tapia's effluent and its impact on the Malibu Creek, Lagoon and surfzone.

- Animal waste: Livestock manure and domestic pet waste not properly disposed of can mix with storm water and/or urban runoff and eventually find its way to the watershed's waterbodies.

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[5] The total contribution of pathogens and nutrients from lower watershed septic systems to nearby receiving waters has not been conclusively determined. However, studies are in progress to assess the impacts, if any, septics have on Lower Malibu Creek and Lagoon.

Excess Flows
About 18,000 acre-feet of water is imported into the Malibu Creek watershed each year. Ultimately, this imported water contributes to higher groundwater tables, increased creek flows, more frequent lagoon breaching events and greater volumes of polluted urban runoff entering storm drains and local waterbodies.

Land Acquisition
Much of the undeveloped land (other than parklands) in the Malibu Creek watershed is privately owned and has the potential to be developed. Acquisition of such properties could increase existing wetlands, protect riparian corridors, preserve open space and provide for greater protection of the watershed's sensitive species.

Shortfalls in Funding
Achieving long term restoration, protection and management goals depends, to a large extent, on the availability of funds to carry out these activities. While a significant amount of funding has been secured for watershed activities (Table 1.3, starting on Page 12), much more is needed to accomplish the goals outlined in the Malibu Creek Watershed Plan.

Inspections and Enforcement
Historically, inspections and enforcement activities have not been a priority among key agencies. However, there are a whole host of enforcement activities that, if aggressively conducted, could improve water quality in the watershed. Examples include: 1) routinely monitoring construction sites to ensure that pollution prevention BMPs are properly implemented; 2) periodically inspecting/monitoring septic systems to ensure that they function properly; 3) identifying and prohibiting illicit connections to the storm drain system; and 4) enforcing local ordinances. Enforcement agencies having local authority include the CA Department of Fish and Game, CA Regional Water Quality Control Board, Los Angeles County Department of Health Services and all watershed municipalities.

Effects on Human Health and Habitats

Human Health Impacts
Pathogens and viruses from septic systems, animal waste and polluted runoff all contribute to exceedances of water quality standards and affect the health of swimmers and surfers in Malibu Lagoon and the adjacent surfzone. This area consistently receive bad grades due poor water quality, and signs are posted much of the year warning swimmers about the health risks associated with recreating in these polluted waters.
Habitat Impacts

The pollutants and other causes of impairments listed above impact the Malibu Creek watershed's habitats and resources in a variety of ways. Non-native plant species displace and/or out-compete native species. Imported water demands disrupt the natural ecosystem, ultimately causing high lagoon water levels and contributing to unnatural lagoon breaches (although the long-term effect of this is not fully known[6]). Construction barriers impede native aquatic species abilities to reach upstream habitats and spawning grounds. And, increased pollutant loadings degrade water quality by lowering dissolved oxygen levels, contaminating sediments with heavy metals and other toxins, and increasing turbidity and nuisance algae.

Watershed Studies and Projects

Table 1.3, starting on page 12, highlights key projects, stakeholder groups and partnerships (e.g., the Executive Advisory Council and its sub-committees) who have been instrumental in applying for and securing grant funds for restoration activities throughout the watershed. Specifically, the table highlights 17 Malibu Creek watershed projects that have been successfully implemented, conducted or started over the past eight years. It also showcases: 1) the partnerships vital to successful implementation of restoration activities, 2) the funds that were leveraged or secured ($4+ million), and 3) the variety and types of projects undertaken in both the upper and lower watershed. For example: alternative wastewater discharge options have been studied; streambanks and other sensitive habitats have been restored and/or constructed; endangered species have been reintroduced; pathogen sources have been evaluated; livestock BMPs have been developed/promoted; and water conservation is being addressed.

Additionally, **Section Four: Moving Forward with Restoration Priorities** identifies the *Top 10 Restoration Priorities in the Watershed* as well as a complete list of recommended projects that are considered high priorities for implementation, but in which little or no progress has been made to date. While some actions lack the necessary funds and/or data to be successfully carried out, others are just now becoming priorities in the watershed. In the coming years, they will no doubt become the focus of the Executive Advisory Council's restoration and preservation efforts.

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[6] Two independent studies conducted six years apart actually show a slight increase in the biodiversity in Malibu Lagoon despite several dozen intervening breaching events. These studies include 1) *Malibu Lagoon: A Baseline Ecological Survey*. Resource Conservation District of the Santa Monica Mountains, 1989 and 2) *Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek*, UCLA, 1995.

Table 1.3. Key watershed projects, studies, stakeholders and partnerships in the Malibu Creek watershed.

Malibu Creek Watershed Restoration Projects/Studies	Funding Source & Amount	
STUDIES AND ASSESSMENTS		
Malibu Creek Discharge Avoidance Study **Timeline:** November, 1997 –January, 2000 **Lead**: LVMWD **Summary**: Assessment of all possible options for disposing of the tertiary-treated wastewater generated by the Tapia treatment plant.	LVMWD	$850,000
Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management **Timeline:** August, 1997 - March, 1999 **Lead:** CSCC/MCW Lagoon Task Force (study conducted by UCLA.) **Summary**: Assessment of the lower Malibu Creek watershed and lagoon, and compilation of management alternatives for implementing restoration, protection and management activities.	CSCC EPA LVMWD SMBRP/F	$100,000 $100,000 $46,000 $30,000
Effects of Sand Breaching the Sand Barrier on Biota at Malibu Lagoon **Timeline:** November, 1996 - Current **Lead**: RCDSMM **Summary**: Survey of birds and fish, and monitoring of water quality parameters (ammonia, nitrates, phosphates, DO, turbidity, water temperature, pH, salinity and lagoon water levels).	CalTrans	$47,000
Septic Tracer Study (The "Dye" Study) **Timeline:** August, 1998 - February, 1999 **Lead**: City of Malibu **Summary**: Phase I: Evaluation of the fate transport of pathogens from septic system effluent at one test site (Cross Creek Shopping Center) to groundwater and Malibu Creek and Lagoon. Phase II: Investigation of the potential for septic contamination from residential and commercial properties in the Malibu Civic Center area, near the creek, lagoon and surfzone.	EPA 319(h) Malibu	$60,000 Contribution not calculated
Evaluation of Rindge Dam For Removal **Timeline:** 1999 - Current **Lead**: Steelhead Recovery Task Force, Army Corps of Engineers, State Parks **Summary:** The Army Corp of Engineers conducted a reconnaissance study to determine the level of support among watershed stakeholders in removing Rindge Dam. Based on their findings, they have made plans to conduct a feasibility study on the various alternatives for removing the dam. Currently, they are looking for a funding source to start the study.	Army Corp of Engineers	Staff Time

Table 1.3. Cont'd.

Water Conservation Study **Timeline:** 1997-98 **Lead:** LVMWD and American Water Works Association Research Foundation **Summary:** Implementation of the North American Residential End Use Study, which installed data loggers in 100 homes to gather detailed information on water use. Data is being used to set national standards on appliance efficiency and conservation program planning. The study confirmed toilet flushing as the largest indoor use and provided data on incidence of leaks.	LVMWD AWWARF	$15,000 $421,000
Septic Systems in Malibu **Timeline:** June 1998 **-** January, 1999 **Lead:** Heal the Bay **Summary:** Estimation of the number of multi-family and commercial septic systems located in the Lower Malibu Creek watershed. Heal the Bay estimates that there are 390 multi-family and commercial septic systems in this area, many of which have not been permitted by the Regional Board. A summary of recommended actions is included in the accompanying report.	Heal the Bay	Staff Time Interns
Framework for Monitoring Enhancement and Action for the Malibu Creek Watershed **Timeline:** January – June, 1998 **Lead:** Heal the Bay, CA State Coastal Conservancy and the Graduate Dept. of Landscape Architecture (CSU Pomona) **Summary:** Watershed assessment and design of a citizen volunteer monitoring program (Stream Team) that collects useable high-quality data that addresses specific issues in the Malibu Creek Watershed and fills data gaps for regional stakeholders. A 150-page easy-to-understand, step-by-step field guide was produced and is used by volunteers to conduct water chemistry and stream walk monitoring activities. The guide also contains educational information about natural processes, issues of concern and the history of urban development in the Malibu Creek watershed.	CSCC	$37,000
3 Endangered Species Protection Studies (Steelhead Trout) **Timeline:** See summaries **Lead:** LVMWD **1) Summary:** April 1998 – June 1999. Recording of temperature data at multiple stations in Malibu Creek for a period of one year and compilation of steelhead trout temperature requirements. The final report (which was submitted to the LARWQCB) found that temperature ranges, while slightly higher than optimal below Rindge Dam, are sufficient to support all states of steelhead trout. **2) Summary:** December, 1997. Compilation of data on the steelhead in Malibu Creek, including original research on steelhead genetics and the recommending of listing steelhead trout as a unique and endangered population. **3) Summary:** November, 1998. Water audit of riparian vegetation in Malibu Creek to determine the minimum flows necessary to sustain steelhead trout while minimizing inflows to the lagoon.	LVMWD LVMWD LVMWD	$10,000 $10,000 Staff time

Table 1.3. Cont'd.

HABITAT/SPECIES RESTORATION PROJECTS		
Tidewater Goby Reintroduction to Malibu Lagoon **Timeline:** April, 1991 **Lead**: RCDSMM; partnership with Heal the Bay **Summary**: Successful re-introduction of 54 tidewater gobies, a federally listed endangered species, into Malibu Lagoon. As many as 1500 gobies were counted in 1998.	State Parks	$23,000
Restoration of Malibu Lagoon Bird Peninsula and Mud Flats **Timeline:** Fall, 1995 - Spring, 1996 **Lead**: RCDSMM **Summary**: In partnership with CA Parks and Recreation, excavation of over 2,200 cubic yards of old fill material within the Lagoon; restoration of aquatic habitat, mud-flat habitat, and high storm flow refuge for the tidewater goby. Post project monitoring of fishes, water quality and invertebrates.	EPA Near Coastal Waters Program Grant CalTrans	$131,695 $30,000 (in-kind services)
Sediment Reduction and Streambank Stabilization – Las Virgenes Creek **Timeline:** 1996 - 1998 **Lead**: RCDSMM **Summary**: Stream bank restoration along 200-foot portion of Las Virgenes Creek to reduce sedimentation; 17,000 cubic yards excavated and new mild slope created along the north bank. Native species planted to prevent future erosion.	EPA 319(h) County of LA (Prop A)	$607,000 (including in-kind services)
DEMONSTRATION PROJECTS AND WATERSHED POLLUTION CONTROL PROGRAMS		
Constructed Wetlands **Timeline:** March, 1998 – Ongoing **Lead:** LVMWD **Summary:** Rehabilitation of an existing percolation pond (on State Parks property) as a constructed wetland to treat Tapia's effluent and to treat urban runoff from the upper watershed.	Prop A funds LVMWD	$260,000 $50,000

Table 1.3. Cont'd.

Livestock Waste Management Pilot Project **Timeline:** 1996 - 1999 **Lead**: RCDSMM **Summary**: The RCDSMM: 1) conducted an extensive research effort to identify all horse owners and corrals in the Malibu Creek watershed; 2) conducted a watershed-wide survey of horse owners to better understand their current management practices and needs 3) hosted a horse manure compost demonstration site; 4) created a video entitled "Horse Management Program." and 5) developed a Stable and Horse Management BMP manual to help reduce point and nonpoint source pollution from livestock waste.	EPA 319(h)	$84,000
Malibu Lagoon Water Level Management Project **Timeline:** September, 1999 - Current **Lead:** CA Department of Parks and Recreation **Summary:** Management of the water level in Malibu Lagoon and disinfection of the water prior to its release to the ocean. As planned, this project should ensure that the lagoon's sandbar remains closed during the dry season (May – October). A Request for Proposals was released by State Parks in September, 1999 seeking a consultant to design a method for water level management of the lagoon. The project should be completed by Summer, 2001.	Prop A funds	$1.2 Million
Urban Runoff Treatment Facilities at Malibu Lagoon **Timeline:** Completed June, 2000 **Lead**: City of Malibu **Summary**: The City of Malibu was awarded Prop A funds to install a Storm-ceptor **J** for the 24-inch Malibu Road Drain (commonly referred to as the Mystery Drain) which discharges directly into Malibu Lagoon. The storm ceptor is designed to remove grease, oil, trash and sediment. The City has also added a disinfection system (as a pilot project) to work in concert with the Storm-ceptor **J** to remove pathogens from the discharge.	Prop A funds Purizer Corp. City of Malibu	$60,000 $600,000 $70,000
Watershed-wide Monitoring Program **Timeline:** April 1999, ongoing **Lead:** Monitoring and Modeling Subcommittee **Summary:** Completion of a draft plan which calls for coordination of existing monitoring programs and addition of supplementary monitoring to create a comprehensive survey of the state of the Malibu Creek watershed.	LVMWD City of LA LAC-DPW Ventura Co EPA 205(j)	$18,000 Beach bacti stations Stream gage Stream gage Application

EPA 319(h) – Environmental Protection Agency Nonpoint Source Implementation grant program
EPA 205(j) - Water Quality Planning grant program
Proposition A funds - Los Angeles County grant funds for storm water control capital projects

SECTION II: ACTION PLAN UPDATE

In order to implement Malibu Creek watershed restoration activities in a more comprehensive and focused manner, in 1994 forty-four action item goals were developed by consensus through a one-year series of facilitated meetings with watershed stakeholders[7]; the process also included identifying implementors responsible for each of the 44 actions. Although no timelines were provided for these restoration activities, there has been and continues to be determination among watershed stakeholders to implement them as soon as technically feasible or financially possible.

This section of the Malibu Creek Watershed report provides complete status updates and assessments for implementation of the 44 actions. They have grouped by topic according to the Action Plan. (see Appendix One for a complete table of these actions).

Overall Water Quality and Quantity Goals

1. ***Protect Beneficial Uses*. Develop and set water quality objectives to prevent point and nonpoint pollutant sources and pathogens from adversely affecting the beneficial uses of the watershed and nearshore environments.**

   The Los Angeles Regional Water Quality Control Board (LARWQCB or Regional Board) is responsible for establishing water quality standards for all Los Angeles and Ventura County waterbodies, including those in the Malibu Creek watershed. The updated *Water Quality Control Plan* (or Basin Plan), prepared by the LARWQCB in 1994, is the guidance document that includes the beneficial use designations within the watershed. Specifically, the Plan:

   - Designates beneficial uses for surface and ground waters;
   - Sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses of and conform to the state's antidegredation policy;
   - Describes implementation programs to protect all waters in the Region; and
   - Incorporates (by reference) all applicable State and Regional Board plans and policies and other pertinent water quality policies and regulations.

[7] A complete summary of the mediation efforts that lead to the development of the Executive Advisory Council and the 44 Action Items can be found in the document, *Comprehensive Malibu Creek Watershed Mediation Effort, Final Report*. May, 1994.

The Basin Plan[8] identifies 19 existing, potential and/or intermittent beneficial use categories for waterbodies in the Malibu Creek watershed (see the 1994 Basin Plan for a complete list). The Plan also sets specific watershed water quality objectives for total dissolved solids (TDS), sulfate, chloride, boron and nitrogen, in addition to general county-wide water quality objectives (ammonia, bacteria, coliform, biochemical oxygen demand (BOD), chemical constituents, chlorine, nitrogen, oil and grease, etc.). The mechanisms used to achieve these water quality objectives include:

- Issuing permits (NPDES, WDRs)[9] with contaminant discharge limits to point source dischargers;
- Requiring cities to prevent/control polluted discharges through implementation of comprehensive urban runoff control programs and best management practices (BMPs) as called for in the 1996 Municipal Storm Water NPDES permit issued by the Los Angeles Regional Water Quality Control Board;
- Requiring cities to adopt local ordinances for the control of nonpoint sources of pollution within their jurisdictions;
- Adopting regional waste discharge requirements for residential septic systems;
- Conducting public education programs to prevent residential sources of pollution (this task is not carried out directly by the Regional Board but is required under the Municipal Storm Water permit).
- Enforcing the California Porter-Cologne Act and the Federal Clean Water Act by conducting routine inspections, issuing fines and/or "Cease and Desist" orders to offenders and requiring cleanup of contaminated sites.
- Initiation of Total Maximum Daily Loads (TMDLs) for pathogens and nutrients for Malibu Creek and Lagoon.
- Following eco-regional (site specific) nutrient criteria development as part of the US Presidential Clean Water Action Plan (http://www.cleanwater.gov/). Under this plan, EPA must develop criteria by 2001 and begin initiation of compliance by 2003.

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[8] The Basin Plan's legal authority is provided under the California Porter-Cologne Act.
[9] National Pollutant Discharge Elimination System (NPDES), Waste Discharge Requirements (WDRs)

2. ***Protect Recreation.*** **Ensure swimming, surfing and fishing without adverse health effects posed by poor water quality. Protect appropriate recreational opportunities such as surfing, swimming, sportfishing, sailing and hiking in the creek, lagoon and surf system as long as it doesn't impact other beneficial uses.**

   This action is a goal rather than an actual action and its success is directly linked to the successful implementation of virtually every other action listed herein.

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3. ***Protect Ecosystem/Endangered Species.***

- **Enhance and protect lagoon, creek, beach and intertidal habitats for threatened and endangered species, native biodiversity and riparian habitat.**
- **Attain and maintain water and sediments of sufficient quality to support a healthy creek, lagoon and surfzone, taking into account interactive impacts.**
- **Prevent any increased input of substances in toxic concentrations into the watershed and surfzone.**
- **Reduce habitat degradation caused by road / bridge building encroachments and dumping of road materials, and adopt ordinances and watershed-wide joint powers agreements to do so.**

Many of the activities that must occur to accomplish the goals of this action are incorporated into the goals of other actions, in particular Eliminate or Reduce Sources (#4), Biological Standards (#5), Reduce Accelerated Sedimentation (#10), Temperature (#12), Restore/Enhance Malibu Lagoon and Surfzone (#20), Malibu Lagoon Bridge (#26), Runoff Reduction (#31), Habitat Protection (#33-38) and Coordinate on a Watershed Basis (#39).

Believed to have vanished from the area some time ago, the federally endangered red-legged frog was recently discovered on the Ahmanson Ranch development site in the northern portion of the Malibu Creek watershed. On that same property, a large patch of 40,000 San Fernando spine flowers was also discovered. Formerly, the flower was believed to be extinct since the 1920s. The fate of these two species is ultimately tied to how the development project proceeds, which, as of the date of this report, has not been determined.

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4. ***Eliminate or Reduce Sources.*** **Eliminate or reduce, by sub-watershed area, sources of harmful pathogens, toxic chemicals, sediments and nutrients.**

Pathogens, toxic chemicals, sediments and nutrients are transported to local waterbodies through groundwater, storm water and urban runoff flows. To help minimize the impacts of these pollutants, the County of Los Angeles and its 85 cities are required under the 1996 Municipal Storm Water NPDES permit[10] to control polluted runoff discharges within their jurisdictions. Since approval of this permit, all four Los Angeles County cities in the Malibu Creek Watershed have adopted local ordinances which clearly identify and prohibit activities specifically known to contribute pathogens, toxic chemicals, sedimentation and nutrients to local waterbodies. Such ordinances also give cities the legal authority to immediately enforce these prohibitions. Table 2.1 highlights the measures covered addressed in the local ordinances recently adopted by Malibu, Calabasas, Agoura Hills, Westlake Village and Thousand Oaks.

Storm Water Ordinance Measures
Illicit Connections and Discharges Prohibition against using, maintaining, or continuing any illicit connections to the municipal sewer system.
Littering Prohibition against littering of garbage, refuse, etc. (pollution) on streets, alleys, sidewalks, storm drains, public and private lands, lakes, streams, etc. within the city.
Storm Drain Discharge Prohibitions
• Landscape Debris
• Untreated wash water from gas stations, auto repair facilities, etc.
• Untreated wastewater from mobile car wash, carpet cleaning, steam cleaning, or other mobile service providers
• Wastewater from repair of machinery and equipment which are visibly leaking oil, fluids or antifreeze [to the maximum extent practicable (MEP)]
• Untreated runoff from storage areas containing oil grease and other hazardous materials
• Commercial/municipal swimming pool filter backwash
• Untreated runoff from washing toxic materials from paved or unpaved areas (some exclusions)
• Untreated runoff from washing impervious surfaces in industrial/commercial areas (MEP, some exclusions)
• Wastewater from concrete truck washing
• Runoff containing banned pesticides, fungicides or herbicides
• Disposal of hazardous waste into containers which causes or threatens to cause discharge to the storm drain
Good Housekeeping Provisions
• Prevent chemicals or septic waste from mixing with rain water which may enter city streets or storm drains
• Minimize runoff generated from irrigation
• Prevent machinery/equipment leaks, spills, etc. from mixing with storm runoff
• Regularly sweep parking lots with 25+ spaces to remove pollutants and debris (can consider other effective means)
• Do not discharge food waste to the storm drain system
• Implement BMPs to MEP for fuel and chemical waste, animal waste, garbage, batteries, etc.
Compliance with Industrial, Commercial and Construction NPDES

The County of Ventura and its Malibu Creek watershed communities have taken a similar approach those listed for Los Angeles County to eliminate sources of pollutants. These include: 1) adoption of local ordinances and the legal authority to enforce them; 2) implementation of public education programs; 3) inspections for all auto repair and food/restaurant facilities to ensure compliance; and 4) establishing guidelines for all new developments to incorporate permanent BMPs as part of their design. Calabasas has also installed a continuous

Because many of the storm water ordinance provisions were only recently adopted by these watershed cities, it will take several years

[10] The Municipal Storm Water NPDES Permit was issued by the Regional Water Quality Control Board in July, 1996.

before the water quality testing data collected can show trends in pollution reduction. Clearly, a comprehensive monitoring program is key to determining whether these measures are working.

Watershed cities also conduct public education programs to reduce point and nonpoint sources of pollution, which are addressed in Public Education (#42). And lastly, watershed efforts to reduce pathogens and nutrients are specifically addressed in Reduce Pathogens (#7), Reduce Nutrients (#9) and Septic Systems (#23).

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5. ***Biological Standards***. **Establish viable minimum habitat standards to support native species of locality.**

A whole variety of fish, bird and plant species, some of which are state and/or federally listed as endangered or threatened, depend on healthy watershed resources for their survival. However, these species may have different or even competing needs to survive. For example, fluctuations in the lagoon's water level and regular tidal flushing are needed for birds to be able to access the mud flats, a situation which is achieved by routine breaching of the lagoon's sand berm. The tidewater goby, on the other hand, can be adversely affected by fluctuations in salinity resulting from a breach. Reconciling these needs makes establishing minimum habitat standards a difficult task.

The Coastal Conservancy/UCLA study, *Lower Malibu Creek and Barrier-Lagoon System Resource Enhancement and Management*,[11] evaluated minimum habitat standards in the lower creek and lagoon to better establish biological water quality objectives for several indicator species. The final draft of this report provided information about the physical tolerances of target species for parameters such as temperature, ammonia, pH, dissolved oxygen, nitrate, nitrite, sulfide chlorine and chloride. Two significant conclusions were drawn from Coastal Conservancy/UCLA's research: 1) different species, even desirable species, have quite different tolerances; and 2) while there is much water quality data available, there is little information available about the tolerances of most of the target species to the physical condition of concern.

Separately, the Las Virgenes Municipal Water District (LVMWD)

[11] *Lower Malibu Creek and Barrier-Lagoon System Resource Enhancement and Management*. Draft Final Report. California State Coastal Conservancy/UCLA, February 1999.

conducted a water audit of riparian vegetation in Malibu Creek to determine the minimum flows necessary to sustain steelhead trout in the creek while at the same time minimizing inflows to the lagoon. It was determined that a minimum of 2-4 cubic feet per second (cfs) would be required at the County gauge station[12] to sustain the steelhead below Rindge Dam. This information was submitted to the National Marine Fisheries Service (NMFS) in 1998 for review. Historical evidence of drought years and groundwater flows and their effect on steelhead will also be considered by NMFS in its final determination of the minimum flow necessary to support steelhead trout.

The County of Los Angeles, Department of Public Works (LAC-DPW) and several other storm water dischargers have organized a regional storm water monitoring coalition whose goal is to establish a monitoring research agenda. Issues being discussed and considered for future research include the use of biological indicators to assess the health of inland and coastal waters in Southern California, and the feasibility of developing bio-criteria. (The coalition only *defines* areas of future research that might be undertaken by interested parties but does not actually conduct research itself.)

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6. ***Monitor Pathogens*. Use appropriate testing techniques to determine the presence of pathogens and test for compliance with established standards. Pathogen testing should be implemented when and where bacteria counts are high.**

Rather than testing directly for pathogens, local agencies routinely test for the presence of pathogens using bacterial indicators such as coliform. Their efforts are highlighted below. Testing for pathogens directly is difficult because there is no rapid method to reliably quantify their presence in water samples. However, direct pathogen testing using one of the methods available has occurred twice in Malibu Creek. These tests were conducted under two studies – the *Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek* study conducted in 1993-94 by UCLA and the *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management* study conducted by the Coastal Conservancy and UCLA in 1998. It is foreseeable that pathogen testing will occur on a routine basis once methods to detect pathogens directly are improved.

[12] The County gauge station records stream flow velocities and collects samples for a variety of constituents in Malibu Creek just below the Tapia outfall and Piuma Road.

- During rain events, LAC-DPW samples for bacteria in storm water runoff near Piuma Road (as required under the 1996 Storm Water NPDES permit). The samples collected show that the amount of bacteria present in wet-weather flows are three to four magnitudes greater than the amount present in dry-weather flows. Since the sampling sites are in areas where there is no public contact, notifications are not made to the public. The monitoring results are, however, reported to the Los Angeles Regional Water Quality Control Board annually and available for public review.

- Since bacteria and pathogens represent a human health concern, the Los Angeles County Department of Health Services (DHS) conducts monitoring activities in unincorporated areas of the County and for any city that does not have its own health department. Where high bacteria counts are observed, DHS takes additional samples to identify the source(s) and closes beaches impacted by the discharge. If a source is identified, then enforcement action is taken by DHS or referred to the appropriate agency with legal jurisdiction (e.g., storm drain entry).

- In 1998, the City of Malibu initiated a septic system tracer study (the "dye" study) adjacent to lower Malibu Creek to determine to what extent, if any, septic systems may contribute pathogens to local receiving waters. In conjunction with the LARWQCB, Malibu then conducted an extensive water quality monitoring program within the creek, lagoon and beach area during the later half of 1999 to identify where septic systems may contribute pathogens and/or nutrients to the lagoon and surfzone. A more detailed update on these activities is provided under Septic Systems (#23).

- The City of Calabasas, through its Volunteer Water Quality Monitoring program, started monthly monitoring for total and fecal coliform in 1999 at six sites in Las Virgenes Creek. Although not currently publicized, the City does submit the monitoring information to the Regional Board and plans to make it available on their city website in the near future.

- Both the City of Los Angeles and the Las Virgenes Municipal Water District have considerable data (from weekly monitoring) on bacteria levels in Malibu Creek and the adjacent surfzone. In addition, LVMWD has funded several special studies which use advanced testing methods to detect the presence of pathogens and has pursued research into new detection methods through their industry research contacts. The District's efforts have resulted in initiation of new studies on available detection methods by the American Water Works Association Research Foundation and the Water Environment Federation.

- Since the Tapia plant began discharging its effluent into Malibu Creek, there have been concerns about its contribution to the presence of pathogens and viruses found in the lower creek and lagoon. LVMWD has monitored Tapia's effluent for more than 15 years and has funded and/or co-funded four independent studies on the quality of its effluent. These studies concluded that there is no significant risk of illness directly associated with Tapia's effluent.

- Several years ago, the SMBRP assisted the Los Angeles County Department of Public Works in testing a new sanitary survey tool to identify the presence of human fecal matter in storm water flows. The goal of the method was to determine whether there was evidence of human waste by extracting coprostanol[13] from storm water runoff samples through a separation process. The expected advantages to this approach were that: 1) identification of human fecal matter could be conducted in the field rather than the lab, and 2) the results would be available in hours rather than days.

  While preliminary lab tests supported the feasibility of this method, field testing proved more difficult. Results of the study showed that field samples did not correlate well to controlled lab samples. Additional drawbacks to this method are: 1) coprostanol testing is considered very expensive (as much as 10x more) when compared to standard bacterial testing, and 2) there is little understanding of the role or impact of other storm water pollutants on the coprostanol extraction process. A significant amount of additional testing will have to be conducted and the cost of conducting field testing will have to decrease considerably before this particular sanitary survey tool will be considered for use in the field.

Although not occurring in this watershed, another sanitary survey method is undergoing preliminary testing in San Diego using DNA identification of human fecal matter to detect pathogen presence. This approach could potentially be considered for use in the Malibu Creek Watershed if results are encouraging.

[13] Coprostanol is a type of sterol found in animal waste in unique ratios, depending on the animal (i.e., human ratios are distinct).

7. ***Reduce Pathogens*****. Reduce human pathogen inputs into the watershed.**

Reducing pathogen loads is one of the premiere goals of the Malibu Creek Watershed Plan and it can be accomplished in two ways: 1) by preventing pathogens from reaching Malibu Creek and Lagoon by eliminating them at the source and/or 2) installing treatment controls (i.e., end-of-pipe solutions). Given the potential sources of pathogens (e.g., septic systems, tertiary-treated effluent, polluted urban runoff and illicit connections), they must all be addressed in a comprehensive manner to effectively reduce pathogen inputs into the watershed. To help further this action, the Regional Board will be looking at these sources and establishing a total maximum daily load (TMDL) for pathogens in the Malibu Creek Watershed by March, 2002 (see Watershed Assessment, #44).

Using Proposition A funds, the City of Malibu installed a Storm-ceptor **J** facility with a disinfection device at the end of a 24-inch pipe that drains into Malibu Creek and Lagoon (commonly referred to as the Mystery Drain). Among other constituents, the system will reduce and/or remove pathogens from Mystery Drain discharges. The City is also considering treatment/disinfection devices for the remaining two storm drains discharging into Malibu Lagoon.

Additional efforts to control pathogen inputs from area septic systems are described in Septic Systems (#23). Also, Las Virgenes Municipal Water District's efforts to find alternative uses and/or disposal options for Tapia's effluent (rather than discharging it into Malibu Creek) are described under Water Imports and Discharge (#28).

8. ***Study Nutrients.*** **Determine and establish achievable nutrient standards to maintain natural populations.**

Several nutrient-based studies and data collection efforts have occurred throughout the watershed for many years, which include:

- Extensive sampling of nutrients was part of the Resource Conservation District of the Santa Monica Mountain's (RCDSMM) *Effects of Breaching on the Biota* study. Water quality parameters such as Ammonia (as nitrogen), nitrates (as nitrogen), and phosphates were sampled in Malibu Lagoon from 1996-98. This data will soon

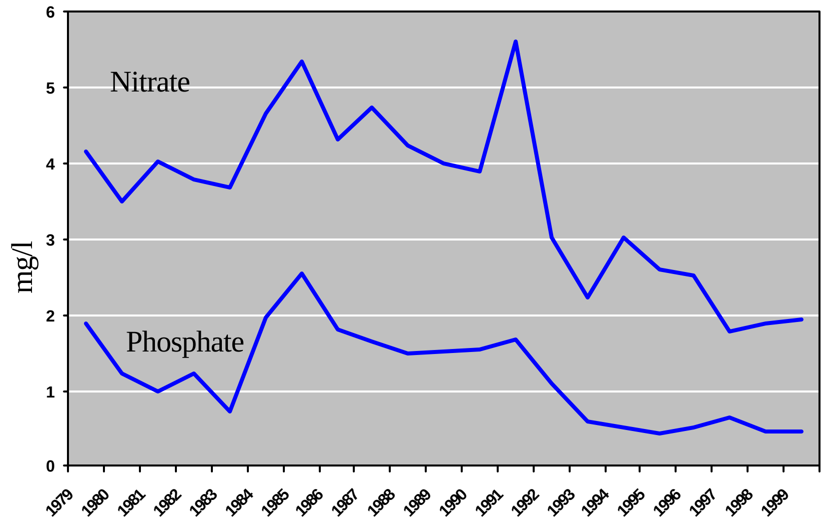

Figure 2. Annual nitrate and phosphate averages at 8-10 stations.

be compiled and available for use to the general public.

- The Las Virgenes Municipal Water District has collected nutrient and phosphate data for more than 20 years at 8-10 stations from the 101 Freeway to Malibu Lagoon. This data, which was also submitted to the LARWQCB suggests decreasing trends in both constituents over the past 20 years. (See Figure 2.)

- In 1979, Dr. David Chapman conducted a study on nutrients. Every month for a period of one year he surveyed algae throughout Malibu Creek and identified algal blooms to the lowest taxonomical level possible (typical species). Using the data collected, Dr. Chapman concluded that: 1) algal mats in Malibu Creek were dominated by *Cladophora*, distributed through the creek where flows were stagnant and shade was lacking, and 2) algal mats were scoured during winter storm events, thus creek algal biomass began afresh each year (i.e., there is no biomass carry over from year to year). His research suggests that the presence of nutrients alone does not govern the amount of or the extent to which algal blooms develop, but rather a collection of factors governs this. A study conducted by LVMWD in 1978 found that algal mats were prevalent in pools and stagnant waters without riparian canopy or shading throughout the watershed. This study supports Chapman's conclusions.

- The Regional Board has established a TMDL unit to set discharge limits for pollutants throughout Los Angeles County. In the Malibu Creek watershed, they will be focusing specifically on nutrient loads, pathogens and coliform. The Regional Board expects to complete the TMDL process for these pollutants by March, 2002.

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9. ***Reduce Nutrients.*** **Reduce nutrient loads into the watershed. Reduce nutrient levels to natural background levels. Encourage the Tapia Treatment Plant to employ state-of-the-art technology to remove nutrients from their discharges.**

Constituent (mg/l)	Creek Background Levels	Tapia Discharge Levels
Nitrates	6-8 mg/l winter 1-4 mg/l summer	15 mg/l, 1999 Annual Average
Phosphorus	Usually no detect or less than 1 mg/l	2.62 mg/l , 1999 Annual Average

Table 2.2. Nitrate and phosphate levels found in Malibu Creek and Tapia discharges. (Data provided by the Regional Water Quality Control Board.)

Tapia's discharges to Malibu Creek contain nitrate and phosphate levels which are higher than typical creek background levels (see Table 2.2). These levels have been identified as possible contributors to the algal blooms that cause lower dissolved oxygen levels in Malibu Creek, although various monitoring results show adequate dissolved oxygen (DO) levels in the creek below Tapia. The Las Virgenes Municipal Water District began voluntary biological nutrient reduction at its Tapia facility in 1992 by decreasing airflow to its aeration basins to reduce nitrate levels, and recently installed mixers to reduce nitrate levels even farther. Overall, the amount of nutrients discharged directly by Tapia has decreased about 35% since 1993.

Additionally, Tapia's wastewater discharge permit, which was re-issued by the Regional Water Quality Control Board in 1997, requires significantly lower nitrate and phosphorus levels than the plant's previous permit required. Specifically, it calls for nitrates to be reduced from 13 milligrams/liter (mg/l) to 10 mg/l and phos-phorus from 6 mg/l to 3 mg/l. To meet these provisions, the Las Virgenes Municipal Water District is studying the effectiveness of percolation beds in removing nutrients from Tapia's effluent. Prior to the permit provisions, however, LVMWD voluntarily imple-mented process changes at the Tapia facility to improve average nitrate and phosphorus removal efficiencies by 25-35%. As men-tioned previously, the permit also prohibits Tapia from releasing its effluent into Malibu Creek from April 15th to November 15th, thereby significantly reducing the amount of nutrients discharged.

As part of its review on the nitrate and phosphorus limits established in Tapia's current permit, the Regional Board is currently analyzing background nutrient levels in Malibu Creek subwatersheds and correlating their effects on biological factors (DO, temperature, pH, etc.). Based on results of the Regional Board's assessment, Tapia may need to further reduce nitrate and phosphorus discharges associated with urban runoff.

The County of Ventura addresses nutrient problems through several programs, including public education targeting pet waste and residential use of fertilizers, education of municipal staff in charge of landscape maintenance, confined animal waste management and storm water discharge prohibitions.

Septic systems also discharge nutrients to the watershed. Septic leach fields which are not sufficiently separated from groundwater, and hydraulic gradients which "pull" septic discharges to local creeks can contribute to the nutrient loadings observed in Malibu Creek and Lagoon. Although the Regional Board is required to issue Waste Discharge Requirements (WDRs) to multi-family and commercial complexes using septic systems, their efforts have lagged in actually identifying and permitting these facilities (see Septics, #23).

Several other programs in the watershed promote nutrient reduction through education, implementation of appropriate BMPs and capital projects. Please see Confined Animals (#18), Septic Systems (#16), Composting, Recycling and Conservation (#29) and Public Education (#42) for related nutrient reduction activities.

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10. ***Reduce Accelerated Sedimentation*. Historical seasonal sediment flow to beaches should be allowed. Human-augmented sediment discharges into the watershed should be reduced by:**

- **Enforcing erosion control regulations on a subwatershed basis.**
- **Encouraging all cities and the County to adopt ordinances of no net increase in sediment from any development into the watershed.**
- **Adopting watershed-wide ordinances to reduce sediment runoff from private property.**
- **Minimizing the loss of topsoil in developing areas through implementation and enforcement of BMPs.**
- **Eliminating dumping of dirt on road shoulders.**
- **Eliminating massive grading within the watershed.**

All construction activities/developments in Los Angeles County over five acres are required to obtain a Construction NPDES permit from the Regional Board by filing a Notice of Intent (NOI) and identifying appropriate/site-specific BMPs that will be implemented. The BMPs selected must be effective in prohibiting contaminated discharges from leaving a site under construction. The requirements will soon apply to construction and development projects greater than one acre.

Under the 1996 Municipal Storm Water NPDES permit, cities are required to adopt local ordinances which include sediment control/reduction strategies (see Table 2.1 under Eliminate Sources, #4 on 20). Sediment control/reduction strategies implemented within the watershed include the following:

- The City of Calabasas conducts annual reviews of erosion control plans for developers that have open construction sites (exposed soil, no stabilization), open City projects and any project starting during the rainy season. City inspectors also ensure that erosion control measures, which must be identified as a condition for receiving a development permit, are correctly installed and maintained (e.g., sandbags, berms).

- The Cities of Agoura Hills and Westlake Village require developers and new construction projects to implement wet weather control plans during the rainy season (October - April) and enforces them as warranted. State permitted construction sites (those 5 acres or greater) are checked at least once during each rainy season by City inspectors.

- The City of Thousand Oaks requires that: 1) all development projects (except single family residences) disturbing one acre of soil or more prepare a storm water pollution control plan (SWPCP) before receiving a grading permit, 2) new developments incorporate permanent BMPs into their site designs, and 3) erosion control plans be developed for all active projects before the start of the rainy season. Construction inspectors routinely check construction sites for proper implementation of SWPCPs and BMPs.

Additionally, in 1997 the RCDSMM (using Proposition A and US EPA 319(h) grant funds) implemented a sediment reduction and stream bank stabilization project along a 200-ft section of Las Virgenes creek adjacent to Lost Hills Road. Initially, the RCDSMM excavated approximately 17,000 cubic yards of old fill material which had been dumped in the streambed by a previous development project. A new mild streambank slope was then reconfigured using bio-engineering techniques (erosion blankets, geo-grid system, and native re-vegetation). The fill material removed from the site was accepted without charge by the County Sanitation District for cover at the Calabasas landfill. This in-kind contribution, estimated at $500,000 was the single biggest factor in allowing the project to proceed, as funds had not been secured to cover the disposal cost of the fill material. Since its completion in 1998**,** the restored streambank has successfully withstood several storms, become stabilized and is now considered fully restored. Based on the RCDSMM's routine inspection of the stream bank, some components will be modified to increase its long-term stability.

11. ***Fire Regulation-Erosion Control*. Modify fire regulation practices and weed abatement programs to reduce erosion. One method is to require mowing rather than discing of weed setback zones.**

Since public safety is the primary objective in preventing wild fires, particularly in the Malibu Creek watershed, native habitats located near commercial establishments and residential homes have historically been removed or degraded. However, per the Los Angeles Fire code, the Fire Department has set in motion a progressive, preventative approach to fire safety while promoting native vegetation retention called the *Fuel Modification Program*. Implemented in 1996, this program requires landowners of any new construction or addition of 50% or more square footage to develop a fuel modification plan showing:

- Specific plant pallets
- Plant spacing and arrangement
- An irrigation plan
- Legal documentation of a comprehensive long-term vegetation maintenance program for the property.

Existing and future landowners are required to adhere to the plan's components. Landowners are also required to comply with existing standards for brush clearance to reduce the threat of fire. The standards do, however, recognize the need for erosion control and watershed protection, and therefore allow up to three inches of grass to remain on relatively flat lands and up to 18 inches on slopes otherwise prone to significant erosion.

Cities in the watershed have also adopted policies promoting mowing rather than discing areas likely to erode and promote the use of drought-tolerant plants where possible.

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12. ***Temperature*. Establish water temperature policies for fisheries.**

The RCDSMM has routinely sampled and accumulated lagoon water temperature data since 1989 as part of all of its Malibu Lagoon projects. Although this relatively long-term data has not yet been used to formulate water temperature policies (no lead agency identified), it is available for use upon request. The Las Virgenes Municipal water district also recorded temperature data continuously for one year at multiple stations in Malibu Creek and compiled temperature requirements for steelhead trout. The RCDSMM's data, along with LVMWD's data and the habitat/species information and assessments contained in the Coastal

Conservancy/UCLA report, could help guide the development of a temperature policy for Malibu Creek and Lagoon.

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13. ***Storm Drains*. Employ appropriate BMPs for storm drains throughout the watershed. Stencil all catch basin inlets (storm drains).**

In 1995 as part of its Gutter Patrol Program, Heal the Bay started stenciling catch basin inlets in the City of Malibu with the message **"NO DUMPING - This Drains to Ocean."** Once the program was completed, they provided city personnel stencils and paint to ensure the longevity of this effort as stencils faded or as new storm drains were installed. Malibu's local residents were also reached with the "No Dumping" message by Heal the Bay through educational door hangers (in the shape of fish), local community events and local newspapers. The same "No Dumping" stencils were provided to other cities in the Malibu Creek Watershed, thus promoting a consistent region-wide message discouraging illegal dumping of materials into storm drains. Storm drain stenciling is now required by all cities under 1996 Municipal Storm Water NPDES permit.

In May 1993, LAC-DPW developed a program to stencil a significant number of catch basins county-wide with the same phrase and logo **"NO DUMPING - This Drains to Ocean.**" Their initial effort included stenciling approximately 72,000 sites. The County then established a periodic re-stenciling schedule whereby three of the nine County areas would be re-stenciled each year (resulting in overall storm drain stenciling maintenance every three years). As part of this program, participating cities in the Malibu Creek watershed are scheduled to be re-stenciled sometime in 1999 (the County only provides stenciling service to those cities who contract with them for catch basin cleaning or who specifically request stenciling services). Cities who choose not to participate in the County's program are required to conduct their own cleaning and stenciling programs and may or may not use the same logo and phrase. In the Malibu Creek watershed, Calabasas and Westlake Village contract with the County for these services. Agoura Hills cleans its own storm drains and removes debris annually prior to the start of the rainy season, but contracts with the County for stenciling of its catch basins. The City of Malibu conducts its own program entirely (as mentioned above).

These watershed cities also conduct regular street sweeping activities to help prevent storm drains from becoming clogged with trash and debris. The City of Calabasas, using Prop A funds, has even installed a state-of-the art continuous deflection system (CDS) unit into one of its storm drains. CDS units use reverse-angle screens to filter out trash and debris once they enter the device. Initial research has shown these units to be quite successful at removing virtually all trash and debris from the system, and they are reportedly easy to maintain.

As mentioned under Reduce Pathogens (#7), three storm drains, which discharge flows directly into Malibu Lagoon were targeted for treatment by the City of Malibu. Starting in the winter of 2000/01, flows from one of the storm drains will be treated using an oxidan gas disinfection facility to eliminate bacteria and viruses before they reach the lagoon. If the results of this treatment process are successful, the remaining two drains will also receive the same treatment. The demonstration project is being sponsored with Prop A funds and by the City of Malibu, Southern California Edison and Purizer Corp, who is contributing the disinfection facility for the project.

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14. ***Mobile Car Washes*. Regulate mobile car washes to prevent discharges from reaching the creek and lagoon.**

Under the 1996 Municipal Storm Water NPDES Permit, all four Los Angeles County watershed cities have adopted local ordinances prohibiting mobile car washes from discharging runoff to the municipal storm drain system. Enforcement of this provision is limited, and is conducted on an as-needed basis. See Enforcement – General (#40).

The County of Ventura and its watershed communities are not required under their Storm Water NPDES permit to regulate mobile car wash discharges. However, this concern is addressed somewhat through public education and outreach.

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15. ***Illegal Drains*. Eliminate known illegal storm drains entering the watershed.**

The County of Los Angeles Department of Public Works prepared maps and connection inventory reports for 1082 storm drain segments county-side, resulting in discovery of 1838 undocumented connections. Of these, 49 illicit connections were found in the Malibu Creek watershed; 21 of them have since been formally documented and the other 28 are in the process of being documented. Typically, the County investigates all reports of illicit connections and advises the owners of these connections to either document them or remove them.

Although no illicit discharges (including gray water and septic connections) have been identified to date, the City of Malibu relies on the legal authority provided under its storm water ordinance to eliminate them if and when they are discovered.

Heal the Bay, through its Malibu Creek Stream Team program, conducts extensive surveys along various creeks and streams throughout the watershed. Volunteers who walk segments of the creek document, among other things, discharge points or outfalls that lead directly to the creek/stream. This information can be compared to known discharge points and legal action can be taken when illegal discharge points are discovered.

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16. ***Septic Systems***. **Implement dye study of the septic systems in the vicinity of the lagoon, creek and surfzone. Study all identified systems and replace all malfunctioning systems.**

Please see summary under Septic Systems (#23).

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17. ***Trash/Park Sanitation***. **Maintain sanitary conditions in parklands. Link to education in English and Spanish to prevent trash from impacting local resources. Manage and eliminate the harmful impacts of day use, including campers, picnickers and transients on water quality.**

The California Department of Parks and Recreation (State Parks) has taken several measures to control the spread of trash and debris within its parkland boundaries, including: 1) installing gull/bird proof lids on trash cans, 2) utilizing bilingual employees to enhance educational efforts to Malibu Creek State Park day-use visitors, and 3) periodic removal of transient encampments. However, signs posted in the park are not in both Spanish and English, and their visibility is poor.

Heal the Bay records dump sites during its stream walk activities, which includes parklands. The information collected should be used in determining where to best place trash cans within State Parks boundaries.

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18. ***Confined Animals.*** **Develop BMPs for livestock waste management.**

- **Conduct a survey of existing locations and amounts of animal waste within the watershed.**
- **Prohibit dumping of horse manure along the creek. Enforce set-backs of horse corrals and horse manure storage.**
- **Set limits on the number of livestock per acre to protect resources from overuse by large domestic animals.**

As one component of its EPA 319(h) Nonpoint Source Reduction grant, the RCDSMM conducted an extensive research effort to identify all horse owners and corrals in the Malibu Creek watershed. Their efforts culminated in the development of a Stable and Horse Management BMP manual to help reduce point and nonpoint source pollution from livestock waste. The manual provides information on how to manage horse waste, site planning and design for corrals, drainage and erosion control, etc. The project also included: 1) conducting a watershed-wide survey of horse owners to better understand their current management practices and needs; 2) designing and building a horse manure compost demonstration site as an educational tool for the public; and 3) producing a video entitled “Horse Management Program.” These materials are available to the public upon request. However, there is some concern that the message is still not reaching horse owners, or that the owners are not motivated to change their stable locations or practices. For example, Heal the Bay’s Stream Team has identified several horse facilities near streams and riparian zones that have poor or non-existent manure management measures. These facilities adversely impact the watershed’s creeks and streams.

The County of Los Angeles, Department of Health Services maintains a horse stable monitoring program through biannual inspection of stables with four or more horses throughout the County. These inspections verify that applicable best management practices related to storm water regulations are being implemented and that horse waste is well contained and prevented from reaching the storm drain system. When violations are discovered, the

Department of Health Services takes action to remedy the situation by first working with horse owners. Fines and restrictions are then imposed if that avenue is not effective.

This City of Malibu plans to conduct a survey of horse corrals within the city and will be providing education for proper management of manure once this activity is completed. Additionally, new and re-development projects within the city will be required to provide measures to assure that runoff from corrals does not reach the storm drain system.

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19. ***Household Irrigation Runoff*. Survey households in upper Medea Creek development to determine reasons and solutions for extraordinary water runoff and report to advisory committee.**

Dry-weather urban runoff from households in the watershed primarily comes from activities such as yard and garden watering, car washing and hosing down driveways and sidewalks. The Metropolitan Water District (MWD) and the Las Virgenes Municipal Water District both offer water conservation education classes for residents addressing such issues as when to water the lawn, what plants are more drought resistant, how to properly install irrigation systems, etc. There are also a host of educational efforts encouraging residents to minimize excessive water use both indoors and outdoors.

However, no official study has been conducted nor report presented detailing reasons for and solutions to the volume of runoff coming from any residential community in the watershed.

20. ***Restore/Enhance Malibu Lagoon and Surfzone*. Restore and/or enhance Malibu Lagoon, including threatened and endangered species.**

The 13-acre Malibu Lagoon and its surrounding coastal salt marsh, wetlands and surfzone are significant biological resources for both bird and aquatic species, some of which are threatened or endangered (see Table 2.3). The area also represents a vital resting and feeding "stop over" point for many migratory birds, which is especially important given Southern California's few remaining viable habitats along the Pacific flyway.

Threatened Species
Snowy Plover (*Charadrius alexandrinus*)
Peregrine Falcon (*Falco peregrinus anatum*)

Endangered Species
Brown Pelican (*Pelicanus occidentalis*)
Clapper Rail (*Rallus longirostris obsoletus*) *
CA Least Tern (*Sterna artilarum browni*)
Willow Flycatcher (*Empidonax traillii extimus*)
Bells' Vireo (*Vireo bellii pusillus*) **
Steelhead Trout (*Onchorhyncus mykiss*)
Tidewater Goby (*Eucyclogobius newberryi*)

* Not observed since 1956
** Not recently observed but suspected former nester

Table 2.3. Threatened and endangered species found in the Malibu Creek watershed.

The avian species listed in Table 2.3 are impacted by a variety of problems in Malibu Creek Lagoon, including: 1) persistently high lagoon water levels which submerge valuable mudflat habitat, 2) human and pet disturbance, 3) poor lagoon water quality, and 4) non-native vegetation. Restoration efforts to improve overall water quality in the lagoon, increase available habitat and limit intrusions have only recently begun. Initial efforts include: 1) the mudflat island created in the lagoon by the RCDSMM through a State Parks grant in 1995, 2) data collection and assessment via several studies and long term projects [see Table 1.3 starting on page 12], and 3) the recent study conducted by the Coastal Conservancy and UCLA on Lower Malibu Creek and Lagoon biota, water quality, hydrology and sources/impacts.

Two primary endangered aquatic species found either currently or historically in the Malibu Creek and Lagoon include steelhead trout and the tidewater goby. The last account of steelhead trout in either Malibu Creek or Lagoon was in 1997, the same year that the species was added to the federal endangered species list. Loss of upstream habitat and spawning grounds are believed to have contributed to its decline and ultimate disappearance in Malibu Creek reaches. Under the guidance of the Santa Monica Mountains Steelhead Trout Recovery Task Force, restoration efforts are just getting underway for this species. The focus of the task force includes assessing the feasibility of removing of Rindge Dam and other creek barriers impeding steelhead migration to upper reaches of the creek.

The tidewater goby, which was added to the federally endangered species list in 1993, was extirpated in Malibu Lagoon in the late 1960's/early 1970's due to the incremental and cumulative effects of environmental stressors such as habitat reduction (resulting from development activities), channelization and destruction of spawning grounds. Prior to the listing, in 1991 restoration efforts had started to both reintroduce and sustain populations of the tidewater goby in Malibu Lagoon. With a grant from the California Department of Parks and Recreation, the Resource Conservation District of the Santa Monica Mountains and Heal the Bay re-introduced 52 tidewater gobies. Seven years later, RCDSMM fish surveyors recorded 1,632 tidewater gobies at four sampling stations in the lagoon. Although the species is nowhere near the point of recovery from a statewide perspective, this number represents a significant improvement for the tidewater goby in Malibu Lagoon. A full report documenting the project, which also includes substantial water quality analysis performed before, during and after the re-introduction, is available from the RCDSMM.

The RCDSMM conducted another lagoon restoration effort in partnership with State Parks and the California Department of Transportation (CalTrans) in 1995. Using *EPA Near Coastal Waters Program* grant funds, a significant portion of Malibu Lagoon was restored by excavating over 2,200 cubic yards of old fill material and creating additional aquatic, mud-flat and high storm flow refugia habitats for birds, tidewater gobies and other aquatic species. Post project monitoring of fishes, water quality, and invertebrates was also performed. This data is available from the RCDSMM.


Malibu Lagoon.

Heal the Bay, through its Stream Team volunteer program, has helped to reduce the volume of trash in the lower creek and lagoon. Since 1998, they have removed over 6 tons of trash. Heal the Bay also serves as the Los Angeles area coordinator for Coastal Cleanup Day, which includes beach clean-up activities at Malibu Lagoon and Surfrider Beach.

State Parks conducts periodic cleanup activities in the lagoon and surfzone area to remove trash and other unwanted materials. Their efforts are helping to preserve the initial restoration efforts conducted by the RCDSMM and others.

Future restoration and enhancement activities are being evaluated by the Lower Malibu Creek and Lagoon Task Force using the Coastal Conservancy/UCLA report recommendations (see Assess Sources/Characteristics, #21, below). A group facilitator is currently helping the task force establish selection criteria and guidelines for voting on the management alternatives outlined in the UCLA report.

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21. ***Assess Sources/Characteristics.***

- **Conduct a thorough and definitive study of lagoon water quality, identify all pollution sources, and develop a remediation plan strategy.**
- **Develop a comprehensive picture of the hydrology, circulation, biota of the lower creek and lagoon and surfzone for policy decision making.**
- **Perform quarterly toxic chemical tests in Malibu Lagoon and surfzone.**

In 1997, the California State Coastal Conservancy contracted with UCLA to conduct the *Lower Malibu Creek and Barrier-Lagoon System Resource Enhancement and Management Study*. The goal of this study was to provide the information and analyses needed for rational, scientifically-based decisions about the management and enhancement of Lower Malibu Creek and Lagoon. The three key objectives of the study were to: 1) compile and synthesize relevant existing information, 2) collect new information to fill critical data gaps, and 3) recommend management and enhancement strategies.

The draft report, which was completed in February 1999, provides information on the hydrology and morphodynamics, biological resources, water quality objectives, effects of eutrophication, management of pathogens and wetlands restoration alternatives for lower Malibu Creek and Lagoon. The report culminates with a list of management alternatives for policy makers to consider when undertaking or planning future restoration efforts. Comments on the draft report were submitted by various watershed stakeholders in May/June, 1999 and have been incorporated into the final report. Already, the Executive Advisory Council and Lower Malibu Creek and Lagoon Task Force members are using this and other data collected by the RCDSMM (see below) to proceed with developing a remediation strategy for the creek, lagoon and surfzone. As a preliminary step, a facilitator/mediator has been retained by the task force to promote consensus among stakeholders in selecting and implementing various management actions identified in the final report.

Additional data on Malibu Lagoon was collected by the RDCSMM over several years. They have more than ten years of water quality survey data available that includes information on: 1) fish species diversity, densities, seasonal and relative abundance; 2) bird species diversity, seasonal relative abundance and specific area usage; and 3) pre and post- sand barrier breaching abundance and usage (for fish and birds). Two reports in particular, *Malibu Lagoon: A Baseline Ecological Survey (1989)* and *The Tidewater Goby (Eucyclogobius newberryi), Reintroduction of a Geographically Isolated Fish Species into Malibu Lagoon (1993),* provide a significant amount of water quality and biotic elements data. The RCDSMM also initiated a two-year study in November, 1996 entitled *Effects of Breaching the Sand Barrier on the Biota at Malibu Lagoon*. As part of this study, fishes and birds were surveyed, lagoon water levels were recorded and extensive water quality data was collected for ammonia (as nitrogen), nitrates (as nitrogen), phosphates, dissolved oxygen, turbidity, water temperature, pH and salinity. Data collection was completed in 1998 and is available for review from the RCDSMM.

Other Malibu Creek/Lagoon biota and water quality data have been collected over the past few years, primarily through projects requiring and/or conducting monitoring programs. These include:

- Construction of the new Pacific Coast Highway bridge (CalTrans);
- RCDSMM's *EPA Near Coastal Waters Grant*;
- *Enhanced Monitoring Program on Lower Malibu Creek and Lagoon*[14];
- Installation of groundwater monitoring wells in Malibu Lagoon State Beach (City of Malibu/State Parks); and
- The RCDSMM's ongoing Marine Sciences Environmental Education Programs at Malibu Lagoon.

Collectively, this relatively long-term data is useful in understanding the comprehensive picture of Malibu Lagoon's dynamic water quality

[14] This study was conducted by Rich Ambrose, et.al. (UCLA) in 1995 and funded by the Las Virgenes Municipal Water District ($110,000).

changes as well as providing insight into the character of the lagoon's biota.

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22. ***Illegal Drains***. **Eliminate known illegal storm drains entering the lagoon and particularly investigate sources emptying into the unclaimed storm drain.**

A number of drain pipes exist that discharge flow directly into Malibu Lagoon. The largest, a 24-inch pipe known as the Mystery Drain, carries runoff from the Malibu Road catch basins adjacent to Webb Way and from private catch basins in the Malibu Colony area (this drain is not considered "illegal" by the City of Malibu). As mentioned under Reduce Pathogens (#7), the City of Malibu was awarded Prop A funds to install a Storm-ceptor **J** near the end of the Mystery Drain to remove grease, oil, trash and sediment. The City has a long-term goal of eliminating "Mystery Drain" flows to Malibu Lagoon by redirecting the discharge through a new ocean outlet at the western end of the Malibu Colony. However, due to the complexities of permitting a new ocean outlet and private property issues, this project has not yet been scheduled.

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23. ***Septic Systems***. **Implement dye study of the septic systems in the vicinity of the lagoon and surfzone. Study all identified septic systems and replace all malfunctioning septic systems.**

Septic systems in the lower watershed have long been suspected of contributing pathogens and nutrients to the Malibu Creek, lagoon and surfzone. However, identifying all sources and reducing pathogen/nutrient loading have proven to be among the most challenging issues facing watershed stakeholders.

There are an estimated 390 multi-family and commercial complexes using septic systems in the City of Malibu. Although these users are required to obtain discharge permits from the Regional Board, only 11 complexes had filed for and received discharge permits by 1999 to operate their septic systems.[15] Single family residential septic systems, estimated at 3,800, are not required to apply for a discharge permit from the Regional Board.

Many of Malibu's 4190 septic systems are suspected of contributing

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[15] *Omission Accomplished: The Lack of a Regional Water Board Enforcement Program, 1992-1997*. Heal the Bay. January, 1998.

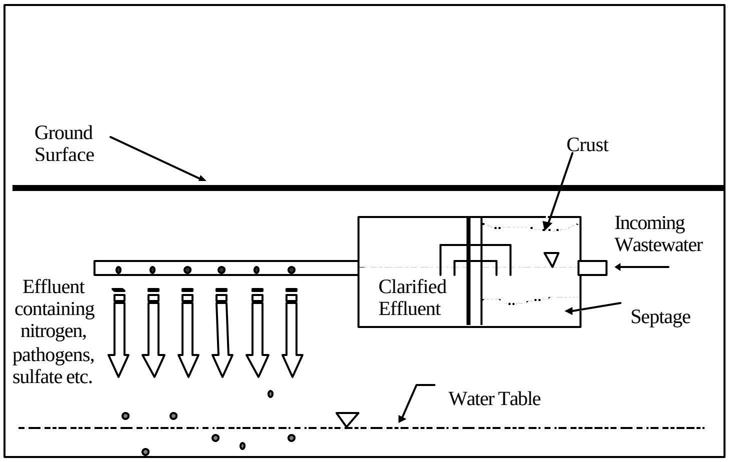

Figure 3. Septic system flow diagram.

pathogens and nutrients to the poor water quality conditions documented in Malibu Creek and Lagoon[16]. They are suspected contributors because septic effluent is released through subsurface discharge pipes into leach fields near the creek, lagoon and surfzone(see Figure 3). This effluent contains pathogens and nutrients which, under the right conditions, can be mobilized in groundwater. The City of Malibu and other enforcement agencies have historically lacked sufficient data to assess whether septic systems actually contribute pathogens and nutrients to nearby receiving waters, and monitoring of homeowner septic maintenance and/or replacement activities has not been conducted.

Several studies over the past few years have been carried out to determine the sources and amounts of pathogens/nutrients contributing to the lagoon and surfzone's degraded water quality. One such study, conducted by the Coastal Conservancy/UCLA, was completed in March 1999. While the report does suggest that nearby septic systems provide nutrients and pathogens to the lower Malibu Creek and Lagoon, how much is not clear. It recommends that more testing be conducted. (The study also included five different sampling events over a nine-month period to identify the presence of specific viruses in the lagoon and surfzone, but none were detected.)

Using consultants, the City of Malibu recently completed an extensive, two-phase study addressing the impacts of septic systems on Malibu Creek, lagoon and surfzone. In 1998 under Phase I, 11 groundwater monitoring wells were installed in strategic locations throughout the study area[17] to evaluate the potential of pathogens to be transported from septic effluent to groundwater and ultimately the creek, lagoon and surfzone. Biophage[18] tracers were used to determine this link. The results of the

[16] Septic discharges occur underground in a leach field. The potential mobility of contaminants found the leach field are influenced by groundwater level and hydraulic gradient (direction and flow velocity).
[17] Two wells were installed between residential septic leach fields and the lagoon, one in the Malibu Lagoon parking lot, seven in the vicinity of the commercial leach field nearest to Malibu Creek and one on Cross Creek Road up-gradient from the other test sites.
[18] A biophage is a genetically synthesized virus that is physically identical to an enteric virus but is non-pathogenic.

first phase indicated two findings[19]:

- Under simulated breach conditions when the groundwater table was at least 2 feet below the leach field, the biophage tracer (PRD-1) did not appear in any samples taken from the monitoring wells. However, bromide (another tracer) did appear in groundwater samples directly below the septic leach field, indicating that there is a hydraulic connection.

- Groundwater that first intersected the leach field and then was subsequently drawn down (simulating breach conditions) showed that both the biophage (MS-2) and bromide were transported beyond the leach field boundary.

Based on these findings, two conclusions were drawn. First, if at least two feet of unsaturated soil can be maintained between the bottom of a leach field and the top of the groundwater table, then there is little concern regarding pathogen transport. However, if the groundwater intersects the bottom of the leach field, then there is cause for concern that pathogens will be transported in the direction of the creek, lagoon and surfzone.

In 1999, a follow-up study (Phase II) was conducted by Malibu in partnership with the Los Angeles Regional Water Quality Control Board to identify potential sources of pathogens in the study area. The City and Regional Board participated in both the design of the study parameters and sampling events. Groundwater, surface water, sediments and storm drain discharge samples were collected and analyzed for coliform (total, fecal, e-coli, enterrococcus), BOD, MBAS (a marker for detergent), nitrogen compounds (NO_3, NO_2, organic N) and phosphates. The samples were collected under different hydraulic conditions – during lagoon closure, breaching and open tidal action. Results of the study have been compiled and are available in the report, *Study of Water Quality in the Malibu Area, City of Malibu, California, Phase II.* Major findings of this report include:

- The discharges from three storm drains into Malibu Lagoon are contaminated with coliform bacteria, but the majority of coliform bacteria (99%) comes from Malibu Creek's upstream sources.
- The height of the groundwater table is influenced by the state of the

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[19] *Study of Potential Water Quality Impacts on Malibu Creek and Lagoon From On-Site Septic Systems*. Prepared for the City of Malibu by URS Greiner Woodward Clyde. June, 1999.

lagoon (breached vs. bermed). Following a lagoon breach, concentrations of bacteria and nutrients found in the corresponding leach field area mobilize in the groundwater but attenuate over distance traveled.
- Samples taken from the wells located between the Colony and Malibu Lagoon suggest possible impacts from septic systems.

Also based on the monitoring results of the Phase II study, the Regional Board concluded in an August, 2000 report[20] that:

- Septic systems contribute to groundwater pollution in the Malibu Valley due primarily to insufficient separation between the groundwater table and septic leach fields.
- There is a hydraulic connection between groundwater in the Malibu Valley and local surface waters as evidenced by the correlation between groundwater movement and Malibu Creek and Lagoon water levels.
- The nutrients and pathogens/bacteria discharged by Malibu Valley septic systems adversely impact Surfrider Beach.

> The Phase II monitoring data confirmed, and study participants agree that if groundwater levels intersect the bottom of a septic leach field near Malibu Creek, then there is cause for concern that pathogens will be transported over longer distances, potentially reaching the Malibu Creek, Lagoon and surfzone.

There is disagreement over some of the conclusions drawn from the Phase I and II studies. Local regulatory agencies feel that additional factors must be considered before making any determination about the impact of septic effluent on Malibu Creek, lagoon and surfzone. Specifically, the geology of the site, direction of groundwater flow, time of day monitoring is conducted and the volume of effluent treated through the system must all be considered. At the time the *Making Progress: Restoration of the Malibu Creek Watershed* report was released, the project design, data collected and all conclusions drawn from the Phase II study had not been peer reviewed or evaluated by outside sources.

Although Malibu has not established an exact count of all private sewage disposal systems (PSDS) within its jurisdiction, the City has begun implementing programs, ordinances and other measures to assure the safe operation of on-site wastewater treatment systems. In 1999, the City adopted modifications to the Plumbing Code addressing or calling for

[20] *Preliminary Results of the Malibu Technical Investigation.* Los Angeles Regional Water Quality Control Board. August 18, 2000.

minimum tank sizes, appropriate flow rates, secondary treatment, filtering systems and more restrictive design criteria for new commercial and multi-family developments. The City has also seen problem septic systems in Malibu remedied through the use of advanced treatment systems. And, while no specific program requirements have been set, Malibu is also considering several strategies to further monitor and control septic system discharges. These include:

- Establishing a *Pumping Records Registration Program*;
- Developing an ordinance which would require mandatory retrofit to ultra low flow and low consumption fixtures/plumbing devices in all occupancy structures;
- Developing an ordinance requiring mandatory installation of grey water systems for all new construction;
- Adopting a contractor/plumber designed registration program; and
- Establishing an on-site, septic system inspection program.

In January 2000, the Santa Monica Bay Restoration Project convened a *Septics Management Task Force*[21] to develop a set of recommendations for how to better manage this potential nonpoint source of pollution. These recommendations, which include local permitting and inspection/monitoring of single family septic systems, were presented to various agencies and stakeholders during the fall of 2000 and will be adopted in the beginning of 2001 by the SMBRP's Bay Watershed Council. Once adopted, it will be the responsibility of the appropriate agencies to begin implementation of these measures.

The Ventura Regional Sanitation District, utilizing US EPA 319(h) grant funds, is planning a demonstration of off-the-shelf advanced individual disposal systems capable of treating household wastewater to less than 10 mg/l of total nitrogen. The results of this demonstration will certainly be useful to planners, agencies and septic system users in the Malibu Creek Watershed.

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24. ***Lagoon/Water Level Breaching*. Evaluate options for regulating lagoon levels without artificial breaching of the lagoon. Prevent unnatural breaching of the creek/lagoon.**

[21] Participating agencies include the SMBRP, Heal the Bay, Supervisor Zev Yaroslavsky's office, City of Malibu, State Department of Health Services, Los Angeles Regional Water Quality Control Board, City of Los Angeles, and Los Angeles County Departments of Health Services, Regional Planning and Public Works.

Until 1997, State Parks was informally permitted the authority to institute breaching activities when Malibu Lagoon's waters reached a certain level. However, at the urging of local resource agencies who were concerned about the impacts of artificial breaches on the lagoon's sensitive aquatic species (i.e., tidewater gobies), the California Coastal Commission (CCC) and Army Corp of Engineers halted all breaching activities until a study could be conducted to assess the overall impact to the system. Exceptions were granted only when public health was threatened, (e.g., when lagoon waters reached levels that caused malfunctions/backups of nearby residential and commercial septic systems).

The RCDSMM conducted a study, *Effects of Breaching on the Biota*, which looked at how breaching affects many species found in the lagoon. They concluded that there is definitely a negative impact on these species when breaches occur.

There are, however, periodic artificial breaches spearheaded by the "shovel brigade," i.e., persons who feel that high water levels combined with poor lagoon water quality directly impact human health at a popular surf area. The shovel brigade takes it upon themselves to "control" where the breach occurs when the lagoon's water level is so high that a natural breach is imminent. This group digs a channel at the western-most edge of the lagoon to prevent the sand that is washed out from piling up at the first break point and adversely altering the shape of the waves for surfing.

In August 1999, State Parks issued a *Request for Proposals* for the design and construction of a system that will help manage the lagoon's water level during the dry season without adversely affecting fish and wildlife (e.g., tidewater gobies, steelhead trout). Until a system is approved and constructed, artificial breaching will not be permitted unless public health and safety are threatened.

25. ***Public Notices.***

- **Breaching / Public Health: Regular notices to inform the public and agencies about breaching times of lagoons.**

  As a standard practice, State Parks informs the public and other concerned parties each time a mechanical/artificial breach of the lagoon is to be performed. In addition to notifying key agencies such as the Coastal Commission, State Parks notifies local newspapers. The Los Angeles County Department of Health Services and LA County Lifeguards posts beach closure signs and warn beach-goers near the breach point.

- **Encourage Los Angeles newspapers to publish weekly monitoring bacteria results at beach entrances**.

  In 1990**,** Heal the Bay launched the first-ever *Beach Report Card*. **J** Using water quality data from samples collected by the Los Angeles County Department of Health Services, County Sanitation District of Los Angeles County (CSDLAC) and the City of Los Angeles Environmental Monitoring Division at Hyperion, Heal the Bay interpreted bacteria results and established a grading/reporting system (A-F) that the general public could easily understand. Initially, beach grades were published on a monthly basis for 61 beaches throughout Los Angeles. Grades are now provided for over 250 beaches in Los Angeles, Orange, Ventura and Santa Barbara Counties via local newspapers, marine shops surf and dive shops and on local weather stations. Grades are also posted on Heal the Bay's website, which has undergone improvements to better inform the public about how the beaches are monitored and the health risks associated with swimming in the Bay.

  Four of the 250 beaches graded are located in Malibu – 3 locations near Surfrider Beach and one at Malibu Pier. Whenever the lagoon is breached, Surfrider Beach receives an "F" grade (based on water quality data). However, the data showed excellent water quality during the four summer months of 1999 when the lagoon was not breached.

- **Implement public notification and education programs about potential health problems at beaches.**

  In 1995, the Santa Monica Bay Restoration Project conducted a comprehensive epidemiological study to assess the correlation between contaminated storm drain discharges and incidence of swimmer illness[22].

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[22] Other organizations and agencies providing funding and support for this study include the

Revised beach warning signs.

Results of this study showed, conclusively, that there is a significant increase in occurrence of illnesses among swimmers who swim within 100 feet of flowing, dry-weather storm drains. Immediately following the release of this study, new warning signs were created and permanently posted directly in front of flowing storm drains, calling attention to the dangers associated with swimming in urban-runoff contaminated waters. The results of the study also triggered revisions to the County's Beach Closure and Health Warning Protocol, which now requires posting the new warning signs and notifying the public of beach closures in a timely fashion and on a more regular basis. Four years later, the results of this study are still used as a guidance tool by the media, environmental organizations and others to inform the public of the risks associated with swimming in front of flowing storm drains.

Following the Epidemiological Study, Heal the Bay initiated, helped draft and advocated for passage of a bill that would require California's popular beaches (i.e., more than 50,000 visitors annually) which receive storm drain discharges to: 1) conduct routine water quality monitoring for three bacterial indicators, and 2) inform the public when established bacterial thresholds have been exceeded by posting warning signs or closing the beach. The bill (AB411), which was passed in October 1997, also requires local health agencies to set up a hotline to inform the public of all beaches currently closed, posted or otherwise restricted. Heal the Bay also utilizes volunteer speakers through its *Speaker's Bureau* program to help educate over 25,000 people every year about: 1) sources of sewage to the bay, 2) the potential health problems associated with swimming in contaminated waters, and 3) where and when to swim in Bay waters. The program targets schools, corporations and community groups.

State Water Resources Control Board, City of Los Angeles, Beach Cities Health District, City of Santa Monica, Los Angeles County Department of Public Works, Los Angeles Regional Water Quality Control Board, Chevron Companies, Las Virgenes Municipal Water District, Milken Family Foundation, Heal the Bay and the US Environmental Protection Agency.

26. ***Malibu Lagoon/Bridge*. CalTrans should set up a mitigation fund to cover the costs of any impacts to Malibu Lagoon and the surfzone resulting from the reconstruction of Malibu's Pacific Coast Highway Bridge.**

Within one year of completing the Pacific Coast Highway bridge across Malibu Creek and Lagoon, CalTrans provided State Parks approximately $110,000 for salt marsh restoration activities. State Parks used these funds to remove exotic plant species in the area just below the bridge and revegetated it using native plants. CalTrans also provided $98,830 to the Resource Conservation District of the Santa Monica Mountains over a five year period (1996-2000) for tidewater goby monitoring and restoration activities (including funds for the *Effects of Sand Breaching the Sand Barrier on Biota* study; see Lagoon/Water Level Breaching, #24).

27. ***Landfill***. **Expand the understanding of the impact of the Calabasas landfill on water quality and especially ensure that Calabasas landfill installs monitoring wells which they were directed to construct in 1990; report monitoring results of findings to the advisory committee.**

In cooperation with the County Sanitation Districts of Los Angeles County (CSDLAC), the National Park Service (NPS) prepared an environmental assessment (EA) on the issuance of a special use permit for continued operation of the landfill. The EAs preferred alternative included issuance of a permit with 13 conditions to mitigate the impacts of the landfill on park resources and visitor enjoyment. These conditions include: 1) off-site preservation of 100 acres of habitat along the US 101 freeway corridor, 2) $40,000/year wildlife fund for wildlife habitat research, 3) native plant restoration of landfill slopes, 4) alternative grading concept plans, and 5) development of an interpretive wayside exhibit addressing solid waste management and environmental issues. The five year permit was issued in November, 1998 and implementation of its 13 conditions began immediately afterward.

As part of the condition of approving the permit, CSDLAC purchased off-site land to permanently mitigate the loss of habitat. The 107-acre parcel purchased (referred to as the Albert Abrams property) is located on the south side of Agoura Road, west of Liberty Canyon Road and is a vital link to the wildlife corridor.

A groundwater study is also being conducted at the landfill to further define the extent of the landfill's effect on groundwater. In August and October 1999, eight piezometers were installed in the area to obtain geologic and hydrogeologic data. The information gathered will be used by the County Sanitation District to: 1) acquire those portions of the Lower Cheeseboro Canyon that contain surface or subsurface contamination and 2) design a water quality corrective action program. Routine post-rainfall surface water testing continues to show no adverse impact to surface water quality resulting from landfill operations.

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28. ***Water Imports and Discharge***. **Maximize environmentally acceptable use of reclaimed wastewater (household and treatment plant) and grey water, and reduce the importation of potable water. Encourage use of reclaimed water for irrigation of landscaping and community open space. Price reclaimed water more competitively.**

Harmoniously implement water conservation efforts and grey water ordinances between cities. Ultimate long-term goal of no-waste discharges into waters used for recreation and/or for sources of food.

The Las Virgenes Municipal Water District provides 65,000 residential customers, nearly 75% of the watershed's residents, with approximately 18,000 acre-ft of imported water each year. Several other water agencies also supply an additional 10,000 acre-ft of potable water to upper watershed customers; these agencies include Callegus Municipal Water District, Triunfo Sanitation District, Oak Park Water Co., California Water Services Company, Lake Sherwood Community Services District and Hidden Valley Mutual Water Company. The amount of water returned by these residents to the Tapia facility for tertiary treatment is about 11,200 acre-ft, of which 5,000 acre-ft is recycled and beneficially used for irrigation. The greatest demand for Tapia's recycled water is for irrigation purposes, usually from mid-June to mid-September, when temperatures are higher. Moderate, but highly variable demand is observed in the "shoulder" periods of May through mid-June and mid-September through October, with much lower demand for the remaining six months of the year. During peak demand, 100% of Tapia's daily volume of recycled water is distributed to users and potable water is often used to supplement the supply. To keep spring and fall surplus water out of Malibu Creek, each year the District installs and then dismantles (to allow mowing and discing) over 35 miles of temporary irrigation pipes for surplus disposal via off-site spray fields. The District has even expanded recycled water incentives, giving surplus water away for free to its existing customers. It is also seeking state and federal co-funding to connect new customers that are currently too far away to serve economically. Combined, these programs/approaches have enabled the District to keep Tapia's effluent out of the creek from mid-April through mid-November.

The Las Virgenes Municipal Water District has also passed ordinances requiring the use of recycled water anywhere state law allows and the distribution system can reach. Price incentives are used to encourage use of reclaimed water. The District also uses a tiered rate structure to discourage waste and runoff of potable water (i.e., the unit rate increases with excess use). Other water conservation efforts are highlighted under Composting, Recycling and Conservation (#29).

In November of 1997, the Regional Board renewed the Tapia Water Reclamation Facility's NPDES permit and included new effluent discharge prohibitions. The new permit prohibits Tapia from discharging its effluent into Malibu Creek from April 15th through November 15th. In 1998, during the first summer of prohibition, Tapia was unable to store or find alternative uses for its effluent and violated the permit several times during that period. Reasons for the violation include: 1) lower recycled water demands, and 2) the limited time period given for LVMWD to evaluate and implement creek discharge avoidance alternatives. However, LVMWD is seeking permanent alternatives to discharging into the creek. They hired consultants and engaged stakeholders to conduct a study which would identify and assess both short- and long-term options for using, storing and/or disposing of the effluent. The resulting report, entitled the *Malibu Creek Discharge Avoidance Study,* identified a whole range of discharge alternatives for LVMWD to consider. An Environmental Impact Report (EIR) was subsequently developed for four project alternatives and seven other potential project alternatives.[23] The results of this report were provided to the Regional Board in late 1999.

At the municipal level, several cities have also taken measures to promote and/or require recycled water use. For example:

- Calabasas' local city ordinance encourages use of reclaimed water for landscape irrigation purposes and planting of drought tolerant native species within its jurisdiction. The City's Landscape Manager also provides technical assistance to residents who want information on efficient water usage by reviewing "plant palettes" for individual homeowners. Commercial development projects within the city require significant water budget calculations and plan checks prior to plan approval. A similar water budget program was instituted for individual homeowners originally, but because of the significant costs associated with developing a water allocation and budget plan, that program has been significantly reduced and is now limited to the elements mentioned above. The City's Planning Department, in conjunction with the Environmental Commission, has developed an Environmental Connection Handbook which addresses many topics such as water conservation, native plants and xeriscape. This handbook is available to residents who request it.

- The Cities of Agoura and Westlake Village endorse water conservation and reuse, and utilizes reclaimed water in all city parks, along the freeway, on street medians and on parkways wherever

[23] The four project alternatives included: 1) Deliver raw sewage to the City of Los Angeles sewer system; 2) Discharge recycled water to the Los Angeles river drainage basin; 3) Expand recycled water system; and 4) Store excess recycled water in the Las Virgenes Valley Basin.

available. Projects are routinely conditioned to utilize reclaimed water, such as landscaping projects along Kanan Road, Agoura Hills Road and along the 101 Freeway in these cities.

- The City of Malibu produced the *Grey Water Handbook* to help eliminate illegal disposal of grey water by encouraging residents to use it for irrigation. The city also modified the Plumbing Code to allow disposal through the use of sub-surface irrigation.

- The Triunfo Sanitation District endorses water conservation and promotes reclaimed wastewater reuse to its customers. These customers, which include the communities of Oak Park, North Ranch, Lake Sherwood and Westlake Village, use reclaimed wastewater on road medians and park grounds, and at schools and homeowners association developments. The City of Thousand Oaks and the County of Ventura also routinely condition projects to use recycled wastewater.

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29. ***Composting, Recycling, Conservation*. Implement improved recycling efforts. Maximize treatment and reuse potential of all aspects of the watershed's waste disposal operations (septic, sewer, sludge farming, and landfill operations).**

- **Encourage composting and other forms of recycling for waste management.**
- **Encourage recycling and reuse efforts to reuse water, household hazardous waste, plastics, paper, glass, cardboard, tin and aluminum.**

Several different agencies, municipalities and organizations are both responsible for and committed to accomplishing the goals of this action. Together, these combined efforts aggressively promote recycling and conservation throughout the upper and lower watershed.

- LAC-DPW and Ventura County both conduct a variety of county-wide outreach programs on composting, recycling and conservation which target residents and businesses. Program components include:
  - Operating residential curbside recycling program for single and multiple family dwellings in most unincorporated areas. In addition to providing collection services, they provide educational brochures to residents to help increase their level of awareness about recycling issues.
  - Conducting Household Hazardous Waste Roundups in

partnership with cities throughout the County. In 1998, Agoura Hills, Malibu, Calabasas, Hidden Hills and Westlake Village participated in roundups that resulted in collection of 24,246 lbs. of waste.

- Producing and distributing of Public Service Announcements (PSAs) and educational advertisements/brochures.
- Hosting free workshops and events to educate residents about green waste recycling, composting and gardening techniques to reduce water use. This program also promotes the recycling of Christmas trees each year.
- Partnering with local agencies to provide household hazardous waste roundups for their residents on a regular basis.

LAC-DPW and Ventura County promote participation in recycling programs through radio PSAs, web sites, local newspapers, fliers, city hall offices, chambers of commerce and libraries. When roundups are scheduled in a particular city, a banner is often hung across a road in a prominent section of town advertising the event. Both Counties also offer semi-annual *Green Gardening* workshops for the general public which include non-toxic gardening suggestions and composting information/supplies.

- The Las Virgenes Municipal Water District promotes composting and conservation efforts through:

  - The *Rancho Composting Facility*, which recycles all of Tapia's biosolids into garden compost. The compost is then sold in nurseries instead of being sent to the Calabasas landfill. The District has also installed two advanced energy fuel cells at the composting facility to convert methane gas generated from wastewater processing into electricity. The cells are now fully operational and generate power for use and sale.
  - A pilot incentive program, which was launched during FY 1998/99 for customers willing to replace all of their toilets with ultra low flow toilets (ULFT). This program tripled the number of ULFT retrofits in one year from 300 to 900.
  - The District co-sponsored *North American Residential End Use Study*, which installed data loggers in 100 homes to gather detailed information on water use. The data is being used to set national standards on appliance efficiency and conservation program planning. The study confirmed that toilet flushing is the single largest indoor use and provided data on leak incidence. Other water conservation practices promoted by LVMWD are

addressed under Public Education: Conservation (#30).

- The City of Malibu, jointly with LAC-DPW, maintains a permanent used oil drop-off site at its City Hall. The City also hosts monthly "Household Hazardous Waste Roundups" for collection of water-based paint, batteries and oil/oil filters, and bi-annual roundups for other chemicals. Malibu promotes its recycling efforts through the City's quarterly newsletter and distributes oil recycling containers and literature through a partnership with a local automotive retailer. Using these collection avenues, local residents recycled approximately 1143 gallons of used motor oil during the fiscal year 1997/98.

- Calabasas recently began offering curbside recycling for green waste and mixed recyclables to local residents. The City also provides: 1) the Environmental Connection Handbook which promotes reducing/reusing/recycling, composting and correct disposal of household hazardous waste, and 2) monthly used oil, paint, batteries, and antifreeze recycling opportunities.

- The City of Agoura Hills offers residents several opportunities to recycle their waste and conserve water. They: 1) conduct a curbside recycling program for paper, metals, and glass (initiated in 1991); 2) conduct a Christmas Tree recycling program each year; 3) initiated yard waste and household hazardous waste collection programs in 1995, and 4) adopted a Water Efficient Landscape/Irrigation ordinance in 1992 to reduce the amount of water being used for landscape/irrigation purposes. The City also began using rubberized asphalt in all overlay programs. During fiscal year 1998/99, the City used over 15,000 recycled tires in the overlay program.

- The City of Thousand Oaks offers weekly curbside pickup of green waste for recycling and bi-weekly pickup for paper, glass and metals.

- State Parks ensures, through its waste hauler contracts, that recycling bins are provided for the public to use when visiting Malibu Creek State Park and Malibu Lagoon State Beach.

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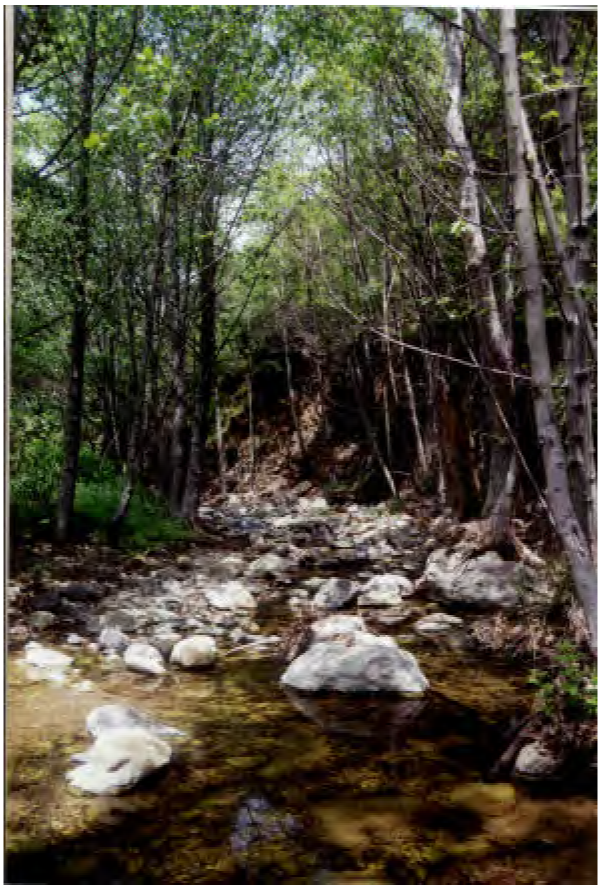
30. ***Public Education - Conservation*. Develop individual support for conservation practices through education, training and workshops which would reduce sediment and storm water runoff from private property.**

Only the activities undertaken by the Las Virgenes Municipal Water District promoting water conservation are addressed here. Other implementor's conservation programs are part of ongoing, wide-scale and multi-issue public education programs and are addressed under Public Education (#42).

The Las Virgenes Municipal Water District conducts a variety of water conservation programs and outreach projects throughout the year, which include:

- Bilingual "Protector del Aqua" classes emphasizing water conservation for local landscape maintenance companies.
- Distribution of educational fliers promoting water conservation to service area residents (in partnership with the Triunfo Sanitation District).
- A comprehensive website (www.lvmwd.dst.ca.us) with easy-to-find water conservation tips and information.
- *The Current Flow*, a quarterly newsletter with periodic information about water conservation and recycling information.
- Participation in local events, such as fairs and farmers markets.
- Classroom presentations and facility tours.
- Water efficiency tours to help residents reduce the amount of water needed for landscape irrigation.

31. ***Runoff Reduction***. **Develop land use decision-making approaches (including land use zoning and ordinances) to reduce point and nonpoint sources of pollution. Specifically, new developments within the watershed should employ on-site reuse of reclaimed water so that there is no net increase of water into the watershed. Develop and implement: 1) guidelines for minimizing and mitigating ecological disturbances related to point and nonpoint water flows into "unimproved" coastal streams; and 2) watershed-wide ordinances which would reduce storm water runoff from private property.**



Riparian corridor in the Malibu Creek Watershed.

In January 2000, the Los Angeles Regional Water Quality Control Board approved strict discharge standards for new developments in all of Los Angeles County. The Regional Board's Executive Officer then issued the new requirements in March, 2000. Specifically, the policy states that all new development projects meeting certain criteria must retain and/or treat the first ¾-inch of rainfall from any storm on-site (i.e., it must not reach the storm drain system). The policy will have a greater impact on newly developing regions than on existing, high density regions. Several cities in the County have appealed this ruling to the State Water Resources Control Board.

The City of Calabasas requires that new developments maintain a certain percentage of pervious surface, depending on what type of construction project is designed. For example, parking lots are required to maintain 30% perviousness. However, in some areas of the City, soils are high in clay content and hence expansive so pervious requirements are challenging. Development projects are thus evaluated on a case-by-case basis. Mitigation measures are required for those sites that do not, or cannot incorporate the pervious surface element into their plans.

The Cities of Agoura Hills and Westlake Village adopted their storm water and urban pollution control ordinances in 1997. As mentioned under Eliminate or Reduce Sources (#4), this ordinance gives Agoura

Hills and Westlake Village legal authority to enforce BMP requirements to reduce point and nonpoint sources of pollution, including site-specific measures for construction projects to minimize ecological disturbances.

The City of Malibu primarily addresses the problem of increased urban runoff from new development through setting limits on impervious surfaces under its zoning ordinance. The criteria for commercial developments includes: 1) devoting 40% of the lot area to landscaping, 2) devoting an additional 25% of the lot area to open space, and 3) limiting the floor area ratio to 15%. The criteria for residential developments includes limiting the use of impermeable surfaces to 30-45% of the total site area. Where downstream flooding and/or erosion is a potential concern, the City also requires developments to provide on-site retention of runoff volumes equal to predevelopment rates.

Recently, the Las Virgenes Municipal Water District, with support from the Metropolitan Water District of Southern California and the US Bureau of Reclamation, installed computerized irrigation controllers on street medians to regulate the amount of water used for irrigation. These controllers were tested against other controllers in the City of Westlake Village. The District also installed advanced plant ETo **J** sensor stations with real-time telemetry which measure the amount of water used by local plants each day. This daily data is linked to the LVMWD website (http://lvmwd.dst.ca.us) and can be accessed by all residents who use irrigation controllers for outdoor irrigation to refine their irrigation schedules. The ultimate goal in providing this data is to reduce: 1) the amount of water needed for irrigation by end users and 2) runoff from street medians. Nearly all large water users such as golf courses, schools, and cities could benefit significantly from the information provided by the ETo **J** sensors. In the coming year, the District will begin to educate the top 20% of its largest users about the sensor data to help them understand its benefits, how to access the data and how to make corresponding changes in their irrigation practices.

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32. ***Recreational Use Impacts.*** **Reconcile demands for public access and resource protection regarding trails and roads.**

There is a need to protect watershed habitats and resources while at the same time allowing these lands to be used for recreational purposes. To better balance these needs, the City of Calabasas outlined a comprehensive Las Virgenes Canyon subwatershed study in 1999 which included: 1) developing a master plan for Las Virgenes creek and 2) outlining issues to be addressed, such as wildlife corridors, potential for recreation and public access, and engineering requirements for flood control. The information collected under this study will be used to develop a priority list of projects to accomplish riparian habitat improvements for both wildlife and residents. The City has submitted three major grant applications to secure enough funds to both initiate the study and to start working on some of the project's components. The SWRCB 205(j) Watershed Planning Grant application received funding to initiate this study; the Federal EPA EMPACT Grant application was initially denied but resubmitted with changes; and the Water and Watersheds Research Grant application was denied.

In addition to installing interpretive signs next to the parking lot at Malibu Creek State Beach, the RCDSMM incorporated a public access trail into its Malibu Lagoon restoration project (highlighted under Restore/Enhance Malibu Lagoon and Surfzone, #20). Visitors can now walk directly to the shores of the lagoon near Pacific Coast Highway via a walk bridge and get an up close look at the lagoon's mud flats, birds and aquatic habitat.

While State Parks provides public access to almost all of its natural resource areas, the agency does limit access in employee housing areas, areas that have been revegetated, nesting areas for sensitive/endangered species and any area considered unsafe.

33. ***Land Purchases***. **Purchase high priority watershed protection areas**.

There are several key parcels of land that, if acquired by a non-profit organization or a state or local government agency, would greatly benefit overall restoration and protection goals throughout the watershed. Although none have yet been purchased, State Parks has identified several of these parcels in an internal report.

One such prominent site in the lower watershed is the golf course area adjacent to Malibu Lagoon (on the north side) and the vacant parcel next to it. This land was once part of the lagoon and has the potential to be restored as additional habitat for native species and birds migrating along the Pacific flyway. Other identified parcels include 160 privately owned, undeveloped acres located just north of the Cold Canyon Road northern loop; the Cross Creek Plaza; Ahmanson Ranch; and land near Lake Sherwood in the Hidden Valley area.

The National Park Service, in partnership with local scientists, planners and resource management professionals developed a set of objective, scientifically credible conservation criteria as a basis for deciding which lands in the Santa Monica Mountains were the highest priority for acquisition and protection. Using geographical information system (GIS) tools, lands high in resource value were identified, gaps in knowledge were identified, and maps identifying significant natural, cultural and recreational areas were produced. Land management agencies are using this data to set priorities for land protection within the Santa Monica Mountains and surrounding areas.

The City of Malibu is investigating the possibility of land acquisition for a constructed wetland in the Civic Center. If acquired, the land would provide for wetland treatment of Malibu Creek's flows and a year-round source of water for the existing seasonal wetland located on the north side of the Civic Center Way (west of Stuart Ranch Rd).

The Malibu Coastal Conservancy, a community-based, non-profit organization whose mission is to facilitate acquisition and restoration of open space and environmentally sensitive lands, has also focused its attention on acquiring the open space considered part of the Malibu Wetlands.

34. ***Buffer Zones*. Develop and mandate site specific buffer zones for sensitive areas.**

Within its park boundaries, State parks has identified areas where buffer zones could be established or improved to protect sensitive areas. One such site is located in Tapia Park. Here, State Parks redesigned the road system to better protect the riparian forest adjacent to Malibu Creek.

The Las Virgenes Municipal Water District, the City of Calabasas and the Santa Monica Mountains Conservancy co-funded ($3,000,000) the purchase of approximately 700 acres of open space adjacent to the District's Rancho Composting facility as a buffer zone against urban encroachment. The City of Calabasas also instituted a development code requiring builders to ensure a 100-ft development setback (or other distance to be determined by a qualified biologist) from watercourses within their jurisdiction.

The City of Agoura Hills has established open space zones for its hillside areas and has adopted County designated "Significant Ecological Area" (SEAs) to help protect local natural resources.

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35. ***Habitat Fragmentation*. Develop and implement land use policy that will eliminate any additional habitat fragmentation. Support existing corridors between isolated open lands and establish alternatives where feasible.**

Together, the National Park Service and State Parks have encouraged and funded habitat linkage studies within Malibu Creek State Park. Through a grant from the National Park Foundation, Canon USA, the Southwest Parks and Monuments Association, California State Parks and the National Park Service, a cooperative research effort was launched in 1996 to address critical concerns associated with carnivores. Because carnivores play a critical role in ecosystem functions and are indicators of ecosystem health, this long-term research will try to determine how urban growth and encroachment impacts carnivore habitat. Components of the study include: 1) radio telemetry to evaluate home range requirements, habitat needs and movement patterns for bobcats, coyotes, badgers and gray foxes, and 2) remote camera surveys to evaluate overall carnivore distribution patterns and to assess population sizes of marked animals. Results of the project will be incorporated into park planning and resource management activities to promote wildlife conservation in the

Santa Monica Mountains. Data on animal movement and critical habitat areas will also be used to guide park planning actions, land protection strategies and habitat restoration efforts.

The City of Calabasas established Open Space Districts through a section of its development code. These districts are intended to prohibit or limit developments in areas: 1) with important environmental resources, 2) with potential hazards, and/or 3) to maintain open space for wildlife habitat.

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36. ***Fish Barriers*. Remove barriers to fish migration, especially Rindge Dam.**

Rindge Dam.

Rindge Dam, which was constructed in 1924, is a 100-ft dam located on Malibu Creek approximately 2.5 miles upstream of Malibu Lagoon. By the late 1950s, the dam had significantly filled with sediment and no longer functioned as intended. The Army Corps of Engineers estimates that 800,000 – 1,600,000 cubic yards of sediment are trapped behind the dam wall today.

Starting in the mid/late 1990s, interest in removing Rindge Dam gained momentum and has since resulted in the formation of the Steelhead Recovery Task Force under the Malibu Creek Watershed Executive Advisory Council. Since its inception, the focus of this task force has expanded from just assessing the feasibility of removing Rindge Dam to addressing all creek barriers prohibiting steelhead trout[24] from reaching valuable upstream spawning grounds. Heal the Bay, through its Stream Team activities, has surveyed 15 miles of Malibu Creek and mapped all barriers to fish passage in the watershed. While Malibu Creek remains the primary focus, several other creeks (Topanga, Solstice and Arroyo Sequit) are also being surveyed and documented for obstructions to steelhead migration.

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[24] Steelhead trout was added to the federal list of endangered species in August, 1998. See Restore/Enhance Malibu Lagoon and Surfzone (#20) for additional information.

Site Statistics	Rindge Dam is located approximately 2.5 miles upstream of Malibu Lagoon. The site selected for construction was the eastern end of a segment of the creek which runs west to east, where the canyon walls narrowed and the geology was most favorable for attaining structural strength and stability.		
Design and Construction	Rindge Dam was constructed in 1924 and the adjacent spillway was completed in 1926. The dam was constructed in a constant arc radius design using Belgian cement and steel railroad rails for reinforcement. Its original purpose was to provide water for irrigation of ranch lands in the Santa Monica Mountains.		
Capacity	The original reservoir capacity of the dam was 574 acre-ft (186 million gallons of water). By about 1956, the capacity had reduced to 50 acre-ft due to increased sediment deposits. By 1965, the reservoir was completely filled with sediment. It is estimated that Rindge Dam now holds approximately 10 million gallons of water within its sediment base.		
Customer Base (No. of Customers,	**Year**	**Commercial Users**	**Irrigation Users**

Steelhead Recovery Task Force efforts led directly to the Army Corps of Engineers (Corps) involvement in assessing the feasibility of the alternatives presented for removing Rindge Dam. In early 1999, the Corps concluded an initial reconnaissance study which determined that there was enough support among watershed stakeholders to move forward with a feasibility study. Among other things, the study also concluded that removal of Rindge Dam and other Malibu Creek barriers would allow steelhead to access an estimated 4630 ft^2 of spawning habitat and 2 linear miles of rearing habitat within the Malibu Creek watershed.

The Corps is now planning a full-scale feasibility study which will assess various removal/mitigation alternatives, associated costs, timelines and federal interest. Potential alternatives include: 1) dam removal, 2) installation of conduits through the dam and reservoir, and 3) construction of a fish ladder.

Despite these efforts, the feasibility of steelhead's survival in the upper watershed has been questioned by some who cite high temperatures, variable creek flows, contaminated discharges and other barriers as detrimental to the survival of the species. Although historical flow data indicates that Malibu Creek was an intermittent stream, several fish biologists looked at recent water quality/quantity data and found that current upper and lower creek conditions would not be detrimental to steelhead trout.

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37. ***Exotic Vegetation***. **Support control of the intrusion of exotic plants into the wilderness areas of the watershed.**

Controlling the spread of exotic vegetation in the watershed is, at best, a daunting task that requires endless effort and resources. More than 20 species have significantly impacted the Malibu Creek watershed and other coastal regions, and their impact is cumulative. Table 2.4 highlights the watershed's most significant non-native plant species. Some plants (grasses) have even changed the soil structure, making it nearly impossible for native species to grow.

Exotic Plant Species Found in the Malibu Creek Watershed

Common Name	**Scientific Name**
Black Mustard	*Brassica nigra*
Castor Bean	*Ricinus Communis*
Eucalyptus	*Eucalyptus sp.*
Euphorbia (false caper)	*Euphorbia terracina*
Giant Reed	*Arundo Donax*
Horehound	*Marubium vulgare*
Harding Grass	*Phalaris aquatica*
Ice Plant	*Carpobrotus edulis*
Italian Thistle	*Carduus pycnocephalus*
Mediterranean Mustard	*Hirschfeldia incana*
Milk Thistle	*Silybum marianum*
Myoporum	*Myoporum laetum*
Pepper Grass	*Lepidium latifolium*
Ripgut	*Bromus diandrus*
Smilo Grass	*Piptatherum miliaceum*
Star Thistle	*Centaurea melitensis*
Sweet Fennel	*Foeniculum vulgare*
Tree of Heaven	*Ailanthus altissima*
White Sweet Clover	*Melilotus albus*
Wild Tree Tobacco	*Nicotiana glauca*
Yellow Star Thistle	*Centaurea solstitialis*

Table 2.4. Exotic plant species found in the Malibu Creek watershed.

One of the most prolific exotic plant species found in lower and upper Malibu Creek Watershed is *Arundo donax* (also known as giant reed). This reed can grow as much as 2.5 inches per day and reach a maximum height of 27 feet. Its growth rate and rapid defense mechanism make it nearly impossibly to eradicate once an area has been invaded. The plant spreads primarily during floods when it is uprooted from upstream locations and transplanted further downstream. *Arundo donax* soaks up huge amounts of water, rapidly replaces native riparian habitats, obstructs wildlife access to waterways and is an extreme fire hazard. Data collected by Heal the Bay's Stream Team shows that there is an enormous amount of *Arundo donax* in Malibu Creek, just below Malibu Creek State Park. Efforts are currently underway to remove it from a 2.5-mile reach of Malibu Creek, between Rindge Dam and Malibu Lagoon. Once removed, native species will be planted as necessary to create a healthy riparian canopy in areas disturbed by this invasive plant.[25]

State Parks, Mountains Restoration Trust and Stream Team volunteers have identified and recorded non-natives throughout the watershed. Stream Team volunteers are even using global positioning system (GPS) devices and field guides which have plant identification keys to identify the

[25] This is a cooperative project between the National Park Service, Santa Monica Mountains National Recreation Area (NPS), California Department of Parks and Recreation, Malibu Creek State Park; and Mountains Restoration Trust.

exact locations of several non-native plants found in riparian zones.

With assistance from the Los Angeles County Fire Department, State Parks has initiated four prescribed burns since 1996 to help control proliferation of milk thistle, an exotic species found on the parklands. They also manually remove, on a regular basis, substantial stands of yellow star thistle, sweet fennel, Arundo, Euphorbia and other exotic plants on the parklands.

Weed Warriors, a volunteer group coordinated by the California Native Plant Society and recruited by word of mouth, has removed invasive exotic vegetation (e.g., castor bean, ice plant, Arundo) from public lands throughout the Santa Monica Mountains since the mid-1980s. Some of their restoration locations include Sycamore Canyon, Cold Creek, Malibu Creek State Park, Lower Malibu Creek and Lagoon, and Bluff Park. The number of volunteers and volunteer hours recruited for restoration activities varies from location to location, but usually ranges somewhere between 1000-2000 hours each year. The frequency of restoration activities ranges from monthly to yearly, depending on the site. However, Weed Warrior's efforts to remove non-native vegetation are significantly boosted immediately after a fire when re-sprouting, non-native plants are small and easy to remove. Heal the Bay has even begun to advertise Weed Warrior event dates in their monthly volunteer newsletter *Sea Stars*. Because Weed Warrior volunteers do not use heavy or powered equipment, they generally choose areas where a native remnant population still exists. This approach increases the success of their efforts because it improves the opportunity for native re-colonization once the exotics are removed.

The City of Malibu reviews all new development plans to ensure that invasive, non-native species are not planted. The City maintains and provides, upon request, a list of prohibited plants to applicants and landscape architects. City personnel also make recommendations on what types of native species to plant. However, the City does not require existing exotics to be removed unless it is required as mitigation for a project, or unless the plants are targeted by the County Fire Department as part of a fuel modification plan to reduce the threat of fire. The City's Environmental Review Board will consider measures to increase the public's awareness about exotic vegetation in their workplan to the City Council in February, 2000.

Most recently, a new sub-committee has been formed under Malibu Creek Executive Advisory Council – the *Invasive Species Task Force*.

Its mission is to identify, assess and initiate removal of invasive species in the watershed.

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38. ***Wetlands*. Maintain, restore, create and enhance wetlands (natural and created).**

The Southern California Coastal Wetlands Inventory, which was established as part of Governor Wilson's *1993 Wetlands Conservation Strategy*, identifies 39 coastal wetlands between the Point Conception and Mexican border. Malibu Lagoon is included in that inventory. The overall goal of the strategy has been to identify regional and statewide wetland restoration and enrichment opportunities. Information for each wetland in the inventory includes: 1) a map of the site's historic perimeter, 2) a map of the site's vegetative communities, and 3) a site profile documenting the wetland's physical and biological characteristics. A comprehensive summary of Malibu Lagoon's inventory information can be found on the internet at http://ceres.ca.gov/wetlands/geo_info/so_cal.html.

Locally, the City of Malibu completed a wetlands delineation for the Civic Center area. Only one site was identified as an existing wetland – a sump area approximately four acres in size which is located north of Civic Center Way and west of Stuart Ranch Road. The City is also considering plans for a constructed wetland/creek paralleling Civic Center Way. The wetland/creek would secure a connection between Malibu Creek and the existing wetland (pond) area to provide: 1) additional biological treatment for dry weather flows and 2) storm water detention in the event of flooding in the Civic Center area.

The Malibu Coastal Land Conservancy helped the City of Malibu secure a $150,000 grant from the Federal Emergency Management Act (FEMA) flood insurance plan to develop a city-wide flood mitigation plan. The plan will: 1) identify areas with repetitive flood damage claims, 2) develop appropriate mitigation measures, and 3) evaluate wetlands restoration as a potential flood mitigation measure in the Civic Center area.

In March 1998, the Las Virgenes Municipal Water District began rehabilitating a percolation pond as a constructed wetland. The pond, once rehabilitated, could be used to polish Tapia's effluent and to treat urban runoff flowing from the upper watershed. However, there is some debate about what the constructed wetland is to be used for during the

Tapia's summer discharge prohibition period each year.

39. ***Coordinate on a Watershed Basis.*** **Create and implement a regional and subwatershed approach to the coordination of land use and water quality decisions for ongoing implementation concerns and to reduce unnecessary overlaps of ordinances and streamline regulations.**

- **Develop guidelines to reconcile the attainment of water quality objectives and resource protection with other, possibly conflicting public service goals, such as fire protection, flood control, and geologic stability.**

  The Resource Conservation District of the Santa Monica Mountains and other members of the Malibu Creek Executive Advisory Council have coordinated with the Los Angeles County Department of Public Works to establish new flood control channel clearing guidelines – guidelines that would preserve the maximum amount of habitat possible while ensuring public safety. As a result, new protocols were established for evaluating the necessary BMPs for each channel clearance site in the Malibu Creek Watershed. The protocols are now being used by FLORA as a model to inventory channel habitats and to develop recommendations for channel clearing in the Los Angeles River watershed.

  LAC-DPW has also improved its BMP practices related to infrastructure construction, maintenance and repair of roads, culverts, bridges, etc. (as called for in the 1996 Municipal Storm Water NPDES permit). These measures help to minimize impacts on local habitats and reduce erosion and sedimentation problems common to these types of activities.

  Please also see responses to Fire Regulation-Erosion Control (#11) and Recreational Use Impacts (#32).

- **Build support for the implementation of the mediation recommendations (research studies, ordinances, joint agreements, etc.) among agency staff and non-agency stakeholders who are working on management plans which affect the watershed – RCD/SCS Natural Resource Plan, SMBRP Comprehensive Conservation Management Plan, LA County NPDES storm water permit, City of Malibu Wastewater Management Plan, General Plans of area cities and the LA County 101 Corridor/Cities Area Plan Update.**

  Several efforts which either build support for, encourage or mandate the implementation of management plan actions/recommendations have been highlighted throughout this report. In summary, these include:

- Formation of the Malibu Creek Executive Advisory Council and its subcommittees;
- The 1996 Municipal Storm Water NPDES permit requirements;
- Local municipal ordinances;
- Public education programs;
- Water quality improvement and habitat restoration pilot projects in the watershed; and
- The availability of Prop A bond funds.

■ **Establish mechanisms, including joint powers authorities (JPAs), watershed commissions, special districts or other cooperative efforts for the integration of efforts aimed at coordinating, planning, and/or implementation where multi, general-purpose jurisdictions exist.**

The Cities of Agoura Hills, Westlake Village, Malibu, Calabasas and Thousand Oaks formed a joint powers authority (JPA) called the Council of Governments (COG). The JPA's governing board consists of one representative from each city and one ex-officio member representing the County of Los Angeles. The governing board then established a technical advisory committee (TAC) to review and make recommendations to the board as necessary. The COG meets monthly to review the TACs recommendations and to set priorities for the watershed as a whole. The formation of the COG has had several beneficial results, including:

- Creation of an operating budget to leverage city funds.
- Increased representation on regional committees in organizations such as the Southern California Association of Governments (SCAG) and the Metropolitan Transportation Authority (MTA).
- Adoption of priorities for the sub-region (transportation, open space preservation, watershed management, pollution reduction and public education).
- Securing funds totaling over $150,000 to study and set regional priorities.
- Promoting legislation that would provide incentives for property owners to donate land for open space.

■ **Develop and field test interactive models to facilitate systems-based watershed planning and management decisions.**

This action has not occurred. The National Park Service has been identified as the oversight agency, but there is no formal lead.

■ **Identify and create appropriate financing options which work and are**

cost effective, including joint financing options so duplication is avoided.

Although no formal source of funding has been established or identified to coordinate watershed planning efforts, agency stakeholders have been quite successful in securing funds to conduct many of the actions called for in the various watershed plans. Table 1.3, starting on page 12 in **Section One: Overview**, summarizes many of the watershed's major restoration projects and studies.

The Joint Powers Authority mentioned above could also be a mechanism for joint financing of watershed projects.

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40. ***Enforcement - General*****. Develop effective means to enforce pollutant reduction programs.**

Local ordinances, developed by watershed cities under the 1996 Municipal Storm Water NPDES permit, have proved to be a creative mechanism for establishing and enforcing local pollution prohibitions. For example, local ordinances now call for developers to implement appropriate, site specific BMPs regardless of the size of their construction site; restaurants must not allow food waste to reach the storm drain system, mobile car washers must comply with wastewater discharge restrictions. Cities are also required to conduct "educational site visits" for businesses regulated under the Storm Water NPDES permit program. Although these visits are not used to enforce pollution reduction programs, city personnel use the opportunity to help businesses understand the rules and regulations governing polluted discharges.

Enforcement of the cities' storm water ordinance prohibitions is primarily passive in nature. Most city personnel do not "patrol" the streets looking for violators, but rather rely on calls/complaints to 1-888-CLEAN LA or to the city directly, or through "seeing" the violation take place. Calabasas also uses the sheriff's department to identify violators, and Thousand Oaks routinely inspects restaurants, automotive repair facilities and constructions sites for compliance. Once violations are discovered, specific steps are taken to resolve them. The City of Westlake Village, for example, employs verbal, written and even prosecution measures to enforce pollution control measures. Enforcement activities do occur through city inspector programs for some industrial/commercial and construction sites, but this is not the case for every facility due to the educational site visits mentioned above.

The City of Malibu and the Los Angeles County Department of Health Services conduct enforcement activities relating to illicit connections and malfunctioning septic systems in the Malibu Creek watershed. However, they are unable to provide staff to conduct these activities on a regular basis and thus rely on tips and complaints from the public to help identify and respond to such problems. Malibu has implemented a 24-hour Emergency Response Program in partnership with the County Sheriff and Fire Departments for septic spills and overflows. The City and the County Sheriff, Fire, and Health Departments are also notified to respond to 911 calls made by the public reporting any spills. In the event of a spill, both the City and County Fire Department are equipped to prevent spills from entering storm drains and take further action as needed. Code enforcement actions follow where necessary.

The Los Angeles County Department of Health Services approves the design aspect of septic systems but does not inspect them or regulate their maintenance and upkeep. Septic system installation permits are issued by LAC-DPW's Building and Safety division as part of an overall building permit of a site. Once installed, the Heath Services department only addresses septic system problems where public health is threatened and, like the City of Malibu, relies on complaints and tips to take enforcement action against violators.

In its report, "*Omission Accomplished: The Lack of a Regional Water Board Enforcement Program, 1992-1997*," Heal the Bay strongly criticized the Regional Board's enforcement activities relating to: 1) sewage, oil and hazardous substance spills; 2) industrial storm water violations; 3) illicit connections and poorly maintained or failing septic systems; and 4) NPDES and WDR permit violations. Since the *Omission Accomplished* report was released in 1998, the Regional Board's enforcement activities have significantly increased as has its budget to conduct these activities. A complete summary of the LARWQCB's enforcement activities are documented in quarterly reports which are available to the public.

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41. ***Enforcement - Camping*. Enforce existing camping restrictions within the watershed.**

When necessary, State Parks removes transient encampments from state park property. They also patrol parklands for illegal campsites on a regular basis and take appropriate action when such sites are encountered.

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42. ***Public Education*. Emphasize and encourage ongoing public education.**

- **Create a nonpoint source pollution education program for watershed occupants.**
- **Develop a *Adopt-A-Watershed* program that is watershed-wide.**
- **Implement effective education programs about the need for urban and non-urban preservation of open space and buffer zones.**

Educational Websites

www.ci.thousand-oaks.ca.us
www.ci.calabasas.ca.us
www.ci.malibu.ca.us
www.ci.agoura-hills.ca.us
www.co.la.ca.us
www.healthebay.org
www.laaudubon.org
www.lvmwd.dst.ca.us
www.ocd.ucla.edu
www.smbay.org
www.surfrider/SFMalibu/

Several watershed-based public education programs were addressed under Composting/Recycling/Conservation (#29) and Public Education: Conservation (#30). In addition to those outreach activities, many more are highlighted here.

- For more than 14 years, the RCDSMM has conducted field-based, year-round Marine Science Programs for students at Malibu Lagoon and Malibu Creek State Park. These programs are active, hands-on and participatory, emphasizing estuarine ecology, water quality and watershed dynamics. The programs further stress the problems caused by urbanization on wildlands, and provide solutions and watershed protection activities that students can incorporate into their daily lives.

The RCDSMM also produced the *Stable and Horse Management BMP Manual* for use by local horse owners and commercial stables (discussed previously under #18, Confined Animals). Complimenting this particular effort, Quint Cities[26] worked with the RCDSMM to create a companion handout entitled *Best Management Practices for Stable and Horse Management*. Both are available to horse owners and commercial stable facilities in the Malibu Creek watershed.

- State Parks gives lectures to teachers in the Los Angeles Unified School District on the values of and need to preserve open space. They have also incorporated open space and watershed protection themes into State Park nature walks, school presentations and campfire programs.

[26] Quint Cities is a consortium of Malibu Creek watershed cities which includes Malibu, Agoura Hills, Westlake Village, Thousand Oaks and Calabasas.

- The City of Agoura Hills has actively targeted local residents since 1993 with educational information on conservation, sediment reduction and nonpoint source pollution prevention. Their endeavors include: 1) sponsoring local advertising campaigns; 2) distributing fliers at community events and at City Hall; 3) sending mailers to local schools; 4) writing about conservation practices in the City newsletter (circulated to 8,000 residents); 5) contracting with the Department of Health Services to educate restaurant employees about BMPs; and 6) conducting educational industrial/commercial site visits. The City also created an Open Space Task Force in 1998 which subsequently developed the *Open Space Preservation Plan* (released Fall, 1999).

- The City of Calabasas has implemented several educational programs addressing open space and buffer zone preservation which are supported by City Council members and CTV (a local cable access channel which serves as a source of environmental information). The City promotes: 1) the availability of biking trails via regional biking fliers; 2) the use of the City's parks through quarterly distribution of recreation booklets; and 3) the use of native, low water use plants (providing technical assistance on plant selection).

  While the *Open Space/Buffer Zone Preservation* concept has City support, there are no specific guidelines for private property owners to follow and actual implementation of this concept is primarily left to the developer's discretion. However, the Transportation Department is in the process of developing a master plan for trails in the city which will require most large developments to dedicate portions of their property to open space, and the City does prohibit new development activities within 100 yards of creeks and streambanks.

  Although the process has been slow, Calabasas also initiated an *Adopt-A-Creek* program to raise awareness about local riparian habitats. As envisioned, the program will be structured to accommodate various levels of public interest, from people who just want to clean up trash to people who want to restore a creek bank on their property or who want to help monitor the health of stream habitats.

- The City of Malibu has plans to implement a pollution prevention advertising campaign using the City's local cable TV channel, starting in November, 1999. The 30-second public service announcements will address how to prevent pollutants from reaching and entering the storm drain system, ultimately polluting local streams and the ocean.

- The City of Thousand Oaks circulates a monthly newsletter, *On the City Scene*, to its residents which highlights a local recycling hotline number, composting and disposal opportunities, hazardous waste collection services, etc. Residents are also encouraged to visit the city's website for up-to-date information on city events.

- In 1995, the County of Los Angeles Department of Public Works initiated a Five-year Storm Water Urban Runoff educational program, targeting residents throughout the entire County. The campaign provided information about various types of nonpoint source pollution such as used motor oil, pet waste, pesticides and herbicides, etc. All cities in Los Angeles County have been invited to join this effort and nearly all have accepted that offer, including the four Los Angeles County cities in the Malibu Creek watershed. Complimenting this five year campaign and building on its own efforts, LAC-DPW also launched the *Storm Water Urban Runoff* campaign and the *Used Oil Recycling* media campaign in 1999.

- Several of the Las Virgenes Municipal Water District's Malibu Creek watershed education programs are highlighted under Composting, Recycling, Conservation (#29) and Public Education – Conservation (#30). Additionally, the District has conducted educational outreach about sensible irrigation practices and the values of landscaping with native species. For example:

  - *Demonstration Gardens* were planted at District Headquarters, along Las Virgenes Road and in Gates Canyon Park. The gardens demonstrate the use of both native and non-native low water use plants.

  - Soil moisture sensors were installed at Gates Canyon Park and Grape Arbor Park in the City of Calabasas.

  - Landscaping software was developed in 1995 and is now routinely distributed by the District. It was also provided to local cities for their building permit plan checks. The software advocates for the landscape ordinance by helping residents understand the water needs for various types of plants and encouraging them to use drought-resistant, native species when landscaping their property.

- Irrigation technical training is intermittently provided (in partnership with local cities) which addresses: 1) basic irrigation principles, 2) irrigation system adjustment, repair and trouble shooting, 3) basic and advanced controller programming and 4) irrigation scheduling.

- Heal the Bay has offered its *Speakers Bureau* program since 1989. This program, comprised of specially trained volunteers, educates local communities and businesses, school children, special interest groups and other interested parties about storm water pollution issues and how each person can make a difference. Heal the Bay's speakers are available upon request and reach out to 25,000 people in Southern California annually.

  In 1998, Heal the Bay launched the *Stream Team* program (mentioned several times throughout this report), which trains and educates volunteers about specific water quality and environmental health issues in the Malibu Creek watershed. Already, The program has trained over 75 volunteers to help measure water quality and to conduct surveys on pollution sources and degraded habitats throughout the watershed. Heal the Bay also participates in the Eco-Heros program. The program has educated over 360 students about the effects of nutrients, sediments, urban runoff, and other water quality impacts to Malibu Creek and its tributaries.

Businesses are also being targeted with educational outreach by a variety of agencies. For example:

- LAC-DPW visits industrial and commercial establishments to educate owners and employees about implementation of on-site best management practices.
- The Los Angeles County Department of Health Service conducts a mandatory training program for restaurants about implementation of storm water BMPs and making modifications to activities known to contaminate urban runoff.

- Through the SMBRP's Public Involvement and Education (PIE) Fund, Quint Cities produced five pollution prevention brochures targeting: 1) painting contractors, 2) landscape and pool maintenance personnel, 3) contractors and site supervisors, 4) horse owners and 5) residents and homeowners. These brochures are available at the permitting counters in each city.

43. ***Watershed Monitoring***. **Develop and implement a coordinated and integrated watershed monitoring program.**

- **Create a centralized database of water quality and resource data accessible to all parties.**
- **Develop a coordinated GIS database network, including a detailed land use map with all septic systems and storm drains, which is accessible to all parties.**

Although no centralized database has yet been created to house water quality and resource data, data collected by various agencies and studies is made available to all interested parties upon request. Many of these watershed monitoring efforts undertaken by watershed stakeholders have been highlighted throughout this report, including:

- Table 1.3, Watershed Restoration Studies/Projects (pgs. 12-15);
- Biological Standards (#5);
- Monitor Pathogens (#6);
- Study Nutrients (#8);
- Temperature (#12);
- Assess Sources/Characteristics (#21);
- Septic Systems (#23); and
- Irrigation Runoff Reduction (#31).

Other specific efforts are summarized here.

- In April 1999, the Monitoring and Modeling sub-committee (formed under the Executive Advisory Council) completed a draft plan calling for a coordinated watershed-wide monitoring program. Its recommendations include adding supplemental monitoring efforts to better establish a comprehensive survey of the state of the Malibu Creek Watershed. Implementation of this action is dependent on the availability of funds to carry it out.

- Through an agreement with two non-profit groups, the Natural Resource Defense Council and Environment Now, the Las Virgenes Municipal Water District contracted with UCLA to conduct a study entitled "*Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek*." During the study, monitoring was conducted over a two year period from 1993-1995 and the data was analyzed to assess the effects of Tapia's effluent on Malibu Creek and Lagoon. Coincidentally, the study occurred both during one of the biggest fires in history and during an extremely wet year.

The report, released in 1995 and containing more than 100 pages of data, found no conclusive evidence of direct impact of Tapia's effluent on Malibu Creek, Lagoon and local habitats.

- As mentioned under Public Education (#42), Heal the Bay launched a Malibu Creek watershed volunteer monitoring program called *Stream Team* and completed their first water quality training program September, 1998. Participants in the program now sample water at 7 fixed stations throughout the watershed on a monthly basis. Two of these sites, which are minimally impacted by upstream activities, have been designated "reference sites." Another two sites overlap with the RCDSMM/City of Calabasas monitoring sites to assure the quality of data being collected. The monitoring locations are recorded using GPS devices, and the data collected is then organized using GIS capabilities. Observations and data collected include: 1) location of discharge points and outfalls, 2) presence of unstable bank conditions, 3) evidence of artificial streambank modifications, 4) impacting land uses, 5) presence of exotic/invasive vegetation, 6) possible barriers to fish migration, and 7) evidence of illegal dumping. A 150-page illustrated field guide was also developed for Heal the Bay's Stream Team activities by graduate students from the Cal State Pomona Landscape Architecture program. The guide includes step-by-step procedures for water quality monitoring.

  Heal the Bay recently started Phase 2 of this volunteer program, which includes: 1) volunteer training to continue monitoring efforts for years to come, 2) professional assessment of benthic macroinvertebrates (conducted by the CA Department of Fish and Game), and 3) the addition of enterococcus to the list of water quality parameters currently measured. Heal the Bay plans to make Stream Team data available on their website.

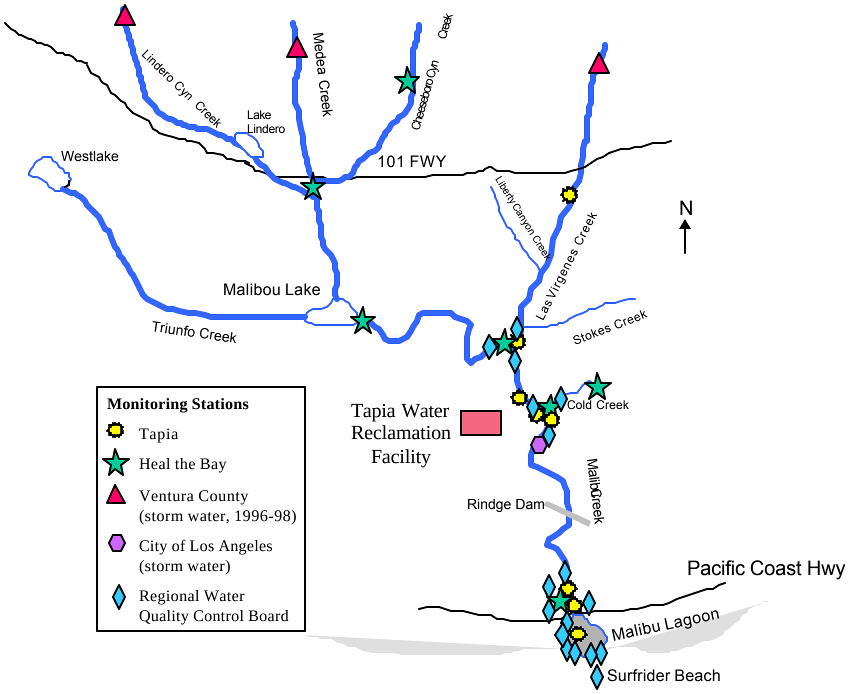

Figure 4. Current monitoring stations in the Malibu Creek watershed.

Heal the Bay has also started creation of a database for monitoring data taken in the Malibu Creek watershed (see Figure 4) and is using GPS to accurately locate other agency/monitoring group and rain gauge stations. To date, the monitoring sites for Calabasas, RCDSMM and the LVMWD have been logged. Ultimately, Heal the Bay plans to become a clearinghouse for all of the monitoring data collected.

Other monitoring data available to the public include: 1) water quality, biological monitoring and surveys of Malibu Lagoon, conducted by RCDSMM (see Assess Sources/Characteristics, #20); 2) volunteer monitoring in the upper watershed, sponsored by the City of Calabasas; and 3) coliform bacteria monitoring in the surf zone, conducted by the Malibu Chapter of Surfrider.

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44. ***Watershed Assessment*. Identify, by subwatershed area, sources of harmful pathogens, toxic chemicals, sediments and nutrients.**

- **Expand an understanding of the hydrology of the watershed and nearshore bathymetry. Agree on needed research on what appropriate and attainable seasonable flows should be for Malibu Creek, Lagoon and nearshore areas.**

At the request of the National Marine Fisheries Service (NMFS), LVMWD conducted a study in 1998 to determine the minimum creek flow needed to sustain steelhead trout populations. Using their own outdoor water audit method and plant types/water needs information collected from the National Park Service and UCLA, the District concluded that a minimum flow (in dry years in late October) of 2-4 cubic feet per second (cfs) recorded at the County gauge station was necessary to ensure at least 1 cfs of flow below Rindge Dam (one cfs is the flow criteria established by NMFS to sustain steelhead trout).

- **Identify and apply suitable models to help target and prioritize pollution prevention, reduction and abatement measures.**

  This action, a fundamental component of several other actions, is summarized in Protect Beneficial Uses (#1), Assess Sources/Characteristics (#21), Runoff Reduction (#31), Habitat Fragmentation (#35), Coordinate on a Watershed Basis (#39) and Monitoring Efforts (#43).

- **Raise funding for and implement study on the health effects of urban runoff on surfers, incorporating Surfrider Beach into the design.**

  In 1995, the Santa Monica Bay Restoration Project conducted an epidemiological study ("Epi Study") to assess the health effects of those who swim directly in front of flowing storm drains. Malibu's Surfrider Beach was one of three locations used in this study. Results of the study showed, conclusively, that there is a significant increase of occurrence in illnesses among those swimming within 100 feet of flowing storm drains. A complete summary of this study is provided under Public Notices (#25).

  Some watershed stakeholders would like to see another epi study conducted that specifically assesses the health-related impacts of surfers using Surfrider Beach. However, the Human Health subcommittee reviewed this possibility with Dr. Charles Gerba (University of Arizona) and concluded that: 1) there were not enough users that could be interviewed in one season to give the study statistical validity, and 2) it's also not clear who would serve as the "control" group for such a study.

- **Establish a Total Maximum Daily Load (TMDL) model for all inputs to the watershed.**

  The Regional Board has been charged with determining how much of a pollutant can be assimilated into a water body without impairing its health and function, i.e., establishing a TMDL. This process, although required in the Clean Water Act for more than a decade, has only just begun. The Regional Board has established a TMDL unit to set discharge limits for pollutants throughout Los Angeles County. In the Malibu Creek watershed, TMDLs are to be developed for nutrients and pathogens/coliform by March, 2002.

- **Develop a research agenda to expand understanding about impacts of land use practices in the watershed.**

  The LVMWD hopes to coordinate its GIS use with data collected from Heal the Bay and others to better understand land use impacts in the watershed. One such application would be to overlay stream location data with district water use data and storm drain locations to better determine where runoff control and treatment efforts would have the greatest impact.

PROGRESS AT A GLANCE

Malibu Creek Watershed Action Plan

MINIMAL	MODERATE	SUBSTANTIAL
WATER QUALITY		**POLICY AND RESEARCH (B-/C+)** **IMPLEMENTATION (D)**
	POLICY AND RESEARCH	
	(1) Develop and set water quality objectives (5) Establish biological (habitat) standards* (8) Determine nutrient standards (21) Assess lagoon characteristics* (27) Landfill impacts on water quality (44) Watershed assessment	(6) Monitor pathogens
	IMPLEMENTATION	
(7) Reduce pathogens (9) Reduce nutrients (23) Manage septic system discharges (40) Enforce Pollution Reduction Programs	(4) Eliminate sources of pathogens, toxic chemicals, sediments and nutrients (10) Reduce accelerated sedimentation* (13) Storm drain stenciling and other BMPs (14) Regulate mobile car washes (15) Eliminate illegal drains (17) Control trash on parklands* (18) Implement confined animal BMPs*	
REDUCING EXCESS FLOWS (WATER QUANTITY)		**(D)**
(19) Household irrigation runoff survey (31) Runoff reduction measures	(28) Maximize use of reclaimed (recycled) water	
MANAGING SOLID WASTE		**(B-)**
	(17) Control trash on parklands* (18) Implement confined animal BMPs*	(29) Implement composting, recycling and conservation measures*
LAND USE		**(C-)**
(34) Create/maintain buffer zones for sensitive areas*	(10) Reduce accelerated sedimentation* (18) Implement confined animal BMPs* (32) Public access and resource protection* (35) Habitat fragmentation* (41) Enforce camping restrictions	(11) Fire regulation and erosion control*
HABITAT RESTORATION AND PROTECTION		**(D-)**
(5) Establish biological (habitat) standards* (12) Establish water temperature policies (24) Regulate lagoon water levels (32) Public access and resource protection* (33) Purchase high priority land areas (34) Buffer zones for sensitive areas* (36) Remove barriers to fish migration (37) Control exotic vegetation in wilderness (38) Maintain, restore and create wetlands	(10) Reduce accelerated sedimentation* (20) Restore Malibu Lagoon (21) Assess lagoon characteristics* (35) Habitat fragmentation*	(11) Fire regulation and erosion control* (26) Mitigate impacts of PCH Bridge reconstruction on Malibu Lagoon
COORDINATION AND OUTREACH		**(A-)**
	(18) Implement confined animal BMPs* (30) Promote water conservation (43) Develop and implement coordinated monitoring program	(25) Post public notices (29) Implement composting, recycling and conservation measures* (39) Coordination efforts (42) Public education programs

SECTON III: KEY FINDINGS

Over the past decade, an enormous amount of energy has been invested into making restoration of the Malibu Creek watershed a reality. These efforts have ranged from establishing an Executive Advisory Council and contributing countless hours for stakeholder meetings to creating a set of restoration priority actions and implementing them. And, while not all of the 44 actions identified in this report have been fully, or even partially implemented, there has been a measure of progress towards achieving their stated objectives. Table 3.1 highlights ten of the most significant accomplishments towards watershed restoration. This list represents the efforts of the entire stakeholder group through its partnerships, review committees, creative funding sources, technical support and hands-on restoration activities.

Section III summarizes the key findings of **Section II: Action Plan Update**. More specifically, it evaluates progress made to achieve the goals of the Malibu Creek Watershed Plan in relation to the key issues of concern in this watershed, i.e., water quality and quantity, solid waste, land use practices, habitats and coordination/outreach efforts. The preceding page provides a snapshot of the results of this assessment, i.e., how well the Plan's 44 actions have been implemented and whether they have made minimal, moderate or substantial progress.[27] Because some actions address multiple issues, they are assessed in each section of relevance. For example, implementing confined animal BMPs affects water quality, solid waste disposal and land use issues, hence a separate summary has been provided in each of these sections.

The reader should keep in mind that as this report is being written, new programs are beginning which

"TOP TEN"
Watershed Restoration Accomplishments

1. Formation and collaboration of the Malibu Creek Watershed Executive Advisory Council, and development of the Action Plan for Restoration.
2. Successful reintroduction of the tidewater goby, a federally listed endangered species, back into Malibu Lagoon.
3. Implementation of the Volunteer Water Quality Monitoring Program.
4. Implementation of the Santa Monica Bay Epidemiological Study linking swimmer illness with poor water quality near flowing storm drains.
5. Completion of the *Lower Malibu Creek and Barrier Lagoon System Resource Management* report addressing the hydrological dynamics of the lower watershed.
6. Restoration of aquatic habitat, mudflat habitat and high flow storm refuge for the tidewater goby in Malibu Lagoon which includes excavation of over 2,200 cubic yards of old fill material. Post-project monitoring of fishes, water quality and invertebrates.
7. Streambank restoration along a 200-foot section of Las Virgenes Creek using bio-technical erosion control techniques.
8. Installation of a storm drain disinfection facility to treat contaminated flows from the Mystery Drain into Malibu Lagoon.

Table 3.2. "Top Ten" watershed restoration accomplishments.

[27] Based on the information provided in Section Two: Action Plan Update, each action was evaluated by members of the Malibu Creek Executive Advisory Council on a scale of one to five according to how well it has met its intended goal(s). The scores submitted for each action were combined, the average taken and the results correlated to a rating of minimal, moderate or substantial progress (similar to a grade point average).

address some of the issues that have made no progress and/or have received very little attention before this time. For example: 1) the Santa Monica Bay Restoration Project has convened a Septics Management Task Force to develop recommendations for septic system placement, management, monitoring and replacement frequency and 2) the Lower Malibu Creek and Lagoon Task Force is addressing the feasibility of a constructed wetland in the Malibu Civic Center area. Although mentioned, these new efforts are not being evaluated in terms of their contribution towards successful implementation of the plan's 44 action items.

Note: For your reference, the numbers located next to each of the following summaries in this section correspond to the same actions discussed in **Section II: Action Plan Update**.

Goal: Improve Water Quality to Protect Beneficial Uses

Eighteen of the Malibu Creek Watershed Plan's actions address water quality issues, accounting for more than 40% of the Plan's total number of actions. Improving water quality key to the overall success of watershed restoration and protection efforts. For review purposes, these eighteen actions have been divided into two major categories – *Policy & Research* and *Implementation*. The actions in the first category, Policy & Research, have achieved moderate success over the last five years as many studies and coordinated assessment efforts have been conducted to improve our understanding of the state of water quality in the watershed. On the other hand, implementation efforts designed to improve water quality have lagged significantly since the Plan was adopted in 1994. Below is an in-depth assessment of both how much and how little has been done towards understanding and improving water quality in the Malibu Creek watershed.

WATER QUALITY:
POLICY and RESEARCH

Substantial Progress

Monitor Pathogens

Moderate Progress

Develop and Set Water Quality Objectives
Establish Minimum Biological Standards
Determine Nutrient Standards
Assess Lagoon Characteristics
Landfill Impacts on Water Quality
Watershed Assessment

Policy & Research Activities

Seven of this section's 18 actions address *Policy and Research* needs in the Malibu Creek watershed. Overall, they have achieved moderate success, with a one notable highlight. A summary of their relative success is provided here.

Substantial Progress

Monitor for Pathogens and Bacteria (#6)

The most significant progress made in addressing key water quality impairments in the Malibu Creek watershed has been in monitoring for bacteria and pathogens. Monitoring for indicator bacteria (i.e., total and fecal coliform) helps to determine whether human pathogens are present Malibu's local waterways and if the waters pose any health risks. Such monitoring has been conducted in the Malibu Creek watershed on a regular basis by several agencies and organizations for more than a decade, and includes data from samples taken during both the wet and dry seasons. Additionally, two separate studies have been conducted in the past seven years in Malibu Creek to directly test for pathogens. Because this type of testing is prohibitively expensive, it has not been conducted on a more regular basis.

Our understanding of the location and amount of bacteria and pathogens present in the watershed has significantly increased due to these studies and monitoring efforts. Collectively, the data gathered conclusively shows that bacteria (and mostly likely pathogens) have been and continue to be a significant water quality problem throughout the watershed. While the data is exhaustive in highlighting the extent of the bacteria/pathogen problem, unfortunately, it does not always pinpoint the source(s) of contamination and their relative contribution(s). The next step towards decreasing pathogen loads is to identify these sources and systematically prevent them from reaching local waterways.

Moderate Progress

Six actions under *Water Quality: Policy and Research* have been implemented with moderate success. These include:

- Develop and set water quality objectives to protect beneficial uses;
- Establish biological (habitat) standards for native species;
- Determine nutrient standards;
- Assess Malibu Lagoon's characteristics;
- Assess the impacts of landfill operations on water quality; and
- Conduct watershed assessment.

Develop and Set Water Quality Objectives to Protect Beneficial Uses (#1)

The Regional Board is charged with the task of developing and setting water quality objectives for waterbodies in the Malibu Creek Watershed, and they have experienced relative success in areas such as: 1) establishing discharge limits for point sources through the permitting process, 2) adopting the 1996 Storm Water Municipal NPDES Permit, and 3) creating a TMDL unit to begin establishing additional water quality objectives for impaired water bodies in the region. However, limits have not been established for non-point source discharges (storm drains, rainfall runoff, landscape irrigation, etc). To control pollutants generated from non-point sources, the Regional Board has created a TMDL unit which is currently in the process of establishing discharge limits for the watershed's primary pollutants of concern – pathogens and nutrients. However, this process is slow. Limits are not expected to be set for pathogens and nutrients until 2001 and not at all for other pollutants such as oil and grease, trash and debris, and heavy metals. Despite the significant limitations placed on Tapia treatment plant discharges, other sources of pathogens and nutrients still adversely impact the beneficial uses of the watershed's receiving waters.

Establish Minimum Biological (Habitat) Standards (#5)

Several habitat restoration activities, such as establishing mud flats in Malibu Lagoon, determining minimum flows to support steelhead populations, and removing exotic species, have resulted in some progress towards improving habitat to support native species. However, establishing water quality objectives based on biological standards has not been as successful. As the Coastal Conservancy/UCLA report states, "while there is much water quality data available, there is little information available about the tolerances of most of the target species to the physical condition of concern." Setting water quality standards is a difficult task without appropriate background information. To come up with sound water quality objectives which take into concern local species needs, their tolerances must be known. Then, where competing needs exist, they should be prioritized for protection, and a balance maintained that supports the most native species possible. More information is needed on the tolerances of native species before this action can be fully implemented.

Determine Nutrient Standards (#7)

Our understanding about the amount of and impacts resulting from nutrient loadings in the watershed is also quite comprehensive, due mostly to the long-term research data collected by several key agencies. Although monitoring efforts have provided a clear picture of the extent of the problem, there is much debate over how to control nutrient loadings, and what discharge limits would be most appropriate given various watershed dynamics such as canopy cover, stream velocity, still pools, water temperatures, etc.

Recently, the Regional Board's TMDL unit has begun to assess the nutrient data available and are in the process of establishing limits for nutrients in the Malibu Creek. Efforts to control/reduce nutrients are discussed under *Water Quality: Implementation*, below.

Assess Malibu Lagoon Characteristics (#21)

A portion of this action has been quite successfully accomplished but some additional steps need to be taken to complete the action as a whole. The Coastal Conservancy/ UCLA study, along with other long term monitoring efforts, provides a quite comprehensive picture of the hydrology, circulation, and biota of the lower creek and lagoon, as well as management recommendations on how to improve/protect the area. Next steps include identifying all the potential and existing sources of pollution/contamination and then developing a remediation strategy to improve the lagoon and surfzone's water quality based on these sources. The Lower Malibu Creek and Lagoon Task Force is currently in the process of ranking the UCLA study's management recommendations and will soon release an action plan of priorities based on the report's recommendations. Completion of the CSCC/UCLA study represents a significant step towards assessing Malibu Lagoon's characteristics.

Assess Impacts of Landfill Operations on Water Quality (#27)
The County Sanitation District of Los Angeles County is the primary agency responsible for landfill operations. Measures to mitigate the impacts of landfill operations (e.g., research, land acquisition, native plant restoration) were approved and adopted in 1998 and are currently being implemented and/or planned for the near future (see page 51). For example, the results of an on-going groundwater monitoring study of the land directly below and surrounding the landfill will direct upcoming restoration and watershed protection efforts. While still too early to assess the benefits all of these measures will have on water quality, those already being implemented represent progress in the right direction.

Conduct Watershed Assessment (#44)
This action contains four subsets which address sources of pathogens, toxic chemicals, sediments and nutrients. As a group, they have been given a moderate rating, although individually some have been very successful, while others have not.

- The first sub-action, which calls for determining adequate seasonal flows for Malibu Creek, Lagoon and nearshore areas, has achieved minimal success. Only one study has been conducted to correlate minimum creek flow requirements with habitat needs (steelhead trout). Although Tapia no longer discharges flows during the dry season, discharge of imported water upstream and higher groundwater tables have permanently altered the creek's flow regime, which is now perennial rather than intermittent or seasonal. How best to address this issue is a daunting task because it requires the resolution of some related controversies (e.g., year-round diversion of Tapia effluent, diverting urban runoff, minimizing import water demands, retaining runoff on-site).

- The second sub-action calls for conducting a study on the health effects of urban runoff on surfers and swimmers. The SMBRP Epidemiological Study, conducted in 1995, did exactly this and was completed with great success. The results of the study showed conclusively the link between contaminated urban runoff and swimmer illness. Based on these results, several measures were taken to inform the public about health risks and to provide alternatives about where and when to swim in the Bay. The results of the study have also been referenced in developing bathing standards at both the state and federal levels.

- The third action, which calls for establishing TMDLs for all inputs into the watershed, has been only marginally implemented. Although the Regional Board has established a TMDL unit, limits for the watershed's pollutants of concern (nutrients and pathogens) will not be established until March of 2002. Furthermore, the Regional Board has no immediate plans to undertake additional TMDLs for the Malibu Creek Watershed for constituents such as heavy metals, trash and debris and other contaminants associated with urban runoff.

  Establishing TMDL limits for impaired water bodies is designed to help improve water quality over the long run, however, the effects of this process will not be immediately evident. Once TMDLs for nutrients and pathogens are established, it will take additional time to change and/or improve how permits are issued to implement appropriate control measures.

- The last action, which calls for developing a research agenda to expand understanding about the impacts of land use practices in the watershed, has made no significant progress. Several agencies have stated their desire to use GIS applications towards understanding land use impacts, but funds and staff time to implement this action have not been forthcoming. Watershed cities are addressing development issues through their municipal master plans, but these efforts are not comprehensive and do not consider the watershed as a whole. The formation of the regional Council of Governments may help bring the need for true watershed planning to the attention of those responsible for the development activities occurring in each city.

Water Quality – Policy and Research Grade: **B-/C+**

Water Quality - Implementation

Eleven water quality actions are considered as "on-the-ground" implementation efforts. Collectively, their success has been somewhat limited, as the call-out box on the next page shows. It is interesting to note that no actions in this section have been rated as substantial. An assessment of their relative success is provided here.

Moderate Progress

Seven of this section's 11 actions have achieved moderate success. These include:

WATER QUALITY: IMPLEMENTATION

Moderate Progress

Eliminate Sources of Pathogens, Toxic Chemicals, Sediments & Nutrients
Reduce Accelerated Sedimentation
Stenciling and Other Storm Drain BMPs
Regulate Mobile Car Wash Discharges
Eliminate Illegal Drains
Control Trash on Parklands
Implement Confined Animal BMPs

Minimal Progress

Reduce Pathogens
Reduce Nutrients
Manage Septic System Discharges
Enforce Pollution Reduction Programs

- Eliminate or reducing sources of harmful pathogens, toxic chemicals, sediments and nutrients;
- Reduce accelerated sedimentation;
- Implement stenciling and other storm drain BMPs;
- Regulate mobile car wash discharges;
- Eliminate illegal drains;
- Control trash on parklands; and
- Implement confined animal BMPs.

Eliminate Sources of Harmful Pathogens, Toxic Chemicals, Sediments and Nutrients (#4)

Passage of the 1996 Municipal Storm Water NPDES permit is key to the progress achieved in implementing this action. It represents the first critical step in implementing this action successfully. The permit not only requires cities to address sources of contaminated runoff, it also requires that they secure the authority to enforce such control measures. Municipal ordinances have now been adopted by every city covered under the storm water permit which stipulate storm drain discharge prohibitions.

However, enforcement actions taken to control contaminated discharges have not been significant since the ordinances were adopted. Cities, lacking personnel and funding to effectively enforce discharge prohibitions, rely on citizen complaints, site visits and educational programs to carry out this action. And, while city personnel do conduct site visits, they lack the staff resources to make return visits on a regular basis. For example, a parcel of land being developed is visited, on average, only once during its construction phase. This is inadequate because the condition of a construction site change dramatically over the course of its development.

More specific information on reducing and/or eliminating pathogens, sedimentation and nutrients are addressed below.

Reduce Accelerated Sedimentation (#10)

Six components are listed under this action and, together, they provide a comprehensive plan for reducing human-induced sedimentation. The components include enforcing erosion control measures, preventing sediment runoff from development projects, adopting erosion control ordinances, implementing BMPs to minimize topsoil loss, preventing roadside dumping of dirt and eliminating massive grading practices.

Mechanisms, such as local ordinances, educational pamphlets and site visits, and construction NPDES permits do bring awareness about sedimentation issues to developers and residents. Cities also require and review erosion control plans for planned and active construction sites, and they require BMPs to be implemented to minimize sedimentation problems. These actions, while proactive and a good start, have not clearly reduced human induced sedimentation into the watershed. Due to limited resources, city personnel are unable to effectively ensure that the BMPs will be implemented over the entire duration of construction. Roadside dumping of dirt has proved virtually impossible to control, and topsoil losses from residential sites remains a concern in developing and newly developed residential neighborhoods.

Implement Stenciling and Other Storm Drain BMPs (#13)

Storm drain stenciling efforts have been well implemented throughout the watershed. Most watershed cities contract with the County of Los Angeles Department of Public Works to conduct this task approximately every three years (Malibu stencils its own storm drains). The stencils are one of the methods used to make residents aware of where storm drain flows eventually end up.

Unfortunately, it's still not uncommon to find catch basins clogged with urban-generated trash and debris, and contaminated discharges are still making their way into the storm drain system. Street sweeping and catch basin cleaning frequencies vary among cities, as do the storm drain cleaning techniques used. However, it's not clear that street sweeping frequency is related to need in the watershed cities. The fact that there is very little data available supporting the benefits of street sweeping has resulted in municipal reluctance to do more on this issue, and no studies have adequately linked land use activities with the volume of trash collected to better determine what frequency would be most cost effective.

Regulate Mobile Car Wash Discharges (#14)

Mobile car wash operators are required under municipal ordinances to ensure that their discharges do not reach local storm drains. Because mobile car wash operations have not been found to be a significant source of water quality impairments to the Malibu Creek watershed, they are not heavily monitored by municipal staff unless complaints are filed. Beyond adopting local ordinances, there is little effort given to address/prevent mobile car wash discharges.

Eliminate Illegal Drains (#15)

Of the 1,838 illicit connections found in Los Angeles County, only 49 were located in the Malibu Creek watershed. The County has already formally documented 21 of these illicit connections and is in the process of documenting the remaining 28. Although there is nothing remaining to accomplish under this action, it only received a moderate rating due to completing documentation of the remaining storm drains.

Control Trash on Parklands (#17)

Efforts to reduce or eliminate the amount of trash from parklands reaching Malibu Creek have been only moderately successful. While State Parks does provide trash receptacles on its property, some of them are either not properly placed to maximize use among visitors, or there simply aren't enough trash cans to hold all that is discarded on a typical weekend day by park visitors. More and better placement of trash cans and bilingual signs are needed to help decrease the amount of trash and debris making its way into Malibu Creek.

Implement Confined Animal BMPs (#18)

[This action primarily addresses horse owners in the Malibu Creek Watershed, most of which are located in the City of Malibu. There are not a significant amount of other types of livestock in this region.]

The Resource Conservation District has made a tremendous effort to monitor, educate and raise awareness among horse owners about the impacts of horse waste on water quality. Unfortunately, changes in manure management measures have not been widely observed since this outreach program began a few years ago. The region's larger stables do implement BMPs designed to control manure and keep it from reaching nearby streams. However, many private horse owners with corrals located near streams do not necessarily have the land or resources to reconstruct their corrals away from adjacent streams. Additionally, municipal ordinances and the Los Angeles County health code are either not adequate or are not being sufficiently enforced to prevent horse manure from contaminating runoff. Horse waste is still observed in and around stream banks and riparian corridors, and in many creek/stream reaches. More attention on enforcing local ordinances and public health codes is needed to ultimately correct this problem.

Minimal Progress

There has been only minimal progress for four *Water Quality:*

Implementation actions. These include:

- Reduce human pathogen inputs;
- Reduce nutrients;
- Manage septic system discharges; and
- Enforce pollution reduction programs.

Reduce Human Pathogen Inputs (#7)
Historically, efforts to implement this action focused on eliminating Tapia Treatment Plant discharges into Malibu Creek while other diffuse or nonpoint sources were not aggressively pursued. These efforts resulted in the Regional Board passing a revised discharge prohibition eliminating flows during the dry season. It was a significant step towards reducing public fear about adverse health effects associated with tertiary treated discharges into Malibu Lagoon. However, bacteria counts are still higher than health code standards allow and Surfrider beach still consistently receives "F" grades during breaching events. Identifying and preventing other sources of pathogen inputs has not been given significant attention until very recently. These potential sources include septic systems, storm drain discharges and livestock wastes. Because programs to address these sources are just getting underway, this action received a minimal rating. It is too early to assess whether all the various sources of pathogens can be effectively controlled.

Reduce Nutrients (#9)
Excess nutrients are a wide-spread concern throughout the watershed both above and below the Tapia treatment plant. Although many studies have documented the extent of nutrient problems watershed-wide, little has been done to determine the extent of all the possible sources contributing to the excess nutrients found in the watershed. And, despite the discharge prohibition of Tapia effluent during the dry season, the amount of nutrients found in the lower creek and lagoon are still too high and cannot be accounted for, making it nearly impossible to develop a plan of action for reducing nutrient inputs. Until all sources of nutrients have been identified, this action cannot be effectively implemented.

Manage Septic System Discharges (#23)
It is widely believed that septic system discharges contribute to the poor water quality observed in the lower creek and lagoon, but studies recently performed to ascertain the degree of pathogen contributions coming from septic systems are considered inconclusive, and funds to conduct extensive groundwater monitoring have been nearly impossible to secure.

How best to manage septic system discharges has proven to be quite controversial. Homeowners are leery of government intervention, fearing that any changes to current systems would cost them thousands of dollars. City leaders have been reluctant to impose additional restrictions on local homeowners or to suggest construction of a centralized sewer system in Malibu. The SMBRP's Septics Management Task Force is in the process of developing recommendations for how to manage septic discharges to better protect water quality in areas such as Malibu. These recommendations will require action by both state agencies and local municipalities.

Ultimately, very little progress has been made towards actually eliminating or reducing the impacts of septic system discharges on water quality. The actual number of installed septic systems in Malibu has not been determined or mapped, and only a small percentage of systems have been recently replaced

Enforce Pollution Reduction Programs (#40)

Enforcing pollution reduction programs is carried out at several levels of government – local, state and federal. Cities have been required to adopt ordinances, and the State Water Resources Control Board and the US Environmental Protection Agency have the ultimate responsibility to ensure that water quality is protected. Both the State and municipalities use enforcement as a means to achieve this goal. Although these mechanisms are in place, almost no enforcement programs have been effectively implemented. Cities, lacking personnel and other resources to conduct all the enforcement that would be necessary within their jurisdictions, have done so only passively. And, until recently the Los Angeles Regional Water Quality Control Board has had an extremely poor enforcement record regarding oil and other hazardous substance spills, sewage spills, and storm water and other NPDES permit violations. However, since 1998 enforcement actions have taken place within the Malibu Creek watershed.

Water Quality — Implementation Grade: D

Goal: Reduce Excess Flows into Malibu Creek

The goal of the following three actions is to reduce excess flows into Malibu Creek. These actions intent to: 1) reduce imported water demands and runoff volumes, and 2) maximize the use of recycled wastewater. Collectively, they have been poorly implemented, with moderate progress in only one instance.

REDUCING EXCESS FLOWS

Moderate Progress

Maximize Use of Reclaimed Water

Minimal Progress

Household Irrigated Runoff Survey
Runoff Reduction Measures

Moderate Progress

Maximize Use of Reclaimed (Recycled) Water (#28)

The Las Virgenes Municipal Water District, the lead agency responsible for promoting reclaimed water use in the watershed, has made significant strides in its efforts to recycle tertiary treated wastewater back to the communities that generate it. Efforts which include getting ordinances passed to require the use of recycled water where feasible and pricing recycled water more competitively have resulted in almost half (44%) of the total volume of wastewater generated by upstream communities being reused rather than discharged to Malibu Creek. Some of the alternatives proposed in the *Malibu Creek Discharge Avoidance Study* are also being implemented to maximize use of recycled water. For example, the District has: 1) increased the number of private end users during the prohibition, effectively doubling the non-creek disposal capacity of Tapia's tertiary treated effluent and 2) sought funding opportunities to help pay for the infrastructure needed to reach distant but potential end users.

Unfortunately, the demand for recycled water is not constant throughout the year and thus less wastewater is recycled in the fall, winter and spring months than during the summer and shoulder months. As a result, excess flows are still discharged to Malibu Creek during the rainy season (November 15th – April 15th). Implementing alternative disposal options during this time has proved more difficult to address and has thus been fairly slow. Still, the District's commitment to exploring several of the discharge alternatives identified in the report and to ultimately find a permanent alternative to discharging effluent into Malibu Creek is a positive step towards maximizing use of recycled water.

Watershed cities have also supported this action by passing ordinances requiring the use of recycled water for landscape irrigation along freeway corridors, in city parks, and other areas where feasible. Such requirements help solve two problems simultaneously – they reduce the amount of wastewater discharged into Malibu Creek during the rainy season and decrease demand for imported water.

Minimal Progress

Household Irrigation Runoff Survey (#19)

The intent of this action was to conduct a survey which would: 1) provide insight as to why such large volumes of runoff are coming from residential developments and 2) develop an awareness campaign based on the survey results to decrease these excess runoff volumes. Although there are several public education campaigns promoting water conservation at the residential level, no household survey has been conducted to determine why excess flows are coming from residential areas. Without the insights that such a survey could provide, it will be difficult to plan an educational awareness campaign specifically targeting those activities most likely to contribute to excessive household-generated runoff.

Runoff Reduction Measures (#31)

Measures designed to reduce the amount of runoff coming from residential and commercial properties have only recently been adopted by local and state agencies. For example: 1) in the last few years watershed cities have passed ordinances calling for more pervious surfaces in new developments; 2) in January 2000, the Regional Board adopted a measure requiring on-site storm water retention or treatment for the first ¾-inches of rain from each storm; and 3) the Las Virgenes Municipal Water District recently installed irrigation sensors to improve irrigation practices to minimize excess flow. Because these measures have been only recently adopted and implemented, whether or not their implementation will prevent increased runoff or actually lead to reductions in runoff remains to be shown. And, because two of the three efforts mentioned above only apply to new and substantial redevelopment projects, the effects of this measure will not be clear until new, isolated developments can be evaluated for runoff reduction. Finally, beyond the public education/outreach efforts implemented, other immediate efforts to reduce runoff in the Malibu Creek Watershed are not widely observed.

***Reducing Excess Flows Grade*: D**

Goal: Improve Management of Solid Waste

MANAGING SOLID WASTE

Substantial Progress

Composting, Recycling & Conservation

Moderate Progress

Control Trash on Parklands
Implement Confined Animal BMPs

The three actions addressing solid waste concerns in the Malibu Creek watershed have achieved relative success, overall rating at high end of moderate. The ultimate goal of these actions is to prevent trash and other forms of solid waste from reaching and adversely impacting watershed creeks, riparian corridors and habitats. A summary of how well these actions are being implemented is provided below.

Substantial Progress

Composting, Recycling and Conservation Measures (#29)
Combined, watershed agencies and municipalities have conducted an enormous amount of outreach promoting the values of composting, recycling and water conservation. They have also provided many opportunities for residents to participate in recycling and conservation efforts through programs like curbside recycling, household hazardous waste roundups, permanent used oil drop-off sites and workshops. While not necessarily cost-effective, these efforts have been successful in increasing public awareness of the need to recycle household waste and have led directly to the increased volumes of residential solid waste collected each year.

Moderate Progress

Two actions have made moderate progress in controlling specific types of waste found in the watershed. These include:

- Reducing the amount of trash found on local parklands; and
- Implementing confined animal BMPs for waste reduction.

Control Trash on Parklands (#17)
Local parks in the Santa Monica Mountains receive a large number of visitors every weekend, particularly to Malibu Creek State Park and Malibu State Beach and Lagoon. Much of the trash found in nearby creeks and the lagoon ultimately comes from park visitors. Whether it is left on the ground, placed in on-site receptacles but then raided by birds or blown out by the wind, too much trash is reaching the creek. State Parks has made moderate progress in its efforts to control the proliferation of trash on its properties through: 1) the installation of new and additional bird proof receptacles in areas of the park

most frequented by the public, 2) posting bilingual signs encouraging visitors to use the receptacles provided and 3) utilizing Spanish-speaking employees to enhance its educational efforts. Although these approaches have been somewhat successful, they could be improved by installing even more bird-proof trash receptacles within State Parks boundaries and placing them in the most popular areas of the parks. State Parks' efforts could also be enhanced by improving the visibility and location of its bilingual signs.

Implement Confined Animal BMPs (#18)

While ensuring proper management and disposal of the solid waste generated by large domestic animals is a daunting task, some key steps towards accomplishing this goal have been taken. The *Horse and Stable Management BMP Manual* and a video created by the RCDSMM provides very specific information on how to manage horse waste. A horse manure composting demonstration site was also created to reinforce the benefits of managing horse manure through composting. These educational tools are very informative and are available to horse owners and the general public. However, as stated in the action summary, it is not clear that this information is in fact reaching enough horse owners. While large stable operations do implement good manure management measures, smaller stables where only a few horses are kept need more focused attention to help them properly manage animal waste.

Managing Solid Waste Grade: B-

Goal: Improve Land Use Management in the Watershed

LAND USE MANAGEMENT

Substantial Progress

Fire Regulation & Erosion Control

Moderate Progress

Reduce Accelerated Sedimentation
Implement Confined Animal BMPs
Public Access & Resource Protection
Habitat Fragmentation
Enforce Camping Restrictions

Minimal Progress

Buffer Zones for Sensitive Areas

Seven actions address land use issues in the Malibu Creek Watershed. Of the five that fall within the range of moderate progress, several of them were actually rated "low moderate." The intent of these actions is to ensure that smart land use decisions are made to protect valuable habitats throughout the watershed. Such planning ranges from improving habitat fragmentation to controlling pollution caused by certain land use activities. In the Malibu Creek watershed, current conventional zoning requirements do not adequately protect riparian habitats, creeks and streams. Below is a detailed summary of how effectively these actions have been implemented.

Substantial Progress

Fire Regulation and Erosion Control (#11)

Only one action, Fire Regulation and Erosion Control, is considered to have made substantial progress in the Land Use category. Four years ago, the Los Angeles County Fire Department implemented a new program, called the *Fuel Modification Program*, to improve fire safety measures for residential and commercial developments. Recognizing the need to also control unnecessary erosion from residential properties, the Fire Department included in its new program standards which allow grass to remain on flat lands and slopes prone to erosion. Additionally, watershed cities now recognize the benefits of mowing, rather than discing, weed setback zones likely to erode and promote the use of drought-resistant, native plants in new landscape plans. These measures highlight the increased awareness among city and county agencies about the sources and importance of balancing erosion control with fire regulation needs.

Moderate Progress

Five actions under *Land Use* have realized moderate success although three of them are considered low-moderate. These five actions include:

- Reduce accelerated sedimentation caused by human activities;
- Implement confined animal BMPs (low-moderate);
- Balance public access and resource protection (low-moderate);
- Eliminate habitat fragmentation (low-moderate); and
- Enforce camping restrictions on parklands.

Reduce Human-based Accelerated Sedimentation (#10)

Efforts to reduce human-based accelerated sedimentation include: 1) passing local ordinances for development projects and enforcing these measures, 2) minimizing the loss of topsoil, 3) preventing roadside dumping of dirt, and 4) eliminating massive grading. Some of these actions have realized greater success than others. For example, in the past few years local ordinances addressing sedimentation control measures have been passed by all watershed cities, which is a milestone achievement. Furthermore, the Regional Board requires all development projects greater than five acres to obtain a Construction NPDES permit and to implement sedimentation control measures. However, enforcing these ordinances and BMP requirements has been relatively inadequate. With few exceptions, on average city inspectors are visiting construction sites required to implement sedimentation control BMPs only once during the rainy season, and the Regional Board lacks sufficient staff resources to conduct regular inspections of large development projects to ensure that pollution control BMPs are being implemented. The mechanisms to control and/or reduce accelerated sedimentation are in place, but enforcement of these measures is not readily occurring.

Implement Confined Animal BMPs (#18)

Among other things, this action calls for setting limits on the number of livestock per acre to protect resources from overuse by large animals, such as horses. Malibu has established limits based on the location of a parcel within the city. The County of Los Angeles Department of Health Services also inspects stables with four or more horses on a yearly basis to determine whether appropriate BMPs are being implemented and to ensure that horse waste is well contained and prevented from reaching creeks. Their surveys confirm that there is definitely a problem with manure waste management in the watershed. Although horse owners are required to ensure that no manure-contaminated runoff reaches adjacent streams and that no stalls are within 50 feet of a stream bank, enforcement of these measures is minimal due to DHS's limited staff resources. Some horse owners simply have not implemented adequate setback zones and pollution control BMPs, and their horse waste is still reaching and polluting adjacent streams in the Malibu Creek watershed.

Balance Public Access and Resource Protection (#32)

The steps needed to accomplish this action are not well defined, and thus what has been reported in Section II of this report is limited. Only a few plans have specifically addressed both resource protection and public access issues. These include the Resource Conservation District's restoration efforts in Malibu Lagoon and the upcoming Las Virgenes Canyon sub-watershed study. A more comprehensive plan focusing on how to minimize the impacts of residents, hikers, horseback riders and campers on the watershed's creeks, streams and sensitive habitats would be a good starting point towards balancing public access needs with resource protection goals.

Eliminate Habitat Fragmentation (#35)

Steps to improve and/or maintain continuous habitats for native species in the watershed have been somewhat limited in scope, and city master plans have focused on other regional impacts of population growth. However, the City of Calabasas' designation of *Open Space Districts* is a creative approach towards reducing habitat fragmentation, and other cities should be encouraged to designate similar districts within their own jurisdictions.

Also, the study initiated by the National Park Service and the California Department of Parks and Recreation four years ago has proved to be a key step in understanding the impacts that habitat fragmentation can have on native species. Over the next several years, the data gathered will be very useful in guiding park planning and habitat preservation efforts.

Enforce Camping Restrictions (#41)

Transient camping is not a significant problem in the Malibu Creek watershed, or on State Parks properties, and thus efforts to control it are minimal. As stated in Section II, State Parks personnel does patrol parklands and takes action as necessary.

Minimal Progress

Create/Maintain Buffer Zones for Sensitive Areas (#34)

While a few agencies have created buffer zones to protect sensitive habitats and prevent urban encroachment within their agency boundaries, the majority of the watershed's sensitive habitats are not well protected. Watershed cities have lagged in their efforts to protect sensitive habitats and setback requirements called for under municipal ordinances are inadequate to protect riparian habitats and stream corridors from development activities. Development projects located too close to stream and riparian corridors lead directly to increased sedimentation, spreading of invasive species and increased trash and debris. Better efforts at the municipal level should be made towards creating adequate buffer zones in the watershed.

***Land Use Management Grade*: C-**

Goal: Restore and Protect the Watershed's Habitats

A total of 15 actions address the need for habitat protection and restoration in the Malibu Creek Watershed. These actions range from purchasing land containing sensitive habitats to preventing sedimentation and the proliferation of exotic species. As the chart to the left shows, collectively low-to-moderate success has been achieved towards restoring, enhancing and protecting the watershed's habitats and resources.

WATERSHED HABITATS

Substantial Progress

Fire Regulation & Erosion Control
Mitigate Impacts of PCH
Bridge Reconstruction

Moderate Progress

Reduce Accelerated Sedimentation
Restore Malibu Lagoon
Assess Lagoon Characteristics
Habitat Fragmentation

Minimal Progress

Establish Minimum Biological Standards
Establish Water Temperature Policies
Regulate Lagoon Water Levels
Public Access & Resource Protection
Purchase High Priority Land Areas
Buffer Zones for Sensitive Areas
Control Exotic Vegetation in Wilderness
Remove Barriers to Fish Migration
Maintain/Restore/Create Wetlands

Substantial Progress

Of the 15 actions in this section, only two have achieved substantial progress in protecting the watershed's habitats. They include:

- Fire regulation and erosion control; and
- Mitigate the impacts of Pacific Coast Highway bridge reconstruction on habitats.

Fire Regulation & Erosion Control (#11)
Development and implementation of the Fire Department's *Fuel Modification Program* was a significant achievement in reconciling public safety with resource and habitat protection. The program's grass height allowances, planting requirements and long-term vegetation maintenance plan help to minimize the erosion and sedimentation caused by excessive brush clearance and mowing practices. Combined, these measures are improving habitats located near developments and are helping to prevent the downstream impacts resulting from uncontrolled erosion and sedimentation.

Mitigate the Impacts of PCH Bridge Reconstruction (#26)
CalTrans established a mitigation fund to help improve various habitats around the Pacific Coast Highway bridge which crosses Lower Malibu Creek and Lagoon. Three very successful projects in the lower watershed were implemented as a result of this mitigation fund: 1) salt marsh restoration (State Parks); 2) five year monitoring of the tidewater goby (RCDSMM); and 3) the *Effects of Sand Breaching the Sand Barrier on Biota* study (RCDSMM). Because CalTrans has met its mitigation requirements, this action is considered fully and successfully completed. Additional lower creek and lagoon restoration efforts are addressed in several other actions throughout this report.

Moderate Progress

Four of this section's 15 actions have achieved moderate progress towards protecting the watershed's habitats. These include:

- Reduce accelerated sedimentation;
- Restore Malibu Lagoon;
- Assess lagoon characteristics; and
- Eliminate habitat fragmentation.

Reduce Human-based Accelerated Sedimentation (#10)
Efforts to control human-induced sedimentation from urbanized areas have been moderately successful, due primarily to: 1) increased public education efforts focused on developers and contractors, 2) adoption of local ordinances by watershed municipalities and 3) enforcement of construction-related BMPs. These efforts could also be improved through enhanced enforcement activities, mowing rather than discing areas likely to erode and educational outreach specifically targeting residential communities about the need for smart landscaping to protect the watershed's habitats from neighborhood-based sedimentation.

Restore Malibu Lagoon (#20)
The components essential to restoring Malibu Lagoon are numerous and complex. Already, a significant amount of attention has been given to the "need" to restore the lagoon, and many studies have been conducted over the years to help assess the extent of the problems associated with the area. This increased level of understanding about the impacts earned this action a moderate rather than minimal ranking. It is a critical first step towards any restoration plan. However, until now actual restoration efforts have been piecemeal, such as increasing the available habitat for migratory birds and the tidewater goby, restoring the salt marsh area, removing trash and debris, and construction of a storm water treatment and disinfection facility at the end of the mystery drain. A comprehensive plan must be developed detailing all of the steps needed for full restoration.

As mentioned in the body of the report, the Lower Malibu Creek and Lagoon Task Force is currently in the process of prioritizing the alternatives contained in the UCLA report and developing a restoration plan. Although not complete at the time of this report, their efforts are aggressively moving along. Once priorities are developed, the group will start seeking funds to implement those measures chosen.

Assess Malibu Lagoon Characteristics (#21)
The primary objectives in assessing Malibu Lagoon's characteristics are to evaluate and establish water quality criteria and habitat needs. The complement to this activity lies in determining how those characteristics actually affect/impact habitats. As

mentioned under both *Establishing Minimum Biological (habitat) Standards* and *Restore Malibu Lagoon* above, several studies have occurred to increase our understanding of the biological condition of the Lagoon, including the degree to which habitats are impaired. However, not all species have been considered in the characterization and there are still gaps in data which need to be filled — in particular, the physical tolerances of key species and the degree to which pollutants adversely affect these species. For this reason, the progress made under this action is considered moderate.

Eliminate Habitat Fragmentation (#35)
While the threat of habitat fragmentation does exist in the Malibu Creek Watershed, the fact that nearly 80% of the watershed is open space helps lessen that threat. The studies undertaken to evaluate the impacts of urban encroachment on habitats and to address critical concerns of carnivores are being used to direct and promote wildlife conservation efforts. Cities, recognizing the need for open space and habitat linkage preservation, are starting to incorporate these concepts into their master plans and to identify land parcels most desirable for acquisition to meet this goal. If acquired, the parcels identified by State Parks will also help reduce habitat fragmentation. And lastly, the on-going educational and awareness efforts targeting city planners and permitting departments should help guide habitat preservation efforts.

Minimal Progress

Nine actions, more than one-half of the total under *Habitats*, have made little or no implementation progress. These include:

- Establish minimum biological (habitat) standards;
- Establish water temperature policies for fisheries;
- Regulate lagoon water levels;
- Public access and resource protection;
- Purchase high priority lands for watershed protection;
- Develop buffer zones for sensitive areas;
- Control exotic vegetation in the wilderness;
- Remove barriers to fish migration; and
- Maintain, restore and create wetlands.

Establish Minimum Biological (habitat) Standards (#5)
Because of the monitoring efforts of many organizations, including the RCDSMM, Las Virgenes Municipal Water District and Coastal Conservancy/UCLA study, there is a greater understanding of the biological condition of the watershed's target and endangered species. However, no studies have been conducted to comprehensively assess the range of tolerances of these species. Although it may prove impossible to

actually optimize the habitat needs for each of the target species, particularly in the lower creek and lagoon area, establishing their minimum needs would provide a good starting point from which to set biological standards.

Establish Water Temperature Policies (#12)

Despite the Las Virgenes Municipal Water District's temperature data for steelhead trout and Resource Conservation District's decade-long Malibu Lagoon temperature data, no recommendations have been made about what the optimum water temperature should be for habitats and species in the Malibu Creek watershed. And, no studies have been conducted to determine the temperature tolerances of the watershed's local key/indicator species.

In its thermal plan, the State sets temperature limits for industrial and treatment plant discharges such as Tapia's effluent. However, such discharges into the Malibu Creek watershed are not a concern because they are well below the limits established by the State. Of greater importance to aquatic species such as steelhead trout is the overall quality of the water, its flow characteristics and whether there is sufficient habitat (e.g., deep pools, upstream spawning grounds) to support native populations.

Notwithstanding the lack of effort, it's not clear that establishing a water temperature policy is needed for Malibu Creek given its current state.

Regulate Lagoon Water Levels (#24)

Perhaps one of the most difficult issues facing the Lower Malibu Creek and Lagoon area has been how to regulate water levels in the lagoon. The unnaturally high water levels found in the lagoon during the dry season affect the hydraulic gradient in and around the lagoon, and this alteration causes many problems. Nearby septic systems become backed up, pollutants become more mobile in groundwater, bacteria counts increase, lagoon salinity decreases and mudflats (bird habitat) disappear. The need to regulate or control lagoon water levels is of critical concern for these and other reasons.

Prop A funds ($1,275,000) were awarded to State Parks and the City of Malibu in 1998 to develop a project to regulate lagoon water levels. Because Malibu is no longer participating in this effort, State Parks has taken on the leadership role in solving this problem. However, progress has been extremely slow. State Parks released a *Request for Proposals* in September, 1999 seeking a sound water level management plan/design and since that time several management alternatives have been discussed. However, a preferred alternative has not been selected and no project has been implemented as of yet. For this reason, this action has been given a minimal rating.

Public Access and Resource Protection (#32)

A balance must be maintained between allowing public access to open space while protecting sensitive habitats in the watershed. Unfortunately, this action has not received much attention until recently. Recognizing the need for balance, State Parks and a few watershed cities have begun to implement resource protection measures such as establishing access trails, erecting informative signs and outlining critical measures to be addressed (e.g., wildlife corridors and recreational needs) in city master plans. Still, local habitats are not adequately protected from community recreational activities. For example, allowing public access to the mud flats in Malibu Lagoon jeopardizes bird safety because some visitors bring their dogs and allow them to roam off-leash. Riparian habitats are trampled on by horses and hikers who may not realize that they are in sensitive areas. And, trash is left on the ground in parks which further impacts wildlife and aquatic habitats. Implementing measures that would *fully* protect sensitive habitats is not a popular idea as it would most likely require prohibiting public access completely. Therefore, a more attention must be given to this action and a plan developed that adequately balances public access with resource protection needs.

Purchase High Priority Land for Watershed Protection (#33)

This action has made little progress on three accounts. First, there has not been a comprehensive, publicly available assessment of which lands within the entire watershed would be the most desirable to acquire from a water quality/habitat prospective. Secondly, there has been little effort made to actually acquire key parcels, or to secure the funds to do so. And thirdly, there has not been an abundance of willing sellers. Obtaining some parcels which have long been sought after, such as the golf course adjacent to Malibu Lagoon, has proved impossible thus far. This action, in some sense, has found itself in a "catch 22" scenario. A seller isn't willing to open discussions about selling his/her land unless funds are available to purchase it, and government agencies will not allocate funds unless the landowner is a willing seller.

Additionally, the few parcels that have been identified as desirable for acquisition have not been selected as part of a greater watershed protection effort. Rather, they represent singular potential restoration opportunities. As an example, the City of Malibu is assessing the feasibility of acquiring land for a constructed wetland in the Civic Center area. While this is an important location, it has not been officially prioritized as the most important parcel for acquisition in Malibu. A comprehensive plan which prioritized parcels for acquisition and determines the likelihood of obtaining them would eliminate this problem.

Develop Buffer Zones for Sensitive Areas (#34)

With a few exceptions, little attention has been given to the importance of creating buffer zones and to identifying sensitive zones throughout the watershed which are in need of buffer areas for protection. And, local ordinances for buffer zone setbacks (up to 100 feet) are inadequate to protect streams and creeks within the watershed. A few buffer zone areas have been identified on State Parks property and land has been purchased near the Rancho composting facility, but this falls far short of protecting many of the sensitive areas throughout the 109 mi^2 watershed. Although the creation or designation of open space zones should help protect sensitive areas contained in these zones, its benefits will not be realized unless there is a real commitment from the watershed's cities to designate open space zones. Like the recommendation to prioritize land parcels for acquisition, a comprehensive survey of significant ecological areas should be conducted and a priority list developed which is specific to the habitat protection needs of the Malibu Creek watershed.

Remove Barriers to Fish Migration (#36)

Efforts to address this action started several years after adoption of the Bay Restoration Plan and the Natural Resources Plan, and began with the formation of the Steelhead Recovery Task Force. In Malibu Creek, there are two primary obstacles impeding steelhead's migration to upper reaches of the creek. These include the Arizona crossing at Cross Creek and Rindge Dam.

Arizona Crossing at Cross Creek

A few years ago, there were discussions about removing this particular obstacle to steelhead migration. However, plans have all but been dropped because funding was never secured to alter the crossing. Only recent passage of Prop 12 has sparked new interest regarding how the crossing could be changed to benefit steelhead trout migration upstream.

Rindge Dam

Although Rindge Dam has not been removed, the fact that the Army Corp of Engineers has conducted a reconnaissance study to confirm local support for the project was a very positive initial step. However, a feasibility study (which has yet to start) needs to be conducted to assess the various restoration alternatives. The Army Corps has appropriated $400,000 for this feasibility study and State Parks will be providing the necessary matching funds. Current cost estimates to remove Rindge Dam, based on several alternatives already proposed, range between $10-30 million. Still, it remains to be seen which restoration alternatives will actually be presented and whether enough funds will then be secured for the alternative ultimately selected.

Maintain, Restore and Create Wetlands (#38)

The majority of interest in maintaining, restoring and creating wetlands has been in the lower watershed, in areas including Malibu Lagoon and the Civic Center area. With the exception of the LVMWD's rehabilitation of a percolation pond as a constructed wetland and some restoration of Malibu Lagoon, no other wetland restoration efforts have been implemented. Part of the reason for this stems from a lack of funds to start such a project. Also, there is some controversy over just which areas are considered "historic wetlands" and can be rehabilitated, and which areas can even be restored given current development obstacles.

Control Exotic Vegetation in the Wilderness (#37)

As mentioned in the body of the report, controlling the spread of exotic vegetation in the watershed is an overwhelming and endless task, and the resources needed to conduct this activity successfully haven't been available. While there are certainly some vigilant efforts by State Parks, Weed Warriors and other volunteer groups, the problem is so great, and some species so prolific, that it seems that it will be all but impossible to permanently remove exotic species. Also, the success of removing one particular invasive species, Arundo donax, is reduced because the target areas for removal are downstream from other upstream patches of Arundo. Unfortunately, the funds made available for this activity limited the geographical area from which Arundo could be removed.

The newly formed Invasive Species Task Force plans to start addressing the need to identify, assess and initiate removal of many types of invasive species. Perhaps their efforts, along with the availability of Prop 12 bond funds will lead to more successful removal of exotics.

Restore and Protect Watershed Habitats Grade: D-

Goal: Improve Coordination & Outreach Among Watershed Stakeholders

COORDINATION and OUTREACH

Substantial Progress

Posting Public Notices
Composting, Recycling & Conservation
Coordination Efforts
Public Education Programs

Moderate Progress

Implement Confined Animal BMPs
Promote Water Conservation
Coordinated Monitoring Program

Overall, the 7 actions designed to improve ***Coordination and Outreach*** have been quite successfully implemented. The goals and objectives of these actions has been: 1) to improve communication and coordination efforts among stakeholders, public agencies and the general public, 2) to better educate the public about sources of pollution and what they can do to minimize the impacts of pollution on the watershed's resources, and 3) to combine monitoring resources to better understand watershed dynamics and impacts. Following is an assessment of progress achieved in meeting the goals of these actions.

Substantial Progress

Some of the more notable achievements have been in the areas of:

- Posting public notices regarding lagoon breaching, and publishing bacteria monitoring results and potential human health concerns;
- Promoting composting, conservation and recycling programs in the watershed through curbside recycling programs, household hazardous waste roundups, educational brochures, PSAs and workshops (just to name a few);
- Coordinating restoration and protection efforts on a watershed basis; and
- Implementing public education programs.

Post Public Notices (#25)
Public access to and understanding of information available on the quality of water in Malibu Creek and Lagoon has dramatically increased in the last five years. This is due to a number of factors, including: 1) regular and frequent posting of Heal the Bay's Beach Report Card through multiple venues, 2) improvements in bacterial monitoring, and 3) local newspaper coverage. The results of the Santa Monica Bay Restoration Project's *Epidemiological Study* also helped improve the protocol for advising the public of health risks associated with swimming in contaminated waters. While the public is made aware of the health risks associated with swimming in the ocean within three days after a rain event through the media, the study provided the information needed to scientifically back up the recommendations and led to revisions in the County's Beach Closure and Health Warning protocol. The study also

led to passage of AB 411, which requires local health agencies to set up a hotline informing the public of closed, posted or restricted beaches. Together, these actions have effectively improved the public's awareness about the water quality and risks associated with swimming in shoreline waters adjacent to Malibu Creek and Lagoon.

Composting, Recycling and Conservation Programs (#29)
As mentioned under **Managing Solid Waste** (starting on page 99), an enormous amount of energy has gone into promoting composting, recycling and conservation awareness among watershed residents. All watershed cities offer some sort of recycling program, whether it be curb-side pickup, roundup events or permanent drop-off sites. Additionally, these recycling opportunities are promoted through city newsletters, public service announcements, local cable channels and city banners. The need for water conservation is also promoted through educational workshops, fliers, newsletters and bill inserts. Combined, these efforts have increased the public's awareness for the need to recycle and conserve.

Coordination Efforts (#39)
The formation of the Malibu Creek Watershed Council has led directly to many of the achievements highlighted in this report. The continued involvement of participating organizations listed in Table 1.1 on page 5 has also led to a better understanding of the dynamics of the watershed and has provided a reliable mechanism for restoring habitats, assessing water quality and protecting species in a constructive, cohesive manner. While implementation has been slow for many actions, it would have been virtually impossible to achieve the progress already made without the long-term commitment of council members working together.

The progress made to coordinate activities among different agencies with seemingly conflicting goals has also been a milestone achievement, which should serve as a model for other watersheds. In particular, reconciling brush clearing needs (fuel modification), flood control and roadside maintenance with preservation of habitats has led to revisions of past practices and establishment of new guidelines within the County Fire and Public Works Departments. The 1996 Municipal Storm Water NPDES permit has also proven to be another avenue for coordinating efforts between the County and cities in the Malibu Creek watershed. Although the activities called for in the permit are mandatory on an individual city basis, cities have realized and been motivated by the cost savings associated with forming partnerships. In particular, the formation of the Council of Governments (see Coordinate on a Watershed Basis, #39) reinforces the advantages of creating such partnerships.

Public Education Programs (#42)
Public education programs targeting watershed residents and businesses have been broad in both message and approach. Many new outreach avenues have become successful realities in recent years, including use of the internet, creation and circulation of city/utility newsletters, use of real-time data, increased numbers of roundups and collection events, and an ever-growing number of hands-on programs and activities (e.g., student field trips, residential gardening workshops, volunteer opportunities, commercial site visits, municipal training and workshop classes, etc.). Additionally, several public education programs have successfully targeted very specific user groups. Examples include: 1) the Resource Conservation District of the Santa Monica Mountains' *Stable and Horse Management BMP Manual*; 2) the Las Virgenes Municipal Water District's water conservation classes for landscape maintenance companies; and 3) State Parks' lectures for teachers on the values of and need to preserve open space.

Moderate Progress

Moderate progress has been achieved in areas such as:

- Implement confined animal BMPs;
- Promote water conservation practices; and
- Implement coordinated monitoring programs

Implement Confined Animal BMPs (#18)
The RCDSMM conducted an extensive survey to identify the horse owners and corrals in the Malibu Creek watershed. They then used the information to produce pollution prevention educational materials for this target group. While the outreach materials are very informative, it's not clear that they are effectively reaching horse owners and are leading directly to changes in habit among them. Many corrals are still placed too close to streams and creeks, management of horse waste is still not closely regulated and people are still riding their horses in adjacent creeks. More outreach using the tools now available is still needed.

Promote Water Conservation (#30)
Because virtually all of the water used by watershed residents is imported, conservation measures are vitally important to both protecting and sustaining natural habitats. The LVMWD has implemented several educational approaches to promote water conservation measures which would reduce the amount of water used by households, including: 1) installation of ultra low-

flow toilets, 2) workshops promoting low water use plants and landscape, and 3) distribution of educational materials promoting water conservation. However, the watershed's population continues to increase and even more must be done to encourage households to install ultra low-flow toilets (the single largest indoor use of water), and to more closely monitor landscape irrigation needs and other activities which cause excessive runoff.

Coordinated Monitoring Programs (#43)

There is an enormous amount of recent and historic monitoring data available for waterbodies in the Malibu Creek watershed, and significant steps have been taken towards collectively integrating the watershed's monitoring activities. Independent studies and routine monitoring activities have also enhanced our understanding of the major pollution issues. However, this data has yet to become available through a centralized, user-friendly database, and it has never been analyzed as a whole. Heal the Bay has only recently received funding for and started to create a database of the monitoring activities of key agencies. And, although the Monitoring and Modeling Subcommittee released a plan detailing a coordinated, watershed-wide monitoring program, it has yet to be implemented. Its implementation depends on securing the funds needed to carry out each component of the plan. Future progress will require adequate resources to realize the goals of the coordinated monitoring plan developed.

***Coordination and Outreach Grade*: A-**

SECTON IV:
MOVING FORWARD WITH RESTORATION PRIORITIES

Significant achievements have been made over the past decade to restore the Malibu Creek watershed. Still, much remains to be done to improve its water quality, habitats and living resources.

This chapter provides a summary of priority watershed restoration and protection activities which will advance the Malibu Creek watershed Action Plan.

The 29 priorities listed (Table 4.2) are based on the assessment of progress contained in this report. From this list, the Malibu Creek Watershed Executive Advisory Council has identified a list of "Top Ten" priorities (Table 4.1). How well and how extensively these actions are implemented will depend on many things, including: 1) availability of funds to carry out programs, 2) policy changes and/or legislation, 3) availability of research data to move actions forward, 4) ability to acquire land, and most importantly, 5) ensuring stakeholder involvement.

This Top-Ten list is not intended to be static or even an exhaustive list of all the watershed's priorities. It is anticipated that priorities will change as actions are implemented and new issues arise.

"TOP TEN"
Watershed Restoration Priorities

1. Map all existing and potential sources of pollution in the watershed. Implement measures to pinpoint sources of pollution in both the upper and lower watershed.
2. Acquire key parcels of land for habitat protection.
3. Remove Arundo donax from the entire watershed.
4. Review general land use practices and past practices for each city and for unincorporated areas in the watershed to predict the impacts on public health, natural and aquatic resources, and recreational benefits.
5. Reduce sedimentation and erosion along stream banks, roadways and at construction sites.
6. Implement the coordinated watershed-wide monitoring plan developed by the Monitoring and Modeling sub-committee and develop a centralized database for the monitoring data.
7. Synthesize water quality data to establish minimum standards for native species of locality and identify where gaps in data still exist.
8. Develop/revise monitoring plan to address data gaps.
9. Develop a plan to identify, remove and prevent exotic plant and animal species from impacting the watershed.
10. Help/Encourage watershed cities to develop uniform development plans and ordinances which would:
    - Set slope minimums for hillside building and construction activities.
    - Establish native plant vegetation requirements
    - Prevent disturbances to natural drainage channels
    - Retain runoff on-site to the maximum extent practicable (including use of pervious surfaces)
    - Prevent sediment loadings to creeks/streams both

Table 4.1. "Top Ten" watershed restoration priorities.

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
Policy and Planning						
1. Revise/modify/update the Malibu Creek Watershed Restoration Plan.	☑	☑		☑	☑	☑
2. Develop a plan to better balance public access needs with habitat/resource protection.					☑	
3. Prioritize land parcels for acquisition that promote water quality and critical habitat protection.	☑				☑	
4. Develop procedural guidelines to address unconventional pollutants as they are discovered.	☑		☑		☑	
5. Review and improve current land use practices for each city and unincorporated areas in the watershed to predict land use impacts on public health, natural and aquatic resources and recreational benefits.	☑		☑	☑	☑	
6. Develop and implement better enforcement programs. Specifically address: • BMP implementation at construction sites; • Polluted discharges from restaurants and gas stations; • Improper grading practices; • Pervious surface requirements; and • Buffer zone setbacks	☑	☑	☑	☑	☑	☑

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
7. Encourage watershed municipalities to integrate a watershed planning perspective into General Plans and local ordinances. Concepts to be considered include: • Setting slope minimums for hillside building/construction; • Establishing native plant vegetation requirements; • Preventing disturbing natural drainage channels; • Minimizing habitat fragmentation; • Retaining runoff on-site to the max. extent practicable (including pervious surfaces requirements for new and substantial redevelopment projects); • Preventing sediment loadings to creeks/streams both during and after construction; • Cumulative watershed-based review of development projects; • Setting standards for streets, sidewalks, driveways and parking lots; • Establishing 200-ft buffer-zone standards near sensitive habitats; and • Establishing setback standards for corrals and stables located near creek and stream banks.	☑	☑		☑	☑	
Watershed Studies and Research						
8. Map all existing and potential sources of pollution in the watershed and use measures to pinpoint exact sources of these pollutants. In particular, identify all sources and relative contributions of pathogens and nutrients.	☑		☑		☑	
9. Identify and develop a monitoring program to fill gaps in data where they exist throughout the watershed.	☑	☑		☑	☑	☑
10. Establish TMDLs for pollutants of concern in the Malibu Creek watershed.	☑	☑	☑		☑	
11. Establish minimum biological standards (habitat needs) for native species. Consider the physical tolerances of birds, plants and aquatic species.					☑	
12. Evaluate the impacts of breaching on Malibu Lagoon aquatic species and birds. Design a lagoon water level management plan based on this research.					☑	

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
13. Determine appropriate seasonal flows into Malibu Creek and Lagoon. Evaluate the feasibility of treating creek and storm drain flows before they reach Malibu Lagoon and consider alternative uses for excess flows.		☑				
14. Assess/determine the impacts of nearby septic system effluent on lower Malibu Creek and Lagoon.	☑	☑	☑			
15. Conduct a household irrigation survey to better determine reasons for excess runoff from residential property.		☑				
Habitat Restoration and Other "On the Ground" Activities						
16. Regulate Malibu Lagoon water levels while minimizing the impacts to local habitats and species.	☑				☑	
17. Prevent/reduce sedimentation along stream banks, roadways and at construction sites.	☑			☑	☑	☑
18. Identify locations for and create buffer zones for sensitive habitats watershed-wide. Promote the need for buffer zones at the municipal, county and state level.				☑	☑	
19. Remove exotic plant, aquatic and animal species in the watershed. Prioritize the most prolific and invasive species for removal first.					☑	
20. Remove barriers to fish migration, particularly in the lower watershed, and enhance fish habitats.					☑	
21. Improve and increase wetlands habitat in the lower watershed.					☑	
22. Enhance bird habitats in Lower Malibu Creek and Lagoon. Consider: • Preventing human and pet intrusion; • Placement of informative/warning signs; • Education of lifeguards and beach-goers; • Removal of invasive species, planting of native species; • Trash can lids; and • Appropriate lagoon water levels.	☑				☑	☑

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
23. Reduce trash inputs into the watershed. Consider: • Requiring outdoor, bird-proof lids in parks, and at beaches and restaurants/shopping centers. • Installing more trash cans where needed in parklands and at beaches. • Promoting/expanding comprehensive recycling programs for paper cardboard, plastics, aluminum and glass • Establishing a permanent recycling center for all watershed residents. • Posting bilingual informative signs in areas most frequently visited.					☑	☑
24. Reduce sources of nutrients, pathogens and bacteria into the watershed. Specifically: • Implement livestock BMPs for horse owners. See #7 above. • Implement siting, monitoring, maintenance, replacement requirements and inspection programs for septic systems. Establish discharge standards for septic system effluent. • Storm drain discharges: identify and eliminate sources entering storm drains (on-going). • Promote year-round diversion of Tapia effluent from Malibu Creek; improve nutrient removal process; and maximize reuse potential.	☑		☑			☑
25. Identify and eliminate illicit connections on a regular basis.	☑		☑	☑		
26. Reduce impacts of landfill operations on nearby habitats. Implement mitigation measures where necessary.					☑	
27. Develop and conduct both general and focused education programs watershed-wide. Specifically, improve outreach to: • Homeowners about: 1) sources of household waste and their impacts to water quality, and 2) the need for water conservation and runoff reduction. • Contractors and developers about how their activities adversely impact water quality and habitats. Incorporate information on smart developing/designs to retain storm water runoff on site. • Horse and other livestock owners about how animal waste impacts water quality, and ways to minimize this source of pollution. • Septic system users (commercial and residential) about the need for and importance of maintaining appropriately functioning septic systems.	☑		☑			☑

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
28. Promote/mandate water conservation practices by: 1) using native, drought-tolerant plants, 2) installing ultra low flow toilets and irrigation sensors, 3) providing price incentives to reduce water usage, 4) incorporating storm water retention designs into all new construction plans and 5) distributing recycled water to the maximum extent practicable.		☑				
29. Implement the coordinated Malibu Creek Watershed Monitoring Program (developed by the Monitoring and Modeling subcommittee) and develop a centralized database for the monitoring data.	☑					☑

Acronyms

BMPs	Best Management Practices
BRP	Bay Restoration Plan (Santa Monica Bay Restoration Project)
BOD	Biochemical Oxygen Demand
CalTrans	California Department of Transportation
CCC	California Coastal Commission
CDS	Continuous Deflection System
cfs	Cubic feet per second
COG	Council of Governments
CSDLAC	County Sanitation Districts of Los Angeles County
DHS	Los Angeles County Department of Health Services
DO	Dissolved Oxygen
EA	Environmental Assessment
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
EPA 319(h)	U.S. EPA Nonpoint Source Reduction Grant Program
EPA 205(j)	U.S. EPA Water Quality Planning Grant Program
GIS	Geographical Information System
GPS	Global Positioning System
JPA	Joint Powers Authority
LAC-DPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LVMWD	Las Virgenes Municipal Water District
MCW	Malibu Creek Watershed
MEP	Maximum Extent Practicable
mg/l	Milligrams per liter
MTA	Metropolitan Transportation Authority
MWD	Metropolitan Water District
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO_2, NO_3, N	Nitrogen Compounds
NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Service
PIE	Public Involvement and Education
PSA	Public Service Announcement
PSDS	Private Septic Disposal System
RCDSMM	Resource Conservation District of the Santa Monica Mountains
Regional Board	Los Angeles Regional Water Quality Control Board
SCAG	Southern California Association of Governments
SEAs	Significant Ecological Areas
SCS	Soil Conservation Service
SMBRP	Santa Monica Bay Restoration Project
State Parks	California Department of Parks and Recreation

SWRCB	State Water Resources Control Board
RCDSMM	Resource Conservation District of the Santa Monica Mountains
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
UCLA	University of California, Los Angeles
ULFT	Ultra Low Flow Toilets
WDR	Waste Discharge Requirements

Definitions

Best Management Practices	Activities, practices, facilities and/or procedures that when implemented to their maximum efficiency will prevent or reduce pollutants in discharges.
Bathymetry	The science of measuring the depths of the ocean, seas, etc.
Benthic	Organisms living on or in the sea floor.
Bio-criteria	Narrative descriptions or numerical values that are used to describe the reference condition of aquatic biota inhabiting waters of a designated aquatic life use. These criteria are used to determine if waters are affected by chemical pollution or other factors.
Biosolids	The solids portion of human waste removed through primary treatment of wastewater. Formerly called sludge.
BOD	Bio-chemical Oxygen Demand. The amount of dissolved oxygen needed to decompose organic matter in wastewater. A high BOD indicates an impaired waterbody with little oxygen remaining for aquatic life.
Breach (lagoon)	Naturally or artificially breaking open the sand barrier that separates Malibu Lagoon from Santa Monica Bay.
Carnivore	Any of an order of fanged, flesh-eating mammals including the dog, bear, cat and seal.
Catch Basin	A sieve-like device at the entrance to a storm drain system to stop matter from entering which could block up the system.
Clean Water Act (CWA)	The Federal Water Pollution Control Act enacted in 1972 by public law and amended by the Water Quality Act of 1987. The Clean Water Act prohibits the discharge of pollutants to waters of the United States unless said discharge is in accordance with an NPDES permit.
Coliform	Relating to, resembling or being the aerobic bacillus normally found in the colon of humans and animals. A coliform count is often used as an indicator or fecal contamination of water supplies.

Delineation (wetlands)	Identification and/or outline an area which encompasses wetlands.
DO	Dissolved Oxygen. The amount of oxygen present in water. A low DO indicates an impaired waterbody with little oxygen remaining to support aquatic life.
Enterococcus	Any of a genus (streptococcus) of non-motile, usually parasitic, gram positive bacteria occurring in the intestinal tract that may be a cause of disease when found in other parts of the body.
Eutrophication	The process in which a nutrient-rich waterbody becomes degraded due to decreased levels of oxygen caused by excessive growth of bacteria. High eutrophication indicates an impaired waterbody with little or no oxygen remaining to support aquatic life.
Extirpate	To remove or destroy completely; exterminate; abolish.
Grey Water	Wastewater discharged from household sinks, showers, washing machines, dishwashers, etc. that does not come into contact with human waste.
Hydrology	The science dealing with the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, flow to the seas, etc.
Illicit Connection	Any discharge to the storm drain system that is prohibited under local, state or federal statutes, ordinances, codes or regulations. This includes all non-storm water discharges except discharges pursuant to an NPDES permit and discharges that are exempted or conditionally exempted in accordance with section II of the 1996 Municipal Storm Water NPDES permit.
Macroinvertebrate	Larger animals without backbones or spines (e.g., shrimp, lobster).
MBAS	Methyl Buyl Activated Substances. Soap and/or detergent compounds which indicate human inputs into a waterbody. MBAS markers are often found in grey water discharges.

Morphodynamics (Definition for this report only). The constantly changing hydrological conditions associated with the Lower Malibu Creek and Lagoon estuarine system; particular attention is given to the morphodynamics of sand bar formation and breaching occurrences, tidal regime, wave climate and creek flows.

Nonpoint Source Discharge Discharge resulting from widespread, diffuse, or unidentifiable sources of contaminants that comes from more than one point which cannot be controlled or easily monitored.

NPDES National Pollutant Discharge Elimination System. A permit issued by the US Environmental Protection Agency, State Water Resources Control Board or California Regional Water Quality Control Boards pursuant to the Clean Water Act that authorizes discharges to waters of the United States and requires the reduction of pollutants or sets pollutant limits in the discharges.

Nutrients Elements necessary for plant growth. Nitrogen and phosphorus are the most common elements. Excess nutrients in waterbodies can stimulate plant and algae growth.

Pathogen Any agent, especially a microorganism, able to cause disease.

pH A symbol for the degree of acidity or alkalinity of a solution, which ranges from 0 to 14. A neutral substance will have a pH value of 7, which is the value of distilled water. Lower number are acidic and higher numbers are alkaline (basic).

Piezometer Any of various instruments used in measuring pressure or compressibility (e.g., to measure water pressure)

Point Source Discharge Discharge from single, known sources, such as publicly owned treatment works (POTWs) or industrial facilities, from which contaminants enter a waterbody.

Porter Cologne Act An Act passed by the California legislature in 1967, to provide for the orderly and efficient administration of the water resources of the state. Periodic amendments have been made since its original adoption date.

Potable Fit to drink; drinkable.

Primary Treatment A treatment process in which the solids portion of wastewater is allowed to settle out before the remaining effluent is discharged. This process does not remove suspended and colloidal matter.

Proposition A Funds Bond funds totaling $8 million which were approved by Los Angeles County voters in 1994 And 1998. These funds are specifically earmarked for capital improvement projects to prevent or reduce urban runoff pollution from entering Santa Monica Bay and its watershed.

Riparian Habitats Those habitats located adjacent to or living on the bank of a lake, pond, river, creek or stream.

Secondary Treatment A biological treatment process in which effluent that has received primary treatment is further processed to remove about 85% of the BOD and suspended solids present (e.g., trickle filters or anaerobic digestion) before being discharged.

Sedimentation The deposit or formation of sediment. Increased sedimentation into waterbodies can increase turbidity and smother natural spawning grounds.

Spawning Grounds A location where eggs, sperm or young (offspring) are produced or deposited.

Storm-ceptor J An in-situ, non-mechanical device which is positioned to receive and separate out trash and other debris found in storm drain flows before they reach receiving waters.

Taxonomical Classification of plants and animals into natural, related groups based on some common factor of each, as structure, embryology or biochemistry.

Telemetry Transmission of measurements of physical phenomena, such as temperature, to a distant recorder or observer.

Tertiary Treatment A treatment process in which effluent that has received both primary and secondary treatment is further processed to remove nutrients and most of the remaining suspended solids before being discharged.

Turbidity	Muddy or cloudy water from having the sediment stirred up. Increased turbidity reduces the amount of light that can penetrate through the water column.
US EPA 205(j) Grant Funds	United States Environmental Protection Agency. Under section 205(j) of the Clean Water Act, grant funds are provided for water quality planning and assessment projects designed to prevent or reduce the release of pollutants into waters of the United States.
US EPA 319(h) Grant Funds	United States Environmental Protection Agency. Under section 319(h) of the Clean Water Act, grant funds are provided for nonpoint source implementation projects to reduce, prevent or eliminate water pollution and to enhance water quality for waters of the United States.
WDR	Waste Discharge Requirement. Waste discharge conditions adversely affecting waters of the state are regulated by the State and Regional Water Quality Control Boards under the Porter-Cologne Act. Permits, called Waste Discharge Requirements, are issued for discharges not covered under the federal NPDES permit (usually for non-surface water discharges).
Xeriscape	Dry landscaping.

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- City of Calabasas
- City of Malibu
- City of Thousand Oaks
- City of Westlake Village
- County of Los Angeles, Fire Department
- County of Los Angeles, Department of Health Services
- County of Los Angeles, Department of Public Works
- Heal the Bay
- Las Virgenes Municipal Water District
- Los Angeles Regional Water Quality Control Board
- Malibu Lands Coastal Conservancy
- National Park Service, Santa Monica Mountains National Recreation Area
- Resource Conservation District of the Santa Monica Mountains
- Santa Monica Audubon
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CITY of CALABASAS

LAS VIRGENES CREEK

POLLUTION SOURCE INVESTIGATION

By: Matt Horns
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May 2007

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INTRODUCTION

Las Virgenes Creek is the largest tributary to Malibu Creek, which is the second-largest stream flowing into Santa Monica Bay. The City of Calabasas straddles Las Virgenes Creek's middle reach for a distance of 3.5 miles. The creek's watershed is relatively pristine upstream from Calabasas. Several water quality monitoring programs have determined that water quality is typically good upstream from Calabasas and becomes impaired as it flows through the city.

Las Virgenes Creek is listed with the following impairments by the Los Angeles Regional Water Quality Control Board (LARWQCB):

Coliform
Nutrients (algae)
Organic enrichment/low dissolved oxygen
Scum/foam, sedimentation/siltation
Selenium
Trash

Sedimentation/siltation is described as having an "unknown source" and the others a "nonpoint source."

TMDL's for some of these parameters have either not yet been established or are subject to change.

Other water quality monitoring projects that sample in Calabasas have included Las Virgenes Creek in the context of Malibu Creek's watershed, the Santa Monica Bay, or other more regional perspectives. This investigation concentrates on water quality within and adjacent to Calabasas. It is not intended to determine where TMDL exceedances occur. This study is an effort to determine sources of listed pollutants within the City of Calabasas. Data from this study will be used in the City's efforts to improve water quality in Las Virgenes Creek.

<u>Potential influences to water quality within Calabasas:</u>

Roads
Urban, suburban, and rural residences
Livestock grazing
Equestrian activities
Imported domestic water
Reclaimed water irrigation
Sewage sludge used as a soil amendment

Pollutants potentially associated with influences listed above (EPA 1993):

Sediment
Petroleum products
Nutrients
Bacteria
Trash
Pesticides
Herbicides

Land uses outside Calabasas but within the upper watershed that have the potential to influence water quality include:

Liberty Canyon Landfill
Rocketdyne Space Research Facility
Horticulture (A commercial nursery upstream from Calabasas has been closed for several decades)

Pollutants potentially associated with these land uses include (EPA 1993)::

Perchlorate
Radioactive substances
Nutrients
Herbicides
Pasticides
Toluene
A wide range of other toxics

The Malibu Creek Water Monitoring Project (MCWMP) samples Las Virgenes Creek both upstream from Calabasas (at the Los Angeles-Ventura County Line) and downstream (at De Anza Park) (Reinhart and Medlin, 2006). Consistently low pollution loads upstream from the city and much higher loads downstream strongly suggest the existence of persistent sources of water quality impairment within the City of Calabasas.

Heal the Bay's Malibu Creek Stream Team sampled Las Virgenes Creek during the early 2000's just upstream from A.E. Wright Middle School and at a site approximately 1 km upstream from the Los Angeles-Ventura County Line (Abramson, 2002). The Stream Team also mapped portions of the stream bed with high embeddedness (fine-grain sedimentation) and with greater than 30% algae cover in the entire reach of Las Virgenes Creek that flows through Calabasas. They found consistently high nutrient loads, bacteria loads, sedimentation, and algae cover within Calabasas. Upstream from Calabasas, the stream had high sediment loads but much lower amounts of bacteria, nutrients, and algae.

Heal the Bay's data suggests that in addition to bacteria, persistent sources of nutrients also exist within the City of Calabasas.

BENEFICIAL USES

The United States Environmental Protection Agency (EPA) determined that Las Virgenes Creek has the following "Beneficial Uses":

REC 1	Water contact activities such as swimming and fishing.
WARM	Warm water fisheries (bass, bluegill, catfish, et. cet.) habitat
WILD	Wildlife habitat
RARE	Federal and/or State listed Rare and/or Endangered species habitat.
WET	Wetland habitat and/or wetland function

The EPA also designated the following potential beneficial uses:

MUN	Municipal (domestic) water resource
REC 2	Non-water contact activities such as boating
COLD	Cold water fisheries (trout) habitat
MIGR	Migration corridor for aquatic species
SPN	Spawning habitat for aquatic species

The potential beneficial uses COLD, MIGR, and SPN are designated to facilitate the eventual return of wild steelhead trout to Las Virgenes Creek and other Malibu Creek tributaries. Steelhead historically spawned in Las Virgenes Creek's lower reaches (Dagit, 2004) but have been absent since migration access from the ocean was blocked by construction of Rindge Dam on lower Malibu Creek in the 1930"s.

Rindge Dam and surrounding property are now owned by California Department of Parks and Recreation (State Parks) and the agency plans to remove the dam (U.S. Army Corp, 2002). With the dam gone, steelhead trout will again have migration access to Malibu Creek's major tributaries Cold Creek and Las Virgenes Creek. State Parks also has long-range plans to remove two migration restrictions (one concrete culvert road crossing and one small concrete dam) on Las Virgenes Creek downstream from Calabasas.

When those projects are implemented, steelhead trout will have migration access from the ocean upstream to the Lost Hills Road crossing. At that time, all remaining steelhead migration restrictions on Las Virgenes Creek will be within Calabasas.

STUDY METHODS

This study used the same field methods, field instruments, and data sheets used by the Malibu Creek Water Monitoring Program. Lab analysis of water samples was performed by American Environmental Testing Laboratory, Inc.

The following parameters were analyzed to evaluate specific water quality impairments:

IMPAIRMENT	TEST	(units)	Field (F) or LAB (L)
Coliform	Total coliform	(MPN/100ml)	L
	Fecal coliform	(MPN/100ml)	L
Nutrients (algae)	Nitrate as N	(mg/l)	L
	Nitrite as N (mg/l)	(mg/l)	L
	Ammonia as N	(mg/l)	L
	N, total Kjeldahl	(mg/l)	L
Organic enrichment/low DO	Dissolved oxygen	(mg/l)	F
Scum/foam	Surfactants	(mg/l)	L
Sedimentation/siltation	Total susp.	(mg/l)	L
Selenium	Selenium	(ug/l)	L
Trash	Trash	(# of items visible from station)	F

Water quality was analyzed at twenty-nine stations within and upstream from Calabasas:

Ten stations were in Las Virgenes Creek, seven within Calabasas and three upstream from the city boundary.
Seven stations were at storm drain outlets adjacent to Las Virgenes Creek within Calabasas.
Five stations were on tributary streams, two within Calabasas and three upstream from Calabasas.
Two stations were at weep holes where groundwater flows through a hole in a concrete-lined channel from alluvial substrate into the stream channel within Calabasas.
Two stations were at opposite ends of the small pond adjacent to the dog park within Calabasas.
Two stations were in road gutters where runoff flowed from the road surface into a storm drain catchment basin.
One station was at small perennial pond at a suspected reclaimed irrigation water leak.

Sampling was performed from 1 November 2006 through 11 March 2007. No major storms occurred during this time, but several minor storms generated small amounts of runoff**.**

DATA and DISCUSSION

Coliform bacteria

Las Virgenes Creek downstream from Calabasas is a popular family picnicking and swimming destination during the summer season. With the presence of people, especially children, in the water, bacteria pollution in Las Virgenes Creek presents a potential public health hazard.

Coliform TMDL's for fresh water in Southern California are not yet determined. The marine water TMDL of 1000MPN/100ml is used for the purpose of discussion in this report,

Three rounds of bacteria sampling were conducted. Results from the first round are presented below. Where stations were sampled twice, both values are included.

STATION	TOTAL COLIFORM MPN/100ml
LAS VIRGENES CR	
LVA	>1,600 33.0
LVB	34.0 900
LVC	>1,600
LVD	>160,000 170
LVE	50000 350
LVF	21 ND
LVG	50
LVG REP	>1,600
LVI	>1,600
LVII	>1,600

STORM DRAINS	TOTAL COLIFORM MPN/100ml
SDA	>1,600
SDB	>1,600
SDC	>1,600 23,000
SDH	>1,600
SDI	>1,600

TRIBUTARY STREAMS	TOTAL COLIFORM MPN/100ml
TSA "101" Creek	300 230
TSB	300 ND

Gates Creek	
TSC	24,000
Sulfur spring at confluence	
TSD	<2.0
Sulfur spring outlet	
TSE	>1,600
East LV Creek	
TSE REP	>1,600

This investigation initially tested samples for total coliform only. High coliform loads (>1000MPN/100ml) were found in 19 out of 38 samples. 8 out of nine stations sampled on Las Virgenes Creek in November exceeded 1000MPN/100ml. This included 5 out of 5 stations within Calabasas.

Exceedances for coliform were found in 5 out of 6 stations in the open space north of (and upstream from) the northern Calabasas boundary.

Five station on Las Virgenes Creek (LVA, LVB, LVC, LVD, and LVE) were sampled in both November and December. In November four out of these five samples exceeded the Marine TMDL, but none exceeded the standard in December. This suggests that the November sampling sessions could be considered to some extent "First Flush" events.

All six samples collected from storm drains downstream from Gates Creek (adjacent to City Hall) had coliform exceedances. All three storm drain discharges upstream from Gates Creek had low or non-detect coliform levels.

Discharge from the storm drain on Lost Hills Road with the dry weather diversion system (SDB) exceeded the TMDL for coliform (>1,600 MPN/100ml) during relatively dry weather. At the time of sampling, this system was not operating.

Four tributary streams were sampled just upstream of their confluences with Las Virgenes Creek. These include the trib that parallels the 101 freeway (TSA), Gates Creek (TSB), the sulfur spring just north of the county line (TSC), and East Las Virgenes Creek (TSE). Samples from East Las Virgenes Creek and the sulfur spring (both upstream from Calabasas) had coliform exceedances. The two tribs that meet Las Virgenes Creek near City Hall had low coliform loads.

Both samples collected from road gutters (AM and PSR) had high coliform loads (>1,600 MPN/100ml). The water sampled at these stations was runoff from landscaped areas that had been over-watered and from sprinklers that spray water directly onto paved surfaces. In a very short amount of time (only a minute or less at Station PSRI) the water apparently picked up coliform and transported it into the storm drain system.

Sample AI also had a very high coliform load. Station AI is a small pool of standing water (~ 1ft x 1ft x 2 inches deep) on the top of the streambank adjacent to the Archstone residential community just south of Meadowcreek Lane. This is a persistently saturated area covered with grass turf and irrigated with LVMWD's reclaimed water. I have observed this feature for several years and it has been saturated at all times of year, even through the hottest driest summers.

To summarize, coliform bacteria is widespread throughout the city. Potential sources of coliform are waste from birds, dogs, and other animals, trash and litter, and decomposing vegetation. Coliform was so prevalent in our water samples that our bacteria data gave little insight concerning potential bacteria pollution sources.

An additional round of bacteria sampling was performed on 1 March 2007 to answer the many questions left unanswered by the initial investigation. Samples were collected from twenty stations and were analyzed for E. coli, fecal enterococcus, fecal coliform, and total coliform.

Bacteria data are presented in the following table. Station types (e.g. storm drain, weep hole) are listed separated and in order progressing downstream. The total stream segment sampled for this event includes the entire reach within the City of Calabasas, extending from De Anza Park (at the downstream boundary of the city), north (upstream) to the Los Angeles-Ventura County Line.

STATION	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
LV CREEK				
LVE	ND	12.0	23.0	23.0
LV3	ND	16.1	>23.0	>23.0
LVD	1.1	12.0	>23.0	>23.0
LVC	ND	3.6	>23.0	>23.0
LV12	ND	3.6	>23.0	>23.0
LVII	2.2	9.2	>23.0	>23.0
LV15	ND	5.1	>23.0	>23.0
LVB	1.1	6.9	>23.0	>23.0
LVA	1.1	9.2	>23.0	>23.0
LV 20	2.2	NA	>23.0	>23.0
STORM	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
DRAINS	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
SD M	ND	12.0	>23.0	>23.0
SDC	ND	6.9	>23.0	>23.0
SDJ	>23.0	9.2	>23.0	>23.0
SDI	ND	5.1	>23.0	>23.0
SDH	ND	6.9	>23.0	>23.0
SDB	ND	9.2	>23.0	>23.0
SDA	3.6	>23.0	>23.0	>23.0
TRIBUTARY	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
STREAMS	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
TSB	ND	9.2	>23.0	>23.0
TSA	2.2	9.2	>23.0	>23.0
WEEP	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
HOLE	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
WH1	ND	ND	>23.0	>23.0

Dilutions used for analysis of these samples gave a maximum value of 23 MPN/100 ml. With the exception of the sample from WH2, which tested "non-detect" for total coliform and fecal coliform, all samples equaled or exceeded this threshold for both parameters.

Dilutions used to analyze the 1 March samples were insufficient to produce meaningful data for the purpose of delineating coliform sources. As a result, a third round of bacteria testing was performed at ten stations on 29 March 2007. these samples were analyzed for both total coliform and fecal coliform. Results are presented in the table below.

STATION		
LV CREEK	**TOTAL COLIFORM**	**FECAL COLIFORM**
LVA	5,000	80.0
STORM	**TOTAL COLIFORM**	**FECAL COLIFORM**
DRAINS	MPN/100ML	MPN/100ML
SDA	8,000	900
SD B	>160,000	2,400
SDC	1,700	19.0
SDH	7,000	3,000
SDI	2,400	2,400
SDJ	50,000	50,000
TRIBUTARY	**TOTAL COLIFORM**	**FECAL COLIFORM**
STREAMS	MPN/100ML	MPN/100ML
TSB	3,000	140
WEEP	**TOTAL COLIFORM**	**FECAL COLIFORM**
HOLE	MPN/100ML	MPN/100ML
WH2	ND	ND

<u>Discussion of bacteria data</u>

When water is deposited on permeable soil surfaces much of it percolates into the ground Any bacteria in the soil, in the water, or on the ground surface that is mobilized by the water is transported downward into the soil. Water that is not utilized by evapo-transpiration or adsorbed to soil particles continues downward through soil and substrate until it eventually enters the groundwater. The aquifer along Las Virgenes Creek is shallow and is hydrologically connected to the creek through highly permeable alluvium, so at least a portion of the groundwater in this aquifer will eventually seep into Las Virgenes Creek. Ideally, during its movement from the ground surface to the stream channel, microbial activity and filtration through the soil removes pathogens from the water.

Water deposited on impermeable surfaces quickly washes away any bacteria present on the ground surface. Ideally, bacteria-laden runoff is directed onto a permeable area where it percolates into the ground. If there is no opportunity for infiltration, the runoff washes the bacteria into a storm drain and then into the creek.

Our coliform data for storm discharge suggests that there are not sufficient opportunities for runoff to infiltrate into the ground to prevent bacteria-laden runoff from flowing through storm drains into Las Virgenes Creek.

Runoff data from stations upstream from Calabasas, however, could be interpreted as a contradiction to the abovementioned conclusion. Total coliform was the only bacteria parameter tested in this study, and total coliform exceedances were found at 5 out of 6 stations upstream from Calabasas that drained relatively pristine watersheds. The only station upstream from Calabasas without a coliform TMDL exceedence was at the outlet of the sulfur spring, where discharge had no exposure to surficial conditions before samples were collected.

Sedimentation / Siltation

Water samples collected during this investigation were analyzed for total suspended solids (TSS) and most were found to contain little or no sediment.

9 samples from Las Virgenes Creek within Calabasas ranged from non-detect to 11 mg/L.

6 samples from Las Virgenes Creek upstream from Calabasas ranged from non-detect to 77 mg/L.

8 samples from storm drains ranged from 7 to 256 mg/L.

2 samples collected from road gutters had the highest TSS levels (AI: 1,520 mg/L and AM: 2,580 mg/L).

Erosion and sedimentation processes are most active during rain storms. No significant storm events occurred during the time of this investigation, so as a result no meaningful sediment data was obtained.

Image 1: East bank at Station LVH

Despite the lack of suspended sediment data, geomorphic features observed along the stream channel during the investigation offer clues regarding Las Virgenes Creek's long-term sedimentation and erosion processes.

Las Virgenes Creek's erosion/sedimentation processes are quite complex, as exhibited by the photo above of the stream bank at Station LVG. The light-colored horizontal bands are a succession of sandy sediment layers that are strengthened against erosion by root systems that developed soon after the sediment layers were deposited. This series of sediment layers represent a time period during which sediment was accumulating in the channel and the stream bed elevation was rising.

Image 2

The photo above is looking downstream at the same location as Image 1. Willow roots that originally grew in the stream bed are now elevated several feet above the thalweg. These exposed tree roots demonstrate that the stream is now downcutting. That is, sediment is now being flushed out of the channel and the stream bed elevation is declining.

While no evidence for the causes of features described above was gathered during this investigation, the processes they suggest are typical of stream channels impacted by urban development. Soil grading associated with urban construction typically generates large amounts of sediments that are stored in the channel. When construction is completed, graded areas that have experienced erosion are replaced by pavement and homes. These impervious surfaces increase storm water runoff and reduce sediment input. Subsequent storm runoff events tend to deliver increased amounts of water and reduced amounts of sediment to the stream channel, which results in stream downcutting through sediment stored in the channel.

Urban development along Las Virgenes Creek has been accompanied by stream channel alterations, which have further complicated the stream channel’s hydrologic and geomorphic regimes and processes.

If the City of Calabasas wishes to further investigate this issue, information on erosion and sedimentation is available from Heal the Bay’s Malibu Creek Stream Team. The Stream Team conducted a watershed inventory on Las Virgenes Creek from 2003 through 2005, and that project compiled extensive data on erosion and sedimentation on Las Virgenes Creek’s entire length. Heal the Bay’s data was submitted to the Water Board and was considered in their decision to list Las Virgenes Creek for erosion/sedimentation impairment. The author participated in this project.

Stream Team data documents large amounts of sedimentation in the stream channel well upstream from Calabasas, where extensive soil erosion and streambank landslide activity delivers large amounts of sediment into the channel. Sediment generated in Las Virgenes Creek’s undeveloped upper watershed was exacerbated by the 2005 wildfire.

Although Las Virgenes Creek’s slopes are naturally susceptible to soil erosion, anthropogenic activities can increase sediment production from these slopes. During e course of this investigation, bare soil was observed on the steep slope east of the Agoura Rd./ Las Virgenes Rd. intersection. This appears to be caused by overgrazing by livestock including sheep and/or goats.

Organic Enrichment / Low Dissolved Oxygen

The currently-used TMDL for dissolved oxygen (DO) in Las Virgenes Creek is a minimum of 5.0 mg/l. DO was analyzed in the field at each station at the time of sampling. DO levels were acceptable (>5mg/l) at all stations on Las Virgenes Creek within Calabasas. DO below the minimum standard was found in the sulfur spring just upstream from Calabasas (TSC and TSD) and in Las Virgenes Creek (LVE) immediately downstream from the sulfur spring confluence.

Decomposing organic muck up to one foot deep was observed on the stream bed at many of the stations but was not analyzed or tested. This organic enrichment often results from decomposition of large amounts of dead aquatic algae. Heal the Bay’s Malibu Creek Stream Team documented the presence of organic muck with very low DO levels in Las Virgenes Creek from its Malibu Creek confluence upstream to approximately the upstream boundary of the City of Calabasas. They observed much smaller amounts of muck farther upstream. Organic muck on the stream bed is closely associated with organic enrichment/low dissolved oxygen impairment.

Biologic activity in this material can reduce DO levels in the lower water column to zero. Since photosynthesis generates DO, and photosynthesizing algae is prevalent in Las Virgenes Creek, DO levels here are greatly influenced by sunlight intensity. A more thorough DO analysis would include day and night sampling, and would analyze DO through the water column and into any organic muck that lies on the stream bed.

Selenium

Selenium is an element that is essential to health for most organisms. The United Nations World Health Organization recommends a selenium level of 10 ug/L in drinking water for human health. The USEPA standard for selenium is 50 ug/L and other entities recommend a standard of 5 ug/L. Selenium is toxic at higher concentrations and was responsible for the massive bird kill in the 1970’s at Kesterson Wildlfe Refuge near Bakersfield, California.

Selenium in Las Virgenes Creek is most likely derived from marine sedimentary bedrock formations that underlie most of the upper watershed. Although this substance occurs naturally in the environment, anthropogenic activities have a large influence on how selenium is stored in sediment and leached into surface water and groundwater.

Selenium was found in all of our samples, ranging from 1.48 to 201 ppb. 33 of a total of 38 samples had more than 5 ug/L selenium. 4 samples had greater than 50 ug/L selenium.

Previous research by Dr. Hibbs suggests that where selenium is present in insoluble forms in the sediment, nitrate in the water tends to convert these bound selenium compounds into soluble forms which results in increased selenium levels in surface water. Perhaps not coincidentally, the sample (WH1) that had the highest selenium (201 ug/L) also had the highest nitrate load (8.15 mg/L).

Dr. Hibbs conducted A study of selenium and nitrate in Las Virgenes Creek in early 2007 (Hibbs and Andrus, 2007). Most of the samples analyzed were shallow groundwater collected from weep holes in concrete-lined stream banks along Las Virgenes Creek within the City of Calabasas. City Environmental Services Division has a digital copy of his report on its computer “f drive.”

Hibbs’ research results are described below in the section on nutrients (algae), organic enrichment / low dissolved oxygen and scum / foam.

Nutrients (algae), Organic Enrichment / Low Dissolved Oxygen and Scum / Foam

These impairments are closely related because increased nutrients results in more algae growth in the stream. Algae blooms, then dies. Decomposition of the dead algae contributes to organic enrichment, low dissolved oxygen, and increased scum/foam.

Nitrate concentrations greater than 1mg/L were found in many samples from storm drains. These samples had high conductivity (2+milliseimens) suggestive of locally-derived (not imported) water.

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Hibbs' research project determined that shallow groundwater is a major source of both selenium and nitrate. Conductivity and sulfate/chloride ratios identify this groundwater as locally-derived and not imported water. Thus, the high levels of selenium and nitrate are not associated with urban runoff.

Farming occurred over much of the Las Virgenes valley bottom within Calabasas where residential areas now exist. Hibbs identified this past legacy of farming activity as a possible source of nitrate now found in shallow groundwater in the area.

Trash

While working in Las Virgenes Creek for several years, the author has observed an annual cycle in which trash accumulates in the stream channel during periods of dry weather, and then much of it is flushed out of the stream during high winter storm flows. Since plastic debris gets caught on trees and shrubs, riparian vegetation plays a large role in trash storage in the channel. High-water levels from past storm runoff events are often apparent from the "high trash level" remaining in streamside vegetation.

High stream flow events effectively removed most trash from Las Virgenes Creek during the winter of 2005-2006, leaving the channel quite clean at the beginning of 2006's summer season. The City of Calabasas conducted a community volunteer creek cleanup during the summer of 2006 which further reduced the amount of trash in Las Virgenes Creek.

At the time of sampling for this project, trash had been allowed to accumulate for several months in what had essentially been a clean stream channel. This afforded a good opportunity to observe locations where trash had recently been deposited, dumped, and/or transported into the creek.

Trash was evaluated in the field during sampling events by counting the number of pieces visible from the sampling location. At most of the stations, small amounts of trash (0-5 items) were observed. 10 items were found in the channel just upstream from the Meadowcreek Road crossing (LVB).

A large amount (~100 items) of trash was observed just upstream from the Las Virgenes Road crossing (LVC). This station is at the downstream end of a long reach of concrete-lined channel where a lack of vegetation or other obstacles allows trash to easily move downstream. Streamside vegetation at LVC tends to catch trash that has washed down from the concrete lined channel immediately upstream.

Large amounts of trash were consistently observed in the tributary channel adjacent to the trash bins at the southwest corner of the parking lot at the business park on the southeast corner of the Las Virgenes Road/Mureau Road intersection. The trash bins have been observed to be closed, but somehow trash seems to be scattered from these bins into the adjacent stream channel.

Large amounts of trash were consistently observed at storm drain outlets downstream from Calabasas City Hall. At stations SDA, SDB, SDC, and SDH, 15-50 items were observed.

Our trash data suggests that trash in Las Virgenes Creek is not dumped directly into the creek, but is instead is transported into the stream through storm drains and other processes.

RECOMMENDATIONS FOR MITIGATING IMPAIRMENTS

NITRATE

This study did not determine the source(s) of nitrate that finds its way into Las Virgenes Creek. Highest levels were found in shallow groundwater that seeps into the creek through countless seeps, springs, and weep holes (see Hibbs and Andrus 2007). Reducing this most significant source is problematic.

Samples from storm drains also contained nitrate, in concentrations up to 4+ mg/L. Reducing storm drain discharge, therefore, will reduce the amount of nitrate that reaches Las Virgenes Creek. See the following section on bacteria for ways to reduce storm drain discharge and urban runoff.

BACTERIA

Two of the samples highest in Coliform bacteria (50,000 and >160,000 MPN/100 ml) was collected from Las Virgenes Creek and East Las Virgenes Creek in some of the most pristine locations sampled. Based on these data, it seems that Total Coliform bacteria alone is not an appropriate measure of bacteria pollution in Las Virgenes Creek.

Fecal coliform/Total coliform ratios might be a better measure of water quality. Results from our Fecal coliform/Total coliform testing are given in the table below.

STATION		
LV CREEK	**TOTAL COLIFORM**	**FECAL COLIFORM**
LVA	5,000	80.0
STORM	**TOTAL COLIFORM**	**FECAL COLIFORM**
DRAINS	MPN/100ML	MPN/100ML
SDA	8,000	900
SD B	>160,000	2,400
SDC	1,700	19.0
SDH	7,000	3,000
SDI	2,400	2,400
SDJ	50,000	50,000
TRIBUTARY	**TOTAL COLIFORM**	**FECAL COLIFORM**
STREAMS	MPN/100ML	MPN/100ML
TSB	3,000	140
WEEP	**TOTAL COLIFORM**	**FECAL COLIFORM**
HOLE	MPN/100ML	MPN/100ML
WH2	ND	ND

Fecal coliform is seen in all storm drain samples but is absent from the sample from the weep hole. Some storm drain discharge is from urban runoff, and some is from groundwater seepage. Even if much of the dry-weather storm drain discharge is from groundwater seepage, the volume of this bacteria laden discharge into Las Virgenes Creek can be reduced by reducing urban runoff.

Urban runoff is responsible for numerous water quality impairments, including erosion/sedimentation, coliform, and nutrients. Reducing the amount of urban runoff that reaches the creek will help reduce all of these problems.

Storm drain diversions

An increasingly popular method to mitigate bacteria is installing storm drain diversions that direct runoff into the sewage treatment system. Their performance does not always meet water quality goals. As City Staff gains experience with the Lost Hills storm drain diversion, costs can be reduced and benefits enhanced. Lessons learned operating this facility can be applied to additional storm drains that deliver chronically-polluted water to Las Virgenes Creek.

Preventing runoff from impervious surfaces into storm drains and watercourses will reduce the amount of coliform entering the creek. Infiltration structures that serve this purpose are gaining in popularity, and are becoming more effective as experience with them grows. When properly designed and constructed, infiltration structures allow bacteria-laden irrigation water and first-flush rainfall runoff to percolate into the ground before it can enter a storm drain or watercourse.

Infiltration structures

Infiltration structures typically consist of gravel backfilled holes or trenches sunk into well-drained soils. They are commonly used to prevent off-property runoff from roof gutters. Infiltration structures are increasingly being installed along the downslope edges of parking lots to prevent parking lot runoff, with its automobile-derived toxics, from flowing off-site. Infiltration structures could also be located beneath road gutters adjacent to storm drain inlets that have a rigid but permeable cover.

Infiltration structures are potentially an effective way to reduce storm drain discharge. Such structures are already required on new construction. Although not required to do by existing laws, landowners have a strong incentive to add them to the margins of preexisting parking lots and driveways. Many private business are increasingly striving for a “Green” image, since that image makes them more attractive to potential customers and clients. If the City of Calabasas partners with private businesses to help design, install, and even fund such structures, their cost could be minimized. Installing these structures to infiltrate runoff from all impervious surfaces on private property would benefit the entire community.

The City could also investigate the possibility of designing infiltration structures at storm drain inlets. These would allow low flows in street gutters as well as “first flush” runoff from rainstorms to flow through a grate just upstream from storm drain inlets and into the ground. The author has never seen such a structure, but it’s design seems relatively simple and costs seem reasonable. City engineers could look into this possibility.

Treatment Wetlands

As in just about all communities, dog waste is perceived as a source of coliform pollution. The Dog Park pond tested clean for coliform, which suggests that this treatment wetland is effective at preventing the discharge of coliform into the creek. Treatment wetlands are applied in numerous scenarios to mitigate a multitude of water quality problems. Calabasas staff should investigate other possible applications of treatment wetlands throughout the city.

Public Education

Several instances were observed during sampling events where water from irrigation on landscaped areas was flowing into sidewalks and streets, and parking lots and flowing into a storm drain. This practice adds considerably to the volume of urban runoff discharged into the receiving water body, in this case Las Virgenes Creek. This practice is also easily prevented by proper watering system design and use.

An extreme example of over-watering was observed on 8 December at the south end of Poppyseed Lane.

Image 3: Irrigation runoff at south end of Poppyseed lane entering a storm drain

Image 4: Runoff from Poppyseed Lane entering Las Virgenes Creek

Urban runoff could most likely be reduced significantly if people that construct and use watering systems are educated in the problems caused by over-watering and misdirected sprinklers. Once they are aware of the problem, they can easily avoid sending irrigation water down the storm drain system.

Problems with over-irrigation can be located by driving around the city looking for irrigation-derived runoff and/or by utilizing LVMWD's system for identifying customers that use excessive amounts of water.

EROSION / SEDIMENTATION

Although much of the sediment in Las Virgenes Creek may be produced by natural processes, Las Virgenes Creek's listing for erosion/sedimentation impairment require the City to take every reasonable precaution to avoid adding to the sediment problem.

The EPA published a document titled "Guidance specifying management measures for sources of non-point pollution in coastal waters" (United States Environmental Protection Agency, 1993) that gives an excellent overview on water pollution causes and mitigation. The issues of erosion and sedimentation are well-addressed in that publication.

EPA guidelines mandate that soil characteristics be considered in the design of erosion control BMPs. Much of Calabasas within the Las Virgenes Creek watershed is underlain by fine-grained poorly consolidated marine sedimentary rocks of the Calabasas Formation. Sediment produced by erosion of this material consists primarily of clay, silt, and fine sand. When it is entrained in turbulent flow, gravity drives these fine particles downward through the water column very slowly. It settles to the bottom after a significant amount of time in standing water.

Stream bank erosion

Stabilize eroding stream banks by employing bioengineering techniques along Las Virgenes Creek from Agoura Road to Lincoln Middle school to enhance stream banks' resistance to bank erosion and bank

Reduce peak flows by enhancing and strictly enforcing regulations that require rainfall storage and/or infiltration. This can be accomplished by increasing the use of pervious asphalt and "grasscrete," settling basins, recharge wells, and other techniques that encourage infiltration.

Soil Erosion from grading sites

Comply with all EPA recommendations:

Consider soil erosion potential.

Cover exposed soil surfaces.

Construct soil traps and/or settling basins that are sufficient to separate all sediment from runoff before it leaves the site.

Plus, very importantly:
Do not allow winter grading in highly-erodible soils.

TRASH

Storm drains have been observed to be a significant source of trash in Las Virgenes Creek. Possible solutions to this problem include:

1. Increased street sweeping.
2. Trash screens at storm drain inlets.
3. Enhanced public education and awareness in reducing litter.
4. Increased enforcement of anti-litter laws.

Of particular concern is the bridge where Las Virgenes Road crosses Las Virgenes Creek just north of the 101 freeway.

West bank immediately upstream from Las Virgenes Road

Concrete walls along the stream bank at this location are popular among graffiti vandals. They routinely leave spray paint cans, used paint brushes, and even cans partially full of highly toxic oil-bases paint in the stream channel, where it is subject to entrainment by high storm flows.

This problem is not easily solved. Here are a few recommendation, but it can be reduced by:

1 Catching, arresting, and prosecuting vandals.
2 Posting signs that warn of littering penalties and/or explain toxic paint's potential destructive environmental effects.
3 Place a trash bin near the location and post signs imploring graffiti "artists" to use them for their painting debris.

CONCLUSION

Sources of trash in the creek were easily located but will be difficult to mitigate. Causes of other water quality impairments in Las Virgenes Creek are much more complicated than expected at the opening of this investigation. Discreet sources of pollution were not found. Instead, the investigation revealed a complex interaction of water chemistry, urban runoff, past land use practices, local and imported water, and geologic substrate.

Solving many of Las Virgenes Creek's water quality problems requires the expertise of Hydrogeologists, City Engineers, and other water quality professionals. It will also require partnering with private property owners and with other municipalities that have experience solving similar problems.

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Species Profile

Environmental Conservation Online System

(http://www.fws.gov)

Inyo California towhee (Pipilo crissalis eremophilus)

Kingdom: **Animalia** Class: **Aves** Order: **Passeriformes** Family: **Fringillidae**

Listing Status: **Threatened**

Where Listed: WHEREVER FOUND

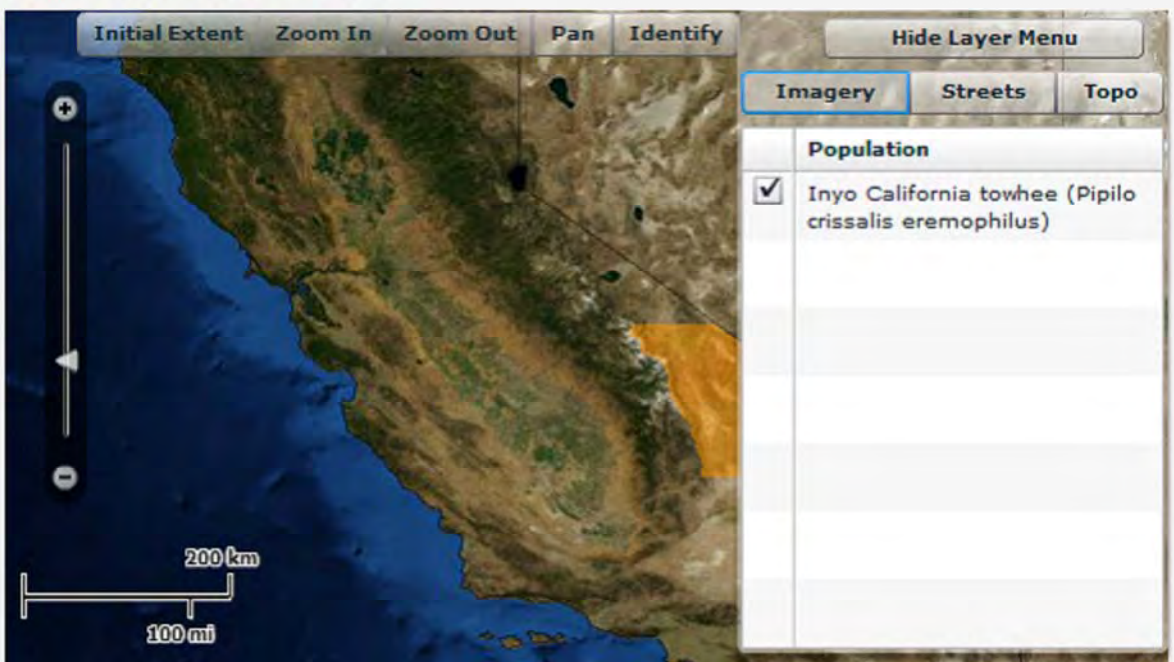
Quick links: Federal Register (#status) Recovery (#recovery) Critical Habitat (#crithab) Conservation Plans (#conservationPlans) Petitions (#petitions) Life History (#lifeHistory) Other Resources (#other)

General Information

Medium-sized songbird. 8-10" (20-25 cm). Uniform gray-brown above and below, with buff or rust-colored undertail coverts. Characteristic long tail with a short, thick, and pointed bill.

This species is listed wherever it is found, but

Map of Species occurrence



This map represents our best available information about where a species is currently known to or is

A Project report:

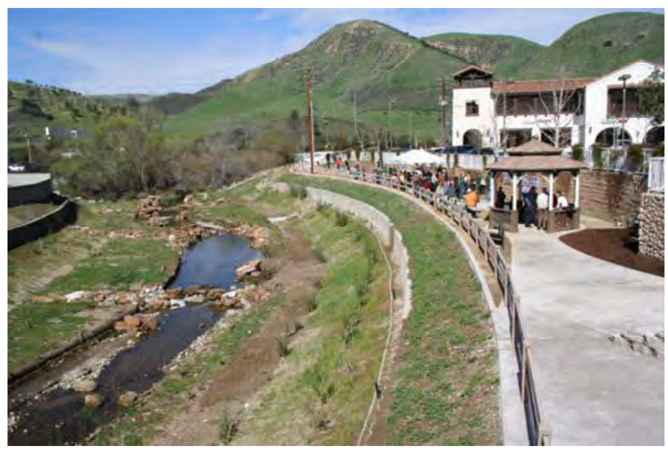
Las Virgenes Creek Restoration Project

Healing a Stream

By: Alex Farassati, Ph.D.
Calabasas Environmental Services Supervisor

Along Las Virgenes Creek in Calabasas, California, passer bys now have a better chance of spotting a deer or turtle rather than trash or graffiti along its banks. The artery within the Malibu Watershed was recently liberated from its concrete shell--installed over three decades ago as a flood control measure-and will once again serve as a habitat-friendly haven for wildlife in the middle of a bustling urban pocket.

Before



After

Since the 1950s, the Los Angeles basin's natural waterways adjacent to developments have regularly been converted to cemented flood control channels to allow for rapid water removal (and the potential for fatal accidents when someone falls in during heavy rains). Urban planners are now realizing that this development practice greatly impacts a stream's natural duties.

In 1977, approximately 440 linear feet of Las Virgenes Creek between Highway 101 and the Agoura Road Bridge was lined with concrete, severely disrupting the wildlife corridor and removing all viable riparian habitats from this once thriving natural creek segment. Cemented-in flood channels have zero habitat value, no water cleansing and generate thermal pollution. The concrete channel removed vegetation and disturbed the creek's natural meander through the landscape.

The Malibu Creek Watershed provides habitats for the southern most documented continuous annual steelhead trout run of the West Coast. In addition to steelhead trout, the watershed provides habitat for arroyo chub, southwestern pond turtle, California slender salamander, California newt, Arroyo toad, Pacific tree frog, American goldfinches, black phoebes, warbling vireos, song sparrows, belted kingfishers, raccoons, ring tailed cats, wrentits, bushtits, California towhees, California thrashers, bobcats, western fence lizards, rattlesnakes, various raptors, coyotes and mountain lions.

This project was identified as a high priority project in the Calabasas Creeks Master Plan and Las Virgenes Gateway Master Plan. It had a regional impact on policy for urban stream restoration in the Santa Monica Mountains.


Concrete Channel built in 1977

The City of Calabasas was successful in securing $1.3 million from the California Coastal Commission California Water Resource Control Board, California Department of Water Resources and Office of Los Angeles County Supervisor for the design and construction of the project. This is the first reach of concrete channel to be targeted for removal in this creek, leading the way toward the future vision of restoring and/or stabilizing the entire length of the Las Virgenes Creek.

Project Objectives

Historically, the Los Angeles basin had many streams that were buried instead of being ecologically engineered into neighborhood design. Natural streams can be brought back and future development should preserve present ones. In 1985, California established an Urban Streams Restoration Program to assist communities with restoring these waterways back to environmental function as well as flood control. While northern California has been taking advantage of the program since its inception, southern California has been slow to participate. The City of Calabasas (located just north of City of Los Angeles) was first in Southern California to accomplish a restoration, which was 10 years in the planning. Since it was a new concept for all the parties involved, the City had no guidelines to follow and spent several years studying the project from every angle--the bioengineering, the ecology, the public safety, and the aesthetics.

As a result of the Creeks Master Plan, the City of Calabasas commissioned a feasibility study to consider alternatives to the existing concrete trapezoidal channel that would facilitate wildlife movement and provide native riparian habitat. The *Feasibility Study for Removal of Concrete Lining in Las Virgenes Creek near Agoura Road* completed in February 2000, concluded that either a gabion structure or concrete block revetment liner would be feasible alternatives to the existing concrete. The City felt this concept was not appropriate and commissioned a second study to re-evaluate the restoration potential. In 2003, Questa Engineering Corp. an Oakland based environmental engineering firm, completed a detailed *Feasibility Study* that under went a public and stakeholder review process, culminating in a City Council approved conceptual design.

The main objective of the restoration was to restore a native creek side habitat, enhance the biological environment, plant native vegetation, and display the importance of environmental stewardship to the community's youth through the addition of an educational gazebo. In addition to providing more native habitat in the region, this project was a high priority for watershed protection because it will help heal some habitat fragmentation in the area.

All objectives of this project are consistent with goals and direction of the Malibu Creek Watershed agencies, nonprofits, and environmentalist. If successful, other interested agencies will be encouraged to restore their own channelized creek segments. This shared vision and opportunity to work incrementally toward full stream restoration from ocean to headwaters will be realized throughout the watershed.

Extensive Feasibility Study

The potential design options were examined considering both technical and practical constraints. The technical analysis and discussion of the design considerations was presented in the report titled: *Preliminary Design and Feasibility Analysis for Restoration, Las Virgenes Creek, Calabasas, California* by Questa Engineering Corporation. This report examined existing geomorphic conditions, located existing utilities, identified right-of-constraints and thoroughly examined several potentially feasible options for concrete channel removal.

The *Feasibility Study* presented the results of Questa Engineering's investigation and analysis of the biologic, geomorphic, and hydraulic conditions within the Las Virgenes Creek Channel in the City of Calabasas, California. The purpose of this study was to gain an understanding of Las Virgenes Creek's channel processes and to determine what factors may lead to a successful restoration strategy.


The design process involved public workshops and design charrettes, City council presentations, and regulatory agency meetings to confirm project design direction and refine the project to achieve a balance between creating functional riparian habitat while still meeting the needs of the community, providing flood control, and ensuring the safety of public infrastructure. The Report provided valuable information and guidance as follows:

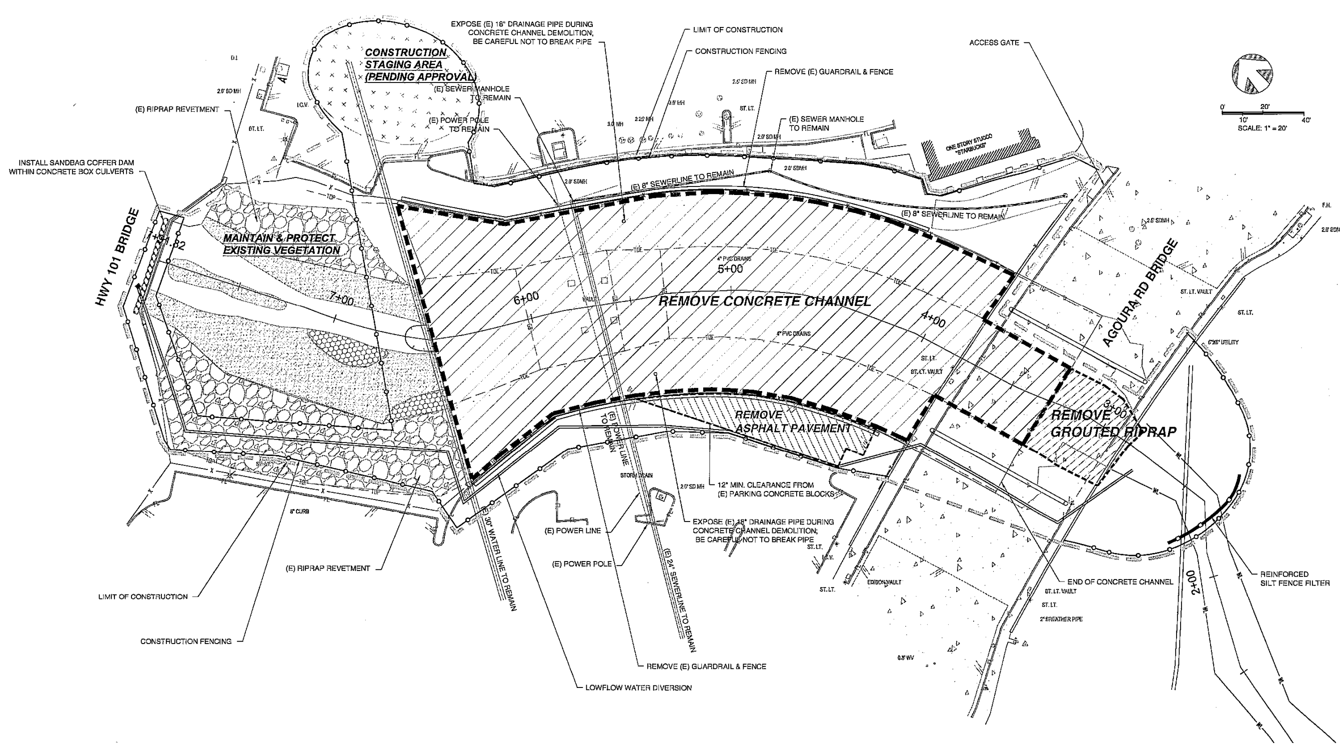
- It described the constraints and realities of urban stream restoration such as existing infrastructure and utility issues,
- A biological database search was conducted for any special status wildlife and plant species within the area,

- The geomorphic analysis examined the existing fluvial geomorphology and adjacent channel geometry parameters to determine appropriate restoration design strategies,
- A detailed topographic survey of the site was completed,
- Hydraulic computer models were developed to quantify existing flow conditions and test various project design alternatives,
- As built drawings of existing facilities, bridge abutments, and utility lines were attained and considered in the design,
- Fish passage conditions and design considerations were discussed and incorporated into analysis.

Additional follow up studies included geotechnical investigations to determine soil properties and detailed engineering design. Compiling all the baseline information and analysis, the report discussed the objectives of the restoration and the potential components of a restoration plan. Finally, the *Feasibility Study* outlined a preferred restoration strategy by combining individual project components to achieve project objectives.

Innovative and Harmonious Design

The final restoration design was based on the approved concept and provided an integrated resources approach that would provide useful riparian habitat while still meeting the flood control requirements through this creek segment. It was chosen from alternatives developed through hydraulic computer models that quantified existing flow conditions. The design of the habitat element of the project was supported through a biological database search for any special status wildlife and plant species within the area. Some important design elements were as follows:



a) Wildlife Protection

The Las Virgenes Creek once provided refuge and a safe passage for wildlife to travel between the Ventura County Open Space and the Malibu Creek State Park. This restoration would re-establish direct connectivity between these two existing riparian communities to the north and south of the concreted segment. The restoration would afford better cover for local wildlife and promotes increased movement of animals and aquatic wildlife up and down the stream course.

b) Public Outreach and Education

The restoration would be used to educate the public regarding urban watershed issues. The project includes a gazebo overlook that would be a public interface with story boards educating visitors about water resource issues and to increase awareness of watershed protection issues and water conservation practices designed to reduce local residential and commercial use of potable water. Messages regarding the importance of water conservation, information on local water use reduction programs and litter prevention was included on the educational panels.

c) Footpath and Trail Connection

The restoration design included a footpath to encourage pedestrian and bike access to the future creek-side park. The establishment of the proposed footpath is part of a larger Trails Master Plan envisioned by the Region and incorporated in the City's General Plan. Easements for the proposed footpath had already been obtained and became part of the Las Virgenes Creek trail that will run northward from Malibu Creek State Park along Las Virgenes Creek, intersecting and following for a short distance the Calabasas/Cold Creek Trail, then continuing north into Las Virgenes Canyon to the upper limits of the Creek in Ventura County.

d) Water Quality Enhancement

This project will restore the biological ecosystem of the Creek by integrating habitat restoration with water quality and public education. It will enhance the water quality of the creek by constructing a vegetated habitat with canopy to deflect the sunlight to reduce dissolved oxygen in the daytime, thereby drastically reducing algal blooms for which this segment has been listed under the Clean Water Act Section 303(d). The planting of native vegetation will partially restore the riparian habitat and tree canopy required for native habitat and ecosystems for wildlife to flourish and travel.

e) Environmentally Harmonious Channel

There are numerous locations throughout this region where flood control agencies have channelized natural stream courses. However, more than 3,600 square yards of concrete was removed from this segment of the creek while recreating the flood control facility in an environmentally harmonious fashion that will undo the wildlife corridor fragmentation, provide essential riparian habitat, protect fish passage, and still provide adequate flood control protection within the confines of the engineered channel that existed there. The success of Las Virgenes Creek Restoration will encourage other interested agencies to restore their own channelized creek segments as well.

Economic Benefits

Investment in public goods like environmental quality can generate very valuable returns, even if they are difficult to measure. Quality of life benefits enjoyed by residents from creek restoration are commonly called non-market goods, because there is no purchase price for them, but they do hold value. The importance of natural amenities and stewardship on homebuyers' location decisions and on young professionals' location decisions should not be underestimated. In fact, many studies have shown that natural and cultural quality of life amenities are increasingly important factors in firm location decisions, particularly for the knowledge-based industries of the New Economy *(Salvesen and Renski, 2002)*. The authors specifically address the unique opportunity for cities in semi-rural regions to attract firms by offering cultural amenities while retaining natural amenities such as clean air, environmental quality, recreation opportunities, and community attitude. As Calabasas works to attract businesses and retain educated young professionals, demonstrating interest in protecting its natural amenities will distinguish it from other cities. Local economic benefits from Las Virgenes Creek restoration can be estimated in three main categories:

A. Local Economic Benefits

They are generated when restoration costs are paid by State restoration funds that circulate as local wages and purchases. Combined with spending planned for the next few years, this project will generate economic benefits to local businesses and residents. Typically, a dollar spent in creek restoration circulates in the local economy approximately 1.28 times—this is called the *multiplier*. The size of multiplier varies depending on location and nature of the economic activity in question. Benefits estimated based on expenditures should be compared with potential benefits forgone from alternative expenditure options.

B. Property Value Boom

Many studies have examined the relationship between environmental restoration and increased property values. Riparian property owners could conservatively expect an immediate increase in property values, generating increased local tax revenues as well. People like to be near water and are willing to pay more to be near water--as "riverfront" real estate often demonstrate. Parks that are improved with naturalization projects also draw more people, which can benefit near-by businesses. Studies can predict how property values would improve after restoration based on similar housing markets near pristine streams or lakes. Research can also follow changes in property values throughout the restoration process, tracking actual improvements. Given experiences of urban stream restoration in other cities, the restored creek could become a property value boom.

C. Sustainable Neighborhood

Benefits accrue to the local economy and to government budgets from future damages that are avoided by restoring the creek. These benefits can include reduced health care costs, reduced infrastructure expansion costs, and sustainable neighborhood development patterns. Some of these benefits will accrue to community residents experiencing an improved quality of life from increased opportunities for passive enjoyment of a restored creek.

To more fully analyze this and all categories of benefits, Las Virgenes creek restoration and naturalization should be considered within a comprehensive and integrated analysis of relevant county and municipal growth and development. Inter-agency development planning can reduce future costs and conflict, advance public private partnerships, and leverage complementary funding sources. This restoration project resolved flood control issues and provided recreational opportunities to the Community.

Achieving the Goal with Limited Budget

Several environmental agencies supported creek restoration efforts, believing it will improve water quality and provide vital resources particularly in the Southern California's arid climate. The State Water Resource Control Board, California Coastal Conservancy, the Department of Water Resources and Office the Los Angeles County Supervisor assisted City of Calabasas with the funding from public bonds through voter-approved propositions directed at the enhancement of the state's diminishing natural areas.

The project design process involved extensive regulatory agency review. This project had been reviewed and permitted by the California Department of Fish and Game, California State Regional Water Quality Control Board, the US Fish and Wildlife Service, the US Army Corps of Engineers and County of Los Angeles Public Works Department and Los Angeles County Flood Control District.

After the design was completed, the cost estimates to implement the project was much more than what initially was assumed. City staff spent thousands of hours to solicit funding from various local and state agencies. Each successful funding commitment was used as match for another funding opportunity, until 90% of the project cost was secured. The other 10% was matched by city either as staff time and construction management. The Project was short listed as one of the 14 priority projects within the County of Los Angeles, as part of the Integrated Regional Water Management Plan (IRWMP).

It was once thought that concrete protected creeks and streams by sending flood water quickly downstream and away from homes and businesses. Now we understand that without trees and shrubs on the banks and stones and rocks in the streambed to slow it down, water flows through these concrete channels so quickly it can cause erosion downstream. And when a stream bank washes away, it takes with it soil and vegetation, which can cause land along to the bank to destabilize and eventually be lost. With this and other restoration projects, communities are starting to realize that these natural waterways should not be turned into sewers. They have multi-objective significance. The project achieved its primary goal: to heal and enhance this part of the natural landscape for ourselves and future generations to enjoy.


Mr. Chris Hooke, vice president of the Ventura Chapter of APWA presenting the Project of the Year Award to the Mayor of Calabasas during the grand opening/dedication ceremony.

Construction Phase

1. Construction Management

The project began on July 27th, 2007 and was completed on schedule by December 18th, 2007. The construction management was critical during this project. Due to the sensitive nature of the project, there needed to be clear and open lines of communication between the City, the design engineer, and the contractor to ensure timely completion of the project, and to resolve field issues before they became costly contract change orders.

The design engineer, Syd Temple of Questa Engineering, worked closely with the contractor, Robert Valdez of Olivas Valdez Inc., during the construction to literally make sure that every rock was in the right place. The exact placement of the rock was critical to the long term stability of the channel. The intent of the design was to replace the concrete channel with a rock lattice. This consisted of a parallel trench dug on both side of the channel, filled with larger boulders, and 5 rock weirs that cut across the channel connecting to the parallel trenches. The rock locks together in a box like structure to keep soil erosion to a minimum. It was vital that the rock in the weir be placed at exact angles so that the force of the falling water would be focused in the center of the channel creating scour ponds. The force of the falling water would churn up the loose soil and thereby keep the ponds from filling up with sediment.

In addition, it was imperative that the coordination between the City Project Manager and the contractor was expedited due to the project starting later in the season. Any issue that might delay construction could have pushed the timeline of the project back and caused the contractor to be working in the channel during the rainy season, which would have created substantial permit issues with Army Corp of Engineers and Department of Fish and Game. City staff worked hard to review and approve all submittals in a timely manner to help the contractor to stay on schedule.

At the same time, City staff worked closely with the design engineer to respond quickly to any design changes that were required in the field. An example of this was a cut off wall that was to be installed under the bridge. The original design called for a cast in place concrete wall to protect the center bridge footing. However, the contractor encountered unforeseen poor soil conditions which made the existing design extremely difficult to construct. The result was a field design change that was implemented within a day. The solution called for grouted riprap to be used instead of the concrete wall. This field change maintained the original design concept and expedited construction.

2. Safety

The project is located next to a busy shopping center with a food court and several commercial office buildings. Based on this, there is a fair amount of both automotive and pedestrian traffic. The main entrance to the site is located just 20 ft from a heavily used driveway entrance, and maintaining normal traffic flow was crucial to the adjacent businesses. Public safety was a primary concern in the pre-construction stages of this project. The contractor performed a careful review of the traffic control plan and devised a system that when truck traffic was leaving the site, a flagman would be used to stop traffic and all pedestrian traffic would be escorted past the site entrance.

In addition to the safety measures, the contractor installed security fencing along the perimeter of the project to secure the site and protect the existing vegetation.

The contractor was very safety conscious. He required his workers to wear safety vests, hard hats and protective gear at all times. However, despite the most vigilant approach to safety, accidents do still occur. In order to remove debris from the channel, a 2 step process was utilized. The lower excavator would place debris in a pile that the upper excavator would then place in the dump truck. In an effort to access some debris, the veteran operator maneuvered too close the back of his platform, lost his stability and rolled the excavator. Fortunately, no one was injured except for some bruised pride.

3. Community Relations

Community relations were a very important element of this project. The project site was bracketed by a busy shopping center on one side, a densely packed office park, and several single family residences nearby, each with a unique concern about the project. City staff consulted with all the local businesses impacted by the project to gage their individual concerns and to create a direct line of communication with the City Project Manager.

On the shopping center side of the project the businesses were concerned that noise and dust from the demolition would create an unpleasant environment for customers. For example, a Starbuck's coffee shop is located just a few feet from the project, and has open terrace seating that overlooks one of the two project access points. The businesses at the other entrance to the job site had similar concerns as well as concerns regarding construction vehicles taking up space in an already crowded parking lot.

To mitigate this, the contractor approached the City with a proposal to do all the channel demolition work in the early morning hours. This was done to protect the workers due to the summer heat and to keep the disruption to the business to a minimum. However, due to the fact that several single family residences were located nearby, this idea was not feasible. This resulted in the contractor working normal construction hours. The parking lane on the bridge was closed to allow for construction parking, and water was used extensively to keep the dust to a minimum. Since the demolition was being performed at a lower elevation than the surrounding populated areas, channel noise was directed upward and was not a nuisance to the surrounding businesses.

On the other side of the channel adjacent to the office park, there was concern, as well. Their employee parking was already tight and the contractor would need access to the parking lot to construct a flood wall. This would involve taking up to 20 parking spaces to create a staging area for equipment. The contractor, City staff, and the property management company for the office park worked together to come to an agreement that would allow the contractor a limited amount of time in which he could access the property and construct the wall.

Despite some initial hesitation by some of the businesses, the strong coordination efforts by the City and the contractor with the businesses paid off, and the City did not receive a single complaint from the adjacent businesses or citizens.

Additional community outreach was implemented through the use of the City's television public access channel which covered the construction extensively and broadcast routine reports on the progress. A local newspaper, The Acorn, published series of articles on the project. City staff received several phone calls from various students requesting information on the project for their own project reports about the creek. Other cities have contacted City staff to inquire how a similar project could be done in their city.

4. Environmental Protection and Awareness

The long term goal of this project is to help restore the creek and generate awareness of the importance of protecting natural open space. A large sign was posted on the bridge crossing the project site and another facing the shopping center informing the public of the project and its purpose. This project also required some protective measures of its own. Netting was placed on the bridge to prevent swallows from nesting and eliminating a problem with the machinery disrupting the birds. The contractor made every effort to minimize the trampling of vegetation by placing security fencing and using established trails when venturing into the wooded creek areas.

Sediment control in the creek and leaving the job site was a very important issue. A water shed of 12 square miles creates flows in the channel all year long. In order for the channel to be demolished and reconstructed, the stream water needed to be captured and then pumped downstream. To achieve this, a settling pond and silt fences were constructed to allow any suspended particles to be deposited so as to not affect water quality downstream. In addition, the contractor would sweep the street after each truck that left the site, and took pride in the fact that he left the job site cleaner than they found it.

5. Unusual and adverse conditions

There were a few noteworthy events that occurred within the project site. The first is that despite the project only being 440 feet long, there are three utility lines that run through the project site. At the upstream end of the project there is a water and wastewater main located under the creek, and a power line runs over it. The water main is located just above the limits of the concrete channel. However, the wastewater main ran under a concrete portion of the channel. The contractor took special care not to damage the sewer when removing the concrete channel lining over the top of it.

After the concrete removal the sewer line was inspected and it suffered no damage. Fortunately, the power pole was located on the bank and due to its elevation was not at risk of being hit by the excavators that were working in the channel. However, one of the power poles did hamper debris removal because it forced the dump trucks to have to use the downstream entrance, which exited directly onto a busy road.

An additional construction challenge was that the contractor was faced with the constant presence of water. Due to the upcoming rainy season the contractor was required to be out of the channel bottom by October 15th. However, Mother Nature doesn't always follow a tight schedule. On Saturday September 22nd the Calabasas area receive a surprise rainstorm. The water shed area upstream is approximately 12 square miles, and the rain water quickly overwhelmed the diversion dam and spilled out on to the bare dirt channel. This resulted in construction being halted for three days while the construction area dried out.

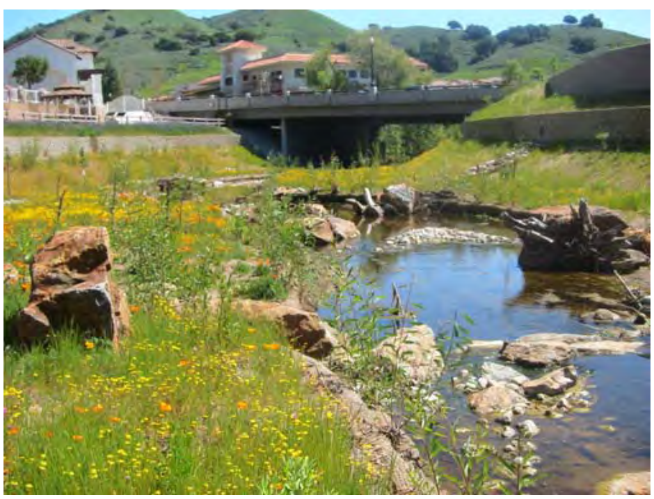
Another source of water is the two drain outlets that feed into the channel. The outlet on the east side of the channel was connected to the parking lot of the shopping center. The shopping center would irrigate extensively at night and all the excess water would run into the channel. The contractor would arrive at the job site every morning to find a muddy mess. A solution was conceived to make use of all the excess water. The contractor used it as temporary irrigation water.

The design called for a five foot trench to be dug on both sides on the channel parallel to the sides for the entire length of the channel. This trench would be filled with large two to four ton boulders that would keep the channel from wandering due to stream bed erosion. Once the boulders were placed, willow stakes were placed around the boulders, followed by smaller rock and finally dirt in a process called “chinking”. In order for the willows to root they needed to be watered. The contractor blocked the outlet on the east side and placed a 4 inch diameter corrugated pipe in the outlet and channeled the water into the pipe. The contractor ran the pipe along the top of the slope above the willow stakes and then perforated the pipe at regular intervals which allowed the water too slowly leak into the trench and keep the willow stakes wet. Thus we managed to utilize all of the wasted water coming from the shopping center parking lot.


The water table was incredibly high on this project. In fact, the only thing keeping the water from surfacing was a two foot thick layer of gravel that was laid down during the initial construction of the channel. Any water that was not captured by the diversionary dam was using the gravel layer as a French drain to make its way downstream. Once the contractor had disturbed this gravel bed, the water surfaced, and created a serious problem at the downstream end of the construction site where it turned the soil conditions to mud. However, it created an opportunity to employ a little ingenuity and value engineering.

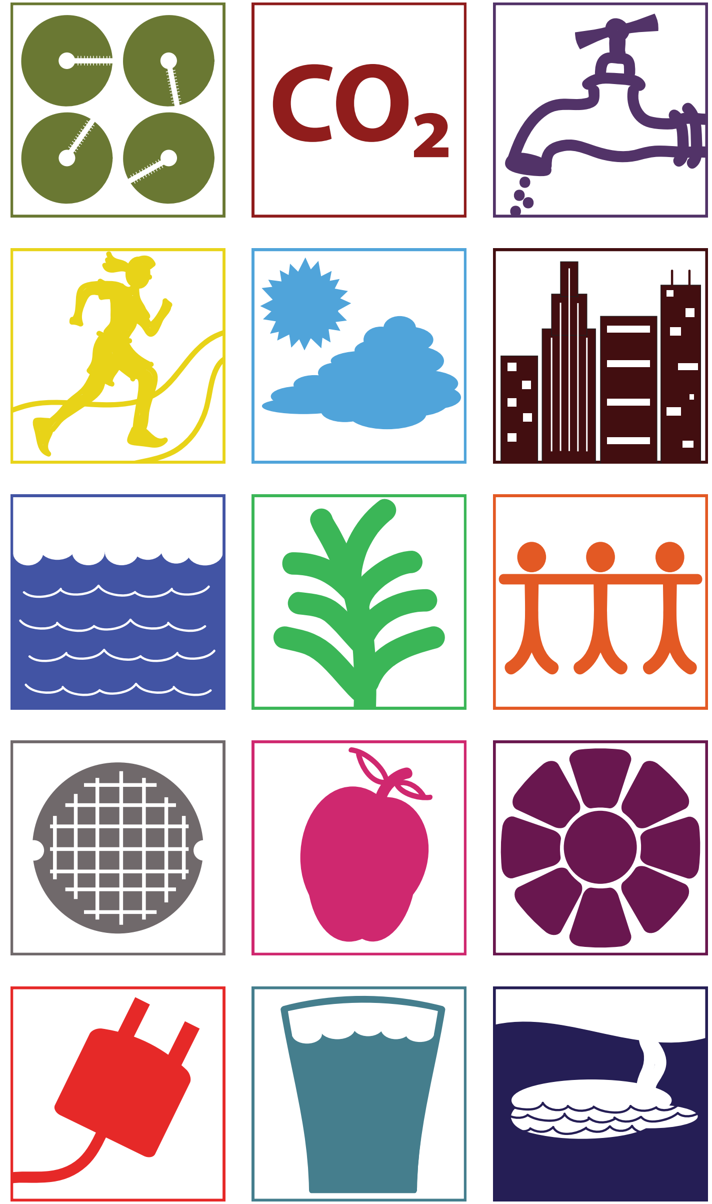
The design called for a concrete cut off wall to be constructed. Due the muddy conditions, this was proving to be very tough. As a result, City staff and the design engineer and came up with a quick and inexpensive design change. The cut off wall design was to be replaced with a grouted riprap. As it turned out the concrete apron under the bridge was not structural but rather ascetics. It was placed to continue the uniform look of the channel.


Design Engineer:	Sydney Temple, Questa Engineering Corp., Pt. Richmond, CA.
Project Manager:	Alex Farassati (City of Calabasas, CA)
Construction Managers:	Larry Edmonson, Todd Evans (City of Calabasas, CA)
Contractor:	Olivas Valdez, Inc. , Covina, CA.



The Value of Green Infrastructure

A Guide to Recognizing Its Economic, Environmental and Social Benefits



CNT

American Rivers
Thriving By Nature

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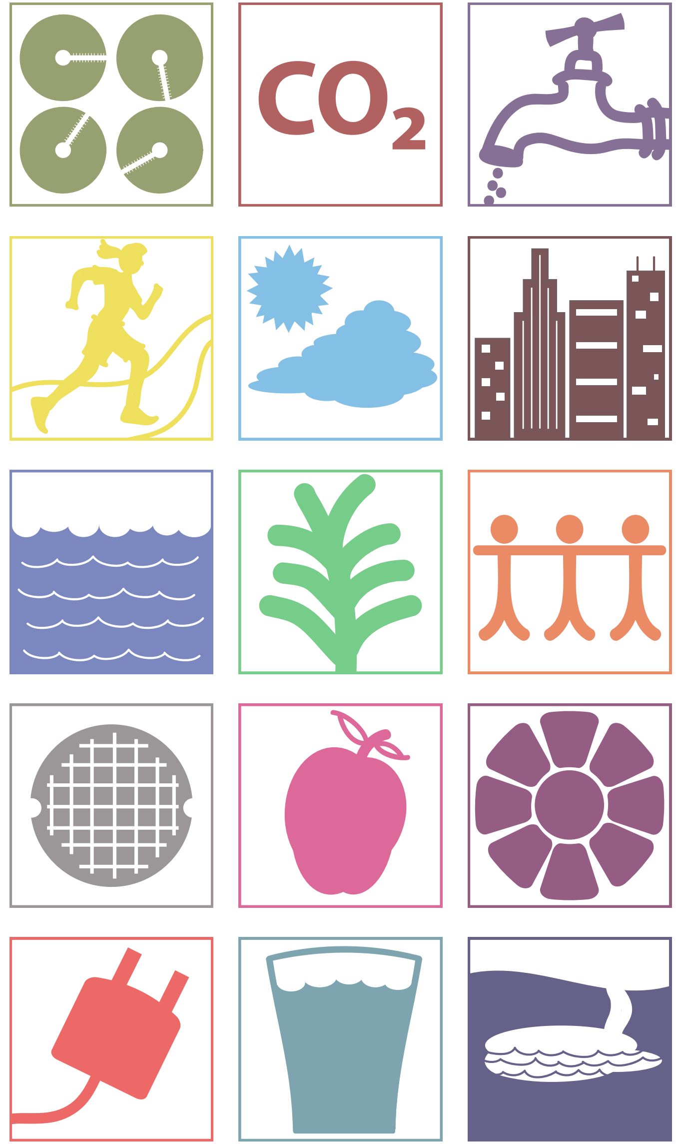


Introduction
What Is Green Infrastructure & Why Does It Matter?

Green infrastructure (GI) is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways. While there are different scales of green infrastructure, such as large swaths of land set aside for preservation, this guide focuses on GI's benefits within the urban context.

The ability of these practices to deliver multiple ecological, economic and social benefits or services has made green infrastructure an increasingly popular strategy in recent years. (See Case Study section.) In addition to reducing polluted stormwater runoff, GI practices can also positively impact energy consumption, air quality, carbon reduction and sequestration, property prices, recreation and other elements of community health and vitality that have monetary or other social value. Moreover, green infrastructure practices provide flexibility to communities faced with the need to adapt infrastructure to a changing climate.

Why This Guide?

Although valuation of green infrastructure's monetary benefits has advanced considerably in recent years, it is still a developing field. The EPA publication *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices* (2007) documented the comparative construction costs of green infrastructure practices in residential construction but did not explore performance benefits. While numerous published studies address either the benefits coming from one type of practice, such as energy implications of green roofs, or the collective impacts of a single practice, such as urban forestry's impact on water, energy, and other elements, such studies do not achieve a cumulative assessment of multiple benefits.

Green infrastructure's value as a municipal or private investment depends in part on its effects beyond water management and thus upon a community's ability to model and measure these additional values. Short of conducting an intensive study and calculation of actions in a specific community, municipalities have generally lacked the tools to determine green infrastructure's multiple benefits. As such, defining or measuring the extent of green infrastructure's multiple benefits has remained a challenge. While a number of cities have begun to explore GI within their own municipal infrastructure programs, no general method for estimating or documenting such benefits has yet emerged.

Due to these gaps in information and methodology, decision-making regarding stormwater infrastructure investments has generally lacked recognition of the monetary benefits that GI provides communities. With limited ability to quantify GI's benefits, municipalities have often favored single-purpose grey infrastructure projects. However, any cost-benefit analysis comparing grey infrastructure with green infrastructure would be incomplete without factoring in the multiple benefits green infrastructure can provide.

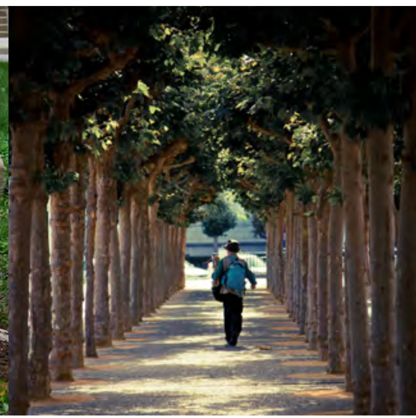
Purpose of the Guide

This guide distills key considerations involved in assessing the economic merits of green infrastructure practices. It examines the steps necessary to calculate a variety of performance benefits gained by implementing GI strategies and then, where possible, demonstrates simplified illustrative examples that estimate the magnitude and value of these benefits.

In clarifying how to assign value to potential green infrastructure benefits, this guide can assist decision-makers in evaluating options for water management. A more clear view of GI's values will help communities decide where, when and to what extent green infrastructure practices should become part of future planning, development and redevelopment.

The guide aims to:

- **Inform decision-makers and planners about the multiple benefits green infrastructure delivers to communities.**
- **Guide communities in valuing the benefits of potential green infrastructure investments.**



Green Infrastructure Benefits and Practices

This section, while not providing a comprehensive list of green infrastructure practices, describes the five GI practices that are the focus of this guide and examines the breadth of benefits this type of infrastructure can offer. The following matrix is an illustrative summary of how these practices can produce different combinations of benefits. Please note that these benefits accrue at varying scales according to local factors such as climate and population.

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Practice										CO_2								
Green Roofs	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Maybe	Maybe	Yes	Yes
Tree Planting	Yes	Yes	Yes	Yes	No	Maybe	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Yes
Bioretention & Infiltration	Yes	Yes	Yes	Yes	Maybe	Maybe	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Maybe	No	Yes	Yes
Permeable Pavement	Yes	Yes	Yes	Yes	No	Maybe	Yes	Maybe	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Water Harvesting	Yes	Yes	Yes	Yes	Yes	Maybe	No	Maybe	Maybe	Maybe	No	No	No	No	No	No	No	Yes

Yes Maybe No

Green Roofs

A green roof is a rooftop that is partially or completely covered with a growing medium and vegetation planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Green roofs are separated into several categories based on the depth of their growing media. **Extensive** green roofs have a growing media depth of two to six inches. **Intensive** green roofs feature growing media depth greater than six inches (GRHC).

As green, or vegetated, roof systems become more prevalent in the United States, the benefits they can provide to a wide range of private and public entities become more apparent. These benefits are outlined below.

Reduces Stormwater Runoff:

- Green roofs can store significant amounts of water in their growing media. This water is eventually evaporated from the soil or transpired by the plants on the roof, thus reducing the runoff entering sewer systems and waterways, which can help alleviate the risk of combined sewer overflows (CSO).

Reduces Energy Use:

- Additional insulation provided by the growing media of a green roof can reduce a building's energy consumption by providing superior insulation compared to conventional roofing materials.
- The presence of plants and growing media reduces the amount of solar radiation reaching the roof's surface, decreasing roof surface temperatures and heat influx during warm-weather months.
- Evaporative cooling from water retained in the growing media reduces roof surface temperatures.

Improves Air Quality:

- Locally, the vegetation planted on green roofs takes up air pollutants and intercepts particulate matter.
- The cooling effect of vegetation lessens smog formation by



slowing the reaction rate of nitrogen oxides and volatile organic compounds.
- By reducing energy use, green roofs lessen the air pollution caused by electricity generation.

Reduces Atmospheric CO_2:
- Green roof vegetation directly sequesters carbon.
- By reducing energy use and the urban heat island effect, green roofs lower carbon dioxide emissions from regional electricity generation.

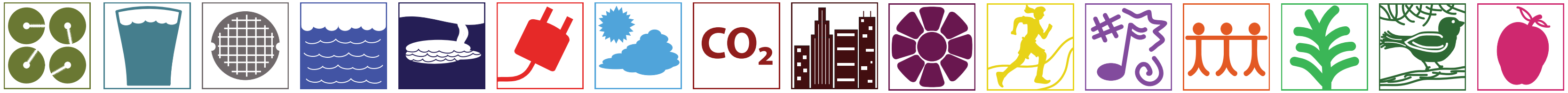
Reduces Urban Heat Island:
- The local evaporative cooling provided by green roofs can reduce elevated temperatures present in urban areas as a result of heat-absorbing surfaces such as streets and conventional roofs.

Improves Community Livability:
- Green roofs improve the local aesthetics of a community.
- Soil and vegetation help reduce sound transmission, thus reducing local noise pollution levels.
- Green roofs can increase recreational opportunities by providing outdoor areas for people to use and enjoy. They also have the potential to foster improved community interactions that help build social capital.
- Green roofs may also provide opportunities for urban agriculture.

Improves Habitat:
- Increased vegetation helps to support biodiversity and provides valuable habitat for a variety of flora and fauna.

Cultivates Public Education Opportunities:
- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- Green roofs increase community interest in green infrastructure through their aesthetic appeal, which provides a great opportunity for public education.

Tree Planting



Planting trees provides many services which have ecological, economic and social implications. Whether measured on a tree-by-tree basis or on a larger scale such as an urban forest, tree planting has a multitude of benefits.

Reduces Stormwater Runoff:

- Trees intercept rainfall and help increase infiltration and the ability of soil to store water.
- Tree canopies diminish the impact of raindrops on barren surfaces.
- Transpiration through leaves minimizes soil moisture, which reduces runoff.

Increases Groundwater Recharge:

- Trees can contribute to local aquifer recharge and to the improvement of watershed system health, from both quantity and quality standpoints.

Reduces Energy Use:

- When properly placed, trees provide shade, which can help cool the air and reduce the amount of heat reaching and being absorbed by buildings. In warm weather, this can reduce the energy needed to cool buildings.
- Trees reduce wind speeds. Wind speed, especially in areas with cold winters, can have a significant impact on the energy needed for heating.
- Trees release water into the atmosphere, resulting in cooler air temperatures and reduced building energy consumption.

Improves Air Quality:

- Trees absorb air pollutants (e.g. NO_2, SO_2, and O_3) and intercept particulate matter (PM10).
- Trees reduce energy consumption, which improves air quality and reduces the amount of greenhouse gases, including N_2O and CH_4.

Reduces Atmospheric CO_2:

- Through direct sequestration, trees reduce atmospheric carbon dioxide levels.
- Tree planting reduces energy consumption, which in turn reduces CO_2 levels.



Reduces Urban Heat Island:

- The various cooling functions of trees help to reduce the urban heat island effect, thereby reducing heat stress-related illnesses and fatalities.

Improves Community Livability:

- Trees provide beauty and privacy, which improve community aesthetics.
- Planting trees increases recreational opportunities for communities by improving pathways, creating places to gather and providing shade during warm weather.
- Trees provide a sense of place and well-being, which can strengthen community cohesion.
- Trees help to reduce sound transmission, reducing local noise pollution levels.
- Tree planting may provide opportunities for urban foraging and food production.

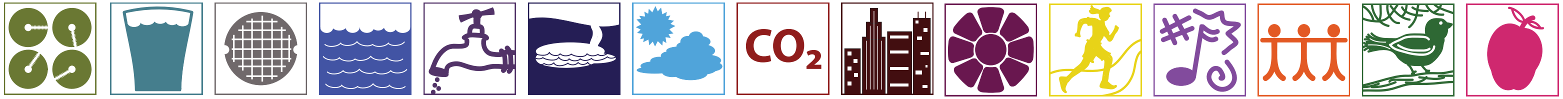
Improves Habitat

- Planting trees increases wildlife habitat, especially when plant species native to the region are used.

Cultivates Public Education Opportunities:

- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- Community tree planting provides a valuable educational opportunity for residents to become more aware of the benefits of green infrastructure.

Bioretention and Infiltration Practices



Bioretention and infiltration practices come in a variety of types and scales, including rain gardens, bioswales and wetlands. Rain gardens are dug at the bottom of a slope in order to collect water from a roof downspout or adjacent impervious surface. They perform best if planted with long-rooted plants like native grasses. Bioswales are typically installed within or next to paved areas like parking lots or along roads and sidewalks. They allow water to pool for a period of time and then drain, and are designed to allow for overflow into the sewer system. Bioswales effectively trap silt and other pollutants that are normally carried in the runoff from impermeable surfaces. While the multitude of benefits provided by wetlands has been well documented elsewhere, this guide only addresses smaller scale practices.

Reduces Stormwater Runoff:

- These practices store and infiltrate stormwater, which mitigates flood impacts and prevents the stormwater from polluting local waterways.

Increases Available Water Supply:

- By reducing the amount of potable water used for outdoor irrigation, these practices may also increase available water supplies.

Increases Groundwater Recharge:

- Bioretention and infiltration practices have the potential to increase groundwater recharge by directing rainwater into the ground instead of pipes.

Improves Air Quality:

- Like other vegetated green infrastructure features, infiltration practices can improve air quality through uptake of criteria air pollutants and the deposition of particulate matter.
- By minimizing the amount of water entering treatment facilities, these practices also reduce energy use which, in turn, reduces air pollution by lowering the amount of greenhouses gases emitted.

Reduces Atmospheric CO_2:

- Bioretention and infiltration practices reduce carbon dioxide emissions through direct carbon sequestration.



- By reducing the amount of energy needed to treat runoff, as well as reductions in energy use for cooling purposes, bioretention and infiltration practices reduce atmospheric CO_2.

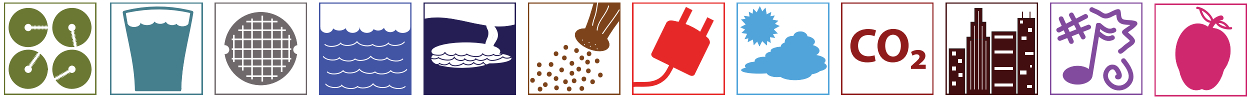
Reduces Urban Heat Island:
- Through evaporative cooling and reduction of surface albedo, these practices work to mitigate the urban heat island effect, reducing energy use.

Improves Community Livability:
- When well-maintained, bioretention and infiltration practices improve local aesthetics and enhance recreational opportunities within communities.
- There is also the potential for these practices to help reduce noise transmission through sound absorption and to improve social networks in neighborhoods.

Improves Habitat:
- Bio-retention and infiltration practices provide habitat and increase biodiversity.

Cultivates Public Education Opportunities:
- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- Rain gardens and bioswales provide an opportunity for residents to contribute to the benefits of neighborhood place-making via green infrastructure.

Permeable Pavement



Permeable pavement allows for the absorption and infiltration of rainwater and snow melt onsite. There are several different names that refer to types of permeable pavement, including pervious or porous concrete, porous asphalt and interlocking permeable pavers.

Reduces Stormwater Runoff:

- Permeable pavement reduces surface runoff volumes and rates by allowing stormwater to infiltrate underlying soils.
- By reducing runoff volumes and rates, permeable pavement can lower water treatment costs and reduce flooding and erosion.

Increases Groundwater Recharge:

- By allowing rainfall to infiltrate, permeable pavement can help increase groundwater recharge.

Reduces Salt Use:

- Permeable pavement has been demonstrated to substantially delay the formation of a frost layer in winter climates, which mitigates the need for salt use. By reducing the need for salt, communities are able to save money and reduce pollution in local waterways and groundwater sources.

Reduces Energy Use:

- The use of permeable pavements also has the potential to reduce energy use by lowering surrounding air temperatures, which in turn reduces demand on cooling systems within buildings.

Improves Air Quality:

- Because permeable pavement captures rainfall onsite, communities can reduce the amount of water treatment needed, in turn reducing air pollution from power plants.

- By reducing the urban heat island effect, permeable pavement decreases ground level ozone formation, which directly impacts air quality.

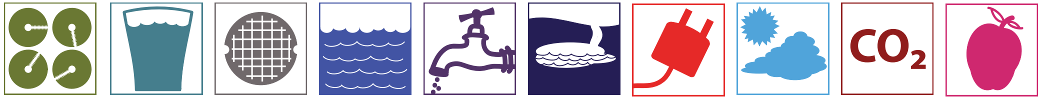
Reduces Atmospheric CO_2:
- Permeable pavement captures rainfall onsite, enabling communities to reduce the amount of water treatment needed, in turn reducing CO_2 emissions from power plants.
- Permeable pavement also has the potential of reducing lifecycle CO_2 emissions compared to asphalt and cement, which produce high lifecycle CO_2 emissions.

Reduces Urban Heat Island:
- Permeable pavement absorbs less heat than conventional pavement, which helps to reduce the surrounding air temperature and decrease the amount of energy needed for cooling.

Improves Community Livability:
- Some types of permeable pavement reduce local noise pollution by increasing street porosity levels.

Cultivates Public Education Opportunities:
- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- The installation of permeable pavement can provide an opportunity to further educate the public about the benefits of green infrastructure.

Water Harvesting



Water harvesting is defined as the redirection and productive use of rainwater by capturing and storing it onsite for irrigation, toilet flushing and other potential uses. Water harvesting treats rainwater as a resource rather than as a waste stream. There are two main water harvesting practices: downspout disconnection and the use of rain barrels or cisterns.

Downspout disconnection is the process of directing roof runoff away from sewer systems and onto local property for irrigation purposes. Using rain barrels or cisterns captures rainwater, diverting it directly into these storage containers. The stored water can be used onsite for multiple purposes such as flushing toilets and irrigation. The practice of water harvesting requires that catchment areas be sized according to projected water-use needs in order to maximize the benefits of this practice.

Reduces Stormwater Runoff:

- Water harvesting minimizes the negative impacts of stormwater runoff by capturing rainfall where it lands and reusing it onsite.
- Onsite reuse of rainwater helps to reduce water treatment needs, which allows communities to save on costs associated with potable water conveyance, treatment and use.

Increases Available Water Supply:

- It is estimated that, nationwide, outdoor irrigation accounts for almost one-third of all residential water use, totaling more than 7 billion gallons per day. Given this estimate, using rainwater for irrigation purposes can substantially reduce the amount of potable water used residentially, effectively increasing supply.

Increases Groundwater Recharge:

- Reusing rainwater for irrigation purposes can help increase groundwater recharge.

Reduces Energy Use:

- Water harvesting has the ability to reduce energy usage by cutting down on potable water use, which requires energy to produce, treat and transport.



Improves Air Quality:

- Because this practice can reduce energy usage, it can also reduce the amount of air pollutants being emitted from power plants.

Reduces Atmospheric CO_2:

- Water harvesting captures rainfall onsite, which can enable communities to reduce the amount of water treatment needed, in turn reducing CO_2 emissions from power plants.

Cultivates Public Education Opportunities:

- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- By providing educational programs through fun activities such as rain barrel design and usage, communities can more effectively train residents in the benefits of green infrastructure.

Rainwater has been found to help improve plant health. Unlike potable water which contains salt, rainwater typically contains nutrients such as nitrogen and phosphorus, which is good for plants.

Economic Valuation in Action

Economic Valuation Methods & Tools

Comparing the benefits of different stormwater management practices requires a common unit of analysis. In making decisions about infrastructure investment, the value of a given set of possible investments is typically expressed monetarily.

One challenge inherent in valuing services provided by green infrastructure is that many of these services are not bought and sold. Fortunately, many techniques have been developed in order to economically value nonmarket ecosystem services. Nonmarket valuation methods include revealed preference methods, stated preference methods and avoided cost analysis.

Revealed preference methods attempt to infer the value of a nonmarket good or service using other market transactions. Hedonic pricing, for example, assumes that the price of a good is a function of relevant characteristics of that good and attempts to isolate the contribution of a given characteristic to the total price (most commonly used with housing prices).

Stated preference methods, such as contingent valuation, ask individuals how much they are willing to pay for a given good or service or how much they would be willing to accept as compensation for a given harm. These methods often assess non-use values; for example, what is the value of a protected wilderness for people who never see it?

Using previous estimates from other revealed or stated preference studies requires caution. These methods capture the value resulting from the complexity inherent in a specific study area. As such there is risk in applying these results to different contexts and subsequent benefit valuations.

Finally, avoided cost analysis examines the marginal cost of providing the equivalent service in another way. For example, rainfall retention and infiltration can offset a water utility's cost to capture, transport, treat and return each additional gallon of runoff. (Tomalty et al 2009; King and Mazzotta 2000).

Customized application of nonmarket valuation methods can be expensive and time consuming to perform. Contingent valuation, for example, can require conducting survey research; a hedonic pricing study may involve extensive data assembly.

There are many existing tools available to those interested in assessing the performance and value of green infrastructure practices, including online calculators, spreadsheet models and desktop software. These tools can be used as a companion to this guide and in many cases will be able to provide calculations with greater sensitivity to locally specific variables than those presented here. A full list and description of these tools can be found in Appendix A.

Our Framework

This guide outlines a framework for measuring and valuing green infrastructure's multiple ecological, economic and social benefits. The following sections integrate existing research on the benefits of five green infrastructure practices that are representative of the current vocabulary of GI in terms of applicable values and possible benefits. These sections explore how to:

- Measure the benefits from each particular practice
- Assign value to those benefits (in monetary terms when possible)

The guide follows a consistent sequence when analyzing each of the benefits defined in the previous section. This analysis allows users to evaluate the cumulative benefits of green infrastructure practices in a number of different benefit categories including water, energy, air quality and climate change. The following describes the two-step framework for this valuation process.

Step 1: Quantification of Benefits

It is first necessary to define a resource unit for the given benefit. For example, when evaluating energy benefits, the resource units are kilowatt hours (kWh) and British thermal units (Btu). Once the resource units are determined, the guide outlines the process for estimating the level of benefit for each practice. Step 1 concludes with an estimate of the total resource units received from a given benefit.

Step 2: Valuation of Quantified Benefits

In this step, values for each benefit are determined based on the resource units from the previous step. The method for translating resource units into a dollar figure differs for every benefit category. For example, the average cost of a kilowatt hour of electricity provides the direct cost saving value of reduced energy use. Because these values are extremely location and site specific, it is beyond the scope of this guide to demonstrate all parameters and local values. Examples demonstrated in this section illustrate the process necessary for determining the accrued value of green infrastructure implementation. Resources and guidance are provided where possible to help tailor these estimates to local projects, however much of the localized information must be gathered by the user. Please note, given the current state of valuation research, this step has not been addressed in the following benefit sections:

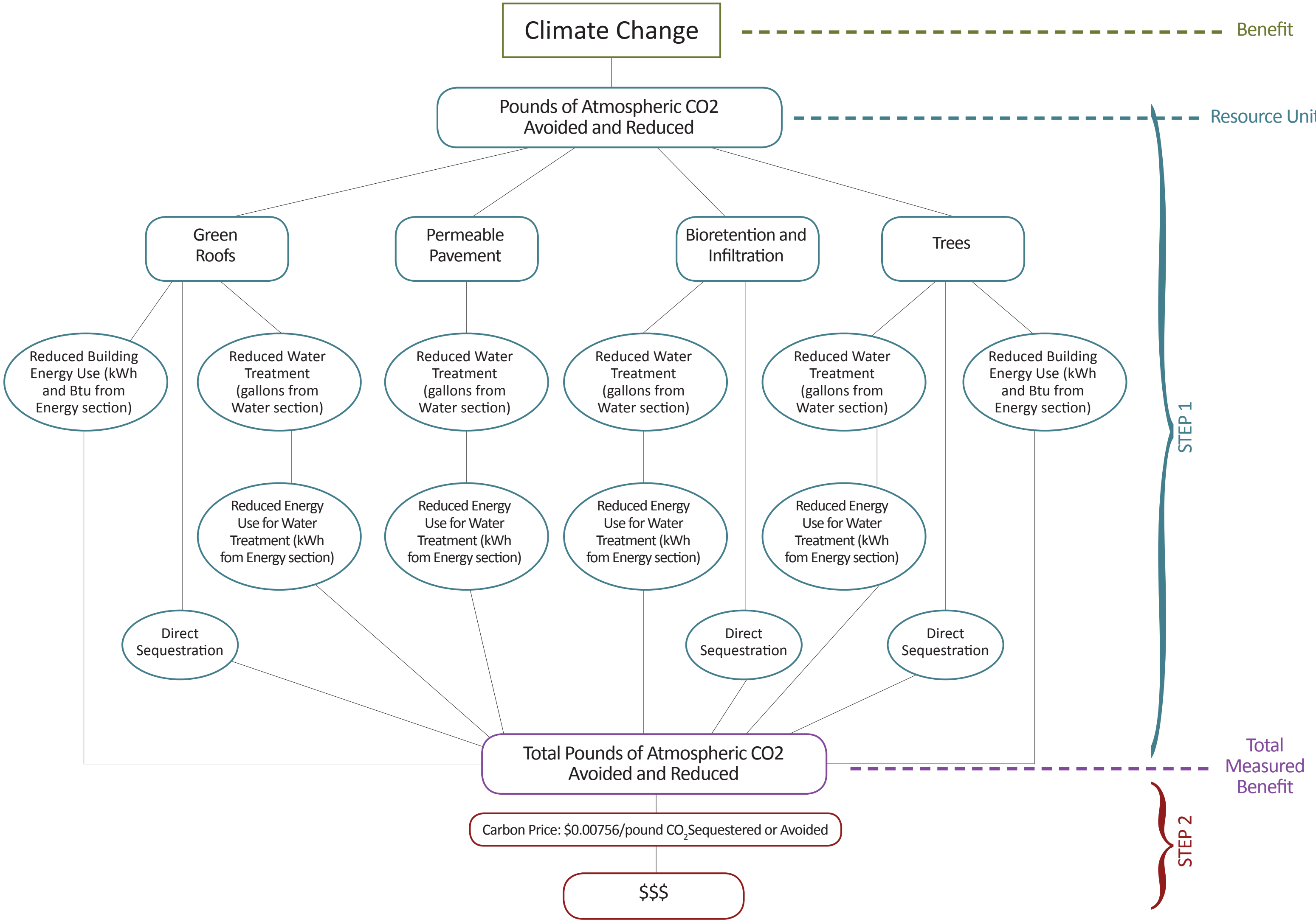
- Urban Heat Island
- Community Livability
- Habitat
- Public Education

Even if no monetary value can be assigned, these services provide valuable benefits which are still worth recognizing in a broader assessment of infrastructure investments.

It is important to keep in mind that the methods described here face a number of limitations. Although the discussion will focus on benefits, estimating the net value of a project would require a comparison of the net benefits compared to the lifecycle cost of constructing and maintaining a given green infrastructure practice. While life cycle cost analysis is beyond the scope of this guide, the Green Values™ Calculator (CNT 2009) can describe the relative cost of the green infrastructure practices (using cost data information through 2009).

Finally, several benefits face uncertainties about both spatial and temporal scale. The "Considerations and Limitations" section at the end this guide further addresses these and other concerns.

The figure below is an illustrative example of the process for valuing the Climate Change benefit section of green infrastructure.



Benefit Measurement and Valuation

1. WATER

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED STORMWATER RUNOFF

The first step in valuing the water benefits from green infrastructure is to determine the volume of rainfall (in gallons) retained on site; this volume becomes the resource unit for all water benefits. When working through the calculations, keep in mind that some of the ranges given are based on the compilation of multiple cases studies and there may be more site-specific numbers to plug into the given equations. Where possible, the guide will suggest strategies for determining site-specific information.

Practices that provide water benefits include green roofs, permeable pavement, bioretention and infiltration, trees and water harvesting.

GREEN ROOFS

To quantify the stormwater runoff retained from green roofs, it is necessary to know the following information:

- Average annual precipitation data (in inches) for the site
- Square footage of the green infrastructure feature
- Percentage of precipitation that the feature can retain

The highly site-specific variables influencing the percentage of annual rainfall that a green roof is capable of retaining, listed below, are important considerations:

- The most important variable influencing the runoff reduction performance of the green roof is the depth of the growing media. The deeper the roof, the more water retained in the media.
- The growing media's antecedent moisture content will influence stormwater retention for any given storm event. This means that irrigation practices and storm frequency affect overall performance.
- Local climate variables also influence stormwater retention performance. For example, hotter, less humid climates lead to less antecedent moisture and more stormwater retention capacity.
- All else being equal, flat roofs retain more stormwater than sloped roofs.
- Size and distribution of storm events affect total stormwater retention. For example, holding the retention rate and annual precipitation constant, a green roof in a place with many small storms retains a greater percentage of the total rainfall than a green roof in a place with fewer, larger storms.

The following equation relies on two conversion factors. The 144 sq inches/square foot (SF) will convert the precipitation over a given area into cubic inches. Then, the factor of 0.00433 gal/cubic inch (i.e. the number of gallons per cubic inch) will convert that volume of precipitation into gallons, which is needed to quantify the amount of runoff reduced.

[annual precipitation (inches) * GI area (SF) * % retained] * 144 sq inches/SF * 0.00433 gal/cubic inch = total runoff reduction (gal)

Empirical studies of green roof stormwater retention performance have found that green roofs can retain anywhere from 40 to 80 percent of annual precipitation. The calculation in Example 1.1

uses the average of this range, or a 60 percent retention rate, to demonstrate a mid-range performance number:

Example 1.1:
A green roof with an area of 5,000 SF, using a 60% retention rate, will reduce annual runoff in Chicago, Ill. as follows:

[38.01 inches annual precipitation * 5,000 SF area * 0.60 retention rate] * 144 sq inches/SF * 0.00433 gal/cubic inch = 71,100 gallons of runoff reduced annually

TREE PLANTING

Water interception estimates, determined on a per tree basis, are needed to calculate the amount of stormwater runoff reduced from a given project. Therefore, it is necessary to know the number of trees being planted and their size and type. For example, the larger leaf surface area on one kind of tree will intercept more rainfall than will a smaller tree or leaf. In addition, the rate at which trees intercept rainfall is significantly impacted by a site's climate zone, precipitation levels and seasonal variability, which affects evapotranspiration rates.

The Center for Urban Forest Research of the US Forest Services, utilizing its STRATUM model, has compiled a set of *Tree Guides* that take into account many of these factors and estimate the level of benefits provided by trees:
http://www.fs.fed.us/psw/programs/cufr/tree_guides.php

These guides are organized by STRATUM climate zone which can be determined from the map provided at:
http://www.fs.fed.us/psw/programs/cufr/images/ncz_map.jpg

Table 1.1
Annual Rainfall Interception in Gallons from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
Rainfall Interception	292 gallons	1,129 gallons	2,162 gallons

Source: McPherson, E. et al. (2006).

Once the climate zone is determined, the tables in the tree guides' appendices are structured according to size of tree, with an example tree type provided. Average annual volume of rainfall interception can then be estimated based on these factors on a per tree basis. Table 1.1 provides an example of this information.

Using these values, the following equation provides an estimate for the volume of runoff intercepted on site:

number of trees * average annual interception per tree (gal/tree) = total runoff reduction (gal)

Example 1.2:
This example demonstrates the annual reduction in runoff yielded from planting 100 medium red oaks in the Midwest Region.

100 medium trees * 1,129 gal/tree = 112,900 gallons of runoff reduced annually

BIORETENTION AND INFILTRATION

Well-designed bioretention and infiltration features capture all or nearly all of the precipitation which falls on the feature and its related drainage area. However, in an urban context, the percentage of rainfall that these features can accommodate depends on available square footage and locally determined maximum ponding times. Determining a more site-specific performance measure requires complex hydrological modeling. The equation for determining the capacity of a bioretention feature requires the following information:

- Area and depth of the bioretention feature
- Relevant drainage area contributing runoff to the infiltration area
- Average annual precipitation data (in inches)
- Expected percentage of retention

These variables also affect the feature's retention percentage:

- Rainfall amount and distribution
- Site irrigation practices
- Temperatures and humidity
- Soil infiltration rate (based on soil type)

The following equation provides a simplified estimate of the potential volume of runoff captured using bioretention and infiltration practices:

[annual precipitation (inches) * (feature area (SF) + drainage area (SF)] * % of rainfall captured] * 144 sq inches/SF * 0.00433 gal/cubic inch = total runoff reduction (gal)

Example 1.3:

A site in Chicago, Ill. that retains 80% of stormwater runoff, with an infiltration area of 2,000 square feet and a drainage area of 4,000 square feet, reduces the volume of runoff as follows:

[38.01 inches annual precipitation * (2,000 SF + 4,000 SF) * 0.80 retention rate] * 144 sq inches/SF * 0.00433 gallons/cubic inch = 113,760 gallons of runoff reduced annually

PERMEABLE PAVEMENT

To quantify the water retained from permeable pavement, it is necessary to know the following information:

- Average annual precipitation data (in inches) for the site
- Square footage of the green infrastructure feature
- Percentage of precipitation that the feature is capable of retaining

Depending on the intensity of the precipitation event, studies have shown that pervious pavement can infiltrate as much as 80 to 100% of the rain that falls on a site (Booth et al 1996; Bean et al 2005; MMSD 2007; USEPA and LID Center 2000). Example 1.2 uses the lower end of this range, or an 80% retention rate. To find a more site-specific percentage, the following factors must be considered:

- Slope of the pavement – flat surfaces typically infiltrate more water
- Soil content & aggregate depth below pavement
- Size and distribution of storm events
- Infiltration rate
- Frequency of surface cleaning

The following equation quantifies the total amount of runoff that a given permeable pavement installation can reduce annually. As with the bioretention and infiltration calculations, the percentage of rainfall that these features can accommodate depends on available square footage and locally determined maximum ponding times:

[annual precipitation (inches) * GI area (SF) * % retained] * 144 sq inches/SF * 0.00433 gal/cubic inch = total runoff reduction (gal)

Example 1.4:
A permeable pavement feature with an area of 5,000 SF, using an 80% retention rate, will reduce annual runoff in Chicago, Ill. as follows:

[38.01 inches annual precipitation * 5,000 SF area * 0.80 retention rate] * 144 sq inches/SF * 0.00433 gal/cubic inch = 94,800 gallons of runoff reduced annually

WATER HARVESTING

Benefits from water harvesting are based on the volume in gallons of stormwater runoff stored onsite. To determine this volume, the following information is necessary:

- Average annual precipitation data (in inches)
- Rainfall intensity
- Size of the water-collecting surface (in square feet)
- Capacity for temporary water storage and release
- Frequency of harvested water use for building needs, irrigation or evaporative cooling (e.g. whether the captured rainwater is used before a subsequent rain event)

For every square foot of roof collection area, it is possible to collect up to 0.62 gallons of runoff per inch of rain with perfect efficiency. However, an efficiency factor of 0.75–0.9 is included in the equation to account for water loss due to evaporation, inefficient gutter systems and other factors (Texas Water Development Board 2005).

Applying the following formula provides a basic understanding of how much rainwater could be captured by this practice, both for site specific measurement as well as a cumulative calculation across a community or region.

annual rainfall (inches) * area of surface (SF) * 144 sq inches/SF * 0.00433 gal/cubic inch * 0.85 collection efficiency = water available for harvest (gal)

Example 1.5:
The following equation illustrates how to determine the capacity of a water harvesting practice using annual rainfall data for Chicago, Ill.:

38.01 inches annual rainfall * 1,000 SF of surface * 144 sq inches/SF * 0.00433 gal/cubic inch * 0.85 collection efficiency = 20,145 gallons captured annually

After estimating the gallons of stormwater a particular site and practice can retain (i.e. the total resource units), this information should be used in Step 2.

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED STORMWATER RUNOFF

The valuation process in the "Water" section is divided into the following four subsections and outlines each separately:

- Reduced Water Treatment Needs
- Reduced Grey Infrastructure Needs
- Improved Water Quality
- Reduced Flooding

Methods for valuation will only be provided in the "Reduced Water Treatment Needs" and "Reduced Grey Infrastructure Needs" subsections. The other two sections discuss benefits and current research, but they do not present a formal valuation method, given the amount of varying factors required to value these benefits.

Reduced Water Treatment Needs

For cities with combined sewer systems (CSS), stormwater runoff entering the system combines with wastewater and flows to a facility for treatment. One approach to value the reduction in stormwater runoff for these cities is an avoided cost approach. Runoff reduction is at least as valuable as the amount that would be spent by the local stormwater utility to treat that runoff. In this case, the valuation equation is simply:

runoff reduced (gal) * avoided cost per gallon ($/gal) = avoided stormwater treatment costs ($)

Example 1.6:

The Metropolitan Water Reclamation District of Greater Chicago has a marginal cost of treating its wastewater and stormwater of $0.0000919 per gallon (CNT 2009). Using Example 1.1, in which the 5,000 SF green roof provided a runoff reduction of 71,100 gallons, the annual avoided cost for water treatment associated with this site becomes:

71,100 gallons * $0.0000919/gallon = $6.53 in annual avoided treatment costs

Keep in mind, the figure from this example is a single unit that can be aggregated to a larger scale, demonstrating the cumulative benefit that can be achieved within a neighborhood or region. Additionally, avoided cost approaches inevitably underestimate the full value of an ecosystem service. As such, this figure should be considered a lower bound for the monetary value of reduced stormwater runoff. More locally specific treatment costs are available from local water treatment utilities.

Reduced Grey Infrastructure Needs

Green infrastructure practices can reduce the volume of water needing treatment as well as the level of treatment necessary. Therefore, utilizing these practices can reduce the need for traditional or grey infrastructure controls for stormwater and combined sewer overflow (CSO) conveyance and treatment systems, including piping, storage and treatment devices. Similar to the approach taken in other sections of this guide, the value of reducing grey infrastructure derives from the benefits transfer method of avoided costs resulting from the use of green infrastructure. While the case studies below give examples of how these costs can be compared, it is beyond the scope of this guide to determine exact cost savings. This is due to the many site-specific variables that effect the monetary values involved, such as soil types, rainfall distribution patterns, peak flow rates and local materials costs.

One method of assessing avoided grey infrastructure costs when using green infrastructure practices is demonstrated by a case study in Portland, Oregon. In this study, the Bureau of Environmental Services estimated that it costs the city $2.71/SF in infrastructure costs to manage the stormwater generated from impervious areas (Evans 2008). The city uses the following equations to estimate the resulting avoided cost savings:

conventional cost of structure ($/SF) * total area of structure (SF) = total expenditure for conventional approach ($)

total expenditure for conventional approach ($) * % retained = avoided cost savings ($)

Please note, while the typical resource unit used within this "Water" section is *gallons* of stormwater retained, this particular benefit instead considers *percent* of stormwater retained.

Example 1.7:

Using Portland, Ore. as an example, a 5,000 SF conventional roof would have a one-time expenditure of $13,550. However, by utilizing a green roof, which in this particular study has been shown to retain 56 percent of runoff, Portland can expect an avoided cost savings of $7,588:

$2.71/SF * 5,000SF = $13,550 in total conventional expenditure

$13,550 * 56% = $7,588 avoided cost savings

Groundwater Recharge

Green infrastructure practices that enable rainwater infiltration contribute to the recharge of both deep aquifers and subsurface groundwater. When rain falls on a permeable surface, some runs off, some returns to the atmosphere through evapotranspiration and the remainder is infiltrated into the ground. This infiltrated water either recharges aquifers or joins subsurface flows, which end up in local streams. Both aquifer recharge and subsurface flow are important components of a functional water cycle that sustains the ecosystem services on which human activity depends.

Aquifers provide water for drinking and irrigation. Aquifer levels are essentially a function of the relationship between discharge (withdrawal by humans, evaporation, interaction with surface waters) and recharge (primarily infiltrated precipitation). Over time, withdrawing more from an aquifer than is recharged through precipitation can cause declining aquifer levels, resulting in higher pumping costs, reduced water availability and even land subsidence that can result in sink holes.

Green infrastructure affects groundwater recharge in highly site-specific ways. Some infiltrated rainfall may discharge back into surface waters after a few days; in other cases, generations may pass before infiltrated water again becomes available for human use. For this reason, this work does not define specific guidelines for quantifying and valuing the groundwater recharge benefit of green infrastructure. Nonetheless, it is important for the future health of watersheds to monitor aquifer levels and stream flows and consider the benefits of restoring infiltration.

Another study, in the Blackberry Creek watershed near Chicago, Illinois, estimated the benefits attributable to green infrastructure practices resulting from avoided costs of infrastructure that would have been needed to control reduced peak discharges (Johnston, Braden and Price 2006). The study found that, based on Federal Highway Department pipe sizing requirements, reduced peak discharges within their low impact development scenario resulted in a downstream benefit of $340 per developed acre. This is an initial cost savings; performing a life-cycle cost analysis would better demonstrate long-term monetary benefits. The calculations for this method are dependent on access to the following variables and results are best determined through the use of hydrologic modeling:

- Peak flow rates
- Allowable ponding time
- Pipe size requirements

In the case of Seattle's Street Edge Alternatives (SEA) project, which utilizes bioswales to capture and treat stormwater runoff, Seattle Public Utilities found that bioretention combined with narrowing the roadway, eliminating the traditional curb and gutter, and placing sidewalks on only one side of the street garners a cost savings for the city of 15–25 percent, or $100,000–$235,000 per block, as compared to conventional stormwater control design (SPU). Additionally, Seattle Public Utilities has identified cost savings in terms of the life span of the project; SEA streets are designed to improve performance as plantings mature, whereas traditional systems tend to degrade over time (Wong and Stewart 2008).

Improved Water Quality

Using green infrastructure for stormwater management can improve the health of local waterways by reducing erosion and sedimentation and reducing the pollutant concentrations in rivers, lakes and streams. These effects, in turn, lead to improved overall riparian health and aesthetics—indicators of improved water quality and channel stabilization.

The impacts of green infrastructure on water quality, while well documented, are too place-specific to provide general guidelines for measurement and valuation. The water quality improvements associated with green infrastructure, furthermore, are not of sufficient magnitude to be meaningful at the site scale. This benefit, therefore, is best evaluated in the context of watershed-scale green infrastructure implementation, accompanied by hydrologic modeling, to estimate changes in sedimentation and pollutant loads resulting from a green infrastructure program.

Regulators measure water quality in a variety of ways. Damaging pollutants carried by stormwater runoff typically include nitrogen, phosphorous and particulate matter. Water quality monitors can measure concentrations of dissolved nitrogen and phosphorous, as well as total suspended solids (TSS), usually in milligrams per liter. In economic valuations, water *clarity* is often used as a proxy measure for water *quality*. While only an approximate measure, water clarity strongly correlates with the presence of phosphorous, nitrogen and TSS pollution. Suspended particulates directly decrease water clarity, while high concentrations of nitrogen and phosphorous lead to eutrophication—a process whereby increased nutrients in waterways lead to algae blooms which cloud the water and decrease dissolved oxygen. In extreme cases, eutrophication can lead to hypoxic conditions, characterized by the absence of sufficient oxygen to support any animal life. Water clarity is typically measured using the Secchi disk test, in which a black and white patterned disk is lowered into the water until no longer visible; this depth is considered the water clarity depth.

Previous research has applied a benefits transfer approach to quantify the expected improvement in water clarity resulting from a green infrastructure program. Several hedonic pricing studies estimated the impact of water clarity changes on lakefront property values. Studies in Maine and New Hampshire have estimated implicit marginal prices for a one meter change in water clarity ranging from $1,100 to $12,938 per lakefront property (Gibbs et al 2002; Boyle et al 1999; Michael et al 1996). A hedonic pricing study of the St. Mary's River Watershed in the Chesapeake Bay estimated home price impacts of water quality changes not merely for waterfront properties but for the entire watershed. It found marginal implicit prices for changes of one milligram per liter in total suspended solids (TSS) concentration of $1,086 and in dissolved inorganic nitrogen (DIN) concentration of $17,642 for each home in the watershed (Poor et al 2007).

Reduced Flooding

By reducing the volume of stormwater runoff, green infrastructure can reduce the frequency and severity of flooding. The impact of green infrastructure on flooding is highly site and watershed specific, and thus this guide does not provide general instructions for quantifying the reduction in flood risk resulting from a green infrastructure program.

There are several ways to assess the value of reduced flood risk provided by green infrastructure practices on a watershed-scale once the risk impacts have been modeled. Some studies use hedonic pricing to examine how flood risk is priced into real estate markets; others use the insurance premiums paid for flood damage insurance as a proxy for the value of reducing the risk of flood damage; others take an avoided damage cost approach and still others have employed contingent valuation methods.
The most robust literature on the economic valuation of flood risk uses hedonic pricing methods to investigate the housing price discount associated with floodplain location. Most of these studies estimate the impact on residential home prices of locations inside or outside of the 100-year floodplain. Those considering implementing a green infrastructure program who are able to model resulting changes in floodplain maps—in particular, to identify the area where annual flood risk is greater than one percent and can be reduced to less than one percent through the use of green infrastructure—can apply the results of these studies to get an estimate of the range of value provided by green infrastructure's flood risk reduction impact.

Until recently, hedonic price studies have found that homes within the 100-year floodplain are discounted between two and five percent compared with equivalent homes outside the floodplain (Braden and Johnston 2004; Bin and Polasky 2004; MacDonald et al 1990; Harrison, Smersh and Schwartz 2001; Shilling, Benjamin and Sermins 1985; MacDonald, Murdoch and White 1987).

In recent years, hedonic pricing techniques have evolved to recognize that hazard risk may be correlated with spatial amenities or disamenities. In the case of flooding, a correlation exists between proximity to waterways and flood risk. Studies that fail to disentangle this correlation will likely underestimate the amount that flood-prone properties are discounted in the marketplace and thus underestimate the value of flood risk

Reduced Salt Use

Research indicates that using pervious pavement can reduce the need for road salt use by as much as 75 percent (Houle 2006). Reducing salt use saves money for individual property owners and municipalities while also protecting water supplies and the environment as a whole. The following variables affect the performance of permeable pavement in reducing salt use:

- Infiltration rate
- Frequency of surface cleaning
- Soil content and aggregate depth below pavement

A study in Iowa comparing the temperature behavior of traditional concrete and Portland Cement Pervious Concrete (PCPC) found the following: "The results show that the aggregate base underneath the pervious concrete substantially delayed the formation of a frost layer and permeability was restored when melt water is present. . . . The melt water immediately infiltrated the pervious concrete pavement, eliminating the potential for refreezing and reducing the slip/fall hazard associated with impervious surfaces" (Kevern et al 2009b).

The National Research Council (NRC) indicates that road-salt use in the United States ranges from 8 million to 12 million tons per year with an average cost of about $30 per ton (Wegner and Yaggi 2001), although this cost has increased in recent years. In winter 2008, many municipalities paid over $150 per ton for road salt; projections for 2009 reported salt prices in the range of $50–$70 per ton (Associated Press 2009; Singer 2009).

reduction. One study applied these new techniques to account for the correlation of flood risk and coastal amenities and found that homes in the 100-year floodplain were discounted an average of 7.8 percent compared to equivalent homes outside the floodplain (Bin, Kruse and Landry 2008). Therefore, we recommend that users of this guide apply the 2–5 percent range as a conservative estimate of the value of flood risk reduction.

US Census Summary File 3[1] provides median home price data and the number of owner-occupied housing units at the block group level.

An example application of this method can be found in a study on green infrastructure implementation in Blackberry Creek Watershed in Kane County, Illinois (Johnston, Braden and Price 2006). The authors used the USEPA's *Hydrologic Simulation Program—Fortan* to model the difference in peak flows of a green infrastructure versus a conventional development scenario. They then input their peak flow results into the Army Corps of Engineers' Hydrologic Engineering Center River Analysis System and found that conventional development would add 50 acres to the floodplain compared to development using green infrastructure for stormwater management. Applying an anticipated density of 2.2 units/acre and the census bureau's reported median home value of $175,600, the study then used the benefits transfer approach to estimate a range of values for flood risk reduction. Using a range of 2–5 percent property value increase for removal from the floodplain yields total benefits of between $391,600 and $979,000 for the flood risk reduction impact of the green infrastructure scenario.

[1] US Census Bureau. American Factfinder: http://factfinder.census.gov/home/saff/main.html?_lang=en

Benefit Measurement and Valuation

2. ENERGY

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED ENERGY USE

The first step to valuing the benefits of reduced energy use is determining the amount of energy saved by each practice. This section quantifies the benefit of energy savings in terms of kilowatt hours (kWh) of electricity and British thermal units (Btu) of natural gas reduced.

Practices that reduce building energy use include green roofs and trees. In addition, green infrastructure can reduce off-site energy use by preventing runoff and by reducing the demand for potable water. Both of these benefits lead to a decrease in water treatment needs, thereby lowering energy use at treatment facilities. Because facility energy costs are incorporated into the cost of treatment, direct energy cost savings have already been captured. Thus, this section will not value the energy benefit from reduced water treatment, as this would result in double counting.

However, benefits from reduced treatment-plant energy use go above and beyond direct cost savings. This guide will provide methods for estimating the indirect benefits of reduced energy use from both air quality improvements and reduced climate change impacts. Therefore, refer to the "Air Quality" and "Climate Change" sections to quantify these.

GREEN ROOFS

When considering to what degree green roofs reduce building energy use, it is important to keep in mind that heat flux through the roof is only one of many factors influencing building energy consumption. A dramatic improvement in energy performance from green roofs compared to conventional roofs may have only a small impact on overall building energy use. That said, to provide a simple estimate of building energy savings, the suggested method treats green roofs as insulation and assumes that a reduction in heat flux translates directly into energy savings (Clark, Adriaens, and Talbot 2008). Equations for both cooling and heating savings can be derived as follows:

annual number of cooling degree days (°F days) * 24 hrs/day * ΔU = annual cooling savings (Btu/SF)

annual number of heating degree days (°F days) * 24 hrs/day * ΔU = annual heating savings (Btu/SF)

Where:
U = heat transfer coefficient, or 1/R; and
R = a measure of thermal resistance.

Therefore, the main pieces of information necessary for this calculation are the average degree days (both cooling and heating) and the ΔU, which will be calculated from R-values (for both the green roof and a conventional roof with which to compare it).

Determining Cooling and Heating Degree Days (°F days)

The EPA defines Cooling and Heating Degree Days as follows:

"*Cooling degree days* are used to estimate how hot the climate is and how much energy may be needed to keep buildings cool. CDDs are calculated by subtracting a balance temperature from the mean daily temperature, and summing only positive values over an entire year. The balance temperature used can vary, but is usually set at 65°F (18°C), 68°F (20°C), or 70°F (21°F).

Heating degree days are used to estimate how cold the climate is and how much energy may be needed to keep buildings warm. HDDs are calculated by subtracting the mean daily temperature from a balance temperature, and summing only positive values over an entire year. The balance temperature used can vary, but is usually set at 65°F (18°C), 68°F (20°C), or 70°F (21°F)."
http://www.epa.gov/hiri/resources/glossary.htm

To assign values for cooling and heating degree days, this guide recommends using the cooling and heating degree day "Normals" from the National Climatic Data Center of the National Oceanic and Atmospheric Administration.
http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html

Determining R-Values and ΔU

According the USEPA, "*R-value* or 'thermal resistance value' is a measure of the resistance of a material to heat flow. The term is typically used to describe the resistance properties of insulation. The higher the R-value, the greater the insulation's resistance to heat flow."
http://www.epa.gov/hiri/resources/glossary.htm

R-values are reported in the units of square feet * degrees Fahrenheit * hours per British thermal unit (SF * °F * hrs/Btu).

The U-value, or the overall heat transfer coefficient, is defined as the inverse of R. Therefore, to find the ΔU, R-Values for the given conventional and green roof are necessary. Clark, Adriaens and Talbot (2008) provide a valuable explanation for estimating R-values for conventional roofs as well as green roofs based on media depth (p. 2,156). For illustrative purposes, the subsequent example uses default values as follows:

For conventional roofs: **R = 11.34 SF * °F * hrs/Btu**
For green roofs: **R = 23.4 SF * °F * hrs/Btu**
(Clark, Adriaens, and Talbot 2008)

The ΔU can be calculated as follows:

$$\Delta U = \left(\frac{1}{R_{\text{conventional roof}}}\right) - \left(\frac{1}{R_{\text{green roof}}}\right) \quad \text{or} \quad \Delta U = \left(\frac{\text{Btu}}{11.34{*}\text{SF}{*}{}^{\circ}\text{F}{*}\text{hrs}}\right) - \left(\frac{\text{Btu}}{23.4{*}\text{SF}{*}{}^{\circ}\text{F}{*}\text{hrs}}\right)$$

Example 2.1:
In this example, the annual cooling savings (kWh) of a 5,000 SF green roof in Chicago, Ill. is calculated as follows:

At Station 32: Illinois Chicago Botanical Garden, the 1971–2000 Normals for Annual Cooling Degree Days is 702 °F days.

annual number of cooling degree days (°F days) * 24 hrs/day * ΔU = annual cooling savings (Btu/SF)

$$702°\text{Fdays} \times \frac{24\text{hrs}}{\text{day}} \times \left[\left(\frac{\text{Btu}}{11.34*\text{SF}*°\text{F}*\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4*\text{SF}*°\text{F}*\text{hrs}}\right)\right] = \textit{annual cooling savings}$$

$$16{,}848°\text{F} * \text{hrs} \times \left[\left(\frac{\text{Btu}}{11.34*\text{SF}*°\text{F}*\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4*\text{SF}*°\text{F}*\text{hrs}}\right)\right] = \textit{annual cooling savings}$$

$$\frac{16{,}848\text{ Btu}}{11.34\text{ SF}} - \frac{16{,}848\text{Btu}}{23.4\text{ SF}} = \textit{annual cooling savings}$$

$$\frac{1{,}485.71\text{ Btu}}{\text{SF}} - \frac{720\text{ Btu}}{\text{SF}} = \textit{annual cooling savings}$$

$$765.71\text{ Btu/SF} = \textit{annual cooling savings}$$

In order to find how cooling savings results in electricity savings (kWh), the Btu units should be converted to kWh using the conversion rate of 1 kWh/3412 Btu. By converting Btu to kWh, annual cooling savings becomes:

$$\frac{765.71\text{ Btu}}{\text{SF}} \times \frac{1\text{ kWh}}{3{,}412\text{ Btu}} = 0.2244\text{kWh/SF} = \textit{annual cooling savings}$$

Thus, for the 5,000 SF green roof, annual electricity cooling savings is: **5,000 SF * 0.2244 kWh /SF = 1,122 kWh**

Example 2.2:

In this example, the annual heating savings (Btu) of a 5,000 SF green roof in Chicago, Ill. is calculated as follows:

At Station 32: Illinois Chicago Botanical Garden, the 1971–2000 Normals for Annual Heating Degree Days is 6,630 °F days.

annual number of heating degree days (°F days) * 24 hrs/day * ΔU = annual heating savings (Btu/SF)

$$6{,}630°\text{Fdays} \times \frac{24\text{hrs}}{\text{day}} \times \left[\left(\frac{\text{Btu}}{11.34*\text{SF}*°\text{F}*\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4*\text{SF}*°\text{F}*\text{hrs}}\right)\right] = \textit{annual heating savings}$$

$$159{,}120°\text{F} * \text{hrs} \times \left[\left(\frac{\text{Btu}}{11.34*\text{SF}*°\text{F}*\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4*\text{SF}*°\text{F}*\text{hrs}}\right)\right] = \textit{annual heating savings}$$

$$\frac{159{,}120\ \text{Btu}}{11.34\ \text{SF}} - \frac{159{,}120\text{Btu}}{23.4\ \text{SF}} = \textit{annual heating savings}$$

$$\frac{14{,}031.75\ \text{Btu}}{\text{SF}} - \frac{6{,}800\ \text{Btu}}{\text{SF}} = \textit{annual heating savings}$$

$$7{,}231.75\ \text{Btu/SF} = \textit{annual heating savings}$$

Since the assumption here is that heating is provided by natural gas, the annual heating natural gas (Btu) savings for the 5,000 SF green roof is:

5,000 SF * 7,231.75 Btu/SF = 36,158,750 Btu

The actual benefits realized in terms of energy savings due to the implementation of a green roof will be significantly impacted by the following variables:

- Growing media composition, depth and moisture content
- Plant coverage and type
- Building characteristics, energy loads and use schedules
- Local climate variables and rainfall distribution patterns

TREE PLANTING

Many variables affect the ability of trees to reduce energy use in neighboring buildings. Perhaps the largest determinant is climate zone. Shading buildings in cool regions can actually increase energy demand, while reducing wind speeds in warm regions will have little to no impact. As the two following examples show, the location of tree plantings relative to buildings also plays a critical role in determining the level of benefits. Climate zone and building aspect must be considered in conjunction to realize the greatest building energy reduction benefits. The size, and therefore age, as well as the type of tree also significantly impacts the level to which trees evapotranspire, provide shade and act as windbreaks.

The Center for Urban Forest Research of the US Forest Service using its STRATUM model, compiled a set of *Tree Guides* that take into account many of these factors and estimate the level of benefits provided by trees:
http://www.fs.fed.us/psw/programs/cufr/tree_guides.php

These guides are organized by STRATUM climate zone which can be determined from the map provided at:
http://www.fs.fed.us/psw/programs/cufr/images/ncz_map.jpg

Once the climate zone is determined, the tables in the tree guides' appendices are structured according to size of tree (with an example tree type provided) as well as the location of the tree with respect to buildings. Average reductions in building energy use can then be estimated based on these factors on a per tree basis.

As an example, Tables 2.1 and 2.2 show the 40-year average electricity and natural gas savings from trees in the Midwest Region.

Table 2.1: 40-year Average Electricity Savings from Trees in the Midwest Region

	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	96 kWh	54 kWh	68 kWh	48 kWh
Medium tree: Red Oak (40 ft tall, 27 ft spread)	191 kWh	99 kWh	131 kWh	67 kWh
Large tree: Hackberry (47 ft tall, 37 ft spread)	268 kWh	189 kWh	206 kWh	136 kWh

Source: McPherson, E. et al. 2006

Table 2.2: 40-year Average Natural Gas Savings from Trees in the Midwest Region

	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	1,334 kBtu	519 kBtu	1,243 kBtu	1,534 kBtu
Medium tree: Red Oak (40 ft tall, 27 ft spread)	1,685 kBtu	-316 kBtu	1,587 kBtu	2,099 kBtu
Large tree: Hackberry (47 ft tall, 37 ft spread)	3,146 kBtu	2,119 kBtu	3,085 kBtu	3,430 kBtu

Source: McPherson, E. et al. 2006

Example 2.3:

Using the data in Tables 2.1 and 2.2, the estimated average annual energy savings from a large tree located opposite a west facing wall of a house in the Midwest Region will be 268 kWh in cooling (electricity) savings and 3,146 kBtu (or 3,146,000 Btu, as 1 kBtu = 1,000 Btu) in heating/natural gas savings.

REDUCED ENERGY FROM REDUCED WATER TREATMENT

As mentioned earlier, it is important to recognize the off-site means by which green infrastructure practices also reduce energy use through reduced water treatment needs in communities with combined sewer systems. While the "Water" section has already accounted for the cost savings of this reduction (i.e. the "valuation" step of this direct benefit), the reduction in energy use will also provide indirect air and climate benefits from reduced emissions, which will be discussed later. Because of these indirect benefits, it is necessary to quantify the amount of energy reduced from water treatment.

To estimate the energy savings from reduced water treatment needs, it is necessary to have calculated the nega-gallons (i.e. gallons of reduced stormwater runoff) resulting from green infrastructure practices, as estimated in the "Water" section.

Table 2.3 outlines how much energy (kWh) is consumed per million gallons of water treated by six different treatment plant sizes using four different types of treatment methods. These should be referenced as default values only when calculating the energy savings from reduced treatment. Local utilities can provide more site-specific figures.

Table 2.3

	Unit Electricity Consumption | kWh/million gallons			
Treatment Plant Size million gallons/day	**Trickling Filter**	**Activated Sludge**	**Advanced Wastewater Treatment**	**Advanced Wastewater Treatment Nitrification**
1 MM gal/day	1,811	2,236	2,596	2,951
5 MM gal/day	978	1,369	1,573	1,926
10 MM gal/day	852	1,203	1,408	1,791
20 MM gal/day	750	1,114	1,303	1,676
50 MM gal/day	687	1,051	1,216	1,588
100 MM gal/day	673	1,028	1,188	1,558

Source: EPRI 2002

Example 2.4:

Referring back to Example 1.1 and relying on the default values in Table 2.3, it is possible to estimate the energy saved from reduced water treatment needs from a green roof. If water treatment needs are reduced by 71,100 gallons in an area with an advanced wastewater treatment nitrification plant with a 100 MM gal/day capacity, electricity consumption could be reduced as follows:

71,100 gal saved = 0.0711 million gal saved

0.0711 million gal * 1,558 kWh/million gal = 110.77 kWh

Thus, the 5,000 SF green roof example contributes to an annual electricity savings from reduced water treatment needs of 110.77 kWh.

STEP 2 **- VALUATION OF QUANTIFIED BENEFITS: REDUCED ENERGY USE**

Having calculated the direct kWh and Btu saved in reduced building energy use, it is possible to assign a dollar value to these savings. Again, note that energy savings resulting from reduced water treatment needs have previously been accounted for and should NOT be valued here. The kilowatt hours of reduced energy from reduced water treatment should be carried directly to the "Air Quality" and "Climate Change" sections to be valued there. (In other words, the answer from Example 2.6 is not valued here, but this figure will be used later to calculate indirect emissions benefits.)

One may calculate the direct cost savings by multiplying the kilowatt hours or Btus of electricity and natural gas, respectively, by local utility rates. If local utility rates are not available, use national average retail electricity and natural gas prices.

The values below represent the U.S. average retail price for electricity for April 2010 and the 2010 forecast retail price for natural gas (US EIA 2010).

The following two equations provide a formula for calculating the value of cooling (kWh) and heating (Btu) savings respectively and rely on these national utility rate averages:

kWh reduced * $0.0959/kWh
= value of cooling or electricity savings

Btu reduced * $0.0000123/Btu
= value of heating natural gas savings

Example 2.5:

Using the cooling savings from Example 2.1 and the heating savings from Example 2.2, the following example calculates the annual direct cost savings provided by a 5,000 SF green roof:

0.2244 kWh/SF for cooling savings * 5,000 SF * $0.0959/kWh = $107.60 annual cooling or on-site electricity savings

7,231.75 Btu/ SF for heating * 5,000 SF * $0.0000123/Btu = $444.75 annual heating natural gas savings

The combined benefits from the green roof result in an average annual on-site energy savings of $552.35.

Example 2.6:

Referencing Tables 2.1 and 2.2 and the cost saving established in Example 2.5, if a house in the Midwest Region has one large tree located opposite a west-facing wall, the direct cost savings can be calculated as:

268 kWh * $0.0959 = $25.70 annual cooling or on-site electricity savings

3,146,000 Btu * $0.0000123 = $38.70 annual heating natural gas savings

The combined benefits from the large tree result in an average annual on-site energy savings of $64.40.

Benefit Measurement and Valuation

3. AIR QUALITY

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED CRITERIA POLLUTANTS

This section quantifies the direct (uptake and deposition) and indirect (avoided emissions) air quality impacts of green infrastructure and provides instructions for valuing these impacts in monetary terms. The criteria pollutants addressed here are nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter of aerodynamic diameter of ten micrometers or fewer (PM-10).

Practices that provide a direct benefit of uptake and deposition include green roofs, trees and bio-infiltration.

GREEN ROOFS

Direct air quality benefits from green roofs depend on several local factors. Different plant species take up pollutants at different rates, so the type of species planted will influence the magnitude of air quality improvement. Local climate factors also influence plants' air quality effects. In cold weather climates, plant uptake will be lower during seasons when plants may be covered in snow. Climates with longer growing seasons will see greater air quality improvements, all else being equal, than those with shorter seasons.

To estimate the direct benefits of green roofs on air quality, we recommend the following range of values as an initial order of magnitude approximation of annual pounds of pollutant removed per square foot of practice installed:

Table 3.1

	Low (lbs/SF)	High (lbs/SF)
NO_2	3.00×10^{-4}	4.77×10^{-4}
O_3	5.88×10^{-4}	9.20×10^{-4}
SO_2	2.29×10^{-4}	4.06×10^{-4}
PM-10	1.14×10^{-4}	1.33×10^{-4}

Source: Currie and Bass (2008) and Yang, Qian and Gong (2008)

The following equation illustrates how to quantify the direct benefit received based on the area of the practice and the average pollutant uptake/deposition for that practice:

area of practice (SF) *
average annual pollutant uptake/deposition (lbs/SF)
= total annual air pollutant uptake/deposition (lbs)

Keep in mind that the subsequent example calculations will only walk through the quantification of reduced NO_2. Other criteria pollutants will not be illustrated, but they should be calculated when conducting a comprehensive benefit analysis.

Example 3.1:

Using the above equation, a 5,000 SF green roof could lead to an improved direct nitrogen dioxide (NO_2) uptake capacity as follows:

Lower Bound (using 3.00×10^{-4} lbs/SF/yr)
5,000 SF * 3.00×10^{-4} lbs/SF = 1.50 lbs total annual NO_2 uptake

Upper Bound (using 4.77×10^{-4} lbs/SF/yr)
5,000 SF * 4.77×10^{-4} lbs/SF = 2.39 lbs total annual NO_2 uptake

In this case, the 5,000 SF green roof would on average take up between about 1.50 and 2.39 pounds of NO_2 annually.

TREE PLANTING

Climate zone, existing air quality and pollutant levels, and the size, age and type of tree all play a role in determining the uptake potential of tree planting.

The Forest Service *Tree Guides* estimate the level of air quality benefits from trees according to climate zone. The tables in the guides' appendices are structured based on the size of the tree (with example tree types provided) and the location of the tree with respect to a surrounding building. One can then estimate air quality benefits based on these factors (on a per tree basis) using the "Uptake and Avoided" data provided in the *Tree Guides*' appendices.

As an example, Table 3.2 shows the 40-year average air quality impacts from trees in the Midwest Climate Region.

Table 3.2
Annual Criteria Pollutant Reductions (uptake and avoided) from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
NO_2 Uptake and Avoided	0.39 lbs	0.63 lbs	1.11 lbs
SO_2 Uptake and Avoided	0.23 lbs	0.42 lbs	0.69 lbs
O_3 Uptake	0.15 lbs	0.2 lbs	0.28 lbs
PM-10 Uptake and Avoided	0.17 lbs	0.26 lbs	0.35 lbs

Source: McPherson, E. et al. 2006

The following equation illustrates how to reach a quantified benefit from a tree planting:

no. of trees * average annual uptake and avoided pollutant emissions (lbs/tree) = total annual air pollutant reduction (lbs)

Example 3.2:

Given the data from Table 3.2, it is possible to use the above equation to determine the annual nitrogen dioxide (NO_2) benefit of 100 medium-sized trees planted in the Midwest Region.

100 medium trees * 0.63 lbs NO_2/tree = 63 lbs total annual NO_2 reduction

Figures provided by the *Tree Guides* for criteria air pollutant abatement include both the direct (uptake and deposition) and indirect (avoided power plant emissions) benefits, which must be kept in mind in order to avoid double-counting these benefits in later calculations. Once a total abatement figure is reached, it is possible to move directly to calculating the monetary value of that tree practice, as outlined in the "Valuation of Quantified Benefits" section.

BIORETENTION AND INFILTRATION

Although many studies agree that vegetative infrastructure elements such as bioswales, rain gardens and other bio-infiltration techniques can provide considerable air quality benefits, there is currently a lack of scientific research measuring and quantifying the direct air pollution uptake potential of these practices. Without studies that derive specific uptake values for bio-infiltration practices, this guide cannot provide the steps to calculate the direct uptake benefit at this time, as further field research and data collection is needed.

Once an average value is quantified (in lbs/SF), provided sufficient research data is published, it can be substituted into the equation below:

total area of practice (SF) * average annual uptake/ deposition (lbs /SF)
= total annual pollutant uptake/deposition (lbs)

This equation could then be used to derive the total air pollutant uptake benefit for a given bioswale or rain garden and later to monetize the practice's direct uptake benefit.

Indirect Benefits

As stated above, this section quantifies not only the direct (uptake and deposition) means by which air quality is improved, but also the indirect means (avoided emissions) that provide air quality improvements.

Practices that indirectly lower emissions of air pollution include any practices that reduce energy consumption through decreased energy use in neighboring buildings or through reduced water treatment needs. These benefits are quantified in the "Energy" section, and they should be accounted for here to estimate in pounds the reduction of criteria air pollutants stemming ultimately from reduced water treatment.

The production of electricity in fossil fuel power plants entails the emission of nitrogen dioxide and sulfur dioxide. Furthermore, the burning of natural gas in homes and businesses produces additional indirect air pollutant emissions. In order to quantify this impact, multiply the estimated electricity use reduction calculated here in the "Energy" section by emissions factors provided by the US EPA. It is important to keep in mind that the net air quality benefit from trees was already calculated above, so to avoid double counting, do not recalculate the reduced pollutants from trees here.

The following equations are used to calculate the total avoided criteria pollutant emissions from reduced energy usage in terms of electricity and natural gas, respectively. Specific practice-based calculations follow from the calculations completed in the "Energy" section and do not require additional individual explanation.

Benefit from kWh of Electricity Saved

annual electricity reduction (kWh) * emissions factor (lbs/kWh)
= annual avoided pollutant emissions (lbs)

In its online eGRIDweb application, the USEPA provides the following figures for estimated annual output emissions rates of national electricity production:

- **NO_2: 1.937 lbs/MWh » 0.001937 lbs/kWh**
- **SO_2: 5.259 lbs/MWh » 0.005259 lbs/kWh**

Source: USEPA 2005

Please note that although power plants and electricity generators emit both ozone and certain particulates into the atmosphere, data could not be found to quantify the emissions factors for those variables.

Example 3.3:

Using the example 5,000 square foot green roof again, remember the annual cooling savings determined in Example 2.1:

5,000 SF * 0.2244 kWh/SF = 1,122 kWh in cooling savings annually

Given the reduced electricity use of 1,122 kWh, the NO_2 emission benefits from that reduction are:

1,122 kWh * 0.001937 lbs/kWh = 2.17 lbs avoided NO_2 emissions from cooling savings annually

More locally-specific figures can be found in the eGRIDweb application. This tool provides emission rates by state, grid region and power plant or generating company.

Benefit from Btu of Heating Natural Gas Saved

annual heating natural gas savings (Million Btu) * emissions factor (lbs/Million Btu) = annual avoided criteria pollutant emissions (lbs)

In the same online eGRIDweb application used previously, the USEPA provides the following figures for the national annual emission factors per Btu of natural gas input:

- **NO_2: 0.721 lbs/Million Btu**
- **SO_2: 0.266 lbs/Million Btu**

Source: USEPA 2005

Please note that although the burning of natural gas emits both ozone and certain particulates into the atmosphere, data could not be found to quantify the emissions factors for those variables.

Example 3.4:

Using the example 5,000 square foot green roof again, remember the annual heating natural gas savings (Btu) determined in Example 2.2:

7,231.75 Btu/SF * 5,000 SF = 36,158,750 Btu = 36.15875 Million Btu annually in heating natural gas savings

Given the reduced heating natural gas use of 36.15875 Million Btu and using the US EPA emissions factors above of 0.721 lbs NO_2 / Million Btu, the NO_2 emission benefits from that reduction are:

36.15875 Million Btu * 0.721 lbs NO_2/Million Btu = 26.07 lbs avoided NO_2 emissions from heating natural gas savings annually

Total Benefit from Electricity and Heating Natural Gas Savings

Now that the indirect air quality benefits from electricity and natural gas savings have been quantified, the pounds of criteria pollutants calculated from both can be added together. This summation will make the later valuation calculation less complicated.

annual avoided pollutant emissions from reduced electricity (lbs) + annual avoided criteria pollutant emissions from reduced heating natural gas (lbs) = total avoided criteria pollutant emissions from electricity and heating natural gas savings annually

Example 3.5:

Taking the answers from Examples 3.3 and 3.4, the total indirect benefit from electricity and heating natural gas savings can be quantified as:

2.17 lbs avoided NO_2 (Example 3.3) + 26.07 lbs avoided NO_2 (Example 3.4) = 28.24 lbs avoided NO_2 emissions from reduced cooling and heating energy use annually.

Now, one can quantify the total air quality benefit by adding together the total direct criteria pollutant uptake/deposition benefit and the total indirect avoided emissions benefit (from reduced energy use) for each practice.

∑ total criteria pollutant uptake/deposition benefit (lbs) + total avoided criteria pollutant emissions (lbs) = total annual criteria pollutant reduction benefit (lbs)

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED CRITERIA POLLUTANTS

In order to arrive at a value for the benefits of air quality improvements from green infrastructure, one must estimate the price or cost (per pound) of the standard air pollutants discussed in this guide.

The following numbers represent US Forest Service recommendations for valuation of criteria air pollutants:

- **NO_2 = $3.34/lb**
- **O_3 = $3.34/lb**
- **SO_2 = $2.06/lb**
- **PM-10 = $2.84/lb**

Source: McPherson et al. (2006), Wang and Santini (1995)

The equation below allows for valuation of air quality benefits derived from using green infrastructure practices:

total annual criteria pollutant reduction benefit (lbs) * price of criteria pollutant ($/lb) = total value of pollutant reduction ($)

Example 3.6:

Recall that Example 3.1 found that a hypothetical 5,000 SF green roof yields an annual nitrogen dioxide (NO_2) uptake benefit between 1.50 and 2.39 pounds of NO_2 reduction, or an average of 1.95 pounds. Furthermore, Example 3.5 found the same roof yields 28.24 pounds of indirect NO_2 reduction. Notice that these figures are the same resource unit and can be summed as follows:

∑ 1.95 lbs NO_2 + 28.24 lbs NO_2 = 30.19 lbs NO_2

Given the above valuation equation and a price per pound of NO_2 of $3.34/lb, the following calculation determines the monetary value of the on-site uptake and off-site emissions benefits, as follows:

30.19 lbs NO_2 * $3.34/lb NO_2 = $100.83

Thus, the green roof would lead to a monetary benefit from on-site and off-site NO_2 benefits of about $100.83 annually.

The Role of Permeable Pavement in Improving Air Quality

In addition to green roofs, trees, and bioretention and infiltration practices, permeable pavement can also improve air quality and reduce atmospheric CO_2. Permeable pavement reduces the amount of water treatment needed by allowing stormwater to infiltrate on site, in turn reducing air pollution and CO_2 emissions from power plants. It also decreases ground level ozone formation and helps to lower pavement surface temperatures by reducing the amount of heat absorbed. This helps to cool the air and decrease the amount of energy needed for cooling. It also mitigates the urban heat island effect.

A recent study comparing pervious concrete to traditional pavement found that "…while the pervious concrete becomes hotter than the surrounding air temperature during the daytime much less heat is transferred and stored in the underlying soil than the traditional pavement. Even though the pervious concrete became warmer than the traditional [concrete], at night the pervious concrete was equal to or cooler than the [traditional concrete] pavement. This indicates less heat storage potential and a greater rate of cooling in the pervious concrete versus the traditional system" (Kevern, J.T. et al. 2009b).

While research has demonstrated the ability of permeable pavement to improve air quality and reduce atmospheric CO_2, not enough data exists to walk through a valuation of these benefits at this time.

4. CLIMATE CHANGE

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED ATMOSPHERIC CO_2

This section provides instructions on how to quantify and value direct (sequestration) and indirect (avoided emissions) climate benefits. While recognizing that there are other types of greenhouse gases that contribute to climate change, the focus in this section is specifically on the climate benefits of reducing atmospheric CO_2, as this is the greenhouse gas most directly affected by green infrastructure. A similar framework can be used to value the climate impacts of those other gases, particularly when they are put in terms of CO_2-equivalents. Outlining those additional steps, however, is outside the scope of this guide.

Green infrastructure practices specifically addressed in this section for their direct benefit of carbon sequestration include green roofs, trees and bio-infiltration. The authors acknowledge that there are additional climate benefits from other practices, such as permeable pavement, which cannot be explicitly quantified at this time due to the infancy of the research surrounding this benefit within those practices. Finally, it is important to note that sequestration benefits only last as long as the plants or trees are alive and that they vary with the age of the vegetation.

The following equation is used to quantify the amount of carbon sequestered for a given area and green infrastructure practice, keeping in mind that the pounds of carbon sequestered per unit area depend on several local factors, including the specific practice, the types of species planted and the local climate:

**total area of practice (SF) *
average annual amt. of carbon sequestered (lbs C /SF)
= annual amount of carbon sequestered (lbs C)**

It is important to note that a common point of confusion when quantifying carbon sequestration benefits is how many pounds of CO_2 are avoided from a certain amount of stored carbon. Due to the molecular structures involved, the pounds of carbon stored in plants do not equal the pounds of carbon dioxide that are removed from the atmosphere (because an atom of carbon has a smaller atomic mass than a carbon dioxide molecule). Employ the following conversion factor ($^{44}/_{12}$ or 3.67) to arrive at the equivalent CO_2 impacts of a specific carbon sequestering practice.

GREEN ROOFS

Research synthesized in a Michigan State University report offers average carbon sequestration values provided by extensive green roofs' aboveground biomass (Getter et al. 2009). Using the data from that report, it is possible to arrive at an estimated range of carbon sequestration per square foot for similarly implemented extensive green roofs. Because one of the two studies lacks belowground sequestration figures, this guide does not take belowground biomass into account when determining the recommended range. (See below.) As such, the given range may provide an underestimate of the practice's full sequestration potential. Further field research and data collection are needed in order to more precisely determine the full carbon sequestration potential of green roofs.

The recommended range of grams of carbon sequestered per square meter from aboveground biomass, as determined by the averages of the two Michigan State University studies (which include data from extensive green roofs surveyed in both Michigan and Maryland), is as follows:

162 g C/m² to 168 g C/m² (Getter et al. 2009)

Converting to lbs C/SF from metric units[2], the range can be defined: 0.0332 lbs C/SF to 0.0344 lbs C/SF

Example 4.1:

A hypothetical 5,000 SF extensive green roof provides an estimated carbon sequestration capacity as follows:

Lower Bound (using 0.0332 lbs C/SF)
0.0332 lbs C/SF * 5,000 SF = 166 lbs of carbon per year

Upper Bound (using 0.0344 lbs C/SF)
0.0344 lbs C/SF * 5,000 SF = 172 lbs of carbon per year

In this case, the hypothetical 5,000 SF extensive green roof would sequester between about 166 and 172 pounds of carbon annually, or an average of 169 pounds of carbon per year.

TREE PLANTING

Local conditions—such as climate zone, existing air conditions and season—as well as size, age and species type all play a role in determining the carbon sequestration potential of a tree.

The referenced Forest Service *Tree Guides* provide an estimate of the level of CO_2-related benefits from trees according to climate zone. Once the climate zone is determined, the tables in the tree guides' appendices are structured on the basis of size of tree (with example tree types provided) as well as the location of the tree with respect to a surrounding building. Climate benefits can then be estimated based on these factors (on a per tree basis) using the "Net CO_2" data provided in the tree guides' appendices. These benefits vary by region and according to energy sources.

As an example, Table 4.1 shows the 40-year average CO_2 benefits from trees in the Midwest Climate Region.

Table 4.1: Annual Net CO_2 (lbs) Benefits from 1 tree, 40-year average, Midwest Region

Net CO_2 (lbs)	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	390	226	335	336
Medium tree: Red Oak (40 ft tall, 27 ft spread)	594	212	487	444
Large tree: Hackberry (47 ft tall, 37 ft spread)	911	665	806	734

Source: McPherson, E. et al. 2006

[2] Converting g C /m² into lbs. C/SF, we multiply the metric units by a conversion factor 0.00220462262 lbs/g to arrive at lbs C/m², then we multiply by a conversion factor of 0.09290304 m² /SF to arrive at the desired lbs C/SF

Example 4.2:

Given the data in Table 4.1, it is possible to determine the benefits of planting 100 medium trees in a public space. In this case, the number of trees planted is used instead of the amount of vegetated area in the equation to arrive at the final figure:

number of medium trees planted * total CO_2 abated (lbs /tree) = total annual climate benefit (direct and indirect) (lbs CO_2)

100 medium trees * 444 lbs total CO_2/tree = 44,400 lbs of total annual CO_2 abatement

Please note that these "total CO_2" figures include both direct (sequestration) and indirect (avoided power plant emissions) benefits for trees, to avoid double-counting these benefits in later calculations. Once an abatement figure is reached, it is possible to calculate the monetary value of the green infrastructure practice following the steps outlined in the "Valuation of Quantified Benefits: Reduced Atmospheric CO_2" section. Notice also that the above figure is already in "pounds of CO_2,"thus no conversion from carbon to CO_2 will be necessary.

BIORETENTION AND INFILTRATION

Although many studies agree that vegetative infrastructure such as bioswales, rain gardens, and other bio-infiltration techniques can provide a considerable amount of carbon sequestration benefit, there is a current lack of scientific research measuring and quantifying the sequestration potential of those practices. Without studies that demonstrate average values for the carbon sequestration potential per square foot of certain bio-infiltration practices, this guide cannot provide the steps to estimate the direct benefit.

Once an average value is quantified (in lbs/SF), it can be used in the equation below:

total area of practice (SF) * average annual amt. of carbon sequestered (lbs C /SF) = annual amt. of carbon sequestered (lbs C)

Once it is possible to determine the total amount of carbon sequestration for a given bioretention or infiltration practice, the resulting pounds can be used to monetize the practice's direct sequestration benefit.

Indirect Benefits

As previously stated, this section quantifies the direct (sequestration) means by which CO_2 is reduced. It also quantifies the indirect means (avoided emissions) that provide climate change improvements.

Practices that provide an indirect benefit of avoided emissions include any practice that reduces energy consumption through reduced energy use in a neighboring building or through reduced water treatment needs. The "Energy" section quantifies these benefits, and they should now be accounted for to estimate the reduced pounds of criteria pollutants.

This section outlines a process for calculating the total avoided CO_2 emissions from reduced energy usage. Specific practice-based calculations follow from the calculations completed in the "Energy" section.

Benefit from kWh of Electricity Saved

The first step toward calculating the total avoided CO_2 emissions is to quantify the amount of electricity (in kWh) saved for a given area and green infrastructure practice. GI practices will reduce energy consumption on site as well as off site at water treatment facilities. These energy reductions depend on several local factors, including the specific practice, the types of species planted and local climate. The total annual electricity-saved calculation from the "Energy" section can be substituted into the equation below to calculate the total pounds of avoided CO_2:

total annual electricity saved (kWh) * lbs CO_2 /kWh = lbs annual avoided CO_2 emissions from practice's electricity savings

Because the amount of CO_2 emissions from power plants varies depending on the electricity source (e.g. coal, nuclear, wind, etc), use Table 4.2 to specify the appropriate figure for "**lbs CO_2 /kWh**" (in the above equation) given the specific region under consideration.

Example 4.3:

Using the example 5,000 SF green roof again, remember the annual building electricity savings determined in Example 2.1 and the water treatment electricity savings determined in Example 2.4:

total electricity savings from a 5,000 SF green roof = 1,122 kWh in building electricity savings + 110.77 kWh in water treatment electricity savings = 1,232.77 kWh annually

Using the U.S. average of 1.33 lbs CO_2/kWh from Table 4.2, the reduced electricity savings would provide the following indirect climate benefit:

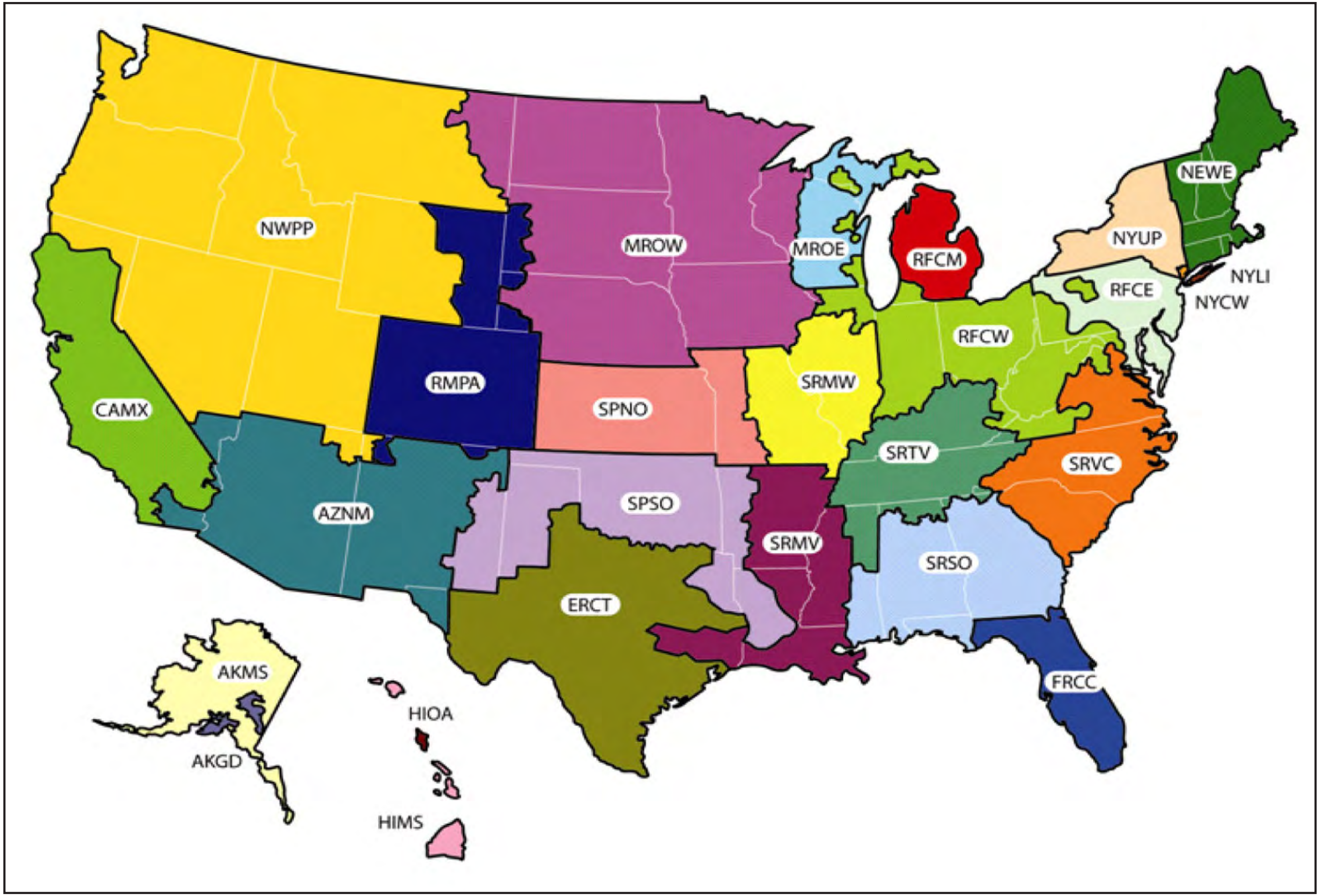
1,232.77 kWh * 1.33 lbs CO_2/kWh = 1,639.58 lbs avoided CO_2 emissions from reduced electricity annually

Table 4.2
Year 2005 eGRID Subregion Emissions, CO_2 Greenhouse Gas

eGRID Subregion Acronym	eGRID Subregion Name	CO_2 Output Emission Rate (lb CO_2/KWh)
AKGD	ASCC Alaska Grid	1.23236
AKMS	ASCC Miscellaneous	0.49886
AZNM	WECC Southwest	1.31105
CAMX	WECC California	0.72412
ERCT	ERCOT All	1.32435
FRCC	FRCC All	1.31857
HIMS	HICC Miscellaneous	1.51492
HIOA	HICC Oahu	1.81198
MORE	MRO East	1.83472
MROW	MRO West	1.82184
NEWE	NPCC New England	0.92768
NEWPP	WECC Northwest	0.90224
NYCW	NPCC NYC/Westchester	0.81545
NYLI	NPCC Long Island	1.5368
NYUP	NPCC Upstate NY	0.7208
RFCE	RFC East	1.13907
RFCM	RFC Michigan	1.56328
RFCW	RFC West	1.53782
RMPA	WECC Rockies	1.88308
SPNO	SPP North	1.96094
SPSO	SPP South	1.65814
SRMV	SERC Mississippi Valley	1.01974
SRMW	SERC Midwest	1.83051
SRSO	SERC South	1.48954
SRTV	SERC Tennessee Valley	1.51044
SRVC	SERC Virginia/Carolina	1.13488
U.S.		1.32935

Source: USEPA 2008c

Year 2005 eGRID Subregion Emissions, CO_2 Greenhouse Gas



Source: USEPA 2008c

Benefit from Btu of Natural Gas Saved

Using the calculation of reduced natural gas from the "Energy" section, the total amount of avoided CO_2 emissions for the given area and green infrastructure practice can be estimated using the following equation:

total heating natural gas saved (Million Btu) * lbs CO_2 /Million Btu = lbs of avoided CO_2 emissions annually from heating natural gas savings

Note that the previous equation relies on the CO_2 emissions factor of 116.89 lbs CO_2/Million Btu of natural gas[3] (i.e. the number of pounds of CO_2 released per million Btu) (US EPA 2009).

Example 4.4:

Using the example 5,000 SF green roof again, remember the annual heating natural gas savings (Btu) determined in Example 2.2:

7,231.75 Btu/SF * 5,000 SF = 36,158,750 Btu = 36.15875 Million Btu annually in heating natural gas savings

Using the CO_2 emissions factor above of 116.89 lbs CO_2/Million Btu, the reduced natural gas savings would provide the following indirect climate benefit:

36.15875 Million Btu * 116.89 lbs CO_2/Million Btu = 4,226.6 lbs avoided CO_2 emissions from reduced natural gas annually

[3] Converting the USEPA Code of Federal Regulations standard of 53.02 kg CO_2 / Million Btu into lbs CO_2 /Million Btu, multiply the metric units by a conversion factor of 2.20462262185 lbs/kg to arrive at the desired lbs CO_2/ Million Btu.

Total Benefit from Electricity and Heating Natural Savings

Now that the indirect benefits from electricity and natural gas savings have been quantified, the pounds of CO_2 from both calculations can be added together. This summation will make the later valuation calculation less complicated.

lbs avoided CO_2 emissions from electricity savings + lbs avoided CO_2 emissions from heating natural gas savings = total lbs avoided CO_2 emissions from electricity and heating natural gas savings annually

Example 4.5:

Recall that Example 4.3 calculated the annual avoided CO_2 from electricity of the 5,000 SF green roof and that the annual avoided CO_2 from natural gas savings was calculated in Example 4.4. Notice that these figures are the same resource unit and can be summed as follows:

1,639.58 lbs CO_2 + 4,226.6 lbs CO_2 = 5,866.18 lbs avoided CO_2 emissions from reduced building cooling and heating and reduced water treatment energy use annually

Now, the total benefit can be quantified by adding together the total carbon sequestered and the total CO_2 emissions avoided (from reduced energy use) for each practice. To do so, any carbon sequestration benefit (lbs C) must be converted, as previously mentioned, to its CO_2 equivalent.

To convert pounds of carbon sequestered into pounds of carbon dioxide equivalent:

total lbs carbon sequestered (lbs C) * 3.67 lbs CO_2/lb C = total annual equivalent sequestration benefit (lbs CO_2)

Then, the user can combine the direct (sequestration) and indirect (off-site avoided emissions) benefits into a figure for the total climate benefit, as follows:

∑ total equivalent sequestration benefit (lbs CO_2) + total avoided CO_2 emissions (lbs CO_2) = total annual climate benefit (lbs CO_2)

An example of this calculation will follow; please refer to Example 4.6.

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED ATMOSPHERIC CO_2

With the total pounds of CO_2 reduced, the following equation estimates the monetary value:

total climate benefit (lbs CO_2) * price of CO_2 (\$/lb) = total annual value of climate benefit (\$)

Example 4.6:

Following from Example 4.1, which quantified the direct and indirect climate benefits of a hypothetical 5,000 SF green roof, it was found that the green roof sequestered between 166 and 172 pounds of carbon per year. (An average of 169 pounds of carbon is used below.) In Example 4.5, this green roof had the indirect benefit of avoiding 5,866.18 lbs of CO_2 emissions from reduced energy use. One can calculate the monetary value of the total climate benefit as follows:

169.0 lbs C * 3.67 lbs CO_2/lb C = 620.23 lbs CO_2 in total annual sequestration benefit

5,866.18 lbs CO_2 in total annual indirect emissions benefit (Example 4.5)

∑ 620.23 lbs CO_2 + 5866.18 lbs CO_2 = 6486.41 lbs CO_2 in total annual climate benefits

This total climate benefit can be valued by multiplying by a price for carbon. In the following parts (4.6.a. and 4.6.b.), the guide walks through calculations of a lower and upper bound for valuing these carbon benefits.

Example 4.6.a:

Lower Bound: EU ETS Carbon Price of \$0.00756 / lb CO_2

*6,486.41 lbs CO_2 * \$0.00756 / lb CO_2 =*
\$49.04 monetary value of the total annual climate benefits

This lower-bound calculation shows that the hypothetical green roof could provide about \$49.04 in annual climate change benefits.

Example 4.6.b:

Upper Bound: Stern's Value of \$0.0386/lb CO_2

*6,486.41 lbs CO_2 * \$0.0386/lb CO_2 =*
\$250.38 monetary value of the total annual climate benefits

This upper-bound calculation shows that the hypothetical green roof could provide about \$250.38 in annual climate change benefits.

Pricing Carbon

To complete the valuation of the direct and indirect climate benefits for a given practice, a monetary price for carbon must be determined. In other words, it is necessary to assign a value to the **\$/ lb of CO_2** figure found in the final equation.

Assigning a price for carbon is not an exact science, and a degree of uncertainty still exists about the "best" or true price of carbon. It is generally accepted within the scientific community, however, that one can arrive at a working price estimate for the purpose of economic valuation of climate change.

Existing literature concerning the price of carbon dioxide and other greenhouse gas emissions offers a wide range of values for the market price of carbon. The latest report by the Intergovernmental Panel on Climate Change (IPCC) surveyed 100 peer reviewed studies and found an average estimated price per metric tonne[4] (Mg) of \$12 (or \$0.00544/lb) in a wide range that tops out at \$95/Mg (or \$0.0431/lb) (IPCC 2007).

The European Union's Emissions Trading System (EU ETS) is an example of a fully functioning carbon cap and trade market. A current average price within this market is about 12€, which according to today's conversion rate is about \$16.66[5] per metric tonne of carbon (Chevallier, J. 2010). However, it is important to note this is only a partial market given that it is not globalized and its prices are dependent upon specific regulatory parameters. In contrast, a widely read and cited report on the economic impact of climate change values carbon emissions at \$85/Mg (or \$0.0386/lb) (Stern 2006). However, this value is strictly academic since it has not been tested in the market.

The IPCC and other experts note that current carbon prices are very likely underestimated in the marketplace, given the exclusion of many unquantifiable risks associated with climate change (for example, future damages from more intense rain events) (IPCC 2007, Clarkson & Deyes 2002). Given the range of potential value for a unit of carbon in the market, the guide provides a low- and high-end valuation example that can be applied to the climate benefit calculations in this section.

[4] Mg=metric tonne or megagram; Conversion: 1 Mg = 2204.62262 lbs.

[5] currency conversion based on a rate of 1 EUR = 1.389 USD from Google Finance, 11/1/2010, 7:00PM

Example 4.7:

Following from the earlier tree example in Example 4.2, the 100 medium trees planted in a public space abated a net amount of 44,400 pounds of CO_2 annually.

Remember that because the *Tree Guide* value includes the net benefit from CO_2 abatement—the direct and indirect benefits—the indirect energy benefit for a given tree practice does not need to be recalculated here. (Otherwise, that calculation would double count the indirect energy benefit.) Instead, just multiply the total amount of CO_2 abatement (44,400 lbs in this case) by a given carbon price.

In the following (4.7.a. and 4.7.b.), the guide walks through calculations of a lower and upper bound for valuing these carbon benefits.

Example 4.7.a:

Lower Bound: EU ETS Carbon Price of \$0.00756 / lb CO_2

44,400 lbs CO_2 * \$0.00756 /lb CO_2 =
\$335.66 in total annual climate benefits

This lower-bound calculation shows that 100 medium trees planted in a public space could provide about \$335.66 in annual climate change benefits.

Example 4.7.b:

Upper Bound: Stern's Value of \$0.0386/lb CO_2

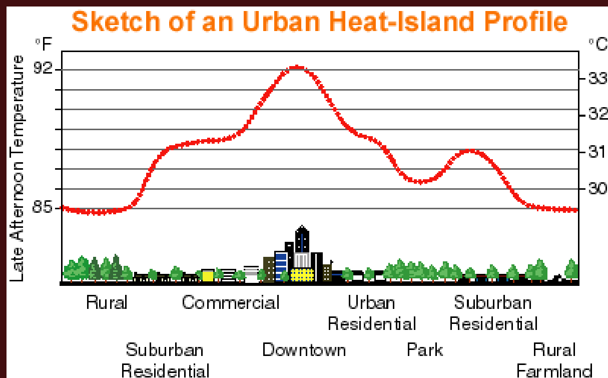
44,400 lbs CO_2 * \$0.0386/lb CO_2 =
\$1,713.84 in total annual climate benefits

This upper-bound calculation shows that 100 medium trees planted in a public space could provide about \$1,713.84 in annual climate change benefits.

Benefit Measurement and Valuation

5. URBAN HEAT ISLAND

The USEPA describes the process by which urban heat islands form as follows: "As urban areas develop, changes occur in the landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist generally become impermeable and dry. This development leads to the formation of urban heat islands—the phenomenon whereby urban regions experience warmer temperatures than their rural surroundings" (US EPA n.d. a).



Source: Lawrence Berkeley National Laboratory

The urban heat island (UHI) effect compromises human health and comfort by causing respiratory difficulties, exhaustion, heat stroke and heat-related mortality. UHI also contributes to elevated emission levels of air pollutants and greenhouse gases through the increased energy demand (via greater air conditioning needs) that higher air temperatures cause. Additionally UHI puts a greater demand on outdoor irrigation needs thus increasing water demand and its associated energy uses. Green infrastructure practices within urban areas can help to mitigate UHI and improve air quality through increased vegetation, reduced ground conductivity and decreased ground level ozone formation.

Various studies have estimated that trees and other vegetation within building sites reduce temperatures by about 5°F when compared to outside non-green space. At larger scales, variation between non-green city centers and vegetated areas has been shown to be as high as 9°F. Likewise, recent studies done on permeable pavement have found that it reduces or lowers the negative impacts of UHI through its porosity, which serves to insulate the ground better and allow more water evaporation. Both of these effects aid in cooling temperatures and mitigating the UHI effect.

One study, evaluating the benefit of reduced extreme-heat events, estimates that, at a city level, 196 premature fatalities can be avoided in Philadelphia (over a 40-year period) by integrating green infrastructure throughout the city landscape to address its combined sewer overflows (McPherson et al 2006; Akbari et al 1992; Stratus 2009). According to figures from the USEPA (n.d. b), the value of a statistical life (VSL) is $7.4 million (in 2006 dollars). Thus, applied to the Philadelphia study, reductions in UHI-related fatalities could save over $1.45 billion. Likewise, the Lawrence Berkeley Lab Heat Island Group estimates that each one degree Fahrenheit increase in peak summertime temperature leads to an increase in peak demand of 225 megawatts, costing ratepayers $100 million annually (Chang 2000).

While the benefits of mitigating the UHI are important to community health and vitality, current valuation of these benefits is not extensive enough to work through quantifying methods and equations in this section.

Benefit Measurement and Valuation

6. COMMUNITY LIVABILITY

Using green infrastructure for stormwater management can improve the quality of life in urban neighborhoods. In addition to the ecological and economic values described elsewhere in this handbook, the goods and services provided by urban vegetation and other green infrastructure practices carry socio-cultural values—aspects that are important to humans because of social norms and cultural traditions. This set of related benefits is grouped under the umbrella category of 'community livability' to describe the many ways in which increasing the use of green infrastructure can improve neighborhood quality of life. Community livability is classified into four categories:

- Aesthetics
- Recreation
- Reduced noise pollution
- Community cohesion

While all of these benefits carry significant value in communities, the literature regarding how to quantify their economic value is not extensive, widespread or well agreed upon at this time. Given the high levels of uncertainty involved in quantifying community livability benefits, this guide does not present methods and equations for quantification or valuation in this section. It does, however, points to ranges of benefit values that have been presented and proposed in various studies.

AESTHETICS

Increased greenery within urban areas increases the aesthetic value of neighborhoods. The positive impact of green infrastructure practices on aesthetics can be reflected in the well-observed relationship between urban greening and property value. People are willing to pay more to live in places with more greenery. To measure this value, various studies employ a Hedonic price method (calculating increases in property value adjacent to green features).

Several empirical studies have shown that property values increase when an urban neighborhood has trees and other greenery. For example, one study reported an increase in property value of 2–10 percent for properties with new street tree plantings in front (Wachter 2004; Wachter and Wong 2008). Another study done in Portland, Oregon, found that street trees add $8,870 to sale prices of residential properties and reduce time on market by 1.7 days (Donovan and Butry 2009). An extensive study on the benefits of green infrastructure in Philadelphia also explores the effect that these practices have on property values (Stratus 2009). While the authors conclude that property values are notably higher in areas with LID and proximity to trees and other vegetation, they also note the difficulty in isolating the effect of improved aesthetics and avoiding double-counting of benefits such as air quality, water quality, energy usage (often relating to heat stress) and flood control that also impact property values. In this study, a range of 0– 7 percent is presented as suggested in literature, and a mean increase of 3.5 percent is chosen (Status 2009). Ward et al. (2008) estimate property values in the range of 3.5–5.0 percent higher for LID adjacent properties in King County, Washington.

The Forest Service *Tree Guides*, referenced previously, provide estimates of the property value benefits trees provide in an urban setting. The property value benefit is found to be the second largest component of the total benefits derived from trees. Benefits are presented on a per tree basis, based on type and size of each tree as well its location.

Table 6.1
Annual Property Value Gains from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
Residential Yard	$4.50	$10.73	$23.44
Public Space	$5.32	$12.67	$27.69

Source: McPherson, E. et al. 2006

RECREATION

Green infrastructure has been shown to increase recreational opportunities (for example, walking the dog, walking or jogging on sidewalks, bench sitting or picnicking) when increased vegetation and treed acreage is added within a community. The value of added recreational opportunities is measured by the increase in recreational trips or "user days" gained from urban greening. Use values can then be assigned to the various recreational activity trips.

In one study, Philadelphia, Pennsylvania, estimated an increase of almost 350 million recreational trips (over a 40-year period) when utilizing green infrastructure within the proposed implementation of its *Green City Clean Waters* plan to control stormwater. The 2009 monetized present value of these added trips could amount to over $520 million (Stratus 2009). Furthermore, a report by the Trust for Public Lands for the Philadelphia Parks Alliance provided critical data on recreational uses, activities and visitation at parks in Philadelphia (Trust for Public Land 2008).

User Day Methodology

User day estimates from the Philadelphia study, although not necessarily universal, may provide a helpful starting point for valuing improved recreation from green infrastructure and increased vegetation.

- 1 additional vegetated acre provides ~1,340 user days per year
- 1 additional vegetated acre provides ~27,650 user days over a 40-year period
- 1 user day provides ~$0.71 in present value for 40-year project period (Stratus 2009)

This translates to a benefit of about $951.40 for each additional vegetated acre per year and about $19,631.50 for each additional vegetated acre over a 40-year project period.

For a complete methodology, please refer to the Stratus (2009) report.

Another approach to valuing recreation is determining the avoided costs in connection to health benefits. An example of this would be studies that correlate lowered medical expenses with increased levels of routine physical activity. In a 2000 study, researchers found that when previously inactive adults regularly incorporated moderate physical activity into their routines, annual mean medical expenditures were reduced by $865 per individual (Pratt et al. 2000).

REDUCED NOISE POLLUTION

Green infrastructure, particularly vegetative practices and permeable pavement, have the added benefit of reducing noise pollution. Planes, trains and roadway noise are significant sources of noise pollution in urban areas—sometimes exceeding 100 decibels, which well exceeds the level at which noise becomes a health risk.

A study in Europe using porous concrete pavement found a reduction in noise level of up to 10 decibels (Olek et al 2003;

Gerharz 1999). Likewise, the British Columbia Institute of Technology's Centre for the Advancement of Green Roof Technology measured the sound transmission loss of green roofs as compared to conventional roofs. The results found transmission loss increased 5–13 decibels in low- and mid-frequency ranges, and 2–8 decibels in the high frequency range (Connelly and Hodgson 2008). Hedonic pricing studies assessing the impact of road and aircraft noise on property values find average reductions in property value per one decibel increase in noise level of 0.55 percent and 0.86 percent, respectively (Navrud 2003).

COMMUNITY COHESION

One way that green infrastructure can make communities better places to live is through its effect on 'community cohesion'—improving the networks of formal and informal relationships among neighborhood residents that foster a nurturing and mutually supportive human environment (Sullivan, Kuo and Depooter 2004).

A study done by the Landscape and Human Health Laboratory at the University of Illinois at Urbana/Champaign (UIUC) found that, "Exposure to green surroundings reduces mental fatigue and the feelings of irritability that come with it. . . . Even small amounts of greenery . . . helped inner city residents have safer, less violent domestic environments." (Kuo and Sullivan 2001b).

Another study documents a link between increased vegetation and the use of outdoor spaces for social activity, theorizing that urban greening can foster interactions that build social capital (Sullivan, Kuo and Depooter 2004). Related to this effect, a further study found a meaningful relationship between increased greenery and reduced crime (Kuo and Sullivan 2001a).

Urban Agriculture Opportunities

As urban populations grow and the costs associated with rural food production and distribution continue to increase, urban agricultural systems are being considered in order to address concerns related to food security and cost (Argenti 2000). According to the USDA, 15 percent of the world's food supply is currently produced in urban areas (AFSIC 2010).

Green infrastructure practices such as green roofs and tree planting can provide increased opportunities for urban agriculture and urban foraging. Urban agriculture can include a multitude of benefits to urban areas, including economic development, recreational and community-building activities, educational opportunities for youth and increased habitat within the urban ecosystem.

While local food production via green infrastructure provides a variety of valuable community benefits, the current state of its valuation is not extensive enough to work through quantifying methods and equations in the guide at this time.

7. HABITAT IMPROVEMENT

Many vegetated green infrastructure features can improve habitat for a wide variety of flora and fauna. Rain gardens and other vegetated infiltration features hold particular value in this regard insofar as they perform best when planted with native species. Ecological economists recognize two aspects of habitat which are preconditions for the provision of a whole array of ecosystem services. First, habitat is living space for both resident and migratory species. Second, habitat provides nurseries for species which live their adult lives elsewhere.

Habitats are typically economically valued using either contingent valuation methods (especially where the conservation of an endangered species is concerned) or using the market price of traded goods that are harvested at the habitat in question (or of traded goods that are harvested elsewhere but for which the relevant habitat provides breeding and/or nursery grounds). The latter method can be useful, for example, in the case of coastal estuaries that provide nurseries for commercially harvested fish, but this approach is less applicable to the relatively small-scale urban vegetated features in question here. Contingent valuation studies might be more useful, but unfortunately, few have been conducted examining the habitat value of urban green space. Thus, this guide does not attempt to provide a framework for valuing this benefit.

Benefit Measurement and Valuation

8. PUBLIC EDUCATION

The USEPA (2008b) has listed public education as one of its six stormwater best management practices, further supporting the need for communities to be educated about water conservation and stormwater management. This is particularly important given the public's lack of understanding about the primary causes of and solutions to water pollution problems. A 2005 report by the National Environmental Education & Training Foundation (NEEFT) came to the following conclusion:

"78 percent of the American public does not understand that runoff from agricultural land, roads, and lawns, is now the most common source of water pollution; and nearly half of Americans (47 percent) believes industry still accounts for most water pollution (NEEFT 2005)."

While quantifying and valuing public education is difficult and the guide does not attempt to do this, educating and informing the general public about the efficient use of water resources is a valuable service that can build support for better water management decisions in the future. It is a vital precursor to achieving widespread adoption of green infrastructure solutions and realizing the many benefits they offer to communities.

Example Demonstration 1: Benefit Assessment of a Single Green Roof

The demonstration below walks through the quantification and valuation steps for the benefits provided by the 5,000 square foot green roof example that recurs throughout this handbook. This example is not a full lifecycle analysis and therefore does not take into account long-term benefits such as extended longevity of the roof membrane.

The table below is set up such that one may easily compile the annual monetary gains from each benefit. Although the green roof's net monetary benefit is calculated at the end of the table, please keep in mind that this will be an underestimate of the green roof's true value. Some benefits, such as reducing the urban heat island effect or improving community livability, are not quantifiable or valued at this time. In addition, this example only considers the benefits from one relatively small project. Initiating a community-wide program that embeds green infrastructure throughout the urban landscape would provide far greater benefits.

Benefit	Step 1: **Benefit Quantification** resource unit(s)	Step 2: **Benefit Valuation** resource unit * price	Annual Benefit $
Reduces Stormwater Runoff	**Annual Stormwater Retention Performance:** 71,100 gal retained *(Example 1.1)*	**Value of Annual Avoided Treatment Cost:** 71,100 gal * $0.0000919/gal = $6.53 *(Example 1.6)*	$6.53
Reduces Energy Use	**Annual Building's Cooling (electricity) Savings (kWh):** 1,122 kWh *(Example 2.1)*	**Value of Annual Building's Cooling Savings:** 1,122 kWh* $0.0959/ kWh = $107.60 *(Example 2.5)*	
	Annual Building's Heating Natural Gas Savings (Btu): 36,158,750 Btu *(Example 2.2)*	**Value of Annual Building's Heating Savings:** 36,158,750 Btu * $0.0000123/Btu = $444.75 *(Example 2.5)*	
	Annual Off-site Water Treatment Electricity Savings (reduced treatment needs of 71,100 gal): 110.77 kWh *(Example 2.4)*	Annual Off-site Water Treatment Electricity Savings will not be valued here because the value has already been accounted for above *(Example 1.6).*	
	Total Annual Electricity Savings (kWh, from on-site and off-site benefits): ∑ 1,122 kWh in cooling savings + 110.77 kWh in water treatment electricity savings = 1,232.77 kWh	The Total Annual Electricity Savings will not be valued here to prevent double counting. Instead, it is used to quantify "Air" and "Climate" benefits.	$107.60 + $444.75
Improves Air Quality *Note: The figures used here only account for the benefits of reduced NO_2. Similar steps should be performed for the other criteria pollutants, when possible.*	**Annual Direct NO_2 Uptake:** Lower Bound = 1.50 lbs NO_2 Upper Bound = 2.39 lbs NO_2 Average = 1.95 lbs NO_2 *(Example 3.1)*	**Value of Total Annual NO_2 Benefit:** 30.19 lbs NO_2 * $3.34/lb NO_2 = $100.83 *(Example 3.6)*	
	Annual Indirect Reduction in NO_2 Emissions (from reduced electricity and natural gas): 28.24 lbs NO_2 *(Example 3.5)*		
	Total Annual NO_2 Benefit (Direct uptake using the average NO_2 uptake value + Indirect avoided emissions): ∑ 1.95 lbs NO_2 + 28.24 lbs NO_2 = 30.19 lbs NO_2 *(Example 3.6)*		$100.83
Reduces Atmospheric CO_2	**Total Annual Indirect Benefit** (from electricity and heating natural gas savings): 1,639.58 lbs CO_2 + 4,226.6 lbs CO_2 = 5,866.18 lbs CO_2 *(Example 4.5)*	**Value of Total Annual Climate Benefit:** 6,486.41 lbs CO_2 * $0.00756/ lb CO_2 = $49.04 in total annual climate benefits *(Example 4.6a)* *Note: Here the lower bound (EU's ETS Carbon Price) of the range of carbon pricing was used. Keep in mind that this provides a conservative estimate of the economic, environmental and other social values of carbon abatement.*	
	Annual Direct Carbon Sequestration Benefit in CO_2 Equivalent (multiplying lbs C from Example 4.1 by conversion factor): = 620.23 lbs CO_2 *(Example 4.6)*		
	Total Annual Climate Benefit (Direct + Indirect): ∑ 620.23 lbs CO_2 + 5,866.18 lbs CO_2 = 6,486.41 lbs CO_2 *(Example 4.6)*		$49.04
		Total Annual Benefit (∑ Annual Benefits)	**$708.75**

Example Demonstration 2: Benefit Assessment of a Neighborhood Scale

This demonstration will walk through the quantification and valuation steps for scaling up the benefits of converting a hypothetical area of Chicago rooftops to green roofs. Following from Example Demonstration 1, these calculations show, in simplified terms, how scaling up the build out of green roofs has the potential to provide significant benefits to a community or urban area.

In this hypothetical demonstration, the City of Chicago plans to implement a green roof program to cover 1,200,000 square feet of viable rooftop area (assuming each green roof is 5,000 square feet in area) and calculates the total annual value of implementing this program. For reference, this converted area covers approximately five city blocks, provided that the average size of a city block in Chicago is 239,580 square feet[6].

In order to scale up the green roof benefits found earlier, one must calculate the number of roofs affected over the converted area (which will become the multiplier used to scale up the benefits):

1,200,000 SF area to be converted / 5000 SF per roof = 240 converted rooftops

The table below summarizes the benefits and corresponding monetary value of converting these 240 rooftops into green roofs.

Benefit	Annual Benefit ($) per 5,000 SF green roof (Example Demonstration 1)	Annual Benefit ($) from scaled green roof program (= annual benefit per roof * 240 converted roofs)
Reduces Stormwater Runoff	$6.53	$6.53 * 240 = $1,567.20
Reduces Energy Use	$107.60 + $444.75= $552.35	$552.35 * 240 = $132,564.00
Improves Air Quality *Note: The figures used here only account for the benefits of reduced NO_2. Similar steps should be performed for the other criteria pollutants, when possible.*	$100.83	$100.83 * 240 = $24,199.20
Reduces Atmospheric CO_2	$49.04	$49.04 * 240 = $11,769.60
Total Annual Benefit (Σ Annual Benefits)	**$708.75**	**$708.75 * 240 = $170,100.00**

[6] Average block size for the City of Chicago was determined using U.S. Census block group data collected from the Center for Neighborhood Technology's H+T® Affordability Index: 5.5 acres = 239,580 SF. Since block size varies from city to city, it is important to use local numbers for block area when available (CNT 2010b).

The previous calculations rely on a few central assumptions. First, the entire area in question will be converted into working and viable green roofs. Second, any additional scaling of green roof area will yield proportional benefits (hence the constant multiplier). Although the economic, environmental and social benefits of green roofs are calculated here, the total benefit value does not include a number of benefit categories, most notably reduced urban heat island effect, improved community livability, enhanced water quality and reduced flood risk. This guide has not attempted to quantify and value these benefits at this time, but they can be expected to significantly increase the overall value of the green roof.

It is also important to note that this example only considers the benefits from a relatively small application of green roofs. Initiating an even larger community-wide program that includes other forms of green infrastructure spread throughout the urban landscape would provide even greater benefits.

A similar example of a scaled-up urban application of green roofs has been done for the city of Washington, D.C. This case study looks at the impacts of green roofs over different coverage scenarios and details a methodology for analyzing an "opportunity area" for green roof implementation within the city (Deutsch et al. 2005). Findings show that both stormwater and air quality benefits are significant for a 20 percent green roof coverage scenario. These benefits include a predicted 13 percent reduction in CSO discharges and the same air quality benefits as would be provided by approximately 19,500 trees. The report concludes that the 20 percent green roof coverage case is both a "reasonable" and "feasible" target for the District of Columbia (Deutsch, B. et al. 2005).

Considerations and Limitations

This section explains key considerations and limitations to the preceding quantitative research and analysis. Due to the nature and scope of this report, every local project will have its own set of case-specific variables and uncertainties that must be evaluated. Particularly when undertaking a more rigorous benefit analysis of a specific green infrastructure program, please keep the following considerations in mind.

Full Life-Cycle Analysis

While a full life-cycle analysis is an important piece of the decision making process, it is beyond the scope of this guide, which has focused only on benefits. That said, it is important to note that when performing this type of valuation analysis, consideration of the counterfactual comparison is necessary. In other words, clearly defining what is being compared is critical. For example, is the analysis comparing whether or not to use green infrastructure instead of conventional grey infrastructure, or is the comparison between no change and the implementation of a green infrastructure project? This counterfactual understanding is important when valuing the overall costs and benefits of an action and should be clearly defined prior to working through a life-cycle analysis comparison.

Local Performance and Level of Benefits Realized

Detailed considerations of local and site-specific variables that impact green infrastructure performance are largely addressed in the previous quantitative section on a case-by-case basis. However, the need for local data when working through a framework for valuing a green infrastructure project or program remains crucial.

Recall that, as stated previously, the placement of trees relative to neighboring buildings will impact the amount of energy saved or that the media depth of a given green roof will impact its water retention capacity. Site-specific considerations should be made (when possible) for each benefit analysis in order to more precisely calculate the benefits accrued from a given project.

Regional and local variables, such as climate, also play a large role. Two green infrastructure installations with the exact same specifications can result in drastically different levels of benefits when implemented in different locations. For example, climate largely determines the reduction in building energy use resulting from trees. As discussed in the "Energy" section, shading




buildings in cool regions can actually cause an increase in energy demand, while reducing wind speeds in warm regions has little to no impact.

Spatial Scaling and Thresholds

Given the lack of large-scale green infrastructure programs and research analyzing their performance, it is uncertain whether one can estimate potential benefits from a community-wide program simply by scaling up smaller-site data. In other words, the benefits from a specific practice may or may not have a linear relationship to the scale of a project.

Some examples used in this guide provide estimates for linear multipliers (for example, the energy saved per square foot of a green roof in the “Energy Section”) and rely on the assumption that the benefit from one unit of a practice is proportional to the benefit from 100 units of the same practice. The complexity of natural functions, however, does not necessarily lend itself to such a simplified aggregation, and system level considerations are important.

Instead of having a linear relationship, it is also possible that green infrastructure could function similarly to the concept of an “economy of scale.” This would be the case if the benefits accrued from a practice have a proportionately greater effect on a large scale than they would if practiced over a small area. In effect, the green infrastructure practice would provide the maximum level of benefit only after achieving a certain scale of implementation. For example, the water quality improvement from a constructed wetland would be significantly and disproportionately larger than the water quality improvement from a smaller-scale rain garden.

An equally important consideration within spatial scaling is the concept of an ecological threshold, which can be described as “the point at which there is an abrupt change in an ecosystem . . . or where small changes in an environmental driver produce large responses in the ecosystem” (Groffman et al 2006). For example, urban heat island mitigation benefits that result from green infrastructure practices may only be realized at an as yet unknown level of incremental spatial implementation. A forest may provide significant cooling benefits, while a smaller number of individual trees in an urban area may have a negligible impact.

Temporal Considerations and Scale

Discounting

When evaluating an investment, economists use a process known as discounting, or present-value determination, to calculate the present-dollar equivalent of an investment's future benefits. In other words, discounting "translate[s] the values of future impacts into equivalent values in today's monetary units" (Goulder and Stavins 2002).

The term "discounting" refers to the adjustment one makes to account for future uncertainty (or the opportunity cost of money: a dollar today is not worth the same as a dollar five years down the road). Our society generally values what an investment gives us in the present more than what we might get for it in the future. The reason for this is future uncertainty, and as such, the future value or benefit of an investment must be adjusted or discounted. It is a technique widely used in benefit-cost analyses to understand and compare a project's implications (its rate of return) over a given temporal scale. Please note, however, that "applying a discount rate is not giving less weight to future generations' welfare" (Stavins 2005). Instead, it simply converts the net impacts from an investment over time into common units (Stavins 2005).

The controversy over discounting arises not from the concept itself but from how one determines which "social discount rate" is appropriate to use, particularly when evaluating environmental considerations. When a discount rate is chosen, there is an implicit judgment made about the value of the future. Oftentimes, an individual and a community value future benefits from a given green infrastructure project or program differently. Furthermore each green infrastructure practice behaves differently over time and requires specific considerations when performing discounting calculations. For these reasons, this guide makes no specific discount rate recommendations.

When proposing a large or long-term green infrastructure project, an in-depth discounting analysis, tailored to the specific case at hand, should be performed.

Operation and Maintenance

As is the case with conventional stormwater controls, green infrastructure depends upon regular maintenance to realize maximum benefits. When undertaking a green infrastructure project, it is important to fully consider the life cycle of the vegetation or capital used. Understanding the amount of maintenance involved in achieving the full benefit from a given practice is extremely important when undertaking large-scale green infrastructure. Many benefits of GI depend on regular maintenance. For example, vegetated green infrastructure elements, like plants on a green roof or tree plantings, will only sequester carbon as long as someone properly and routinely maintains them.

Other more capital-intense green infrastructure may require operational maintenance (for example, regularly cleaning permeable pavement for optimal performance) and repair over time to extend the life of the practice and to ensure that maximum benefits are realized. Conventional grey infrastructure, however, requires regular maintenance as well. Full lifecycle analysis must also evaluate operation and maintenance costs of conventional projects, which periodically require intense capital investments themselves.

Pricing Variability

During the valuation step (Step 2) in each subsection of the "Economic Valuation in Action" part of this guide, market prices are needed to calculate a final monetary value for each benefit. Although recommendations or sample prices for water treatment, electricity, criteria air pollutants and carbon can be found in the "Water," "Energy," "Air" and "Climate" sections, respectively, it is important to tailor these values to specific local data numbers whenever possible. The prices used in these calculations will have a significant impact on the magnitude of monetary value realized.

In addition, it is often difficult to find a strict market value for variables that may be too abstract or complicated to put in a market setting or in monetary terms. This lack of certainty is most pronounced in sectors that currently have few or no markets from which to derive prices. Prominent examples of this uncertainty can be taken from the debate over the value of a statistical life or the price of carbon. Property values and hedonic pricing (i.e. the perceived value of a good or service) also have an inherent degree of uncertainty and subjectivity when used to derive the value of a good or service.

For the purpose of this guide, it is necessary to rely on existing estimates to value the benefits of green infrastructure. However, given local variations, pricing uncertainty and economic fluctuation, market prices will likely vary over time. Please keep these considerations in mind when undertaking any in-depth analysis of green infrastructure valuation.

Double Counting

Summing up the benefits from multiple green infrastructure practices can be extremely complex, as many of the benefits are interconnected and correlated. This creates the risk of double counting or capturing the value of the same benefit multiple times. For example, in the "Water" section, valuation estimates from a property value study may account for both water treatment costs and reduced risk of flooding. Many of these specific precautions are directly addressed in each of the valuation sections.

It is important to keep in mind which aspects of each benefit are being captured in each stage of the valuation. For example, valuing the benefit of direct cost savings from reduced water treatment needs captures the cost of the energy associated with the treatment. It is, therefore, not necessary to account for the direct cost savings from the reduced energy use associated with reduced water treatment. It is, however, important to still calculate the energy reduction associated with reduced water treatment needs, because it is unlikely that the reduced emissions associated with the reduced energy use are captured in the direct cost savings from the reduced water treatment needs.

Also, as discussed in detail in the "Climate Change" and "Air Quality" sections, remember that the direct and indirect benefits realized from trees are combined. Because the *Tree Guides* consider carbon sequestration and avoided carbon dioxide emissions from reduced energy use in conjunction, it is important to not include these benefits twice. The same holds true for pollutant uptake and avoided emissions resulting from trees.

Case Studies: Valuing Green Infrastructure Across the United States

Throughout the United States, there is a growing recognition of the benefits green infrastructure provides to communities. Many municipalities have begun to recognize the additional benefits green infrastructure and effectively incorporate these practices. The following case studies illustrate the process these municipalities have implemented and what some of the findings have been.

Aurora, Illinois

Faced with aging infrastructure, an already impaired local water way and projected population growth, Aurora wanted to strengthen its downtown economy while providing environmentally and economically sustainable solutions to its stormwater management issues.

The City's leaders recognized the potential value green infrastructure could provide in solving some of these issues and began to analyze where GI might be appropriate. The resulting plan, highlighted in Aurora's *Rooftops to Rivers* program, seeks to bring green infrastructure to scale and attain quantifiable, replicable results.

Early estimates conclude that current stormwater runoff issues within the city could be substantially reduced, with "nearly 141 million cubic feet of stormwater (about 1.05 billion gallons) [diverted] from the sewer" (NRDC 2009). These results would yield about $108,632 in annual savings and reduce energy use by 1.37 million kWh, or the equivalent of 990 metric tons (about 2.2 million pounds) of carbon dioxide.

Chicago, Illinois

In an effort to address and plan for the future impacts of climate change, including increased flood risks and public health stresses, Chicago adopted and is currently implementing its *Chicago Climate Action Plan*. The plan emphasizes green infrastructure




(including green roofs, tree plantings and rainwater harvesting) as a strategy for adapting to the risks this region faces as climate change develops (Chicago 2008).

Chicago has also been a leader in promoting urban green roofs due to the combined sewer overflows problems within the region. The 20,000 square foot roof atop City Hall has helped decrease stormwater runoff and improve urban air quality by reducing the urban heat island effect around the site. Since its completion in 2001, the green roof has saved the city $5,000 a year in energy costs (Chicago Green Roofs 2006). Monitoring of local temperatures found that the "cooling effects during the garden's first summer showed a roof surface temperature reduction of 70 degrees and an air temperature reduction of 15 degrees" (ASLA 2003). To date, Chicago has over 400 green roof projects in various stages of development, with seven million square feet of green roofs constructed or underway.

Milwaukee, Wisconsin

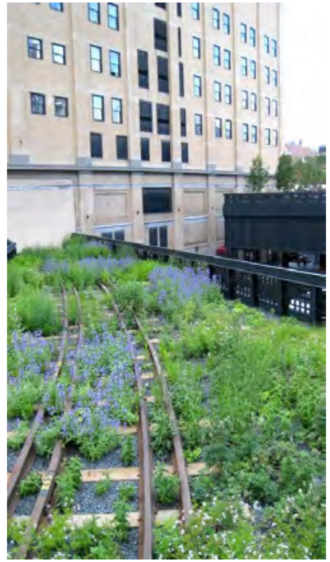
In an effort to reduce the occurrence of combined sewer overflows and reduce stress on aging grey infrastructure, the Milwaukee Metropolitan Sewerage District (MMSD) created a program called GreenSeams, which purchases upstream land for infiltration and riparian services. The program makes voluntary purchases of undeveloped, privately owned properties in areas expected to have major growth in the next 20 years. It also purchases open space along streams, shorelines and wetlands.

MMSD estimates that the total acreage holds over 1.3 billion gallons of stormwater at a cost of $0.017 per gallon. In contrast, one of its flood management facilities holds only 315 million gallons at a cost of $0.31 per gallon (MMSD 2010). While the comparison is not an apples-to-apples application, Milwaukee has found that, for managing stormwater and its potential flooding and overflow problems in urbanized areas, upstream conservation and the use of green infrastructure is cheaper than capital infrastructure build-out. This type of GI program works to save money for both the utility and its ratepayers.

New York, New York

Like most municipalities across the country, New York City (NYC) faces economic challenges. It must look at new strategies for getting the greatest amount of value out of every dollar invested in infrastructure. Due to its high percentage of impervious surfaces, the city generates a significant volume of stormwater runoff. In addition, NYC's aging infrastructure is under increasing pressure due to current and projected population growth. In an effort to address these issues while providing benefit to its residents, the city has adopted a Green Infrastructure Plan as part of its PlaNYC initiative. The plan presents "an alternative approach to improving water quality that integrates green infrastructure, such as swales and green roofs, with . . . smaller-scale grey or traditional infrastructure" (NYC 2010). One of its goals is to manage 10 percent of the runoff from impervious surfaces in combined sewer watersheds through these detention and infiltration approaches.

Additionally, since 1991, New York City has committed upwards of $1.5 billion toward maintaining and preserving its source waters in the Catskill and Delaware Watersheds (NYC DEP 2006). This initiative has thus far eliminated the need for a filtration plant that could cost as much as $10 billion. The city has not only improved its water quality, it has reduced the potential cost of water supply service to its ratepayers and reduced downstream flooding concerns. It has at the same time increased habitat and recreational opportunities for surrounding communities.



Philadelphia, Pennsylvania

Philadelphia faced the fact that conventional grey infrastructure approaches to managing the region's growing stormwater management issues would be cost prohibitive and would not adequately enable the City to meet its water quality standards. So, it turned to green infrastructure for possible solutions. The City hired Stratus Consulting to do a triple bottom-line assessment comparing traditional and green infrastructure. The final report's analysis shows that the net present-value of the benefits from green infrastructure greatly outweigh those of traditional grey infrastructure. For example, the city-wide implementation of green infrastructure at a 50 percent LID level—an option that would manage runoff from 50 percent of impervious surfaces in Philadelphia through green infrastructure—would provide a net benefit of $2,846.4 million. A 30-foot tunnel—the grey infrastructure option—would provide a net benefit of only $122 million (Stratus 2009).

In seeing the additional value that green infrastructure would provide its residents, Philadelphia has gone on to create a long-term combined sewer overflow control plan that invests heavily in GI initiatives. The program, titled *Green City Clean Waters*, is designed "to provide many benefits beyond the reduction of combined sewer overflows, so that every dollar spent provides a maximum return in benefits to the public and the environment" (PWD 2009).

Portland, Oregon

As in most urbanizing areas, Portland's increasing development has led to greater volumes and velocities of stormwater runoff, which has threatened critical waterways. Combined sewer overflows have also decreased water quality in the region. In search of methods to alleviate these environmental strains, the City of Portland Bureau of Environmental Services analyzed the key ecosystem benefits of replacing traditional grey infrastructure with green infrastructure in their ten year "Grey to Green" program, which encourages innovative stormwater management.

In addition to ecosystem benefits, the city has begun to research the many additional social and economic benefits that GI can provide. For example, in its "Energy and Greenhouse Gases" section, the report calculates the energy savings from the Grey to Green's proposed 43 acres of green roofs. The calculations estimate an annual savings of 63,400 kWh (ENTRIX 2010). The next step would be to translate this energy-savings benefit into a monetary value by multiplying by a price per kilowatt-hour. While as yet no monetary value has been assigned for these benefits, the city is working toward a better understanding of the underlying additional value green infrastructure can provide its communities.

Seattle, Washington

Since the late 1990s, the Seattle Public Utilities (SPU) agency has undertaken a variety of green infrastructure pilot programs including the well-known Street Edge Alternative (SEA) project. This and similar programs aim to reduce and treat runoff impacting water quality and aquatic habitat in the Puget Sound watershed by managing stormwater more effectively at a localized level. With this and other pilot programs, Seattle has collected performance data and made the case for substituting green infrastructure practices for traditional grey infrastructure in urban and suburban areas. For example, SPU estimates that a local street converted to the SEAStreet design saves $100,000 per block (330 linear feet) compared to a traditional street design, while achieving the same level of porosity (35 percent impervious area). In addition to these avoided-cost savings, the program claims these designs have provided additional community benefits such as traffic calming, improved neighborhood aesthetic and bioremediation (SPU 2010).

For more examples of communities implementing green infrastructure practices, please check-out The Conservation Fund's Green Infrastructure Leadership Program, which has assembled an online database of green infrastructure projects being planned and implemented across the country.
http://www.greeninfrastructure.net/content/projects

Conclusion

This guide distills some of the considerations involved in assessing the financial viability of common green infrastructure practices that are gaining ground in municipal water management. It aims to assist decision-makers in evaluating options and deciding where, when and to what extent green infrastructure practices should become part of future planning, development and redevelopment within communities.

In clarifying how to assign value to potential green infrastructure benefits, the guide begins to describe and demonstrate a process that works toward estimating the monetary value of GI, when possible, through the following steps:

Step 1: Quantification of Benefit
Step 2: Valuation of Quantified Benefit

By dividing this process into the above steps, this handbook allows for the cumulative assessment of the values associated with these practices. Clarifying these steps enables decision-makers to develop a better understanding of the potential benefits green infrastructure investments can provide their communities.

The field of green infrastructure and its valuation is still developing. Challenges in assigning value still exist. The following list outlines critical next steps in fully realizing the values of green infrastructure in the market place:

- More research regarding the social benefits of GI in order for these types of values to be included in the overall monetary valuation process
- A full life cycle analysis to recognize the long-term value of potential GI programs in municipal budgeting and infrastructure decisions
- Further development of tools, such as CNT's GreenValues Stormwater Calculator, to include the monetary benefits of GI in benefit-cost analysis
- Valuation of a range of GI practices beyond the five common practices listed in this guide
- Increased availability of local and regional data and modeling to more accurately assess the valuation of GI practices within a particular area
- The ability to better scale up the benefits of a proposed GI program in order to develop a clearer picture of the municipal or regional impact such practices can have on community's quality of life

While the above steps will help to improve the range and accuracy of benefit calculations from GI practices, the "Case Study" section demonstrates the growing trend of green infrastructure adoption throughout the country. Decision-makers are coming to understand the full range of infrastructure choices available to them. Recognizing green infrastructure's benefits will help municipalities make choices that not only provide solutions to urban stormwater management issues but also bring a plethora of additional benefits to their communities.

Appendix A

CNT's Green Values® Calculator

http://greenvalues.cnt.org/national/calculator.php

CNT's Green Values Calculator™ is a tool for quickly comparing the performance, costs, and some benefits of green infrastructure practices to those of conventional stormwater management practices. The GVC takes users through a step-by-step process of determining the average precipitation at the site, choosing a stormwater runoff volume reduction goal, defining the impervious areas of the site under a conventional development scheme and then choosing from a range of green infrastructure best management practices (BMPs) to find the combination that meets the runoff volume reduction goal in a cost-effective way. The calculator provides construction, annual maintenance and lifecycle (NPV) cost comparisons to manage a specified volume of stormwater for green infrastructure and conventional scenarios. The calculator also estimates some of the non-hydrologic benefits of using green infrastructure.

GreenSave Calculator

http://www.greenroofs.org

The *GreenSave Calculator*, developed by Green Roofs for Healthy Cities and the Athena Institute, allows for the analysis of various roof types over a set period of time in order to compare life-cycle costs. The tool is intended to help users examine future operating, maintenance, repair or replacement costs, as well as benefits such as energy savings. This enables users to determine whether higher initial costs are justified by reducing future costs. It also makes it possible to determine whether some roofs have lower initial costs that may increase over time.

Urban Forest Effects Model (UFORE)

http://www.ufore.org/

The UFORE model, developed by United States Department of Agriculture Forest Service researchers at the Northeastern Research Station in Syracuse, New York, is able to provide detailed, locally specific results regarding the air quality, building energy, greenhouse gas emissions, carbon storage and sequestration impacts of the existing urban forest. The model does, however, require substantial field data collection by users.

Street Tree Resource Analysis Tool for Urban Forest Managers (STRATUM)

http://www.fs.fed.us/psw/programs/cufr/stratum.shtml

Like the UFORE model, STRATUM, developed at the Center for Urban Forest Research at the Pacific Southwest Research Station of the US Forest Service, uses field data collected by the user in order to model tree impacts. Unlike UFORE, STRATUM is designed to assess not the entire urban forest but street trees in particular. The model not only quantifies benefits but also includes costs, making it more applicable as an asset management tool. In addition to quantifying and valuing the energy conservation, air quality improvement and climate benefits of trees, STRATUM also includes stormwater management benefits and property value impacts.

i-Tree Software Suite

http://www.itreetools.org/index.php

The i-Tree Software Suite from the USDA Forest Service is a helpful tool for analyzing and assessing the benefits of urban trees. Developed by adapting both the UFORE model (in i-Tree Eco) and the STRATUM model (in i-Tree Streets), the suite examines the pollution mitigation, reduction of stormwater run-off, and carbon sequestration benefits of urban trees.

The National Tree Benefit Calculator

http://www.treebenefits.com/calculator/

Casey Trees and Davey Tree Expert Co. have developed a National Tree Benefit Calculator which allows users to determine the stormwater, property value, energy (both electricity and natural gas), air quality and climate benefits and values for an individual tree. Users are required to input a zip code, the tree species, the tree's diameter and the land-use type.

Green Roof Energy Calculator

http://greenbuilding.pdx.edu/test.php#retain

The Green Building Research Laboratory at Portland State University is developing an online calculator to allow users to compare the energy performance of a building with a green roof to the performance of the same building with a conventional (black) or high-albedo (white) roof. Users input building location, roof area, and building type information, as well as green roof growing media depth and leaf area index. Users also have the option of inputting their own utility cost data or accepting default values. The calculator returns comparative annual electricity and natural gas consumption and total annual energy costs for the three roofing scenarios.

Low Impact Development Rapid Assessment Tool (LIDRA 2.0 model)

http://www.lidratool.org/

The Low Impact Development Rapid Assessment Tool is a model designed to compare the life-cycle values of implementing various green infrastructure techniques used in reducing runoff versus conventional stormwater management practices. The tool pulls from a database of performance and cost values derived from national data.

CITYgreen

http://www.americanforests.org/productsandpubs/citygreen/

American Forests' CITYgreen is an extension of ESRI's ArcGIS software. It converts stormwater and energy impacts (among others) from trees and other vegetation into monetary values based on local specifications.

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