Rain Year 2000/2001

Water Quality Analysis Report

County of Santa Barbara, California
September 2001

Public Works Department
Public Health Department

Staff Contact:
Robert Almy
Manager, Project Clean Water
568-3542
Ralmy@co.santa-barbara.ca.us

HTTP://WWW.COUNTYOFSB.ORG/PROJECT_CLEANWATER

Storm water sampling takes a great deal of commitment and energy in order to respond efficiently to the many false alarms, the many late nights, and the many unexpected storm events. The County is grateful to the many volunteers and staff that participated in the efforts or who made themselves available on a stand-by basis. In particular, we would like to thank the work done by the Public Health staff, including the lab. Also, special thanks to Tommy Liddell and Willie Brummett who keep the program running smoothly day and night.

Table of Contents

Appendices

Executive Summary

During Fiscal Year 1999-2000, Project Clean Water staff designed a water quality sampling program with two basic objectives: 1) to screen storm water runoff for a large number of potential pollutants and 2) to identify pollution sources and transport mechanisms under low flow conditions. This information was intended to be the basis for source reduction and treatment control efforts and expanded efforts to characterize surface water pollution in selected urbanized watershed in the County. Long term, some of this data may serve as a baseline with which to measure progress of cleaning up local watersheds.

This same water quality sampling program was continued through Fiscal Year 2000-01 with some minor modifications. Over 30 creeks were sampled during up to four storm events in each creek to 1) identify the types of contaminants that appear to be present in significant concentrations, 2) ascertain relative levels of contamination in each watershed and 3) identify problematic watersheds. With this information staff will both refine storm sampling and better focus implementation of source and treatment control Best Management Practices.

Samples were tested for a wide range of potential contaminants including bacteria, pesticides, volatile organic compounds (VOCs), nutrients, metals, and others (oil and grease, total suspended solids, etc.). Sample sites were set up in 44 locations within 22 watersheds. Six storms were sampled between October 2000 and May 2001. Sampling was conducted during the initial period of runoff ("first flush") as creek levels approached their maximum flow.

Results from the 1999-2000 storm sampling indicated that bacteria levels were consistently above applicable standards, (for example several orders of magnitude above the State's ocean water standards for body contact recreation), in the lower portions of all watersheds during storm events. Therefore, bacteria sampling was conducted primarily in the upper watersheds during the 2000-01 stormwater sampling. While results show that the bacterial levels are lower in the upper watersheds, they still exceeded the State's ocean water standards for body contact recreation, except at some localities in the highest reaches of the watershed.

Samples from the 2000-01 rainy season also contained metals (such as copper, chromium, zinc and lead) in quantities approaching or at times exceeding EPA standards in many creeks. The widely used pesticides glyphosate, chlorpyrifos, and diazinon were found in a majority of watersheds. Nutrient levels in storm runoff varied greatly among watersheds. Only one volatile organic compound (VOC), 4-isopropyltoluene, was detected in the three sites sampled for VOCs.

Because transport of contaminants is a complex phenomenon, many factors affect the measurement and portrayal of pollutants in storm water runoff. Contaminant characteristics, source location, dilution, mixing, speed of transport, exposure to various chemical and physical reactions, and sorption onto sediment particles (or subsequent release back into the water column) are some of the factors that affect measurements. These and other factors dictate that many samples are required for the analysis necessary to fully characterize surface water quality. Thus results from single samples of storm-water cannot be used to characterize pollution from an individual storm, much less establish

regulatory standards. As a result, these data are being used as a guide for further characterization of the creeks and their pollution sources.

Sampling data were analyzed by County staff and a Technical Advisory Committee. A draft of this report was made available to Project Clean Water stakeholders for their input. Recommendations for sampling storms during FY 2001-02 include: 1) elimination of testing for contaminants which were not detected, 2) adding sampling points in sub-watersheds, 3) sampling alternative storm drain discharges, and 4) continued intense sampling of a 'pilot' watershed to explore pollutant loading in that watershed.

In addition to water chemistry data collected by Project Clean Water, staff has began sampling benthic macroinvertebrates as a way of measuring the general biological condition of local streams. Data collected this year will serve as a baseline for comparison with information collected during future years. Preliminary data suggest that creek study reaches subject to a high degree of human disturbance have poor overall water quality.

This entire report can be viewed online at:
http://www.countyofsb.org/project_cleanwater/reports_and_studies.htm

1.0 INTRODUCTION

Project Clean Water, initiated in the fall of 1998, is Santa Barbara County's programmatic effort to improve the water quality in local creeks and in the ocean. The program is implemented by staff from the Public Works Department and the Public Health Department. Project Clean Water is driven by public concern over numerous beach advisories and historic closures due to elevated levels of bacteria. Bacteria levels are measured by weekly ocean-water sampling near the creek outfalls at 20 popular local beaches. Creeks and storm-drain outfalls appear to be the major source of bacteria in the nearshore environment. The sampling is conducted year-round under the Ocean Water Monitoring Program by the County Public Health Department.

As an initial investigation, the South Coast Watershed Characterization Study was conducted in 1998 by Project Clean Water staff to characterize the water quality of four south coast streams (URS Greiner Woodward Clyde 1999). This study marked the first major local effort at evaluating baseline water quality conditions and water quality impacts from storm water runoff and wet weather conditions. Both dry and wet weather sampling occurred within the watersheds of Arroyo Burro, Mission, Carpinteria, and Rincon Creeks. The most significant water quality parameter that was consistently high was the indicator bacteria (total coliform, fecal coliform, and enterococcus groups).

In order to gain a better understanding of the types and extent of pollutants contributed by storm water and low flow runoff, as well as to address future regulatory requirements (see Section 2.0, Regulatory Setting), Project Clean Water staff designed an expanded program of dry and wet weather sampling for the 1999-2000 season. The sampling program significantly broadened the previous year's study by adding many more creek sites and water quality parameter measurements, such as volatile organic compounds (VOCs) and various pesticides. In addition, the 1999-2000 storm water sampling program focused heavily on collecting samples during the "first flush" of each storm event, i.e., during increasing flow due to initial runoff.

The purpose of this sampling effort was to conduct a broad screening of water quality in local creeks in order to ascertain which contaminants are present at significant levels, and which watersheds exhibit consistently higher levels of contaminants. Once this is determined, a more informed approach can be made in identifying geographic areas (and their associated problematic contaminants) in need of treatment or source control Best Management Practices.

The 2000-01 water quality sampling program was a continuation of the effort begun during the 1999-2000 season. Project Clean Water Staff believe that the information collected, combined with one more year of sampling, will compliment our existing data and make statistical evaluation of the results more robust.

A description of the methods used and results are presented in this report along with a discussion of the findings and recommendations for further study.

2.0 REGULATORY SETTING

There are two main regulatory programs under which the County must address the quality of surface water. These are the National Pollutant Discharge Elimination System (NPDES), and Total Maximum Daily Loads (TMDLs). Under the Federal Clean Water Act both of these programs are enforced through regulations promulgated by the U.S. Environmental Protection Agency (EPA), and both programs have been delegated to the California State Water Resources Control Board and Regional Water Quality Control Boards.

2.1 NPDES

One of the programs under the federal NPDES regulations addresses storm water discharges. The storm water program is divided into two phases. The first phase was promulgated in 1987 and affected municipalities with populations greater than 100,000 people. Storm water permits for these medium to large municipalities, such as the counties of Ventura, Los Angeles, and San Diego, were submitted to their respective Regional Water Quality Control Boards in the early 1990s.

Those portions of Santa Barbara County with an urban population of at least 50,000 and a population density of at least 1,000 per square mile fall under the Phase II NPDES regulations for small municipalities. Additional requirements may, at the discretion of the State Board, be applied to those areas with at least 10,000 and a population density of at least 1,000 per square mile. Under the Phase II requirements, owners and operators of municipal separate storm sewer systems ("MS4s") must obtain a storm water permit for discharges into surface waters and must develop a program to reduce pollutant runoff to the maximum extent practicable. The application for this permit, which must include Best Management Practices to reduce pollutant runoff into the storm sewer system, is due to the Regional Water Quality Control Board on March 1, 2003.

There are some differences between the Phase I and the Phase II programs, notably the requirement for storm water monitoring. Phase I communities are required to conduct storm water monitoring; Phase II communities (at least in the first five years) are not. Nonetheless, a watershed monitoring program has been established under Project Clean Water. Although storm water monitoring is not a requirement under NPDES Phase II regulations, this information will be used to define pollution types and sources, guide development of Best Management Practices, and establish current conditions to gage the success of the long-term goals of Project Clean Water.

2.2 TMDLs

TMDL regulations are contained in Section 303(d) of the Clean Water Act. TMDLs are designated for water bodies of the state that have indicated signs of being impaired or impacted for beneficial uses of these waters. The State Water Resources Control Board (SWRCB) with concurrence of the EPA and the Regional Water Quality Control Boards established a listing of all impaired water bodies. This list is updated every two years. The most recent listing was in 1998.

This listing is subsequently prioritized based upon known and/or perceived impacts to the beneficial uses of these waterbodies. Santa Barbara County currently has eight listed water bodies for specific pollutants of concern, which are listed in Table 2-1 below.

Table 2-1 Santa Barbara County Section 303(d) Impaired Watersheds

Watershed	Beneficial Use Impairment
Arroyo Burro Creek	Pathogens[1]
Rincon Creek	Pathogens, sedimentation
Santa Ynez River	Nutrients, salinity, sediments
San Antonio Creek	Sediments
Goleta Slough	Metals, pathogens, sedimentation, etc.
Carpinteria Salt Marsh	Nutrients, sedimentation, etc.
Mission Creek	Pathogens

The TMDL process begins once impaired waterbodies have been established and prioritized. The total amount of pollution that can be discharged to these impaired water bodies (load allocation) from all land use categories in the watershed is determined by the agencies that have jurisdiction in the watersheds in coordination with the local Regional Water Quality Control Board. From these load allocations, appropriate water quality standards are established for each beneficial use impairment identified in the 303(d) list.

Local entities that have jurisdiction over the impacted watershed must develop a formalized implementation plan to reduce or eliminate the discharge of these pollutants to levels that meet the previously developed water quality standards. Often this means the cooperation of agencies that have overlapping jurisdiction such as in the Rincon Creek area where both Santa Barbara County and Ventura County have jurisdiction over parts of the creek.

Preliminary target dates have been established for the start of the TMDL process for all of the waterbodies prioritized in the Section 303(d) listing. For Santa Barbara County all impaired waterbodies are scheduled to begin development of the appropriate water quality standard(s) for each waterbody by 2006, except for the Santa Ynez River, which is 2003. Full plan development including establishment of the appropriate water quality standards is to be completed within five years of the target start date. In every watershed but the Santa Ynez River, this will occur by the year 2011.

The TMDL process has gained more attention in recent years due to lawsuit judgments that have forced local jurisdictions such as Ventura and Los Angeles to establish TMDLs more rapidly.

TMDLs are created for individual watersheds that often cross-jurisdictional boundaries and may be outside of the NPDES permit areas. As such, they offer a unique challenge and opportunity to

[1] See Section 4.5.1, Bacteria, for explanation of relationship between pathogens and indicator bacteria

cooperatively work with all agencies that may be discharging to the local watersheds. Because TMDLs have not yet been established in Santa Barbara County, it is difficult to estimate actual costs associated with specific projects or system components. Nor is it possible to judge their effect on the scope of Project Clean Water

2.3 Basin Plan Objectives and State Ocean Water Quality Standards

In addition to NPDES and TMDLs, the Regional Water Quality Control Board sets water quality objectives to provide the highest quality water reasonably possible (RWQCB 1994). These are presented in the Water Quality Control Plan, or Basin Plan. The objectives are implemented and enforced through waste discharge permits or NPDES permits. Table A-4 lists those objectives, and Table A-5 shows the applicable designated uses assigned to each watershed. The Basin Plan is also implemented by the Board's support of local programs that help achieve the goals of the Basin Plan. Numeric and narrative objectives are established in the Basin Plan and these objectives are used in this report to compare with the results of the 2000-01 water quality monitoring data.

The Basin Plan establishes freshwater objectives for fecal coliform for inland surface waters. However, the standards require a minimum number of sampling events within a given time period. Due to the limited number of sampling events spread out over a significant period of time (several months) comparison to these standards was not possible. Therefore, another set of standards is used to determine creek water quality.

The State Ocean Water Quality Standards[2] for bacteria have been established as follows:

Total Coliform –	10,000 MPN
Fecal Coliform –	400 MPN
Enterococcus –	104 MPN

where MPN is the most probable number, describing the statistical concentration of bacteria in 100 ml of water. Exceedance of these standards requires the local Health Officer to post warning signs at the beach area where recreational water contact may occur. This same mandate does not currently apply to freshwater areas such as creeks, streams and/or freshwater lakes.

[2] There is a fourth standard that is a ratio of Total Coliform to Fecal Coliform levels, which was not calculated or utilized, since comparison to individual indicator bacteria standards sufficed for the purposes of this study.

3.0 METHODS

The major goal of the 2000-01 water quality monitoring program was to evaluate and compare runoff from all of the urbanized watersheds in the south coast area and to a limited extent in the unincorporated urbanized areas of the north county area. This watershed-based approach focuses on the overall pollutant contributions from the entire watershed as opposed to pollutant contributions from specific sources or defined land uses. A watershed-based approach was selected for this program in order to maximize the area covered, while minimizing the total number of sampling sites.

3.1 Sampling Overview

Creek water was sampled during both low flow and storm flow conditions. Low flow sampling in the lower portions of the watershed included some base flow but mostly urban runoff from nuisance flows (i.e., pavement cleaning, irrigation, car washing, etc.), illicit connections, or non-storm water runoff from adjacent properties.

Storm flow conditions were sampled throughout the south coast and at seven locations in the north coast. The number of individual watersheds makes the south coast unique, and also difficult to characterize. Due to the high cost of laboratory analysis, only one station was monitored for the full suite of parameters in most watersheds. One station was usually located at the most downstream point in the watershed above tidal influence. (The cost of laboratory services for analyzing the full suite of constituents in one sample was approximately $1,000.) Bacteria and other selected constituents were collected at additional upstream locations.

3.2 Sample Sites

On the south coast alone, there are over 50 individual watersheds draining to the ocean in Santa Barbara County, about 23 of which drain the urbanized areas from Goleta to Rincon. Sample sites were selected on all major south coast watersheds within the urbanized portions of the county from Eagle Canyon Creek in western Goleta to Rincon Creek on the border with Ventura County. Sample sites were also selected for north county creeks that drain unincorporated urbanized areas, including Davis Creek in Vandenberg Village and Orcutt Creek in Orcutt. See Table A-1 for a list of creeks sampled and Figures A-1 and A-2 for maps of the sample locations.

On the south coast, one site per watershed was sampled as close to the mouth of the creek as possible (avoiding tidal influence) for a full suite of constituents. In North County, sites were located in creeks at the most downstream end of the urbanized areas. Two sites, in Orcutt, were sampled for the full suite of constituents in North County.

In addition to the creek sampling, four storm drains were selected for sampling this year. The sites were chosen as potential treatment control pilot project Best Management Practice sites. The data collected will not only help to characterize target pollutants, enabling selection of the proper Best Management Practice technology, but the data will also act as baseline conditions to evaluate performance of the Best Management Practice after implementation.

We also sampled one site on several occasions throughout each storm in an effort to calculate pollutant loading (see section 3.5). The site on Atascadero creek (ATA 030+00), just above the check structure at the end of Ward Drive, was chosen because of access to volume (discharge) measurements from the United States Geological Survey.

The sampling program also included bacteria and other selected constituents-only sampling sites. These sampling sites therefore reflect smaller areas within each creek's watershed and may in some cases partially reflect storm water runoff from certain land uses, such as agriculture or residential.

A total of 44 sites were sampled countywide, of which 29 sites were sampled for the full suite of constituents. Note that not all sites were sampled during low flow conditions, or for all storm events. Table A-1 describes the type and amount of sampling which occurred at each site.

3.3 Sample Collection

The south coast contains a relatively large number of small watersheds, and thus grab samples were determined to be the most cost-effective use of resources for this year's expanded program. The advantage of grab samples is they can be collected over a large area with a minimum of field crew. The disadvantage is that they represent a single snapshot of water quality at one instant during a storm. In contrast, composite samples combine smaller samples throughout the storm into one single, more representative sample. However, composite samples still only provide a snapshot of the tremendous amount of water that passes through a creek during a storm, *and* require additional manpower by repeated sampling of the same site or automatic samplers, both of which were unavailable during the 2000-01 season.

Since the goal of the 2000-01 program was to continue characterizing the types and, in selected watersheds, the extent, of pollutants within the south coast watersheds, it was desired to collect data representing the maximum concentrations or the maximum range of pollutants within the creeks. It was assumed that the most pollutants would be observed in the creeks during the rising limb of the creek hydrograph, i.e., during the period when the water levels in the creek are rising or at their peak. Every effort was made to capture samples during peak runoff in the creek, although many factors affect the timing of peak runoff. Variability due to permeable surfaces (pavement, etc), orographic effects, saturation of soils, and limitations in predicting peak flow and mobilizing personnel over a wide area to collect the samples are some of the factors.

PCW staff made up the core group of samplers with support from additional County employees and volunteers to make up the necessary numbers of samplers. For safety and efficiency reasons, samplers were divided into teams of two. Ideally, a minimum of seven teams (14 samplers) would be sent out into the field. With seven sampling teams, samples could be collected from all locations within 2 to 3 hours. However, 14 samplers were not always available. As a result, a fewer number of teams were sent into the field for some of the sampling events. This increased the overall sampling time to a maximum of 4 hours per team.

At the Atascadero loading site, we had originally planned to take samples for all constituents every hour during sampled storms. This would allow us to capture pollutants on the rising and falling limbs of the hydrograph. However, this sampling method turned out to be logistically difficult and samples were taken when the opportunity arose.

3.4 Analysis Performed

Numerous water quality analytes (128 total) were chosen based upon previous storm water quality assessments in the southern California area (SCWCS 1998, SCCWRP 1996), analytes required to be monitored by Phase 1 communities under their NPDES permit conditions, and pollutants that may be present in the Santa Barbara south coast area. General categories of constituents include bacteria, pesticides, VOCs, metals, nutrients and other constituents (such as total suspended sediments and oil and grease). The constituents (not including bacteria) are shown in Table A-2. Table A-3 shows the EPA method used in processing the constituents, and their associated lab cost.

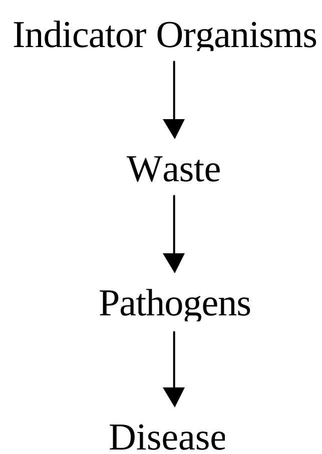
See Section 4.2, Storm Sampling Results, for a description of the storms that were sampled. No analytes were dropped throughout the 2000-01 storm sampling program.

Each category of analytes is briefly discussed below.

3.4.1 Bacteria

Several watersheds in the county have had TMDLs assigned to them for impairment due to pathogens (see Section 2.2, TMDLs). Pathogens are, by definition, disease-causing organisms. This concern is based upon historic measurements of indicator organisms. Current water quality testing methodologies relies on the usage of indicator organisms- total coliform, fecal coliform and enterococcus- as a measure of the potential for human pathogens to be present in the sampled waters. Indicator organisms are more readily detected and quantified than many human pathogens. As shown in Figure 3-1, indicator organisms are used to reveal the presence of waste in a water sample. Waste may be of plant, animal or human origin and may or may not contain human pathogens

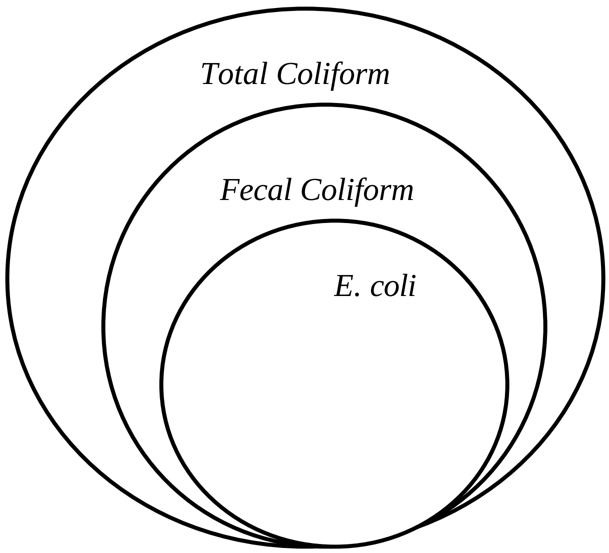
Figure 3-1 Chain of inference for indicator



For fecal coliform and enterococcus species, these organisms exist in the intestines of both human and animal populations. Their presence in the water has a relationship to public health risk (e.g. skin rashes, respiratory infections, gastro-intestinal illness and other diseases).

Water samples were collected and sent to the County Public Health Laboratory for analysis of the concentrations of three indicator organisms: total coliform, enterococcus and *Eschericia coli* (*E. coli*) bacteria. Figure 3-2 below displays the relationship between total coliform, fecal coliform, and *E. coli*. *E. coli* bacteria is the most prevalent form of fecal coliform bacteria. This species normally comprises approximately 85-95% of the fecal coliform that may be present in water sample. Once again, the vast majority of *E. coli* bacteria are not human pathogens and in most cases are beneficial to humans by aiding in digestion of food. One subspecies of *E. coli* (0157:H7) is pathogenic. This pathogenic *E. coli* has been involved in several foodborne illness outbreaks.

Figure 3-2 Schematic Showing Relationship Among Bacteriologic Indicators



3.4.2 Pesticides

Pesticides include all chemicals used to control "pests" of any sort, including herbicides, algaecides, fungicides, and rodenticides. These chemicals are used by homeowners and commercial operations to control weeds, ants, termites, and harmful garden bugs, among other things.

The presence of these chemicals, particularly chlorinated pesticides, are being monitored because of their toxicity to aquatic life and humans. Several pesticides are described in more detail below.

Chlorpyrifos, an organophosphate pesticide, is sold under several trade names, but the most common is Dursban. Chlorpyrifos made headlines two years ago as the EPA and the manufacturer reached an agreement to cease manufacturer's retail distribution prior to December 2000 and all product sales by December 2001 due to increasing evidence of aquatic toxicity at very low concentrations. Dursban is used for professional as well as non-professional applications, for the control of ants, fleas, and termites.

Diazinon is often used by homeowner's to combat ant infestations. Diazinon has been shown to be toxic to aquatic life at very low levels, often below the normal detection limits of testing laboratories.

Discussions with pesticide regulators are ongoing regarding the licensing of Diazinon. It is possible that Diazinon will, like Chlorpyrifos, be removed from the retail shelving in the near future, although we may not see any water quality benefits from these restrictions for years to come.

Glyphosate is a non-selective systemic herbicide that is applied to and absorbed by the leaves of plants. It is available to the general public at most lawn and garden stores under the trade name of Roundup-Pro or Rodeo, which is the form used for aquatic applications. The prevalence and frequency of glyphosate suggests its common usage and over-application.

There are no known aquatic standards for environmental exposure of Glyphosate; only drinking water standards exist. Environmental toxicity tests show a slight to moderate toxicity (LC50) based upon exposures ranging from 3.9 mg/L for fish (carp) to greater than 1,000 mg/L for crayfish (Pesticide Management Education Program).

Endosulfan is a pesticide group that is not available over-the-counter but is permitted for agricultural use.

3.4.3 VOCs

Volatile organic compounds can come from cleaners, solvents, and petroleum products. Although they are short-lived in the surface water environment, they are important because of their toxicity to aquatic life and humans, and the large number of their potential sources. However, VOCs are difficult to measure because they volatize under the turbulent, high flow conditions in creeks during storms.

3.4.4 Metals

Metals are ubiquitous in the environment. Anthropogenic sources of metals include: brake pads, industrial activities, tire wear (steel belted tires), air deposition, and some types of pesticides (copper algaecides, etc.). Metals can be toxic in both solid and dissolved form and therefore warrant monitoring.

3.4.5 Nutrients

Nutrients are vital to the health of an aquatic environment. However, they can be detrimental to aquatic life in high concentrations. Nitrogen and phosphorus tend to be the most commonly problematic nutrients because homeowners and agricultural operations add these nutrients to their lawns and gardens in vast quantities to increase productivity. The presence of nutrients can accelerate growth and the preponderance of water plants such as algae. When water becomes stagnant and temperatures increase, algal growth greatly increases, leading to the formation of large patches of thick green algal mats. These mats are not harmful to humans, but reduce light and oxygen availability in the water and may lead to anaerobic conditions, odors, and severe impacts to other aquatic life.

The nitrogen cycle is normally driven by nitrogen fixing bacteria in the soil. Ammonia, often deposited as animal waste, is oxygenated to nitrites and further to nitrates. In an oxygenated environment, nitrites are short-lived.

3.4.6 Other Constituents

Other constituents sampled for include turbidity, total suspended solids, hardness, specific conductance, oil and grease, and total recoverable petroleum hydrocarbons, among others. While many of these physical parameters are expected to be present and may not be toxic in the aquatic environment, their concentrations may be indicative of other problems, or useful for general characterization of the creek.

Hardness is a measure of the level of dissolved carbonates in the water column. Geological formations in this area (mainly lime and sandstone formations) are easily degraded by water. As a result, most ground and surface water displays fairly high hardness in the range of 300-500 mg/L.

Specific conductance can help to determine the degree of tidal influence at a given sample point, since higher levels of specific conductance indicate higher concentrations of salinity.

The presence of high concentrations of total suspended solids can be attributed to sediment runoff from the development of the watershed or from construction sites, erosion on the banks and creek bed due to increased flow rates.

Total Organic Carbon (TOC) and Biological Oxygen Demand (BOD) are indicators of biological activities within the watersheds. Elevated TOC indicates an abundance of organic (most likely vegetative) materials. Elevated organic materials often lead to an increase of organisms that work to break down these materials (e.g. bacteria, insects, etc.). This degradation activity puts a “demand” on the supply of oxygen in the water. Left unchecked, with an ongoing supply of organic materials, the oxygen supply in the watershed will ultimately drop and the watershed fauna may become impacted due to this reduction.

3.5 Changes to Sampling Program

3.5.1 Water Chemistry Analysis

We made several modifications to the 2000-01 sampling program based upon our discussions with the TAC and evaluation of last year’s sampling program.

Because dissolved metals are used to measure aquatic toxicity standards, total metals were dropped and replaced with dissolved metals. Last year, the total metal data was converted into dissolved metal data using an EPA conversion equation in order to compare to the toxicity criteria. Results indicated relatively high levels of dissolved metals, often exceeding the chronic toxicity criteria. This year, that conversion will not be necessary. Some select stations located in the upper portions of the watershed were tested for both total and dissolved metals in order to 1) understand the relationship between the two fractions and confirm last year’s conclusions, and 2) determine background levels originating from natural sources.

We discontinued testing for Methyl Blue Activated Substances (MBAS). MBAS is an indicator of soaps and detergents and is often used to detect sanitary sewer leaks. We dropped this constituent because there are many sources of MBAS aside from sanitary sewer leaks (e.g., car washing) and it was detected in most creeks from last year's data. Based on local experience, we feel MBAS is a better analyte for low-flow conditions where sanitary waste is suspected.

Last year's data showed that volatile organic compounds (VOCs) were typically low or non-detectable. Volatile compounds tend to dissipate in rapidly flowing creeks under storm conditions. Therefore, we dropped VOCs for most creeks and will now rely on Total Recoverable Petroleum Hydrocarbons and oil and grease as indicators of the presence of petroleum products that contain VOCs. We continued testing for VOCs this year at Bell Canyon and Arroyo Burro Creeks since they exhibited relatively high levels of these constituents last year.

Also, chlorinated pesticides were typically low or non-detectable in most creeks last year. This class of pesticides has become less commonly used than other pesticides. However, since chlorinated pesticides were detected in Santa Monica Creek on more than one occasion last year, we continued testing chlorinated pesticides at lower Santa Monica Creek (SM 061+00). We also added an additional site along upper Santa Monica (SM 088+00) creek to better determine source areas.

Four entirely new sites at storm drain outfalls were added. These sites were or still are under consideration as potential treatment control pilot project Best Management Practice[3] project sites. These sites are located at Carneros Creek (Robin Hill Road), San Jose Creek (North Kellogg), Atascadero Creek (South Turnpike Connector), and Carpinteria Creek (6th Street). As opposed to the creek sampling sites, this data shows direct urban runoff undiluted by creek flows.

The indicator bacteria tests were discontinued at most sites during storm sampling because results from the South Coast Watershed Characterization Study and last year's Project Clean Water sampling effort were consistently very high and additional testing seemed unnecessary. Bacteria testing will be continued at 303(d)-listed creeks and other creeks of concern (Carpinteria, Arroyo Paredon, Arroyo Burro and Atascadero Creeks). In addition, several bacteria-only sites were added at upstream locations to determine the bacteria levels that are introduced upstream of the urbanized areas.

Finally, we sampled Atascadero Creek (AT 030+00) throughout the storms to reflect pollutant loading. Our goal was to collect samples during the rising limb, at the apex, and during the falling limb of the creek hydrograph, to the extent practicable. This effort, in conjunction with the collection of flow volume data, will help us to track the variability of water quality within the creek throughout the storm event. Four discreet samples were collected at the Atascadero site during the October 26, 2000, storm, and three discrete samples were collected during the remaining storms (January 8, 2001, January 24, 2001 and April 6, 2001).

---

[3] Under a state grant, the County will install urban runoff treatment control Best Management Practices to treat stormwater runoff. Four sites were sampled to generate baseline information.

3.5.2 Biological Monitoring

To augment water chemistry data, Project Clean Water staff conducted biological monitoring using the Environmental Protection Agency's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (1999). Our goal is to continue the monitoring over several years to evaluate the ecological health of and track changes in south-county urbanized streams. Data collected this year will be used as a baseline for monitoring in future years. Twelve representative sites were selected for comparison of urbanized-impacted reaches with relatively undisturbed reaches. Sites were selected along Carpinteria (2), Gobernador (1), San Jose (3), Atascadero (2), Arroyo Burro(2), San Onofre (1), and Arroyo Hondo (1) Creeks.

Study and comparison of the selected creeks will provide a better understanding of their physical and biological conditions, and how they are influenced by the various natural and human-induced factors. Specifically, this program has been developed to answer the following questions:

- What range of physical and biological conditions are characteristic of relatively undisturbed, pristine local creeks?
- What physical and biological impacts have resulted in local creeks due to various types and intensities of human development including agriculture, suburban, and urban?
- Which land uses, activities, and water pollutants are most harmful to creek ecosystems?

Field surveys were conducted between the dates of May 17, 2001, and June 1, 2001, to evaluate the physical and biological conditions present at each study reach. Field work conducted at each study reach included plant and wildlife surveys, collection of three BMI samples from the creek bed, mapping, photography, and measurement of several parameters (e.g., stream flow, temperature, pH, conductivity, and riparian corridor width). In addition, a semi-quantitative creek habitat assessment was conducted using a protocol developed by the EPA. The EPA protocol involves visual assessment and numeric scoring of the physical habitat present at the study reach.

Research is being conducted determine numerous physical parameters for each of the study reaches, including watershed area, elevation, gradient, upstream creek channel length, stream order, and watershed land use types (e.g., open space, agriculture, residential, commercial, industrial, etc.) and percent cover, respectively.

Laboratory work is being conducted to process BMI samples collected during the field surveys. This involves the random selection and identification of 100 BMIs from each sample (300 per study reach) to the lowest practicable taxonomic level (typically genus). Quality control measures are being implemented to ensure random selection and accurate, consistent identification of BMIs. Preliminary processing and identification of the BMI samples is complete. Quality control is underway.

Quantitative and qualitative analysis will be conducted to assess relationships between biological metrics (e.g., BMI diversity, proportion of disturbance-sensitive taxa, etc.), physical factors (e.g., watershed area, gradient, water quality, etc.), and measures of human disturbance (e.g., percent of watershed disturbed, habitat assessment scores, etc.). Quantitative statistical methods including linear regressions and analysis of variance (ANOVA) will be used to establish the strength of these relationships, and whether they are statistically significant. The use of statistical methods will provide greater scientific validity to the conclusions of the analysis.

The Annual Program Report will be prepared to more fully describe the purpose of the biological monitoring, study watersheds, and bioassessment methodology, and to present all data gathered during field and laboratory work, results of the data analysis, and recommendations for future work.

3.6 Precipitation and Storm Tracking

Based upon local experience, samples were collected following a minimum rainfall of at least 0.25 inches within a period of several hours. Amounts less than this or distributed over a longer duration were not expected to generate sufficient runoff to mobilize pollutants. Also, storm water runoff was not sampled if more than 0.25-inch of rain occurred within the previous three days. Antecedent dry conditions of at least three days prior to storm water monitoring is common practice among the Phase I regulated communities, such as Ventura County (Ventura County 1999). Allowing sufficient antecedent dry conditions is thought to maximize the build-up of pollutants and subsequent flux measured in the runoff.

Each storm is unique in the quantity and intensity of rain, so weather data was closely tracked to determine the best time to initiate sampling. Due to the variation in rainfall within the watersheds sampled, sampling was occasionally initiated at a point when some areas received more than 0.25 inches while other areas did not. Every attempt was made to collect data from a storm that delivered at least 0.25 inch to the entire south coast and/or north coast area.

Historical average annual rainfall for the south coast area is approximately 18 inches per year (based on period from September 1 to August 31, and an average of data since 1868). Rainfall varies greatly from year to year, with a standard deviation of 8.17 inches. (SB County Flood Control 1999). During the 2000-01 storm sampling season, 25.97 inches of rainfall fell in downtown Santa Barbara.

Weather data available on the Internet from various sources including satellite imagery, radar, and modeling was used to forecast storm events. For real-time data, the County maintains a comprehensive flood warning system, the Automated Local Evaluation in Real Time (ALERT) network, that provides rainfall and stream flow gage data. This network is used to determine when, where, and how much rainfall has occurred. Figure B-1 show the location of rainfall and stream gauges throughout the county

Cumulative precipitation during the 2000-01 monitoring season is shown for one station (Santa Barbara #545) in Figure B-2. Hourly precipitation during the monitored storms is shown in Figures B-3 through B-6.

3.7 Sampling QA/QC

Project Clean Water staff developed an extensive quality assurance/quality control plan for field sampling. A sampling protocol document was created (Appendix E) and a preliminary training session was held for the County staff members and volunteers that would be participating in the sampling. The individuals were composed of Project Clean Water staff, Environmental Health Services staff, and volunteers. As mentioned above, for certain sampling events not all of these trained individuals could participate in the sampling events. At no time was a sample team created that did not have at least one trained sampler. Volunteers or less experienced samplers were paired with experienced samplers that performed on-site training during the collection process.

All sample bottles were labeled, handled and transported following the developed protocols. Chain of custody forms identified sample locations, date and time of collection, samplers and time of delivery to testing laboratory and/or transfer to laboratory technicians for transport to testing laboratories. Bacteria analyses were conducted at the Santa Barbara County Public Health Laboratory, while all other analyses were sent to Zymax Envirotechnology laboratory in San Luis Obispo. The Public Health Laboratory is certified by the State of California's Environmental Laboratory Accreditation Program and Zymax is certified by the State of California's Department of Health Services.

Field duplicates were not taken due to the higher lab cost of processing and previously demonstrated reliability of analysis in the South Coast Watershed Characterization Study (1998). Blanks were not included in the shipment of samples to the labs, again due to the high lab cost of processing the constituents. Each laboratory performed QA/QC procedures according to certification criteria.

4.0 RESULTS & DISCUSSION

Table A-4 shows the Practical Quantitation Limit (PQL) and any known standard or objective for each constituent. The PQL is the lowest level that the lab is confident of reporting. Therefore, a null result means that the constituent was not detected or the lab was not confident of the value because it was at or below the PQL.

Zymax would often report different PQLs for the same constituent and the same storm for different sites. Zymax would also report the same PQL for a constituent for each site for one storm, and then the PQL would change to a new value for the same constituent for each site for a different storm. The variation in PQLs was due to turbidity and subsequent dilution of samples. Therefore, if the PQL changed over the course of the four storms sampled for the full suite of constituents, then the range of PQLs was provided in Table A-4.

4.1 Low Flow Sampling

Samples were collected prior to and during the winter storm season at storm drain sites that contained flow. Bacteria levels under low flow conditions were consistently lower than bacteria levels for storm water runoff. The same is generally true for all other parameters. Selected Zymax results are shown in Table 4-1 below.

Table 4-1. Selected Low-Flow Sampling results

Constituent	2000-01 Low Flow Sampling		2000-01 Storm Sampling		
	Results (# of Detections)	# of Non-Detections	Min.	Avg.	Max.
Chlorpyrifos		7	0.00004	0.00030	0.00290
Demeton		7	--	--	--
Diazinon	0.00008, 0.00023 (2)	5	0.00004	0.00042	0.00840
Malathion		7	0.0001	0.0002	0.0007
Parathion		7	--	--	--
Glyphosate	0.014 (1)	6	0.009	0.034	0.160
Ammonical Nitrogen	0.1-0.4 (5)	1	0.1	0.4	1.8
Nitrate as Nitrogen	1, 1.3 (2)	4	0.5	4.8	24
Nitrite as Nitrogen		6	0.5	0.5	0.5
Phosphate as P		6	1.1	1.9	2.7
Total Kjeldahl Nitrogen	0.5-1.3 (6)		0.5	2.6	13.0
Total Phosphorus	0.16-0.4 (6)		0.02	1.20	8.40

4.2 Storm Sampling Results

Although each site was only to be sampled four times, samples were taken during six storms, as described above, due to differing rainfall in the north and south county. South county sites were sampled October 26, 2000, January 8-10, 2001 (sites not sampled on the 8th were sampled on the 10th), January 24, 2001 and April 6-7, 2001. North county sites were sampled January 24, 2001, February 9, 2001, April 6-7, 2001, and April 20, 2001. After each sampling event, the sites were reevaluated to determine whether they were still appropriate in terms of safety, accessibility and tidal influence. No sites were dropped during the 2000-01 season.

As discussed above, grab samples were collected at or before the peak runoff. The results of the timing of each storm, stream hydrographs, precipitation data, and time of sample collection is shown in Appendix B. Samples were collected during the first few hours of the storm runoff when expected pollutant loads would be at their highest. Sampling during this period is sometimes referred to as the "first flush", a time when pollutants are initially mobilized, especially from impervious areas, and runoff is most concentrated. This differs from the timing of storm water sampling that was conducted in the 1998 South Coast Watershed Characterization Study, where sampling often occurred several hours following the peak runoff.

Preliminary analysis of the results reveals high levels of bacteria in the creeks (up to 25 times the State's Ocean Water Advisory level). Metals were also detected in many creeks at levels approaching or, in a few cases, exceeding basin plan standards. Nitrogen and phosphorus were found in all creeks with highest levels found in agriculturally dominated watersheds. A limited number of VOCs were detected in some creeks. Pesticide results indicate that glyphosate and diazinon were present in a majority of the creeks.

Tables C-1 and C-2 summarize results from 2000-01, while Table C-3 compares these results to 1999-2000. In addition, graphs have been prepared showing data for all storms and all constituents that appeared in the results (Appendix C). All graphs are labeled from west to east according to the site numbers listed in Tables A-1a-c and shown in Figures A-2a-c. Appendix D shows the same figures for the Atascadero loading site.

4.3 Summary of Findings

Described below are the findings observed from this year's storm water sampling, presented by categories of constituents. For each category, a table is provided (Tables 4-1 through 4-7) which shows a summary of the results presented in Appendix C.

Although some geographic and temporal trends were observed and some constituents were found in relatively higher concentrations compared to regional and national criteria and objectives, the data discussed below represent only two years of sampling. Therefore, the data may not necessarily be statistically significant or representative. It is not apparent from these results that any watershed stood out dramatically from the rest as having unusually high concentrations for contaminants during a majority of the storms.

4.3.1 "First Flush" Pollutant Loading

In some areas it has been found that the first storms of the season transport a relatively high load of pollutants, and that subsequent storms may transport somewhat less. Previous national evaluations such as the National Urban Runoff Program (NURP) study (EPA 1983 *Results of the Nationwide Urban Runoff Program, Volume 1- Final Report*) as well as more localized studies (Marsalek, J. 1990 "Evaluation of Pollutant Loads from Urban Nonpoint Sources" *Wat. Sci. Tech.* 22(10/11):23-30) have shown this correlation between elevated pollutant concentrations and the "first flush," or the first rain of the season. The first flush usually occurs in areas where a long dry period is followed by consistent and frequent rains. During the dry period, pollutants build up on impervious surfaces and are subsequently washed off during the rain, diminishing in concentration as the rainy season progresses. In fact, NPDES Phase I regulated communities are required to sample storm water runoff during the first three storms of the season in order to characterize the maximum pollutant concentrations expected. Although investigators have demonstrated the accuracy of this assumption in many regions of the country, they are not well-defined in southern California (SCCWRP 1996). This is probably due to long periods of dry weather and pollutant accumulation between storms.

Some Santa Barbara County data (e.g., biochemical oxygen demand, dissolved zinc) exhibited higher concentrations of pollutants in the first storm vs. later storms, whereas for some pollutants (e.g., dissolved mercury and total suspended solids), concentrations appeared higher in the later storms. For example, a comparison of Diazinon levels in Atascadero Creek over three sampling periods, the second and third sampling events showed higher concentrations than the first sampling event. Carpinteria Creek on the other hand had higher levels of the pesticide in the first event and lower levels in subsequent events. In this case, it is possible that seasonal use of pesticides and/or fertilizers may be reflected by these results.

4.3.2 Bacteria

Table 4-2. County-wide Bacteria Results Summary

		Minimum	County			Maximum*
			Average	Standard Deviation	# of Samples	
Storm Sample	Total Coliform	496	317,209	503,865	122	2,419,200
	E. coli	17	24,413	99,959	122	1,046,200
	Enterococcus	31	22,163	42,688	122	241,920

*Maximum detection at 1:1000 dilution (performed for Total Coliform and *E. coli*) is 2,419,200 and 241,920 at 1:100 dilution (Enterococcus).

Table 4-3. Area-Wide Bacteria Results Summary

		Goleta			Montecito/Carpinteria			North County		
		Avg.	Standard Deviation	# of Samples	Avg.	Standard Deviation	# of Samples	Avg.	Standard Deviation	# of Samples
Storm Sample	Total Coliform	386,796	529,382	63	318,789	66,475	34	169,675	114,616	25
	E. coli	22,477	39,952	63	13,843	751	34	45,604	18,172	25
	Enterococcus	30,784	46,553	63	17,263	6,534	34	8,879	8,135	25

During the October 26, 2001, storm, total coliform, *E. coli* and enterococcus were above the State Ocean Water Quality Standards (shown below) at all creeks including the new added sites located in the upper portions of the urbanized areas. One exception was the first of four samples that were taken at Atascadero Creek as part of the pollutant loading effort. In this first grab sample, Total Coliform was below the State Ocean Water Quality Standards, while *E. coli* and Enterococcus were above these standards. All indicator bacteria in the subsequent three samples at this site were above State Ocean Water Quality Standards.

During the second storm on January 8, 2001, results from nine tests were below State Ocean Water Quality Standards, although no site passed all three criteria. Things took a turn for the worse on January 24, 2001, when only five sites were below State Ocean Water Quality Standards for *E. coli*. During the last storm in which samples were taken along the South Coast and in North County, results from seven tests were below State Ocean Water Quality Standards; again, no site passed all three criteria. Only one site, Gobernador (GO 080+00) on Jan. 8, 2001, passed with respect to State Ocean Water Quality Standards for enterococcus.

In an effort to better determine the background levels of bacteria coming into the urbanized areas, Project Clean Water staff sampled the uppermost accessible section of Cold Springs Creek (near the Tangerine Falls) during a February 24, 2001, storm. The results from this sample passed the State Ocean Water Quality Standards for all the indicator bacteria. These results, combined with background samples taken in the past, indicate that the bacteria counts quickly rise with exposure to urban impacted creek stretches.

- Bacteria results were by far the most consistent. Previous studies (SCWCS, SCCWRP 98 Bight Dry and Wet Weather studies, ongoing monitoring by the ocean water monitoring program) have shown that stormwater runoff greatly increases the amount of bacterial in the creeks and subsequent transport to the ocean. Comparison of this sampling period's dry weather sampling to wet weather sampling shows, on average, 1 to 2 orders of magnitude increase in the bacterial levels during wet weather events. In most of the watersheds tested during dry weather, background levels of total coliform and enterococcus were at or exceeding current ocean water standards. Recreation 1 standards contained in the Basin Plan cannot be used for comparison purposes with this year's data because the sampling frequency and patterns do not meet the criteria for statistical evaluation as spelled out in the Basin Plan for recreational water contact areas.

4.3.3 Pesticides

Table 4-4. County-wide Pesticide Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Glyphosate	0.009	0.034	0.160	0.029	67
4,4'-DDT	0.00004	0.00004	0.00004	0	1
Endosulfan I	0.00004	0.00009	0.00017	0.00007	3
Endosulfan II	0.00005	0.00008	0.00011	0.00003	1
Endosulfan sulfate	0.00004	0.00007	0.00011	0.00004	3
Chlorpyrifos	0.00004	0.00030	0.00290	0.00055	30
Diazinon	0.00004	0.00042	0.00840	0.00120	65
Malathion	0.0001	0.0002	0.0007	0.0002	16

- The number of detections of pesticides increased dramatically this year from last year.

- Detections and exceedances of chlorpyrifos and malathion were generally more frequently detected, but not always in higher concentration, during the first part of the rainy season. This is especially true for western Goleta creeks

- The temporal variation exhibited by chlorpyrifos and malathion was absent with diazinon.

- Although 4-4'-DDE was detected last year, it was not detected this year. However, 4,4'-DDT was detected this year in one creek on one occasion (SM 061+00 on October 26, 2000).

- The California Office of Environmental Health Hazard Assessment has developed a Public Health Goal of 1.0 mg/L for glyphosate in drinking water, whereas the federal EPA has published a maximum contaminant level of 0.7 mg/L for glyphosate in drinking water. The Regional Water Quality Control Board has set water quality objectives for glyphosate in drinking water at 0.7 mg/L. Last year, the maximum value observed during the storm events sampled was 0.57 mg/L, which occurred in Carpinteria creek on November 8, 1999. This year, the maximum value observed was 0.16 mg/L, which occurred in Carneros creek on October 26, 2000.

4.3.4 VOCs

- The number of detections of VOCs was lower, but this can be attributed to the fact that the number of tests for these constituents was greatly reduced.

4.3.5 Metals

Table 4-5. County-wide Metal Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Arsenic	0.05	0.05	0.05	0	1
Chromium	0.01	0.02	0.03	0.01	5
Copper	0.01	0.03	0.47	0.06	63
Lead	0.013	0.014	0.015	0.001	2
Mercury	0.00009	0.00043	0.00110	0.00025	32
Nickel	0.01	0.02	0.09	0.02	13
Zinc	0.01	0.09	0.33	0.09	71

- The number of detections of dissolved metals showed no particular pattern compared to last year; some were detected more often, others less often, and some approximately the same number of times. Thus, overall trends for metals were difficult to ascertain other than for the group as a whole. Results indicate earlier storms liberated more metals into the creeks than later storms. For example, of the 71 detections of dissolved zinc, almost one-third of these detections occurred during the first storm of the year.

- Almost every watershed normally sampled for metals displayed some level of metals present in the water samples collected. The only watershed that did not have any metals detected was Maria Ygnacio (MYW 158+00).

- As shown in Tables C-1 and C-2, metals exceeded standards more than any other constituent (besides bacteria). With increased detection capabilities and the ability to better observe environmental impacts, standards have become more restrictive. As an example, the EPA Gold Book standard (1986) indicates a chronic standard for Copper as 0.12 mg/L. Recent revisions to the EPA Aquatic Toxicity Standards indicate that this standard has been revised to 0.009 mg/L. Although these standards are not currently part of the NPDES permit/program requirements, they may be incorporated in new or renewal permits or as part of the TMDL process.

4.3.6 Nutrients

Table 4-6. County-wide Nutrient Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Ammonical Nitrogen	0.1	0.4	1.8	0.3	78
Nitrate as Nitrogen (NO_3-N)	0.5	4.8	24	5.2	94
Nitrite as Nitrogen (NO_2-N)	0.5	0.5	0.5	0	1
Phosphorus as Phosphorus (PO_4-P)	1.1	1.9	2.7	0.6	10
Total Phosphorus	0.02	1.19	8.4	1.56	110
Total Kjeldahl Nitrogen	0.5	2.6	13	2.0	103

- The number of detections of nutrients during this year's sampling were generally the same as those from last year.

- Many nutrients are found in all creeks and at all times of the year.

- Nitrate as nitrogen was found in much higher concentrations in creeks influenced by agricultural runoff.

- In the three watersheds with an upper and lower site (Orcutt, Santa Monica, and Carpinteria), detections were more frequent and in higher concentration at the downstream site (e.g., ammonical nitrogen, nitrate, Total Kjeldahl Nitrogen, and total phosphorus).

4.3.7 Other Constituents

Table 4-7. County-wide Results Summary for Other Constituents

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Total Recoverable Petroleum Hydrocarbons	1	1.3	1.7	0.3	6
Total Organic Carbon	3.2	24.1	110	17.3	100
Oil and Grease	1	2.7	8.5	2.2	22
Hardness	8	329	2200	339	113
Specific Conductance (umhos/cm)	28	850	10000	1213	113
Total Dissolved Solids	22	607	4700	690	113
Total Suspended Solids	5	425	4000	815	102
Biochemical Oxygen Demand	5	18	73	14	63
Turbidity (NTU)	2.1	286.8	3700	665.3	110

- Average specific conductance was greatly reduced from last year. This can be attributed to the adjustment of a couple of sampling locations away from tidal influence.

- Average total dissolved solids were considerably lower this year than last year.

- Total suspended solids were considerably lower for the last storm of the season than during the previous storms.

- Total dissolved solids, hardness, and specific conductance were highest at the Devereaux sample site (DE 000+00). This may be attributed to tidal influence or that the sample point is directly downstream of a golf course.

- Average turbidity was approximately 3 times greater this year, with the first storms of the year being far more turbid than the later storms.

- Biochemical Oxygen Demand was highest during the first two storms and then diminished or was undetectable for the third and fourth storms.

4.3.8 Atascadero Loading Site

Graphs for the Atascadero loading site are shown in Appendix D.

- Glyphosate and malathion, for example, were not detected in the first sample or generally increased in concentration as the storm progressed. Conversely, concentrations of chlorpyrifos tended to decrease on the falling limb of the hydrograph.

- Based upon the relatively small amount of flow in Atascadero on January 24, 2001, it appears that many dissolved metals do not appear in low flows, at least not above the Practical Quantitation Limits (detection limits) offered by Zymax.

- Specific conductance and total dissolved solids tapered off as the storm progressed.

4.3.9 Treatment Control Pilot Project (TCPP)

For most constituents, the Best Management Practice sites were no worse than non-Best Management Practice sites with the following exceptions:

- Dissolved zinc was detected in 15 of the 16 samples taken at these sites. This percentage of detection is greater than the average for other non-Best Management Practice sites.

- The North Kellogg site had a significantly greater BOD than other Best Management Practice and non-Best Management Practice sites. Also, BOD was detected at the 6^{th} Street site during the last storm and not at any other Best Management Practice or non-Best Management Practice sites.

- Oil and grease was detected in 9 of the 16 samples taken at these sites. This percentage of detection is greater than the average for other non-Best Management Practice sites.

4.3.10 Benthic Macroinvertebrate Sampling

The locations of the 12 Program study reaches are shown in Figures F-1 to F -4. Preliminary physical and biological data produced thus far is provided in Table F-1. It is important to realize that the data set provided in Table 1 is incomplete and preliminary, and, especially in the case of the BMI data, is subject to change based on the results of the quality control efforts that are underway. Nevertheless, based on a cursory analysis of the preliminary data, it appears that there are strong relationships between human disturbance, water quality and BMI community diversity and composition in the study creeks.

In general, it appears that creek study reaches subject to a high degree of human disturbance have poor overall water quality as indicated by elevated conductivity, and support BMI communities of low diversity that are almost completely dominated by disturbance-tolerant taxa such as true flies (Order Diptera) from the families Chironomidae and Simulidae, and non-insects such as gastropods (snails), copepods, and oligochaete worms. This is especially the case for study reaches with a substantial proportion of urban (i.e., commercial and industrial) development in their watersheds, and those that have been subject to a great deal of creek bed and bank alterations and loss of riparian vegetation e.g. such as AT-1, AT-2, AB-1, C-1 and C-2). Conversely, creek study reaches that are relatively undisturbed by human development have good overall water quality as indicated by lower conductivity, and support diverse BMI communities including numerous disturbance-sensitive taxa such as caddisflies (Order Trichoptera), stoneflies (Order Plecoptera) and mayflies (Order Ephemeroptera).

Thus far, the preliminary data appears to be consistent with what was expected at the outset of this study, and with the results of several similar studies that have been completed in other parts of the state and country. A full analysis, including statistical testing, will be undertaken immediately after the data is complete and finalized. The results of the data analysis will be presented in the consultants' report.

5.0 RECOMMENDATIONS

The storm-water quality data obtained in FY 1999-2000 and 2000-01 was developed in part to be the basis for more focused sampling in subsequent years. Since very little was previously known about the characteristics of the County's urban runoff prior to last year's sampling effort, results from these first two full seasons of water quality testing have established a baseline and provided a screening-level evaluation of overall water quality in local creeks.

Staff recommends that the sampling program of 2001-02 be continued with modifications that take advantage of additional resources while maintaining some continuity so as to develop a sufficient data base upon which to guide measures to improve water quality within our community.

Recommendations developed by staff and by the County's Technical Advisory Committee on Water Quality Sampling for the 2001-02 season are presented below. County staff will evaluate the cost and resources necessary to implement these recommendations as appropriate.

- Send field duplicates of a percentage of selected samples to another laboratory for QA/QC purposes.

- Study one creek and/or one storm in greater detail. Focus down to level of TCPP sites, sub-watersheds, and/or storm drains. Staff has selected San Jose creek to assess relative input of pollutants from various land uses.

- Discontinue testing at Vandenberg Village due to likelihood that this community will not be included in the County's Phase II permit.

- Discontinue bacteria sampling at Orcutt 2 and 3. The catchments above these sites drain an agricultural field and a golf course, respectively. As such, they are not good indicators of the type and quantity of bacteria contained in urban stormwater.

- Discontinue testing at the two Best Management Practice sites (North Kellogg and Robin Hill Road) ranked lower by the consultant (Geosyntec). Add sampling site at Bella Vista open space (Devereaux creek) to generate baseline data for a potential treatment control pilot project Best Management Practice site.

- Drop total metals at all sites.

- Continue benthic macroinvertebrate sampling.

Below are suggestions that should be considered for future programs, or as suggestions for academic studies.

- Conduct a pilot study to determine a spatial distribution of pollutants as measured across a cross section of flow. (This would help establish the variability of water quality in flowing streams, thus providing a basis of estimating sampling error.)

- Consider adding bioassay tests for toxicity, while keeping all other potentially toxic compounds such as metals and pesticides. (This would help establish the relationship of measured pollutants and environmental effects.)

6.0 REFERENCES

EPA 1983. Results of the Nationwide Urban Runoff Program, Volume 1- Final Report

EPA 1986. "Goldbook" Quality Criteria for Water.

EPA. 1999. National Recommended Water Quality Criteria-Correction (EPA 822-Z-99-001).

Haile, R. W., Witte, J. S., Gold, M., Cressey, R., McGee, C., Millikan, R. C., Glasser, A., Harawa, N., Ervin, C., Harmon, P., Harper, J., Dermand, J., Alamillo, J., Barrett, K., Nides, M. & G.-Y. Wang. 1999. The health effects of swimming in ocean water contaminated by storm drain runoff. *Epidemiology*. 10: 355-363.

Marsalek, J. 1990. "Evaluation of Pollutant Loads from Urban Nonpoint Sources" *Wat. Sci. Tech*. 22(10/11):23-30

Noble, R. T., Dorsey, J. H., Leecaster, M., Orozco-Borbon, V., Reid, D., Schiff, K. & Weisberg, S. B. 2000. A regional survey of the microbiological water quality along the shoreline of the southern California Bight. *Environ. Monit. Assess.* 64.

Pesticide Management Education Program, Cornell University. http://pmep.cce.cornell.edu/profiles/herb-growthreg/fatty-alcohol-monuron/glyphosate/herb-prof-glyphosate.html

RWQCB (Regional Water Quality Control Board). 1994. Water Quality Control Plan.

Santa Barbara County Flood Control District. 2000 . Precipitation Report

SCCWRP 1998. Bight Study.

SCCWRP. 2000. Estimates Of Mass Emissions to the Southern California Bight. *(draft).*

URS Greiner Woodward Clyde. 1998. South Coast Watershed Characterization Study - An Assessment of Water Quality Conditions in Four South Coast Creeks. Prepared for County of Santa Barbara Public Health Department.