PROJECT CLEAN WATER

Rain Year 1999/2000

Water Quality Analysis Report

County of Santa Barbara, California
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Public Health Department

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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 Kerry Sears, who kept the program running smoothly from start to finish.

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Executive Summary

During Fiscal Year 1999-2000, Project Clean Water staff conducted 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 efforts and expanded efforts to characterize surface water pollution in selected urbanized watershed in the County.

A large number of creeks were sampled for up to 128 potential contaminants during five storm events 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 (BMPs).

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 57 locations within 22 watersheds. Five storms were sampled between November 1999 and April 2000. 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 indicate that bacteria levels are consistently above applicable standards, (for example several orders of magnitude above the State’s ocean water standards for body contact recreation), in all watersheds during storm events. Stormwater samples also contained metals (such as copper, chromium, zinc and lead) in quantities approaching or exceeding EPA standards in many creeks. While the insecticide diazanon was found in all watersheds, other pesticides were found in a majority of watersheds, but not in all storms. Nutrient levels in storm runoff varied greatly among watersheds. Volatile organic compounds (VOCs) were found in only a few samples.

Other sampling efforts included sampling water during outflow of the Goleta slough (to gain insight into bacteria survival during large tide cycles), sampling creek and storm-drain flow to identify pollution sources, and evaluating sources of the fecal coliform bacteria *E. coli* in the Rincon Lagoon using DNA typing. Results are summarized in appropriate sections of the report.

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 2000-2001 include: 1) elimination of testing for contaminants which were not detected, 2) adding sampling point in sub-watersheds, 3) sampling selected storm drain discharges, and 4) intense sampling of a ‘pilot’ watershed to explore pollutant loading in the watershed.

The entire report can be viewed online at:
http://www.co.santa-barbara.ca.us/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 (BMPs).

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/or an overall population density of at least 1,000 per square mile, fall under the Phase II NPDES regulations for small municipalities. Under the Phase II requirements, small 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 (BMPs) 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 BMPs, 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

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

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 judgements 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 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

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 (for discharges to land) or NPDES permits (for discharges to surface water). 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 1999-2000 water quality monitoring data.

3.0 RELATED STUDIES

In addition to storm-water runoff sampling, several other water quality studies were also conducted by the County during Fiscal Year 1999-2000. These included a study of the effects of salt water on bacteria in the Goleta Slough, a comparison of bacteria levels between the ocean and adjacent creeks following a rain event, and a DNA investigation on sources of fecal coliform at Rincon. These studies and their findings are presented below.

3.1 Goleta Slough Discharge Sampling (October 1999)

The Santa Barbara County Flood Control District periodically opens the mouth of Goleta Slough by excavating a channel through the sand berm that forms between the slough and the ocean. (During the summer months, the mouth of the slough closes off from the ocean.) The slough is opened prior to the rainy season by the District to allow runoff from four major tributaries to adequately drain and prevent flooding during the first few storms of the season.

In order to investigate the effects of ocean water on bacteria, water samples were analyzed prior to and just after the opening. Four representative sample sites were chosen, located in the ocean 25 yards west of the newly opened channel, in the channel itself, on lower Atascadero Creek, and on lower Tecolotito Creek. Background bacteria samples were collected the day before the opening at the same locations. For two days after the opening, bacteria and salinity samples were taken every hour and a half for six hours following high tide. This timing was intended to allow sampling to begin when salt water levels in the slough and tributaries were high, and subsequent samples would contain lower salinity.

The test hypothesis was that indicator bacteria would be lower due to die-off under conditions of higher salinity and lower temperature, and that bacteria levels would increase over time following the high tide as fresh, bacteria-laden slough water drained into the ocean.

Results showed that creek waters were occasionally high in indicator bacteria (standards would exceed ocean water levels for "warning") whereas the ocean water was not. However, bacteria levels in the ocean did show a slight trend of increasing during the period of discharge from the slough. There was no clear relationship between bacteria and salinity. Some potential shortcomings of the study include the limited number of samples taken both spatially or temporally and no duplicate samples.

3.2 Southern California Coastal Water Research Project (SCCWRP) Sampling, February 2000

SCCWRP is a joint powers agency focusing on marine research. In 1998, SCCWRP facilitated a study of the Southern California surf-zone from Point Conception to south of the Mexican Border. This area is known as the southern California bight and the study was titled "Southern California Bight 1998 Regional Monitoring Program: I Shoreline Microbiology " (Noble et al.). Microbiological and viral testing was conducted by over 28 monitoring agencies throughout the region. Santa Barbara County, Public Health Department participated in the initial study in August of 1998 and a subsequent wet weather study in February of 2000. The purpose of both of these studies was to assess surfzone water quality throughout the Bight in urbanized as well as rural areas.

For the 98 Bight study, water samples were collected from the ocean surf-zone at or within 100 yards of a storm-drain or at randomly chosen sample locations within stratified beach areas. Results of this study indicated that surf-zone water quality is very good, except immediately adjacent to creek mouths and storm drains.

For the wet weather study in February 2000, Project Clean Water staff assisted the Public Health Department and collected samples at the lowest creek locations above tidal influence, corresponding to the same locations as some of the storm water sample sites (discussed in Section 4.2, Sample Sites). This provided data from creek locations for comparison to the surf-zone sample locations near the corresponding creek-mouths.

Results showed higher bacterial levels in all of the Santa Barbara County creeks compared to the adjacent sites in the ocean. This indicates a large and continuous source of bacteria from terrestrial sources, which quickly disperses, becomes diluted or dies off upon reaching the surf-zone. See Figures 3-1, 3-2, and 3-3 below for results.

In addition, throughout the bight, indicator bacterial levels were significantly higher in both the creeks and oceans due to increased flow from the rain event. Between 86 and 97 percent of the samples tested exceeded current state ocean water standards. These results corroborate other investigations where a disproportionately large frequency of exceedances occurs on beaches near perennially flowing storm drains (Noble et al 2000). Furthermore, it has been shown that swimmers near storm drains have an increased risk of illness (Haile et al., 1999).

Figure 3-1. SCCWRP Study Results Showing Fecal Coliform

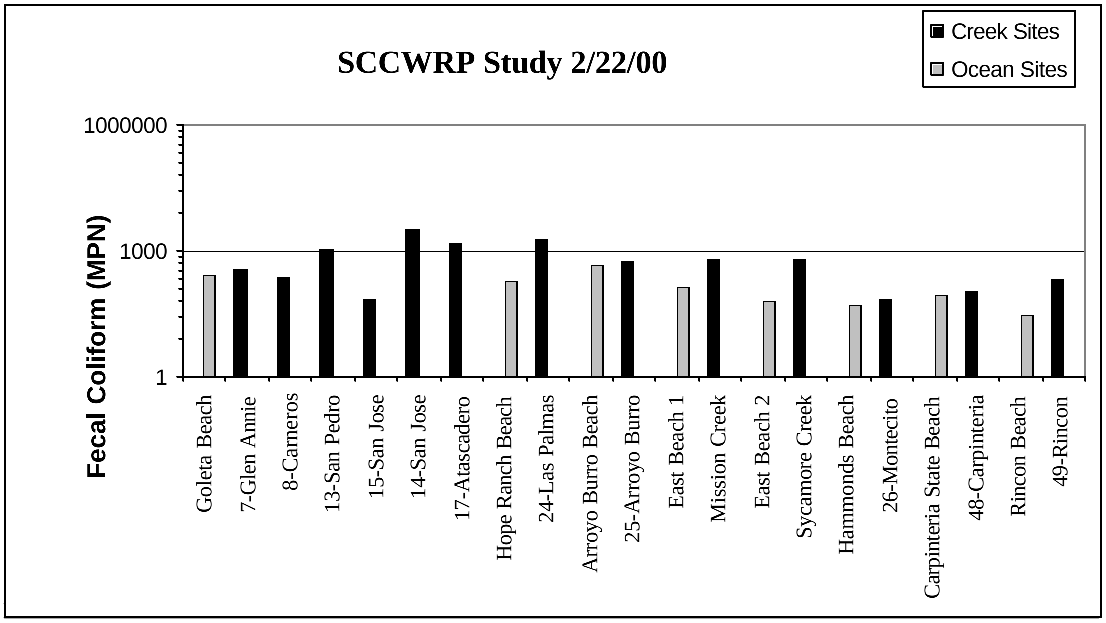
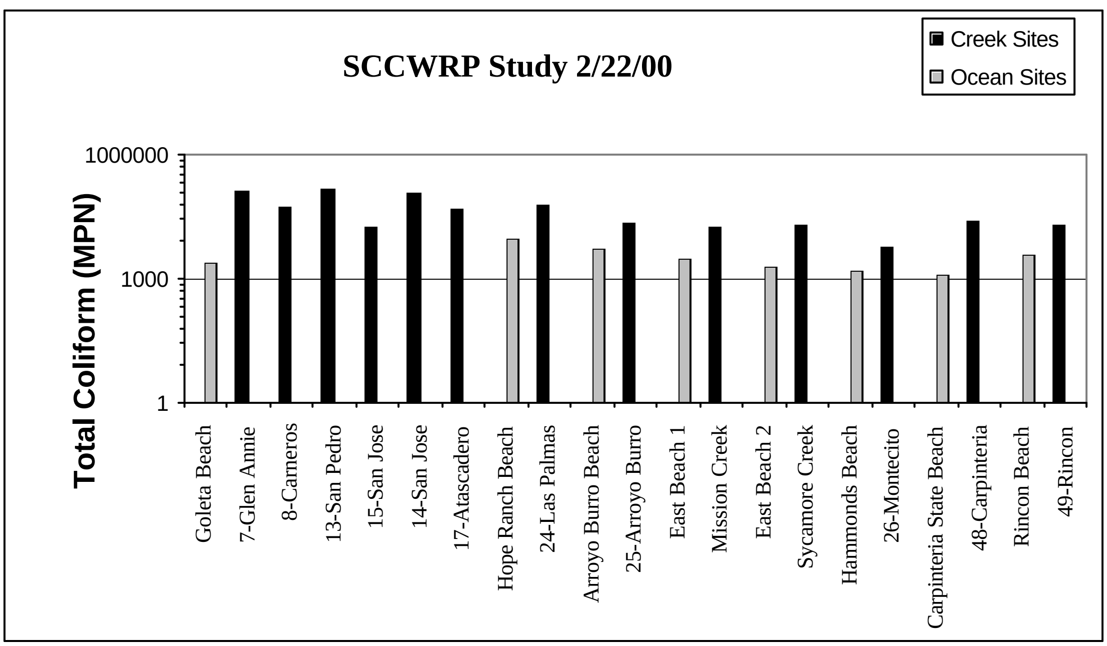
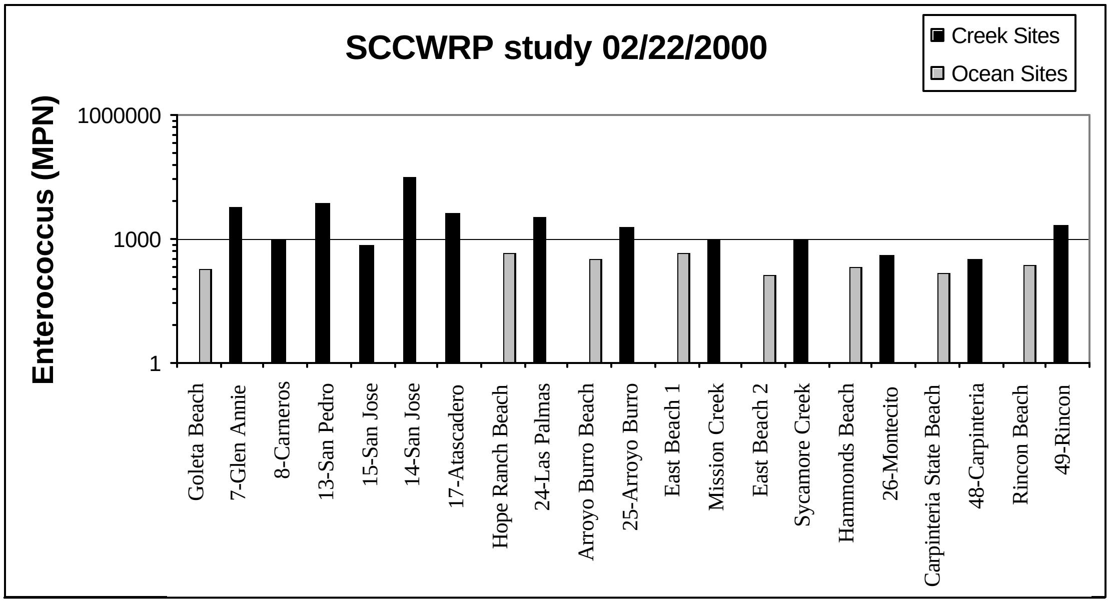


Figure 3-2. SCCWRP Study Results Showing Total Coliform



Note: Mission Creek sampled at Montecito Street, Sycamore Creek sampled at the 101, East Beach 1 sampled at Mission Creek, East Beach 2 sampled at Sycamore Creek, All other creek sites described by site number in Figures A-1a,b and Tables A-1a,b.

Figure 3-3. SCCWRP Study Showing Enterococcus



Note: Mission Creek sampled at Montecito Street, Sycamore Creek sampled at the 101, East Beach 1 sampled at Mission Creek, East Beach 2 sampled at Sycamore Creek, All other creek sites described by site number in Figures A-1a,b and Tables A-1a,b.

3.3 Lower Rincon Creek Watershed Study (August 1999)

Elevated levels of coliform bacteria have been noted in local watersheds and the ocean surf-zones at the mouths of these watersheds. These levels often exceed state standards for recreational salt water. Ongoing monitoring of coliform bacteria using traditional testing methods does not differentiate between animal and human origins for fecal coliforms. As a result, source reduction strategies are difficult to design and implement. One technique (genetic fingerprinting of *E.Coli*) offers some assistance in source identification.

Dr. Mansour Samadpour at the University of Washington has been studying the coliform bacteria *Eschericia coli* (*E.coli*). *E. coli* is present in the intestines of all warm-blooded animals, including humans. Dr. Samadpour has established that species of *E.coli* exhibit genetic differences that are unique within species or groups of like species (e.g. coyotes and dogs). Dr. Samadpour has established a technique for analysis of the genetic material (genetic fingerprinting) of this *E. coli*. Collection of fecal samples from known animal species (i.e. dogs, cats, humans, cows, raccoons, etc.) and determination of the specific genetic fingerprint for many of these species has allowed Dr. Samadpour to establish a reference library of over 24,000 different genetic fingerprints. Collection of water samples from a natural setting, removal and isolation *of E. coli* present in the water column, and comparison to Dr. Samadpour's ever increasing reference library leads to identification of source organisms for the fecal contamination present in the water samples.

The Lower Rincon Creek Watershed Study was a collaborative effort between the County Public Health Department, Heal the Ocean (a local community action coalition), and Dr. Samadpour's laboratory at the University of Washington.

Water and source samples were collected in the lower reaches of the watershed adjacent to the Rincon Point residential area. The Rincon Creek Watershed was selected due to the relatively few land uses within the watershed (single family residential, agriculture and ranchlands). The lower watershed area contains 74 homes (split equally between Santa Barbara County and Ventura County) that currently use onsite (septic) sewage disposal systems. Initial hypothesis included suggestions that these septic systems were contributing to the bacterial levels noted in the lower watershed and ocean surf-zone.

Results of the study indicated that 20% of the identified sources were of human origin. Overall, contributions from domestic sources (i.e. human, dog, cat, cattle, horses and sheep) accounted for 46% of the identified sources.

Water and sources samples were collected in late spring/early summer (May and June, 1999). Flow in the Rincon Creek was significantly lower than winter conditions. Bacterial concentrations were much lower than in previous months and never exceeded state standards for ocean water contact during the 5 weeks of sample collection.

The Rincon Point homeowners are moving forward with bringing sanitary sewer facilities to the community. The homeowners have also been instrumental in educating residents of the study results and ways to control domestic pet waste (such as use of mutt mitts to clean up and properly dispose of pet waste). Project Clean Water is in the process of coordinating an educational outreach effort with the County of Ventura to target domestic animal owners further back up into the watershed. Voluntary implementation of best management practices for animal waste management will provide significant reductions to the fecal coliform loading from these sources.

4.0 METHODS

The major goal of the 1999-2000 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.

4.1 Sampling Overview

Creek water was sampled during both low flow and storm flow conditions. Low flow sampling was conducted at various locations for bacteria only. 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 one location 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 each watershed. This one station was 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 $1,400.)

Bacteria samples, however, were collected at additional upstream locations. The laboratory cost of bacteria is much less per sample, at approximately $60 per site. Therefore, additional sites along each creek were selected at each major upstream confluence for bacteria only.

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4.2 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 Tables A-1a-d for a list of creeks sampled and Figures A-1 and A-2a-d 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. Only one site, in Orcutt, was sampled for the full suite of constituents in the North County.

The sampling program also included bacteria-only sampling sites. Bacteria samples were collected at various points within the creeks immediately upstream of major tributary confluences. The bacteria-only 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. However, all sampling sites are located in the creeks (not in storm drains) and as such reflect runoff characteristics from all upstream land uses.

There were a total of 57 sites sampled countywide, out of which 26 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. Tables A-1a-d describe the types and amount of sampling which occurred at each site.

4.3 Watershed Descriptions

Table A-2 shows the approximate percentage of each land use type within the County watersheds studied. The land uses shown on this table, derived from the tax-assessor's parcel data, indicate that much of the south coast watersheds are under agricultural use. Watersheds that contain more than 50 percent agricultural land use include Bell, Tecolotito, San Pedro, Arroyo Paredon, Santa Monica, Franklin, and Carpinteria creeks. Watersheds influenced (>50%) by residential runoff include Las Palmas, Oak, and Tecolote creeks. Commercial and industrial land uses in the unincorporated areas of the County are generally less than 10 percent of the total drainage area. Those drainages with commercial and industrial land use greater than 3 percent of the entire watershed include Devereaux, Tecolotito, Arroyo Burro, and Franklin Creeks.

4.4 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 1999-2000 season.

Since the goal of the 1999-2000 program was to characterize the types, and to some degree 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. See Section 4.6 for a discussion on the timing of the data collection during each storm.

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.

4.5 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-3. Table A-4 shows the EPA method used in processing the constituents, and their associated lab cost.

Note that organo-phosphorus pesticides and phenoxyacid herbicides were not added until after the first storm. Methyl Blue Activated Substances (MBAS) and Turbidity were added for the last two storms. See Section 5.2, Storm Sampling Results, for a description of the storms that were sampled. No analytes were dropped throughout the 1999-2000 storm sampling program.

In addition to the constituents measured in each sample, flow was also measured at the same time samples were collected at several stations. Water depth and velocity were noted to calculate flow. Velocity was measured by timing a floating block of wood over a certain distance. This method of determining flows offers a rough approximation of flows in the channel. The flows measured during the storm events are shown in Figure B-8, Appendix B.

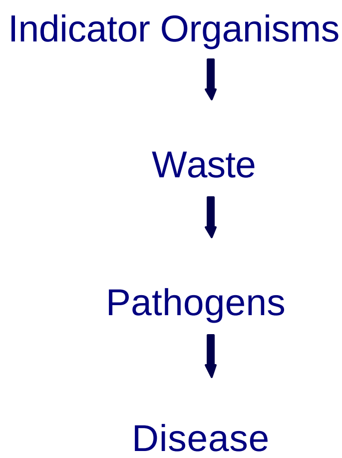
Each category of analytes is briefly discussed below.

4.5.1 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 4-1 below, 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

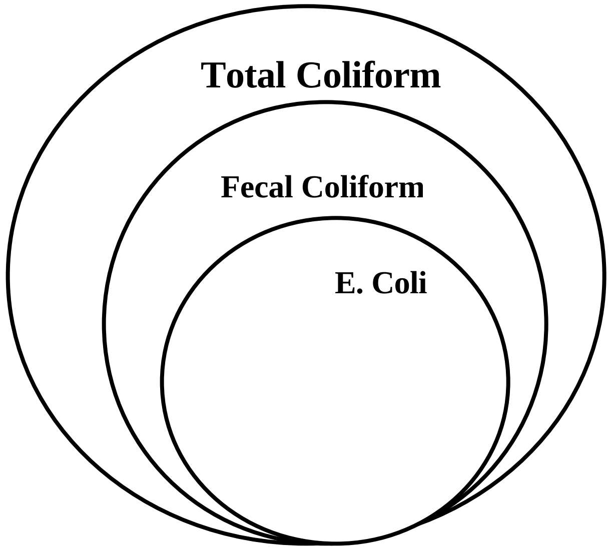
Figure 4-1. Chain of inference for indicator organisms



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).

The three indicator bacteria were sampled for during the storm season were: total coliform, fecal coliform (as *Eschericia coli*), and enterococcus. The testing methodology used by the Public Health Laboratory identifies total coliform, enterococcus and *Eschericia Coli* (*E.Coli*) bacteria. Figure 4-2 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 4-1. Bacteriologic Indicators



4.5.2 Pesticides

Pesticides include all chemicals used to control "pests" of any sort, including herbicides, algaecides, fungicides, rodenticides, etc. These chemicals are used by homeowners and commercial operations to control weeds and ants, among other things. They are also present in some soaps and shampoos used to control fleas, ticks and lice.

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 the tradename "Dursban". Chlorpyrifos recently made headlines as the EPA and the manufacturer reached an agreement to cease manufacturer's retail distribution prior to December, 2000 and all product sales to cease 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 standard 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 which is not available over-the-counter but permitted for agricultural use.

4.5.3 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. VOCs are difficult to measure because they volatize under the turbulent high flow conditions that occur during storms at the downstream end of creeks.

4.5.4 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.

4.5.5 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 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 deposited as animal waste is oxygenated to nitrites and further to nitrates. In an oxygenated environment, nitrites are short-lived.

4.5.6 Other Constituents

Other constituents sampled for include turbidity, total suspended solids, hardness, and specific conductance, oil and grease, 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, for instance, was used to convert the total metals to dissolved metals (see Section 5.2.1, Practical Quantitation Limit, Water Quality Standards, and Basin Plan Objectives). 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.

Methyl Blue Activated Substances (MBAS) are indications of synthetic detergents- and hence human activity such as wastewater discharges from sewage or car washes- present in the water column (creeks).

The presence of high concentrations of total suspended solids can be attributed to development of the watershed, the associated sediment runoff 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 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. Hence, elevated BOD levels in the creeks provide an opportunity for increased biological activity. 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.

4.6 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 southcoast and/or northcoast 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 1999-2000 storm sampling season, 22.75 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, called the ALERT network, that provides rainfall and stream flow gage data. The ALERT network includes 8 rainfall stations and 2 stream gage stations in the South Coast watersheds and several stations throughout the North County. This network is used to determine when, where, and how much rainfall has occurred. Tables B-1a and B-1b list the location of the rainfall and stream gages in the south coast, and Figures B-1a and B-2b show maps of the gage locations.

Cumulative precipitation during the 1999-2000 monitoring season is shown for one station (Santa Barbara #545) in Figure B-2. Hourly precipitation during the monitored storms is shown in Figure B-3 through B-7.

4.7 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 D) 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 Louis Obispo. Both laboratories are certified by the EPA.

Field duplicates were only taken for bacteria samples due to the higher lab cost of processing the other constituents (and previously demonstrated reliability of analysis for other constituents in the SCWCS, 1998.). For bacteria, duplicates were taken for approximately 10% of all samples. Blanks were not included in the shipment of samples to the labs, again due to the high lab cost of processing the constituents. Blanks and duplicates were measured by the individual laboratories following their respective QA/QC procedures.

5.0 RESULTS & DISCUSSION

5.1 Low Flow Pre-Storm Season Sampling (October 1999)

Bacteria samples were collected in October, prior to the winter storm season at all sites chosen for storm water sampling that had water flow. See Appendix A, Tables A-1a-d and Figures A-2a-d for the locations of the low flow sampling sites. The results are used to compare bacteria levels in base flow or nuisance flow conditions to that of storm water runoff. Bacteria levels under low flow conditions were consistently lower than bacteria levels for storm water runoff.

5.2 Storm Sampling Results

Four storms were sampled as described above, plus an additional storm where only bacteria was sampled. The storm dates were 11/8/99, 1/17/00, 1/30/00 (bacteria only), 2/10/00, and 4/17/00. After each sampling event, the sites were reevaluated to determine whether they were still appropriate in terms of safety, accessibility and tidal influence. Three sites were relocated due to unanticipated tidal effects. These were Tecolotito Creek (Site #s 9 and 10), San Jose Creek (Site # 15) and Franklin Creek (Site # 43). If any sites were dry or stagnant during the storm event, they were not sampled.

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.

Graphs have been prepared showing data for all storms and all constituents that appeared at least once in the results. All graphs are labeled from west to east according to the site numbers listed Tables A-1a-d and shown in Figures A-2a-d. Figures C-1 through C-9 show bacteria, Figures C-10 through C-18 show pesticides, Figures C-19 through C-24 show VOCs, Figures C-25 through C-32 show nutrients, Figures C-33 through C-39 show metals, and Figures C-40 through C-50 show all other constituents, such as oil and grease and turbidity. In addition, Table C-1 is a summary table of all the results.

5.2.1 Practical Quantitation Limit, Water Quality Standards, and Basin Plan Objectives

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.

The standards listed in Table A-5 are from the EPA aquatic toxicity criteria for both acute and chronic levels, including the National Recommended Water Quality Critieria - Correction (EPA 1999), and the EPA Goldbook (EPA 1986).

The Regional Water Quality Control Board (RWQCB) assigns designated uses to each watershed as well as associated water quality objectives for each designated use. Table A-5 lists those objectives, and Table A-6 shows the applicable designated uses assigned to each watershed.

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.

The State Ocean Water Quality Standards[1] 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 freshwater lakes.

It should be noted that the metals were processed as total metals, not dissolved metals. The results were converted from total to dissolved in order to compare to the relevant EPA toxicity standards, which are given in terms of dissolved metals. Dissolved metals give a better indication of toxicity because the dissolved portion of the metal is more available to organisms for uptake than the suspended portion. The EPA (1999) provides a suggested empirical formula to convert from total metals to dissolved. The process of converting the EPA's dissolved metals standards to total metals standards is shown below. This conversion is dependent upon the hardness, which varies over three orders of magnitude.

Total = Dissolved / CF

Where:
Total is the total metals value in mg/l
Dissolved is the dissolved metals value in mg/l
CF is a conversion factor dependent on hardness.

CF is also defined as,

[1] 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.

CF = Dissolved / exp[m*(ln(hardness))+b].

Therefore,

Total = exp[m*(ln(hardness))+b].

Figures A-3 and A-4 show the relationship between hardness and converted total metals criteria for EPA's aquatic toxicity standards.

5.3 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 5-1 through 5-7) 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 one year of sampling. Therefore, the data may not necessarily be a statistically significant or representative. It is not apparent from this year's results that any watershed stood out dramatically from the rest as having unusually high concentrations for contaminants during a majority of the storms.

5.3.1 "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 sufficiently long periods of dry weather and pollutant accumulation between storms. The Santa Barbara County data did not exhibit higher concentrations of pollutants in the first storm vs. later storms. For some pollutants, concentrations appeared higher in the later storms. For example, total nitrogen levels were much higher in the first sample event whereas levels decreased over subsequent sampling events. However, as is indicated by 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.

5.3.2 Bacteria

Table 5-1. County-wide Bacteria Results Summary

		Minimum	County			Maximum[1]
			Average	Standard Deviation	# of Samples	
Storm Sample	E. coli	0	22466	40503	228	241920
	Total Coliform	4106	188675	81152	228	241920
	Enterococcus	152	27007	34244	228	241920
Low Flow Sample	*E. coli*	0	984	2593	18	11199
	Total Coliform	10	40502	48088	18	155310
	Enterococcus	0	786	879	18	2613

[1]Maximum detection at 1:100 dilution is 241920

Table 5-2. Area-Wide Bacteria Results Summary

		Goleta			Montecito/Carpinteria			North County		
		Average	Standard Deviation	# of Samples	Average	Standard Deviation	# of Samples	Average	Standard Deviation	# of Samples
Storm Sample	*E. coli*	25099	45090	119	21300	45598	97	41397	46452	12
	Total Coliform	198535	76967	119	170079	88041	97	203621	72403	12
	Enterococcus	24929	26372	119	27610	42899	97	44144	20353	12
Low Flow Sample	E. coli	1978	3761	8	189	339	10	493	86	2
	Total Coliform	56318	45679	8	27850	48423	10	7046	3058	2
	Enterococcus	1206	824	8	450	805	10	189	60	2

- 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.

- *E. Coli* levels were slightly below the ocean water state standards during low flow periods, especially in the eastern watersheds such as Franklin and Carpinteria. The north county sample locations displayed levels of bacteria at or above ocean water standards for all indicator bacteria, but only increased approximately 1 order of magnitude in concentration levels during the two wet weather events. This may be due to the fact that the areas tested are not as urbanized as most of the south coast urbanized areas.

- There does not appear to be much difference between upstream site bacterial levels and downstream site bacterial levels during wet weather events. Not enough data is available this year to compare dry weather values upstream and downstream.

- Pre-storm season low flow samples were consistently lower in bacteria than storm water samples.

5.3.3 Pesticides

Table 5-3. County-wide Pesticide Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Hits
Glyphosate	0.0098	0.067	0.57	0.11	41
4,4'-DDE	0.00003	0.00003	0.00003	0	1
Endosulfan I	0.00005	0.00005	0.00005	0	1
Endosulfan II	0.00003	0.00003	0.00003	0	1
Endosulfan sulfate	0.00005	0.000065	0.00008	.00002	2
Chlorpyrifos	0.00004	0.000196	0.00052	0.0002	5
Diazinon	0.00004	0.00065	0.018	0.003	39
Malathion	0.00007	0.0002	0.00048	0.0002	6
2,4-D	0.006	0.006	0.006	0	1

- Santa Monica Creek contained members of the pesticide group Endosulfan. Only one sample event contained Endosulfan I, II and Sulfate.

- Chlorpyrifos was present in San Ysidro and Oak Creek.

- Diazinon levels were detected in most of the watersheds with the highest levels detected in earlier sampling events. Diazinon has shown to be very prevalent in urbanized watersheds.

- Glyphosate was present in a variety of watersheds. Carpinteria Creek, San Jose and Santa Monica Creeks showed levels of glyphosate in all wet weather sampling events.

  The California Office of Environmental Health Hazard Assessment has developed a Public Health Goal of 1.0 mg/l for drinking water, whereas the federal EPA has published a maximum contaminant level of 0.7 mg/l for drinking water. The Regional Water Quality Control Board has set water quality objectives for glyphosate in drinking water at 0.7 mg/l. The maximum value observed during the storm events sampled was 0.57 mg/l, which occurred in Carpinteria Creek on 11/8/99.

5.3.4 VOCs

Table 5-4. County-wide VOC Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Hits
Chloroform	0.0007	0.0007	0.0007	0	1
4-Isopropyltoluene	0.0007	0.0014	0.0021	0.00099	2
Naphthalene	0.0032	0.0032	0.0032	0	1
Toluene	0.0006	0.00105	0.0015	0.000636	2
1,2,4-Trimethylbenzene	0.0011	0.0011	0.0011	0	1
Xylenes	0.0011	0.0011	0.0011	0	1

- In general, volatile organic compounds (VOC's) were not present in either elevated levels (exceeding standards) nor in very many of the watersheds. Many of these compounds (also some pesticides) could volatize under the relatively turbulent conditions of the creeks during sampling.

5.3.5 Metals

Table 5.5. County-wide Metal Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Hits
Arsenic	0.05	0.07	0.12	0.03	9
Chromium	0.01	0.07	0.42	0.08	56
Copper	0.01	0.05	0.27	0.06	62
Lead	0.01	0.01	0.04	0.01	46
Mercury	0.00	0.00	0.01	0.00	3
Nickel	0.01	0.03	0.27	0.05	41
Zinc	0.02	0.11	0.68	0.11	68

- Every watershed displayed some level of metals present in the water samples collected.

- Romero Creek was the only watershed that revealed high levels of mercury. Glen Annie and Orcutt creeks also showed detectable levels of mercury.

- As shown in Table C-1, 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.

- 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.

- The Arroyo Burro Watershed displayed levels of copper, zinc, lead and nickel for each of the sampling events. Concentrations of nickel were much higher in this watershed on a couple of sampling events than any of the other watersheds.

- Arsenic was noted in only the first sampling event for a few scattered watersheds.

5.3.6 Nutrients

Table 5-6. County-wide Nutrient Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Hits
Ammonical Nitrogen	0.1	0.7	3.8	0.9	48
Nitrate as Nitrogen (NO3-N)	0.5	4.4	22	5.3	68
Nitrite as Nitrogen (NO2-N)	0.5	1.0	1.8	0.6	4
Phosphorus as Phosphate (PO4-PO4)	3	5.6	10	2.4	13
Phosphorus as Phosphorus (PO4-P)	1	1.8	3.4	0.8	13
Total Phosphorus	0.02	1.4	13	2.0	73
Total Kjeldahl Nitrogen	0.2	2.5	12	2.2	73

- Nitrogen and nitrate levels were much higher and more consistent than nitrite levels. Nitrates were noted in all four sampling events for Santa Monica Creek.

- Nutrients were present in many watersheds, especially in the eastern watersheds. Arroyo Paredon and Santa Monica Creeks demonstrated elevated levels of phosphorous and phosphates. Arroyo Burro Creek water samples contained elevated levels of total phosphorous.

5.3.7 Other Constituents

Table 5-7. County-wide Results Summary for Other Constituents

	Minimum	Average	Maximum	Standard Deviation	# of Hits
Total Recoverable Petroleum Hydrocarbons	1.0	1.4	1.9	0.4	7
Total Organic Carbon	1.7	22	130	23	62
Oil and Grease	1	2	4	1	12
Hardness	32	425	2400	561	74
Specific Conductance	69	2324	52000	7405	74
Total Dissolved Solids	140	1685	26000	4098	74
Total Suspended Solids	10	587	18000	2215	72
Biochemical Oxygen Demand	3	15	84	15	69
Turbidity (NTU)	2	97	950	184	42
MBAS	0.04	0.15	0.44	0.09	37

- Indicators of waste oil and/or fuel were traced using Total Recoverable Petroleum Hydrocarbons (TRPH); Oil & Grease (O&G) as well as other constituents of gasoline such as toluene, xylene, etc. TRPH levels and O&G

results were very similar. A few watersheds such as San Pedro, San Jose, Romero and Carpinteria Creeks showed elevated levels for a single, consistent sampling event. Bell Creek displayed elevated levels of xylene, trimethylbenzene as well as TRPH and Oil & Grease although for different early season sampling events.

- MBAS levels were measured for the last two sampling events and were detected in most of the watersheds. In general, levels were higher in the second storm event for which MBAS testing was done than the first storm event tested. This may be due to differences in flow noted for the two storms.

- Turbidity was also tested for the fourth and fifth sampling events. Only Arroyo Burro and Orcutt Creeks displayed any significant turbidity issues.

- Several sites were identified as having higher levels of Total Dissolved Solids, Specific Conductance and Hardness. The associated watersheds were Devereaux, Tecolotito, San Jose, Atascadero, and Franklin. It was determined that these sites were influenced by salt water flowing into the creeks from the ocean. Other results might have been influenced by this salt water. The sites were relocated throughout the sampling season to a more upstream location, absent of tidal influence.

- Arroyo Burro and Orcutt displayed the highest levels of Total Suspended Solids.

- Early storm events displayed hardness levels at or near 2,000 mg/l especially in the western Goleta watersheds. This may be a result of early storm erosion of stream banks and other areas of the watershed. Hardness levels dropped more towards background levels for the latter storm events.

- Elevated TOC levels were found in Garrapata, Romero and San Ysidro Creeks. Elevated BOD levels were found in Garrapata and Montecito Creeks. The combined high values for TOC, BOD, and MBAS, such as for San Ysidro, Toro Canyon, Garrapata, may indicate possible sewage contamination.

5.4 Comparisons of 1999-2000 Sampling to South Coast Watershed Characterization Study (1998) Constituents

The SCWCS (URS Greiner 1999) analyzed runoff during the 1998-1999 season in four watersheds: Arroyo Burro, Rincon, Carpinteria, and Mission.

In comparison to the data collected in the 1999-2000 sampling season, pollutant concentrations found in the more limited results from the South Coast Watershed Characterization Study (1998) were lower overall. It is thought that this is because the 1998 data were collected several hours or more after the peak flow from each storm, thus missing the bulk of pollutants. In addition, the sampling that occurred during 1998 followed a very wet 1997-1998 El Nino year (46.99" total), whereas the 1999-2000 (22.75") rainy season was drier.

5.4.1 Bacterial levels

The 1999-2000 data showed higher bacteria concentrations for wet weather events. In some of the SCWCS sampling events, water samples were not collected until several hours after the storm event, and therefore did not capture the higher levels of bacteria that are found in the initial runoff.

There was little variation in bacteria results related to location in the watershed for 1999-2000 data, whereas a strong trend was seen in the SCWCS data revealing higher bacteria levels in more densely developed areas of the watershed. This may be partially due to fewer representative sample locations in the upper watersheds for the 1999-2000 study, as compared to the SCWCS. Also the results exceeded the limits of the test for many sites, regardless of location in the watershed, making comparisons impossible to the 1999-2000 study.

5.4.2 Other Constituents

The most noticeable difference between the test results of the SCWCS and the 1999-2000 storm testing was in the concentrations of metals. Results from the 1999-2000 sampling showed an order of magnitude increase for zinc, nickel and copper for Arroyo Burro and Rincon Creeks. No significant differences were noted for metal concentrations in Carpinteria Creek. The general consensus is that this is due to the timing of the sampling, as discussed above, rather than increases in pollutant loading from previous years.

Total suspended solids were measured only for the Rincon Creek as part of the SCWCS. There were no significant differences in these values between the various sampling periods.

All other constituents that overlapped between the two studies did not demonstrate significant differences that warrant further discussion.

5.5. Comparison with the City of Santa Barbara

The City of Santa Barbara conducted limited storm water runoff testing. Samples were collected at two stations along Sycamore Creek and one in Laguna Channel. Sycamore Creek was sampled during the November 8, 1999 storm and the January 17, 2000 storm at a site located immediately south of US101 and the railroad tracks. Sycamore Creek was also sampled during the January 17 storm at a station located downstream of Alameda Padre Serra. Laguna Channel was sampled once during the April 17, 2000 storm in Chase Palm Park just before the channel crosses under Cabrillo Boulevard.

City staff collected water samples at approximately the same time as the County during the same storms. The City's water samples were transported together with the County samples to the same laboratories for analysis (Zymax Labs and County Public Health lab). The data are presented in Table C-2.

Laguna channel had some measurable levels of oil and grease and methylene chloride, a VOC that was not detected in any other creek. The detection for toluene that occurred in the April 17, 2000 storm was low in concentration.

General parameters such as total dissolved and suspended solids, conductance, hardness, TOC, BOD, etc. were similar to other creek data. Heavy metals were also similar to other creek data. Nutrients were relatively low compared to some creeks.

Both Sycamore Creek and Laguna Channel contained low levels of glyphosate and the Laguna Channel sample from April 17, 2000 contained low levels of diazinon. There was no chlorpyrifos observed, nor any chlorinated pesticides.

Overall, the results from this year's sampling show that Sycamore Creek and Laguna Channel were relatively similar to other creeks in the south coast.

5.6 Comparison with Ventura County

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The Ventura Countywide Stormwater Quality Management Program includes regular storm water monitoring, as required under their NPDES permit. One of their storm water quality monitoring stations is in a receiving water that drains a mixed land use area (site W-4 in Revolon Slough). Samples were collected as manual grab samples during storms events that occurred on 1/25/99, 1/31/99, and 3/15/99. The remaining sampling sites in Ventura County represent specific land use types (i.e., residential, commercial, or industrial runoff) and samples are composited. For these reasons, the Revolon site provides the most closely comparable data to the Santa Barbara County sampling program.

Selected results presented in the Annual Report for Permit Year 5 for Revolon Slough (Ventura County 1999) are summarized below.

Table 5.8 Selected Results from Revolon Slough (Ventura County)

	Min (mg/l)	Max (mg/l)
Total Dissolved Solids	600	1,700
Total Suspended Solids	1,340	3,480
Total Organic Carbon	15	20
BOD	14	40
Total Recoverable Petroleum Hydrocarbons	<0.5	1.1
Oil & Grease	0.8	1.3
Lead	0.006	0.05
Arsenic	0.01	0.03
Copper	0.06	0.17
Mercury	.00007	.00018
Nickel	0.03	0.08
Zinc	0.34	0.67
Chromium	0.06	0.13
Kjehldal Nitrogen	5.8	18.2
Ammonical Nitrogen	<0.1	1.0
Nitrate Nitrogen	2.4	16.6
Total Phosphorus	1.05	3.3
Diazinon	0.00017	0.00027
Chlorpyrifos	0.00019	0.00048
Malathion	<0.0001	0.0001
4,4 DDE	0.0000276	0.000198

From: Annual Report for Permit Year 5 (Ventura County 1999)

General parameters such as total dissolved and suspended solids, TOC, BOD, TRPH and oil and grease were very similar to the average of Santa Barbara County creeks. Compared to the Ventura 1999 data for mixed land use runoff, some Santa Barbara County creeks stood out with relatively higher values for metals. Specifically, mercury in Romero Creek during the April 17, 2000 storm (0.005 mg/l), nickel in Arroyo Burro during the November 11, 1999 and April 17, 2000 storms (0.16 mg/l and 0.27 mg/l), and chromium in Arroyo Burro and Toro Canyon during the November 8, 2000 storm (0.42 mg/l and 0.38 mg/l, respectively), were relatively higher. Nutrients were generally similar with Santa Barbara County creeks, except for total phosphorus in Arroyo Burro during the November 8, 1999 and April 17, 2000 storms (9.3 mg/l and 13.0 mg/l).

6.0 RECOMMENDATIONS

The storm-water quality data obtained in FY 1999-2000 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 urban runoff prior to this year's sampling effort, results from the first full season 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 2000-2001 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 2000-2001 season are presented below. County staff will evaluate the cost and resources necessary to implement these recommendations as appropriate.

6.1 Additional sampling locations

- Establish additional site(s) in the Orcutt area for the full suite of constituents.

- Select one station to collect multiple samples on a flow-weighted time series throughout the storm event. (Data on discharge must be available for the stream reach sampled.) Use data to develop a pollutant-loading estimate for one or more creeks, and to determine the pollutant flux throughout a storm event. Consider collecting multiple samples in other creeks during the year, if sufficient resources are available.

- Increase sites for bacteria sampling and sample from storm drains where possible to identify problematic catchments. Measure bacteria levels at locations higher in the watershed for source identification and determining "background" concentrations.

- Add additional site(s) in catchments or subwatersheds with representative land uses (including samples taken directly from the storm drain system) and test for the full suite of constituents. Select areas that are considered potential pollutant sources in order to confirm data from other regions. Include commercial, industrial, and residential land use types.

6.2 Changes in analyses

- Replace total metals with dissolved metals on the list of full suite tests for better comparison with toxicity standards; add total+dissolved metals on selected creeks with upstream sites to distinguish contribution from non-urbanized upper watershed areas and to establish background levels.

- Drop chlorinated pesticides from the full suite tests since many if not most are no longer in use and the remaining use is limited to commercial operations. (The Endosulfan group, 4,4-DDE, and 2,4-D were the only chlorinated pesticides detected.) To the extent that these were detected, target the chlorinated pesticide analysis to specific watersheds.

- Discontinue testing for VOCs, relying upon TRPH and oil and grease as an indicator of the presence of petroleum products that contain VOCs.

- Discontinue testing for MBAS in storm runoff, except in specific situations where sanitary wastes are suspected and the presence of MBAS together with elevated nutrients, bacteria, and TSS may be used to identify a potential source. (MBAS may remain useful to identify sources in dry weather sampling.)

6.3 Some 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.)

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