FECAL BACTERIA SOURCE STUDY FOR PILARCITOS AND GAZOS CREEK WATERSHEDS

PREPARED BY:
COUNTY OF SAN MATEO
PUBLIC HEALTH AND ENVIRONMENTAL PROTECTION DIVISION

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INTRODUCTION AND BACKGROUND

The state of California established the Clean Beaches Initiative Grant program as part of the Budget Act of 2001, Senate Bill 739- to provide funding in a statewide effort to reduce health risks and increase the public's access to clean beaches.

San Mateo County Public Health and Environmental Protection Division regularly collects water samples from county beaches to evaluate for the presence and extent of fecal bacterial contaminants. The data collected includes levels of total coliform, fecal coliform and enterococcus. Bacterial sampling is conducted in accordance of State Assembly Bill 411.

San Mateo County was awarded funding from the California State Water Resources Control Board of $250,000, in accordance with the Costa-Machado Water Act of 2000, to study and mitigate contaminants that have resulted in periodic posting of the state beaches at Pilarcitos and Gazos creek mouths. The project was a comprehensive study over the period July 01, 2001 through March 31, 2006
The project (and contract) had two phases. Phase one was allocated $175,000 to address the Pilarcitos watershed and the remaining $75,000 to address the Gazos watershed.

This study contains the findings of water testing that was conducted in these watersheds by the SMCPHEPD. It highlights the results of weekly water monitoring for fecal indicator bacteria and reports on sampling surveys and remediation efforts. The overall goal of the project was to identify and remove sources of fecal contamination that was detected in the watersheds.

PILARCITOS CREEK WATERSHED

The Pilarcitos watershed encompasses approximately 30 square miles of the coastal zone east of Half Moon Bay, extending from Montara in the North to Miramontes Point in the South. The main stem, Pilarcitos Creek, arises on the western slope of Montara Mountain on the San Francisco Public Utilities Commission property. The creek feeds a drinking reservoir - Pilarcitos Lake – and another reservoir, Stone Canyon Dam, before entering the main canyon leading to Half moon Bay. The creek and its numerous tributaries flow through privately owned agricultural land, urban areas of the City of Half Moon Bay, a privately owned landfill and privately owned open space before emptying into the Pacific Ocean at Venice Beach, one of Half Moon Bay State Park's beach accesses.

Frenchman's Creek also empties into the ocean in the same area. Therefore, Frenchman's Creek was assumed into the Pilarcitos watershed and is included in the project. The amount of bacteria carried by these creeks into the ocean has resulted in postings at the adjacent beaches at least annually for decades

GAZOS CREEK WATERSHED

Gazos Creek watershed is a relatively small watershed of approximately 16 square miles. It is a perennial creek and has Coho salmon, steelhead trout, California red-legged frog and marbled murrelet living in the watershed. The main stem consists of three forks; there are two named tributaries and many unnamed tributaries. The creek and these tributaries pass through California State Parks property. A rural residential development with 20 to 25 dwellings is to the South of the middle fork. West of the merging North/Middle and South forks is Slate Creek, one of the other two creeks entering the main stem. The main stem then winds westwards with a further set of rural residences on the south side of Gazos Creek. Old Woman's Creek joins the main stem downstream and westward of these residences. The most direct impact on the creek takes place closer to Highway 1, near where it empties into the Pacific Ocean. A residence is situated on the north side of Gazos Creek, off of Gazos Creek Road, close to the intersection of Highway 1. Also at this location, but on the south side of Gazos Creek, is a gas station and Gazos Grill Restaurant. Other uses of the watershed include recreation, hiking, cycling, swimming and beach activities. Some creek side transient camping also takes place during the summer months.

The goal is to locate and remove sources of fecal contamination that affect the creeks and thus the beaches.

PROJECT OBJECTIVES AND METHODOLOGY

The objective of this project was to identify sources of E.coli contamination that were conducive to elevated bacteria levels at the beaches for Pilarcitos and Gazos Creek watersheds. The main emphasis of the project was conducting sanitary surveys in conjunction with weekly water sample collection.

SAMPLING PROGRAM METHODOLOGY

Water sample collection sites were chosen taking into consideration a variety of variables. That is, conspicuous geographic markers, accessibility, tributaries, human activity and elevated spikes in E.coli levels. Sample points were marked using a GPS unit for mapping purposes. Corrections were made where necessary. All creeks were walked to the furthest point upstream. This was performed in order to establish baseline data at an unpolluted site or one as close as possible.

Weekly sampling was conducted using the grab sample method with sterile bottles supplied by SMCPHL. Sanitary surveys played a key role in the process.
A total of approximately 1,346 samples were taken over approximately 74 weeks for the Pilarcitos watershed. Gazos Creek had approximately 1,050 samples taken over approximately 70 weeks. Appropriate field anecdotal notes were made to indicate any possible conditions which would affect results, such as the number of gulls in the creek.

ABORATORY PROCEDURES

l water samples were analyzed by staff at SMCPHL using Colilert testing protocols, Colilert TM 18 Medium)EXX) (Quanti-Tray TM). Precision for bacterial parameters was determined by having the same analyst mplete the procedure for laboratory duplicates of the same sample. The Colilert test can detect a minimum 1 CFU/100 ml. The SMCPHL is a State and FDA certified water/shellfish Lab. The EPA laboratory # is CA 14

RESULTS

Data was compiled and the E.coli analysis conducted using the geomean statistical method. Comparing this data to the California Beach Water Quality Standards for AB411 resulted in numerous areas of Pilarcitos watershed exceeding these maximum values set by the state.

Several potential sources of fecal contaminants for the Pilarcitos watershed:

- Horse manure pile located alongside a culvert draining to the creek. The pile has been removed at this time.
- Agricultural laborers and transients using the creek as a latrine (PC-6 and 7)
- Horse manure falling onto the bridge (PC-3) and horse riding in the creek (PC-3 and 4)
- Large numbers of gulls located at the Venice Beach area. Bird's number in the thousands and the number and presence may be related to the proximity to the BFI Ox Mountain landfill and the tributary, Corinda Los Trancos.

Conversely, Gazos Creek watershed was found to be relatively pristine. Potential sources of contamination are residential and commercial septic systems located in the vicinity of Highway 1. Pacific Ocean Mushroom Farm has resumed operation which may also be a future potential source of creek contamination.

CONCLUSION

Pilarcitos Creek Watershed (which includes the Frenchman's Creek Watershed) is highly impacted by human activities while the Gazos Creek watershed has been minimally impacted. The increased human activity increases creek contamination potential.

The approach to this project was based on the success of the first County of San Mateo creek project on the San Vicente Creek watershed. While the two watersheds studied in this project are diametrically different to San Vicente and each other, each project was a success within its boundaries. Various sources of contamination, point and non-point were identified. There were reductions in the fecal counts when one point source was eliminated with Best Management Practices (BMP's). Remediation of the remaining identified sources has the potential to reduce the fecal bacterial numbers significantly. However the exact degree of success cannot be predicted given the variables unique to each source. Certainly addressing each of them will result in a cumulative reduction in fecal pollution. These measures will require a long term commitment by the San Mateo County Public Health and Environmental Protection Division and ongoing monitoring of at least half of the established static sites to determine the efficacy of the remediation action plans.

2.1 Statement of purpose:

The goal is to locate and remove sources of fecal contamination that affect the creeks and thus the beaches. The following describes the status of the watersheds at the inception of the project. Pilarcitos, Frenchman's and Gazos Creeks were sampled on a regular basis. Test results show that these creeks were intermittently contaminated with fecal material. Nearby beaches (Venice Beach and Gazos Creek Beach Access) were being affected by the high numbers of bacteria in the creek, which has resulted in the beaches exceeding State Bacteria Standards.

Pilarcitos Creek is a perennial Creek that arises on the western slopes of Montara Mountain in the San Francisco state fish and game refuge and enters the Pacific Ocean at Half Moon Bay State Beach. Frenchman's creek also empties into the ocean in the same area and therefore is included in the project and assumed into the Pilarcitos watershed. The amount of bacteria carried by these creeks into the ocean has resulted in postings at the adjacent beaches at least annually for decades.

Gazos Creek Beach Access is one of the southernmost beaches in San Mateo County; it is within the Ano Nuevo State Park. Ano Nuevo Island, with its elephant seal population, lies just south of Gazos Creek Beach access. It is fed by Gazos Creek.

The fecal bacterial data collected during the state mandated weekly monitoring of Venice and Gazos Creek Beach Access over the past six years has been analyzed and is represented in the graphs and tables below (Table 1 and Figures 7A+B). This represents historical data as well as data collected during period of the project (2002-2005).

Gazos Creek Beach Access shows only 2 postings for Enterococcus over the past 6 years and no postings for E.coli.

YEAR	POSTINGS CFU/100 ml
2000	0
2001	0
2002	0
12/29/2003	782
11/1/2004	288
2005	0

TABLE 1
HISTORY OF POSTINGS FOR ENTEROCOCCUS AT GAZOS CREEK BEACH ACCESS: 2000-2005

All Venice Beach data that was out of the assumed limits was designated a point (assumed limits were set at the single standard level of the State bacteria standards). These points are represented on the graphs (Figure 7A Enterococcus and Figure 7B E.coli). The number of postings for Enterococcus and E.coli increased dramatically in year 2003. This elevated trend continued through 2004 for Enterococcus. The reduction in numbers for 2005 might be due to limited sampling.

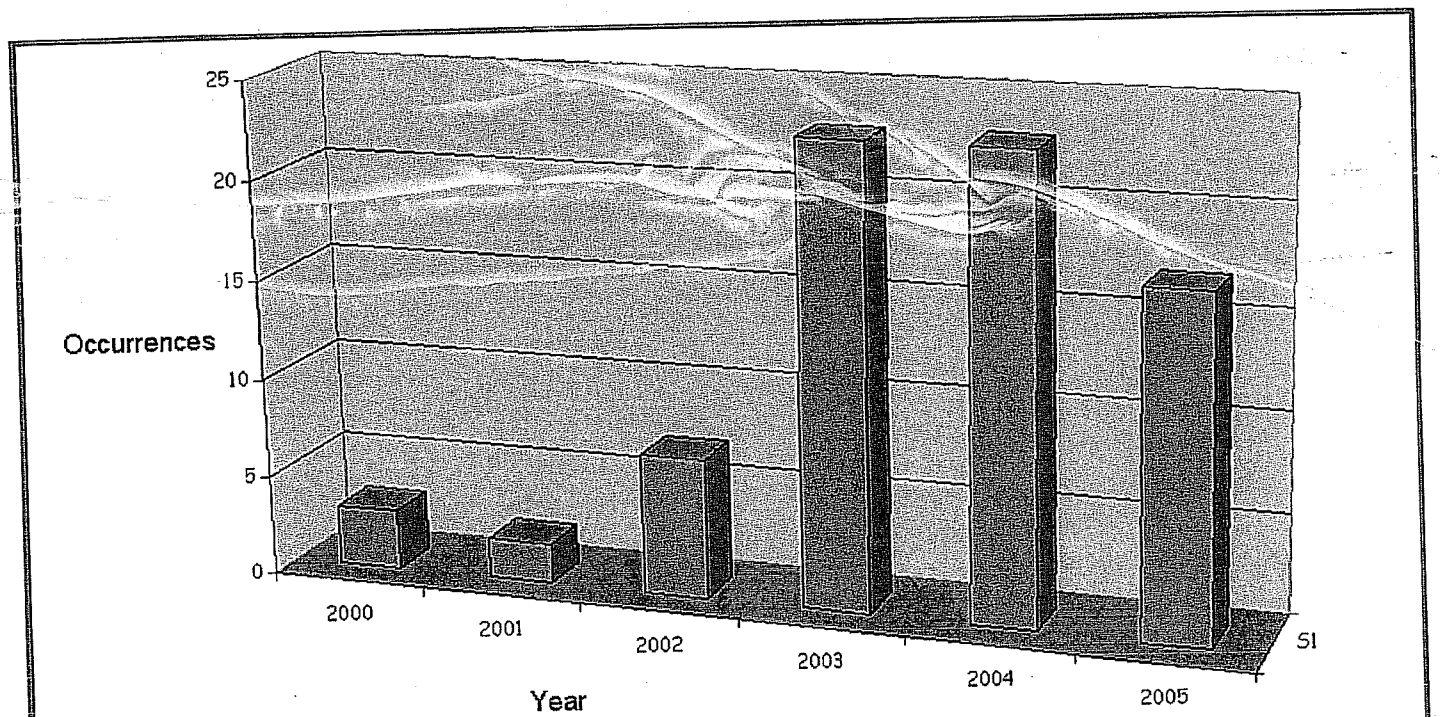

FIGURE 7A
NUMBER OF BEACH POSTINGS FOR ENTEROCOCCUS AT VENICE BEACH:2000-2005

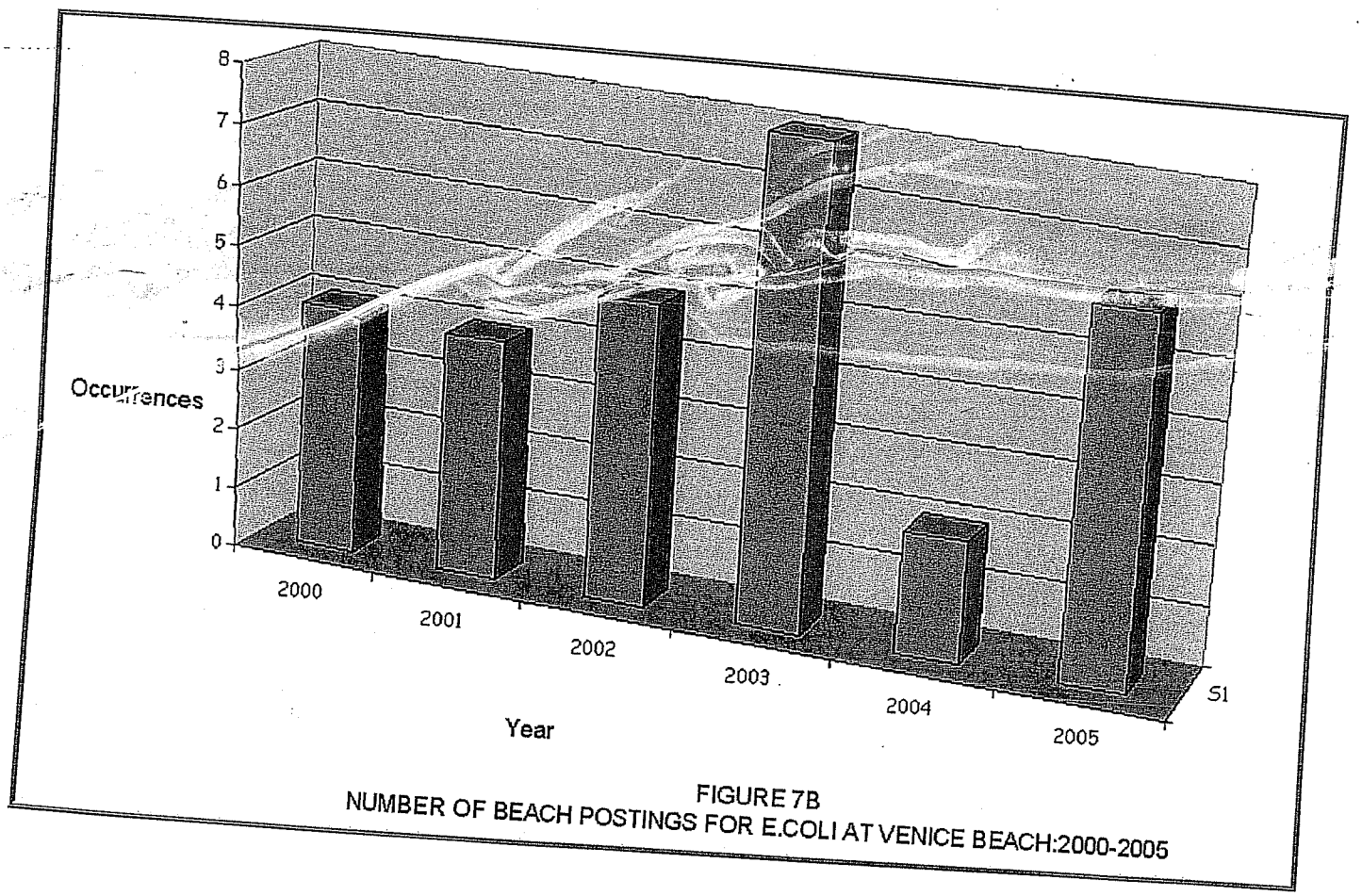

FIGURE 7B
NUMBER OF BEACH POSTINGS FOR E.COLI AT VENICE BEACH:2000-2005

FIGURES 7A+B
GRAPHICAL REPRESENTATION OF BEACH POSTINGS FOR VENICE BEACH

2.2 Scope of the project:

Most, if not all, potential sources of contamination (septics and storm drains) as well as samples sites within the watersheds were located and mapped using GPS and GIS technology. Site proximities were compared against each other. Landowners were approached and permission to access private lands, where needed, was obtained. Landowners were also kept informed of the status of the data obtained on their properties. Static sites were sampled weekly and were tested for bacteria using the guidelines of the California Beach Water Quality Standards (hereafter referred to as State Bacteria Standards). Each variance from the standard was further investigated individually.

2.3 Background:

The state of California established the Clean Beaches Initiative grant program as part of the Budget Act of 2001, Senate Bill 739- to provide funding in a statewide effort to reduce health risks and increase the public's access to clean beaches.

San Mateo County was awarded funding of $250,000, in accordance with the Costa-Machado Water Act of 2000, to study and mitigate contaminants that have resulted in periodic posting of the state beaches at Pilarcitos and Gazos. The project was a comprehensive study over the period July 01, 2001 through March 31, 2006. The project amount totaled $240,000.

The project (and contract) had two phases. Phase one was allocated $175,000 to address the Pilarcitos watershed and the remaining $75,000 to address the Gazos watershed.

Deliverables in chronologic order were as follows: establish and have an approved Quality Assurance Project Plan (QAPP) in place and thereafter map known potential sources of contamination (i.e. storm water drainages and septic systems). Identify sample site locations and then collect water samples for bacteriological analysis weekly from these locations resulting in further tracking, identifying and attempting to eliminate identified sources. The project was a complex study identifying many levels of potential sources of fecal bacterial contamination. The project involved intensive sampling along the length of each creek in order to identify possible areas of contamination. Such sites were then further investigated using established techniques e.g. sanitary surveys and monitoring at additional water sample collections points. Once these potential sources were identified they could be addressed. Ultimately their impact could be reduced or eliminated. Thus the number of beach closures in the area would be greatly reduced.

The main emphasis of the actively participating organizations and key personnel are given below:

SMCPHEPD
Organized community involvement, conducted surveys and sampling and enforced regulations as needed.
Carolann Towe - Monitoring Team Leader

SMCSF
Assist with community involvement
Ellen Gartside – Blue Water Task Force Chairperson

SMCFB
Acted as liaison with large agricultural community.
Jack Olson/Tim Frahm

SMCPHL
Conducted analysis of samples.
Doug Coffman – Lead Technician

SMCPHL
Conducted analysis of samples.
Doug Coffman – Lead Technician

PCAC
Keith Mangold – Contact

2.4 Brief description of the approach and techniques used during the project:

Sample location selection:
Creeks were initially walked in order to observe the following:
a) Culverts and potential sources of contamination (i.e. septics, horse crossings, bridges and subdivisions, storm sewers, etc.)
b) Accessibility was also a criterion with simple geographic as well as private property limitations. Wherever possible, sites were selected both up and downstream of potential sources and the ability to adjust site locations accordingly when numbers required additional sample sites, was also a consideration.

One site on Gazos Creek (GC-6) had to be abandoned 18 weeks into the study when it collapsed during a storm event.

Coordinates for the mapping requirement were obtained using a Trimble GPS unit. Two thirds of the Gazos Creek Watershed was walked manually using a "Rola tape" distance-measuring wheel to capture readings. The dense canopy and topography prevented the use of a GPS in this section and the watershed was broken into 4 sections to complete the task.

An Arcview layer map with all components was then created.
Nomenclature is as follows:

Corinda Los Trancos:	CLT
Frenchman's Creek:	FC
Pilarcitos Creek:	PC
Gazos Creek:	GC
Gazos Creek culvert drainages:	GCu

The Tables 3 through 7 give the fecal bacterial results (in CFU/100 ml) for each of the water sample collection locations. Table column headings refer to sample locations referenced by the sample site nomenclature reflected on Figures 1 through 6 on the various creek maps.

Water samples:
Water samples were collected using an extension pole and sterile sample bottles supplied by SMCPHL. Samples were collected using only the grab sample method in running water deeper than 1" and per QAPP guidelines. Point locations were typically off of a bridge or the creek bank. Samples were then transported, on ice, in coolers to the SMCPHL within 4-6 hours.

Data Interpretation:
I) California Beach Water Quality Standards: (hereafter referred to as State Bacteria Standards)
With the passage of Health and Safety Code 115880 (Assembly Bill 411, Statutes of 1997, Chapter 765) California Department of Health Services developed a set of regulations for public beaches and ocean water contact sports areas. The project adopted the 30-day log mean standard (mathematical average) as its guideline. The maximum standards are as follows:

30-day log mean standard (these are used herein):

Total coliform	1,000 organisms per 100 ml sample
Fecal coliform	200 organisms per 100 ml sample
Enterococcus	35 organisms per 100 ml sample

Single sample standards:

Total coliform	10,000 organisms per 100 ml sample
Fecal coliform	400 organisms per 100 ml sample
Enterococcus	104 organisms per 100 ml sample

II) Fecal Bacteria Analysis:

Geomean: Simple measures of central tendency that are used for data evaluation are not reliable if the data does not fit a normal distribution. Bacterial population densities are typically highly-skewed distributions because populations can easily range from 10,000 or higher than typical results, but can never be below zero (because of lower detection limits). A very high number will result in an average much higher than actual conditions. Using the geomean, the data is normalized logarithmically and the mean is a valid measure of typical results.

E.coli data was analyzed weekly as individual values and also over the periods selected (by rainfall) using the geomean calculation. Geomean were calculated for each creek as follows: data was divided into groups according to the preselected months with precipitation of 1" and above. The mathematical geomean function was then applied to the group. For the geomean calculations <10 CFU/100 ml was assumed to be 9 and > 24,192 CFU/100 ml was assumed to be 24,193. The geomean are given in the bacteriological data Tables 3 through 7.

Sample sites showing trends exceeding State Bacteria Standards were each investigated further on foot, looking for potential sources of contamination. This included wading upstream in, or alongside, the creeks and tributaries as well as walking through brush and forest terrain. Additional samples were taken when necessary to try to determine the source of the bacteriological load.

III) Statistical periods:

Sources of contamination in water are many and varied and can be further separated into dry and wet weather events. Normal runoff from urban, suburban and rural areas, aging sewer systems and contaminated flows from creeks and rivers are further exacerbated during storm/wet weather events. In addition to the sources listed above, overflow of sewer systems, septic leaching, and non-point run-off also contribute. Thus it was decided the data would allow for the most meaningful interpretation if it were divided into dry and wet weather sections. Each were then reviewed and compared against each other. Months with precipitation of 1" and above were selected and categorized (identified in light blue on all tables) into three sections coinciding with the average rainfall periods of 1" or greater (calculated as far back as 1849 for the San Francisco area), and then the geomean for each section was determined.

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
0.02	0.04	0.27	1.01	2.63	4.21	4.64	3.71	3.04	1.48	0.62	0.15

TABLE 2
HISTORICAL RAINFALL DATA (GEOMEAN) IN INCHES, FOR THE SAN FRANCISCO BAY AREA, OVER THE PERIOD 1847 - 2003

Summary and potential solutions:
Pilarcitos Creek Watershed (this includes the Frenchman's Creek Watershed) is highly impacted by human activities while the Gazos Creek watershed has been minimally impacted. The increased human activity increases creek contamination potential. This is evident when comparing the geomean data tables (listed below) for the two watersheds. (Red font illustrates results greater than the State Bacteria Standards)

Pilarcitos Creek:

E.Coli	PC-10	PC-9	PC-8	PC-7	PC-6	PC-5	PC-4	PC-3	PC-2	PC-1	CONTROL
10/23/02-04/23/03	96	*241*	178	*263*	*290*	*253*				*1950*	<10
04/30/03-10/22/03	154	*400*	*354*	*471*	*492*	*317*	*506*	*4416*	*497*	*3173*	<10
10/29/03-05/26/04	65	*248*	*354*	*298*	*355*	*259*	*323*	*2207*	*310*	*2214*	<10

Corinda Los Trancos Tributary:

E.Coli	CLT-11	CLT-10a	CLT-10b	CLT-10c	CLT-8	CLT-7	CLT-7a	CLT-7b	CLT-7c	CLT-6	CLT-5	CLT-4	CLT-3	CLT-2	CLT-1
10/23/02-04/23/03													*408*		*381*
04/30/03-10/22/03	20		50		170	*467*				*771*	*470*	14	91	65	169
10/29/03-05/26/04	19	10	10	546	*553*	*231*	<10	*438*	*530*	148	*781*	123	*313*	*200*	*296*

Frenchman's Creek:

E.Coli	FC-14	FC-11	FC-13	FC-12	FC-10	FC-9	FC-8	FC-7	FC-6	FC-5	FC-4	FC-3	FC-2	FC-1	Control
10/23/02-04/23/03									175	180	*268*	*280*	*317*	*968*	<10
04/30/03-10/22/03		29	90	119	90	*282*	136	*284*	*341*	*324*	*307*	*303*	*333*	*2111*	<10
10/29/03-05/26/04	40	28	198	62	38	70		59	77	67	76	97	135	*372*	<10

Gazos Creek:

E.Coli	GC-18	GC-17	GC-16	GC-15	GC-14	GC-13	GC-12	GC-11	GC-10	GC-9	GC-8	GC-7	GC-6	GC-5	GC-4.1	GC-4	GC-3	GC-2	GC-1	Control
9/14/2004-3/26/2005	12	21	23	21	20	23	11	26	23	20	18	56	32	35	702	36	50	62	21	<10
5/3/2005-10/25/2005		13	16	24	17	20	16	23	14	15	29	27		47		58	43	80	32	<10
11/1/2005-02/26/2006				25	13	29	10	20	20	16	26	28		22		29	24	35	12	<10

TABLE 3
E.COLI (CFU/100 ml) SUMMARIES FOR THE SAMPLE SITES IN THE FOUR CREEKS INCLUDED IN THIS PROJECT

(All figures in red, underlined or bold italics represent data out of the State bacteria standards. See Figures 1 through 6 for watershed maps showing sample site locations).

Pilarcitos Watershed is further analyzed into 5 potential sources:

Frenchman's Creek

Manure Pile (resolved):
The first 6 months of testing showed the highest static sampling point selected was not always consistent. To establish some base line data, permission was obtained to access the property further east and more static sampling points were added. Upon inspection, it was observed that there was a manure pile being stored on the roadside. This was adjacent to a storm drain. The landowner moved the pile and the numbers for this site showed an improvement over the third semester of the project from this site and all the way to the mouth of the creek.

- PC-9 Sampling of this site was obtained off a bridge at the entrance to the property. To be able to explore possible sources of contamination with a sanitary survey, access to the property was required. Since access could not be obtained, any commentary cannot be included.

- Corinda Los Trancos Tributary (See Venice Beach below) CLT-1 through CLT-11

- Agricultural and Open Space: PC-6 + PC-7
  Providing sufficient outdoor latrine facilities (Porta Potties) for Ag labor and the ongoing education in the environmental importance of using them vs. the creek, is deemed essential.
  Homeless and transient usage is much harder to control and is dependant on law enforcement.

- Horse Crossing PC-3
  Potential solution:
  State Parks permits the commercial ranch that leases out horses for rides to cross through the creek, alongside the Trail Bridge. The distance required to be covered by a new and separate horse-only bridge is considerable. It would likely be a very costly venture and not viable given the selective usage. However, an alternative option would be to add an extension to the current bridge dedicated to horse traffic. A project much larger in scope is the "Nippon clip-ons" added on to Auckland Harbor Bridge in the form of box girder clip on sections, but serves to illustrate the principle.

  This would give the horse traffic an alternative to crossing the creek and keep the horses and human pedestrian and cyclist traffic on the trail bridge safely separated. No new bridge construction would be required.

- Venice Beach Gulls
  The Corinda Los Trancos Tributary and the gull population at Venice Beach appear to be connected. The Ox Mountain landfill supplies a plentiful and continuous food source and the freshwaters of Pilarcitos and Frenchman's Creeks provide for bathing and drinking. Little to no predation exists. Instituting strict long-term bird control at the landfill and continuing to monitor Corinda and Pilarcitos Creeks will determine whether this is effective.

A similar situation existed in Santa Barbara County at the Lower Arroyo Quemado Creek watershed and the Tajiguas Landfill. The County employed the services of a falconer on the landfill site. This deterred the gulls from foraging at the landfill and encouraged them to move on, reducing the numbers of birds remaining at the beach and lowering the bacterial contamination levels.

CONCLUSION 3.0

Gazos Watershed potential sources:

These are the only potential sources of contamination detected during the study:

- Gazos Creek Grill Restaurant
- Residential septic at intersection of Gazos Creek Road and Highway 1

No contamination of the creek, by the restaurant and residence during the project, was observed.

- Hillside Drainage: GC-4.1

Conclusive data was not obtained due to lack of access to the facility. It was out of operation for most of the duration of the project.

The approach to this project was based on the success of the first County of San Mateo research project on the San Vicente Creek watershed. While the two watersheds studied in this project are diametrically different to San Vicente and each other, each was a success within its boundaries. Various sources of contamination, point and non-point were identified. There were reductions in the fecal counts when one point source was eliminated with Best Management Practices (BMP's). Remediation of the remaining identified sources each have the potential to reduce the fecal bacterial numbers significantly. However the exact degree of success cannot be predicted given the variables unique to each source. Certainly addressing each of them will result in a cumulative reduction in fecal pollution. These measures will require a long-term commitment by the San Mateo County Public Health and Environmental Protection Division and ongoing monitoring of at least half of the established static sites to determine the efficacy of the remediation action plans.