California Regional Water Quality Control Board
Central Coast Region

Total Maximum Daily Loads for Pathogens in Aptos Creek, Valencia Creek, and Trout Gulch, Santa Cruz County, California

Final Project Report

For the May 8, 2009 Water Board Meeting

Adopted by the
California Regional Water Quality Control Board
Central Coast Region
on _____, 200x

Approved by the
State Water Resources Control Board
on _____, 200x
and the
Office of Administrative Law
on _____,200x
and the
United States Environmental Protection Agency
on _____, 200x

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION
895 Aerovista Place, Suite 101, San Luis Obispo, California 93401
Phone • (805) 549-3147
http://www.waterboards.ca.gov/centralcoast/

To request copies of the Basin Plan Amendment and Final Project Report for Total Maximum Daily Loads for Pathogens in Aptos Creek, Valencia Creek, and Trout Gulch, Santa Cruz County, California, please contact Kim Sanders at (805) 542-4771, or by email at ksanders@waterboards.ca.gov.
Documents also are available at:
http://www.waterboards.ca.gov/centralcoast/TMDL/303dandTMDLprojects.htm

STATE OF CALIFORNIA

ARNOLD SCHWARZENEGGER, Governor
LINDA S. ADAMS, Agency Secretary, California Environmental Protection Agency

State Water Resources Control Board

Tam Doduc, *Chair*	Civil Engineer, Water Rights
Gary Wolff, *Vice Chair*	Professional Engineer, Water Quality
Charles R. Hoppin	Water Quality
Arthur G. Baggett, Jr.	Attorney, Water Supply & Water Rights
Frances Spivey-Weber	Public Member

Dorothy Rice, *Executive Director*

California Regional Water Quality Control Board Central Coast Region

Jeffrey S. Young, *Chair*	Water Supply
Russell M. Jeffries, *Vice Chair*	Industrial Water Use
Leslie S. Bowker	County Government
Monica S. Hunter	Public
Gary C. Shallcross	Recreation, Fish or Wildlife
David T. Hodgin	Water Quality
Daniel M. Press	Water Quality
John H. Hayashi	Irrigated Agriculture
Vacant	Municipal Government

Roger Briggs, *Executive Officer*
Michael Thomas, *Assistant Executive Officer*

This report was prepared under the direction of

Lisa H. McCann, *Environmental Program Manager*
Angela Schroeter, *Senior Engineering Geologist*

by

Kim Sanders, *Environmental Scientist*
Shanta Keeling, *Water Resources Control Engineer*
Angela Carpenter, *Water Resources Control Engineer*
Chris Rose, *Environmental Scientist*

with the assistance of

Larry Harlan, *Environmental Scientist*
Katie McNeill, *Environmental Scientist*
David LaCaro, *Environmental Scientist*
Michael Higgins, *Water Resources Control Engineer*

CONTENTS

CONTENTS ..... **IV**

1. PROJECT DEFINITION **1**

1.1. INTRODUCTION 1
1.2. LISTING BASIS 2
1.3. BENEFICIAL USES 3
1.4. WATER QUALITY OBJECTIVES 3
1.5. WASTE DISCHARGE PROHIBITION 4

2. WATERSHED DESCRIPTION **6**

2.1. LOCATION, CLIMATE, AND HYDROLOGY 6
2.2. JURISDICTIONAL BOUNDARIES AND LAND USE 8

3. DATA ANALYSIS **13**

3.1. WATER QUALITY DATA 13
3.2. FLOW DATA 14
3.3. DATA ANALYSIS 14
3.4. DATA ANALYSIS AND IMPAIRED REACHES CONCLUSIONS 18
3.5. MICROBIAL SOURCE ANALYSIS RESULTS 18

4. SOURCE ANALYSIS **22**

4.1. MECHANISMS OF TRANSPORT FOR VARIOUS SOURCES OF PATHOGEN INDICATOR ORGANISMS 22
4.2. SOURCE ANALYSIS CONCLUSIONS 29
4.3. COMPARISON WITH SOURCES IN OTHER PATHOGEN IMPAIRED WATERS 31

5. CRITICAL CONDITIONS AND SEASONAL VARIATION **32**

5.1. CRITICAL CONDITIONS AND UNCERTAINTIES 32
5.2. SEASONAL VARIATIONS 32
5.3. CONCLUSION 33

6. NUMERIC TARGETS **33**

7. LINKAGE ANALYSIS **34**

8. TMDL CALCULATIONS AND ALLOCATIONS **34**

8.1. PROPOSED WASTELOAD AND LOAD ALLOCATIONS 35
8.2. MARGIN OF SAFETY 37

9. PUBLIC PARTICIPATION **38**

10. IMPLEMENTATION PLAN **39**

10.1. IMPLEMENTATION ACTIONS 39
10.2. EVALUATION OF IMPLEMENTATION PROGRESS 43
10.3. TIMELINE AND MILESTONES 44

10.4. ECONOMIC CONSIDERATIONS 44

11. MONITORING PLAN 50

11.1. INTRODUCTION 50
11.2. MONITORING SITES, FREQUENCY, AND RESPONSIBLE PARTIES 50
11.3. REPORTING 52

REFERENCES 53

Table of Tables

Table 1. Beneficial Uses for Aptos Creek, Valencia Creek and Trout Gulch 3
Table 2. Characteristics of the Main Tributaries of the Aptos Creek watershed (Swanson 2003). 9
Table 3. Santa Cruz County Environmental Health Services Fecal Coliform Sampling Activity Since January 1, 2000 (listed by sampling site from the mouth of Aptos Creek upstream to Valencia Creek) 13
Table 4. Estimated Summer Flows in the Aptos Creek watershed (Santa Cruz County, 2006) 14
Table 5. Aptos Creek watershed Percent Exceedances of Fecal Coliform Water Quality Criteria (January 2000 – June 2006) 15
Table 6. Percent Source Contributions from Aptos Creek watershed (1/13/04 – 2/3/05) 21
Table 7. Allocations and Responsible Parties 36
Table 8. Required Monitoring 51

Table of Figures

Figure 1. Location of the Aptos Creek watershed. 7
Figure 2. Jurisdictional Boundaries within the Aptos Creek watershed. Santa Cruz County jurisdiction is the unhatched area on the east side of the figure 8
Figure 3. Aptos Creek watershed Land Uses 11
Figure 4. Percent Land Use in the Aptos Creek watershed. 12
Figure 5. Aptos Creek watershed Sampling Site Locations and Percent Exceedance of the Maximum Water Quality Objective (400 MPN/100 mL) from January 2000 to June 2006. 17
Figure 6. Aptos Creek watershed Ribotyping Data Sites 20

Appendices

Appendix A. Water Quality Data
Appendix B. Fecal Coliform Data Analysis
Appendix C. Microbial Source Tracking Data

List of Acronyms and Abbreviations

This report contains numerous acronyms and abbreviations. In general, staff wrote an acronym or abbreviation in parentheses following the first time a title or term was used. Staff wrote the acronym/abbreviation in place of that term from that point throughout this report. The following alphabetical list of acronyms/abbreviations used in this report is provided for the convenience of the reader:

CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CFU	Colony Forming Units
cfs	Cubic Feet per Second
CWA	Clean Water Act
E. coli	Escherichia coli bacteria
MPN	Most Probable Number
REC-1	Water Contact Recreation
REC-2	Non-contact Water Recreation
SCCSD	Santa Cruz County Sanitation District
SWMP	Stormwater Management Plan
TMDL	Total Maximum Daily Load
WDR	Waste Discharge Requirements
WWTP	Waste Water Treatment Plant

1. PROJECT DEFINITION

1.1. Introduction

The Aptos Creek watershed is in southern Santa Cruz County and encompasses approximately 21 square miles. Aptos Creek's main tributaries are Valencia Creek, Mangels Gulch, and Bridge Creek. Trout Gulch is a tributary to Valencia Creek. Aptos Creek drains to the Aptos Creek Lagoon and ultimately to Monterey Bay, south of Santa Cruz, California. Throughout this report, staff refers to the entire watershed as the Aptos Creek watershed. Aptos Creek watershed encompasses all tributaries to Aptos Creek and their watersheds.

The Clean Water Act Section 303(d) requires the State to establish Total Maximum Daily Loads (TMDLs) for Aptos and Valencia Creeks. TMDLs are required because these waters have been identified as impaired for pathogens and have been placed on the Clean Water Act 303(d) list (303(d) list). The State must also incorporate seasonal variations and a margin of safety into the TMDLs that takes any lack of knowledge into account concerning the relationship between load limits and water quality.

Staff also proposes load allocations in this report for an unlisted waterbody, Trout Gulch. Staff determined this was necessary because Trout Gulch is impaired and it flows into Valencia and Aptos Creek, respectively. Staff proposes allocations and water quality improvement measures in the Implementation Plan section for this waterbody in addition to Aptos and Valencia Creeks.

Aptos Creek

Aptos Creek is on the 303(d) list for non-attainment of pathogen water quality objectives. Staff determined that based on historic and recent data, pathogen indicator organism (fecal coliform) concentrations exceeded Water Quality Control Plan for the Central Coast Basin (Basin Plan) water contact recreational use objectives during both wet and dry seasons.

Valencia Creek

Valencia Creek is on the 303(d) list for non-attainment of pathogen water quality objectives. Staff determined that based on historic and recent data, fecal coliform concentrations exceeded Basin Plan water contact recreational use objectives during both wet and dry seasons.

Trout Gulch

Trout Gulch is not on the 303(d) list, however, staff determined it did not attain pathogen water quality objectives. Staff determined that based on historic and recent data, the fecal coliform concentrations exceeded Basin Plan water contact recreational use objectives during both wet and dry seasons.

1.2. Listing Basis

According to the EPA Protocol for Developing Pathogen TMDLs (EPA Protocol), "the numbers of pathogenic organisms present in polluted waters generally are few and difficult to isolate and identify, as well as highly varied in their characteristic and type. Therefore, scientists and public health officials typically choose to monitor nonpathogenic bacteria that are usually associated with pathogens transmitted by fecal contamination and are more easily sampled and measured. These associated bacteria are called indicator organisms. Indicator organisms are assumed to indicate the potential presence of human pathogenic organisms. When large pathogen indicator organism populations are present in the water, it is assumed that there is a greater likelihood that pathogens are present." The Basin Plan uses fecal coliform concentrations as water quality objectives to represent pathogenic organisms.

Aptos Creek

The California Regional Water Quality Control Board, Central Coast Region (Central Coast Water Board) placed Aptos Creek on the 303(d) list of impaired waters for pathogens in 1994. Aptos Creek exceeded water contact recreation water quality objectives for fecal coliform. County of Santa Cruz Environmental Health provided the data to support the listing. Staff discussed the County's recent data in Section 3 *Data Analysis*.

Valencia Creek

The Central Coast Water Board placed Valencia Creek on the 303(d) list of impaired waters for pathogens in 1994. Valencia Creek exceeded water contact recreation water quality objectives for fecal coliform. County of Santa Cruz, Environmental Health provided the data to support the listing. Staff discussed the County's recent data in Section 3 *Data Analysis*.

1.3. Beneficial Uses

The Basin Plan contains beneficial uses for Aptos Creek, Valencia Creek, and Trout Gulch. The beneficial uses are shown in Table 1.

Table 1. Beneficial Uses for Aptos Creek, Valencia Creek and Trout Gulch

Beneficial Use	Waterbody Name[1]		
	Aptos Creek	Valencia Creek	Trout Gulch
Municipal and Domestic Supply (MUN)	X	X	X
Agricultural Supply (AGR)	X		
Industrial (IND)	X		
Groundwater Recharge (GWR)	X	X	X
Water Contact Recreation (REC-1)	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X
Wildlife Habitat (WILD)	X	X	X
Cold Fresh Water Habitat (COLD)	X	X	X
Migration of Aquatic organisms (MIGR)	X	X	
Spawning, Reproduction, and/or Early Development (SPWN)	X	X	
Preservation of Biological Habitats of Special Significance (BIOL)	X		
Rare, Threatened, or Endangered Species (RARE)			
Estuarine Habitat (EST)	X		
Freshwater Replenishment (FRSH)	X		
Commercial and Sport Fishing (COMM)	X	X	X

[1] – Bridge Creek is a small tributary to upper Aptos Creek and has beneficial uses identified in the Basin Plan. However, staff did not consider Aptos Creek above the confluence with Valencia Creek as impaired (see Section 3). Therefore, staff did not propose any load allocations for Bridge Creek and did not identify its beneficial uses in this table.

1.4. Water Quality Objectives

The following Water Quality Objectives apply to all the impaired waterbodies that are part of this project.

The Basin Plan states "controllable (emphasis added) water quality shall conform to the water quality objectives contained herein. When other conditions cause degradation of water quality beyond the levels or limits established as water quality objectives, controllable conditions shall not cause further degradation of water quality." This requirement applies to all waters of the State.

The Basin Plan contains specific water quality objectives that apply to fecal coliform (Basin Plan, pg. III-10). These objectives are linked to specific beneficial uses and

include the following. All of the impaired waterbodies in this project are designated with these beneficial uses (See Table 1 Section 1.3 *Beneficial Uses*)

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

The Basin Plan contains the following objective to protect the water contact recreation beneficial use: Fecal coliform concentration, based on a minimum of not less that five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL.[1]

Non-Contact Water Recreation (REC-2):
The Basin Plan contains the following objective to protect the non-contact water recreation beneficial use: Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 2000 MPN per 100 mL, nor shall more than10 percent of samples collected during any 30-day period exceed 4000 MPN per 100 mL.

1.5. Waste Discharge Prohibition

In 2004, the State Water Resources Control Board (State Board) adopted the *Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program,* May 20, 2004 (Nonpoint Source Implementation Policy). The Nonpoint Source Implementation Policy requires the Central Coast Water Board to regulate all nonpoint sources (NPS) of pollution using the administrative permitting authorities provided by the Porter-Cologne Water Quality Control Act. Administrative permitting authorities include Waste Discharge Requirements (WDRs), waivers of WDRs, or Basin Plan Prohibitions. Responsible parties are to participate in the development and implementation of NPS Pollution Control Implementation Programs designed around their type of nonpoint source discharge.

Staff is proposing to address specific types of nonpoint sources of pollution in the Aptos Creek Watershed by adding the Watershed as a named area subject to two proposed nonpoint source pollution prohibitions: (1) the Human Fecal Material Discharge Prohibition and (2) the Domestic Animal Waste Discharge Prohibition. These two prohibitions will be proposed as amendments to the Basin Plan with the TMDLs for the

[1] Throughout this document, fecal coliform units are expressed as colony forming units (CFU) (#/100mL or CFU/100 mL) and most probable number (MPN). All unit expressions are considered equivalent fecal coliform bacteria concentration measures (Reference: Protocol for Developing Pathogen TMDLs).

Pajaro River Watershed at the March 20, 2009 Board Meeting (see Resolution No. RB3-2009-0008).

2. WATERSHED DESCRIPTION

2.1. Location, Climate, and Hydrology

The following describes the Aptos Creek Watershed's location, climate, and hydrology (Swanson 2003):

> [The Aptos Creek Watershed is located in Santa Cruz County, California.] There are two main subwatersheds that make up the Aptos Creek Watershed: Aptos Creek and Valencia Creek. These two subwatersheds are similar in size; Aptos Creek totals 11.2 square miles and Valencia Creek totals 9.41 square miles. Their confluence occurs approximately 0.5 miles upstream of the coastal lagoon. Several other smaller subwatersheds occur within each of these primary subwatersheds, including Bridge and Mangels Gulch in the Aptos Creek subwatershed, and Trout Gulch in the Valencia Creek subwatershed.
>
> The Aptos Creek watershed is located in the temperate climate of the Central California coast, characterized by cool wet winters and dry warm summers. The dry season typically lasts from May to October with stream flow declining through this period. The lowest flows of the season typically occur in August and September until the winter rains return in December. Summer days near the coast can stay fairly cool due to the influence of the coastal marine layer. When winter rains hit the coastline, the amount of precipitation is enhanced by steep terrain, producing orographic uplift and heavy rains, especially in the upper watershed. Average annual rainfall totals range from over 50 in/yr in the headwaters to 22 in/yr at the mouth.
>
> The hydrology of the Aptos and Valencia Creek watersheds is typical of the conditions found in most small coastal streams of Santa Cruz County. Winter peak flow events can be characterized as flashy and are tied closely to the duration and magnitude of winter rainfall and antecedent soil moisture conditions. At the onset of the rainy season in late Fall, much of the rainfall acts to saturate the soil and fill depression storage on the landscape, with little direct runoff to the stream channels. Once the soil is saturated, additional rainfall directly contributes to runoff and other sources of flow, such as springs and seeps, become active. In an average winter, soil conditions will be saturated through April. Consequently, these months tend to have the highest runoff.

The Swanson report (2003) had a figure detailing the average monthly stream flow for Aptos Creek. Based on data collected from two USGS gage stations between 1973 and 1985, average monthly stream flow ranges from about 29 cfs in February (winter) to about 2 or 3 cfs in September (summer).

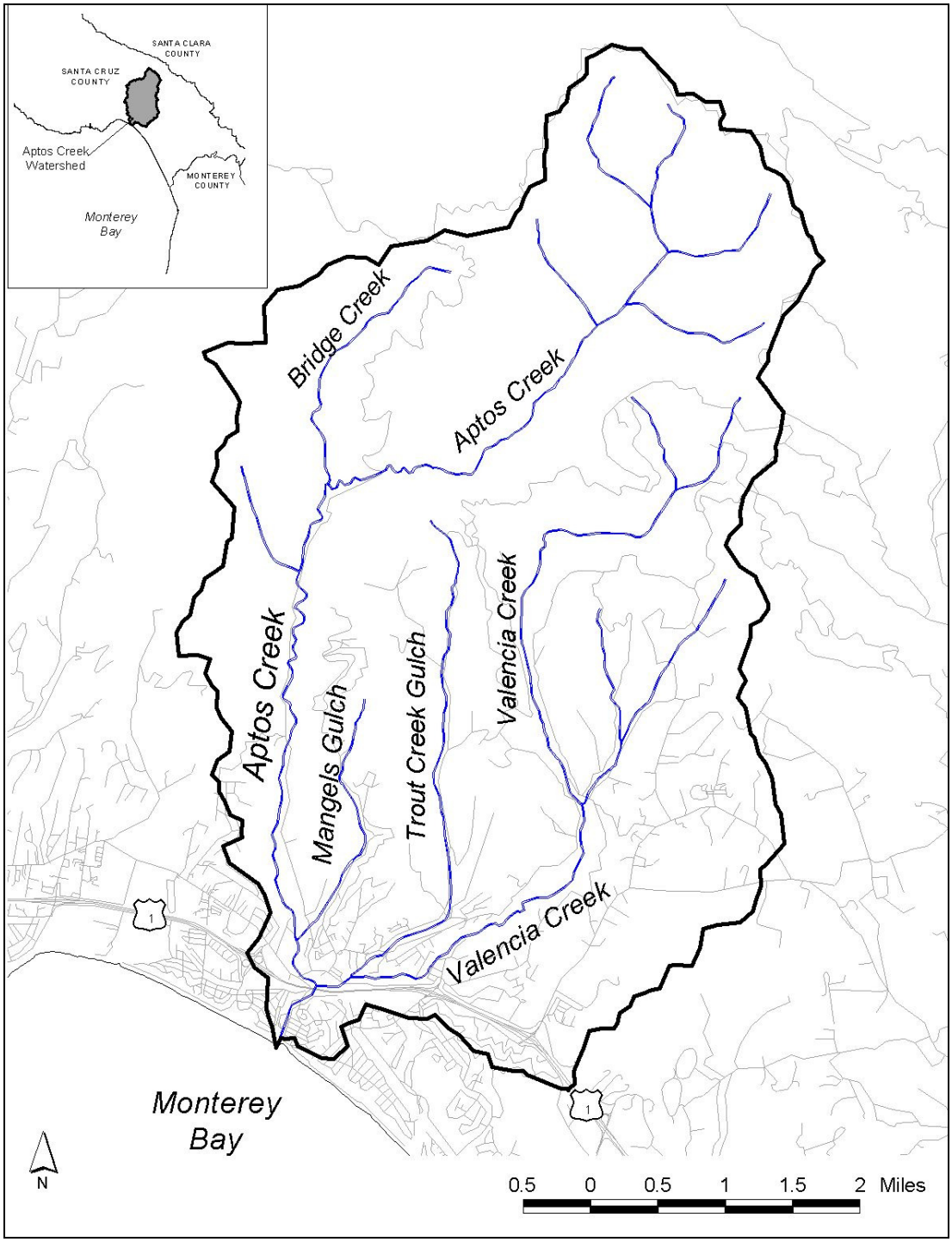

Figure 1. Location of the Aptos Creek watershed.

2.2. Jurisdictional Boundaries and Land Use

Jurisdictional Boundaries

The Aptos Creek watershed includes lands under the jurisdiction of the County of Santa Cruz and California State Parks system (Figure 2).

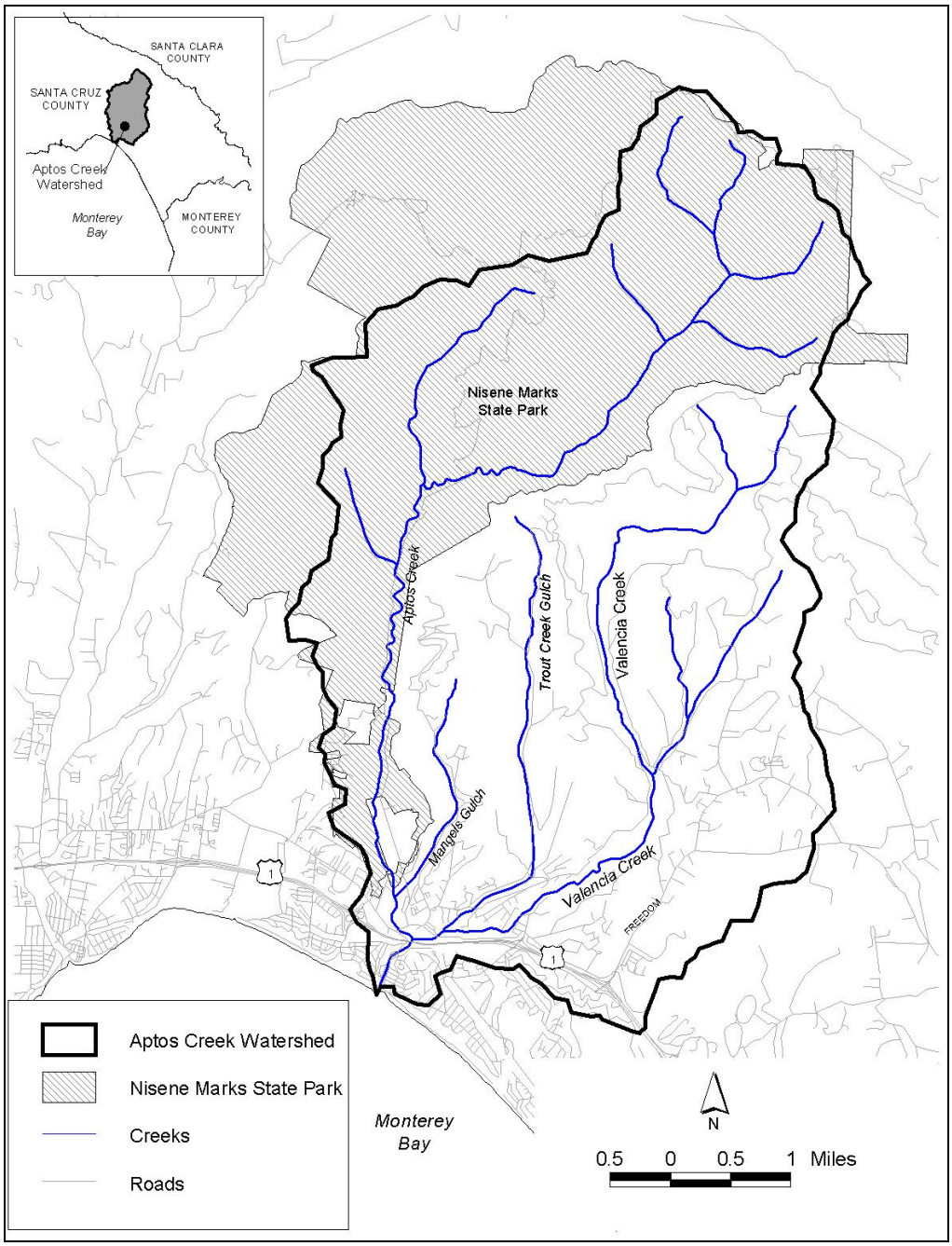

Figure 2. Jurisdictional Boundaries within the Aptos Creek watershed. Santa Cruz County jurisdiction is the unhatched area on the east side of the figure.

Land Use

Swanson Hydrology's report also gave a good description of land use in the watershed (2003):

> Historically, both the Aptos and Valencia Creek watersheds were heavily forested…and extensively logged through the 1920's. Recent land use conditions in these two watersheds have diverged considerably…(Table 2 of this report). Much of the Aptos Creek subwatershed is protected in the Forest of Nisene Marks, part of the California State Parks system, with the exception of Mangels Gulch and the lower portion of the Aptos Creek watershed where urban and rural residential land uses dominate. The Valencia Creek subwatershed, including Trout Gulch, is predominately privately owned with much of the lower watershed dominated by urban and rural residential land uses. Rural residential development is increasing in the upper watershed, though much of the land consists of large parcels dominated by orchards and selective logging.

Table 2. Characteristics of the Main Tributaries of the Aptos Creek watershed (Swanson 2003).

Subwatershed	Sub-Shed Area (mi^2)	Main Tributary Length (mi)	Elev. Peak of Sub-Shed (ft)	Area and (%) of Impervious Surfaces[1]	Predominant Land Uses
Aptos/Bridge Creek	11.2	7.2	2624	0.23 mi^2 (2.1%)	Predominantly dense forested in upper watershed with a few residential parcels and open spaces in lower watershed.
Mangels Gulch	0.85	2.0	860	0.04 mi^2 (4.7%)	Predominately rural residential.
Trout Gulch	2.33	4.0	979	0.12 mi^2 (5.2%)	Rural residential, forested lands, and orchards.
Valencia Creek	9.41	7.3	1928	0.72 mi^2 (7.7%)	Dense residential in lower watershed with rural residential, forested lands, and orchards in upper watershed.
Total	24.2	20.5	2624	1.1 mi^2 (4.5%)	Urbanized in lower portions with channel highly modified through lagoon reach.

[1] – Percent impervious was estimated using a set of Santa Cruz County GIS layers depicting roads and parcels. Total road length was summed for each subwatershed area and multiplied by 30, assumed to be an average road width, to generate a total road area. The parcel layer was used to determine the total number of parcels in each subwatershed. Each parcel was assumed to have an impervious surface area of 2,000 sq ft including driveways, runoff areas, etc. Both values were converted to square miles and summed to provide an estimate of the total impervious surface area for each subwatershed.

Staff obtained Geographic Information System (GIS) land use data from the Multi-Resolution Land Characterization (MRLC)/National Land Cover Data (NLCD) database

and subsequently grouped the data into land use categories (Figure 3 and Figure 4). The MRLC/NLCD data was created by various governmental agencies using satellite imagery. Staff used this data which represents land uses from 1988 to 1994. Staff presented these land uses because pathogen indicator organism concentrations can be associated with certain land uses.

During staff's field reconnaissance staff noted that the urban land use representation in Figure 3 and Figure 4 was not accurate. Although unable to accurately quantify, staff concluded that there was greater urban land use than shown in the figures. Urban land use covered the area surrounding Aptos Creek from approximately 0.25 mile upstream of the confluence with Valencia Creek, to the Pacific Ocean. Urban land use also covered more of the area surrounding lower Valencia Creek and Trout Gulch, and south of Highway One, than shown in Figure 3.

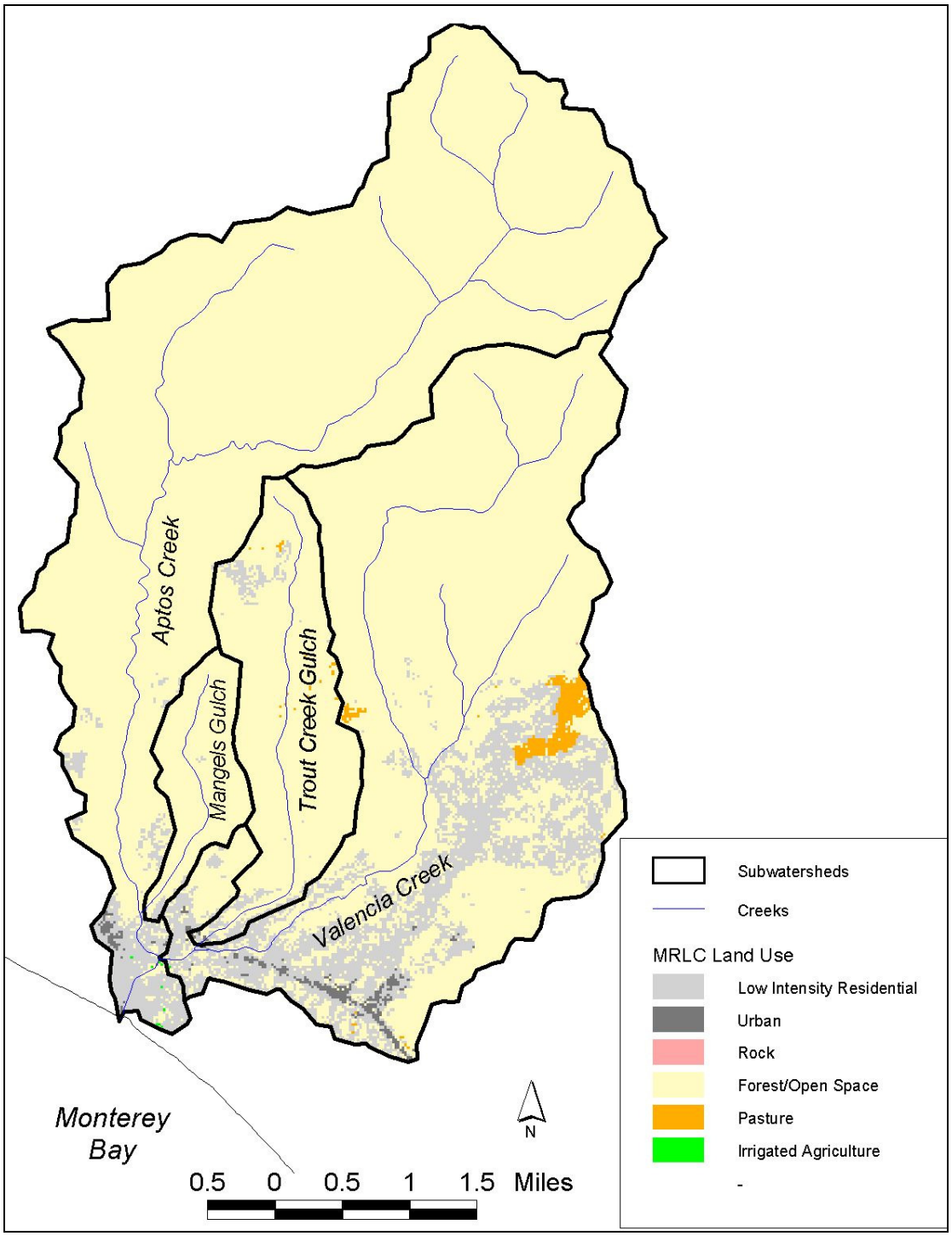

Figure 3. Aptos Creek watershed Land Uses

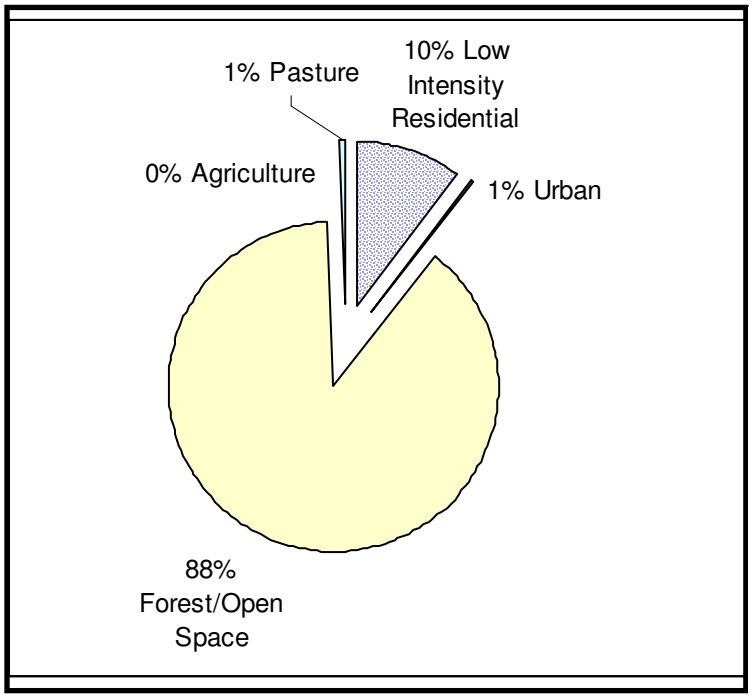

Figure 4. Percent Land Use in the Aptos Creek watershed.

See from Figure 3 and Figure 4 that the vast majority of the watershed consisted of forest or open space (88 percent). This land use is not typically associated with elevated levels of pathogen indicator organisms from controllable sources.

The second largest land use was low intensity residential land use with 10 percent land coverage. These lands can contain pathogen indicator organism sources such as cats, dogs, humans, and horses.

As staff explained above, urban land use covered more area than indicated in Figure 4. Staff is uncertain of how much land was in urban use, however it was greater than one percent. Staff suspected that pathogen indicator organisms from sources such as humans, dogs, cats, and wildlife (present as a result of human activity) came from this land use.

3. DATA ANALYSIS

3.1. Water Quality Data

This section presents the water quality data staff used to develop the TMDLs. Staff used data from the County of Santa Cruz Environmental Health Services (County) water quality sampling. Recent (since 2000) fecal coliform sampling activities for the Aptos Creek watershed are shown in Table 3 below. Although staff is only presenting recent data, the County collected water quality data for several sites since the mid 1970's. Staff determined that the "historic" data showed approximately the same trends as the recent data, with the exception of site A2, which showed improvement in recent years.

Table 3. Santa Cruz County Environmental Health Services Fecal Coliform Sampling Activity Since January 1, 2000 (listed by sampling site from the mouth of Aptos Creek upstream to Valencia Creek)

Waterbody	Sampling Site #[1]	Sampling Site	Number of Samples	Frequency	Period of Record
Aptos					
	A0	Aptos @ Creek Mouth	352	Weekly	1/05/2000 - 6/26/2006
	A03	Aptos C @ Bridge on Spreckels	20	Less than monthly	2/15/2000 - 9/13/2005
	A2	Aptos C @ Valencia Creek	85	Approximately monthly	2/1/2000 - 6/12/2006
Valencia Creek					
	A1	Valencia C @ Aptos C	107	Approximately monthly	2/01/2000 - 6/12/2006
	A12	Valencia Creek @ Trout Gulch	25	Sporadic	5/24/2000 - 9/13/2005
	A121	Valencia Creek Behind School	5	Sporadic	9/28/2000 - 1/25/2005
	A1213	Valencia Creek @ Fork (East Branch at intersection of Cox and McKay Roads)	9	Sporadic	1/25/2005 - 9/13/2005
	A12125	West Branch Valencia Creek	8	Sporadic	2/03/2005 - 9/13/2005
Trout Gulch					
	A11	Trout Gulch @ Valencia Creek	5	Sporadic	5/24/2000 – 9/13/2005
	A113	Trout Gulch @ Valencia Road	16	Sporadic	10/24/2000 – 9/13/2005
	A118	Trout Gulch @ End of Baker Road	9	Sporadic	1/25/2005 - 9/13/2005

[1] Figure 5 shows sampling site locations.

The purpose of the above table is to show that some sites had a more robust data set, while others had less data points. Staff also included the table to show the dates of record. Staff presented sampling site locations and results of the data in Section 3.3 Data Analysis Summary. A more complete data analysis is shown in Appendix B.

3.2. Flow Data

The County of Santa Cruz estimated average summer flows for the Aptos Creek watershed in their "Assessment of Sources of Bacterial Contamination at Santa Cruz County Beaches" (2006; Table 4). The estimates were based on inspection of a limited number of actual instantaneous flow measurements collected from 2003-2006. Winter flows were normally much higher. These average summer flows are comparable to Swanson Hydrology's 2003 report cited in Section 2 *Watershed Description*. Staff included these estimates to show the relative contribution of flow from Aptos and Valencia Creeks. As Table 4 shows, the majority of the flow in the watershed comes from Aptos Creek. Valencia Creek contributes about 20 percent of the flow to Aptos Creek after they join.

Table 4. Estimated Summer Flows in the Aptos Creek watershed (Santa Cruz County, 2006)

Location	Flow (cfs)
Aptos Creek [upstream of confluence with Valencia Creek]	2.5
Valencia Creek	0.5
Aptos At Spreckels [downstream of confluence with Valencia Creek]	3.0
Non-Specific Sources	0.1
Aptos @ Mouth	3.1

3.3. Data Analysis

Staff summarized the data and statistics contained in Appendix A and B in this section. Staff included a complete analysis of the fecal coliform data in Appendix B of this report. Staff analyzed water quality sampling results using a program titled "Fecal Coliform Investigation and Analysis Spreadsheet" (FECIA; Riverson, 2003). FECIA is a fully automated spreadsheet designed to assist in characterization and quantification of pathogen indicator instream water quality objectives exceedances. Observed data are compared against specified values equal to water quality objectives to determine the magnitude and nature of exceedances.

Staff used FECIA to generate figures for each sampling site for data presented in Section 3.1. The figures (included in the appendices) display water quality objectives, concentration ranges, the range of concentrations within the 25th -75th percentile range, the mean concentration, and the median concentration.

Staff also used FECIA to generate tables (also presented in the appendices) that show summary statistics for the figures described above. The tables display monthly statistical data combined for all analyzed years including the mean, median, minimum, maximum, the 25th percent deviation, the 75th percent deviation, the number of water quality objective exceedances, the sample count, and the percent sample exceedance.

In Table 5 staff presented each sampled site, the percent exceedance of the geometric mean water quality objective (200 MPN/100 mL) and the percent exceedance of the maximum water quality objective (400 MPN/100 mL). There were not enough data for staff to calculate the geometric mean for any of the sampled sites except for the Aptos @ Creek Mouth site (AO).

Table 5. Aptos Creek watershed Percent Exceedances of Fecal Coliform Water Quality Criteria (January 2000 – June 2006)

Sampling Site	Sampling Site Number	Geometric Mean Water Quality Objective (200 MPN/100 mL)		Maximum Water Quality Objective (400 MPN/100mL)	
		% Exceedances	Number of Sample Sets	% Exceedances	Number of Samples
Aptos @ Creek Mouth	A0	78%	310	53%	352
Aptos C @ Bridge on Spreckels	A03	(1)	(1)	30%	20
Aptos C @ Valencia Creek	A2	(1)	(1)	5%	85
Valencia C @ Aptos C	A1	(1)	(1)	59%	107
Valencia Creek @ Trout Gulch	A12	(1)	(1)	60%	25
Valencia Creek Behind School	A121	(1)	(1)	80%	5
Valencia Creek @ Fork (East Branch at intersection of Cox and McKay Rd.)	A1213	(1)	(1)	0%	9
West Branch Valencia Creek	A12125	(1)	(1)	0%	8
Trout Gulch @ Valencia Creek	A11	(1)	(1)	89%	28
Trout Gulch @ Valencia Road	A113	(1)	(1)	69%	16
Trout Gulch @ End of Baker Road	A118	(1)	(1)	22%	9

(1) Insufficient data to calculate geometric mean

Staff analyzed the percent exceedance of the maximum water quality objective spatially, to determine where this water quality objective was exceeded (Figure 5).

Aptos Creek

Staff determined the maximum water quality objective was exceeded in Aptos Creek at the two most downstream sampling sites (A0 and A03). Exceedances occurred in 53 percent and 30 percent of the water samples at these two sites, respectively. The most upstream Aptos Creek sampling site (A2) exceeded the maximum water quality objective in five percent (four of 85) of the samples. Staff noted that the four samples that exceeded the maximum water quality objective at site A2 were collected in December of 2002 or earlier (see Appendix A). All four samples were 1050 or lower (640, 710, 490, and 1050). In the last year of data analyzed for this site (June 2005 through June 2006),

all samples were less than 180 MPN/100mL, and all but two samples were 75 MPN/100mL or lower.

Trout Gulch

Staff concluded water quality samples from Trout Gulch exceeded the maximum water quality objective at the two sampling sites located on Trout Gulch, A11 and A113 (89 percent and 69 percent of the samples, respectively). Twenty two percent of the water quality samples from sampling site A118 exceeded the maximum water quality objective. Sampling site A118 was on a tributary to Trout Gulch.

Valencia Creek

Staff determined the maximum water quality objective was exceeded at the Valencia Creek sampling sites up to and including site A121 (approximately 0.5 mile upstream of the confluence with Aptos Creek). The maximum water quality objective was not exceeded at upstream sites A1213 or A12125. These two upstream sites had small data sets of nine and eight, respectively. Staff noted that none of the samples from A12125 spread among eight months exceeded 40 MPN/100mL (see Appendix A). Of the nine monthly samples from site A1213, there were three that ranged from 204 to 220 MPN/100 mL. The remaining values were 156 MPN/100mL or less.

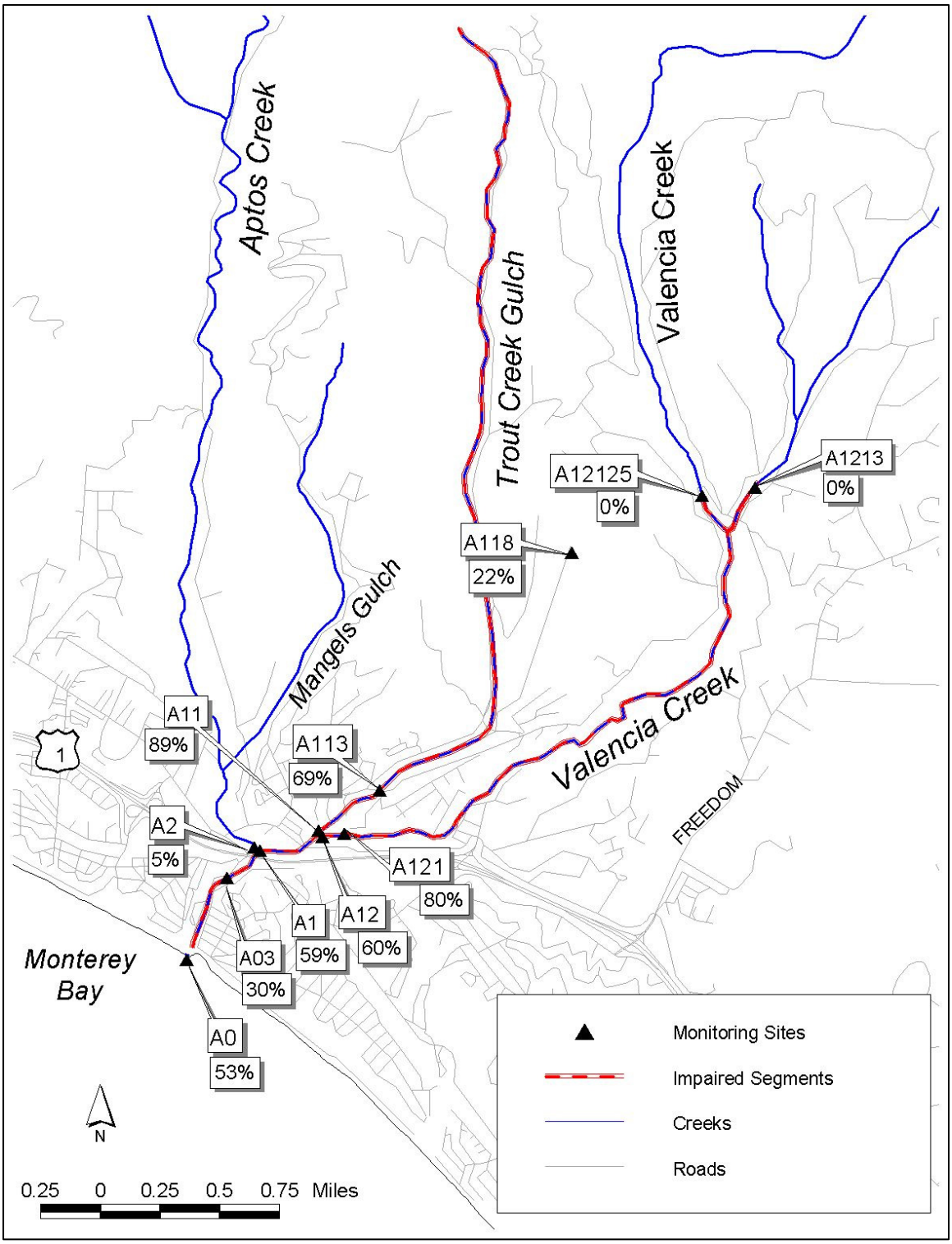

Figure 5. Aptos Creek watershed Sampling Site Locations and Percent Exceedance of the Maximum Water Quality Objective (400 MPN/100 mL) from January 2000 to June 2006.

3.4. Data Analysis and Impaired Reaches Conclusions

Staff concluded that data from Aptos Creek suggested it was impaired downstream from the confluence with Valencia Creek to the Pacific Ocean. The four out of 85 samples that exceeded the maximum water quality objective at the A2 site were collected five years ago or earlier, and were 1050 MPN/100mL or lower. Also, the majority of the most recent data was below 75 MPN/100mL. Staff surmised that there was not enough of an exceedance at this site to require TMDLs and assign allocations. Furthermore, per the Water Quality Control Policy (State Water Resources Control Board, 2004), 15 of the 85 samples would have to show exceedances in order to include the waterbody on the 303(d) list.

Based on land uses, staff also concluded that the reach of Aptos Creek upstream of the A2 site was being managed favorably with regard to water quality (see Section 4.1.1.e.1. *Homeless Person/Encampment Discharges not covered by Stormwater Management Plan*).

Staff concluded Trout Gulch was impaired from the confluence with Valencia Creek upstream to the headwaters. Water quality samples from Trout Gulch exceeded the maximum water quality objective at both sampling sites within 0.5 mile upstream of the confluence with Valencia Creek. Since there were no other sampling sites with which to gauge water quality, staff could not determine if there was a location where water quality improved. Therefore staff designated the whole reach as impaired.

Staff concluded that Valencia Creek was impaired from the confluence with Aptos Creek up to sites A1213 (on the east fork) and A12125 (on the west fork). Samples sites A1213 and A12125 were the first upstream sites that showed no impairment. Staff considered both the west and east branches of Valencia Creek to be unimpaired upstream from sites A1213 and A12125.

3.5. Microbial Source Analysis Results

Genetic ribotyping is a microbiological source tracking method that differentiates animal sources of *Escherichia coli (E. coli)*. Mansour Samadpour of the University of Washington Public Health Department has worked with over 100,000 *E. coli* samples and has developed genetic fingerprints that are specific to certain *E. coli* sources of animal origin. This method compares Ribonucleic Acid band patterns extracted from contaminated stream sites with known sources of *E. coli*. Numerous entities in California have successfully used this method, including California Polytechnic State University's (at San Luis Obispo) study of Morro Bay, California.

Although staff presents various sources in "percent contribution" values in this report, staff considers ribotyping results as an <u>estimate</u> of relative source contributions among all of the various sources. Ribotyping represents one of the "lines of evidence" in determining source contribution.

Santa Cruz County personnel collected water samples and submitted them for source tracking analysis from five different locations in the Aptos Creek watershed (Figure 6).

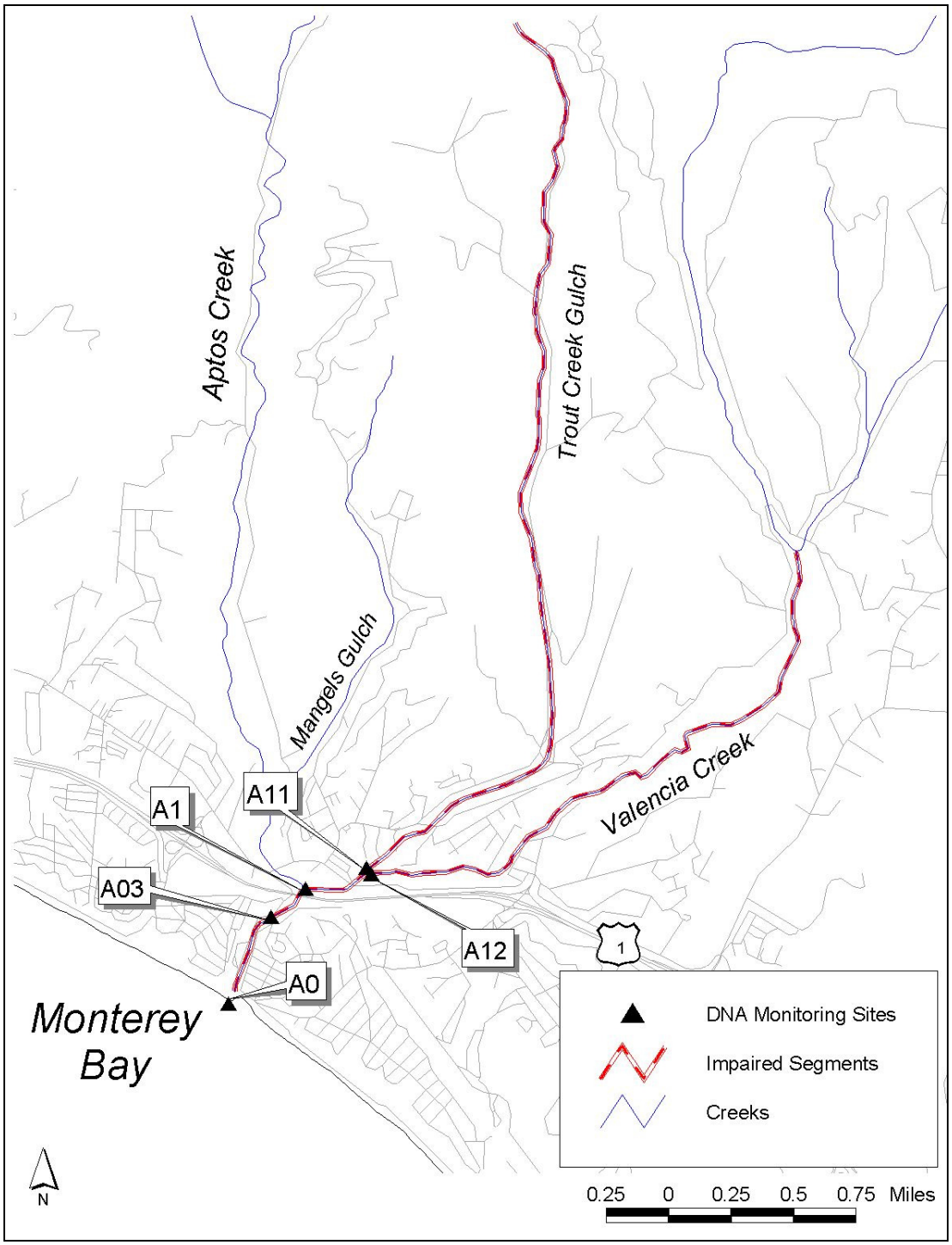

Figure 6. Aptos Creek watershed Ribotyping Data Sites

Santa Cruz County collected ribotyping samples between January 13, 2004 and February 3, 2005. Because the County collected the majority of samples during dry weather, there were not enough data to determine seasonal variation in terms of source contribution. Sometimes one source had a higher percent contribution during the wet season collection period, while another sample showed the same source to be higher during the dry season sampling period. Staff combined both wet and dry sample collections in the ribotyping analysis results (Table 6)

Table 6. Percent Source Contributions from Aptos Creek watershed (1/13/04 – 2/3/05)

Sampling Sites	Aptos Creek @ Mouth (A0)	Aptos Creek @ Bridge on Spreckels (A03)	Trout Gulch @ Valencia Creek (A11)	Valencia Creek @ Aptos (A1)	Valencia Creek @ Trout Gulch (A12)
Source					
Bird	62%	52%	43%	48%	40%
Marine Mammal	0%	0%	0%	0%	0%
Wildlife	11%	19%	17%	7%	17%
Cat	1%	0%	0%	0%	0%
Cow	0%	0%	0%	0%	0%
Dog	7%	11%	17%	22%	14%
Horse	1%	0%	1%	7%	0%
Human	2%	0%	0%	0%	0%
Rodent	10%	15%	7%	7%	17%
Unknown	6%	3%	13%	7%	12%
Total No. Days Water Sampled	13	9	5	3	2
Total Water Samples	30	23	21	9	13
Total Isolate Samples	128	93	69	27	42

Staff concluded that the genetic data suggested that a majority of the sources were birds (from 40 to 62 percent; Table 6). Staff also concluded that wildlife, dogs, and rodents were prevalent sources (between 7 and 22 percent). A smaller percentage of the sources were horses, humans, and cats. Staff concluded it is noteworthy that human contribution (2 percent) was only found at one site, the lowest point on the watershed. Additionally, this human contribution was only found during dry season sampling.

Staff concluded that birds, wildlife (raccoon, deer, and opossum), and rodents are generally considered natural and uncontrollable because their presence is generally not a result of human activities. However, staff considered animals such as raccoon and opossum as controllable to some degree. For example, these animals are attracted to trash dumpsters and urban areas where human activities involving food occur. Therefore, they are present partially as a result of human activities. Staff concluded some of their waste can be controlled by managing these human activities.

Dog, human, horse, and cat sources were considered controllable sources because they are present as a result of human activities and land management.

Genetic data (Table 6) suggested that a portion of the *E. coli* comes from unknown sources. The University of Washington Public Health Department does not have a genetic fingerprint match that is specific to these unknown sources.

4. SOURCE ANALYSIS

Staff based this source analysis on existing water quality data, wastewater spill data, microbial source data, land use, flow estimates, discussions with staff at County of Santa Cruz Environmental Health Services Agency, Santa Cruz County Sanitation District (SCCSD), Coastal Watershed Council, and observations made in the field. Staff did not determine sources solely on ribotyping results, but used the ribotyping results as one of the tools to help determine sources and relative contributions.

Staff also considered information provided in a report prepared by the County of Santa Cruz, Environmental Health Services, Water Resources Program titled *Assessment of Sources of Bacterial Contamination at Santa Cruz County Beaches* prepared in March, 2006 (Proposition 13 Report).

4.1. Mechanisms of Transport for Various Sources of Pathogen Indicator Organisms

In this section, staff discussed pathogen sources of concern in the Aptos Creek watershed. The modes by which various sources reached surface waters are also discussed.

4.1.1. WASTE DISCHARGES SUBJECT TO REGULATION BY THE CENTRAL COAST WATER BOARD

In this section staff discussed potential pathogen sources subject to regulation by the Central Coast Water Board.

4.1.1.a. Storm Drain Discharges to Municipally Owned and Operated Separate Storm Sewer Systems (MS4s) Required to be Covered by an NPDES Permit

Staff concluded that the following sources were likely in the storm drain discharge (to MS4s) from the Aptos Creek watershed. Storm drains can be a conduit for pathogens to reach surface waterbodies. During storms, rainwater can come in contact with human or animal waste and carry pathogens to a storm drain.

Pathogens deposited by pets, birds, rodents, or wildlife can enter storm drains. Water flowing to storm drains can collect pathogens. This water originates from a variety of

sources during wet (from rainfall) and dry weather (from over-watering, car washing, or other forms of cleaning). Although this is a typical vehicle for pathogens to enter the creek, the Proposition 13 Report stated that, "limited past sampling suggested high levels of pathogen indicator organisms in the storm drains, but investigations during the present study [Prop. 13 study] found the drains to be dry during the summer period." Because of these results, staff concluded that urban runoff during dry season was not a major source of pathogen contribution to the creek. Staff expected stormwater during wet seasons to be a contributor.

4.1.1.a.1. Controllable Bird Waste

Controllable sources of bird waste may be dumpsters, trashcans, and litter. Birds may frequent these locations as feeding sites. Bird waste may be carried to storm drains or surface waters when storms occur. Microbial source tracking results suggested that birds were the biggest contributor of *E. coli* to all five of the sites sampled (between 40 percent and 62 percent).

Water Board staff concluded it was likely that pathogens from this source contributed to the impairment in surface waters of the Aptos Creek watershed. The Implementation Plan in Section 10 *Implementation Plan* recommends methods to minimize this source.

4.1.1.a.2. Pet Waste

Pet wastes can reach the creeks via storm drain discharges during wet seasons. Also pet wastes can reach storm drains during the dry season if wash water comes into contact with pet waste. Microbial source tracking results suggested dog waste was present at all five sampling sites (between 7 percent and 22 percent).

Water Board staff concluded it was likely that pathogens from this source contributed to the impairment in surface waters of the Aptos Creek watershed. The Implementation Plan in Section 10 *Implementation Plan* recommends methods to minimize this source.

4.1.1.a.3. Controllable Rodent and Wildlife Waste

Controllable rodent and wildlife waste can reach the surface waters the same way that bird waste can enter surface waters. Microbial source tracking results suggested rodents and wildlife contributed *E. coli* to all the sampling sites.

Water Board staff concluded it was likely that pathogens from this source contributed to the impairment in surface waters of the Aptos Creek watershed. The Implementation Plan in Section 10 *Implementation Plan* recommends methods to minimize this source.

4.1.1.a.4. Dumpster Leachate

When it rains, rainwater can enter dumpsters and discharge leachate. This occurs when dumpsters are uncovered and containers leak. Dumpsters are often repositories for pet

waste and human waste (diapers). Recent microbial source tracking suggested pet waste existed at each sampling site and human waste existed at the Aptos Creek mouth. Staff estimated a small portion of pet and human waste detected from microbial source tracking analysis may be from dumpster leachate.

During dry seasons, bird waste may reach surface waters when trash-holding areas are washed down. Wash down waters may reach stormwater drains and surface waters.

Water Board staff concluded it was likely that pathogens from this source contributed to the impairment in surface waters of the Aptos Creek watershed. The Implementation Plan in Section 10 *Implementation Plan* recommends methods to minimize this source.

4.1.1.a.5. Human Waste Discharges

Human waste discharges can reach surface waters via storm drains. For example, human discharges can occur when homeless people do not have access to restroom facilities. In addition to human waste, staff suspected that homeless encampments generated wastes from other sources such as rodent waste, pet waste, and bird waste.

At a June 26, 2006 CEQA scoping meeting, staff learned that homeless people commonly occupy the land below the railroad trestle at Soquel Drive. Steve Peters, Water Quality Specialist, Health Services Agency, County of Santa Cruz, also said that he has observed homeless near the Britannia Arms Restaurant at the railroad trestle location (personal communication, October 9, 2007). This land may drain to stormwater conveyance systems.

Water Board staff concluded it was likely that pathogens from this source contributed to the impairment in surface waters of the Aptos Creek watershed. The Implementation Plan in Section 10 *Implementation Plan* addresses this source.

4.1.1.b. Pet Waste in Areas that do not Drain to MS4s

Staff concluded that pet waste in areas that do not drain to MS4s likely contributed pathogens to surface waters in the Aptos Creek watershed. Staff discussed pet waste in Section 4.1.1.a.2. *Pet Waste Transport Mechanisms*. As mentioned, microbial source tracking results suggested dog waste was a source at each of the five sites analyzed. Additionally, County staff observed pet waste in riparian areas (personal communication, John Ricker, County of Santa Cruz Environmental Health Services, September 18, 2007). Pet waste that is directly deposited to surface waters from riparian areas is not regulated by MS4s. Furthermore, staff observed other watersheds in which owners and operators of dogs did not pick up their waste in riparian areas. Staff concluded similar activities occur in this watershed.

Staff concluded that pet waste in areas that do not drain to MS4s, was a source of pathogens that can be controlled and is proposing additional actions in Section 10 *Implementation Plan*.

4.1.1.c. County of Santa Cruz Sanitary Sewer Collection System Spills and Leaks

Water Board staff concluded that sanitary sewer collection system spills (sewer line overflows) and leaks contributed pathogens to surface waters in the Aptos Creek watershed. Sewage spills can occur when roots, grease buildup, hair, or other debris block sewer lines. Wastewater can leak from cracked lines or lines with faulty connections. Rainfall and groundwater infiltration into lines with these conditions contribute to sewer system overflow (or spills) during the wet season. Infiltration can result in a greater amount of flow than the line and connected pump stations were designed to handle. The entry of rainwater into the system through illicit openings (inflow) can produce the same result. When sewer lines are blocked or leaking, sewage may run onto the street, into gutters, and into storm drains. Conversely, sewage exfiltration potential exists in dry seasons. Exfiltration occurs when sewage leaks from lines underground. These types of leaks often go unnoticed and pathogens can be transported to surface waters.

The SCCSD collects wastewater from some areas within the Aptos Creek watershed. Waste water travels in the SCCSD collection system to the Waste Water Treatment Plant in the City of Santa Cruz. Waste Discharge Requirements (WDR; Order No. R3-2005-0043) issued to the SCCSD addresses their collection system. Areas not connected to the SCCSD system have onsite wastewater disposal systems.

Staff requested spill information from the SCCSD from 2000 to 2007. Staff concluded that there were two spills in that time period within the Aptos Creek watershed, both of which occurred in 2007. One was a 200 gallon spill that occurred on April 4, 2007 and did not affect surface waters in the Aptos Creek watershed. The other spill of 28,800 gallons reached Valencia and Aptos Creeks and Monterey Bay on January 16, 2007. Staff determined leaks were also a source than needs to be addressed.

The Proposition 13 Report (2006) stated that,

> Almost 4,700 linear feet of sewer line was video-tested in the Rio del Mar near Aptos Creek. After a review of the logs and videos, Sanitation District staff concluded that, “there are many avenues for high groundwater to enter the sewers and to also flow out of the sewer mains/laterals."

The SCCSD budget included funding a number of sewer rehabilitation projects. Currently, the SCCSD is planning on replacing sections of the sewer main in areas that they have found to be problematic in the Aptos Creek watershed. The Proposition 13 Report stated that,

> …over 2,350 linear feet of line is recommended to be replaced. Funding for the design is included in the 2005-06 budget and the replacement is anticipated to be constructed in 2006-07. Replacement of all the lines and reconnection of the existing laterals is estimated to cost $1,015,000.

Staff reviewed the proposed budget to rehabilitate the collection system for the fiscal years 2005/2006 and 2006/2007. Staff concluded the SCCSD's projects should result in improved water quality. Also, the project to correct the problem resulting in the 28,800 gallon spill is being designed this year and will likely go into construction in 2009 (personal communication, Rachel Lather, Senior Civil Engineer of the SCCSD).

Although staff considered discharge from the sanitary sewer collection system a source, staff considered the actions of the SCCSD to comply with Waste Discharge Requirements. No additional requirements are necessary provided the County continues to rehabilitate sewer lines in need of repair. See Section 10 *Implementation Plan*, for how staff will address the SCCSD.

4.1.1.d. Private Sewer Laterals

Staff found information that private laterals and pump stations connected to the SCCSD were leaking and that some spills occurred. Staff determined it was likely private lateral leaks and spills contributed pathogen indicator organisms to the Creeks in the Aptos Creek watershed. Staff researched spill reports, the California Integrated Water Quality System database, and the results of a televised sewer survey from the SCCSD as a basis for this conclusion. Staff also considered the findings in the Proposition 13 Report and the proximity of private laterals to surface waters.

The SCCSD sewer line television report stated that, "there are many laterals (presumed in use and abandoned) whose invert is below the flow of the sewer main and are undoubtedly a source of infiltration and contamination of the surrounding soil," (SCCSD, 2005). The Proposition 13 Report included an assessment of sewage lines in the Rio del Mar area. The Proposition 13 Report indicated substantial deficiencies of mainlines and private laterals, as staff stated in Section 4.1.1.c. County of Santa Cruz Sanitary Sewer Collection System Spills and Leaks. From the report, staff determined that cracks, roots, sediment buildup, and winter time seepage indicated a high likelihood for sewage to exfiltrate out of the system where it could have entered groundwater and/or the storm drain system.

Spill reports indicated that three lateral spills and one pump station spill were reported from 2000 to present. Staff concluded that this number may not represent an accurate count of the lateral spills in the watershed during this time period. Private lateral spills are often unreported because they are either unnoticed, or repaired but not reported to the County.

Staff concluded there were not enough pump station spills or additional evidence regarding pump stations to require implementation for this source. Also, staff concluded private pump stations are rare within this Watershed.

Water Board staff concluded it was likely that pathogens from this source contributed to the impairment in surface waters of the Aptos Creek watershed. The Implementation Plan in Section 10 *Implementation Plan* recommends methods to minimize this source.

4.1.1.e. Farm Animals and Livestock Discharges

Based on microbial source tracking, field and aerial imagery observation, and information from stakeholders, staff concluded that farm animals and livestock likely contributed pathogen indicator organisms to the Aptos Creek watershed. Staff concluded that microbial source tracking data suggested horses contributed about 1 percent at the mouth of Aptos Creek. Also, on Trout Gulch at Valencia Creek (A11), microbial source tracking suggested horses contributed 1 percent, while at Valencia Creek at Aptos (A1), the percentage increased to 7 percent. Staff determined this was noteworthy because approximately 0.25 mile upstream of site A1 (site A12), no horse input was detected. Staff speculated that the increase in horse input in this short reach may have been from runoff from Freedom Blvd., a road that has horse properties. Although Freedom Blvd. is east of the A1 sampling site, runoff from Freedom Blvd. flows in the direction of the confluence of Aptos and Valencia Creeks.

Staff also observed horses on residential properties in the watershed in addition to various farm animals such as emu, chickens, and goats during field reconnaissance (April, 2006). Additionally, staff observed livestock facilities along Freedom Boulevard in aerial imagery (Google Earth, 2008), and was informed that two boarding facilities are located on this road. Polo grounds also are located within Aptos watershed, adjacent to Valencia Creek. Staff determined farm animals and livestock are likely contributing pathogens to the Creeks. The Implementation Plan in Section 10 *Implementation Plan* addresses this source.

Staff acknowledges the work done by the Santa Cruz County Environmental Health Department. They have had success with improvement of runoff and manure management at many of the larger farm animal/livestock operations throughout the County. Also, a cooperative education and technical assistance project for farm animal/livestock owners is underway as a joint effort between the Santa Cruz County Resource Conservation District, Ecology Action, and the Santa Cruz Horsemen's Association.

4.1.1.e. Other Sources Considered

4.1.1.e.1. Homeless Person/Encampment Discharges not covered by Stormwater Management Plan

Staff discussed homeless persons and encampments in areas covered under the Stormwater Management Plan in Section 4.1.1.a.5 *Human Waste Discharges*. Staff determined homeless persons and encampments in the remaining areas of the watershed, e.g., riparian areas, were not a source of the pathogens to the Creeks. Staff noted that the reach between the confluence of Aptos and Valencia Creeks and the channelized lagoon area was less than 0.25 mile in length. In the channelized lagoon area, the water is frequently bank to bank. Staff did not suspect homeless persons use this area, nor did they see evidence of use in this area, or the less-than 0.25 mile reach upstream of the lagoon. Also, County Health Officials who sample in this area have not found evidence of homeless (personal communication, Steve Peters, Water Quality Specialist, Health Services Agency, County of Santa Cruz, October 9, 2007).

Water Board staff and County Health Officials also do not have evidence of homeless in areas upstream of the confluence. However, there were homeless persons within Nisene Marks State Park. Supervising Ranger, Bill Wolcott, said they patrol the park daily to address any homeless persons, as time allows (personal communication, September 17, 2007). Staff determined that homeless persons within the Park were being sufficiently managed and that water quality will not suffer as a result. Staff concluded that water quality data supported this conclusion and that additional measures to control this source are not necessary in this reach of Aptos Creek.

4.1.1.e.2. Onsite Wastewater Disposal System Discharges

Staff did not consider onsite wastewater disposal systems (OWDSs) to be a contributing source of pathogens to surface waters in the Aptos Creek watershed. There was no human contribution at any of the source tracking sites, except for Aptos Creek at the Mouth (A0). Staff concluded that if the pathogen contribution from OWDSs were contributing to the impairment, the ribotyping data would likely have shown some human contribution at any of the four upstream sites, or there would be additional information that would lead staff to conclude septic systems were failing and contributing to impaired water quality.

Staff questioned Santa Cruz County Environmental Health Services Water Resources Division Director, John Ricker, who said he did not know of any septic problems in the Aptos Creek Watershed.

Water Board staff researched the soil mapping units (identified in the USDA Soil Survey for Santa Cruz County, California, 1980) in which septic systems were located in the Watershed. Staff found that in some areas near the Creeks soils were unsuitable for septic system leachfields either due to slow permeability or steepness of slope. Staff plans further research into septic systems in these areas as staff resources allow.

Additionally, Water Board staff is in the process of developing revisions to existing Basin Plan criteria for onsite wastewater systems. The proposed criteria include recommendations and requirements for proper siting, design, maintenance and management of onsite wastewater systems. The proposed Basin Plan revisions also will require municipalities to develop onsite wastewater management plans (which the current criteria only recommend). In addition Water Board staff is in the process of developing a waiver of waste discharge requirements for owners of onsite wastewater systems that will ensure proper siting, design, maintenance and management. All owners of new onsite wastewater systems will have to enroll in the waiver if they plan to operate in areas without onsite wastewater management plans approved by the Executive Officer. Local permitting agencies will be required to characterize and address water quality impacts from existing onsite wastewater systems in management plans.

4.1.2. NATURAL SOURCES - WASTE DISCHARGES NOT SUBJECT TO REGULATION BY THE CENTRAL COAST WATER BOARD

Staff determined that ribotyping data indicated that birds and other wildlife contributed to fecal coliform loading in the Aptos Creek Watershed. Birds made up between 40 percent and 62 percent, wildlife contributed between seven percent and 19 percent, and rodents contributed between seven percent and 17 percent of the isolates identified by ribotyping. A direct one-to-one transfer from the percent of identified isolates to the percent of total contribution could not be made with the ribotyping data. However, the ribotyping results did suggest that wildlife contributions could have been significant. Furthermore, conversations with County staff (personal communication, Steve Peters, Water Quality Specialist, Health Services Agency, County of Santa Cruz, several conversations in 2006), and Water Board staff observations of the Watershed also lead staff to conclude that wildlife contributions may have been significant.

Therefore, staff distinguished "natural sources" from "controllable" wildlife sources. Controllable sources were those caused or influenced by human activity, such as littering or leaving trash receptacles accessible to wildlife. Another controllable source was the entrance of wildlife fecal matter into storm drains through wash water. Staff discussed controllable wildlife sources above (Section 4.1.1.a. *Storm Drain Discharges to Municipally Owned And Operated Storm Sewer Systems (MS4s) Required to be Covered by an NPDES Permit*), and included measures to minimize their contribution to pathogen loading in the Implementation Plan in Section 10 *Implementation Plan*.

4.2. Source Analysis Conclusions

Staff estimated the relative order of controllable pathogen indicator organism sources for the impaired surface waters of Aptos Creek Watershed, beginning with the largest source first. The relative order is a staff estimate only. Staff noted that there are uncertainties associated with such estimates. For example, staff cannot be certain of the magnitude and location of private lateral leaks.

Staff estimated the relative order of controllable sources as follows (1) storm drain discharges to MS4s; (2) pet waste in areas that do not drain to MS4s; (3) County of Santa Cruz sanitary sewer collection system spills and leaks; (4) private sewer laterals; and (5) farm animals and livestock discharges. The order was based on the information in Sections 3 and 4 of this report. As stated previously, staff used water quality data, discharger data and reports, flow estimates, land use data, ribotyping results, field reconnaissance work, and conversations with County staff and stakeholders to complete the source analysis conclusions. Staff explained the rationale for the relative order of pathogen indicator organism sources below.

1. Storm Drain Discharges to MS4s

Staff estimated storm drain discharges were the largest controllable source of pathogen indicator organisms because storm drain discharges resulted from all land uses within the Stormwater Management Plan coverage area. They can contain controllable bird, wildlife, and rodent waste; pet waste; dumpster leachate; private lateral leaks; and homeless encampment discharges.

2. Pet Waste in Areas That Do Not Drain to MS4s

Staff estimated that Pet waste in areas that do not drain to MS4s was the second largest pathogen indicator organism contributor. Dogs were one of the most prevalent sources in the ribotyping analysis. Also, according to Santa Cruz County staff, pet waste was observed in the Valencia Creek Bed during dry periods. Because riparian areas were attractive dog walking areas, dog waste was observed there, and the riparian areas were directly connected to the Creeks, staff concluded that dog waste was a large source of pathogen indicator organisms to this watershed.

3. County of Santa Cruz Sanitary Sewer Collection System Spills and Leaks

As indicated in Section 4.1.1.c. *Sanitary Sewer Collection System Spills and Leaks*, staff concluded that spills and leaks from the collection system contributed pathogens to surface waters in this watershed. However, it was difficult for staff to distinguish between the severity of the contributions from this source and pets. Table 6 indicated the human waste contribution was not as large as the other sources such as dogs. Although the contribution from the sanitary sewer spill (January 16, 2007) was high in volume, staff concluded leaks from the sanitary system were intermittent and indirect compared to the common activity of pets defecating directly in or near the creek beds, or in other areas that do not drain to MS4s.

4. Private Sewer Laterals

Staff determined private sewer lateral leaks were almost as large a contributor as the Sanitary Sewer System itself because private laterals were experiencing what staff concluded as just as many problems as the sewer. However, staff assumed there was less sewer line devoted to laterals than to the sewer main lines, and the volume of wastewater through each lateral was lower than the volume of wastewater flowing through a sewer main line.

5. Farm Animals and Livestock Discharges

Staff estimated farm animals and livestock contributed the least to the impaired waters of this watershed. Low intensity residential lands were the second largest land use in this watershed (Figure 3) and staff concluded many landowners had horses and other farm animals on this type of land use. Although this land use was second largest, staff concluded the animals in this land use did not cover the entire land use area and they were not always in areas upstream of impaired waters, and were also not always located in proximity to a Creek. Whereas, staff knew that sewage spills were transported to surface waters and knew that collection system lines were leaking in proximity to surface waters.

4.3. Comparison with Sources in Other Pathogen Impaired Waters

The purpose of this section is to describe how sources from the Aptos Creek watershed compared with sources identified in other TMDL Project Reports. Staff compared this watershed's pathogen sources with similar sources identified in the San Lorenzo River Watershed TMDL project report.

Storm Drain Discharges to MS4s: The San Lorenzo River Watershed Pathogen TMDL project report also indicated stormwater contributed pathogens to surface waters.

Pet Waste in Areas That Do Not Drain to MS4s: The San Lorenzo River Watershed Pathogen TMDL project report also indicated pet waste in areas that do not drain to MS4s contributed pathogens to surface waters.

County of Santa Cruz Sanitary Sewer Collection System Spills and Leaks: The San Lorenzo River Watershed Pathogen TMDL project report identified the municipal collection systems as a source of pathogens in the San Lorenzo River Watershed. This Project Report includes similar results.

Private Sewer Laterals: The San Lorenzo River Watershed Pathogen TMDL project report identified private sewer laterals as a source of pathogens in the San Lorenzo River watershed. This Project Report includes similar results.

Farm Animals and Livestock Discharges: The San Lorenzo River Watershed Pathogen TMDL project report also indicated farm animals and livestock discharges contributed pathogens to surface waters.

5. CRITICAL CONDITIONS AND SEASONAL VARIATION

This section discusses factors affecting impairment, critical conditions, and seasonal pathogen indicator organism variations.

5.1. Critical Conditions and Uncertainties

The critical conditions of impairment occur when fecal coliform levels rise above a log mean of 200 MPN/100mL. This level is used because it is the water quality objective that gauges the protection of the water contact recreation beneficial use (see Section 1.4). Exceedance of this water quality objective is considered critical (for this analysis) when:

1. A prolonged exceedance of the objective occurs.
2. When the exceedance is consistent throughout one or more seasons.

Exceedance of the water quality objective is usually measured by calculating the log mean of sample data from a monitoring site. A log mean is used because pathogen indicator organism levels can be highly variable, subject to plumes of fecal contamination resulting in high levels for a short duration. The log mean reduces the sensitivity to outliers or unusually high concentrations.

Staff concluded there are several uncertainties with pathogens. Stream flows may serve to either increase or dilute pathogen indicator organism concentrations. Stagnant pools may be areas where pathogen indicator organism concentrations fluctuate due to evaporation. Increased stream flows may dilute fecal coliform concentrations.

Staff determined that another uncertainty was the limited information available to develop relative contributions. In other words, staff concluded that both “controllable” and “non-controllable” sources were contributing fecal input into the waterbodies. However, staff was uncertain about the “load” that each of these sources was contributing.

5.2. Seasonal Variations

Staff analyzed pathogen indicator organism data in the Aptos Creek watershed and found slightly higher levels of pathogen indicator organisms during the summer months at most of the sites, but, there was not enough data to conclude this with certainty or statistical significance. Genetic testing also did not include enough wet season samples for staff to make a conclusion whether certain sources were contributing more during either season. Therefore, staff did not adjust load allocations and numeric targets to account for critical conditions.

5.3. Conclusion

Although the Aptos Creek watershed Waters were impaired (as described in section 3.4 *Data Analysis and Impaired Reaches Conclusions*), staff concluded there were no critical condition considerations. Therefore, staff did not adjust load allocations and numeric targets to account for critical conditions. The numeric targets provided in Section 6 apply to both wet and dry weather.

6. NUMERIC TARGETS

The Basin Plan contains fecal coliform water quality objectives. These water quality objectives are in place to protect the water contact recreational beneficial use.

The numeric target used to develop the TMDLs for Aptos Creek, Valencia Creek, and Trout Gulch was:

> Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL.

Natural non-controllable sources are a contributor of pathogen indicator organisms in the Aptos Creek Watershed. Some doubt exists whether the non-controllable fraction of pathogen indicator organisms alone are causing receiving water concentration of pathogen indicator organisms to exceed the numeric target. However, there is evidence that non-controllable sources alone may not cause receiving water concentration to exceed the numeric target, i.e., that the numeric target can be achieved by managing controllable sources of pathogen indicator organisms. For example, Waddell[2] and Scott's Creeks[3] are coastal streams with lagoons. Both Waddell and Scott's Creeks, as well as their lagoons, carry pathogen indicator organism concentrations that achieve the geometric mean value of the numeric target. Single samples from these water bodies have exceeded the numeric target, but again, the monthly geometric mean achieves the numeric target. Staff, therefore, concludes that the potential exists to achieve the numeric targets by managing the controllable fraction of pathogen indicator organisms in the impaired waters of the Aptos Creek Watershed. Staff acknowledges that Aptos Creek is a waterbody heavily influenced by urban sources of pathogen indicator organisms, whereas Waddell and Scott's Creek are much less developed with less human presence in their watersheds. Therefore, staff offers the above example as more of an indirect comparison, showing concentrations of pathogen indicator organisms that more "natural"

[2] Waddell Creek is located in the Redwood Belt of the Santa Cruz Mountains. The California Big Basin State Park occupies approximately 85% of the Waddell Creek watershed. The lower watershed is comprised of developed open space with a ranger/nature station at the bottom.

[3] Scott's Creek is also located in the Santa Cruz Mountains. The watershed is very rural with a small number of humans in residence. Low intensity timber harvesting, row-crop farming, and cattle ranching are practiced in a sustainable fashion.

waterbodies may exhibit in this area, and not to show a direct comparison to other urban waterbodies that are achieving numeric targets.

In the event that the numeric target cannot be achieved through management of controllable sources, staff will consider other regulatory options; please see the discussion in the TMDL and Allocations section.

7. LINKAGE ANALYSIS

The goal of the linkage analysis is to establish a link between pollutant loads and water quality. This, in turn, supports that the loading capacity specified in the TMDL will result in attaining the numeric targets. For these TMDLs, staff determined this link is established because the numeric target concentrations are the same as the TMDLs, expressed as a concentration. Staff identified sources of pathogen indicator organisms that caused the elevated concentrations of pathogen indicator organisms in the receiving water body. Therefore, staff concluded reductions in pathogen indicator organism loading from these sources should cause a reduction in the measured pathogen indicator organism concentrations. The numeric targets are protective of the recreational beneficial use. Hence, staff concluded the TMDLs define appropriate water quality.

8. TMDL CALCULATIONS AND ALLOCATIONS

A TMDL is the pollutant loading capacity that a water body can accept while protecting beneficial uses. Usually, TMDLs are expressed as loads (mass of pollutant calculated from concentration multiplied by the volumetric flow rate), but in the case of pathogens, it is more logical for TMDLs to be based on concentration. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure [40 CFR §130.2(I)]. Concentration based TMDLs make more sense in this situation because the public health risks associated with recreating in contaminated waters scales with organism concentration, and pathogens are not readily controlled on a mass basis. Therefore, staff established concentration-based TMDLs for pathogens in Aptos Creek, Valencia Creek, and Trout Gulch.

Staff proposes the TMDLs as the same set of concentrations as staff proposed in the numeric targets section. The TMDLs for all impaired waters of Aptos Creek, Valencia Creek, and Trout Gulch are concentration based TMDLs applicable to each day of all seasons and are equal to the following:

> Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL.

8.1. Proposed Wasteload and Load Allocations

The wasteload and load allocations are receiving water concentrations (Table 7). Responsible parties can not cause pathogen indicator organism (e.g. fecal coliform) concentration to exceed the allocations in the receiving water body.

The wasteload and load allocations are applicable to all responsible parties. For all sources not containing human fecal material the wasteload and load allocation is:

Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL.

For all sources containing human fecal material the wasteload and load allocation is

Fecal coliform concentration shall not exceed zero MPN per 100mL.

All responsible parties for sources of pathogens to the impaired waters of Aptos Creek watershed will be accountable to attain these allocations. The parties responsible for the allocations to non-natural (controllable) sources are not responsible for the allocation to natural (uncontrollable) sources.

Table 7. Allocations and Responsible Parties

WASTE LOAD ALLOCATIONS		Receiving Water Fecal Coliform (MPN/100mL)
Waterbody	**Responsible Party (Source)**	
Aptos Creek[1], Trout Gulch[2], Valencia Creek[3]	Santa Cruz County (Storm drain discharges to municipally owned and operated separate storm sewer systems (MS4s) required to be covered by an NPDES permit)	Allocation 1
Aptos Creek[1], Trout Gulch[2], Valencia Creek[3]	Santa Cruz County Sanitation District (Sanitary sewer collection system spills and leaks)	Allocation 0
Aptos Creek[1], Trout Gulch[2], Valencia Creek[3]	Owners of private sewer laterals (Private laterals connected to municipal sanitary sewer collection system)	Allocation 0
LOAD ALLOCATIONS		**Receiving Water Fecal Coliform (MPN/100mL)**
Waterbody	**Responsible Party (Source)**	
Aptos Creek[1], Trout Gulch[2], Valencia Creek[3]	Owners/Operators of land used for/containing pets (Domestic animals not regulated by WQ Order No. 2003-0005-DWQ [Storm Water General Permit]. Including but not limited to dogs, cats, or any other animals in the care of owners/operators)	Allocation 1
Aptos Creek[1], Trout Gulch[2], Valencia Creek[3]	Owners/Operators of land used for/containing farm animals and livestock (Domestic animals not regulated by WQ Order No. 2003-0005-DWQ [Storm Water General Permit]. Including, but not limited to, farm animals, livestock in the care of owners/operators)	Allocation 1
Aptos Creek[1], Trout Gulch[2], Valencia Creek[3]	Natural sources	Allocation 1

[1] Aptos Creek from the Pacific Ocean to the confluence of Aptos and Valencia Creeks
[2] All reaches of Trout Gulch
[3] Valencia Creek from the confluence with Aptos Creek upstream to the west fork, where it intersects with Valencia Road, and to the east fork at the intersection of McKay and Cox Roads.

Allocation 1: Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN/100mL, nor shall more than ten percent of total samples during any 30-day period exceed 400 MPN/100 mL.

Allocation 0: Allocation of zero; no loading allowed from this source.

Should all control measures be in place, pathogen indicator organism concentrations remain high, and a TMDL not be met, staff may investigate (e.g., genetic studies to isolate sources or other appropriate monitoring) to determine if the high level of indicator organisms is due to uncontrollable sources. Responsible parties may demonstrate that controllable sources of pathogen indicator organisms are not contributing to exceedance

of water quality objectives in receiving waters. If this is the case, staff may consider re-evaluating the numeric targets and allocations. For example, staff may propose a site-specific objective to be approved by the Central Coast Water Board. The site-specific objective may be based on evidence that natural or background sources alone were the cause of exceedances of a TMDL.

8.2. Margin of Safety

The TMDL requires a margin of safety component that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water (CWA 303(d)(1)(C)). For pathogens in Aptos Creek, Trout Gulch, and Valencia Creek, a margin of safety has been established implicitly through the use of protective numeric targets, which are the water quality objectives/criteria for the Aptos Creek watershed's beneficial uses.

The pathogen TMDLs for the impaired waters of the Aptos Creek watershed are the Basin Plan water quality objective for fecal coliform for water contact recreation. The Basin Plan states that, "controllable water quality shall conform to the water quality objectives..." When other conditions cause degradation of water quality beyond the levels or limits established as water quality objectives, controllable conditions shall not cause further degradation of water quality" (Basin Plan, p. III-2). Because the allocation for controllable sources is set at the water quality objective, if achieved, these allocations will by definition contribute as much as possible to achieving the water quality objectives in the receiving water. Thus, in these TMDLs there is no uncertainty that controlling the load from controlled sources will positively affect water quality by reducing the pathogen indicator organism contribution.

However, in certain locations there is a possibility that non-controllable, or natural sources, will themselves occur at levels exceeding water quality objectives. And while it is controllable water quality conditions ("actions or circumstances resulting from man's activities" (Basin Plan, p. III-2)) that must conform to water quality objectives, receiving water quality will contain discharge from both controllable and natural sources.

The ability to differentiate the controlled from the natural sources is the chief uncertainty in these TMDLs. The ribotyping method used for this report is one of the best methods available, but it is not 100 percent accurate. This ribotyping method results in greater variability of false positive rates among genotypic library-based methods, with incorrect classification ranging from 25-75 percent (John F. Griffith, Stephen B. Weisberg, Charles D. McGee 2003).

Additionally, these data, which confirmed the presence of natural sources, do not estimate loads; they only provide the relative percent of samples that indicated a type of source. Reporting and monitoring will indicate whether the allocations from controllable sources are met, thereby minimizing any uncertainty about the impacts of loads on the water quality.

9. PUBLIC PARTICIPATION

Public participation began when the County developed a report required by Proposition 13 Grant Funds. The grant required a Technical Advisory Committee to meet periodically.

Central Coast Water Board staff presented the TMDL project report at two meetings. Staff solicited comments at both meetings. One meeting was held during the early phase of Central Coast Water Board TMDL project development on November 16, 2005. At the second meeting, on June 26, 2006, staff presented preliminary project report findings. Staff incorporated public comments into this report where appropriate. Staff also scoped issues pursuant to the California Environmental Quality Act at this meeting. Staff prepared environmental documents indicating any potential environmental impacts and considered alternative allocations schemes and implementation strategies prior to soliciting formal public comments on these TMDLs and implementation plans.

Central Coast Water Board staff solicited public comments before the Central Coast Water Board public hearing to consider adoption of Aptos Creek watershed TMDLs. Staff received comments from:
1. Teri Caddell, A-1 Septic Service, Inc. in a letter dated December 6, 2007, and
2. John Ricker, Water Resources Division Director, Santa Cruz County Environmental Health Services, in an email dated January 23, 2008. Comments from the abovementioned individual/agencies are included as Attachment 7 to the staff report. Some comments resulted in changes to the Project Report and are noted in Attachment 7.

On March 21, 2008 in Salinas, California, the Central Coast Water Board held a public hearing and heard and considered all public comments and evidence in the record regarding these TMDLs and Implementation plan. The TMDLs and implementation plan were amendments included in resolution no. R3-2008-0003. The Central Coast Water Board also adopted resolution no. R3-2008-0003 on March 21, 2008.

On November 6, 2008, the Central Coast Water Board's Executive Officer withdrew resolution no. R3-2008-0003 from consideration for adoption by the State Water Resources Control Board. The Executive Officer withdrew the resolution for consideration due to State Board staff's request to clarify language regarding the amendments before submittal to the State Water Resources Control Board for approval. The clarifications included changing the allocations to human sources to zero, clarifying and simplifying the prohibition language and changing some of the nonpoint sources to point sources.

On May 8, 2009 in San Luis Obispo, California, the Central Coast Water Board held a public hearing and heard and considered all public comments and evidence in the record.

10. IMPLEMENTATION PLAN

The purpose of the Implementation Plan is to describe the steps necessary to reduce pathogen loads and to achieve the TMDLs. The Implementation Plan identifies the following: 1) actions expected to reduce pathogen loading; 2) parties responsible for taking these actions; 3) regulatory mechanisms by which the Central Coast Water Board will assure these actions are taken; 4) reporting and evaluation requirements that will indicate progress toward completing the actions; and 5) a timeline for completion of implementation actions. A monitoring plan designed to measure progress toward water quality goals is included in the following section.

Local agencies and landowners already implemented many corrective actions that resulted in improved water quality in this watershed. This report provides some additional measures local agencies and landowners can use to continue the water quality improvement efforts already begun.

Recall from Section 1.5 Waste Discharge Prohibition that staff is proposing to address specific types of nonpoint sources of pollution in the Aptos Creek Watershed by adding the Watershed as a named area subject to two proposed nonpoint source pollution prohibitions: (1) the Human Fecal Material Discharge Prohibition and (2) the Domestic Animal Waste Discharge Prohibition. Also, recall that these two prohibitions will be proposed as amendments to the Basin Plan with the TMDLs for the Pajaro River Watershed at the March 20, 2009 Board Meeting (see Resolution No. RB3-2009-0008). Some of the required implementation actions described in the following subsections are actions required to demonstrate compliance with the Human Fecal Material Discharge Prohibition and the Domestic Animal Waste Discharge Prohibition.

10.1. Implementation Actions

Staff discusses the proposed actions necessary for the Aptos Creek watershed impaired surface waters to attain pathogen indicator organism water quality standards in this section. The actions are presented with the sources of pathogen indicator organisms to the Aptos Creek watershed.

10.1.1. Storm Drain Discharges

The Central Coast Water Board will address fecal indicator bacteria (FIB), e.g. fecal coliform and/or other indicators of pathogens, discharged from the County of Santa Cruz' municipal separate storm sewer system (MS4) by regulating the MS4 under the provisions of the State Water Resource Control Board's General Permit for the Discharges of Storm Water from Small Municipal Separate Storm Sewer Systems (General Permit) (NPDES No. CAS000004). As an enrollee under the General Permit, the MS4 must develop and implement a Storm Water Management Plan (SWMP) that controls urban runoff discharges into and from its MS4. To address the MS4s TMDL wasteload allocations, the Central Coast Water Board will require the MS4 to specifically

target FIB in urban runoff through incorporation of a Wasteload Allocation Attainment Plan in its SWMPs.

The Central Coast Water Board will require the Wasteload Allocation Attainment Plan to include descriptions of the actions that will be taken by the MS4 to attain the TMDL wasteload allocations, and specifically address:

1. Development of an implementation and assessment strategy;
2. Source identification and prioritization;
3. Best management practice identification, prioritization, implementation schedule, analysis, and effectiveness assessment;
4. Monitoring program development and implementation;
5. Reporting; including evaluation whether current best management practices are progressing towards achieving the wasteload allocations within thirteen years of the date that the TMDLs are approved by the Office of Administrative Law.
6. Coordination with stakeholders; and
7. Other pertinent factors.

The Wasteload Allocation Attainment Plan will be required by the Central Coast Water Board to address each of these TMDLs that occur within the MS4 entities' jurisdictions.

The Central Coast Water Board will require the Wasteload Allocation Attainment Plan to be submitted at one of the following milestones, whichever occurs first:

1. Within one year of approval of the TMDLs by the Office of Administrative Law;
2. When required by any other Water Board-issued storm water requirements (e.g., when the Phase II Municipal Storm Water Permit is renewed).

For an MS4 that is enrolled under the General Permit at the time of Wasteload Allocation Attainment Plan submittal, the Wasteload Allocation Attainment Plan must be incorporated into the SWMPs when they are submitted. For an MS4 that is not enrolled under the General Permit at the time of Wasteload Allocation Attainment Plan submittal, the Wasteload Allocation Attainment Plan must be incorporated into the SWMP when the SWMP is approved by the Central Coast Water Board.

The Executive Officer or the Central Coast Water Board will require information that demonstrates implementation of the actions described above, pursuant to applicable sections of the California Water Code and/or pursuant to authorities provided in the General Permit for storm water discharges.

10.1.2. Domestic Animal Discharges Not Regulated by WQ Order No. 2003-0005-DWQ [Storm Water General Permit]

Owners and/or operators of lands containing domestic animals (including pets, farm animals, and livestock) in the Aptos Creek Watershed must comply with the Domestic

Animal Waste Discharge Prohibition; compliance with the Domestic Animal Waste Discharge Prohibition implies compliance with the load allocation for these TMDLs.

Within three years of approval of these TMDLs by the Office of Administrative Law, the Executive Officer will notify owners and/or operators of lands used for/containing domestic animals of the requirement to comply with the Domestic Animal Waste Discharge Prohibition. In his notification, the Executive Officer will also describe the owner's/operator's of lands containing domestic animals options for demonstrating compliance with the Domestic Animal Waste Discharge Prohibition; pursuant to California Water Code section 13267 and within six months of the notification by the Executive Officer, owners/operators of lands containing domestic animals will be required to submit the following for approval by the Executive Officer or the Water Board:

1) Clear evidence that the owner/operator of lands containing domestic animals is and will continue to be in compliance with the Domestic Animal Waste Discharge Prohibition; clear evidence could be documentation submitted by the owner/operator to the Executive Officer validating current and continued compliance with the Prohibition, or
2) A plan for compliance with the Domestic Animal Waste Discharge Prohibition. Such a plan must include a list of specific management practices that will be implemented to control discharges containing fecal material from domestic animals. The plan must also describe how implementing the identified management practices are likely to progressively achieve the load allocations to domestic animals, with the ultimate goal achieving the load allocations no later than thirteen years after Office of Administrative Law approval of these TMDLs. The plan must include monitoring and reporting to the Central Coast Water Board, demonstrating the progressive progress towards achieving load allocations for discharges from domestic animals, and a self-assessment of this progress. The plan may be developed by an individual discharger or by or for a coalition of dischargers in cooperation with a third-party representative, organization, or government agency acting as the agents of owners/operators of lands containing domestic animals, or
3) Submittal of a Report of Waste Discharge pursuant to California Water Code Section 13260 (as an application for waste discharge requirements; WDRs or National Pollutant Discharge Elimination System (NPDES permit)).

10.1.3. County of Santa Cruz Sanitary Sewer Collection System Spills and Leaks

Entities with jurisdiction over sewer collection systems in the Aptos Creek Watershed must comply with the Human Fecal Material Discharge Prohibition; compliance with the Human Fecal Material Discharge Prohibition implies compliance with their load allocation for these TMDLs.

To comply with the Human Fecal Material Discharge Prohibition, the Santa Cruz County Sanitation District (SCCSD) must continue to implement its Collection System Management Plan, as required by Waste Discharge Requirements (WDRs) (Order No. R3-2005-0043).

Staff will continue to assess the effectiveness of the SCCSD Collection System Management Plan. Staff will utilize annual reporting associated with the SCCSD WDR, and other information, to make this assessment. Within one year following adoption of these TMDLs by the Office of Administrative Law, the Executive Officer will evaluate the annual reporting associated with the SCCSD WDR to determine compliance with the requirement to prevent spills and leaks and corresponding compliance with the Human Fecal Material Discharge Prohibition. If necessary, the Executive Officer or the Central Coast Water Board will require modifications to the Collection System Management Plan (e.g. through revisions of WDRs) and/or require actions pursuant to applicable sections of the California Water Code to ensure compliance with the Human Fecal Material Discharge Prohibition.

Within one year following approval of these TMDLs by the California Office of Administrative Law, the Executive Officer or the Central Coast Water Board will amend the Monitoring and Reporting Program of the SCCSDs WDRs to incorporate stream monitoring for fecal coliform and reporting of such stream monitoring activities.

10.1.4. Private Sewer Lateral Discharges

Individual owners and operators of private laterals to sanitary sewer collection systems are ultimately responsible for maintenance of their private laterals and are, therefore, responsible for complying with the Human Fecal Material Discharge Prohibition; compliance with the Human Fecal Material Discharge Prohibition implies compliance with their load allocation for these TMDLs.

Within three years of approval of these TMDLs by the Office of Administrative Law, the Executive Officer will notify owners and/or operators of private laterals to sanitary sewer collection systems (owners/operators of private laterals) of the requirement to comply with the Human Fecal Material Discharge Prohibition. In his notification, the Executive Officer will also describe the owner's/operator's of private laterals options for demonstrating compliance with the Human Fecal Material Discharge Prohibition; pursuant to California Water Code section 13267 and within six months of the notification by the Executive Officer, owners/operators of private laterals will be required to submit the following for approval by the Executive Officer or the Water Board:

1) Clear evidence that the owner/operator of private lateral is and will continue to be in compliance with the Human Fecal Material Discharge Prohibition; clear evidence could be certification by a sanitary collection system jurisdiction that owner/operator of private lateral is in compliance with the Human Fecal Material Discharge Prohibition, or
2) A schedule for compliance with the Human Fecal Material Discharge Prohibition. The compliance schedule must include a monitoring and reporting program and

milestone dates demonstrating progress towards compliance with the Human Fecal Material Discharge Prohibition, with the ultimate milestone being compliance with the Human Fecal Material Discharge Prohibition no later than three years from the date of the Executive Officer's notification to the owner/operator requiring compliance, or

3) Submittal of a Report of Waste Discharge pursuant to California Water Code Section 13260 (as an application for waste discharge requirements; WDRs or National Pollutant Discharge Elimination System (NPDES permit)), or
4) Clear evidence of current or scheduled compliance with the Human Fecal Material Discharge Prohibition (as described in number-1 and number-2 above, respectively) through the submittal of the required information by a sanitary collection system jurisdiction, acting as the voluntary agents of owners/operators of private laterals. Note that an owner/operator of a private lateral cannot demonstrate compliance with the Human Fecal Material Discharge Prohibition through this option if: 1) a sanitary collection system jurisdiction is not their voluntary agent, or 2) if the owner/operator of the private lateral does not choose the sanitary collection system jurisdiction as their agent, or, 3) the Executive Officer or Water Board does not approve the evidence submitted by the sanitary collection system jurisdictions on behalf of the owners/operators of private laterals.

10.2. Evaluation of Implementation Progress

Every three years, beginning three years after the Office of Administrative Law approves the TMDLs, the Central Coast Water Board will perform a review of implementation actions, monitoring results, and evaluations submitted by responsible parties of their progress towards achieving their allocations. The Central Coast Water Board will use annual reports, nonpoint source pollution control implementation programs, evaluations submitted by responsible parties, and other available information to determine progress toward implementing required actions and achieving the allocations and the numeric target.

Responsible parties will continue monitoring and reporting according to this plan for at least three years, at which time the Central Coast Water Board will determine the need for continuing or otherwise modifying the monitoring requirements. Responsible parties may also demonstrate that although water quality objectives are not being achieved in receiving waters, controllable sources of pathogens are not contributing to the exceedance. If this is the case, the Central Coast Water Board may re-evaluate the numeric target and allocations. For example, the Central Coast Water Board may pursue and approve a site-specific objective. The site-specific objective would be based on evidence that natural, or background sources alone were the cause of exceedances of the Basin Plan water quality objective for fecal indicator bacteria.

Three-year reviews will continue until the water quality objectives are achieved. The compliance schedule for achieving the allocations and numeric target required under these TMDLs is 13 years after the date of approval by the Office of Administrative Law.

10.3. Timeline and Milestones

Staff anticipates that the allocations, and therefore these TMDLs, will be achieved thirteen years from the date the TMDLs become effective (which is upon approval by the California Office Administrative Law). This estimation is in part based on the difficulty of identifying responsible parties of nonpoint sources, and their inexperience with complying with the Aptos-Soquel prohibition. The estimation is also based on the uncertainty of the time required for in-stream water quality improvements resulting from management practices to be realized. Staff anticipates that the full in-stream positive effect of all the management measures will be realized gradually.

Stormwater permits or nonpoint source implementation programs may include additional provisions that the Central Coast Water Board determines are necessary to control pollutants (CWA section 402(p)(3)(B)(iii)). The Central Coast Water Board will consider additional requirements if implementation of management practices do not result in achievement of water quality objectives.

10.4. Economic Considerations

Overview

Porter-Cologne requires that the Central Coast Water Board take economic considerations, into account when requiring pollution control requirements (Public Resources Code, Section 21159 (a)(3)(c)). The Central Coast Water Board must analyze what methods are available to achieve compliance and the costs of those methods.

Staff identified a variety of costs associated with implementation of these TMDLs. Costs fall into four broad categories: 1) planning or program development actions (e.g., establishing nonpoint source implementation programs, conducting assessments, etc.); 2) implementation of management practices for permanent to semi-permanent features; and 3) TMDL inspections/monitoring; and 4) reporting costs.

Anticipating costs with any accuracy is challenging for staff for several reasons. Many of the actions, such as review and revision of policies and ordinances by a governmental agency, could incur no significant costs beyond the program budgets of those agencies. However, other actions, such as establishing nonpoint source implementation programs and establishing assessment workplans carry discrete costs. Cost estimates are further complicated by the fact that some implementation actions are necessitated by other regulatory requirements (e.g., Phase II Stormwater) or are actions anticipated regardless of adoption of these TMDLs. Therefore assigning all of these costs to TMDL implementation would be inaccurate.

Cost Estimates

Storm Drain Discharges

The State Water Resources Control Board adopted an NPDES General Permit for stormwater discharge. The General Permit requires smaller State municipal dischargers, such as the County of Santa Cruz, to develop and implement a Stormwater Management Plan (SWMP). As of the date of writing this report, the County has submitted a SWMP for the Central Coast Water Board's approval. The Central Coast Water Board has not approved the SWMP for the County of Santa Cruz.

Staff notes that the County has a difficult time collecting costs for the SWMP from individual property owners, and could require a proposition 218 vote. This may impose a financial hardship upon the County.

Note: Because the County of Santa Cruz is required to develop a SWMP independent of the TMDL, the below costs would be incurred regardless of the implementation requirements in this project report.

Planning or Program Development Actions: Central Coast Water Board staff estimate no significant costs beyond the local agency program budget.

Implementation:
To implement the requirements of the TMDL, the Central Coast Water Board may ask local agencies to develop additional management measures for pathogen reduction; identify measurable goals and time schedules for implementation; develop a monitoring program; and assign responsibility for each task. The specifics of the stormwater program efforts will not be known until Central Coast Water Board adoption of the SWMP occurs. An estimate of the stormwater program efforts and their associated costs are provided below.

The University of Southern California conducted a survey of NPDES Phase I Stormwater Costs in 2005 (Center for Sustainable Cities, University of Southern California, 2005). They determined the annual cost per California household ranged from $18 to $46. However, these costs were just to keep the existing plan running and did not include start-up costs which may increase the total cost per household. According to Central Coast Water Board Stormwater Unit staff, recently approved Phase II SWMPs in Region 3 ranged from $21 to $130 per household. Stormwater Unit staff reported that the wide range of costs in both cases was based on many factors including the amount of revenue generated by the municipality, the size of the area covered by the SWMP, and because some municipalities did not include the cost of programs such as street sweeping that are already accounted for in other program budgets, while other municipalities did include this cost.

It was difficult for staff to estimate the cost of a SWMP for the above reasons. To get a rough idea of how much a SWMP program would cost in the Aptos Creek watershed, staff calculated an average annual cost from the range of costs for recently approved Phase II SWMPs in Region 3 ($21 in Seaside to $130 in the City of Monterey). Staff calculated an average annual cost of $77 per household. Staff used this cost per household to estimate the cost per year of SWMP implementation in the County of Santa Cruz.

> Aptos Creek watershed: 9,374 (population) (http://www.city-data.com/housing/houses-Aptos-California.html , June 8, 2007) ÷ 2.3 (persons per household) (http://www.city-data.com/city/Aptos-California.html) x $77 (cost per household per year) = $313,825 (total cost per year)

The County is required to develop and implement a SWMP for this watershed independently of the Basin Plan amendment. Since this is an existing requirement under Phase II of the stormwater program, no additional cost is estimated for implementing the existing SWMP. Some additional implementation measures or management programs may be needed for pathogen reductions. The specific measures are not known at this time. However, the California Regional Water Quality Control Board, San Francisco Bay Region's *Pathogens in the Napa River Watershed Total Maximum Daily Load*, June 14, 2006, Marin County estimated additional pathogen-specific measures would result in a 2 to 15 percent increase to their annual program budget. Therefore staff estimates the total cost between the following minimum and maximum ranges:

> Aptos Creek watershed: $313,825 (total cost per year) x 1.02 (percent minimum increase) = $320,102 (total cost per year with 2 percent increase)
>
> $313,825 (total cost per year) x 1.15 (percent maximum increase) = $360,899 (total cost per year with 15 percent increase)

Inspections/Monitoring: Central Coast Water Board staff is proposing the County monitor storm drains. The purpose of the monitoring is to determine the effectiveness of management measures. (The Central Coast Water Board will not impose targets/allocations as effluent limits on the County.)

Central Coast Water Board staff estimated monitoring will cost the County approximately $5,600 per year. According to John Ricker County of Santa Cruz Environmental Health Services, the cost of sampling is $40 for sample collection and field analysis plus $20 for each bacterial sample (personal communication, September 18, 2007), for a total of $60 per sample. Staff proposed the County sample each storm drain 10 times per year. Staff also estimated approximately 6 sample sites will be analyzed per year. Therefore, staff estimated the total water sampling cost per year at approximately $3,600 ($60/sample x 10 samples x 6 sites). Water Board staff also assumed County staff resources will cost $200 per sampling day. Therefore total sampling costs per year

including staff resources would cost approximately $5,600 ($3,600 + ($200/sampling day x 10 sampling days/year)).

Reporting: The County of Santa Cruz is required to report independent of the TMDL under Phase II of the municipal stormwater program. Therefore, no costs have been estimated for reporting.

Private Sewer Lateral Upgrade

Implementation: According to the Proposition 13 Report, the cost to repair a leaking private lateral is estimated to be $5,000.

Inspections/Monitoring: According to the Proposition 13 Report, the cost to test for leaking private laterals is approximately $1,000.

Reporting: All responsible parties shall submit a report documenting that their private sewer lateral was inspected and/or repaired or replaced and is effectively minimizing pathogen discharges. Water Board staff estimated this report will require approximately six hours or less of land owner time.

Pet Waste Not Covered By Stormwater Management Plan

Planning or Program Development Actions: Central Coast Water Board staff estimated no significant costs to plan or develop this implementation requirement.

Implementation: Staff determined that bags that can be used to pick up waste are available starting at approximately $2.50 to $4.50 per box. The following website sells biodegradable dog waste pickup bags for 3.99 per box of thirty bags: http://www.alphadogtoys.com/biodegradable_dog_waste_bags.html. Plastic bags from grocery stores or other stores that can be reused for picking up waste are typically available at no cost (with a purchase from the store).

Inspections/Monitoring: Staff estimated no significant cost for inspections and monitoring of discharge of pet waste because staff concluded this can be easily done by walking the property. The time it takes to inspect the property increases as the property size increases.

Reporting: All responsible parties are required to submit triennial reports to the Water Board. All responsible parties shall submit a report documenting that measures are in place and effectively minimizing discharges or demonstrating that no discharge is occurring from pet waste. Water Board staff estimate this report will require approximately three hours or less of land owner time.

County of Santa Cruz Sanitary Sewer Collection System Spills and Leaks

Implementation: All sanitary sewer activities specified in the Basin Plan amendment are currently required under the existing Water Board permits and requirements. No new costs are anticipated as a result of these TMDLs.

Inspections/Monitoring: These costs are currently required by Central Coast Water Board permits.

Reporting: These costs are currently required by Central Coast Water Board permits.

Farm Animals and Livestock Discharges

Planning or Program Development Actions: The cost to develop pathogen control measures at these facilities will vary from site to site depending upon constraints present at each site. Central Coast Water Board staff estimate approximately eight hours is necessary for planning control actions.

Implementation: Staff concluded there are a variety of methods owners of farm animals and livestock can use to help control wastes. Some methods include installing livestock exclusion barriers, stables for horses, corrals, and manure bunkers at locations that prevent runoff from entering surface waters.

1. Livestock Exclusion Barriers: According to the U.S. EPA, the cost of permanently excluding livestock from areas where animal waste can impact surface waters ranges from $2,474/mi to $4,015/mi (*Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. 840-B-92-002,* United States Environmental Protection Agency, January 1993).

2. Horse Stables: Horses can be boarded at stables. According to the American Miniature Horse Association, miniature horses can be boarded in a professional stable for $50 to $150 per month per horse and full size horses can be boarded for $200 to $550 per month per horse. The cost depends on the facilities, pasture, and riding opportunities (http://www.amha.com/MarketTools/Profitibility.html).

3. Corral Cost: According to a Progressive Farmer website, a corral (excluding the head gate) can cost less than $7,000. Gates cost (at the most) between $3,000 and $4,000 (http://www.progressivefarmer.com/farmer/animals/article/0,24672,1113452,00.html).

4. Manure Bunker Costs: Ecology Action has worked with landowners to install manure bunkers. Manure bunkers help prevent stormwaters from infiltrating the manure thereby causing runoff of pollutants from the manure. According to Ecology Action, the average cost for constructing a manure bunker on properties in the Aptos Creek watershed was approximately $4000. (Each bunker was constructed on an existing cement slab, or a new one was poured and employed some type of cover - either a permanent roof or a tarp.) The cost of bunker construction varies greatly depending on the size and materials

choice. When looking at bunkers for the entire program, costs ranged from $3000 to $15,000 (Reference: E-mail dated 5-1-2007 from Jennifer Harrison of Ecology Action).

Inspections/Monitoring: The landowner cost for inspections/monitoring will vary depending upon the elements of the Nonpoint Source Implementation Program. The cost could be low for frequent periodic property inspections to assess and prevent discharges. Costs are higher if a landowner performs water quality monitoring.

Reporting: Central Coast Water Board staff estimated it would take approximately eight hours of land owner time to prepare a report to the Water Board. This report is required every three years.

11. MONITORING PLAN

11.1. Introduction

The Monitoring Plan outlines the monitoring sites, frequency of monitoring, and parties responsible for monitoring. The monitoring proposed below for complying with the TMDLs is the minimum staff finds is necessary. However, if a change in these requirements is warranted after the TMDLs are approved; the Executive Officer and/or the Central Coast Water Board will require such changes.

11.2. Monitoring Sites, Frequency, and Responsible Parties

The following monitoring plan proposes specific monitoring sites, frequency, and indicators to be monitored. *Staff will work with parties responsible for monitoring when the implementation and monitoring phase of the project commences, and will make revisions, if appropriate, to the monitoring plan outlined below.*

Central Coast Water Board will require the responsible parties to perform fecal coliform monitoring in receiving waters (Table 8). Staff also proposes fecal coliform monitoring for stormwater. The County of Santa Cruz will develop and propose the monitoring sites for approval by the Executive Officer of the Central Coast Water Board. The purpose of storm drain sampling is to assess the effectiveness of management measures. Storm drain samples will not be used to determine if the TMDL is attained. The Central Coast Water Board will use receiving water samples to determine compliance.

Monitoring activities will commence as directed by the Executive Officer of the Central Coast Water Board. Each party responsible for monitoring will be required to provide the data to the Central Coast Water Board.

Staff proposes fecal coliform monitoring in receiving waters at the following sites:

- Aptos Creek @ Mouth
- Aptos Creek @ Bridge On Spreckels
- Aptos Creek @ Valencia Creek
- Valencia Creek @ Aptos Creek
- Valencia Creek @ Trout Gulch
- Trout Gulch @ Valencia Creek

Table 8 identifies the monitoring required for this TMDL Project Report.

Table 8. Required Monitoring

RECEIVING WATER MONITORING				
Responsible Party	**Monitoring Site**	**Sampling Period**	**Number of Samples Per Sampling Period**	**Constituent (#/100 mL)**
Santa Cruz County and Santa Cruz County Sanitation District	Aptos Creek @ Mouth	Weekly	1	Fecal coliform
		One month in each of the last three years of sampling [1]	5	
Santa Cruz County and Santa Cruz County Sanitation District	Aptos Creek @ Bridge On Spreckels	weekly	1	Fecal coliform
		One month in each of the last three years of sampling [1]	5	
Santa Cruz County	Aptos Creek @ Valencia Creek	monthly	1	Fecal coliform
		One month in each of the last three years of sampling [1]	5	
Santa Cruz County and Santa Cruz County Sanitation District	Valencia Creek @ Aptos Creek	weekly	1	Fecal coliform
		One month in each of the last three years of sampling [1]	5	
Santa Cruz County	Valencia Creek @ Trout Gulch	monthly	1	Fecal coliform
		One month in each of the last three years of sampling [1]	5	
Santa Cruz County	Trout Gulch @ Valencia Creek	monthly	1	Fecal coliform
		One month in each of the last three years of sampling [1]	5	
STORM DRAIN MONITORING				
Responsible Party	**Monitoring Site**	**Sampling Period**	**Number of Samples Per Sampling Period**	**Constituent (#/100 mL)**
Santa Cruz County	Storm Drain or Drainage Ditch along Freedom Boulevard (preferably at south end)	Wet Season	5	Fecal coliform
		Dry Season	5	
Santa Cruz County	Storm Drain that empties to Valencia Creek along Soquel Dr.	Wet Season	5	Fecal coliform

RECEIVING WATER MONITORING				
Responsible Party	**Monitoring Site**	**Sampling Period**	**Number of Samples Per Sampling Period**	**Constituent (#/100 mL)**
	Boulevard (upstream of confluence of Valencia Creek and Trout Gulch)	Dry Season	5	
Santa Cruz County	To Be Determined	Wet Season	5	Fecal coliform
		Dry Season	5	
Santa Cruz County	To Be Determined	Wet Season	5	Fecal coliform
		Dry Season	5	
Santa Cruz County	To Be Determined	Wet Season	5	Fecal coliform
		Dry Season	5	
Santa Cruz County	To Be Determined	Wet Season	5	Fecal coliform
		Dry Season	5	

1 Responsible Party must determine which month will produce samples with the best representation of water quality conditions, i.e., not at the end of major storm events, not when Creek is dry.

Where landowners need to demonstrate their activity is not passing fecal material into waters, landowner monitoring for pathogen indicator organisms may provide evidence of complying with load allocations. Landowners have the option of performing individual monitoring or participating in a cooperative monitoring program. Individual landowner monitoring can comprise either water quality monitoring or other forms of monitoring (such as a report documenting visual site inspections supported by site photos). Central Coast Water Board staff will review data every three years to determine compliance with the TMDL. If the Executive Officer determines additional monitoring is needed, the Executive Officer shall request it pursuant to applicable sections of the California Water Code.

11.3. Reporting

The parties responsible for implementation and monitoring will incorporate the results of monitoring efforts in reports filed pursuant to the NPDES permit, Small MS4 Stormwater Permit, Nonpoint Source Implementation Program, or other correspondence as requested by the Central Coast Water Board pursuant to California Water Code.

If reporting changes become necessary based on staff's assessment of the TMDL implementation progress, the Executive Officer or the Central Coast Water Board will require such changes. At a minimum, the Central Coast Water Board will evaluate monitoring reporting data and implementation reporting information every three years.

REFERENCES

California Regional Water Quality Control Board, Central Coast Region *Water Quality Control Plan, Central Coast Region,* September 8, 1994 (amended April 14, 1995).

California Regional Water Quality Control Board, San Francisco Bay Region, *Pathogens in the Napa River Watershed Total Maximum Daily Load*, Staff Report, June 14, 2006.

Ecology Action, *Manure Management Survey Results*, 2006

Google Earth. 2008 Europa Technologies and 2008 TeleAtlas Image AMBAG, 2008. Retrieved on February 7, 2008.

Griffith, John F., Stephen B. Weisberg, Charles D. McGee. *Evaluation of Microbial Source Tracking Methods using Mixed Fecal Sources in Aqueous Test Samples*, 2003

Harrison , Jennifer, Ecology Action, Email, May 1, 2007.

http://www.alphadogtoys.com/biodegradable_dog_waste_bags.html. Staff retrieved information in approximately January 2008.

http://www.amha.com/MarketTools/Profitity.html. American Miniature Horse Association. Staff retrieved January 24, 2007.

http://www.appliedsurveyresearch.org/homeless-sc.htm. Applied Survey Research. Staff retrieved information from preceding web address in approximately 2007.

http://www.city-data.com/city/Aptos-California.html. © 2003-2007 Advameg, Inc. Staff retrieved information in 2007.

http://www.city-data.com/housing/houses-Aptos-California.html. © 2003-2007 Advameg, Inc. Staff retrieved information in 2007.

http://www.progressivefarmer.com/farmer/animals/article/0,24672,1113452,00.html. Staff retrieved January 24, 20007.

http://www.security-ness.com/DesignDetail.html. Retrieved January 23, 2007

Lather, Rachel. Senior Civil Engineer , Santa Cruz County Sanitation District, personal communication, November 5, 2007.

Peters, Steve. Water Quality Specialist, County of Santa Cruz Health Services Agency, personal communication, several conversations in 2006 and email, October 4, 2007 to October 9, 2007.

Peters, Steve. Water Quality Specialist, County of Santa Cruz Health Services Agency, personal communication, October 9, 2007.

Ricker, John. Water Resources Division Director, County of Santa Cruz Environmental Health Services, personal communication. September 18, 2007.

Riverson, J. 2003. Fecal Coliform Investigation and Analysis Spreadsheet (FECIA) [computer program]. Version 3, 8/25/2003. Tetra Tech, Inc., 2003. Fairfax, VA.

Santa Cruz County, Health Services Agency, Environmental Health Services, Assessment of Sources of Bacterial Contamination at Santa Cruz County Beaches, March 2006.

Santa Cruz County, Sanitation District, *Annual Spill Summary 2005*. January 30, 2006.

Santa Cruz County, Sanitation District, Final Approved Aptos Video Results. February/March 2005.

Santa Cruz County, Sanitation District, Ordinance No. 111. An Ordinance Adding Sections 7.04.325 and 7.04.515; Amending Sections 7.04.030, 7.04.310 and 7.04.510; and Deleting and Replacing Section 7.04.545, Relating to the Use of Sewers, Permits and Fees. March 2, 2006.

State Water Resources Control Board, 2004a. Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (and Fact Sheet). May 20, 2004. (Adopted August 26, 2004).

State Water Resources Control Board, Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Adopted September 2004.

Swanson Hydrology & Geomorphology. Aptos Creek watershed. Assessment & Enhancement Plan. May 1, 2003.

United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Santa Cruz County, California*, 1980

United States Environmental Protection Agency, Ambient Water Quality Criteria for Bacteria-1986, January 1986.

United States Environmental Protection Agency, Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. 840-B-92-002, January 1993

United States Environmental Protection Agency, Protocol for Developing Pathogen TMDLs, January 2001.

University of Southern California, *NPDES Stormwater Cost Survey.* Center for Sustainable Cities, University of Southern California, January, 2005.

Wolcott, Bill. Supervising Ranger, Nisene Marks State Park, personal communication, September 17, 2007.