California Regional Water Quality Control Board
Central Coast Region

Total Maximum Daily Load for Fecal Indicator Bacteria for the Arroyo de la Cruz Watershed, San Luis Obispo County, California

Final Project Report
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http://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/303d_and_tmdl_projects.shtml

STATE OF CALIFORNIA

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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:

CalWater22	CalWater22 is a suite of watershed data developed by the California Interagency Watershed Mapping Committee
CCAMP	Central Coast Ambient Monitoring Program
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CFU	Colony Forming Units
CWA	Clean Water Act
DAR	Drainage Area Ratio
DHS	California Department of Health Services
E. coli	Escherichia coli bacteria
FIB	Fecal Indicator Bacteria
FMMP	Farmland Mapping and Monitoring Program
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
LA	Load Allocation
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
OSDS	Onsite Waste Disposal System
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RCD	Resources Conservation District
REC-1	Water Contact Recreation
REC-2	Non-contact Water Recreation
SSURGO	Soil Survey Geographic Database
SWRCB	State Water Resources Control Board (State Board)
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Water Board	California Central Coast Regional Water Quality Control Board
WDR	Waste Discharge Requirements
WLA	Waste Load Allocation
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

Arroyo de la Cruz creek is located in a 43 square mile watershed in coastal northern San Luis Obispo County. Arroyo de la Cruz is listed on Central Coast Region's Clean Water Act Section 303(d) List due to impairment by *E. coli* bacteria. *E. coli* is an indicator for disease causing pathogens and high concentrations of *E. coli* in fresh water that exceed U.S. Environmental Protection Agency water quality criteria indicate a higher risk of infectious diseases. Consequently, the Basin Plan's general toxicity objective is not being protected. The Basin Plan narrative toxicity objective requires that all waters be maintained free of substances which produce detrimental physiological responses in humans, plants, animals, or aquatic life.

It should be noted that Arroyo de la Cruz is currently meeting Basin Plan water quality objectives for fecal coliform bacteria, and the magnitude of the impairment by *E. coli* appears to be quite moderate. *E. coli* water quality criteria exceedances are not severe or routine. As such, Staff anticipates that a modest amount of management measure implementation and additional water quality monitoring may be sufficient to ultimately de-list the waterbody.

The following Fecal Indicator Bacteria Total Maximum Daily Load (TMDL) Project Report evaluates fecal indicator bacteria loading in Arroyo de la Cruz, evaluates what water bodies are affected by these TMDLs, assesses the sources of bacteria loads, identifies responsible parties, and presents an implementation plan to reduce pollutants so that the waterbody is no longer impaired.

This TMDL address the 303(d) listings of impairment due to *E. coli* in the Arroyo de la Cruz creek, WBID number CAR31012013200201171413339.

Total Maximum Daily Load (TMDL)

TMDLs are strategies to ensure attainment of water quality standards. They are implemented through existing regulatory and non-regulatory programs to control pollutant discharges from point sources (e.g., discharges from wastewater treatment plants) and nonpoint sources (e.g., runoff from livestock operations). The term Total Maximum Daily Load is used to describe the maximum amount of a pollutant(s) - in this case, fecal coliform bacteria - that a water body can receive and still meet water quality standards. A TMDL study identifies the probable sources of pollution, establishes the maximum amount of pollution a water body can receive and still meet water quality standards, and allocates that amount of pollution to all probable contributing sources.

The federal Clean Water Act requires every state to evaluate its waterbodies, and maintain a list of waters that are considered "impaired" either because the water exceeds water quality standards or does not achieve its designated use. California's water quality standards designate beneficial uses for each waterbody (e.g., drinking water supply, aquatic life support, recreation, etc) and the scientific criteria to support that use. The California Central Coast Water Board is required under both State Federal Law to protect and regulate beneficial uses of waters of the state. For each water on the Central Coast's "303(d) Impaired Waters List", the California Central Coast Water Board must develop and implement a plan to reduce pollutants so that the waterbody is no longer impaired and can be de-listed.

In the case of this TMDL project, the Basin Plan's general toxicity objective is not being supported and water contact recreation is the most sensitive applicable beneficial use (i.e., most stringent numeric water quality standard). The loading capacity and allocations for this TMDL are therefore equal to USEPA guidance for *E. coli* – which are protective of the Basin Plan's toxicity objective - and the numeric water quality objective for fecal coliform which is protective of all water contact activities. When the numeric water targets *E. coli* and for fecal coliform are met, the TMDL is achieved and applicable beneficial uses and water quality objectives of the water bodies are considered restored.

The TMDLs established in this TMDL for *E. coli* and fecal coliform are as follows:

Fecal coliform
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 200/100mL, nor shall more than ten percent of total samples during any 30-day period exceed 400/100mL.

E. coli
Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of E. coli densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986)

Impaired Waterbodies
Based on data from the Water Board's Central Coast Ambient Monitoring Program, Arroyo de la Cruz exceeded Basin Plan *E. coli* water quality criteria at the Arroyo de la Cruz monitoring site 310ADC in 8 out of 42 samples (19%). Therefore, based on the State Water Quality Control Policy (SWRCB, 2004) Arroyo de la Cruz is impaired due to *E. coli.*

Sources
E. coli and fecal coliforms are shed by all warm-blooded animals including humans, pets, livestock and birds and other wildlife. Sources identified in this TMDL Report include:

Source Category	Land Use Category
Livestock	Rangeland, Pasture
Wildlife	All

Numeric Targets
E. coli and fecal coliform are used as a indicators for fecal waste and the potential for pathogens in the water column in this TMDL. The Arroyo de la Cruz watershed is impaired due to *E. coli*, but is meeting fecal coliform water quality objectives based on water quality monitoring data. *E. coli* data from Arroyo de la Cruz indicate that Basin Plan narrative toxicity objective is not being supported. The Central Coast Basin Plan explicitly specifies water quality objectives for fecal coliform. This FIB TMDL Report proposes that all waterbodies achieve a level of bacteria concentration that is safe for human contact recreation. The following are current Central Coast Basin Plan standards, and U.S. Environmental bacterial criteria which are used as numeric targets in this fecal indicator bacteria TMDL:

Indicator	**Numeric Targets**
E. coli [A]	Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of *E. coli* densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986)
Fecal Coliform	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.
[A] refer to Table 4 (page 15), and Freshwater EPA Criteria (page 16) in USEPA Ambient Water Quality Criteria for Bacteria (1986), EPA440/5-84-002	

Allocations

The table below identifies the allocations assigned to responsible parties and the affected water bodies; this table is also presented and discussed in Section 5.4.

WASTE LOAD ALLOCATIONS			
Waterbody	**WBID**	**Party Responsible for Allocation (Source) NPDES/WDR number**	**Receiving Water Fecal Coliform (MPN/100mL)**
All impaired water bodies[a]	CAR3101201320020117141339	NONE IDENTIFIED	NOT APPLICABLE
LOAD ALLOCATIONS			
Waterbody	**WBID**	**Responsible Party (Source)**	**Receiving Water Fecal Coliform (MPN/100mL)**
All impaired water bodies[a]	CAR3101201320020117141339	Owners/operators of land used for/containing domestic animals/livestock (Domestic animals/livestock waste)	Load Allocation-1 Load Allocation-2
All impaired water bodies[a]	CAR3101201320020117141339	No responsible party (Natural sources)	Load Allocation-1 Load Allocation-2
Wasteload Allocation: None – not applicable. Load Allocation- Allocation 1: (Equal to the TMDL for *E. coli*.): Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of *E. coli* densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986) Load Allocation - Allocation 2: (Equal to the TMDL for fecal coliform):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.			

[a] Arroyo de la Cruz: all reaches and tributaries of the waterbody to the confluence with the Arroyo de la Cruz estuary

TMDL Implementation

TMDLs are strategies to restore clean water. Implementation plans specify actions needed to solve the problem, and are required under California Law. Implementation measures aimed at improving water quality are implemented, where appropriate, by responsible parties. A responsible party is an entity or an individual who's operations or property have been identified as a probable source of fecal coliform pollution.

In accordance with the California Impaired Waters policy the Water Board may exercise its independent discretion to certify that a nonregulatory action will correct the impairment if supported by findings in the record. On these occasions the Water Board may not always need to adopt its own implementation program, but may instead rely upon the program adopted by the other entity. When doing so, the Water Board should establish the TMDL via a formal recognition which certifies that Water Board has determined that the other entity's program will comply with the TMDL and attain standards.

While the State Impaired Waters policy recognizes that certification of alternative programs of implementation may be merited as appropriate and as a matter of efficiency, it is important to emphasize the Water Board retains the authority to commence a regulatory response if an impairment has not been adequately addressed by a non-regulatory action within a specified time period. The Water Board may not indefinitely defer taking necessary action if another entity is not properly addressing a problem. Note that a regulatory response by the Water Board must use the administrative permitting authorities as outlined in the Nonpoint Source Implementation and Enforcement policy (see Section 6.3.3).

Accordingly, staff proposes that the Water Board certify the California Rangeland Water Quality Management Plan (Rangeland Plan) as the mechanism for implementing this TMDL. The Rangeland Plan was accepted by the State Board in 1995 (SWRCB Resolution No. 95-43). It summarizes authorities and mandates for water quality and watershed protection on non-federal rangelands, and specifies a framework for the cooperative development of ranch management strategies for water quality protection. The Rangeland Plan also provides that where beneficial uses of water are impaired or threatened, as determined by the Water Board, ranch owners shall assess and report to the Water Board the impact of their operations on beneficial uses; and show the existence of a viable Rangeland Plan with implementation underway; or schedule an assessment and begin development of a Rangeland Plan.

As such, the implementation process will include the following.

1) By five years after final approval of the TMDL, Water Board staff and stakeholders will identify specific sites within the TMDL project area contributing controllable fecal coliform loads to Arroyo de la Cruz that need management measures for pathogen control. Problem assessment and planning for management measure implementation on non-federal rangelands will follow the implementation procedures in the California Rangeland Water Quality Management Plan (July 1995).

2) By eight years after final approval of the TMDL, depending on progress toward management measure implementation under the 1995 California Rangeland Water Quality Management Plan and the 2000 California Nonpoint Source Plan, staff will consider the need for regulatory action to ensure implementation of management measures to control external sources of fecal coliform loading to Arroyo de la Cruz.

3) By 12 years from the date the TMDL becomes effective (which is upon approval by the Water Board), management practices will be fully implemented for nonpoint sources of fecal coliform loading and the load the allocations, and therefore the TMDL, will be achieved

Water Board staff will verify implementation of the California Rangeland Water Quality Management Plan via a program of implementation monitoring and water quality monitoring, as described in Section 6.5 of this Project Report.

Timeline to Achieve TMDL
Staff anticipates that the allocations, and therefore the TMDL, will be achieved ten years from the date the TMDL becomes effective (which is upon approval by the Water Board). This estimation is in part based on the amount of time necessary to identifying responsible parties of the TMDL 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.

The Central Coast Water Board will consider additional requirements, or commence a regulatory response in accordance with the State Nonpoint Source Implementation and Enforcement policy if implementation of management practices do not result in achievement of water quality objectives.

1 INTRODUCTION

1.1 Clean Water Act Section 303(d) List

Section 303(d) of the federal Clean Water Act requires every state to evaluate its waterbodies, and maintain a list of waters that are considered "impaired" either because the water exceeds water quality standards or does not achieve its designated use. For each water on the Central Coast's "303(d) Impaired Waters List", the California Central Coast Water Board must develop and implement a plan to reduce pollutants so that the waterbody is no longer impaired and can be de-listed. Section 303(d) of the Clean Water Act states:

Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

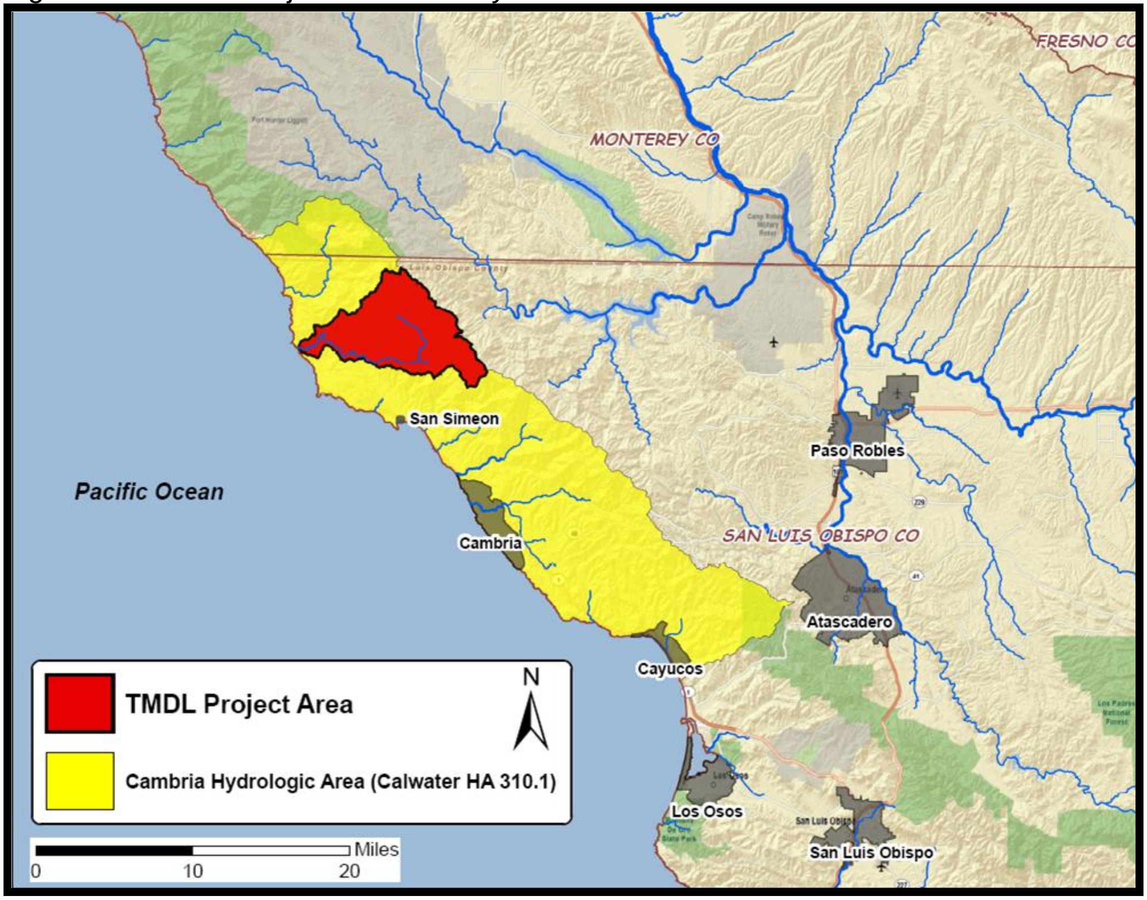
The State complies with this requirement by periodically assessing the conditions of the rivers, lakes and bays and identifying them as "impaired" if they do not meet water quality standards. These waters, and the pollutant or condition causing the impairment, are placed on the 303(d) List of Impaired Waters. In addition to creating this list of waterbodies not meeting water quality standards, the Clean Water Act mandates each state to develop TMDLs for each waterbody listed. The Central Coast Regional Water Quality Control Board is the agency responsible for protecting water quality consistent with the Basin Plan, including developing TMDLs for waterbodies identified as not meeting water quality objectives.

1.2 Project Area

The proposed geographic scope of this TMDL (the project area) encompasses 43 square miles of the Arroyo de la Cruz watershed (CalWater hydrologic subarea 310.12) located in coastal northern San Luis Obispo County. The project area[1] includes the watershed area contributing flow to the Arroyo de la Cruz creek, and downstream to the Arroyo de la Cruz's confluence with the Arroyo de la Cruz estuary. Figure 1-1 illustrates the location of the project area.

[1] The terms "project area" and "Arroyo de la Cruz watershed" are synonymous in the context of this report, and the terms are therefore used interchangeably.

Figure 1-1. TMDL Project Area – Arroyo de la Cruz watershed.



1.3 Pollutants Addressed

The pollutant addressed in this TMDL is fecal waste. Pathogenic microbes are associated with fecal waste. Pathogens include viruses, protozoa, and pathogenic strains of bacteria. These microbes can cause a variety of diseases or illnesses (hepatitis, cholera, parasites, diarrhea, etc.) through ingestion of contaminated water or the consumption of contaminated shellfish. The presence of fecal waste in the water column is measured by taking water and analyzing those samples for the concentration of total coliform, fecal coliform and/or *E. coli*. These constituents will collectively be referred to as fecal indicator bacteria or FIB. FIB is used to determine the most probable number of fecal indicator bacteria in the water at a given time. This number is used to determine the risk associated with recreating in this water. Reducing the amount of fecal waste that enters a water body will help to preserve and maintain the beneficial uses.

2 PROBLEM IDENTIFICATION

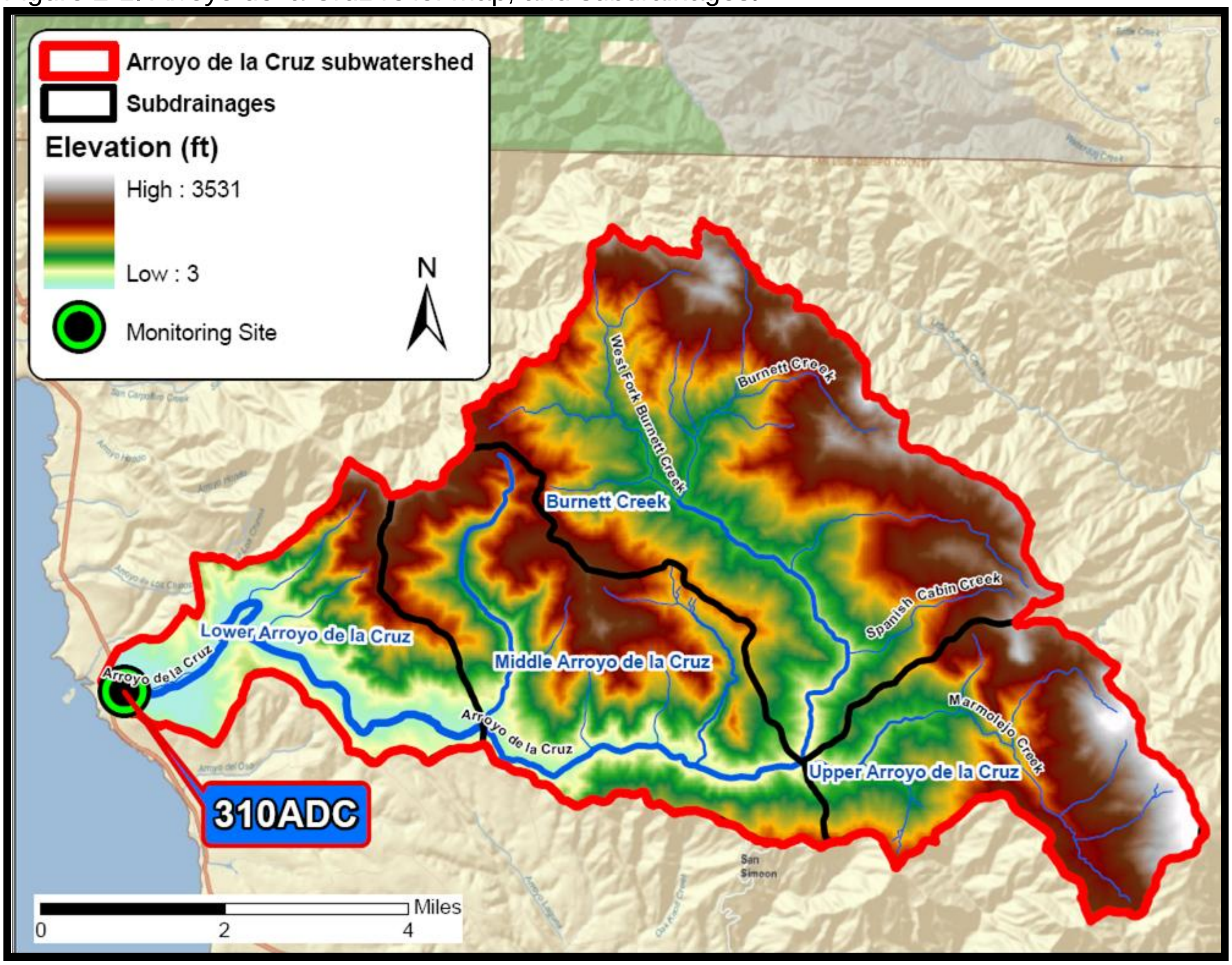
2.1 Watershed Description

Arroyo de la Cruz is located in a 43 square mile coastal watershed draining the western slopes of the Santa Lucia Range of northern San Luis Obispo County. The downstream drainage outlet of the Arroyo de la Cruz creek is at the confluence with the Arroyo de la Cruz estuary. The Arroyo de la Cruz watershed is in a sparsely-populated rural setting. The creek drains a rural, coastal watershed within an ecosystem characterized by oak woodland, chaparral, montane hardwood, and grassland (sources: National Land Cover Dataset, 2001; Calif. Dept. of Forestry and Fire Protection, 1977). The watershed has negligible amounts of cropland or residential areas (source, Calif. Department of Water Resources, 1997)

2.1.1 Watershed Delineation

ESRI™ ArcMap® 9.2 was used to create a watershed layers for the project area. The drainage boundaries of the Project Area were delineated on the basis of the Watershed Boundary Dataset, which contain digital hydrologic unit boundary layers organized on the basis of Hydrologic Unit Codes (HUCs). The Arroyo de la Cruz watershed drains the Arroyo de la Cruz subwatershed (HUC 180600060403) and the Burnett Creek subwatershed (HUC 180600060402) – and encompasses 43 square miles of coastal northern San Luis Obispo County. Figure 2-1 illustrates a relief map of Arroyo de la Cruz watershed, and subdrainages nested within the watershed based on CalWater planning watershed shape files.

Figure 2-1. Arroyo de la Cruz relief map, and subdrainages.

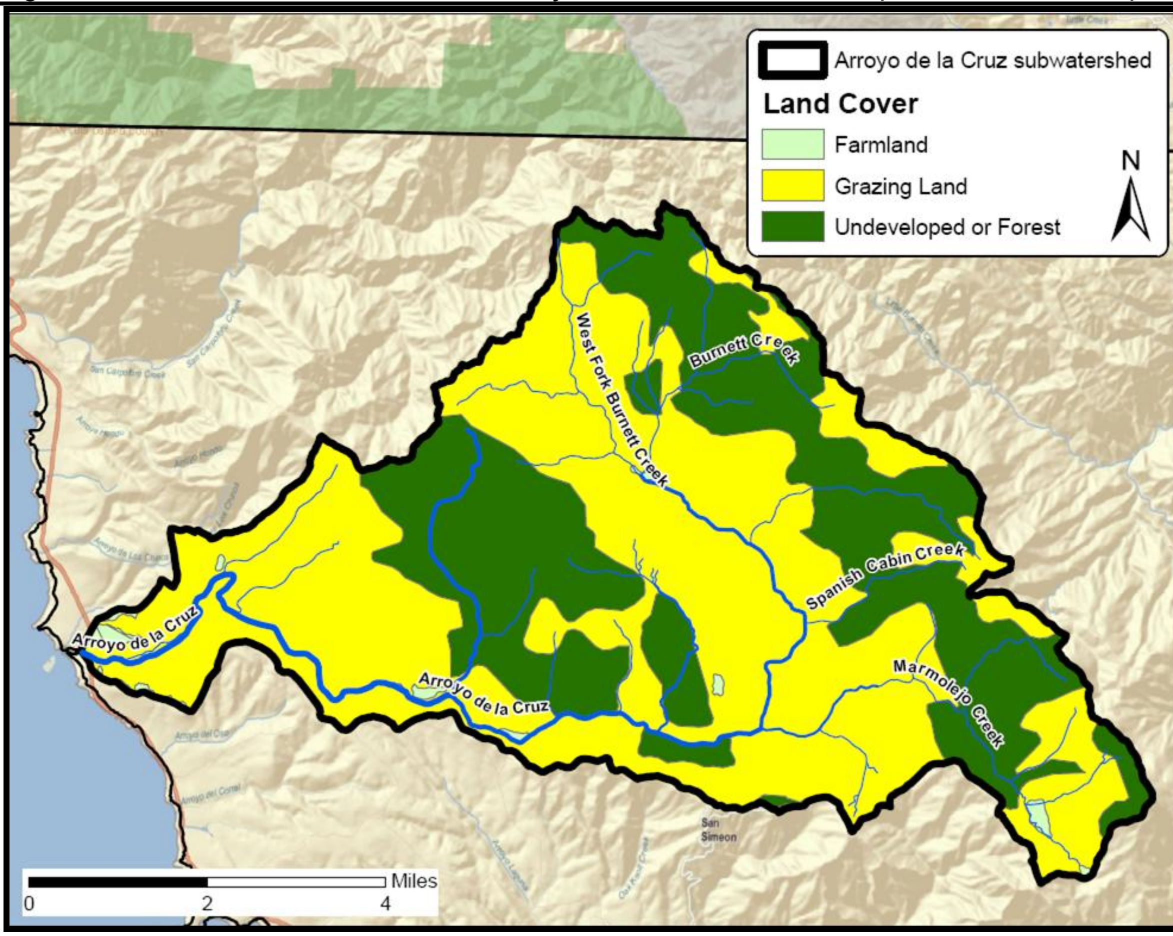


2.1.2 Land Use and Land Cover

Land use and land cover in the project area can be evaluated from digital data provided by the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). The FMMP digital land use dataset was compiled by the California Dept. of Conservation, in cooperation with the California Cattlemen's Association and others. For this Project Report, the 2008 FMMP mapping data for San Luis Obispo County was used. Figure 2-2 illustrates land use and land cover in the project area. Table 2-1 tabulates the distribution of land use in the project area.

It is worth noting with regard to spatial data and census data used throughout this Project Report that these types of datasets are widely used in TMDL studies for scoping purposes and are not intended or required to accurately represent the full range of local conditions or site-specific real time conditions.

Figure 2-2. Land Use – Land Cover in Arroyo de la Cruz watershed *(source: FMMP, 2008).*



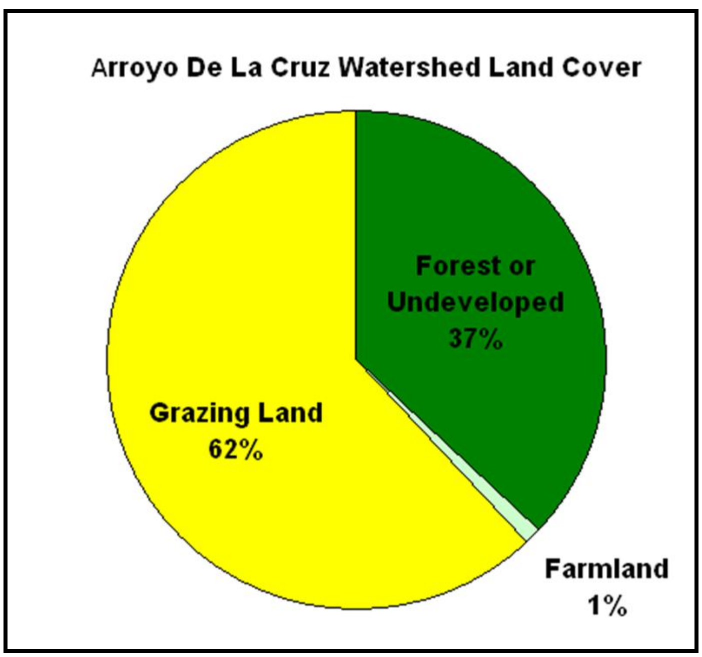


Table 2-1. Tabulation of Arroyo de la Cruz watershed land use / land cover.

Land Use/Land Cover	Acres	% of Project Area
Residential	8	0.02%
Grazing Land	16,937	62%
Farmland	253	0.9%
Forest or Undeveloped	10,107	37%
Total	27,304	100%

2.1.3 Hydrology

Arroyo de la Cruz has historical flow gage data from USGS 11142500. The USGS flow gage 11142500 was discontinued in September 1979. A synthetic flow record for Arroyo de la Cruz to infill flows subsequent to September 1979 at monitoring site 310ADC was developed in conjunction with flow records from USGS gage 111592900 at Corrilitos Creek (Santa Cruz County) as a suitable reference flow gage, as described in Appendix B: *Synthetic Flow Record*.

Figure 2-3 illustrates the flow duration curve for Arroyo de la Cruz at monitoring site 310ADC. Flow duration curves are graphical representations of the flow regime of a stream at a given site. The horizontal axis is essentially a flow frequency distribution, depicting the percentage of times a certain flow is exceeded on a daily basis. As such, highest flows are represented on the extreme left side of the horizontal axis, lowest flows recorded are represented the extreme right side of the axis. The median flow occurs at a flow exceedance frequency of 50 percent.

Figure 2-4 illustrates the hydrologic stream channel classifications in the project area. The source of these hydrologic classification attributes is from the USGS's high resolution National Hydrography Dataset (NHD).

Figure 2-3. Flow duration curve for Arroyo de la Cruz.

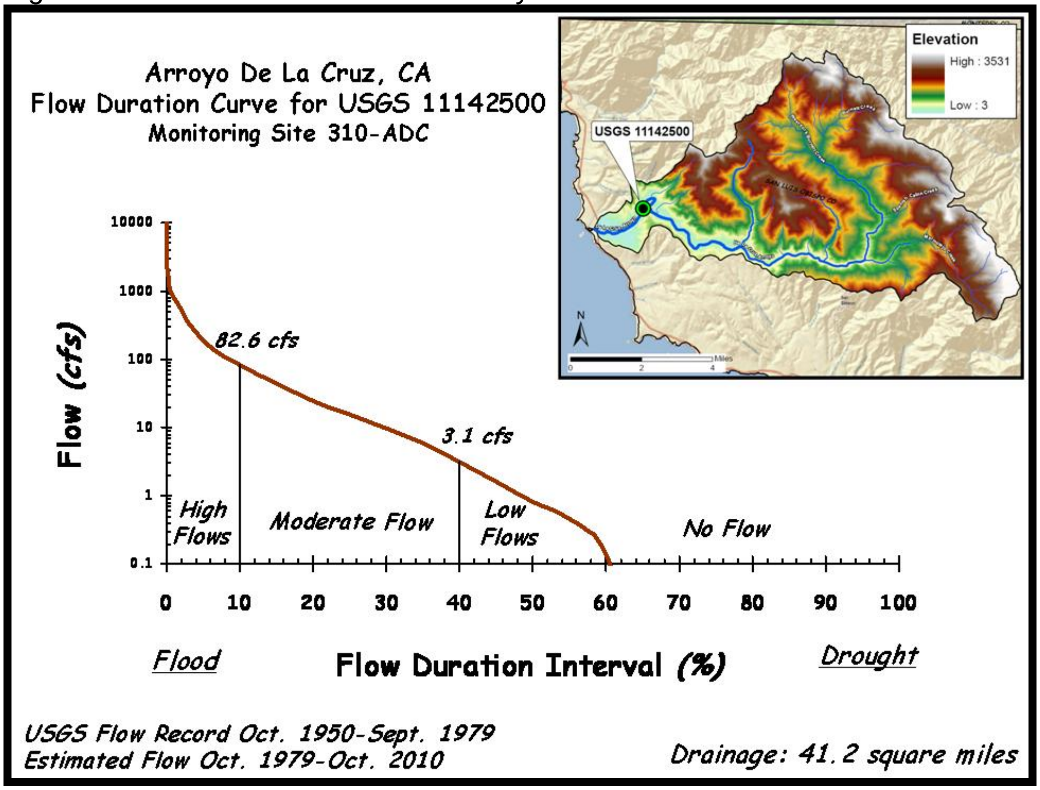
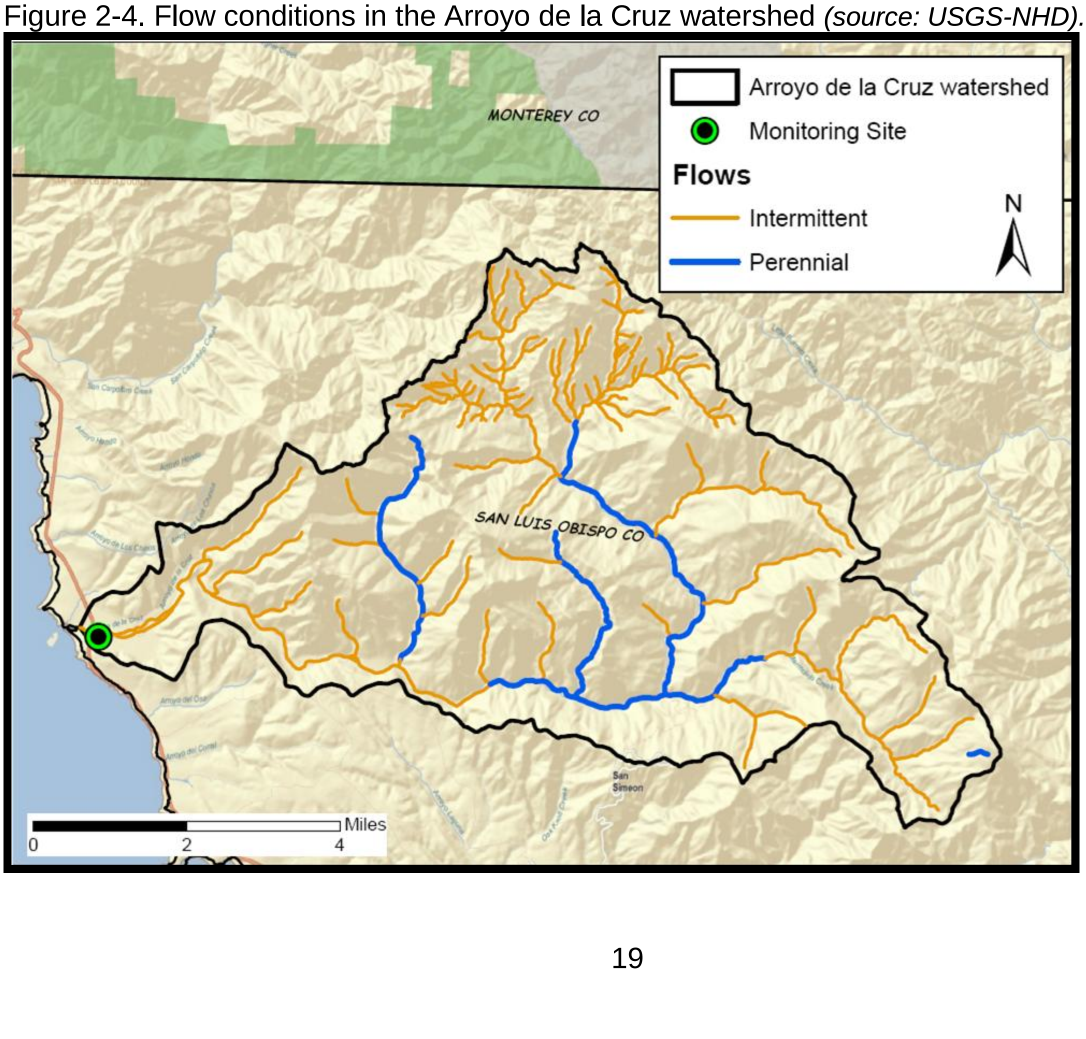


Figure 2-4. Flow conditions in the Arroyo de la Cruz watershed *(source: USGS-NHD).*



In central coast streams, pathogen loading in ephemeral or intermittent drainages is typically limited to the wet season or to precipitation events. Nonetheless, it is also important to recognize that indicator bacteria (e.g., *E. coli*) or pathogens in manure that are deposited on grasses or in ephemeral stream beds may survive for weeks or months (Guan and Holley, 2003; Avery et al., 2004), potentially being mobilized in the water column by subsequent stream flows.

2.1.4 Climate and Precipitation

Precipitation data can be used, in conjunction with other physical metrics, to estimate flow for ungaged streams. For example the California State Water Resources Control Board (SWRCB) uses a precipitation-based proration method to estimate flow at ungaged streams (SWRCB, 2002).

The Arroyo de la Cruz watershed has a Mediterranean climate, with the vast majority of precipitation falling between November and April. Precipitation gage data in the vicinity of the project area is available from the National Oceanographic and Atmospheric Administration - Western Regional Climate Center (http://www.wrcc.dri.edu). As shown in Table 2-3 the mean annual precipitation for National Climatic Data Center (NCDC) weather station 043882, located at Hearst Castle is 28.4 inches per year.

Table 2-2. Precipitation record for NCDC weather station 043882

NCDC Weather Station 043882 – Hearst Castle, CA (elevation 1600 ft.) Period of Record: Dec. 1999 to July. 2010													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Total Precipitation (in.)	5.83	6.97	2.92	2.27	0.72	0.04	0.01	0.01	0.13	1.89	2.33	6.29	**29.40**

It is important to recognize that rainfall gauging stations have limited spatial distribution, and that gauging stations tend to be located in urban areas or valley floor areas. Consequently, these locations can bias estimates of regional rainfall towards climatic conditions at lower elevations. The topography of the California central coast region however, can result in significant orographic enhancement of rainfall (i.e., enhancement of rainfall due to topographic relief and mountainous terrain).

Therefore, mean annual precipitation estimates for the project area may be assessed using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) (http://prism.oregonstate.edu/). PRISM is a climate mapping system that accounts for orographic climatic effects and is widely used in watershed studies and TMDL projects to make projections of precipitation into rural or mountainous areas where rain gage data is often absent, or sparse. An isohyetal map for estimated mean annual precipitation in the Arroyo de la Cruz watershed based on PRISM data is presented in Appendix C: *Supplemental Maps and Spatial Data*

2.1.5 Geology and Soils

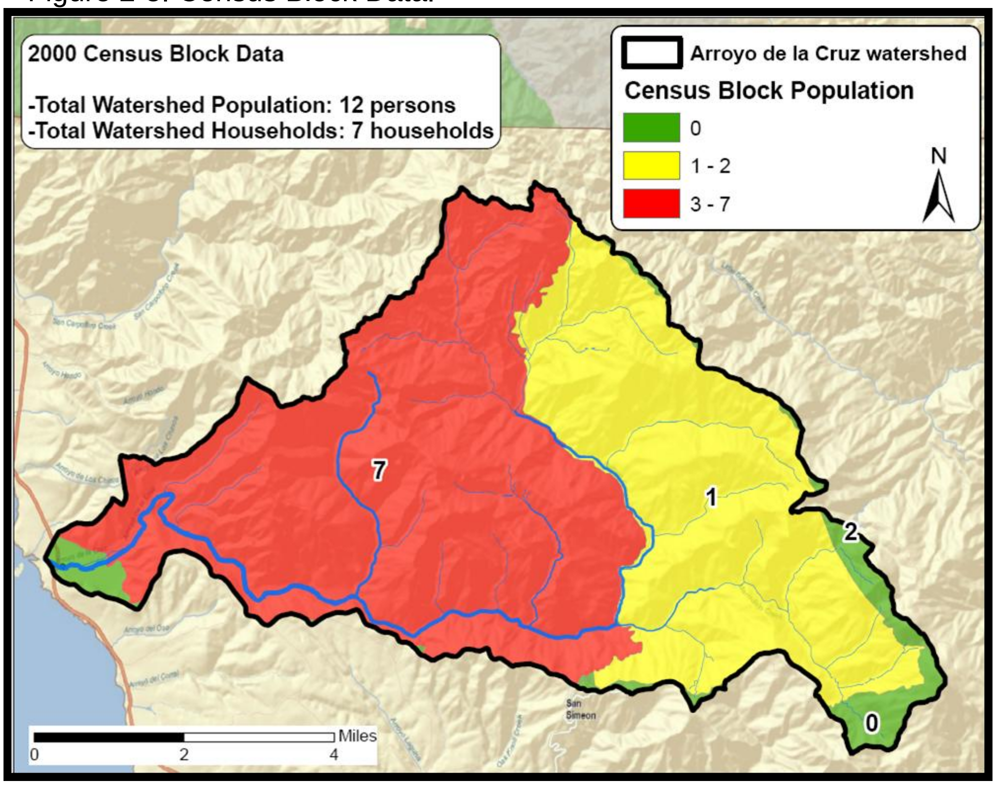
Soils and rocks have physical and hydrologic characteristics which may have a significant influence on the transport and fate of pollutants. For pathogen TMDLs, geology and soils information may be important in terms of assessing the potential risk of OSDS (i.e., septic tanks) effluent transport through bedrock fractures, the risk of pollutant wash-off associated with poorly-drained or relatively impermeable soils, or the potential for sediment-associated bacteria loads.

Digital data for California geology is available from the California Department of Conservation, Division of Mines and Geology. The digital database contains the geologic units and faults as shown on the Geologic Map of California by Charles W. Jennings published in 1977. Soil surveys for Monterey County are compiled by the U.S. Department of Agriculture National Resources Conservation Service (NRCS) and are available via the Soil Survey Geographic (SSURGO) Database. The distribution of geology and of hydrologic soil groups in the Project Area along with a tabular description of the soil group's hydrologic properties is presented in Appendix C: .

2.1.6 Demographics

To estimate the potential contribution of human fecal material (for example, failing septic systems) to surface water pathogen impairments, it is necessary to have watershed-specific demographic data on the number of people, households, and septic systems in the project area. Section 4.1 provides detail on the sources of census data that are used to establish these estimates. Figure 2-5 presents the estimated population distribution in the watershed. As indicated in the figure, the Arroyo de la Cruz watershed is a rural setting with a negligible human population of approximately 12 people and an estimated 7 households.

Figure 2-5. Census Block Data.



2.2 Beneficial Uses

California's water quality standards designate beneficial uses for each waterbody (e.g., drinking water supply, aquatic life support, recreation, etc) and the scientific criteria to support that use. The California Central Coast Water Board is required under both State Federal Law to protect and regulate beneficial uses of waters of the state. In the case of this TMDL project, water contact recreation (REC-1) is the most sensitive water recreation use, i.e. more stringent numeric water quality objectives for fecal indicator bacteria. The REC-1 beneficial use states:

"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."

Table 2-3 shows the current beneficial use designations for water bodies in the Arroyo de la Cruz watershed.

Table 2-3. Beneficial uses of Arroyo de la Cruz.

Beneficial Use	**Arroyo de la Cruz Creek**	**Arroyo de la Cruz Estuary**
MUN	X	
AGR	X	
PRO		
IND	X	
GWR	X	
REC1	X	X
REC2	X	X
WILD	X	X
COLD	X	X
WARM	X	
MIGR	X	X
SPWN	X	X
BIOL		X
RARE	X	X
EST		X
FRESH	X	
COMM	X	X
SHELL		X

MUN: Municipal and domestic water supply.
AGR: Agricultural supply.
PRO: Industrial process supply.
IND: Industrial service supply
GWR: Ground water recharge.
REC1: Water contact recreation.
REC2: Non-Contact water recreation.
WILD: Wildlife habitat.
COLD: Cold fresh water habitat.
WARM: Warm fresh water habitat
MIGR: Migration of aquatic organisms.
SPWN: Spawning, reproduction, and/or early development.
BIOL: Preservation of biological habitats of special significance.
RARE: Rare, threatened, or endangered species
EST: Estuarine habitat
FRESH: Freshwater replenishment.
COMM: Commercial and sport fishing.
SHELL: Shellfish harvesting.

2.3 Water Quality Objectives and Criteria

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to indicator bacteria (CCRWQCB, 1994, pg. III-3). These objectives are linked to specific beneficial uses and include:

2.3.1 Shellfish Harvesting (SHELL)):

At all areas where shellfish may be harvested for human consumption, the median total coliform concentration throughout the water column for any 30-day period shall not exceed 70/100 ml, nor shall more than 10% of the samples collected during any 30-day period exceed 230/100 ml for a five-tube decimal dilution test or 330/100 ml when a three-tube decimal dilution test is used.

The California Department of Health Services (DHS) standards for the protection of the shell fishing beneficial use are:

i. The total coliform median or geometric mean MPN of the water does not exceed 70 per 100 mL and not more than 10 percent of the samples exceed a MPN of 230 per 100 mL for a five-tube decimal dilution test.

ii. The fecal coliform median or geometric mean MPN of the water does not exceed 14 per 100 mL and not more than 10 percent of the samples exceed a MPN of 43 for a five-tube decimal dilution test.

The DHS often uses the fecal coliform standard to classify growing areas (as opposed to total coliform).

Please note: The Arroyo de la Cruz estuary is the downstream receiving waterbody of the Arroyo de la Cruz creek. Currently, there are no water quality data at the Arroyo de la Cruz estuary to determine impairment status with respect to SHELL. As such at this time, we are not requiring work related to the SHELL standard in the proposed Implementation Plan. The State Water Resources Control Board (SWRCB) is conducting a project to re-assess the areas designated for the shellfish harvesting beneficial use. As a result of this project SWRCB may potentially separate out the commercial from the other components of the shellfish definition. The current definition is broad, encompassing recreational harvesting for consumption, harvesting for bait, and commercial aquaculture. The breadth of the definition reduces flexibility to apply the most appropriate water quality standards to each of these applications. The Water Board may require water quality monitoring in the estuary during TMDL implementation by appropriate land owners/dischargers to assess potential impairment status with respect to SHELL of the estuary, pursuant to Water Code Section 13267 authorities. However, waterbodies designated with SHELL beneficial use in Project Area will be addressed in a separate SHELL TMDL and/or standards action pending the outcome of the work of the statewide task force involving the Ocean Planning Unit of the State Water Board, the California Department of Public Health, the USEPA, and the coastal Regional Water Boards whom are involved in re-assessing the SHELL standard.

2.3.2 Water Contact Recreation (REC-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 per 100ml, nor shall more than 10% of total samples during any 30-day period exceed 400 per 100ml.

2.3.3 Non-Contact Water Recreation (REC-2):

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 per 100ml, nor shall more than 10% of samples collected during any 30-day period exceed 4000 per 100ml.

2.3.4 Controllable Water Quality conditions

Controllable water quality must conform to the water quality objectives stated in the Basin Plan. The Basin Plan defines controllable water quality conditions as:

"Controllable water quality conditions are those actions or circumstances resulting from man's activities that may influence the quality of the waters of the State and that may be reasonably controlled."

2.4 Data Analysis

The data used for this Project included water quality data from the Central Coast Ambient Monitoring Program. CCAMP is the Central Coast Water Board's regionally scaled water quality monitoring and assessment program. The CCAMP dataset used for this project ranged in time from April 2001 to and June 2010 were collected at monitoring site 310ADC (Arroyo de la Cruz at Highway 1). In addition, four *E. coli* water quality samples for monitoring site 310ADC were available from the Monterey Bay National Marine Sanctuary Citizen Watershed Monitoring Network. There are currently no water quality monitoring data from the Arroyo de la Cruz estuary, which is on private property. The estuary is the coastal confluence downstream receiving waterbody for the Arroyo de la Cruz creek.

In the case of this TMDL project, contact recreation (REC-1) is the most sensitive applicable beneficial use. The REC-1 water quality objective is therefore protective of all designated beneficial uses of Arroyo de la Cruz pertaining to indicator bacteria. Accordingly, the water quality objective to assess impairment status for this TMDL project is equal to the REC-1 water quality objective (numeric target) for fecal coliform. The Basin Plan's water quality objective for waters designated for REC-1 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 per 100ml, nor shall more than 10% of total samples during any 30-day period exceed 400 per 100ml."

Available datasets often do not contain five samples in a 30-day period, so the portion of the objective that is evaluated is that "no more than ten percent of total samples during any 30-day period exceed 400/100 mL." In instances where fewer than five samples were collected in 30 days, the "ten percent" threshold is exceeded if any one sample exceeds 400/100 mL.

2.4.1 Water Quality Impairments

The California Listing Policy (SWRCB, 2004) provides standards for interpreting data and information as they are compared to beneficial uses and existing numeric and narrative water quality objectives. The California Listing Policy uses a binomial distribution of sample data to determine whether waters shall be placed on the Section 303(d) list. In the absence of a site-specific exceedance frequency (e.g., five samples in a 30-day period), a water segment shall be placed on the section 303(d) list if bacteria water quality objectives are exceeded at the frequencies and sample sizes indicated in Table 2-4.

Table 2-4. Data required to assert impairment *(source: SWRCB, 2004).*

Sample Size	Number of Exceedances[1] needed to assert impairment
5-30	5
31-36	6
37-42	7
43-48	8
49-54	9
55-60	10
61-66	11
67-72	12
73-78	13
79-84	14
85-91	15
92-97	16
98-103	17
104-109	18
110-115	19
116-121	20

*Application of the binomial test requires a minimum sample size of 26. The number of exceedances required using the binomial test at a sample size of 26 is extended to smaller sample sizes.

[1] Equal to or greater than 400 MPN/100 ml fecal coliform and 235 MPN/100 ml *E. coli*.

Recent monitoring data collected in Arroyo de la Cruz measures *Escherichia coli* indicator bacteria. *Escherichia coli (E. coli*) is one species within the broader category of fecal coliform bacteria and can be used to evaluate whether fecal coliform water quality objectives is being met in the subject water bodies (USEPA, 2010). *E. coli* data was collected by CCAMP in the 2005-10 monitoring cycles of Arroyo de la Cruz. Table 2-5 summarizes USEPA recommended bacterial water quality criteria for the protection of human health in recreational waters.

Table 2-5. USEPA recommended criteria for E. coli.

Indicator	Risk Level	Geometric Mean Density (per 100 mL)	Single Sample Maximum Allowable Density (per 100 mL)[a]			
			Designated Beach Area (75th percentile)	Moderate Full Body Contact Recreation (82nd percentile)	Lightly Used Full Body Contact Recreation (90th percentile)	Infrequently Used Full Body Contact Recreation (95th percentile)
E. coli	8	126[b]	235	298	409	575

Source: U.S. EPA (1986).
a. Calculated using the following: single sample maximum = geometric mean * 10^(confidence level factor * log standard deviation), where the confidence level factor is: 75%: 0.675; 82%: 0.935; 90%: 1.28; 95%: 1.65. The log standard deviation from EPA's epidemiological studies is 0.4 for fresh waters.
b. Calculated to nearest whole number using equation: geometric mean = antilog_{10} [(risk level + 11.74) / 9.40].

USEPA recommends that California use USEPA's Ambient Water Quality Criteria for Bacteria (1986) when there is no adopted *E. coli* standard (USEPA, 2010). Specifically, USEPA recommends that for REC1 uses the following criteria be used:

> Steady state geometric mean indicator density - 126 indicator densities/100ml
> Designated beach area (upper 75% confidence limit) - 235 indicator densities/100ml (EPA, 1986, Table 4, pp.15)

Additionally, USEPA has provided guidance in using the recommended *E. coli* criteria to evaluate whether water bodies are impaired (Mary Adams, Central Coast Water Board, December 2007, personal communication). USEPA recommended having at least three samples in a 30-day period to apply the geometric mean criteria of 126 MPN/100mL. If three samples in a 30-day period were not available, USEPA recommends using the concentration of 235 MPN/100mL as a benchmark, with the number of exceedances of 235 MPN/100mL needed to assert impairment increasing with the number of available data. Note from Table 2-4 that at least five data and exceedances are required to assert impairment. Accordingly, Table 2-6 summarizes the number and percent of samples that exceeded water quality criteria for fecal coliform and *E. coli* in Arroyo de la Cruz.

Table 2-6. Fecal Indicator Bacteria samples exceeding water quality objectives.

Waterbody	**Fecal Coliform Exceedances**	
Arroyo de la Cruz @ 310ADC	Number of Samples Exceeding 400 MPN/100mL	% of Samples Exceeding 400 MPN/100mL
	3 of 59	5%
	E. Coli **Exceedances**	
	Number of Samples Exceeding 235 MPN/100mL	% of Samples Exceeding 235 MPN/100mL
	8 of 42	19%

Figure 2-6 presents a statistical summary of the water quality data for fecal coliform at monitoring site 310ADC. The box and whiskers plot illustrates a statistical representation of the data and indicates that the nature of the *E. coli* impairment is quite moderate, and not routine or severe.

Figure 2-6. Statistical summary of fecal indicator bacteria water quality data.

Statistical Summary – Fecal Coliform				
No. of Samples	**Minimum**	**Mean**	**Median**	**Maximum**
59	2	214	40	5000

Statistical Summary – *E. coli*				
No. of Samples	**Minimum**	**Mean**	**Median**	**Maximum**
42	2	181	26	1700

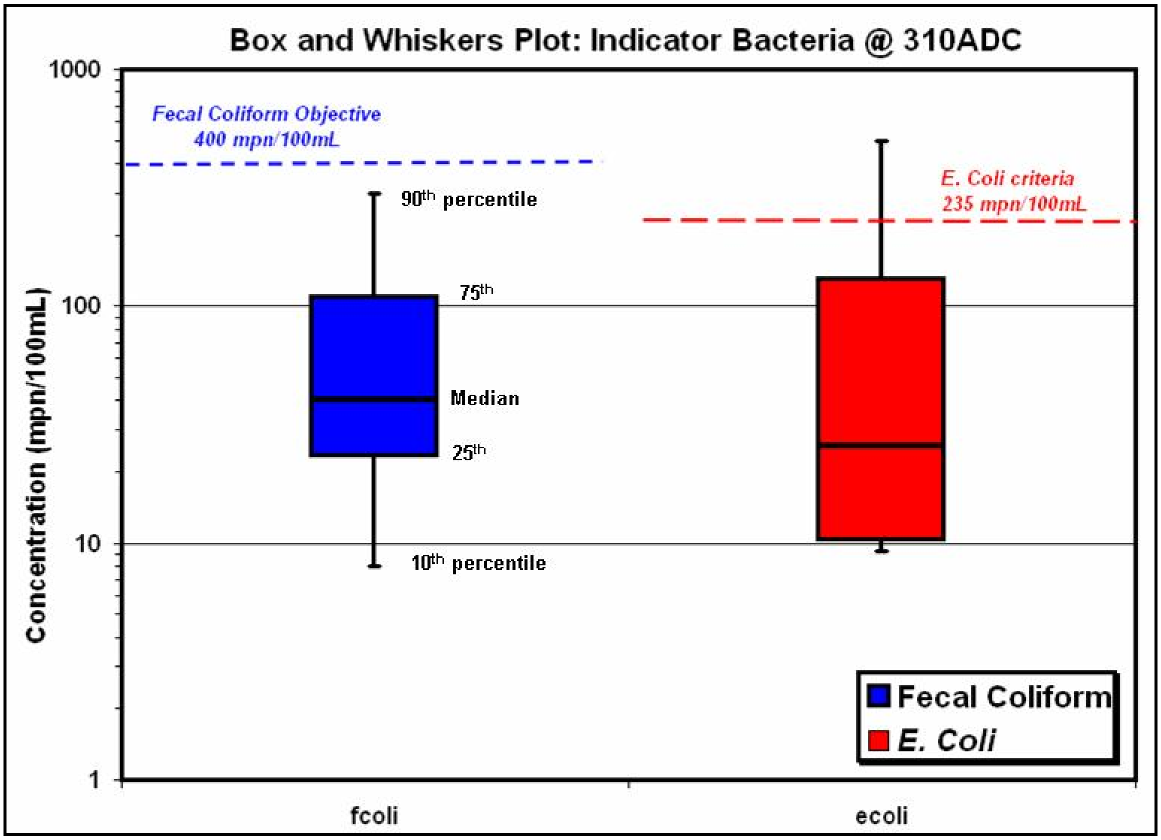


Table 2-7 presents staff's conclusions regarding impairment status. Arroyo de la Cruz is confirmed by staff as an impaired water body due to *E. coli* indicator bacteria, and is also currently listed as impaired on the 2010 303(d) list.

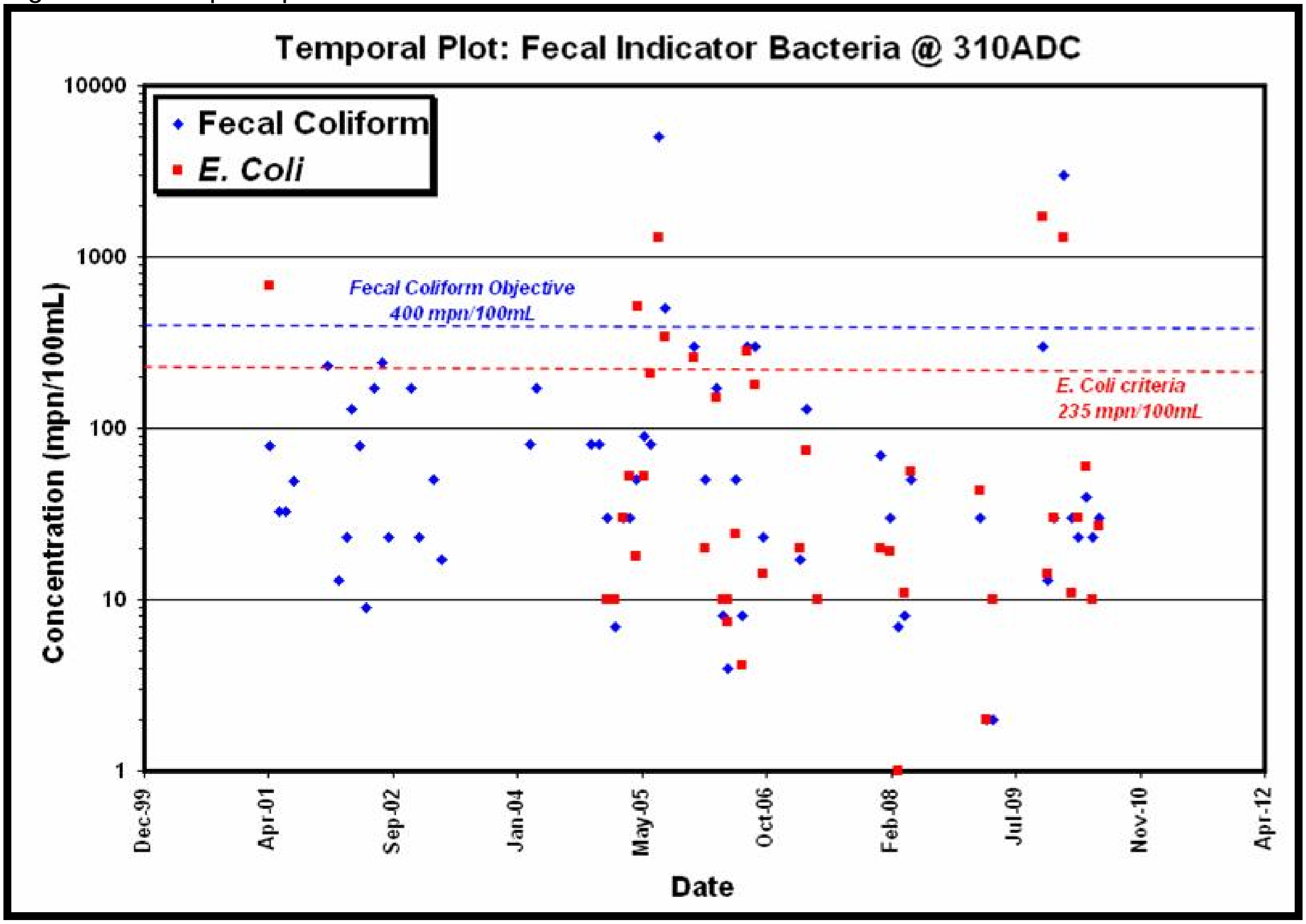
Table 2-7. Confirmed impaired waterbodies.

Waterbody	**Waterbody Identification (WBID)**	**Exceeding a water quality objective or recommended level?**	**Water quality objective or USEPA criteria exceeded?**		**Currently listed on 303(d) list?**
			Fecal Coliform	***E. Coli***	
Arroyo de la Cruz	CAR3101201320020117141339	YES	NO	YES	YES

2.4.2 Water Quality Temporal Trends

Figure 2-7 illustrates a temporal plot of fecal indicator bacteria water quality data from monitoring site 310ADC. Qualitatively, based on this dataset, the magnitude of the indicator bacteria impairment is quite modest and does not appear to have changed substantially between the monitoring cycles.

Figure 2-7. Temporal plot of fecal indicator bacteria data.



2.4.3 Problem Statement

Waterbodies in the Arroyo de la Cruz watershed are impaired due to exceedance of *E. coli* water quality criteria. Consequently, water the Basin Plan general toxicity objective is not being protected (see Section 3). However, the nature of the impairment appears to be quite moderate and exceedances of *E. coli* water quality criteria are not routine. This project identifies the causes of impairment and describes solutions to achieve water quality objectives and protection of beneficial uses.

TMDLs, numeric targets, and allocations are established for *E. coli* and fecal coliform in this project. This TMDL addresses the 303(d) listings of impairment due to *E. coli* in Arroyo de la Cruz creek, WBID number CAR3101201320020117141339.

3 NUMERIC TARGETS

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

<u>Fecal coliform</u>
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.

Available datasets often do not contain five samples in a 30-day period, so the portion of the objective that is evaluated is that "no more than ten percent of total samples during any 30-day period exceed 400/100 mL." In instances where fewer than five samples were collected in 30 days, the "ten percent" threshold is exceeded if any one sample exceeds 400/100 mL.

The Arroyo de la Cruz watershed is impaired due to *Escherichia coli* (*E. coli*), but is meeting fecal coliform water quality objectives based on CCAMP data (see Section 2.4.1). *E. coli* is one species within the broader category of fecal coliform bacteria and monitoring data for *E. coli* can be used to evaluate whether fecal coliform water quality objectives are being met in the subject water bodies (USEPA, 2010). For example, USEPA has recommends that California use EPA's Ambient Water Quality Criteria for Bacteria (1986) when there is no adopted *E. coli* standard. Note that the Basin Plan does not have a specific *E. coli* objective; however the Basin Plan has a general toxicity objective applicable to all inland surface waters and estuaries, which states:

"All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board."

Because illnesses are considered detrimental physiological responses in humans, the narrative toxicity objective applies to fecal indicator bacteria. *E. coli* is an indicator for disease causing pathogens. The United States Environmental Protection Agency (USEPA) published revised bacteria guidance in 1986 that recommends *E. coli* water quality criteria to protect bathers from gastrointestinal illness in fresh recreational waters. USEPA based its revised criteria guidance on a review of epidemiological studies relating gastrointestinal illness to specific bacterial indicators. Generic *E. coli* bacteria are not a direct cause of illness, but high concentrations of *E. coli* in fresh water that exceed water quality criteria indicate a higher risk of infectious diseases. The use of USEPA's *E. coli* criteria as a numeric target to assess if water quality objectives are being maintained and protected in Arroyo de la Cruz is therefore appropriate based on the Basin Plan's narrative toxicity objective. Based on the information presented in Section 2.4.1, *E. coli* data from Arroyo de la Cruz indicate that Basin Plan narrative toxicity objective is not being supported. It is worth noting again, that the impairment by *E. coli* appears to be quite moderate.

USEPA has recommended that California use USEPA's Ambient Water Quality Criteria for Bacteria (1986) when there is no adopted *E. coli* standard. The USEPA freshwater guidance for *E. coli*, (USEPA, 1986), and thus the *E. coli* numeric target used to develop the TMDLs for the Arroyo de la Cruz watershed is:

<u>E. coli</u>
Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of E. coli densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using

the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986)

Note that currently the State Water Resources Control Board is working on a statewide policy for bacteria standards for water contact recreation in fresh waters, which may include replacing fecal coliform water quality objectives with a revised indicator organism (*E. coli* and/or enterococci) and risk protection level. Adoption of *E. coli* objectives will be considered through the Basin Planning process which necessarily entails compliance with California Water Code Section 13241, which requires the consideration of a number of factors, including economics, when setting or revising water quality objectives. In addition, while the *E. coli* TMDL numeric target shown in above is an interpretation of an existing narrative water quality standard, it is not a water quality standard itself, and is not directly enforceable against dischargers absent a corresponding Porter-Cologne or NPDES permitting authority (SWRCB, Office of Chief Counsel, 2002a).

Consequently, TMDL compliance via *E. coli* and fecal coliform numeric targets proposed here will sunset and be superseded by revised bacterial indicator objectives when the State Water Resources Control Board adopt statewide revised bacterial indicator water quality objectives through the Basin Planning process.

4 SOURCE ANALYSIS

4.1 Inventory of Fecal Indicator Bacteria Producers

Fecal coliforms and *E. coli* are produced by all warm-blooded animals. The first step in this source analysis is to compile population estimates and the amounts of *E. coli* produced by each animal type in the Arroyo de la Cruz watershed.

Table 4-1 summarizes the inventory of major producers (humans, pets, livestock, and wildlife) of fecal indicator bacteria in the project area. The amount of fecal coliform produced by individual animal species is obtained from scientific literature as identified in Appendix D: *Fecal Indicator Bacteria Producer Inventory Data*. Daily fecal coliform production is converted to *E. coli* consistent with the methodology of Rifai (2006) – see footnotes in Table 4-1. The methodologies used in compiling the animal inventories are described in Appendix D: *Fecal Indicator Bacteria Producer Inventory Data*. The goal of compiling an inventory is ultimately to assess the potential relative magnitudes of contributions of non-controllable (natural background) loads, and controllable (anthropomorphic) loads to waterbodies.

It is important to emphasize that there is uncertainty in these population estimates; they are approximations based on census statistics and estimated wildlife population densities. It is not practical or possible to precisely quantify project area-specific populations of humans, wildlife and livestock in most pathogen TMDL projects. However, these approximations are based on widely accepted methodologies that have been previously used in numerous USEPA and State-approved pathogen TMDLs.

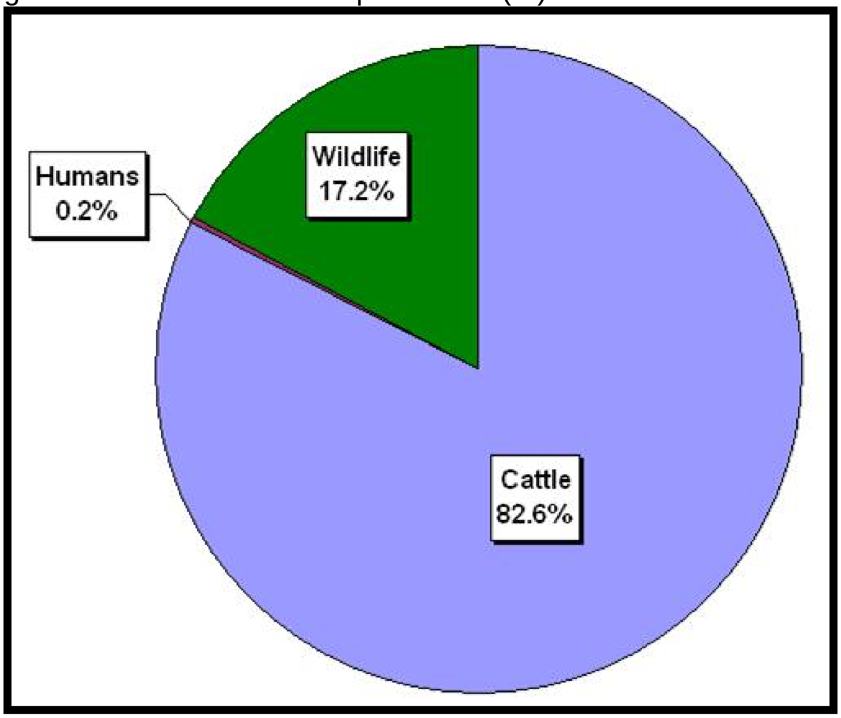
Table 4-1. Fecal indicator bacteria producer estimated inventory.

Category	**Sub-Category**	**Estimated Population**	**Source of Population Estimate**[A]	**Fecal Coliform produced per Individual/day (cfu)**[B]	***E. coli* produced per Individual/day (cfu)**[C]
Livestock	Cattle	341	Hearst Ranch website	3.3 E+10	2.08 E+10
Humans	OSDS	12	U.S. Census Bureau 2000 Decennial Census	2.0 E+09	1.26 E+09
	Sewered	0			
Wildlife	Deer	273	California Dept. Fish and Game	3.5 E+08	2.21 E+08
	Feral Pig	164	California Dept. Fish and Game	1.1 E+10	6.93 E+09
	Coyotes	27	Gese et al. (1989); Babb et al. (1989)	4.50E+08	2.84 E+08
	Raccoons	420	California Dept. Fish and Game	5.0 E+07	3.15 E+07
	Opossum	233	Kissell and Kennedy (1992)	Assume equal to Raccoon	Assume equal to Raccoon
	Skunk	317	Ontario Ministry of Natural Resources (1987)	2.50E+07 Muskrat value, assume skunk=muskrat	1.58 E+07
	Wild Turkey	352	California Dept. Fish and Game	9.3 E+07	5.86 E+07
	Duck (peak season)	93	Estimated from California Det.. of Fish and Game (2008)	2.40E+09	1.51 E+09
	Geese	9	Assume = approx. 10% of Duck population, based on Calif. DFG Waterfowl Hunt Results Report (2007), which indicates Geese harvest is typically around 10% of Duck harvest[J]	8.00E+08	5.04 E+08
	Other bird	Reliable estimates of numbers for other birds were not available. To attempt to account for the fecal coliform bacteria that would be produced by other birds, an equivalency to all wild turkey in the project area was assumed.		Assume equivalency to all wild turkey in project area.	Assume equivalency to all wild turkey in project area.
	Other mammal	Reliable estimates of numbers for other mammals were not available. To attempt to account for the fecal coliform bacteria that would be produced by other wildlife, an equivalency to all deer in the project area was assumed.		Assume equivalency to all deer in project area.	Assume equivalency to all deer in project area.

A - Citations and Links to Sources of Population Estimates: See Appendix D: *Fecal Indicator Bacteria Producer Inventory Data*.
B – References for fecal coliform production, see Appendix E: *Bacteria Source Load Calculator (BSLC) Spreadsheets*
C – Fecal coliform daily production converted to *E. coli* using ratio of the geometric means for water quality criteria (126/200) in accordance with methodology used by Rifai, 2006.

Figure 4-1 shows the relative proportion of *E. coli* production by animal source group. It is important to note, that Figure 4-1 represent the total amount of E. coli produced, not the amount delivered to surface waters. The estimates of the proportion of *E. coli* potentially delivered to surface waters will be developed in subsequent sections of this TMDL project report.

Figure 4-1. Estimated *E. coli* production (%)



To estimate the relative proportion of FIB delivered to surface waters from the various fecal indicator bacteria sources in the project area a spreadsheet tool, and some simplifying assumptions were used to assess potential load contributions.

The load to land and load to stream contribution of *E. coli* nonpoint sources were estimated with the Bacteria Source Load Calculator (BSLC) spreadsheet, available from the Virginia Tech University Center for TMDL Studies. BSLC characterizes how bacterial loads are spatially and temporally distributed in the watershed from user input, and processes the source data to calculate 1) non-point source fecal coliform loads to land; and 2) fecal coliform loads to stream from direct in-stream deposition. Note that the BLSC spreadsheet was modified to use the E. coli daily production rates from Table 4-1 for animals, in place of the spreadsheet default fecal coliform production rates. The BSLC spreadsheet calculations and input parameters are included in Appendix E: *Bacteria Source Load Calculator (BSLC) Spreadsheets*. BSLC itself does not simulate die-off once bacteria reach the land surface. However, attenuation of bacteria prior to runoff into streams was incorporated by comparing the *E. coli* totals deposited on land, to reasonable area loading rates found in published literature (Horner, 1992 as reported in Shaver et al., 2007; New Jersey Dept. of Environmental Protection, 2008).

Accordingly, staff approximated attenuation of *E. coli* prior to discharge into surface waters by using delivery ratios previously developed in the Central Coast Water Board's Total Maximum Daily Load for Fecal Coliform for the Lower Salinas River Watershed project report (Central Coast Water Board, 2010). Estimated delivery ratios of pollutants to receiving surface waters are a commonly used methodology to approximate attenuation of pollutants deposited on land

and subject to distance attenuation, die off, and/or filtering prior to discharging to the surface waterbody (for example, Watershed Treatment Model, 2002; Minnesota Pollution Control Agency, 2002; Minnesota State University, 2007).

As such, for the Arroyo de la Cruz project area the fractional amount of total *E. coli* potentially discharged to surface water is estimated by multiplying the total *E. coli* produced from sources in the BSLC spreadsheets by the estimated delivery ratio shown in. Table 4-2. The results of the BSLC calculations are shown in Appendix E: *Bacteria Source Load Calculator (BSLC) Spreadsheets*.

Table 4-2. *E. coli* delivery ratios.

Land Use / Source Category	**Delivery Ratio:** % of Total *E. coli* Potentially Available for Runoff/Discharge to Surface Water
Crops	**5%**
Pasture Grassland Rangeland	**0.1%**
Forest	**0.7%**
Direct In-Stream Defecation	**100%***

* livestock/wildlife defecation into a stream is assumed to have a 100% delivery ratio, because all fecal coliforms are discharged directly into the surface water body, with no opportunity for attenuation.

The delivery potential ratios in Table 4-2 should be considered gross screening-level approximations of the “averaged” fractional amounts of fecal material potentially available for delivery to surface waters. This is an important distinction, because there remains substantial uncertainty about the exact relationship between FIB loads observed in overland runoff, and the water column FIB loads observed in streams. In many reported studies, it is not clear whether the monitored overland flow ultimately discharges to a waterway or simply infiltrates into the soil at some point down the hill slope. The uncertainty associated with delivery hinders quantification of the overland flow contribution to FIB loading of streams (Collins, et al. 2005).

4.2 Point Sources

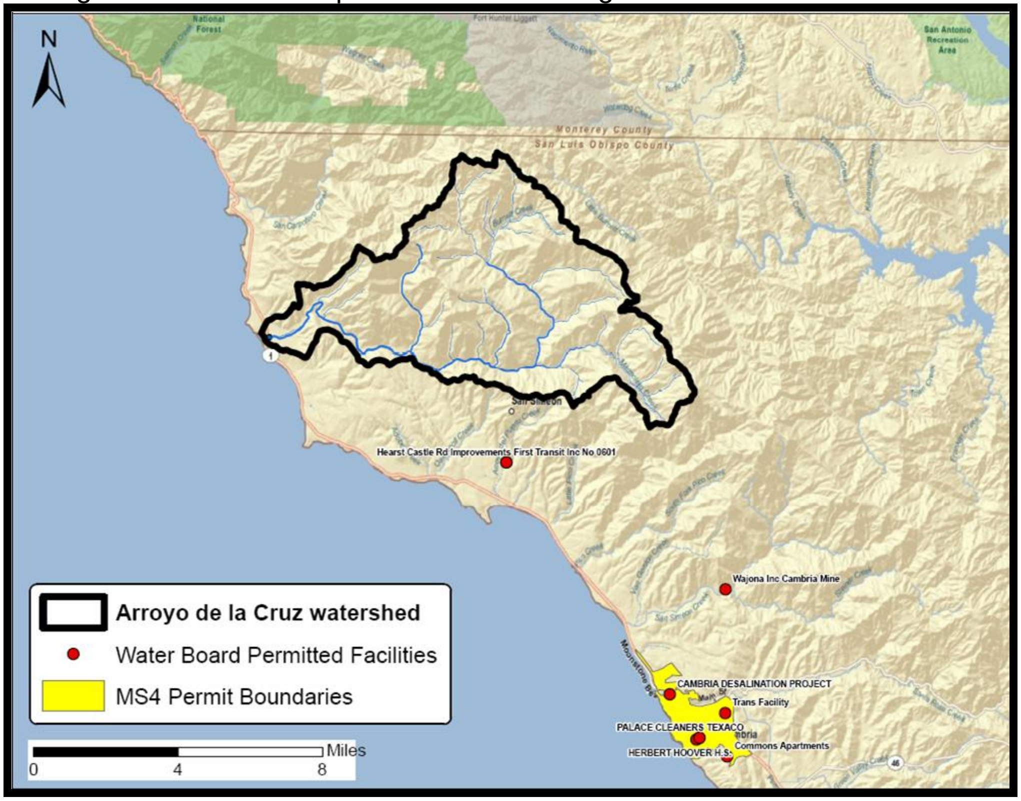
4.2.1 Entities Subject to Waste Discharge Permits

Discharges from wastewater point sources can be a significant source of anthropogenic FIB loads to surface waters (USEPA, 1999). However, in the Arroyo de la Cruz watershed there are no waste water treatment plants (WWTP), sanitary sewer collection systems, permitted industrial discharges, concentrated animal feeding operations (CAFO) or other NPDES-permitted dischargers (see Figure 4-2). As such, no wasteload allocations are developed for these source categories.

4.2.2 MS4 Storm Water Permits

There are no census designated urbanized areas or NPDES permitted MS4 stormwater entities in Arroyo de la Cruz watershed as illustrated in Figure 4-2 As such, no wasteload allocations are developed for these source categories.

Figure 4-2. Permitted point source dischargers.



4.3 Nonpoint Sources

4.3.1 Domestic Animal Discharges

Livestock such as cattle, goats, and horses spend most of their time grazing on pasture or rangeland. It has been well established that grazing livestock can be a significant, diffuse source of fecal indicator bacteria loads to surface waters (Baxter-Potter and Gilliland, 1988; Rosen, 2000). Runoff from rainfall washes some of the manure deposited in the pastures into drainage features and nearby surface water bodies. Additionally, cattle and other animals are often allowed access to streams and ponds. Direct manure deposition may occur when cattle cross a stream, or through sporadic incursions into the stream channel for water or shade. Fecal material deposited directly into surface waterbodies may be a significant source of fecal indicator bacteria loads, in addition to the surface runoff from rangeland or pasture.

It is important to note that Staff acknowledges the work done by California Cattleman's Association, the Central Coast Rangeland Coalition, the Monterey County Cattlemen's Association, Conservation Districts, Natural Resource Conservation Districts, University of California Cooperative Extension, and rangeland managers within the Central Coast region. These entities have provided and attended educational courses, provided research and funding assistance to rangeland managers, and have reportedly implemented rangeland management practices to improve water quality. The California Cattlemen's Association has developed a draft Nonpoint Source Grazing management strategy, containing information and strategies to manage pollutant loads from lands with domestic animals. In spite of some water quality issues associated with rangeland, staff acknowledges that it is widely accepted among many resource professionals that well-managed rangeland in California's central coast region can have significant ecological and land use benefits overall.

Grazing lands comprise the overwhelming majority of land use in the Arroyo de la Cruz watershed. 62% of the land cover supports grazing lands, according to the 2008 FFMP land cover data set (see Section 2). The vast majority of the remainder of land cover is classified as forest or undeveloped lands. The FMMP land cover is a digital dataset depicting the location and extent of grazing lands, and is compiled by the California Department of Conservation, in cooperation with the California Cattlemen's Association and the University of California Cooperative Extension.

Water Board staff have routinely observed evidence of grazing cattle in and around Arroyo de la Cruz at monitoring site 310ADC, including observations of cows upstream of monitoring site 310ADC, and evidence of cattle in the in stream (cow tracks and cow manure in the creek) (personal communication, Erin Sanderson, CCRWQCB Dec. 1, 2010; Mary Adams, CCRWQCB Dec. 17, 2010). These visual observations indicate that cattle manure is a probable source of fecal indicator bacteria loads to the water body. It should be noted that in recent years the property owner(s) appear to have installed barbed wire fencing along the creek which presumably indicates management practices to exclude cattle from the riparian area.

Using the BSLC spreadsheet tool, and delivery assumptions outlined in Section 4.1, the estimated annual potential load to Arroyo de la Cruz from domestic animals is shown in Table 4-3. The total amount of *E. coli* available for potential discharge is obtained by multiplying the total amount of livestock fecal coliform deposited to pasture/rangeland or stream (from BLSC spreadsheets), and multiplying it by the delivery potential (%) shown in Table 4-2.

Table 4-3. Estimated annual *E. coli* bacteria load from domestic animals available for potential discharge into surface waters.

	Domestic Animal *E. coli* Available for Potential Discharge (MPN/year)		**Total *E. coli* Available**
Subwatershed	Pasture/Rangeland	Direct In-stream Defecation	
Arroyo de la Cruz watershed	3.19E+12	1.42E+13	**1.74E+13**

Given the information presented above, staff concludes that livestock and other domestic animals are probable source categories of indicator bacteria in surface waters of the project area. As such, this source category is assigned a load allocation in this TMDL. Actions to control these sources are included in the Implementation Section.

4.3.2 Confined Animal Facilities

Animal waste associated with confined animal operations (feedlots, dairies, etc.) can constitute a potential significant source of fecal indicator bacteria loads to surface waters. Unregulated or poorly managed confined animal facilities on a unit area basis (e.g., per acre) can typically be a higher pollutant loading risk than lightly grazed rangeland. The California Department of Water Resources (DWR) Agricultural Land Use Survey program has compiled digitized crop data which identify the locations of feed lots, dairies, and poultry facilities. The digital DWR crop data can be downloaded from:

http://www.water.ca.gov/landwateruse/lusrvymain.cfm

According to the most recent vintage DWR crop map data available for the project area, there are no livestock feedlots, dairies, or poultry facilities in the Arroyo de la Cruz watershed. As such, this source category is not assigned a pollutant load allocation in this TMDL.

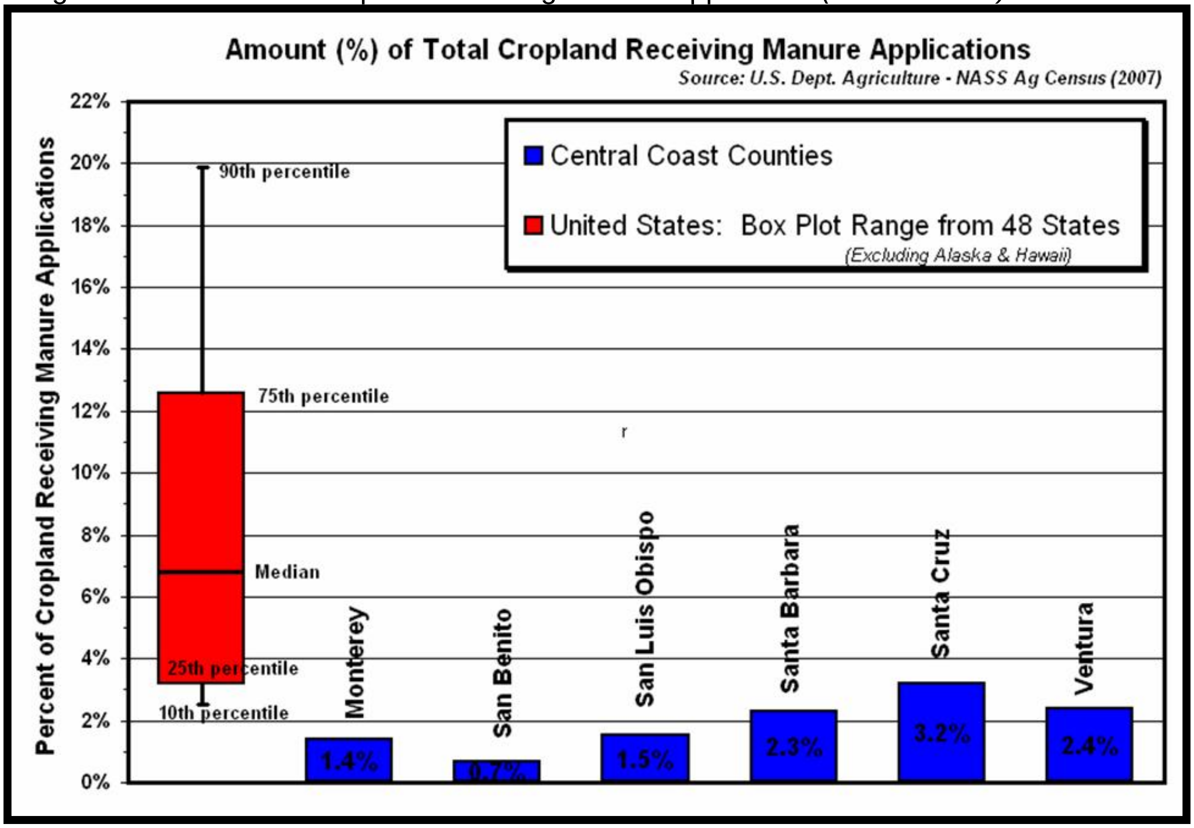
4.3.3 Cropland and Manure Application

It is widely accepted that a major risk of controllable pathogen loading from croplands is associated with application of raw or untreated manure, or the improper storage of manure (USEPA, 2001). However, less than 1% of the Arroyo de la Cruz watershed's land cover is comprised of cropland.

Furthermore, the Resource Conservation District (RCD) of Monterey County reports that raw manure application in the Central Coast region has been largely phased out (Monterey County RCD, 2006). To validate the RCD reporting, staff evaluated 2007 county-level agricultural census data available from the U.S. Department of Agriculture National Agricultural Statistics Service (NASS) database (www.nass.usda.gov). Staff presumed that reported manure application practices at the San Luis Obispo county scale is representative of manure application rates/practices croplands of the Arroyo de la Cruz watershed of northernmost San Luis Obispo county. NASS reports that in San Luis Obispo county, only 1.5%% of total cropland acreage received manure application. In fact, the overwhelming majority of farms in these counties with irrigated cropland used inorganic chemical fertilizers, lime, or soil conditioners (CalFERT, 2007; NASS 2007).

For comparative purposes, staff evaluated NASS census data for manure application in the entire conterminous United States. Ranges of manure application rates in other states were significantly higher relative to the manure application rate in San Luis Obispo County (see Figure 4-3). In fact, the manure application rate in San Luis Obispo county is well below the 10th percentile (i.e., the extreme low end range) of manure application rates reported in the entire conterminous United States. Additionally, although NASS doesn't report the exact nature or type of manure application, it is probable that most, or at least some fraction, of the acreage in San Luis Obispo County receiving manure application were with treated or composted manure, rather than raw manure (for example, see CalFERT, 2007). Treated or composted manure typically have negligible pathogen content, since the composting process involves the removal of the pathogenic fraction of the raw stock manure.

Figure 4-3. Percent of cropland receiving manure application *(source: NASS).*



In summary, based on the small amount of cropland in the subwatershed, and considering that raw or untreated manure application is evidently negligible, staff concludes that agricultural cropland operations are not a significant source of controllable fecal indicator bacteria loads contributing to exceedance of water quality objectives in the Arroyo de la Cruz watershed. Consequently, this source category is not assigned to the load allocation in this TMDL. Staff recognizes that fecal material from natural wildlife sources is deposited on cropland, and potentially mobilized in runoff. Natural background has been identified as a source and will be assigned a load allocation. It is important to note that non-controllable natural background loads are not subject to regulatory actions by the Water Board.

4.3.4 Onsite Disposal Systems

Onsite disposal systems (i.e., septic systems) can potentially contribute significant pathogen loads to receiving surface waterbodies due to leakage or system failure (USEPA, 2001). However, due to the negligible human population and housing in the Arroyo de la Cruz watershed (see Section 2.1.6) it does not appear to be plausible that onsite disposal systems are causing or contributing to the *E. coli* impairment. As such, this source category is not assigned to the load allocation in this TMDL.

4.3.5 Sediment Sources (Bedload)

Stream and lake sediments can serve as an environmental reservoir for fecal coliform and other indicator bacteria. In previous central coast pathogen TMDLs, staff has received recommendations from scientific peer reviewers to consider including sediment resuspension of indicator bacteria as a distinct nonpoint source load (Wuertz and Schriewer, 2009).

Surviving fecal coliforms deposited in sediments and organic material at some time in the past, and which are not attributable to a recent pollution event, could be swept up into the water column due to a resuspension event. This may constitute a naturalized source of fecal indicator bacteria stream loads, referred to in this section as "bedloads". Sediments can be resuspended when shear stress exerted on the stream bed exceeds the critical shear stress for incipient motion. This scouring results in stream sediment with associated indicator bacteria being resuspended, and thus contributing to the overlying water column concentrations of fecal coliform.

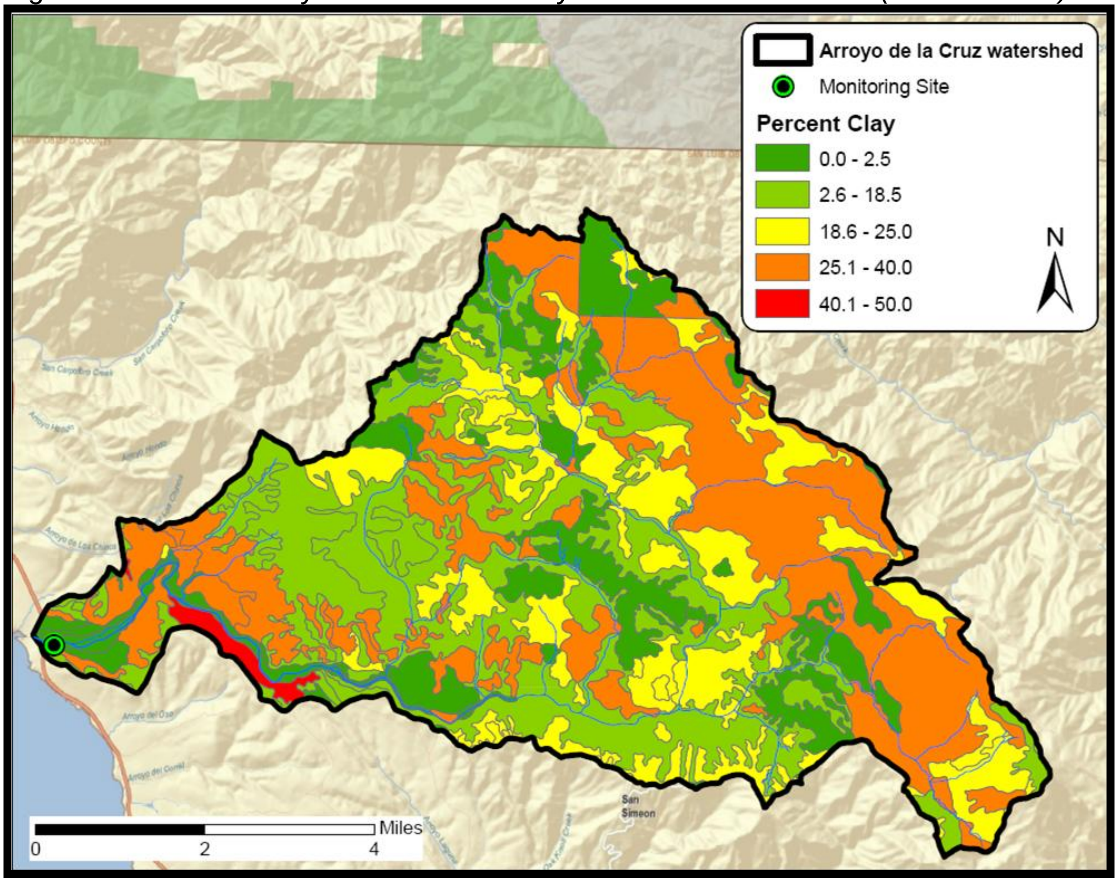
Staff considers the fecal indicator bacteria resulting from propagation and multiplication from controllable sources to be a naturalized source. Staff does consider these indicator bacteria controllable, insofar as the parent coliforms are from controllable sources. It is reasonable to presume that a substantial fraction of sediment-associated indicator bacteria originally came from controllable sources given that the overwhelming majority of fecal indicator bacteria production in the project area appears to be from anthropogenic activities and domestic animal operations (refer back to Figure 4-1).

There is uncertainty about the scope and extent of this source in the project area, and the potential for propagation of microbial indicators deposited in sediment or organic matter in the Arroyo de la Cruz watershed is largely unknown at present. However, using GIS spatial data for soils it is possible to develop screening-level assessments of the potential risk of sediment-associated *E. coli* sources in the Project Area.

Sediment-associated bacteria are typically associated with fine, or cohesive sediment particles in aquatic environments (Gannon, et al., 1983; Wilkinson et al., 1995). Cohesive sediments are defined as sediment particles less than 60 microns in diameter; this generally includes silt-sized and clay-sized particles (NRCS, 1999). Typical flow velocities that cause streambed erosion of fine-grained sediments range from 3.0 feet/sec for silty loams to 5.0 feet/sec for colloidal clays and silts (City of Raleigh, 2003).

Therefore, based on the aforementioned literature, staff presumes that locations in the project area comprised of soils with ≥40% clay-sized particles would constitute potential significant source areas of sediment-associated bacteria loads. The 40% clay content criterion was chosen by staff because this is consistent with published U.S. Department of Agriculture (USDA) soil criteria. The USDA's soil texture chart classifies soils with greater than 40% clay content as clay, silty-clay, or sandy-clay depending on the fractional content of sand or silt: http://soils.usda.gov/technical/aids/investigations/texture/ Soil characteristics are contained in the Monterey County Soil Survey, published by the Natural Resources Conservation Service (NRCS), and the Soil Survey Geographic (SSURGO) database for soils. Staff used NRCS soil attribute data to geographically locate regions characterized predominantly by clay-rich soils in the project area (see Figure 4-4).

Figure 4-4. Percent clay in soils in the Arroyo de la Cruz watershed *(source: NRCS)*



The NRCS soil data indicates that only 1% of soils in the Arroyo de la Cruz watershed TMDL project area are comprised of soils containing greater than 40% clay materials (see Table 4-4). Therefore, there does not appear to be a substantial amount of fine-grained, cohesive sediment particles within the project area, and sediment associated bacteria loads at the watershed-scale are presumably negligible. .

Table 4-4. Percent of TMDL project area comprised of clay-rich soils.

Arroyo de la Cruz watershed (acres)	Amount of Subwatershed Comprised of >40% Clay Soils[A] (acres)	Percent of Subwatershed Soils Comprised of > 40% Clay Soils
27,304	272	**1%**

A- Corresponds to USDA soil texture classifications as: clay; silty-clay; or sandy-clay.

However, because virtually all of clay rich soil that do occur in the TMDL project area are located directly upstream of monitoring site 310ADC (see Figure 4-4), staff consider it prudent to include sediment-associated bacteria loads as a probable source category for the water column concentrations observed from 310ADC. The loads associated with resuspension of sediment (bedloads) can be estimated using the Bacteria Load Estimation Spreadsheet (BLEST) tool, developed by the Texas Commission on Environmental Quality. The methodology for calculating bedloads with BLEST is detailed in Appendix F: *Bedloads - Bacteria Load Estimator Spreadsheets (BLEST)*. By multiplying the occurrence of resuspension flows (i.e., storm events), bacteria resuspension rates, estimates of the length of time the stream experiences critical shear conditions, and estimates of stream width and stream lengths, estimated fecal indicator bacteria bedloads were calculated as shown in Table 4-5.

Table 4-5. Estimated *E. coli* bacteria bedloads.

Waterbody	Ave. No. of Storm Events/Year*	Median *E. Coli* Resuspension Rate (MPN m^{-2} sec^{-1})**	MPN / Storm Event	Annual Bedload (MPN/yr)
Arroyo de la Cruz @ 310ADC	8	11,000	4.78E+11	**3.82E+12**

* Average number of annual precipitation events $\geq$ 0.5 inches in 24 hour period, 2001 to 2010 (source: daily precipitation data from San Luis Obispo West CIMIS weather station #160) , available from California Irrigation Management Information System)

** Jamieson et al. (2005*)*.

In summary, based on the information presented above, staff considers bacteria from resuspended sediments (bedload) to be a probable source contributing to observed indicator bacteria loads in the water quality monitoring data from Arroyo de la Cruz. As such, sediment sources are assigned to the load allocation for this TMDL.

4.3.6 Non-controllable Natural Sources

Wildlife (mammals and birds) contribute a background level of fecal indicator bacteria to surface waters. Wastes from wildlife may be carried into nearby streams by runoff during rainfall. Animals can also defecate directly into streams. These constitute non-controllable natural sources not subject to regulation by the Water Board.

Some uncertainty exists whether the non-controllable fraction of fecal indicator bacteria alone is causing receiving water concentration of *E. coli* to exceed the numeric target. The ability to differentiate between controllable and natural sources is an uncertainty in these TMDLs. This phenomenon represents an uncertainty that staff has attempted to address through an empirical analysis of land use data, sources of fecal indicator bacteria (humans, wildlife, livestock), hydrologic data, livestock and wildlife inventory data in this Project Report.

Using the species-specific *E. coli* production and the delivery ratio assumptions outlined in Section,4.1 and the calculations from the BSLC spreadsheet tool, the annual amount of *E. coli* that is potentially available for runoff or discharge into surface waters is shown in Table 4-6.

Table 4-6. Estimated annual *E. coli* bacteria load from wildlife available for potential discharge into surface waters.

Watershed	Wildlife *E. coli* Available for Potential/Discharge (MPN/year)				Total *E. coli* Available
	Forest	Cropland	Pasture/ Rangeland	Direct In-stream Defecation	
Arroyo de la Cruz watershed	1.41E+12	2.20E+11	2.78E+11	1.26E+13	**1.45E+13**

The calculated potential annual load of 1.45E+13 mpn/year is less than the potential contribution from domestic animals (see Section 4.3.1), but the magnitude nonetheless represents a substantial load to surface waters in the project area.

In summary, staff concludes that wildlife is a source category of indicator bacteria in surface waters of the project area. As such, this source category is assigned a load allocation in this TMDL. Loads from non-controllable natural sources are not subject to regulation by the Water Board.

4.4 Summary of Sources

Table 4-7 shows the summary of identified sources of indicator bacteria in the Arroyo de la Cruz watershed TMDL project area. Staff listed the sources by source category and the estimated proportional magnitude of *E. coli* loads. The source loads are staff estimates based on the amounts of *E. coli* that are available to potentially be discharged to surface waters from various sources. It is worth reiterating that these estimates are for the amount of fecal indicator bacteria *potentially* available for discharge to surface waters; there is no attempt to make discounts for load reductions resulting from improved management practices that may already be in place along some stream reaches.

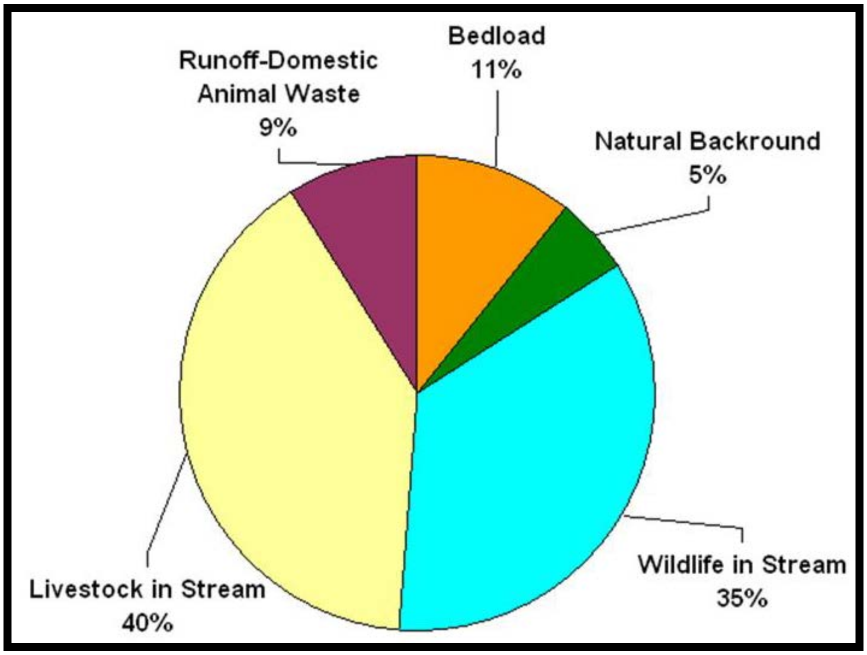
The estimated relative magnitude of identified sources are also shown graphically in Figure 4-5. As noted previously, there are uncertainties associated with such estimates. The estimated population and/or densities of fecal coliform sources are approximations based on census data, scientific literature, or indirect evidence. The delivery ratios of fecal coliform used from section 4.1 are broad approximations, derived from literature values for loading rates or best professional judgment. The Bacteria Source Load Calculator spreadsheet results represent one line of evidence in TMDL source characterization, producing a scoping level risk assessment of sources and potential loads. The amount of fecal material delivered from any one source will vary depending on numerous factors, including the degree and extent to which land and animal management practices to reduce loading are employed. Because of this uncertainty, these are estimates only as the actual loading from each source is unknown. That said however, in making these estimates Staff employed methods and techniques that are recognized by USEPA or other Agencies to develop approved TMDLs.

It is important to emphasize that these estimated amounts of fecal indicator bacteria available for discharge to surface waters represents an aggregate load for the entire Arroyo de la Cruz watershed. It is not known what proportion of the entire watershed load is actually being measured at monitoring site 310ADC. This is because bacteria flowing from the upper reaches of a watershed may have little impact on a stream reach in the lowermost parts of the watershed due to die off and attenuation. Note also that the estimated relative magnitude of potential source contributions is calculated on an annualized basis. These represent annual estimated loads from the entire watershed drainage. Loads from various source categories could have substantial variability on different seasonal and temporal scales, or due to localized conditions.

Table 4-7. Estimated annual *E. coli* bacteria from all sources available for potential discharge into surface waters (MPN/year).

	Point Sources (WLA)	Nonpoint Sources (LA)					
	None Identified	**Runoff - Domestic Animal Waste**	**Runoff- Natural Background**	**Domestic Animals In-stream**	**Wildlife In-stream**	**Bedload**	**Total**
Arroyo de la Cruz watershed	**0**	**9.30E+12**	**1.91E+12**	**1.42E+13**	**1.26E+13**	**3.82E+12**	**3.57E+13**

Figure 4-5. Estimated distribution of *E. coli* bacteria annually available for potential discharge to surface waters.



5 LOADING CAPACITY AND ALLOCATIONS

5.1 Introduction

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 fecal coliform, 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)]. Expressing the TMDL as a concentration equal to the water quality objective ensures that the water quality objective will be met under all flow and loading conditions. The density (concentration) of fecal indicator organisms in a discharge and in the receiving waters is the technically relevant criterion for assessing the impact of discharges, the quality of the affected receiving waters, and the public-health risk.

5.2 Loading Capacity

The loading capacity for water body segments in the Arroyo de la Cruz watershed is the amount of *E. coli* and fecal coliform that can be assimilated without exceeding the water quality objectives. USEPA freshwater guidance for *E. Coli* (USEPA, 1986) and the Basin Plan water quality objective for fecal coliform, and thus the loading capacity for the waterbodies are:

E. coli

Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of E. coli densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using *the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986)*

Fecal coliform
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.

5.3 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 TMDLs will result in attaining the numeric target. For these TMDLs, this link is established because the numeric target concentrations are the same as the TMDLs, expressed as a concentration. Sources of *E. coli* that lead to waterbody impairment have been identified. Therefore, reductions in fecal indicator bacteria loading from these sources should result in a reduction of water column concentrations. The numeric targets are protective of recreational beneficial uses; hence the TMDLs define appropriate water quality conditions.

5.4 TMDL Allocations

Allocations are concentrations, loads, or some other measure that when totaled, equals the loading capacity described as shown in Section 5.2. Allocations are applied to the sources identified in the Source Analysis Section.

5.4.1 Concentration-based TMDL

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 fecal coliform, 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 fecal coliform is not readily controlled on a mass basis. Establishment of a concentration-based, rather than a load-based TMDL has the advantage of eliminating the need to conduct a potentially error-prone analysis to link loads and expected concentrations. A load-based TMDL would require calculation of acceptable loads based on acceptable bacterial concentrations and expected flows, and then back-calculation of expected concentrations under various load reduction scenarios. Since flows in the Arroyo de la Cruz, are highly variable and difficult to measure, such an analysis would inevitably involve a great deal of uncertainty, with no increased water quality benefit.

As such, staff proposes the TMDLs as the same set of concentrations as staff proposed in the numeric targets section. Therefore, the concentration-based TMDLs for fecal indicator bacteria for all impaired waters in the Arroyo de la Cruz watershed, including:

The following waterbodies currently listed on the 303(d) list:

1. The Arroyo de la Cruz (the entire Creek) from the uppermost reaches of the waterbody to the confluence with the Arroyo de la Cruz estuary.

And for all tributaries to the above-named waterbodies, as well as herein un-named waterbodies situated in the Arroyo de la Cruz watershed are concentration-based TMDLs applicable to each day of all seasons and are equal to the following:

Discharges may not cause receiving water concentration of fecal indicator bacteria to exceed the following:

Table 5-1. Total Maximum Daily Loads for Fecal Bacteria Indicators, Arroyo de la Cruz.

Indicator	TMDLs
E. Coli [A]	Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of *E. coli* densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986)
Fecal Coliform	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.

[A] refer to Table 4 (page 15), and Freshwater EPA Criteria (page 16) in USEPA Ambient Water Quality Criteria for Bacteria (1986), EPA440/5-84-002

5.4.2 TMDL Allocations

Table 5-2 shows the load allocations to responsible parties. All the allocations are equal to the TMDLs, which are expressed as receiving water concentrations. As noted previously, staff proposes to implement a concentration-based TMDL, equal to the numeric targets for fecal coliform and *E. coli*.

All responsible parties for sources of fecal coliform to the Arroyo de la Cruz 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 5-2. TMDL Allocations.

WASTE LOAD ALLOCATIONS			
Waterbody	**WBID**	**Party Responsible for Allocation (Source) NPDES/WDR number**	**Receiving Water Fecal Coliform (MPN/100mL)**
All impaired water bodies[a]	CAR3101201320020117141339	NONE IDENTIFIED	NOT APPLICABLE
LOAD ALLOCATIONS			
Waterbody	**WBID**	**Responsible Party (Source)**	**Receiving Water Fecal Coliform (MPN/100mL)**
All impaired water bodies[a]	CAR3101201320020117141339	Owners/operators of land used for/containing domestic animals/livestock (Domestic animals/livestock waste)	Load Allocation-1 Load Allocation-2
All impaired water bodies[a]	CAR3101201320020117141339	No responsible party (Natural sources)	Load Allocation-1 Load Allocation-2
Wasteload Allocation: None – not applicable. Load Allocation- Allocation 1: (Equal to the TMDL for *E. coli*.): Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of *E. coli* densities should not exceed: 126 per 100mL; and no sample should exceed a one sided confidence limit (C.L.) calculated using the following as guidance: lightly used for contact recreation (90% C.L.) = 409 per 100mL (USEPA, 1986) Load Allocation - Allocation 2: (Equal to the TMDL for fecal coliform):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.			

[a] Arroyo de la Cruz: all reaches and tributaries of the waterbody to the confluence with the Arroyo de la Cruz estuary

The TMDLs are considered achieved when the allocations assigned to all individual responsible parties are met, or when the numeric targets are consistently met.

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.

5.4.3 Daily Load Expressions

Staff provides daily load expressions in light of a court decision (Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, D.C. Cir. 2006), and USEPA guidance {USEPA 2007(b)}, despite the fact that this is a concentration-based TMDL and a daily or average daily TMDL is not appropriate for this TMDL project. Mass-based daily load expressions are provided to comply with USEPA technical and legal guidance. USEPA continues to recognize the validity of concentration based TMDLs, in accordance with 40 CFR 122.45(f), but recommends supplementing a concentration-based TMDL with a daily load expression, as shown below:

> *"For TMDLs that are expressed **as a concentration of a pollutant**,* a *possible approach would be to use a **table and/or graph to express the TMDL as daily loads for a range of possible daily stream flows**. The in-stream water quality criterion multiplied by daily stream flow and the appropriate conversion factor would translate the applicable criterion into a daily target."*
>
> **emphasis added
>
> From: USEPA. 2007. Options for Expressing Daily Loads in TMDLs. USEPA Office of Wetlands, Oceans, and Watersheds, Draft Guidance, June 22, 2007.

The mass-based daily load expressions for the Arroyo de la Cruz fecal indicator bacteria TDML are presented in Appendix H: *Daily Load Expressions*. Nonetheless, we intend to implement the concentration-based TMDLs and allocations, consistent with the aforementioned USEPA guidance {USEPA, 2007(b)}. As such, daily load expressions presented in Appendix H: *Daily Load Expressions* represent an alternative way to express concentration-based allocations, but the mass-based daily load expressions do not formally constitute the TMDL or the allocations.

5.5 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 this project, a margin of safety has been established implicitly through the use of protective numeric targets, which are, in this case, the water quality objectives for water contact recreational uses.

The total and fecal coliform TMDLs for the water bodies in this project are the Water Board's Basin Plan 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 numeric targets, if achieved, these allocations will achieve the water quality objectives in the receiving water. Thus, in this TMDL there is no uncertainty that controlling the load from controlled sources will positively affect water quality by reducing the fecal indicator bacteria 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.

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.

5.6 Critical Conditions and Seasonal Variation

Critical conditions occur when the prescribed load allocation results in achieving the water quality standard by a narrow margin. The condition is considered critical because any unknown factor regarding environmental conditions or the calculation of the load allocation could result in not achieving the water quality standard. Therefore, critical conditions are particularly important with load-based allocations and TMDLs. However, this TMDL is a concentration-based TMDL. As such, the numeric targets and allocations are the concentrations equal to the water quality objectives. Therefore, there exists no uncertainty as to whether the allocations and TMDLs will result in achieving water quality objectives. Variability is accounted for and addressed by use of the allocations equal to the USEPA bacterial criteria for *E. coli* and equal to the REC-1 water quality objective which assures the loading capacity of the water body be met under all flow and seasonal conditions.

6 IMPLEMENTATION AND MONITORING

6.1 Implementation Plan

The purpose of the Implementation Plan is to describe the steps necessary to reduce pathogen loads and to achieve these TMDLs. The Implementation Plan identifies the following: 1) parties responsible for taking these actions 2) actions expected to reduce pathogen loading; 3) 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; 5) and a timeline for completion of implementation actions.

The Implementation Plan also outlines economic considerations to achieve compliance. A monitoring plan designed to measure progress toward water quality goals is included in Section 6.5.

6.2 Implementing Parties

Table 6-1 identifies the probable sources contributing to fecal coliform impairment and the parties responsible for implementation of this TMDL.

Table 6-1. Source Categories and Implementing parties.

Source Category	Implementing Parties
Livestock	Owners and Operators of Lands Containing Domestic Animals
Wildlife	Not Subject to Regulation

6.3 Existing Plans and Policies

6.3.1 California Impaired Waters Policy and Impaired Waters Guidance

The State of California *TMDL Guidance: A Process for Addressing Impaired Waters in California* (SWRCB, 2005) and the *Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options* (SWRCB, 2005) provide guidance and policy that describe the process for developing and adopting TMDLs.

The Policy states that the Water Boards *"have broad flexibility and discretion in fashioning TMDL implementation programs and are encouraged to be as innovative and creative as possible and, as appropriate, to build upon Third-Party Programs."* Accordingly, the policy indicates that in developing and adopting TMDLS the Boards may use any combination of existing regulatory tools to do so. Existing regulatory tools include individual or general waste discharge requirements (be they under Chapter 4 or under Chapter 5.5 (NPDES permits) of the Porter-Cologne Water Quality Control Act), individual or general waivers of waste discharge requirements, enforcement actions, interagency agreements, regulations, basin plan amendments, and other policies for water quality control.

In summary, the Impaired Waters Policy states that TMDLs may be adopted in any of the following ways:

1. *Multiple actions of the Water Board*: If multiple actions by the Water Board are required, the solution must be implemented through a Basin Plan amendment or other regulation.
2. *Single Vote of the Water Board*: In some circumstances a single discharger may be responsible for the impairment or a single order of the Water Board may be adequate to address the impairment. If the solution can be implemented with a single vote of the Water Board, it may be implemented by that vote. When an implementation plan can be adopted in a single regulatory action, such as a permit, a waiver, or an enforcement order, etc., there is no legal requirement to first adopt the plan through a Basin Plan amendment.
3. *Regulatory Action of Another State, Local, or Federal Agency*: If the Water Board finds that a proposed solution will correct the impairment, the Water Board may certify that the regulatory action will correct the impairment and, if applicable, implement the assumptions of the TMDL, in lieu of adopting a redundant program.
4. *Nonregulatory Action of Another Entity*: If the Water Board finds that the action will correct the impairment, the Water Board may certify that the nonregulatory action will correct the impairment and, if applicable, implement the assumptions of the TMDL, in lieu of adopting a redundant program.
5. *Voluntary Actions by Nonregulatory Entities*: Such actions are appropriate if the Water Board makes findings, supported by substantial evidence in the project record, that a program being implemented by a nonregulatory entity will be adequate to correct the impairment.

Note that in accordance with the Impaired Waters Policy, in some circumstances the Water Boards may rely upon actions by non-regulatory entities, if the Water Board makes findings that a program being implemented by a non-regulatory entity will be adequate to correct the impairment. The Impaired Waters Guidance states:

> "The fact Regional Boards have limited resources to accomplish their water quality mission can and should be used as a basis to encourage interested persons to undertake to abate impairments in the time before the Regional Boards may otherwise be able to address them…Employing these abbreviated procedures when warranted is a matter of efficiency and resource allocation. California is obligated to establish and implement 800 or more TMDLs over the next ten years for over 1,800 pollutant/water body combinations. Given existing resource constraints (both financial and personnel), to the extent California can consolidate regulatory actions or eliminate unnecessary regulatory processes when fulfilling our obligations under Section 303(d), the State and Regional Boards can expedite their responsibility to address and correct impaired waters in California, and expend resources on more TMDLs instead of redundant processes." *
>
> **Emphasis added*
>
> From: *STATE OF CALIFORNIA S.B. 469 TMDL GUIDANCE A PROCESS FOR ADDRESSING IMPAIRED WATERS IN CALIFORNIA (California State Water Resources Control Board, June 2005 - Approved by Resolution 2005-0050)*

Consequently, the State Impaired Water policy establishes a certification process whereby the Water Boards can formally recognize appropriate regulatory or nonregulatory actions of other entities as alternative implementation programs when the Water Boards determine those actions will result in attainment of standards. For alternative programs intended to control nonpoint source contributions to an impairment, such programs must be consistent with the Key Elements of an NPS Pollution Control Implementation Program (see Section 6.3.3), pursuant to the SWRCB Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program.

While the State Impaired Waters policy recognizes that certification of alternative programs of implementation may be merited as appropriate and as a matter of efficiency, it is important to emphasize the Water Board retains the authority to commence a regulatory response if an impairment has not been adequately addressed by a non-regulatory action within a specified time period. The Water Board may not indefinitely defer taking necessary action if another entity is not properly addressing a problem. Note that a regulatory response by the Water Board must use the administrative permitting authorities as outlined in the Nonpoint Source Implementation and Enforcement policy (see Section 6.3.3).

6.3.2 California Nonpoint Source Program Plan

The Nonpoint Source Program is a regulatory strategy aimed at addressing nonpoint source pollution throughout the State of California. .In July 2000 the State Water Resources Control Board and the California Coastal Commission developed the *Plan for California's Nonpoint Source Pollution Control Program* to reduce and prevent nonpoint source pollution in California, expanding the State's nonpoint source pollution control efforts. This effort represented the first significant upgrade of California’s Nonpoint Source Pollution Control Program since its inception in 1988. The Nonpoint source Program was revised to enhance efforts to protect water quality and to conform to the Clean Water Act Section 319 (CWA 319) and the Coastal Zone Act Reauthorization Amendments Section 6217 (CZARA). The lead state agencies for the NPS Program are the State Water Board, the nine Regional Water Boards and the California Coastal Commission. The NPS Program’s long-term goal is to “improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. Under the California NPS Program Pollution Control Plan, TMDLs are considered one type of implementation planning tool that will enhance the State’s ability to foster implementation of appropriate NPS management measures.

6.3.3 Policy for Implementation and Enforcement of the Nonpoint Source Program

The *Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program* adopted in August 2004, explains how Water Board authorities granted by the Porter-Cologne Water Quality Control Act will be used to implement the California NPS Program Plan (see Section 6.3.2). The *Nonpoint Source Implementation and Enforcement Policy* requires the Regional Water Boards to regulate all nonpoint sources (NPS) of pollution using the administrative permitting authorities provided by the Porter-Cologne Act. Nonpoint source dischargers must comply with Waste Discharge Requirements (WDRs), waivers of WDRs, or Basin Plan Prohibitions by participating in the development and implementation of Nonpoint Source Pollution Control Implementation Programs. NPS dischargers can comply either individually or collectively as participants in third-party coalitions. (The “third-party” Programs are restricted to entities that are not actual discharges under Regional Water Board permitting and enforcement jurisdiction. These may include Non-Governmental Organizations, citizen groups, industry groups, watershed coalitions, government agencies, or any mix of the these.) All Programs must meet the requirements of the following five key elements described in the NPS Implementation and Enforcement Policy. Each Program must be endorsed or approved by the Regional Water Board or the Executive Officer (if the Water Board has delegated authority to the Executive Officer).

Key Element 1:	A Nonpoint Source Pollution Control Implementation Program's ultimate purpose must be explicitly stated and at a minimum address NPS pollution control in a manner that achieves and maintains water quality objectives.
Key Element 2:	The Program shall include a description of the management practices (MPs) and other program elements dischargers expect to implement, along with an evaluation program that ensures proper implementation and verification.
Key Element 3:	The Program shall include a time schedule and quantifiable milestones, should the Regional Water Board require these.
Key Element 4:	The Program shall include sufficient feedback mechanisms so that the Regional Water Board, dischargers, and the public can determine if the implementation program is achieving its stated purpose(s), or whether additional or different MPs or other actions are required (See Section 12, Monitoring Program).
Key Element 5:	Each Regional Water Board shall make clear, in advance, the potential consequences for failure to achieve a Program's objectives, emphasizing that it is the responsibility of individual dischargers to take all necessary implementation actions to meet water quality requirements.

6.3.4 Central Coast Basin Plan

The Central Coast Basin Plan provides the Water Board's goals and description of general control actions with regard to discharges from rangeland (Basin Plan, Chapter 4, section VIII.C.6.), as reproduced below.

The Water Board encourages grazing strategies that maintain adequate vegetative cover to reduce erosion and sedimentation. The Water Board promotes dispersal of livestock away from surface waters as an effective means of reducing nutrient and pathogen loading. The Water Board encourages use of Best Management Practices to improve water quality, protect beneficial uses, protect stream zone and lakeshore areas, and improve range and watershed conditions including:

- *Implementing rest-rotation grazing strategies*
- *Changing the season of use (on/off dates)*
- *Limiting the number of animals*
- *Increasing the use of range riders to improve animal distribution and use of forage*
- *Fencing to exclude livestock grazing in sensitive areas*
- *Developing non-stream zone watering sites*
- *Conducting physical improvements such as restoring riparian habitat.*

These same Best Management Practices may result in improved range and increased forage production, resulting in increased economic benefit to the rancher and land owner. The Water Board also encourages land owners to develop appropriate site-specific Best Management

Practices using the technical assistance of the U.S. Soil Conservation Service and the U.S. EPA.

The Basin Plan states that in addition to relying on the grazing management expertise of agencies such as the U.S. Forest Service, U.S. Bureau of Land Management, or Range Management Advisory Committee the Water Board can directly regulate grazing activities to protect water quality, under the authorities granted to it by the Porter-Cologne Water Quality Control Act.

6.3.5 California Rangeland Water Quality Management Plan

The California Rangeland Water Quality Management Plan was developed by the Rangeland Management Advisory Committee, a statutory committee which advises the California Board of Forestry on rangeland resources. The Committee developed a California Rangeland Water Quality Management Plan (Rangeland Plan) which concludes that ranches should complete Rangeland Water Quality Management Plans for their respective ranches. The Rangeland Plan was accepted by the State Board in 1995 (SWRCB Resolution No. 95-43). It summarizes authorities and mandates for water quality and watershed protection on non-federal rangelands, and specifies a framework for the cooperative development of ranch management strategies for water quality protection. The Rangeland Plan also describes sources of technical and financial assistance available to ranch owners.

The California Rangeland Plan was developed by a broad array of interest groups, including livestock interests, and is supported by the grazing industry. The State formally incorporated the Rangeland Water Quality Management Plan for private rangelands into SWRCB Nonpoint Source Program Plan (see Section 6.3.2)

The Rangeland Plan states that where beneficial uses of waters are impaired or threatened by rangeland operations as determined by the Water Board, land owners shall assess the impact of their operations on beneficial uses; show the existence of a viable Rangeland Plan with implementation underway; prepare and implement a nonpoint source management plan (as described in section 2.b. or the Rangeland Plan); or contact the NRCS, RCD, UC Cooperative Extension, or a qualified resource professional of their choice, to schedule an assessment and begin development of a Rangeland Plan.

6.4 Implementation Mechanism for the Arroyo de la Cruz TMDL

Implementation of the TMDL is the responsibility of owners/operators of lands containing domestic animals. The implementation program does not specify the means of compliance with the TMDL. The Water Board is prohibited by Section 13360 of the California Water Code from specifying the manner of compliance with its orders. Rather, the implementation plan establishes a process for achieving the TMDL, including: 1) identifying parties responsible for taking these actions 2) actions expected to reduce pathogen loading; 3) 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; 5) and a timeline for completion of implementation actions. The implementation program will involve an adaptive management approach.

In accordance with the California Impaired Waters policy the Water Board may exercise its independent discretion to certify that a nonregulatory action will correct the impairment if supported by findings in the record. The Impaired Waters Guidance explicitly states that the fact that the Regional Boards have limited resources to accomplish their water quality mission can and should be used as a basis to encourage non-regulatory entities to undertake to abate impairments in the time before the Water Boards may otherwise be able to address them through a formal regulatory program. On these occasions the Water Board may not always need to adopt its own implementation program, but may instead rely upon the program adopted by the other entity. When doing so, the RWCQB should establish the TMDL via a formal recognition which certifies that RWQCB has determined that the other entity's program will comply with the TMDL and attain standards. This approach is consistent with the State Water Resources Control Board's Impaired Waters Guidance which states: *"Employing these abbreviated procedures when warranted is a matter of efficiency and resource allocation. California is obligated to establish and implement 800 or more TMDLs over the next ten years for over 1,800 pollutant/water body combinations. Given to the extent California can consolidate regulatory actions or eliminate unnecessary regulatory processes when fulfilling our obligations under Section 303(d), the State and Regional Boards can expedite their responsibility to address and correct impaired waters in California, and expend resources on more TMDLs instead of redundant processes."*

Note that certifying a non-regulatory response to implement a TMDL does not preclude the Water Board's authority to develop a regulatory response, should the non-regulatory action be ultimately deemed inadequate to implement the TMDL. Consistent with the State Water Resources Control Board's policy and guidance for developing TMDLs (see Section 6.3), where appropriate the Water Board may exercise its independent discretion to certify non-regulatory actions to implement a TMDL; however, when Water Board priorities and resources are available to commence regulatory action on an unresolved nonpoint source impairment, the Water Board is obligated to use the permitting authorities as outlined in the Nonpoint Source Implementation and Enforcement policy (see Section 6.3.3)

Accordingly, staff proposes that the Water Board certify the California Rangeland Water Quality Management Plan (Rangeland Plan) as the mechanism for implementing this TMDL. Note that in accordance with the Impaired Waters Guidance, the Water Board may use its independent discretion to implement TMDLs through Memorandums of Understanding (MOUs), Management Agency Agreements (MAAs), or Water Quality Management Plans (WQMP). Examples of TMDLs that have been implemented by using MOUs, MAAs, or WQMPs include *Salmon River Temperature TMDL*, 2006 (MOU with U.S. Forest Service), *San Joaquin River at Vernalis Salt and Boron TMDL*, 2008 (MAA with U.S. Bureau of Reclamation), and the *Indian Creek Reservoir TMDL*, 2002 (Rangeland Plan for non-federal grazing lands).

The California Rangeland Water Quality Management Plan was accepted by the State Board in 1995. The grazing industry gave its support to the California Rangeland Plan (SWRCB Resolution No. 95-43). Further, the State formally recognized and incorporated California Rangeland Plan for private rangelands in the SWRCB Nonpoint Source Program Plan (see Section 6.3.2). The SWRCB Nonpoint Source Program Plan identifies the California Rangeland Water Quality Management Plan (along with several other MOUs, MAAs, and WQMPs) as recognized and viable nonpoint source pollution control tools (see Table 10 –*Summary of Existing MAAs and MOUs* located in *Plan for California's Nonpoint Source Pollution Control Program,* SWRCB 2000*)*.

The Rangeland Plan also provides that where beneficial uses of water are impaired or threatened, as determined by the Water Board, ranch owners shall assess and report to the Water Board the impact of their operations on beneficial uses; show the existence of a viable Rangeland Plan with implementation underway; prepare and implement a nonpoint source management plan (as described in section 2.b. or the Rangeland Plan); or contact the NRCS, RCD, UC Cooperative Extension, or a qualified resource professional of their choice, to schedule an assessment and begin development of a Rangeland Plan.

6.4.1 For Control of Pathogen Loading - Milestones

The implementation process will include the following.

1) By five years after final approval of the TMDL, Water Board staff and stakeholders will identify specific sites within the TMDL project area contributing controllable fecal coliform loads to Arroyo de la Cruz that need management measures for pathogen control. Problem assessment and planning for management measure implementation on non-federal rangelands will follow the implementation procedures in the California Rangeland Water Quality Management Plan (July 1995).

2) By eight years after final approval of the TMDL, depending on progress toward management measure implementation under the 1995 California Rangeland Water Quality Management Plan and the 2000 California Nonpoint Source Plan, staff will consider the need for regulatory action to ensure implementation of management measures to control external sources of fecal coliform loading to Arroyo de la Cruz.

3) By 12 years from the date the TMDL becomes effective (which is upon approval by the Water Board), management practices will be fully implemented for nonpoint sources of fecal coliform loading and the load the allocations, and therefore the TMDL, will be achieved

In accordance with Section 13360 of the California Water Code the Water Board cannot mandate or designate the specific types of on-site actions necessary to reduce indicator bacteria loading, or to meet allocations by the various responsible parties. Potential implementation measures identified in the California Rangeland Water Quality Management Plan (1995) include:

1. LIVESTOCK MANAGMENT

   Practices which assist with the control, time, frequency, or intensity of grazing to maintain vegetative cover sufficient to protect the soil and maintain or improve the quantity and quality of desired vegetation (e.g. prescribed grazing, feeding and salting locations, etc.)

2. STRUCTURAL IMPROVEMENTS

   Infrastructure improvements (e.g. water development, fencing, erosion control, etc.) and structures associated with normal livestock production operations (barns, sheds, corrals, shipping pens, etc.) may be used to facilitate grazing management. These practices should be planned, constructed, and utilized in a manner that enhances or maintains water quality.

3. LAND TREATMENT

   Land treatments (e.g. burning, mechanical manipulation, seeding, weed control, fertilization, etc.) may be used to manage vegetation, reduce erosion, improve range or improve wildlife habitat.

4. LIVESTOCK HEALTH

   Practices used to reduce internal/external parasites and pathogens.

Potential implementation measures are also identified in the *California Nonpoint Source Program Plan* (2000) - *California Management Measures for Polluted Runoff (CAMMPR)*, as reproduced below:

> **Grazing Management**. Management Measure 1E is intended to protect sensitive areas (including streambanks, lakes, wetlands, estuaries, and riparian zones) by reducing direct loadings of animal wastes and sediment. This may include restricting or rotationally grazing livestock in sensitive areas by providing fencing, livestock stream crossings, and by locating salt, shade, and alternative drinking sources away from sensitive areas. Upland erosion can be reduced by, among other methods: (1) maintaining the land consistent with the California Rangeland Water Quality Management Plan or Bureau of Land Management and Forest Service activity plans or (2) applying the range and pasture components of a Resource Management System (NRCS FOTG). This may include prescribed grazing, seeding, gully erosion control, such as grade stabilization structures and ponds, and other critical area treatment.

6.5 Monitoring and Reporting

Consistent with the California Rangeland Water Quality Management Plan (Rangeland Plan), implementation will be conducted in concert with monitoring and reporting to the Water Board, so that progress in achieving the TMDL can be demonstrated.

The primary measure of success for this TMDL is attainment or continuous progress toward attainment of the TMDL targets and load allocations. However, in evaluating successful implementation of this TMDL, attainment of trackable implementation actions will also be heavily relied upon. Therefore, staff proposes a two-phased approach to monitoring for this TMDL:

1) Monitoring of implementation of actions; and
2) Water quality monitoring

Staff proposes to focus on implementation monitoring during the early years of TMDL implementation. Staff anticipates that water quality response to improved management practices will not occur or be demonstrated until after improved management practices are implemented. It is also important to note that Arroyo de la Cruz creek is currently meeting fecal coliform water quality objectives, and is only modestly impaired with respect to *E. coli*. Staff will work with implementing parties to develop a suite of monitoring and reporting methods consistent with the California Rangeland Plan that could include self-assessment site inspections, photo monitoring by implementing parties, water quality testing, reporting of land and animal management practices implemented, and other methods that will assist in achieving water quality improvements and allow the Water Board to track/verify the implementation of management practices. 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 proposed monitoring plan outlined below.

6.5.1 Implementation Monitoring

In accordance with the California Rangeland Water Quality Management Plan (RWQMP), where beneficial uses have been impaired as determined by the Water Board, land owners/operators contributing to the impairment will be asked by the Water Board to:

1. assess the impact of their operations on beneficial uses, and
2. prepare and implement a nonpoint source management plan as described in section 2b, approach #2 or #3, of the RWQMP;

or,

1. show existence of a viable RWQMP with implementation underway, or
2. contact the NRCS, RCD, UCCE, or a qualified resource professional of their choice, to schedule an assessment and begin development of a RWQMP.

Consistent with the California Rangeland Water Quality Management Plan (RWQMP), if owners/operators contributing to the impairment do not respond to the Water Board's request to develop and implement a viable RWQMP or nonpoint source management plan; do not demonstrate the existence of a viable RWQMP with implementation underway, and/or do not demonstrate a good faith effort towards implementation of recommended management practices where appropriate, the Water Board will require the appropriate technical information or reports to be submitted via authorities granted to the Water Board in Section 13267 of the Porter Cologne Water Quality Control Act.

6.5.2 Water Quality Monitoring

At this time, Arroyo de la Cruz is impaired by *E. coli* but is meeting fecal coliform water quality objectives. As such, Staff propose that water quality monitoring for fecal coliform is unnecessary in Arroyo de la Cruz creek at this time, and any potential future fecal coliform monitoring be deferred pending the results of the next CCAMP sampling cycle in the watershed and/or results of the next 303(d) listing cycle. The next CCAMP sampling cycle in the watershed is tentatively in 2015-16.

Staff anticipates that water quality response to improved management practices will not occur or be demonstrated until after management practices are implemented. Central Coast Water Board will request that the responsible parties perform *E. coli* monitoring in receiving waters to verify progress towards TMDL achievement. The nature of the *E. coli* impairment appears to be quite moderate (see Section 2.4) and it is possible that a modest amount of additional *E. coli* water quality data supplemented with implementation monitoring (see Section 6.5.1) could result in de-listing the waterbody for *E. coli* impairment. Water Board staff will work with parties responsible for monitoring regarding the scope and timelines for submission of water quality monitoring data. Landowners have the option of performing individual monitoring or participating in a cooperative monitoring program. Monitoring may be done in concert with, or supplemented by the Water Board's CCAMP existing five-year rotational monitoring in the project area, or with other appropriate monitoring entities. If necessary, the Water Board will require the collection and submission of water quality monitoring data pursuant to authorities granted in Section 13267 of the Porter Cologne Water Quality Control Act.

The following monitoring plan proposes specific monitoring sites, frequency, and indicators to be monitored. To limit the burden of monitoring to the minimum amount necessary to evaluate attainment of the TMDL and compliance with allocations, staff identified one receiving water monitoring location at the following location, shown in Table 6-2. At this time, due to the size of the watershed, and water quality data available from only one site (310ADC) the spatial extent of the impairment is not known. If appropriate, staff will work with implementing parties to select additional or alternate indicator bacteria monitoring site(s), to establish baseline water quality conditions or to measure progress towards TMDL achievement in the watershed, subject to Executive Officer approval.

Table 6-2. Proposed monitoring location.

Site Code	Waterbody	Site Location	Latitude -	Longitude
310ADC[A]	Arroyo de la Cruz	Arroyo de la Cruz at Highway 1	35.708341981	-121.303499

[A] Central Coast Ambient Monitoring Program (CCAMP) Site Code

The *E. coli* monitoring frequency required at a receiving water site must satisfy the minimum number of USEPA-recommended samples needed to evaluate compliance with USEPA bacterial indicator criteria, and thus compliance with the Basin Plan general toxicity objective. USEPA guidance is to have at least three samples in a 30-day period to apply the geometric mean criteria of 126 MPN/100mL. As such, responsible parties will monitor receiving waters according to the following schedule:

Receiving Waters – Three samples from each monitoring site collected at approximately equal intervals over one 30-day period in each of the following seasons:

- ✓ Wet Season: December 1 – February 28 (or 29th)
- ✓ Dry Season: April 1 – September 30

The wet season time frame of December 1 to February 28 was identified because precipitation data show that mean rainfall intensity in the project area is greatest from December through February (see NCDC Weather Station 043882 – Hearst Castle data in Table 2-2).

If three samples are not collected or available for the 30-day averaging period, the available data shall be evaluated consistent with Section 6.1.5.6 of the SWRCB Listing Policy (SWRCB, 2004).

Also, 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 annually 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.

6.6 Timeline and Milestones

6.6.1 Timeline to Achieve Loading Capacity

Staff anticipates that the allocations, and therefore the TMDL, will be achieved 12 years from the date the TMDL becomes effective (which is upon approval by the USEPA). This estimation is in part based on the amount of time necessary to identifying responsible parties of the nonpoint source 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, and progress towards achieving load allocations will be evaluated consistent with the timeline milestones presented in Section 6.4.1.

The Central Coast Water Board will consider additional requirements if implementation of management practices do not result in achievement of water quality objectives.

6.6.2 Evaluation of Progress

It is important to monitor water quality progress, track TMDL implementation, and modify TMDLs and implementation plans as necessary, in order to assess trends in water quality to ensure that improvement is being made; oversee TMDL implementation to ensure that implementation measures are being carried out; address any uncertainty in various aspects of TMDL development; and ensure that the TMDL remains effective, given changes that may occur in the watershed after TMDL development.

The primary measure of success for this TMDL is attainment or continuous progress toward attainment of the TMDL targets and load allocations. However, in evaluating successful implementation of this TMDL, attainment of trackable implementation actions will also be heavily relied upon. Therefore, we propose two types of monitoring for this TMDL: 1) water quality monitoring, and 2) monitoring of implementation of actions.

Water Board staff will perform annual reviews 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 information submitted by implementing parties (as outlined in previously in Section 6.5), Central Coast Ambient Monitoring Program data, 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 eight years, at which time the Water Board staff will determine the need for continuing or otherwise modifying the monitoring requirements. Additionally, within eight years of TMDL adoption staff will consider the need for regulatory action to ensure implementation of management measures to control fecal coliform loads consistent with the timeline presented in Section 6.4.1.

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 Water Board staff may re-evaluate the numeric target and allocations. For example, the Water Board staff may consider the need for 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.

Annual reviews will continue until the water quality objectives are achieved, or another regulatory action establishes alternative requirements. The compliance schedule for achieving the allocations and numeric target required under these TMDLs is ten years after the date of approval by the Central Coast Water Board.

6.7 Cost Estimates and Funding Sources

Staff provides estimates of total implementation costs below in Appendix I: *Cost Estimates*. These costs are approximations and come with significant uncertainties, since the number of properties that will require implementation is unknown, and also because the Water Board cannot mandate or designate the specific types of on-site actions necessary to reduce indicator bacteria loading, or to meet allocations by the various responsible parties.

Potential sources of financing to TMDL implementing parties are also provided in Appendix I: *Cost Estimates*.

7 PUBLIC PARTICIPATION

Staff conducted stakeholder outreach efforts for these TMDL projects. Staff scheduled public workshops in San Luis Obispo (January 20, 2011) and King City (February 9, 2011) and engaged with interested persons during the development of the TMDL. Interested persons that participated in TMDL development workshops and outreach included representatives from the following:

- California Cattlemen's Association
- University of California Cooperative Extension
- Hearst Ranch
- California Polytechnic University
- District Representative for State Senator Sam Blakeslee
- Commercial ranches and private landowners
- San Luis Obispo Farm Bureau
- San Luis Obispo County Cattlemen's Association
- Monterey County Cattlemen's Association

This Staff Report, Executive Officer Certification Order, and technical project reports were made available for a 45-day formal public comment commencing on February 3, 2011. Comments provided at workshops during the public comment period will be considered prior to issuing the final TMDL certification.

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APPENDIX A: *WATER QUALITY DATA AND FIELD NOTES*

Sampling Site	Date	Fecal Coliform Concentration (mpn/100mL)	*E. Coli* Concentration (mpn/100mL)	Total Coliform Concentration (mpn/100mL)	Sampling Entity
310ADC	4/21/01		681		MBNMS Volunteer Monitoring Network
310ADC	4/24/01	79		1600	CCAMP
310ADC	5/29/01	33		49	CCAMP
310ADC	6/26/01	33		1100	CCAMP
310ADC	7/26/01	49		1700	CCAMP
310ADC	12/13/01	230		1400	CCAMP
310ADC	1/22/02	13		170	CCAMP
310ADC	2/26/02	23		33	CCAMP
310ADC	3/19/02	130		240	CCAMP
310ADC	4/16/02	79		79	CCAMP
310ADC	5/14/02	9		49	CCAMP
310ADC	6/18/02	170		220	CCAMP
310ADC	7/18/02	240		240	CCAMP
310ADC	8/15/02	23		230	CCAMP
310ADC	11/13/02	170		5000	CCAMP
310ADC	12/12/02	23		23	CCAMP
310ADC	2/11/03	50		50	CCAMP
310ADC	3/12/03	17		70	CCAMP
310ADC	3/2/04	80		130	CCAMP
310ADC	3/30/04	170		900	CCAMP
310ADC	11/3/04	80		500	CCAMP
310ADC	12/6/04	80		500	CCAMP
310ADC	1/10/05	30	10	500	CCAMP
310ADC	2/8/05	7	10	170	CCAMP

Sampling Site	Date	Fecal Coliform Concentration (mpn/100mL)	*E. Coli* Concentration (mpn/100mL)	Total Coliform Concentration (mpn/100mL)	Sampling Entity
310ADC	3/10/05	30	30	60	CCAMP
310ADC	4/6/05	30	52	80	CCAMP
310ADC	5/4/05	50	18	500	CCAMP
310ADC	6/7/2005		512		MBNMS Volunteer Monitoring Network
310ADC	6/2/05	90	52		CCAMP
310ADC	6/29/05	80	210	130	CCAMP
310ADC	8/3/05	5000	1300	5000	CCAMP
310ADC	8/31/05	500	340	2200	CCAMP
310ADC	12/19/05	300	260	5000	CCAMP
310ADC	2/8/06	50	20	50	CCAMP
310ADC	3/20/06	170	150	170	CCAMP
310ADC	4/19/06	8	10	220	CCAMP
310ADC	5/6/2006		10		MBNMS Volunteer Monitoring Network
310ADC	5/9/06	4	7.4	30	CCAMP
310ADC	6/7/06	50	24	80	CCAMP
310ADC	7/6/06	8	4.1	70	CCAMP
310ADC	7/26/06	300	280	500	CCAMP
310ADC	8/23/06	300	180	300	CCAMP
310ADC	9/27/06	23	14	110	CCAMP
310ADC	2/21/07	17	20	500	CCAMP
310ADC	3/22/07	130	74	240	CCAMP
310ADC	5/5/2007		10		MBNMS Volunteer Monitoring Network
310ADC	1/8/08	70	20	800	CCAMP
310ADC	2/20/08	30	19	170	CCAMP
310ADC	3/20/08	7	1	50	CCAMP
310ADC	4/15/08	8	11	110	CCAMP
310ADC	5/13/08	50	56	270	CCAMP

Sampling Site	Date	Fecal Coliform Concentration (mpn/100mL)	*E. Coli* Concentration (mpn/100mL)	Total Coliform Concentration (mpn/100mL)	Sampling Entity
310ADC	2/11/09	30	43	240	CCAMP
310ADC	3/11/09	2	2	500	CCAMP
310ADC	4/9/09	2	10	30	CCAMP
310ADC	10/20/09	300	1700	5000	CCAMP
310ADC	11/10/09	13	14	170	CCAMP
310ADC	12/9/09	30	30	140	CCAMP
310ADC	1/13/10	3000	1300	5000	CCAMP
310ADC	2/17/10	30	11	130	CCAMP
310ADC	3/16/10	23	30	240	CCAMP
310ADC	4/14/10	40	60	500	CCAMP
310ADC	5/13/10	23	10	300	CCAMP
310ADC	6/8/10	30	27	240	CCAMP

CCAMP = Central Coast Ambient Monitoring Program
MBNMS = Monterey Bay National Marine Sanctuary

CCAMP Field Notes

310ADC	4/24/01 13:30	deep, no flow
310ADC	5/29/01 13:15	no flow evident. Floating algal mats. Water level greatly reduced
310ADC	6/26/01 14:00	dry above bridge, no flow, green fil algae, killdeer
310ADC	7/26/01 13:57	dry riffles above and below sampling site
310ADC	8/1/01 3:54	data hand entered on 5/2/02
310ADC	12/13/01 14:09	BATTERY TOO LOW ON HYDROLAB
310ADC	1/22/02 11:02	water level M but velocity is very low
310ADC	2/26/02 13:22	cows u/s, evidence of cows at site, killdeer = 1, no flow evident, lagoon-like environment
310ADC	3/19/02 12:38	HL data hand entered, cattle tracks, cloudy green algae
310ADC	4/16/02 13:11	many swimming invertebrates, blackbird, water level dropped from last month
310ADC	5/14/02 12:53	fluorescent green algae, tree frog, swallows, killdeer, evidence of cows in channel
310ADC	6/18/02 12:42	200+ swallows, cow pies adjacent to stream
310ADC	7/18/02 12:37	100's of swallows nesting under bridge
310ADC	8/15/02 10:55	water level has dropped
310ADC	11/13/02 12:00	steady flow into pool under bridge, 30 small fish, looks like HF was very high, 4-5' above current level.evidence of cows in channel
310ADC	12/12/02 13:53	thin green peri covers gravel, vater very low vs. last month. Cattle tracks and scat in creek
310ADC	2/11/03 12:09	Evidence of recent cattle activity in creek. 1 Kingfisher and 1 mallard
310ADC	3/12/03 13:29	Evidence of cattle in stream. 2 ducks.

CCAMP Field Notes

310ADC	3/30/04 13:08	Large pools with little flow between them
310ADC	11/3/04 13:04	Evidence of cattle in creek bed. Beetle saves the day!!!!
310ADC	12/6/04 13:41	low flow. Evidence of cattle in creek. Highly branched, mat forming algae unique to this site.
310ADC	1/10/05 13:47	Changed temp from data sheet
310ADC	2/8/05 14:44	new cow fence (barbedwire) installed acrossed creek
310ADC	3/10/05 12:27	Data hand entered from field sheet, data not stored in Hydrolab. Sampled ~ 100 ft u/s from normal samle site, color = clear.
310ADC	4/6/05 13:28	sign of cattle recently in creek, smells like cow poo, water = clear, large tick found.
310ADC	5/4/05 13:18	sign of cows in stream bank, took flow about 500 ft up stream, little flow, lots of swallows
310ADC	6/2/05 14:04	measured flow d/s ~ 30 m from bridge, water clear, algae floating down stream, cow pies on bank, kildeer, swallows nesting under bridge.
310ADC	6/29/05 13:55	high algae content, low flow, lots of bird poo u/s, 2 bacti samples taken 1 u/s of bridge and 1 d/s. No field pH measured.
310ADC	8/3/05 14:36	water-clear and colorless.Chlorophyll probe in for repairs, sent chlor a filter to lab. Sampled by hand mid channel
310ADC	8/31/05 14:26	water color-colorless. Water clarity-clear.site odor-sour manure/death smell. Sent filter to lab-200mL filtered.Hand sampled mid channel.
310ADC	12/19/05 13:53	water color-slightly yellow.water clarity-murky. Hand sampled mid channel. Rained >7" 12/18/05. Foam on surface of channel. Cow feces on bank. 30+ waterfowl u/s
310ADC	2/8/06 14:22	water color-colorless.water clarity-clear. Hand sampled thalweg. Water is not flowing
310ADC	3/20/06 14:05	water colorless. water clarity-clear. Hand sampled mid channel.Stored on other surveyor-battery died. Not wadeable. Site odor-cows. Sign of cows on Left bank. Hydrolab recorded conductivity as 362,but recorded in field as 461.3
310ADC	4/19/06 13:35	water color-colorless. water clarity-clear. Hand sampled thalweg. Evidence of recent scour. Evidence of cows. Kingfisher, 200+swallows, overhead
310ADC	5/9/06 14:32	water color-colorless. Water clarity-clear.Hand sampled mid channel. Snake in water. Evidence of cows
310ADC	6/7/06 14:07	water color-colorless. Water clarity-clear. Hand sampled mid channel. Kildeer nesting. Evidence of cow
310ADC	7/6/2006 14:06	water color- colorless. Water clarity-clear. Hand sampled mid channel. No flow. Just mearsured depths
310ADC	7/26/2006 12:38	water color- colorless. Water clarity-clear. Hand sampled mid channel.
310ADC	8/23/2006 12:17	water color- colorless. Water clarity-clear. Hand sampled mid channel. Evidence of cows
310ADC	9/27/2006 13:03	water color- colorless. Water clarity-clear. Hand sampled mid channel. Site odor-cows. Cow poop on right bank
310ADC	2/21/2007 13:49	Water color-colorless. Water clarity-clear. Hand sampled mid channel. Barely flowing.
310ADC	3/22/2007 14:20	water color-colorless. Water clarity-clear. Hand sampled mid channel. Sampled down stream from bridge ~ 100 ft
310ADC	1/8/2008 13:11	water color-colorless. Water clarity-clear. Hand sampled mid channel. Faulty pH probe-calibration failed!! Recent scour! Beautiful! Poop on right bank.

CCAMP Field Notes

310ADC	2/20/2008 13:11	water color-colorless. Water clarity-clear. Hand sampled mid channel. Flowing back.
310ADC	3/20/2008 15:01	water color-colorless. Water clarity-clear. Hand sampled mid channel. Backed up- not flowing out
310ADC	4/15/2008 13:01	water color-colorless. Water clarity-clear. Hand sampled mid channel.
310ADC	5/13/2008 12:46	water color-colorless. Water clarity-clear. Hand sampled mid channel.
310ADC	7/15/2008 12:30	No sample collected. No probe measurements taken. Isolated pools at sample site.
310ADC	8/12/2008 15:11	No sample collected. No probe measurements taken. Dry.
310ADC	9/18/2008 12:55	Very small isolated pools. No sample taken.
310ADC	10/22/2008 13:00	Dry. No sample taken.
310ADC	11/5/2008 14:00	Dry. No sample taken
310ADC	12/3/2008 13:00	Dry. No sampke taken.,
310ADC	1/13/2009 16:25	Dry. No sample taken.
310ADC	2/11/2009 12:14	water color-colorless. Water clarity-clear. Hand sampled mid channel. Hydrolab stored turbidity as 84.9, but recorded it as 0 in the field.
310ADC	3/11/2009 15:53	water color-colorless. Water clarity-clear. Hand sampled mid channel. Too deep and fast to cross safely to measure flow.
310ADC	4/9/2009 10:11	water color-colorless. Water clarity-clear.Hand sampled mid channel.
310ADC	7/15/2009 15:55	Dry. No sample taken
310ADC	8/12/2009 16:00	Dry. No sample taken
310ADC	9/16/2009 18:10	Dry. No sample taken
310ADC	10/20/2009 16:46	water color-colorless. water clarity-clear. Hand sampled mid channel. Evidence of recent scour. Cannot cross to measure flow---lagoon!
310ADC	11/10/2009 15:10	water color-colorless. water clarity-clear. Hand sampled mid channel. Hydrolab stored chlor a as non detect(-0.05), but recorded it as 0 in the field. Barbed wire fence instream. No lagoon. Flowing out!
310ADC	12/9/2009 14:41	water color-colorless. water clarity-clear. hand sampled mid channel.
310ADC	1/13/2010 13:00	water color-light brown. water clarity-cloudy. Hand sampled bank. Hydrolab stored turbidity as 150.8 in the field, but recorded it as 33.0 in the field.
310ADC	2/17/2010 15:21	water color-colorless. water clarity-clear. Hand sampled mid channel. 2 fisherman in creek under bridge. Hydrolab stored chlor a as non-detect (-0.05), but recorded it as 0 in the field.
310ADC	3/16/2010 12:57	water color-colorless. water clarity-clear.Hand sampled mid channel. Hydrolab stored chlor a as non-detect(-0.05) but recorded it as 0 in the field.
310ADC	4/14/2010 14:30	water color-colorless. Water clarity-clear. Hand sampled mid channel.Not wadeable. Hydrolab stored chlor a as non-detect(-0.05), but recorded it as 0 in the field.
310ADC	5/13/2010 12:34	water color-colorless. Water clarity-clear. Hand sampled mid channel. Shading estimation is partially from bridge. Swallows under bridge nesting.
310ADC	6/8/2010 14:32	water color-colorless. Water clear-clear. Hand sampled mid channel. Hydrolab stored chlor a as non-detect(-0.05), but recorded it as 4.80 in the field.
310ADC	7/14/2010 15:20	No sample taken. Dry
310ADC	8/10/2010 13:23	Dry. No sample taken
310ADC	9/8/2010 12:38	Lagoon. No flow. No sample taken
310ADC	10/6/2010 13:00	No sample taken. Dry.
310ADC	11/2/2010 13:49	Sample site dry. No sample taken.

APPENDIX B: *SYNTHETIC FLOW RECORD*

Arroyo de la Cruz has historical flow gage data from USGS 11142500. The USGS flow gage 11142500 was discontinued in September 1979. . To develop flow duration curves, and ultimately conduct a load duration curve analysis, it is necessary to have a continuous flow record covering a broad range of flow conditions during times of water quality sampling in the impaired stream. Ungaged flow can be estimated for the impaired waterbody based on nearby USGS gages draining creeks with similar watershed characteristics, or from instantaneous flow measurements and water budget analyses from literature sources. Based on knowledge of climatic and unregulated flow conditions that would be expected in the Arroyo de la Cruz watershed, USGS gage 111592900 at Corrilitos Creek (Santa Cruz County) was used as a suitable reference gage to infill the missing flow data for Arroyo de la Cruz after September 1979. USGS 111592900 at Corrilitos Creek captures drainage from a similar sized watershed, with similar climatic conditions and land uses, and exhibits intermittent flow patterns consistent with the 1950-1979 historical flow record from USGS11142500 at Arroyo de la Cruz.

A simple and widely used analytical method to develop a flow record for ungaged watersheds, is the drainage area ratio method (DAR). The DAR method is a simple, widely used analytical approach for developing discharge for ungaged watersheds/sites using discharge data from gaged watersheds. DAR is recognized by USEPA as a standard flow estimation method for ungaged sites (USEPA, 2007(a) and 2007(b)). The DAR method is most reliable when land use characteristics of the ungaged and gaged watersheds are similar, and when the size ratio between the drainage areas of the ungaged site and the gaged site is between 0.3 and 1.5 (USGS, 2000). DAR assumes that flow at the ungaged stream is proportional to the ratio of the drainage areas between the ungaged stream, and the gaged stream. The DAR flow transfer method is calculated as:

$$Flow_{ungaged} = Flow_{gaged} \times \frac{Area_{ungaged}}{Area_{gaged}}$$

Because DAR simply assumes that the streamflow at an ungaged site is the same per unit area as a nearby hydrologically similar stream gaged station, and the method does not account for spatial variations in precipitation and runoff, the DAR method is generally best used for transferring flows between sites within the same drainage basin.

To minimize uncertainty in flow estimates in this project report, the State Water Resources Control Board DAR method (SWRCB, 2002b) was used, making corrections for spatial variation in precipitation. Unlike the standard DAR method, which simply transfers flows between gaged and ungaged sites by making a correction based on the drainage area ratio (i.e., ratio of ungaged watershed size to the gaged watershed size), the SWRCB DAR method incorporates a correction factor for spatial precipitation variations. The SWRCB method can be used to transfer flow statistics from one drainage basin to another basin (personal communication, Bill Cowen, SWRCB). The DAR equation used by the SWRCB to estimate streamflow statistics is:

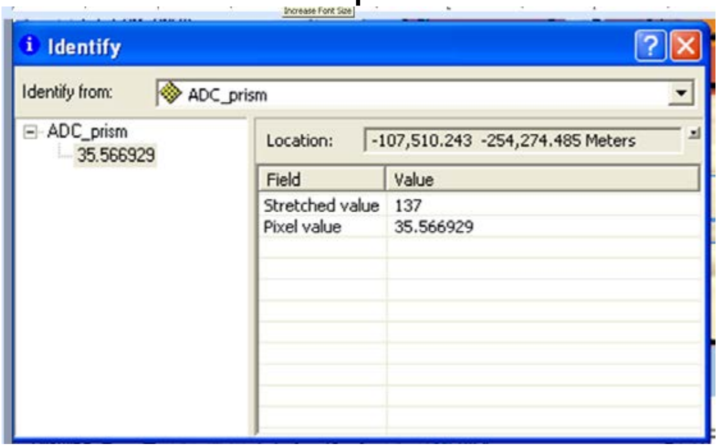
$$Q_{ug} = Q_g \times \frac{A_{ug}}{A_g} \times \frac{I_{ug}}{I_g} \quad \text{(equation 1)}$$

Where

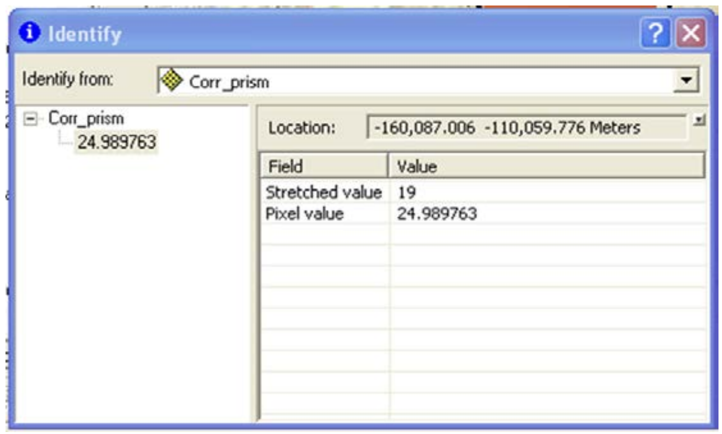
Q_{ug} is the mean daily flow (cfs) at ungaged location.
Q_g is the mean daily flow (cfs) at gaged location.
A_{ug} is the watershed drainage area above the ungaged site (acres).
A_g is the watershed drainage area above the gaged site (acres).
I_{ug} is mean annual precipitation in the ungaged watershed.
I_g is mean annual precipitation in the gaged watershed.

111592900 at Corrilitos Creek (Santa Cruz county) was used as a reference gage for Arroyo de la Cruz. USGS 111592900 at Corrilitos Creek captures drainage from a similar sized watershed, with similar climatic conditions and land uses, and exhibits intermittent flow patterns consistent with the 1950-1979 historical flow record from USGS11142500 at Arroyo de la Cruz. The PRISM precipitation value associated with a pixel at the mean center of each watershed was assumed to represent mean annual precipitation in that watershed.

Prism Mean Annual Precipitation at Mean Center of Watersheds



Estimated Mean Annual Precip, (in.) – Arroyo de la Cruz



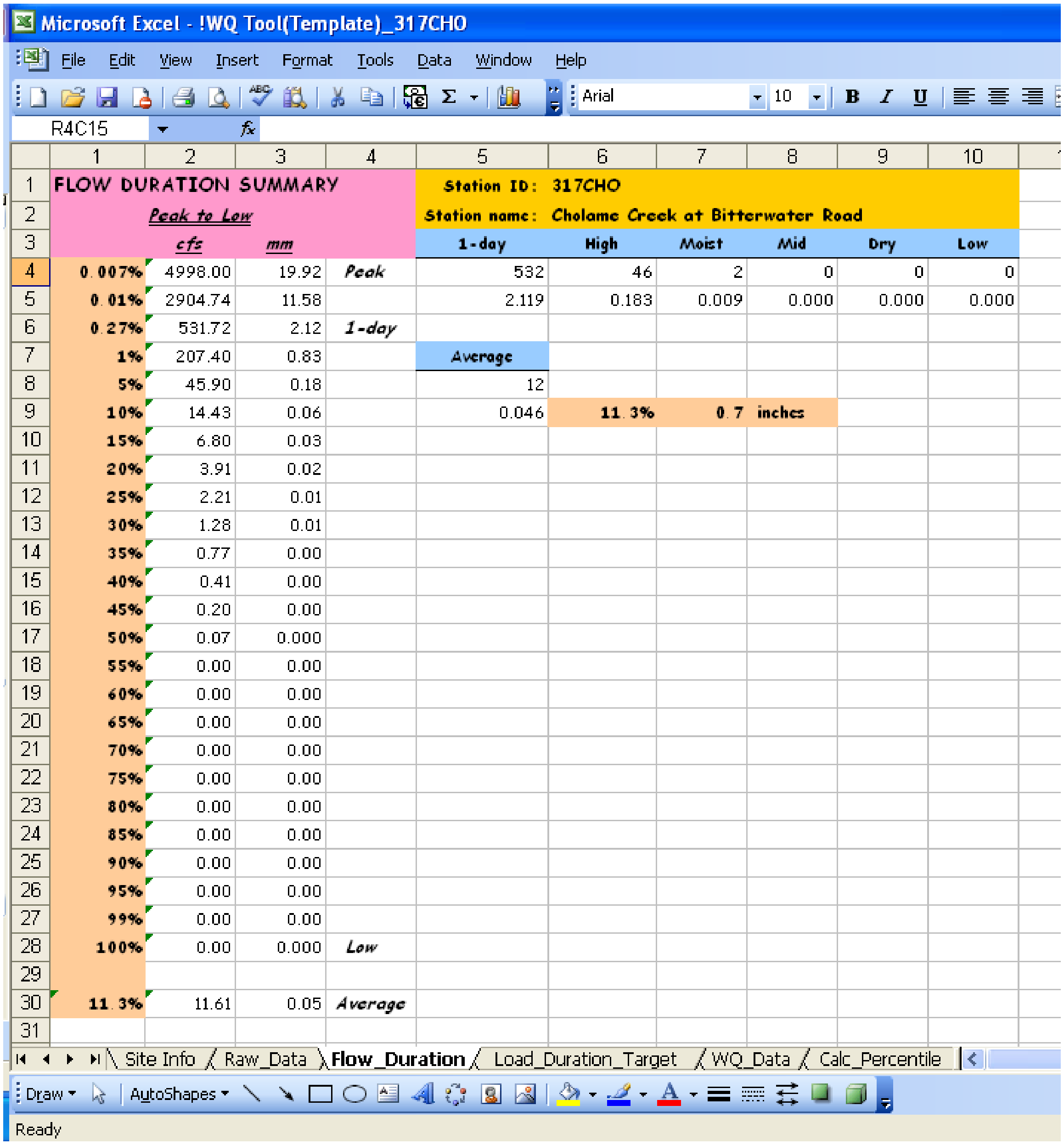
Estimated Mean Annual Precip, (in.) – Corrillitos Creek

Using the SWRCB DAR relationship between the USGS 11224500reference gage, and water quality monitoring site 317 CHO on Arroyo de la Cruz River is shown in the table below.

Topography	Location	Drainage Area (sq. mi.)	DAR A_{ug}/A_g	Precipitation (inches)	Precipitation Ratio I_{ug}/I_g	Final Flow Adjustment Ratio
Rolling	Corrilitos Creek @ USGS 11159200	27.8	-	25	-	-
	Arroyo De La Cruz USGS 11142500	41.2	1.48	35.6	1.4	**2.07**

= Gaged Reference stream

Accordingly, estimated unregulated flow for Arroyo de la Cruz was derived from the 111592900 reference stream gage record using the flow adjustment ratio of 2.0. In other words, the mean daily 111592900 flow record was adjusted by a factor of 2.0, to derive a synthetic unregulated flow record to infill the missing flow records after September 1979 in Arroyo de la Cruz. The flow duration summary for the flow record developed for water quality monitoring site 310ADC is shown in the figure below.



Microsoft Excel - !WQ Tool(Template)_317CHO

File Edit View Insert Format Tools Data Window Help

R4C15

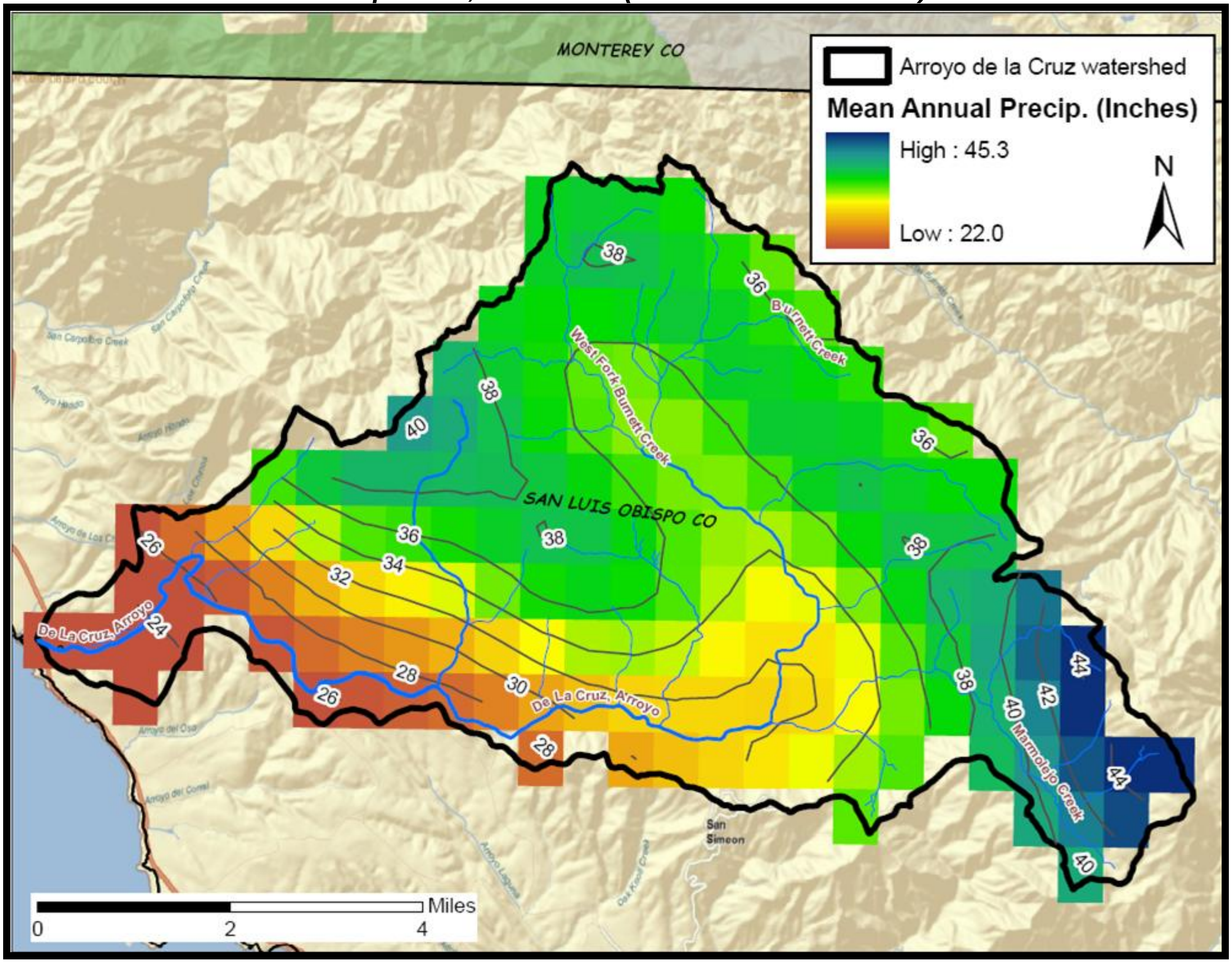
	1	2	3	4	5	6	7	8	9	10
1	FLOW DURATION SUMMARY				Station ID: 317CHO					
2		Peak to Low			Station name: Cholame Creek at Bitterwater Road					
3		cfs	mm		1-day	High	Moist	Mid	Dry	Low
4	0.007%	4998.00	19.92	Peak	532	46	2	0	0	0
5	0.01%	2904.74	11.58		2.119	0.183	0.009	0.000	0.000	0.000
6	0.27%	531.72	2.12	1-day						
7	1%	207.40	0.83		Average					
8	5%	45.90	0.18		12					
9	10%	14.43	0.06		0.046	11.3%	0.7	inches		
10	15%	6.80	0.03							
11	20%	3.91	0.02							
12	25%	2.21	0.01							
13	30%	1.28	0.01							
14	35%	0.77	0.00							
15	40%	0.41	0.00							
16	45%	0.20	0.00							
17	50%	0.07	0.000							
18	55%	0.00	0.00							
19	60%	0.00	0.00							
20	65%	0.00	0.00							
21	70%	0.00	0.00							
22	75%	0.00	0.00							
23	80%	0.00	0.00							
24	85%	0.00	0.00							
25	90%	0.00	0.00							
26	95%	0.00	0.00							
27	99%	0.00	0.00							
28	100%	0.00	0.000	Low						
29										
30	11.3%	11.61	0.05	Average						
31										

Site Info / Raw_Data / Flow_Duration / Load_Duration_Target / WQ_Data / Calc_Percentile

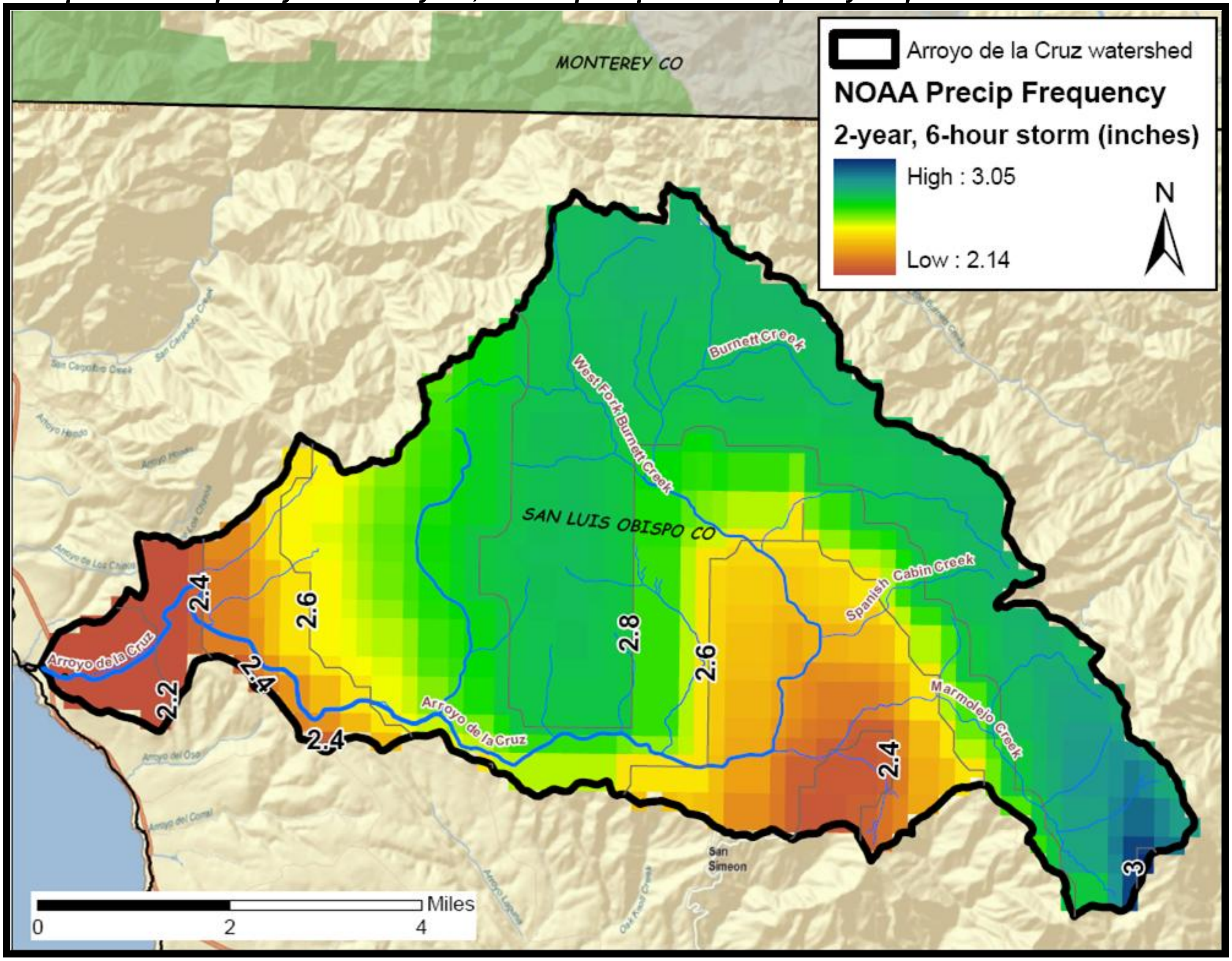
Ready

APPENDIX C: *SUPPLEMENTAL MAPS AND SPATIAL DATA*

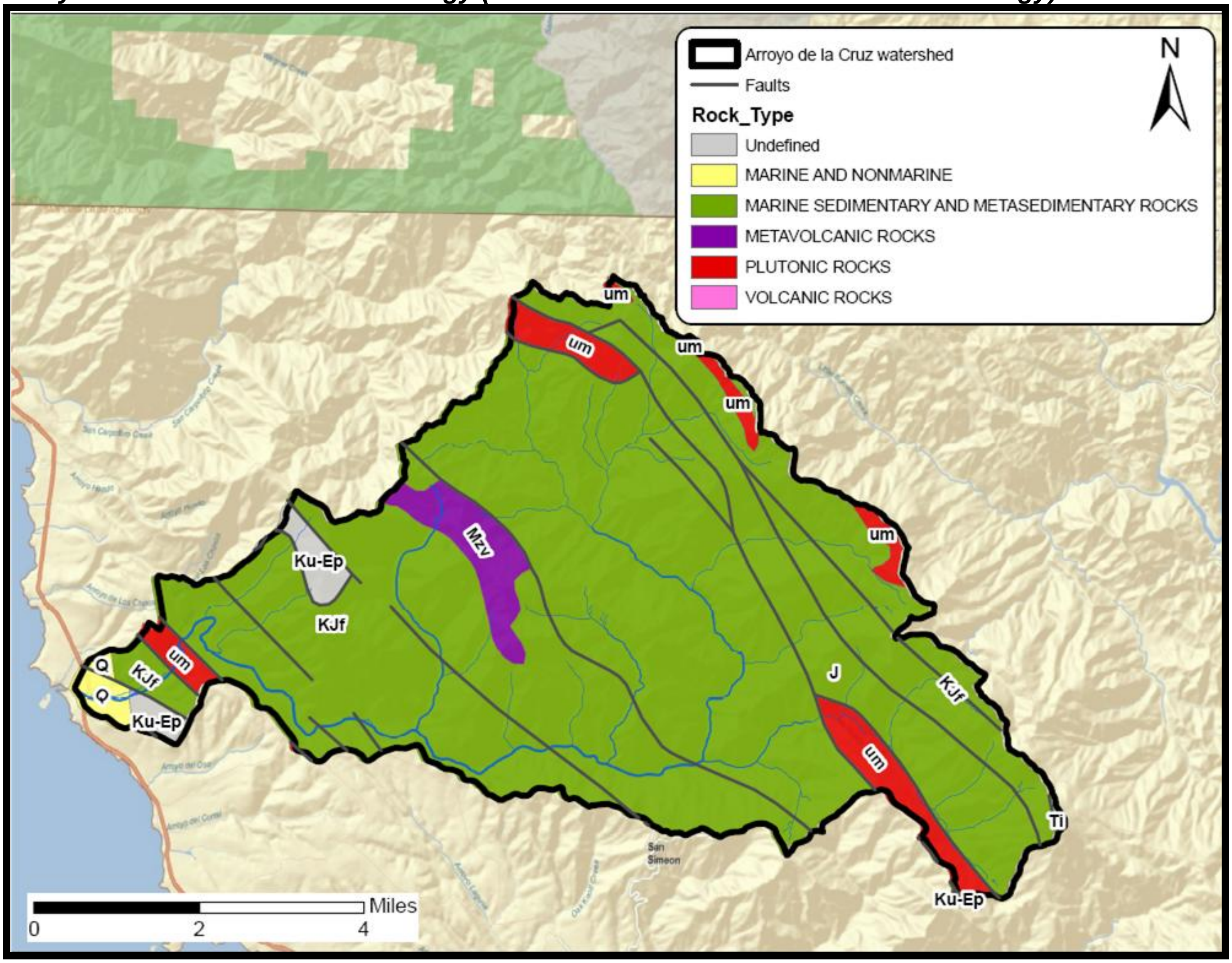
Estimated Mean Annual Precipitation, 1970-2000. (source: PRISM dataset)



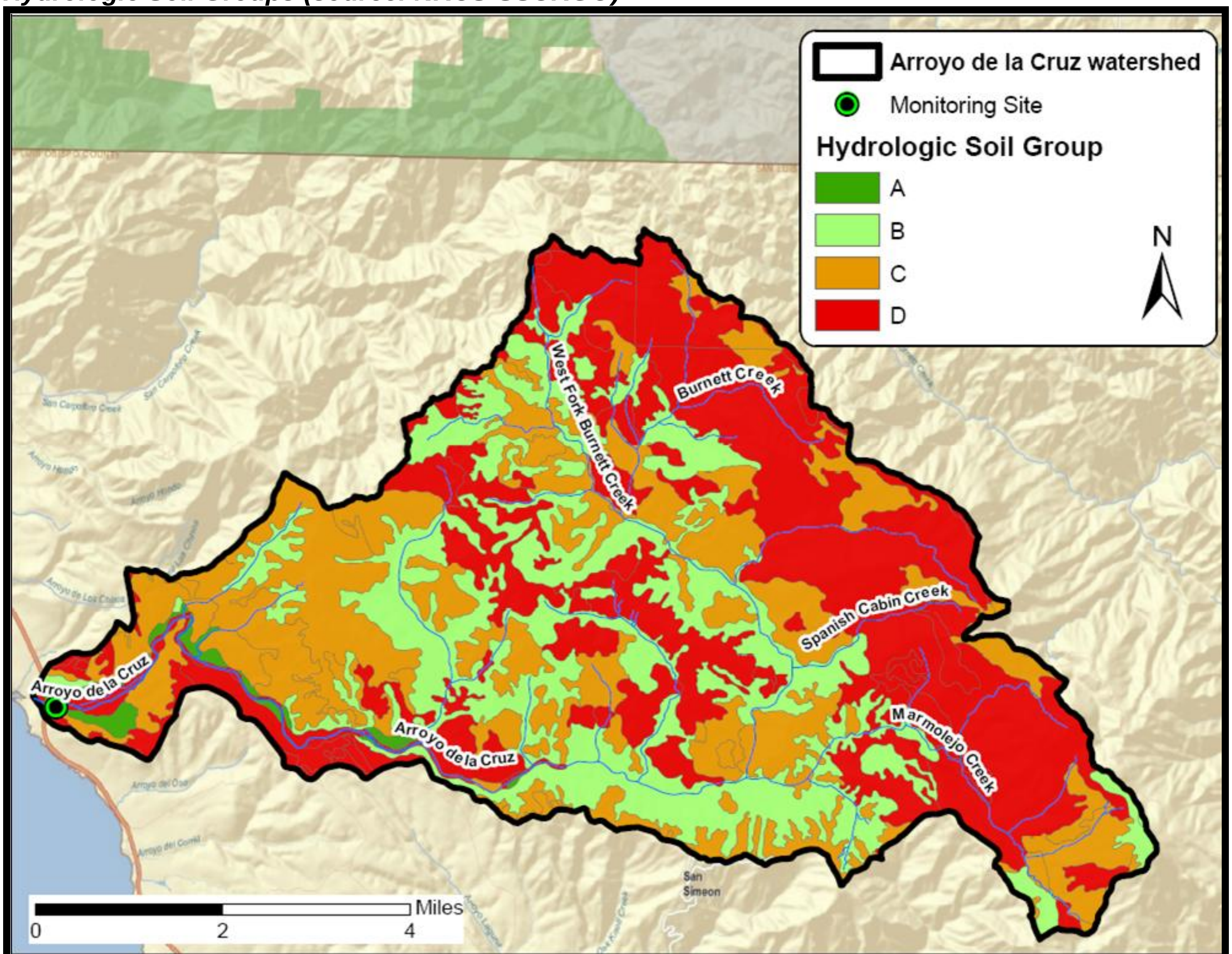
Precipitation Frequency: NOAA 2-year, 6-hour precipitation frequency map.



Arroyo de la Cruz watershed Geology (source: Calif. Division of Mines and Geology).

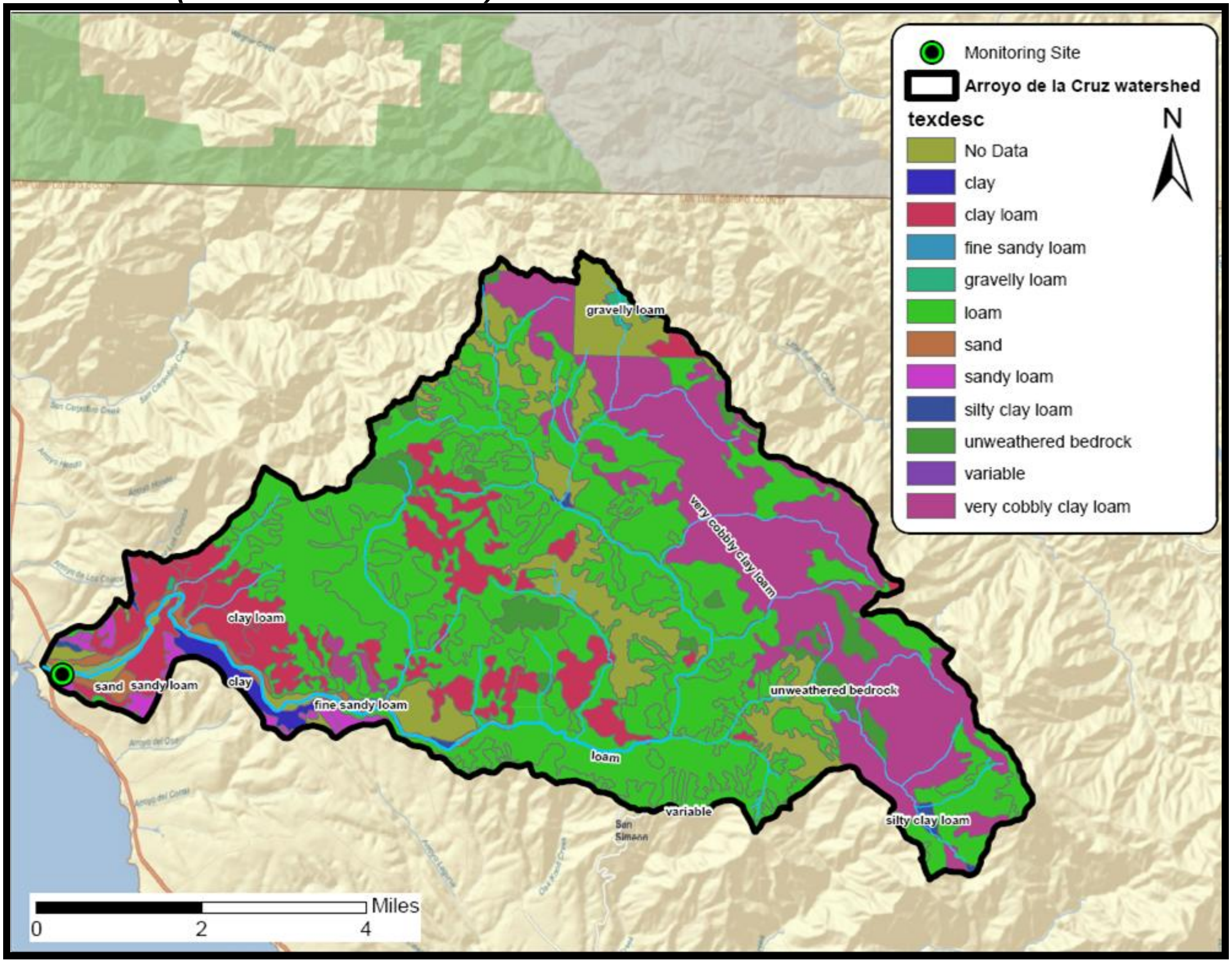


Hydrologic Soil Groups (source: NRCS-SSURGO)



Hydrologic Soil Group Descriptions:	
A	Well-drained sand and gravel; high permeability
B	Moderate to well-drained; fine to moderately course texture; moderate permeability
C	Poor to moderately well-drained; moderately fine to fine texture; slow permeability
D	Poorly drained; clay soils, or shallow soils over nearly impervious layers(s)

Soil Textures (source: NRCS-SSURGO)



APPENDIX D: *FECAL INDICATOR BACTERIA PRODUCER INVENTORY DATA*

The data and calculations for estimated domestic animal and wildlife populations in the TMDL project area are presented in this Appendix.

Livestock numbers are estimated from a Hearst Ranch website (www.hearst.com/real-estate/hearst-ranch.php). The Hearst Ranch website reports that the ranch maintains a 1,000-head base cowherd at the San Simeon Heart Ranch. The San Simeon Hearst Ranch include the Arroyo de la Cruz watershed. During public review and comment of the TMDL project staff attempted to obtain updated cattle population estimates for the Arroyo de la Cruz watershed from local stakeholders, but were unsuccessful. Based on the ratio of the reported size on the San Simeon Heart Ranch (80,000 acres), and the size of the Arroyo de la Cruz watershed (27,304 acres), and the total number of Hearst cattle staff estimated the number of cattle in the Arroyo de la Cruz watershed to be 341 animals using the following equation: [(27,304 acres/80,000 acres) = 0.341 X 1000 cattle = 341 cattle)]

The number of people and the number of households in the watershed is estimated from census block data in the U.S. Census Bureau 2000 decennial census. Note that census blocks boundaries don't necessarily coincide with watershed boundaries; as such staff digitally clipped electronic shapefiles of the census blocks which are located completely within the boundaries of the Arroyo de la Cruz watershed, and then extracted population attribute information from the digitally clipped census blocks.

The number of domestic pets, such as cats and dogs, is presumed to be negligible in the watershed due to the virtual absence of people and residential areas.

Wildlife populations are estimated from animal population densities available from the California Department of Fish and Game (CDFG), from other agencies or from credible peer-reviewed scientific sources shown in the table below. Additionally, Water Board staff interviewed CDFG staff for information, and used published CDFG reporting. For the majority of wildlife species inventoried in the project report, staff used population density estimates that were based on Monterey County-specific, central coast region-specific, or California-specific reporting. Using these numbers, habitat densities (animals/unit area) were derived, and it was assumed that the distribution of animals was spread uniformly across all suitable habitat. To obtain wildlife populations, staff multiplied the animal population density estimates by the acreage of suitable habitat obtained from digital land cover data. The habitat ranges, habitat requirements, and seasonality of wildlife species shown in Table 4-1 were corroborated with digital databases and literature available from the CDFG Wildlife Habitat Relation System, found online at: www.dfg.ca.gov/biogeodata/cwhr/.

Livestock

Project area estimates for numbers of livestock.

Livestock	Source	Total Livestock
Cattle	Hearst Ranch website	**341**

Wildlife

Project area land cover distribution for calculating wildlife populations (source FFMP, 2008).

Land Use/Land Cover	Acres
Residential	8
Grazing Land	16,937
Farmland	253
Forest or Undeveloped	10,107
Total	27,304

Estimated wildlife population densities and habitat requirements.

Wildlife Type	Reported Population Density Range (animals/mi^2)	Average Density (animals/mi^2)	Estimated Population Density (#/per acre)	Land Cover Distribution	Habitat Notes
Deer[A]	4.4 to 7.8	6.1	0.01	Forest, Grazing Land, Farm Land	Prime habitat: Entire watershed
Feral pig[B]	1.3 to 2.1	1.7	0.003	Forest, Grazing Land, Farm Land	Prime habitat: Entire watershed
Coyote[C]	0.75 to 0.91	0.83	0.001	Forest, Grazing Land, Farm Land	Prime habitat: Entire watershed
Raccoon[D]	6 to 52	29	0.045	One-half mile buffer around perennial waterbodies	Prime habitat wetland, riparian, forest. Closely associated with permanent water (e.g., perennial streams). Virginia TMDL program used habitat and population estimate base[d] on 0.5 mile buffer around streams. This buffer range is broadly consistent with home ranges of individual raccoons as reported by CDFG.
Opossum[D]	5.8 to 26.2	16	0.025	One-half mile buffer around perennial waterbodies	Prime habitat wetland, riparian, forest. Closely associated with permanent water. (see raccoon)
Skunk[E]	6.2 to 37	21.6	0.034	One-half mile buffer around perennial waterbodies	Prime habitat wetland, riparian, forest. Closely associated with permanent water. (see raccoon)
Turkey[F]	7 to 9.6	8.3	0.013	Forest, Grazing Land	Entire watershed excluding urban and farmland (trees/shrubs required for roosting habitat)
Duck[H]	-	5.5	0.009	Farm Land, Grazing Land, Urban	Cropland, Pasture, Wetland, Urban. Upland forest and shrubland not not prime habitat; consequently did not include in grazing lands. Used statewide duck population estimate to interpret gross average watershed population density. Ducks also "much more numerous" in winter, according to DFG.

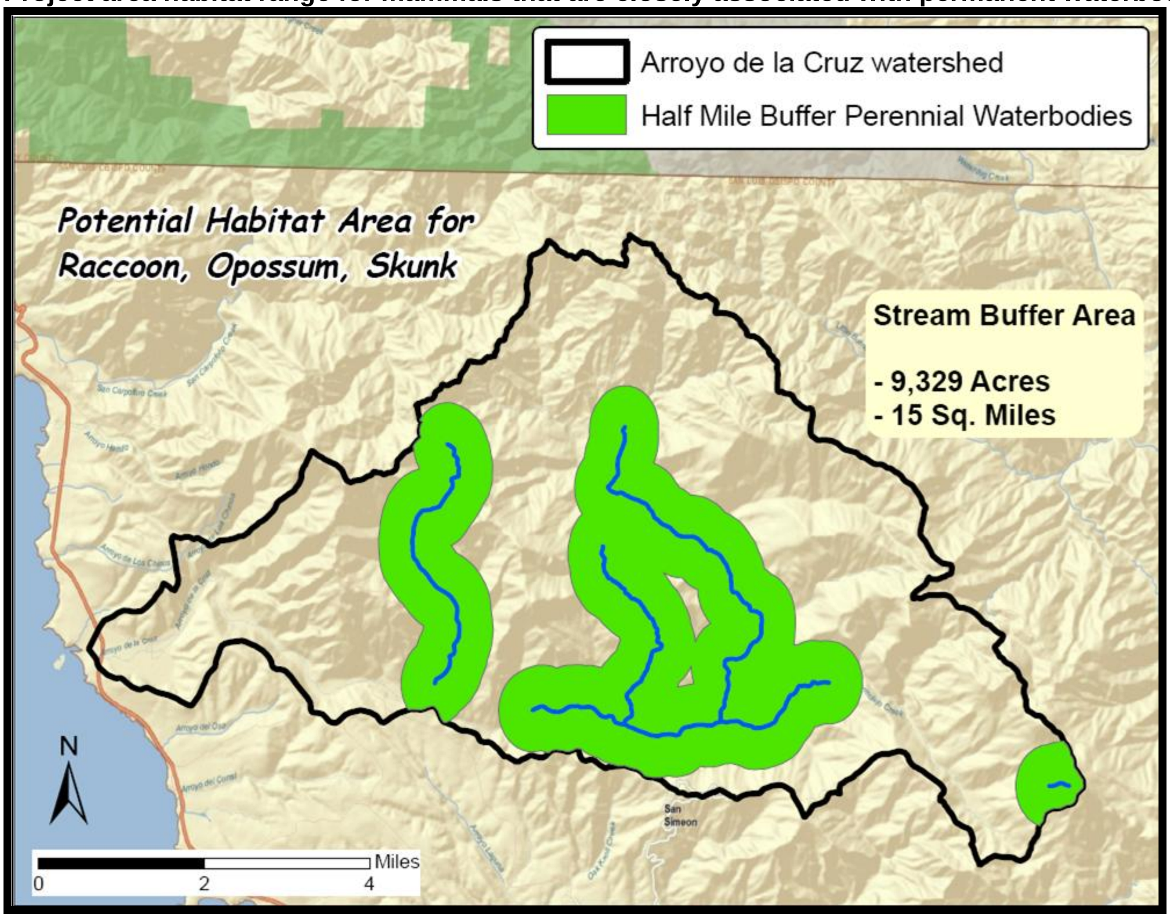
Population Density and Habitat Sources

A: California Dept. of Fish and Game - http://www.dfg.ca.gov/wildlife/hunting/deer/docs/habitatassessment/part4.pdf

B: California Dept. of Fish and Game - Game http://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx

C Babb and Kennedy, 1989. An Estimate of Minimum Density for Coyotes in Western Tennessee, Journal of Wildlife Management Vol. 53 (1): pp 186-188.
D:: Kissel and Kennedy, 1992. Ecological Relationships of Co-occuring Populations of Opossums and Raccoons. Journal of Mammalogy, vol. 73, pp. 808-813.
E. Ontario Ministry of Natural Resources. Wildlife Research Service, 1987. Wildfurbearer Management and Conservation in North America, Chapter 45, Striped, Spotted, Hooded and Hog-Nosed Skunk.
F.: California Dept. of Fish and Game - http://www.dfg.ca.gov/wildlife/hunting/uplandgame/docs/turkplan_04.pdf
G: Interpreted from Cal. DWR Interagency Ecological Program - http://www.iep.ca.gov/suisun_eco_workgroup/workplan/report/wildlife/pheasant.html
H. California Dept. of Fish and Game, 2008 Waterfowl Breeding Population Survey. http://www.dfg.ca.gov/news/news08/08045.html
Geese population interpreted from. California Dept. of Fish and Game, Waterfowl Hunt Comparison Report. http://www.dfg.ca.gov/wildlife/waterfowl/shoot/ComparisonTables/docs/HT_CMP07.pdf

Project area habitat range for mammals that are closely associated with permanent waterbodies.



The table below presents the estimated project area population of wildlife based on the habitat and population density outlined above.

Estimated Populations of Wildlife in TMDL Project Area.

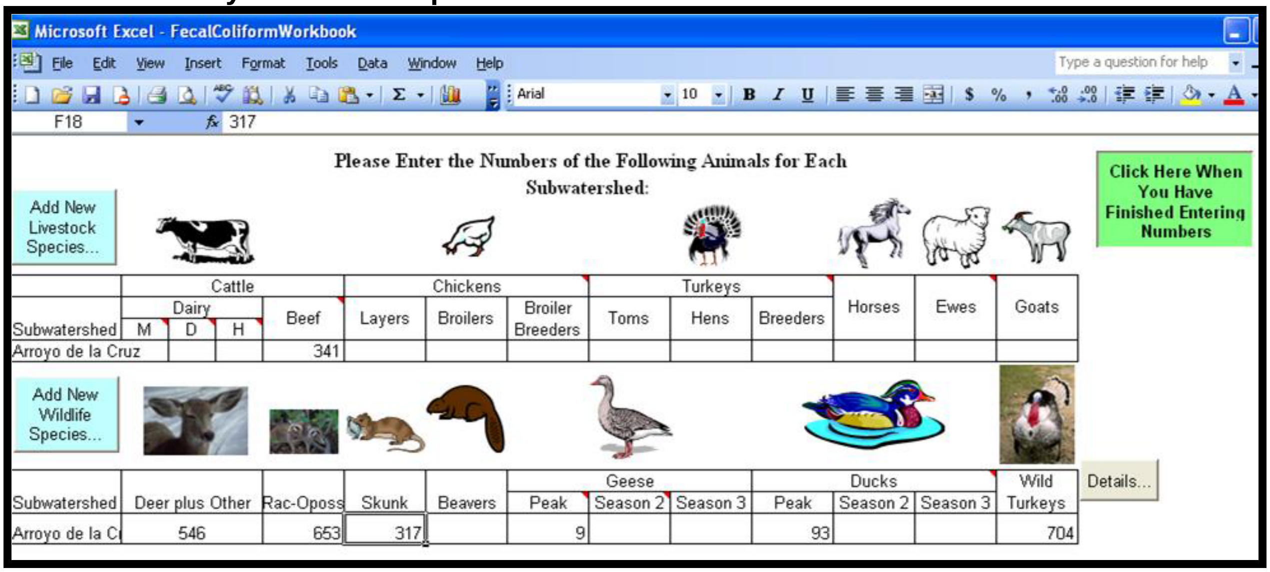
Wildlife Type	Estimated Population Density (#/per acre)	Habitat: Land Cover Distribution	Acres of Habitat in Project Area	Estimated Project Area Population
Deer	0.01	Forest, Grazing Land, Farm Land	27296	**273**
Feral pig	0.003	Forest, Grazing Land, Farm Land	27296	**164**[A]

Wildlife Type	Estimated Population Density (#/per acre)	Habitat: Land Cover Distribution	Acres of Habitat in Project Area	Estimated Project Area Population
Coyote	0.001	Forest, Grazing Land, Farm Land	27296	**27**
Raccoon	0.045	One-half mile buffer around perennial waterbodies	9329	**420**
Opossum	0.025	One-half mile buffer around perennial waterbodies	9329	**233**
Skunk	0.034	One-half mile buffer around perennial waterbodies	9329	**317**
Turkey	0.013	Forest, Grazing Land	27044	**352**
Duck	0.009	Farm land, Urban, Forest	10368	**93**
Geese	Assume 10% of duck			**9**

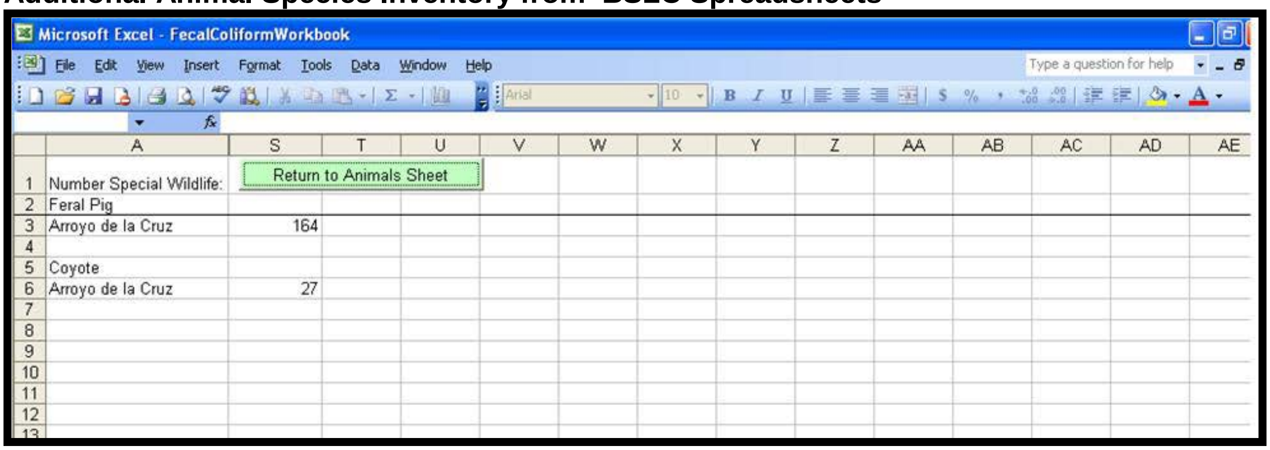
[A] Based on input from stakeholders, the feral pig population estimate was doubled (Calif. Dept. of Fish and Game Monterey County feral pig density estimate X 2)

APPENDIX E: *BACTERIA SOURCE LOAD CALCULATOR (BSLC) SPREADSHEETS*

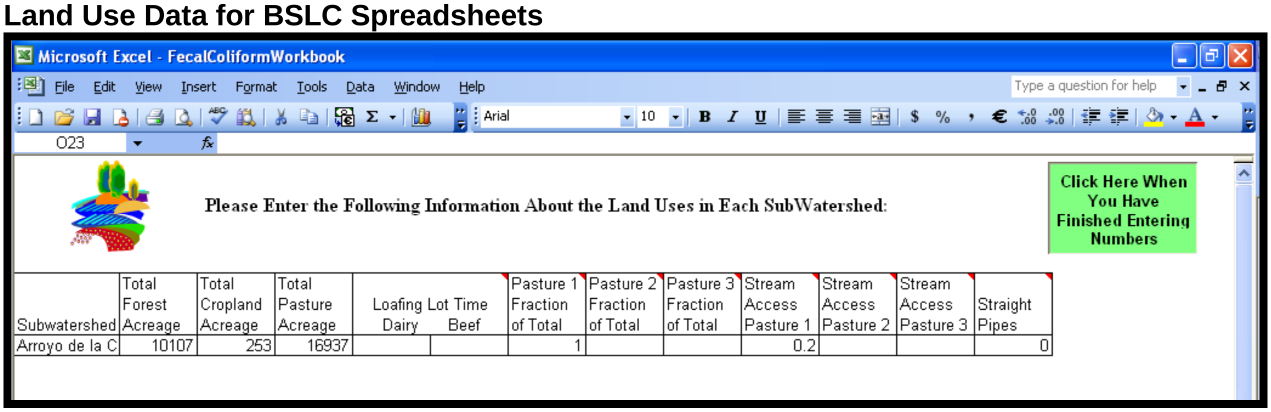
Animal Inventory from BSLC Spreadsheets



Additional Animal Species Inventory from BSLC Spreadsheets



Land Use Data for BSLC Spreadsheets



References for BSLC Spreadsheets

Parameter	Arroyo de la Cruz	Units	Source
Dairy Cow Parameters			
Weight of milk or dry cow	1400	lbs	Livestock Waste Facilities Handbook, MWPS - 18
Weight of heifer	640	lbs	study
Manure production by heifers	40.7	lbs/day	Livestock Waste Facilities Handbook, MWPS - 18
Ratio of dairy cows on: Pasture 1	4	ratio	
to Pasture 2	2	ratio	
to Pasture 3	1	ratio	
Fraction of cows defecating in stream as compared to the cows that are in/around streams (dairy)	0.3	ratio	assumed
Fecal coliform production by milk or dry cow	2.50E+10	total cfu/day-animal	within range of values from literature (Mountain Run TMDL, ASAE Standards, Geldreich)
Manure excreted by milk or dry cow	115	lb/day-animal	Virginia Department of Conservation and Recreation
Liquid manure produced by confined milk cows	17	gal/day-animal	Virginia Department of Conservation and Recreation
Fraction of fecal coliform produced per milk cow lost in milk parlor wash-off	0.025	ratio	
Die-off coefficient for liquid manure	0.375	1/day	Kimberly Panhorst's research
Die-off coefficient for solid manure pile	0.05	1/day	Kimberly Panhorst's research
Survival factor for liquid manure	0.0345	factor	
Survival factor for solid manure	0.068	factor	
Beef Cow Parameters			
Average weight of beef cow	1000	lb	
Fecal coliform production by 1000-lb beef cow	2.08E+10	total cfu/day-animal	within range of values from literature (Mountain Run TMDL, ASAE Standards, Geldreich)
Ratio of beef cattle on: Pasture 1	4	ratio	Assumed to be 4:2:1 based on information gathered from
to Pasture 2	2	ratio	beef extension specialists at Virginia Tech.
to Pasture 3	1	ratio	
Manure excreted by beef cow	60	lb/day-animal	Livestock Waste Facilities Handbook, MWPS - 18
Fraction of cows defecating in stream as compared to the cows that are in/around streams (beef)	0.3	ratio	assumed
Wildlife Parameters			
Deer fecal coliform produced	2.21E+08	total cfu/day-animal	Yagow (2001) FC and Harlow (1983) forage
Fraction of deer defecating in stream	0.01	ratio	
Raccoon fecal coliform produced	3.15E+07	total cfu/day-animal	
Fraction of raccoons defecating in stream	0.1	ratio	
Muskrat fecal coliform produced	1.58E+07	total cfu/day-animal	Mountain Run TMDL (Yagow, 2001)
Fraction of muskrats defecating in stream	0.25	ratio	
Goose fecal coliform produced	5.04E+08	total cfu/day-animal	Moyer and Hyer, 2003
Fraction of geese defecating in stream	0.25	ratio	
First Month of Goose Peak Season (mm format, e.g., Dec=12)	9	month number	
Last Month of Goose Peak Season (mm format, e.g., Dec=12)	2	month number	
Duck fecal coliform produced	1.51E+09	total cfu/day-animal	ASAE 1998 Standards: D384.1 DEC93
Fraction of ducks defecating in stream	0.25	ratio	
First Month of Duck Peak Season (mm format (e.g., Dec = 12))	9	month number	
Last Month of Duck Peak Season (mm format (e.g., Dec = 12))	2	month number	
Wild Turkey fecal coliform produced	5.86E+07	total cfu/day-animal	
Fraction of wild turkeys defecating in stream	0.01	ratio	
Beaver fecal coliform produced	2.00E+05	total cfu/day-animal	MapTech, 2000
Fraction of beavers defecating in stream	0.5	ratio	

APPENDIX F: *BEDLOADS - BACTERIA LOAD ESTIMATOR SPREADSHEETS (BLEST)*

Loads associated with resuspension of sediment (bedloads) can be estimated using the Bacteria Load Estimation Spreadsheet (BLEST) tool, developed by the Texas Commission on Environmental Quality. By multiplying the occurrence of resuspension flows, sediment scour rates, and estimates of stream width and stream lengths, the fecal coliform bedloads can be calculated. . Because loading is a function of stream width and length, the streams with the largest stream surface area exposed to bed sediment will consequently have the largest bed sediment contribution.

The methodology used in BLEST to estimate bedloads is outlined below:

1. Estimate Average Stream Width (from observations, photos).
2. Estimate Stream Length (from monitoring point, to upstream extent of sediment fines source area).
3. Estimate indicator bacteria resuspension from cohesive sediments (Jamieson et al., 2005). In these calculations, the average resuspension rate for bacteria (11,000 CFU $m^{-2}s^{-1}$) from Jamieson et al. was used.
4. Estimate length of time stream experiences critical shear conditions (used default from BLEST spreadsheet, 0.4 hours, using data from NOAA).
5. Assume shear is occurring along the entire stream reach.

Arroyo de la Cruz Estimated Bedload

Methodology

1. Estimate Average Stream Width (from observations, photos)
2. Estimate Stream Length (from monitoring point, to upstream extent of sediment fines source area)
3. Estimate indicator bacteria resuspension from cohesive sediments (Jamieson et al., 2005)
4. Estimate length of time stream experiences critical shear conditions (used default from BLEST spreadsheet, 0.4 hours, using data from NOA/
5. Assume shear is occurring along the entire stream reach.

Input Data

	Stream Width (ft)	
Arroyo de la Cruz	10	
Number of Rain Days (>0.5 inches precip	8	source: CIMIS Station 113 - King City
Typical Storm Length	8	
Portion of storm experience shear > Tc =	5%	default value
Resuspension Rate (cfu/m2/s)	11000	(See Table 3 to right)
cfu/m2/hr	3.96E+07	
cfu/ft2/hr	3.68E+06	
Resuspension rate per storm (cfu/ft2)	1.47E+07	

Table 3. Summary of resuspension parameters computed for the three Swan Creek storm events.

Storm	Critical bed shear stress	Critical flow	Resuspension rate
h	$N\ m^{-2}$	$m^3\ s^{-1}$	CFU† $m^{-2}\ s^{-1}$
225	1.7	0.37	11 000
550	1.6	0.33	8 200
600	1.5	0.3	15 000

† Colony forming units.

From Jamieson et al., 2005

BLEST Calculations:

LOAD CALCULATION:

Subbasin #	Stream	Stream Width (ft)	Stream Length (ft)	Majority Concrete Lined?	MPN/yr	End of MPN/wet day	End of 1013	Begin 1014 1014	End of Res	1017
1	Whiteoak Bayou	10	32467	N	3.82E+12	4.78E+11				4.78E+11

Load Calculation

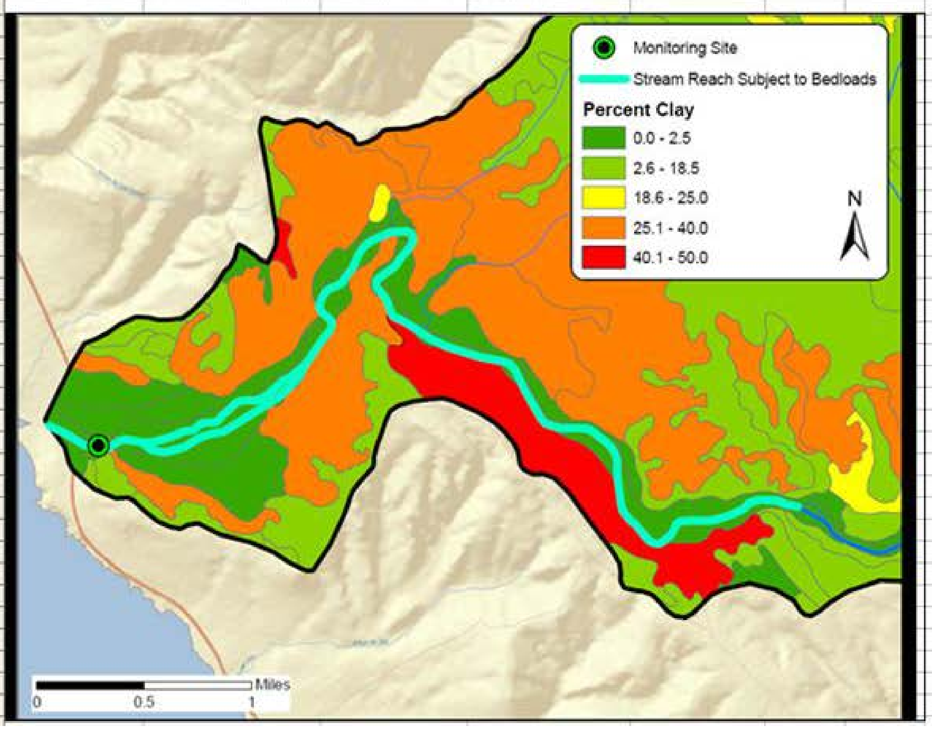
Stream	Stream Width (ft)	Stream Length (ft	MPN/storm event	MPN/year
Arroyo de la Cruz	10	32467	4.78E+11	3.82E+12

Wet day = Day with Precip >0.5 inches, from CIMIS #160 San Luis Obispo West (ave. 8 Wet days per year at CIMIS #1(

Stream Length Calculation

Total Length of NHDplus Stream Reaches Subject to Bedload = 9.9 kilometers, or 32,467 feet

Length of Streams Subject to Bed loading = 32,467 feet feet of stream reach receiving bed load



APPENDIX G: *LOAD DURATION CURVES*

Load duration curves provide a graphical context for looking at monitoring data and can also potentially be used to focus and inform implementation decisions (Stiles and Cleland, 2003). A load duration curve is the allowable loading capacity of a pollutant, as a function of flow. The flow duration curve is transformed into a load duration curve by multiplying the flow by the water quality objective and a conversion factor. The water quality objective that staff selected to calculate the load duration curve was the instantaneous fecal coliform Basin Plan criterion 400 MPN/100 mL. The load duration curve is thus calculated by multiplying the flow at the given flow exceedance percentile, by the instantaneous fecal coliform criteria and unit conversion factors; therefore the loading capacity is:

Water Quality Criterion → 400 MPN/100mL; Flow → Q (cfs); Unit Conversion Factors → 283.2 100mL/ft³ * 86400 sec/day

$$\underline{\text{Loading Capacity}}\ (\text{MPN/day}) = 400\ \text{MPN/100mL} * Q\ (\text{cfs}) * 283.2\ \text{100mL/ft}^3 * 86400\ \text{sec/day}$$

The load duration method essentially uses an entire stream flow record to provide insight into the flow conditions under which exceedances of the water quality objective occur. Exceedances that occur under low flow conditions are generally attributed to loads delivered directly to the stream such as straight pipes, domestic animals or wildlife with access to the stream, or some other form of direct discharge. Exceedances that occur under high flow conditions are typically attributed to loads that are delivered to the stream in stormwater runoff. Exceedances occurring under during normal flows can be attributed to a combination of runoff and direct deposits. As such, the load duration curve may illustrate how flow conditions relate to a variety of pollutant sources, and therefore load duration curves can be useful in differentiating between loading from point and nonpoint sources, as shown in the table below.

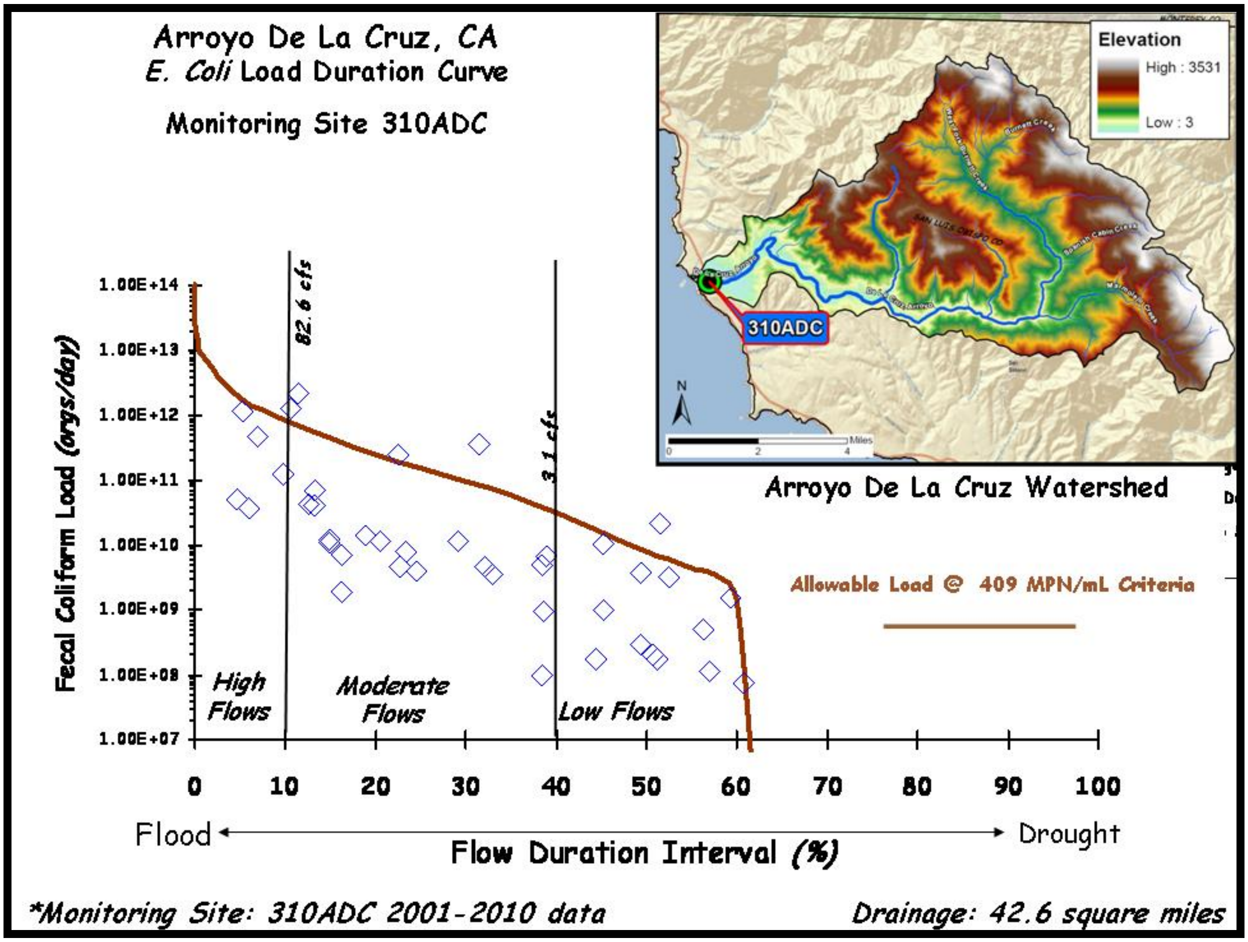
Potential Relationship Between Load Duration Curve and Contributing Sources

Contributing Source	**Flow Regime-Load Duration Curve**		
	High Flow	**Moderate Flow**	**Low Flow**
Direct Point Sources (pipe discharge, etc)			*H*
Direct Delivery (livestock in-stream, wildlife, pets, illegal dumping)		*M*	*H*
Failing OSDS		*M*	*H*
Sediment Resuspension	*H*	*M*	
Stormwater: Impervious areas	*H*	*H*	
Combined sewer overflows	*H*	*H*	
Overland flow/Bank erosion	*H*	*M*	

-Note: Color Shading = Potential relative importance of source area to contribute loads under given hydrologic condition **(H=High; M=Medium)**
-Table adapted from USEPA, Bruce Cleland, and Oregon Dept. of Environmental Quality.

A load duration curve (shown below) for Arroyo de la Cruz at 310ADC was constructed using estimated daily flow records and a spreadsheet tool developed by Bruce Cleland, USEPA (Cleland, 2002).

E. coli **Load duration curve for monitoring site 310ADC**



The load duration curve for Arroyo de la Cruz presented above indicates that excursions above the water quality criteria are relatively infrequent across the low and moderate flow regimes. There are no excursions above the water quality criteria in the high flow regime.

Load duration analysis included a "percent reduction" that was calculated for informational purposes only, to illustrate the difference between existing conditions and the loading capacity at the time the streams were sampled. The Load Duration Curve (the "TMDL) in this case represents a single-sample maximum criterion for *E. coli* at a concentration of 409 MPN/100mL. The existing load was calculated as the arithmetic mean value of the observed loads within each flow regime and then compared to the allowable load (the load duraction curve) at the flow at the middle of the flow exceedance percentile. For example, the middle percentile (25%) of the moderate flow regime was used, to assess load percent reductions at moderate flow (10-40th percentile flow class). Low flows were handled differently. In Arroyo de la Cruz flow is not observed 100% of the time. Therefore, the existing loading at low flow conditions is compared to the allowable load (the TMDL) at the 50th percentile flow.

A TMDL provides a foundation for identifying, planning, and implementing water quality-based controls to reduce both point and nonpoint source pollution. Though the data used to calculate the percent reductions may be considered "historical", it provides a representation of the existing FIB loads in the waterbodies over a range of hydrologic conditions. Therefore, the percent reduction ***should not be viewed as the TMDL*** but rather a goal to work towards in the implementation phase of the TMDL process with the ultimate goal being the restoration and maintenance of in- stream water quality so that beneficial uses are met. The percent reductions are presented in the table below and can be calculated as:

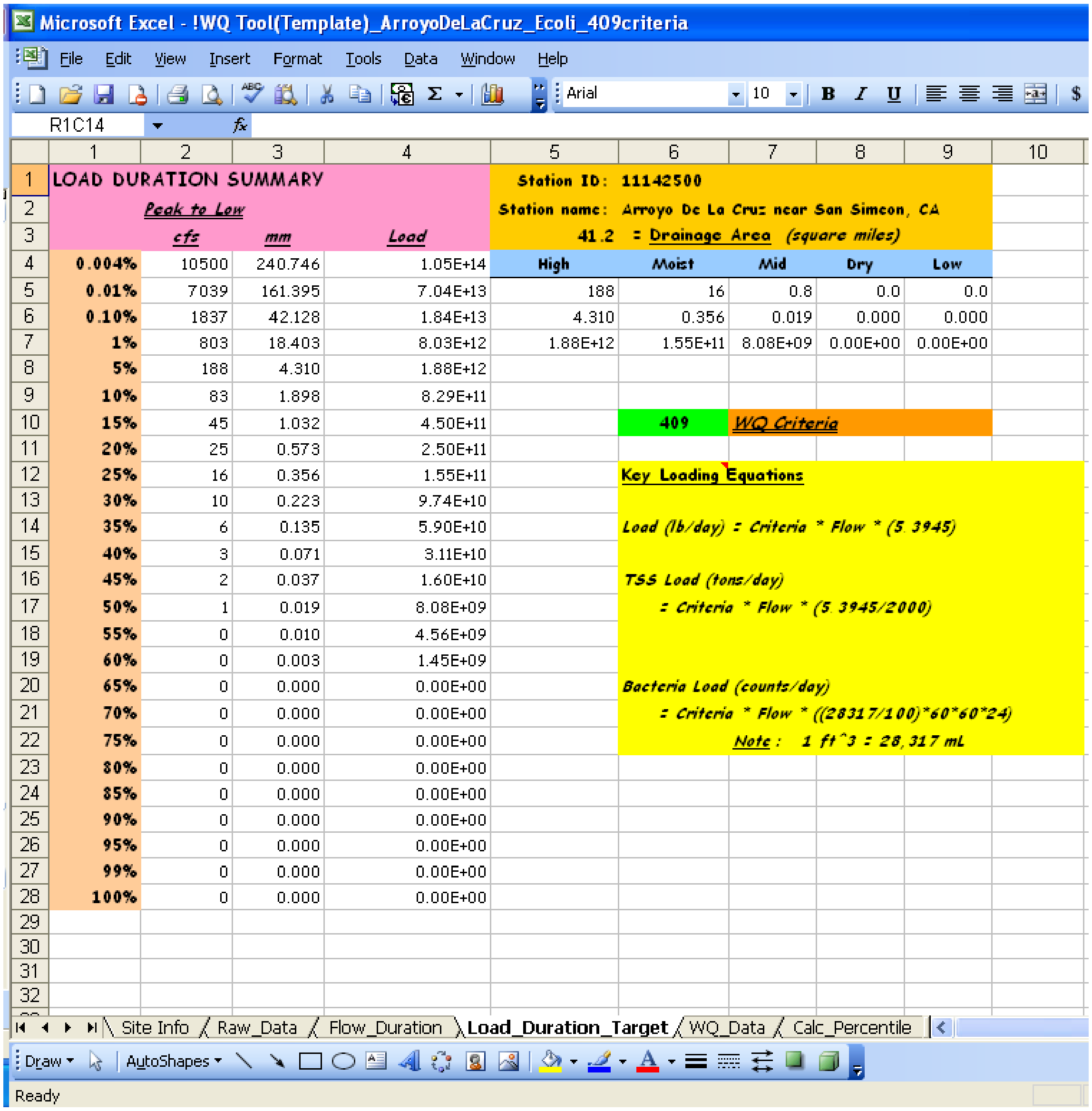
Percent reduction = [(existing load) - (allowable load)/(existing load)] *100

Estimated Existing *E. coli* Loading for 310ADC with Critical Condition Highlighted

Flow Regime	**Loading Capacity**	**Estimated Existing Load**	**Percent Reduction Goal**
High Flows	1.88 E+12	3.68 E+11	0%
Moderate Flows	1.55 E+11	1.80 E+11	14%
Low Flows	8.08 E+09	3.32 E+09	0%

Exceedences of the water quality objective occurs low and moderate flow regimes; however, the highest percent exceedences of the water quality objective appears to occur in the moderate flow regime.

The load duration calculations, using Bruce Cleland's (2002) spreadsheet tool, are presented below.



	1	2	3	4	5	6	7	8	9	10
1	LOAD DURATION SUMMARY				Station ID:	11142500				
2		Peak to Low			Station name:	Arroyo De La Cruz near San Simeon, CA				
3		cfs	mm	Load	41.2	= Drainage Area (square miles)				
4	0.004%	10500	240.746	1.05E+14	High	Moist	Mid	Dry	Low	
5	0.01%	7039	161.395	7.04E+13	188	16	0.8	0.0	0.0	
6	0.10%	1837	42.128	1.84E+13	4.310	0.356	0.019	0.000	0.000	
7	1%	803	18.403	8.03E+12	1.88E+12	1.55E+11	8.08E+09	0.00E+00	0.00E+00	
8	5%	188	4.310	1.88E+12						
9	10%	83	1.898	8.29E+11						
10	15%	45	1.032	4.50E+11		409	WQ Criteria			
11	20%	25	0.573	2.50E+11						
12	25%	16	0.356	1.55E+11		Key Loading Equations				
13	30%	10	0.223	9.74E+10						
14	35%	6	0.135	5.90E+10		Load (lb/day) = Criteria * Flow * (5.3945)				
15	40%	3	0.071	3.11E+10						
16	45%	2	0.037	1.60E+10		TSS Load (tons/day)				
17	50%	1	0.019	8.08E+09		= Criteria * Flow * (5.3945/2000)				
18	55%	0	0.010	4.56E+09						
19	60%	0	0.003	1.45E+09						
20	65%	0	0.000	0.00E+00		Bacteria Load (counts/day)				
21	70%	0	0.000	0.00E+00		= Criteria * Flow * ((28317/100)*60*60*24)				
22	75%	0	0.000	0.00E+00		Note : 1 ft^3 = 28,317 mL				
23	80%	0	0.000	0.00E+00						
24	85%	0	0.000	0.00E+00						
25	90%	0	0.000	0.00E+00						
26	95%	0	0.000	0.00E+00						
27	99%	0	0.000	0.00E+00						
28	100%	0	0.000	0.00E+00						

APPENDIX H: *DAILY LOAD EXPRESSIONS*

Staff provides daily load expressions in light of a recent court decision (*Friends of the Earth, Inc. v. EPA, et al.*, No. 05-5015, D.C. Cir. 2006), and USEPA guidance {USEPA 2007(a}, despite the fact that this is a concentration-based TMDL and a daily or average daily TMDL is not appropriate for this TMDL project. Mass-based daily load expressions are provided to comply with USEPA technical and legal guidance. USEPA continues to recognize the validity of concentration based TMDLs, in accordance with 40 CFR 122.45(f), but recommends supplementing a concentration-based TMDL with a daily load expression

The District of Columbia (D.C.) Circuit Court of Appeals issued a decision in *Friends of the Earth, Inc. v. EPA, et al.*, No. 05-5015 (D.C. Cir. 2006), in which the D.C. Circuit held that two TMDLs for the Anacostia River did not comply with the Clean Water Act because they were not expressed as *daily* loads.

As a result of the decision, USEPA issued a memorandum entitled *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015* (April 25, 2006) and Implications for NPDES Permits in November 2006 that recommends that all TMDLs and associated load allocations (LAs) and wasteload allocations (WLAs) include a daily time increment in conjunction with other temporal expressions (e.g., annual, seasonal) that may be necessary to implement the relevant water quality standards.

The 2007 USEPA draft guidance for establishing Total Maximum Daily Loads includes the following statements:

> *"If technically appropriate and consistent with the applicable water quality standard, it may also be appropriate for the TMDL and associated load allocations and wasteload allocations to be expressed in terms of <u>differing maximum daily values depending on the season of the year, stream flow</u> (e.g., wet v. dry weather conditions) or other factors. In situations where pollutant loads, water body flows, or other environmental factors are highly dynamic, it may be appropriate for TMDLs and associated allocations <u>to be expressed as functions of controlling factors such as water body flow</u>. For example, <u>a load-duration curve approach to expressing a TMDL and associated allocations might be appropriate</u>, provided it clearly identifies the allowable daily pollutant load for any given day as a function of the flow occurring that day. Using the load-duration curve approach also has the advantage of addressing seasonal variations as required by the statute and the regulations."*

> *"For TMDLs that are expressed **<u>as a concentration of a pollutant</u>**, a <u>possible approach would be to use a table and/or graph to **express the TMDL as daily loads for a range of possible daily stream flows.**</u> The in-stream water quality criterion multiplied by daily stream flow and the appropriate conversion factor would translate the applicable criterion into a daily target."**

* emphasis added

From: USEPA. 2007. <u>Options for Expressing Daily Loads in TMDLs</u>. USEPA Office of Wetlands, Oceans, and Watersheds, Draft Guidance, June 22, 2007.

A daily or average daily TMDL is inappropriate for the proposed allocations and TMDLs due to both (1) the temporal component embedded in the applicable water quality criteria for indicator bacteria; and (2) the episodic and highly variable nature of FIB transport and loading in streams make daily fecal indicator bacteria loads inappropriate for this TMDL project.

U.S. EPA noted in this guidance document that "for pollutants where the [water quality standard] has a longer than daily duration (e.g., monthly or seasonal average), individual values that are greater than the daily expression do not necessarily constitute an exceedance of the applicable standard." This is the case with this TMDL project, which is in response to elevated FIB concentrations in project area waterbodies, and the water quality criteira that has an embedded monthly temporal component.

Staff, nonetheless, provide the following interpretations of our concentration-based allocations and TMDLs as a daily load expression in MPN/per day in accordance with the draft U.S. EPA guidance. However, we intend to implement the concentration-based TMDLs and allocations.

The *E. coli* mass-based daily load expressions for the Arroyo de la Cruz fecal indicator bacteria TDML are presented in the Table below.

Total Maximum Daily Load, Arroyo de la Cruz at 310ADC – *E. Coli* Daily Load Expressions.

Impaired Stream Reaches	Flow Regime	Flow Exceedence Percentile	Flow (cfs)	Flow-based Total Maximum Daily Load	WLA	Load Allocation	MOS
					None	Nonpoint Sources	
Arroyo de la Cruz at 310ADC	High	5%	83	1.88 E+12	-	1.88 E+12	Implicit
	Moderate	20%	16	1.55 E+11	-	1.55 E+11	Implicit
	Low	40%	0.8	8.08 E+09	-	8.08 E+09	Implicit
	Mean Annual Flow	15%	45	4.50 E+11		4.50 E+11	Implicit

However, we intend to implement the concentration-based TMDLs and allocations, consistent with the aforementioned USEPA guidance {USEPA, 2007(b)}. As such, daily load expressions presented in this Appendix represent an alternative way to express concentration-based allocations, but the mass-based daily load expressions do NOT formally constitute the TMDL or the allocations.

APPENDIX I: *COST ESTIMATES AND SOURCES OF FUNDING*

While it is possible to identify a discrete range of costs associated with implementing management practices, there is substantial uncertainty in calculating total costs, or costs associated with future measures. This is in part, due to the uncertainty surrounding the number of facilities, ranches, farms, etc. that will require implementation. Also, specific actions or management measure that are described or identified in the project report can only be suggestions or examples of actions that are known to be effective at reducing loading.

Staff provide estimates of total implementation costs below in Table 6-7. These costs are approximations and come with significant uncertainties, since the number of properties that will require implementation is unknown, and also because the Water Board cannot mandate or designate the specific types of on-site actions necessary to reduce indicator bacteria loading, or to meet allocations by the various responsible parties.

Also, staff did not consider or incorporate improved profitability and economic performance metrics that are commonly reported (e.g., U.S. Dept. of Agriculture and South Dakota State Univ., 2008) to be associated with some of the management practices identified here). Additionally, as a substantial number of grazing lands operators are reportedly proactive with regard to land and animal management, some of the identified management practices presumably have been, or will be implemented, with or without a TMDL. As such, economic estimates provided below are strictly based on an out-of-pocket gross expenditure basis; not a net cost-benefit economic basis.

Cost estimates for specific implementation actions shown here were tabulated from sources provided by the National Resources Conservation Service, U.S. Environmental Protection Agency, U.S. Department of Agriculture, and other sources.

Planning or Program Development Actions: The cost to develop FIB 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 domestic animals 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: Based on a survey of professional and technical literature, the Iowa State University Extension program (Mayer and Olsen, 2005) reports the cost of fencing to exclude livestock from areas where animal waste can impact surface waters ranges from $0.18 to $1.51 total construction costs per foot of fence ($950.40 to $7,972.80 per mile, respectively). Mayer and Olsen (2005) report that that all configurations of fencing shown in their publication “can be used with cattle, and that woven wire and high tensile electrified fencing can be used with sheep, and woven wire can be used with hogs.”

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 stormwater 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 $4,000. (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 $3,000 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.

Tabulated Example Costs: Costs associated with on-site management practices for rangeland, grazing animals, and domestic farm animal operations, are tabulated in Table H-1.

Table H-1: Example Costs for Grazing Animal Management Practices.

Practices	Cost (Maximum, unless otherwise noted)	Practices	Cost (Maximum, unless otherwise noted)
Access Road (repair)	$5/ft.	Pond (repair)	$10,000 ea.
Attend Training Sessions	Usually <$40 (transportation/registration fess)**	Range Seeding:	
Brush Mgt.	$10/ac.	Native species	$250/ac.
Channel Vegetation	$600/ac.	Introduced species	$100/ac.
Clearing and Snagging	$10/ft.	Riparian Buffer Strip	$600/ac.
Conservation Tillage	$20/ac.	Roads*	
Cover/Green Manure Crop:		Culverts and Water Bars	$150/mile
Native species	$250/ac.	Road Repairs	$1,500/mile
Introduced species	$100/ac.	Spring Development	$1,000/ea.
Critical Area Planting	$1,000/ac.	Streambank Protection:	
Fence (upland)	$2/ft.	mechanical	$100/ft.
Fence (riparian)	$2/ft.	Vegetative	$12.50/ft.
Fence, Electric	$1.25/ft.	Tank	$2,500 ea.

Practices	Cost (Maximum, unless otherwise noted)	Practices	Cost (Maximum, unless otherwise noted)
(upland)			
Fence, Electric (riparian)	$1.25/ft.	Tree Planting w/ irrigation	$600/ac.
Grade Stabilizer	$20,000 ea.	Tree Planting w/o irrigation	$300/ac.
Grassed Waterways	$20/ft.	Trough (w/ concrete pad)	$1,000 ea.
Grazing Management:		Trough (w/o concrete pad)	$800/ea.
Hardened Stream Crossings	$2,000 to $6,000**	Trough (small wildlife)	$500/ea.
Prescribed Grazing	$6.95/ac. (median)**	Upland Wildlife Habitat Mgt.	$400/ac.
Provide Shade away from riparian area	$500/accommodate 5-6 cows**(moveable shading structures)	Vegetative Buffer Strip:	
Remote waterers in pastures	$4,500 to $8,200 to install (could be <$1,000 if water piped from existing well)**	Native Species	$200/ac.
Rotational Grazing	$30 to $70/acre	Introduced Species.	$75/ac.
Streamside livestock exclusion	(see fence est.) Funding may be available through local conservation office**	Wildlife Watering Facility	$4,000/ea.
Pipeline	$1.25/ft.		

Source: NRCS Templeton Service Center Environmental Quality Improvement Program Practices Information (as reported in CCRWQCB Watsonville Slough Pathogen TMDL Project Report, 2005)
* Estimate provided by Cal Poly State Univ. for Chumash Creek Watershed road improvements.
** U.S. Dept. of Agriculture and South Dakota State Univ., 2008. Reicks et al., "Better Management Practices for Improved Profitability and Water Quality" : SDSU publication FS994

Table H-2 presents the estimated number of implementing parties in the TMDL project area

Table H-2: Estimated number of properties with domestic animals requiring implementation.

Category	Land Use*	Project Area Acres*	Number of Property Owner/Operators in Land Use Category	Number of Properties with Domestic Animal Operations	Number of Properties Requiring Implementation[C]	Number of Acres Requiring Implementation[D]
Grazing Operations	Grazing Lands	27,304	25[A]	13[B]	7	1400

Data and Assumptions:
* FMMP Land Cover Dataset, from Section 2.1.2.
A: Based on parcel data: (Number of parcels intersecting FMMP grazing land data) x (0.5) = 50 X 0.5=25.
B: Assumed only a fraction (~50%) of parcel property owners on grazing land are engaged in livestock grazing operations: 12 * 0.5 = 6
C: It is assumed that 50% of properties with livestock grazing operations will require some form of implementation measures. Some properties reportedly already have implemented management practices; also staff presumes that some properties are currently not contributing to fecal coliform loading to receiving waters.
D. Acres requiring implementation will depend on grazing management method employed (for example, rotational grazing), and the size and number of paddocks. Assume 200 acres average per each grazing operation that requires implementation (200 X 7 = 1400).

In Table H-3 staff provide cost estimates based on a range of land management practices or structural management practices and associated costs (from Table H-1 and narrative previously presented in this Section) that can plausibly be anticipated to be associated with TMDL implementation activities. It is presumed that management practices will focus on measures that limit that amount of time that domestic animals will spend in creek beds, or limit the opportunity for their waste to be discharged to creeks (e.g., grazing management practices, off-stream watering systems, exclusion barriers). However, it is important to emphasize again that the Water Board cannot mandate a specific type of management measure to achieve load allocations. Additionally, staff provides a range of cost estimates based on the median cost, the 25th percentile cost, and the 75th percentile cost of the management measures presented in Table H-3. Staff presumes that range and variety of management measures will be implemented in the project area and that therefore including a 25th percentile and 75th percentile estimate capture a plausible low-end and high-end economic cost estimates, respectively.

Table H-3: Tabulation of range of costs of selected management practices.

Category	**Land or Animal Management** Cost Range of Land Management Practices		**Structural Measures** Cost Range of Structural Management Practices	
Grazing Operations: Livestock	Prescribed Grazing	$6.95/acre (median)	Provide Shade away from riparian area	$500
	Rotational Grazing	$30/acre (min)	Remote waterers	$1000 (min)
			Remote waterers	$4,500 (max)
			Streamside Livestock Exclusion (fencing)	$950/mile (min)*
	Rotational Grazing	$70/acre (max)	Streamside Livestock Exclusion (fencing)	$7973/mi le(max)*
			Attend Training Sessions	$40
			Trough	$800 (min)
			Trough	$1,000 (max)
	Median cost	$30/acre	*Median cost*	$875
	P25 Cost	$18/acre	*P25 Cost*	$385
	P75 Cost	$50/acre	*P75 Cost*	$1000
	Acres requiring implementation	1400	*Properties requiring implementation*	7
Total Cost for Grazing Operations *(Acres or Properties Requiring Implementation multiplied by per acre cost or per structural measure cost)*	***Total Median Cost***	$42,000	***Total Median Cost***	$6,125
	Total P25 Cost	$35,000	***Total P25 Cost***	$2,695
	Total P75 Cost	$70,000	***Total P75 Cost***	$7,000

* for fencing cost estimates, grazing operations costs are calculated on a per mile basis. Since rural residential properties are associated with much smaller tracts of land, fencing cost estimate is calculated on one-tenth of a mile basis. Fencing cost estimates are from Mayer and Olsen (2005)

Finally, Table H-4 tabulates the range of costs to implement the TMDL. These represent the collective total cost to all implementing parties over the 13 year timeline of TMDL implementation.

Table H-4: Costs to Implement the TMDL.

Category	**P25 Cost (low)**	**Median Cost**	**P75 Cost (high)**

Grazing Operations Land Management Measures	$35,000	$42,000	$70,000
Grazing Operations Structural Management Measures	$2,695	$6,125	$7,000
Total Aggregate Cost to Implement TMDL	**$37,695**	**$48,125**	**$77,000**

Sources of Funding

Potential sources of financing to TMDL implementing parties are described in the Basin Plan, Chapter 4, in section VIII.C.6, as reproduced below.

On private lands whose owners request assistance, the U.S. Natural Resource Conservation Service (NRCS), in cooperation with the local Resource Conservation Districts (RCDs), can provide technical and financial assistance for range and water quality improvement projects. A Memorandum of Understanding is in place between the U.S. Soil Conservation Service and the State Board for planning and technical assistance related to water quality actions and activities undertaken to resolve nonpoint source problems on private lands.

In addition, staff provides some examples of funding sources below:

Environmental Quality Incentives Program (EQIP)
EQIP is a program designed to address significant natural resources needs and objectives including: soil erosion and water pollution prevention, farm and ranch land production, agricultural water conservation, and wildlife habitat preservation and development. EQIP offers financial and technical assistance to eligible participants for the installation of vegetated, structural and management practices on eligible agricultural land. EQIP typically cost-shares at 90 percent of the costs of eligible conservation practices Incentive payments may be provided for up to three years to encourage producers to conduct management practices they would not otherwise do without the incentive. Limited resource producers and beginning farmers and ranchers may be eligible for cost-share up to 90 percent.

More information is also available from the local NRCS or RCD office or at the Monterey County RCD website at
http://www.rcdmonterey.org/Growers_Ranchers_Landowners/funding_services.html

Clean Water Act 319(h) Grant Program
This program is a federally funded nonpoint source pollution control program that is focused on controlling activities that impair beneficial uses and on limiting pollutant effects caused by those activities. The 319(h) grant program offers funds to non-profit organizations, government agencies including special districts, and education institutions. Specific non-point source activities that are eligible for 319(h) funds may include, but are not limited to: the implementation of best management practices for agricultural drainage, physical habitat alteration, channel stabilization, sediment control, hydrologic modification, livestock grazing, irrigation water management, and confined animal facilities management. Other eligible activities include technology transfer, ground water protection, pollution prevention, technical assistance, facilitation of citizen monitoring and facilities of education elements of projects.

More information is also available from the California State Water Resources Control Board site at http://www.swrcb.ca.gov/water_issues/programs/grants_loans/319h/index.shtml, or contact Melenee Emanuel, State Board Division of Water Quality, 319(h) Grants Program at (916) 341-5271.

Other Sources of Funding for Growers, Ranchers, and Landowners

The Monterey County RCD can provide access to and/or facilitate a land owners application for federal cost-share assistance through various local, state and federal funding programs. For certain projects the RCD may also be able to apply for other grant funds on behalf of a cooperating landowner, grower or rancher. More information is available at the Monterey County RCD website at http://www.rcdmonterey.org/Growers_Ranchers_Landowners/index.html.