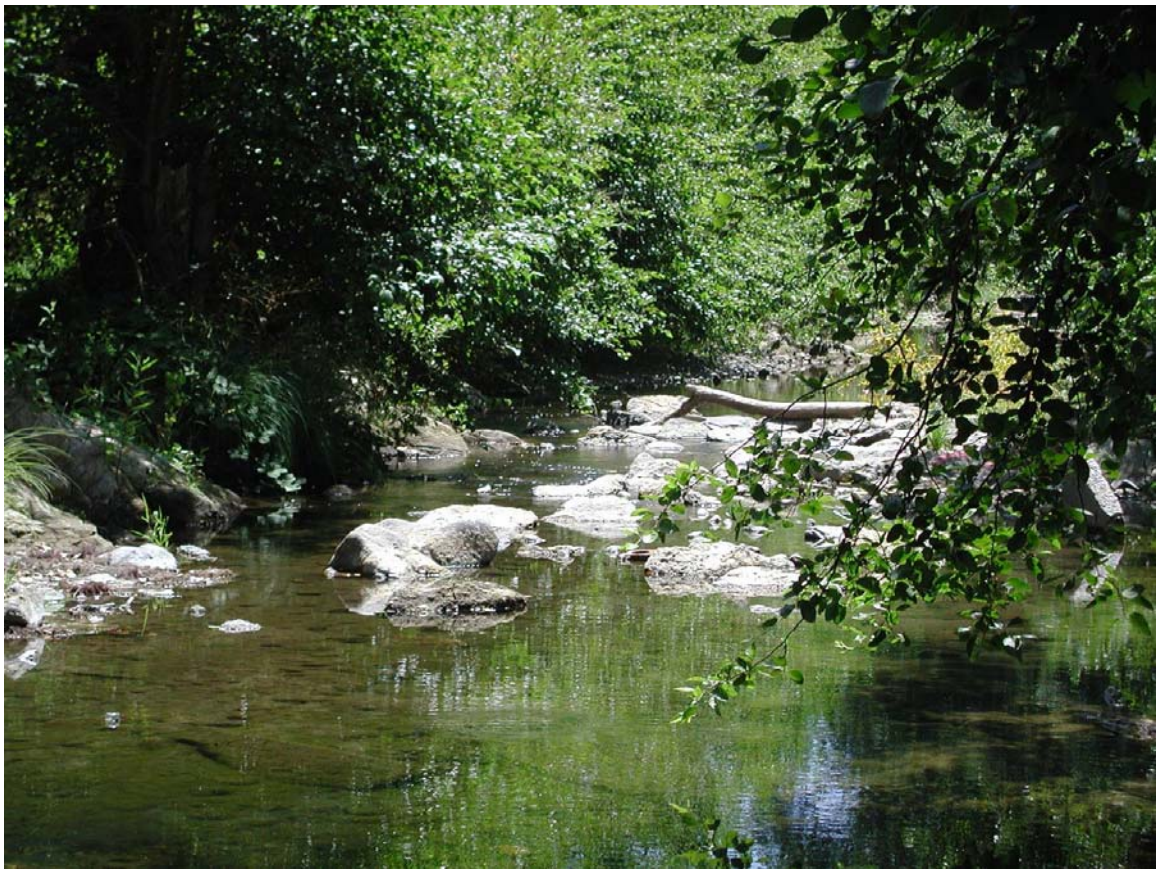
Pathogens in Sonoma Creek Watershed Total Maximum Daily Load (TMDL)

Staff Report



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San Francisco Bay Region

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1. INTRODUCTION

1.1 Overview

This staff report provides the technical background and basis for a proposed amendment to the *Water Quality Control Plan, San Francisco Bay Region* (Basin Plan) (Water Board, 1995). This staff report contains results of staff analysis of pathogen impairment and sources, recommended pathogen load allocations, and a plan to implement the allocations. If adopted, the Basin Plan amendment would: 1) establish a pathogen Total Maximum Daily Load (TMDL) in the Sonoma Creek Watershed pursuant to Section 303(d) of the Clean Water Act, and 2) establish an implementation strategy to achieve and support the TMDL. If adopted, portions of Basin Plan Chapter 4 (implementation plan) will be revised.

This report provides the scientific basis for the TMDL and associated implementation plan for the Sonoma Creek Watershed. It discusses background conditions and current pathogen loads. It also describes how the TMDL ensures attainment of water quality objectives and protects beneficial uses of the Sonoma Creek Watershed.

1.2 Compliance with the California Environmental Quality Act (CEQA)

This staff report meets the requirements of the California Environmental Quality Act (CEQA) for adopting Basin Plan amendments. CEQA authorizes the California Resources Agency Secretary to exempt a state agency's regulatory program from preparing an Environmental Impact Report or Negative Declaration if certain conditions are met. The Resources Agency has certified the basin planning process to be "functionally equivalent" to the CEQA process. Therefore, this report is a functional equivalent document and fulfills CEQA environmental documentation requirements.

1.3 Description of TMDL Process

The federal Clean Water Act requires states to identify impaired waters and the pollutants causing impairments. This list of water bodies is often referred to as the "303(d) list",referencing the identification requirement in section 303(d) of the Clean Water Act).. In California, it is the State Board that adopts this list of impaired water bodies, with input from the regions and stakeholders. The Clean Water Act also requires states to establish Total Maximum Daily Loads (TMDLs) for the listed pollutants in those impaired waters, which is the resonposibility of the Regional Water Boards. TMDLs are essentially water body-specific cleanup or restoration plans that target the pollutants causing impairment. Essential components of TMDLs include: numeric target(s) that define the desired condition or "restored" condition of the waterbody; the maximum amount of pollutant(s) or stressor(s) the waterbody can tolerate while meeting these targets; identification of the sources of the pollutant(s) reaching the waterbody; and allocations of pollutant loads or load reduction responsibility to these sources.

Sonoma Creek (including its tributaries) is listed as impaired for pathogens, as well as sediments and nutrients . Sonoma Creek lies within the jurisdiction of the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board), and therefore the Water Board is responsible for developing a TMDL to address the impairment of Sonoma Creek by pathogens. This report describes the water quality problem causing the impairment, pollution sources and actions needed to restore or cleanup the water body. This report provides the technical and scientific basis for the Basin Plan amendment.

TMDLs are established via Board-approved amendments to our Basin Plan, and these amendments must also include plans to implement the TMDLs. As required, the proposed amendment and this staff report contain a detailed implementation plan, identify responsible parties and schedules for actions, and describe monitoring to track the actions and attainment of water quality standards. Additional studies may be prescribed to confirm key assumptions made while developing the TMDL, resolve any uncertainties remaining when the TMDL is adopted, and establish a process for revising the TMDL, as necessary, in the future.

1.4 Next Steps

The Water Board will hold two public hearings, a testimony hearing and an adoption hearing, for this TMDL. The first, a testimony hearing, is scheduled for April 12, 2006. This hearing will provide an opportunity for interested parties to hear and comment on the proposed Basin Plan amendment and associated staff report, which includes an implementation plan. In addition, Water Board members will be able to ask questions of staff and stakeholders. At the second hearing, which is the adoption hearing, the Water Board will be asked to consider comments received, consequent staff responses, and any proposed revisions, and to begin the process of establishing the TMDL by adopting the proposed Basin Plan amendment. The adoption hearing is anticipated to be held on June 14, 2006. After adoption by the Water Board, the TMDL will be sent to the State Water Board, the California Office of Administrative Law, and U.S. EPA for approval.

2. WATERSHED DESCRIPTION

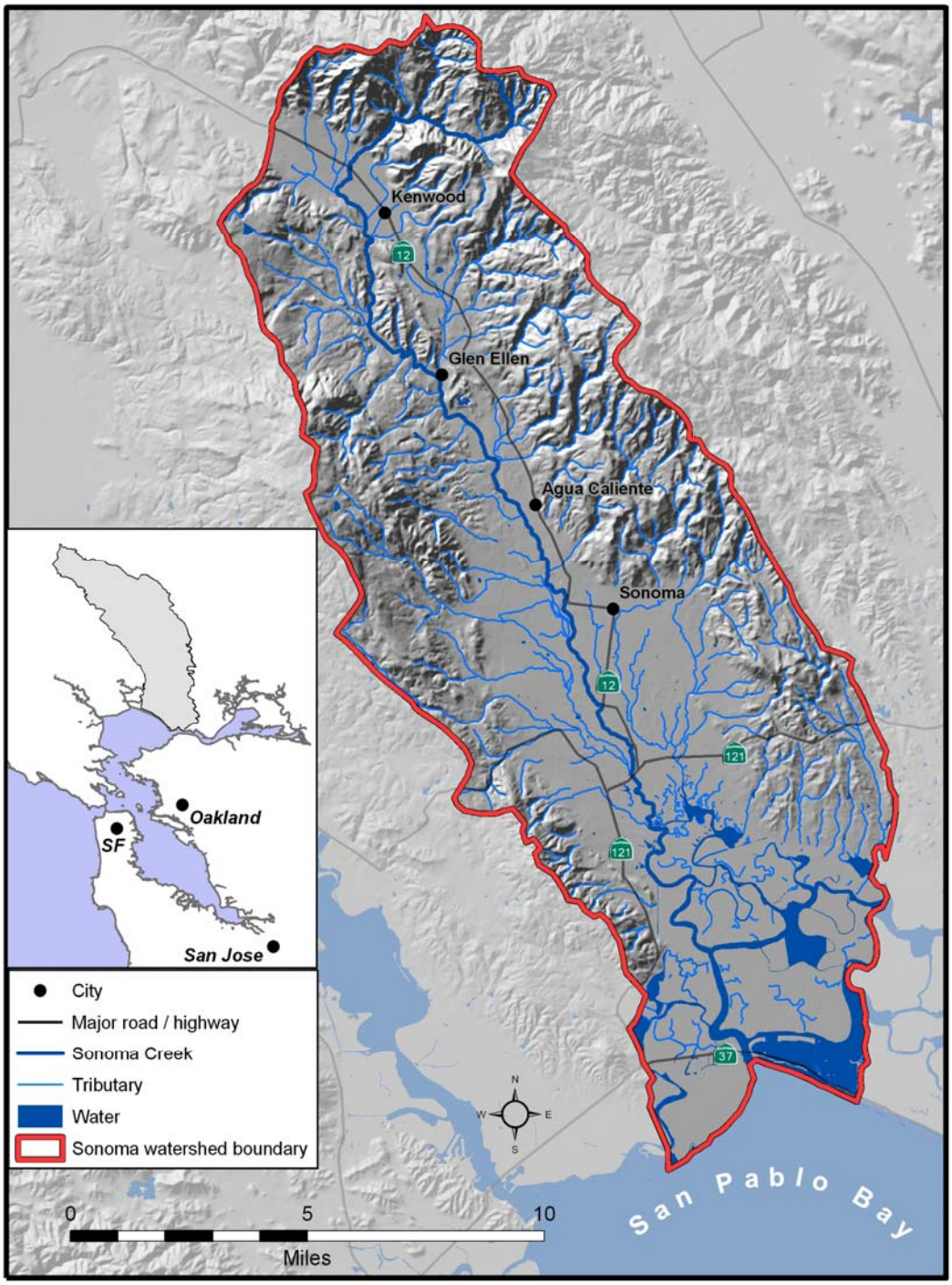
The Sonoma Creek watershed is located in the California Coast Ranges north of San Pablo Bay (Figure 1), covering an area of approximately 166 square miles (430 km^2). The main stem of Sonoma Creek flows in a southeasterly direction from headwaters on Sugarloaf Ridge though the Sonoma Valley before discharging to San Pablo Bay. Numerous tributaries enter the main stem from the mountains that rise on both sides of the valley.

Average annual rainfall in the watershed ranges from approximately 23 inches in the lower portions of the Sonoma Valley to greater than 50 inches in the highest slopes of the Sonoma Mountains to the west and Mayacamas Mountains to the east. The large majority of rainfall occurs from November through April, with heaviest rainfall occurring from December through February. This rainfall regime results in two distinct seasons in the watershed. During the winter wet season streamflow and pollutant loading are dominated by precipitation-driven surface runoff. In contrast, groundwater inflow or runoff from human activities dominate during the dry summer months.

Major land cover types in the watershed are forest (approximately 30%), grassland/rangeland (20%), and agriculture (30%, a large and growing percentage of this in vineyards). Developed land—residential, industrial, or commercial—accounts for approximately 15% of the watershed (Association of Bay Area Governments, 2000).

The watershed contains about 465 miles of blue-line streams mapped by the USGS (Sonoma Creek Watershed Limiting Factors Analysis, Sonoma Ecology Center, December 2004) and supports the following Beneficial Uses, as defined by the Basin Plan: cold freshwater habitat, warm freshwater habitat, water contact recreation, noncontact water recreation, fish migration, preservation of rate and endangered species, fish spawning, warm freshwater habitat, and wildlife habitat. In addition, the Sonoma Creek watershed provides habitat for several native species of concern, including steelhead trout (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), and California freshwater shrimp (*Syncaris pacifica*). Sonoma Creek is also listed as impaired by nutrients and sediment. It is likely that actions implemented to reduce pathogen loading will also reduce nutrients and sediment, and help Sonoma Creek in supporting many of its designated Beneficial Uses.

Figure 1. Location of the Sonoma Creek Watershed



3. PROBLEM DEFINITION

Elevated levels of fecal coliform bacteria have been observed in Sonoma Creek since the 1970s. These bacteria indicate the presence of fecal contamination and attendant health risk to recreational users of the Creek from water-borne pathogens. Fecal contamination is the primary mechanism for the spread of water-born illness (American Public Health Association, 1998; U.S. EPA, 2001, 2002).

Recent monitoring (Section 3.4) confirmed the presence of elevated Escherichia coli (*E. coli)*; a subset of the fecal coliform group and pathogen indicator) levels in the Creek and its tributaries. The following sections discuss the use of pathogen indicator bacteria in water quality monitoring and regulation, relevant water quality standards, historic bacterial monitoring in the watershed, and current bacterial water quality studies.

3.1 Use of Fecal Bacteria as Indicators of Pathogens

More than 100 types of pathogenic microorganisms may be found in water polluted by fecal matter and can cause outbreaks of waterborne disease (Havelaar, 1993). Techniques currently available for direct monitoring of specific pathogens in water have several shortcomings that preclude their use in routine water quality monitoring. Some common disease-causing viruses (Hepatitis A virus, Rotaviruses, and Norwalk virus) cannot as yet be detected practically; techniques for the recovery and identification of human enteric viruses (viruses affecting the intestines) often have limited sensitivity, are time consuming, and expensive (U.S. EPA, 2001).

Due to these difficulties, indicator organisms—principally bacteria—are commonly used to assess microbial water quality for recreational use waters. Indicator bacteria colonize the intestinal tracts of warm-blooded animals (including humans) and are routinely shed in animal feces. These organisms are not necessarily pathogenic, but are abundant in wastes from warm-blooded animals and are easily detected in the environment. The detection of these organisms indicates that the environment is contaminated with fecal waste and that pathogenic organisms may be present.

Commonly used bacterial indicators of fecal contamination include total coliforms, fecal coliforms, *E. coli*, and fecal enterococci. Total coliforms include several genera of bacteria commonly found in the intestines of warm-blooded animals. However, many types of coliform bacteria grow naturally in the environment—that is, outside the bodies of warm-blooded animals. Fecal coliforms are a subset of total coliform and are more specific to wastes from warm-blooded animals, but not necessarily to humans. *E. coli* are a subset of fecal coliforms, and are thought to be more closely linked to the presence of human pathogens than fecal coliforms (U.S. EPA, 2002). Fecal enterococci represent a different bacterial group from the coliforms, and are also regarded to be good indicators of fecal contamination, especially in salt water (U.S. EPA, 2002).

Although fecal bacteria have historically been the indicator organisms of choice, they have three primary shortcomings: 1) the presence of these indicators does not necessarily mean that human pathogens are present—only that they may be present; 2) bacterial indicators may not have the same levels of survival in the environment as the pathogens for which they are intended to serve as sentinels; and 3) these indicators are not human-specific, and therefore do not fully assess the health risk from human enteric viruses and other human-specific pathogens. The third limitation is of less importance than might be assumed, since fecal contamination from a wide range of non-human species—both domesticated and wild—often carry human pathogens (U.S. EPA, 2002). Despite these shortcomings[1], no practical alternative to the use of fecal indicator bacteria is currently available. The Sonoma Creek Pathogen TMDL uses fecal coliforms and *E. coli* as pathogen indicators. Use of these indicators is consistent with state water quality criteria and with federal guidance (U.S. EPA, 2002). If in the future better indicator organisms are identified and new standards are put into place for these organisms, this TMDL will be modified accordingly.

Microbial Source Tracking (MST) methods have recently been used to help identify nonpoint sources responsible for the fecal pollution of water systems. These methods involve examining the DNA or antibiotic resistance properties of fecal indicator bacteria to determine if the bacteria originated from humans, domesticated animals, or wildlife (Santa Domingo et al., 2002). Microbial source tracking was not employed in this TMDL for the following reasons:

- This approach is very expensive and time-consuming;
- Results are often imprecise and equivocal (Stoeckel et al, 2004); and
- Since both human and non-human fecal contamination is known to pose human health risks (Atwill, 1995; U.S. EPA, 2001) identification of a pathogen source as non-human does not eliminate the need to control the source.

[1] An important additional limitation that applies to ambient sampling for any type of microorganism—including both indicator bacteria and actual pathogenic organisms—is that reported sample values are subject to error resulting from limitations in sampling and analytical methods, and should therefore be regarded as approximations. Sources of error can include non-uniform distribution of target organisms in the water being sampled, differential survival of organisms during sample storage and in the test media, clumping of multiple organisms in the test media (with the result that several organisms are counted as just one), and statistical limitations of the testing procedure. Sampling and analytical procedures are designed to minimize these errors, but even in the best of situations the precision of laboratory analysis for bacteria is low relative to chemical analyses. In many cases the true value for a single sample may range from one-third to three times the reported value (American Public Health Association, 1998). This uncertainty can be considerably reduced through repeated sampling and use of geometric means or medians, rather than single-sample values.

3.2 Water Quality Standards

Water quality standards consist of: a) beneficial uses for the waterbody, b) water quality objectives to protect those beneficial uses, and c) the Antidegradation Policy, which requires the continued maintenance of existing high-quality waters. The Water Board's Basin Plan specifies beneficial uses for waterbodies in the Region and the objectives and implementation measures necessary to protect those beneficial uses. The beneficial uses of Sonoma Creek and its tributaries impaired by high levels of pathogens are water contact recreation (REC-1) and non-contact water recreation (REC-2). These beneficial uses are described in Table 1. The purpose of this TMDL is to protect and restore these beneficial uses by reducing the levels of pathogens in this watershed. Water quality objectives for REC-1 use are more stringent than those for REC-2, since REC-1 can involve water ingestion. Since both beneficial uses occur in Sonoma Creek, this TMDL will be driven by the more rigorous REC-1 requirements.

Table 1. Beneficial Uses of Sonoma Creek and Its Tributaries Potentially Impaired by Pathogens

Designated Beneficial Use	Description (as defined in Basin Plan)
Water Contact Recreation (REC-1)	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, whitewater activities, fishing, and uses of natural hot springs.
Non-contact Water Recreation (REC-2)	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, bathing, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Table 2 lists the Water Board's Basin Plan numerical water quality objectives for fecal and total coliforms for contact recreation (REC-1). The Basin Plan also cites U.S. EPA bacteriological criteria "to supplement objectives for recreational waters" (Water Board, 1995). The U.S. EPA criteria are presented in Table 3.

Table 3 presents recently recommended criteria for protecting recreational users. The percentile criteria were originally expressed as single sample maximums (U.S. EPA, 1986). The 75th percentile value was applied as a single sample maximum at designated beaches, the 82nd at moderately used areas, the 90th at lightly used areas, and the 95th at infrequently used areas. Reconsideration of the epidemiological data on

which these criteria are based and the statistical implications of these data led U.S. EPA to revise the single sample maximum interpretation to a percentile-based interpretation (U.S. EPA, 2002). While the Basin Plan citation still reflects the old U.S. EPA interpretation, Table 3 is based on the newer interpretation.

Table 2. Water Quality Objectives For Coliform Bacteria[a]

Beneficial Use	Fecal Coliform (MPN[2]/100 mL)	Total Coliform (MPN/100 mL)
Water Contact Recreation (REC 1)	Log mean[b]<200 90th percentile<400	Median< 240 No sample> 10,000
Non-contact Water Recreation (REC 2)	Mean<2000 90th percentile<4000	N/A

a. Based on a minimum of five consecutive samples equally spaced over a 30-day period.
b. "Log mean" is in this case synonymous with geometric mean, the latter being the preferred term.

Table 3. U.S. EPA Recommended Water Quality Criteria for Bacteria in Fresh Water-Contact Recreational Waters

	Enterococci (CFU[a]/100 mL)	*E. Coli* (CFU/100 mL)
Steady State (all areas):	33	126
Percentiles[b]:		
75th	61	235
82nd	89	298
90th	108	406
95th	151	576

a. Colony forming unit (CFU)[3].
b. U.S. EPA does not specify a minimum number of samples upon which to base percentile calculations.

It is noteworthy that U.S. EPA does not specify criteria for total coliforms in contact recreational waters. As discussed in Section 3.1 above, total coliform bacteria can reproduce in the environment outside the bodies of warm-blooded animals, and are therefore a poor indicator for pathogens in ambient water samples. The use of total coliform as indicators in fresh recreational waters is generally considered obsolete.

[2] MPN (Most Probable Number) is used here as a unit of measure, equivalent for practical data interpretation and regulatory purposes to CFU, described in the following footnote. The term MPN also describes a laboratory method consisting of a multi-phase laboratory assay followed by a statistical estimate of the number of organisms present.

[3] Throughout the remainder of this document, bacterial counts are expressed as colony forming units (CFU). The term MPN in Table 2 is used in order to be consistent with Basin Plan language. For practical data interpretation and regulatory purposes, MPN and CFU can be considered equivalent *when used as units of measurement*, both referring to the estimated number of viable bacteria in the sample (U.S. EPA, 2001).

However, total coliforms are still frequently used to monitor disinfection efficiency in wastewater treatment facilities.

3.3 Bacterial Water Quality Studies in the Sonoma Creek Watershed

In 1977 the Sonoma County Water Agency reported fecal coliform densities ranging from 1500 and 4600 CFU/100 mL in Sonoma Creek at Agua Caliente during storm runoff conditions. A recent review of historical data for the watershed reported spring and summer fecal coliform densities at five stations on Sonoma Creek between 1973 and 1988 (Dombeck and Hymanson, 1997). Although only between one and five samples were collected at each site, bacteria levels were highly elevated at all stations except the Highway 12 station located upstream of Kenwood (Table 4).

Table 4. Reported Sonoma Creek Fecal Coliform Densities 1973-1988.

Station Location	minimum	Maximum	average	# of samples
Highway 12 above Kenwood	49	49	49	1
Agua Caliente Road	23	24,000	8,031	3
Leveroni Road	24,000	24,000	24,000	1
McGill	490	24,000	12,245	2
Second Napa Slough	310	3,500	1,905	2

Beginning in 2002 the Water Board, in cooperation with the San Francisco Estuary Institute (SFEI), and with laboratory support from U.S. EPA, conducted an intensive study to assess fecal coliform levels in the Sonoma Creek watershed. Nine main-stem sampling stations were sampled in between Sugarloaf State Park and Highway 12, with seven additional tributary stations (Figure 2). Stations were selected randomly (constrained only by the requirement for relatively easy access) with the intent of obtaining a general characterization of the watershed. Sampling was conducted in October 2002, January 2003, and July 2003. The January sampling began approximately one week following a major winter storm event, and was intended to represent stable-flow wet season conditions. The other two events were selected to represent typical dry season conditions. At most of the sites a single sample was collected during each event. In addition, for each event, a subset of five sites was selected for more intensive sampling. Intensive sampling consisted of five samples collected at weekly intervals, allowing calculation of geometric means. Selection of sites for intensive sampling was non-random, and was based on suspected bacterial contamination, or on frequency of contact recreational use.

Results of the Water Board/SFEI study are summarized in Table 5 (raw data are presented in Appendix A). The 2002-2003 data indicate much better water quality than

the historical data presented above. The newer results show moderate, somewhat localized impairment. Exceedances of U.S. EPA recommended criteria (geometric mean value of 126 CFU/100 mL) occurred at several locations, during both wet and dry season sampling. The most severe and consistent exceedances were observed on Sonoma Creek downstream of the community of Kenwood, with additional exceedances further downstream on Sonoma Creek, and in the Nathanson/Schell Creek watershed. These results will be discussed in greater detail in the source assessment section of this report.

Figure 2. Sites Monitored in the Water Board/SFEI Study

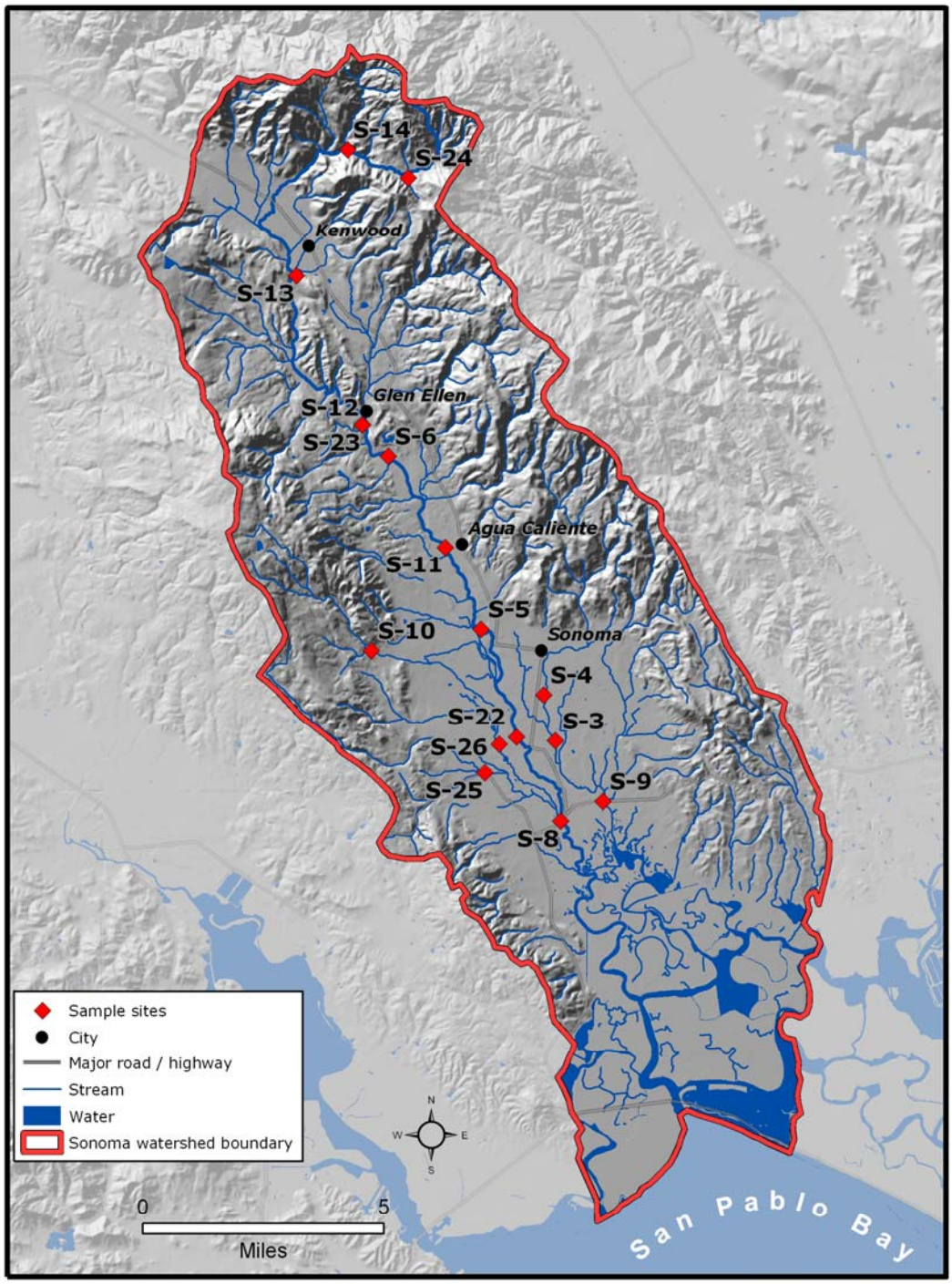


Table 5. *E. Coli* Densities Observed in the Water Board/SFEI Study, October 2002–July 2003.

Station	Location	*E. coli*, CFU/100 ml		
		Wet Season	Dry Season	
		Jan-03	Jul-03	Oct-02
S-24	**Sonoma Creek at Sugarloaf S.P. Campground**	20	52	dry site
S-14	**Sonoma Creek at Goodspeed Trail in S.P.**	**26**[a]	**16**	**41**
S-13	**Sonoma Creek below Kenwood**	***206***[b]	***562***	***196***
S-23	**Calabazas Creek at Glen Ellen**	31	63	dry site
S-12	**Sonoma Creek at Glen Ellen**	***207***	130	**45**
S-6	**Sonoma Creek at Developmental Center**	***206***	**38**	***128***
S-11	**Sonoma Creek at Agua Caliente**	180	31	10
S-5	**Sonoma Creek at Maxwell Park**	150	**42**	63
S-10	**Upper Carriger Creek**	41	no access	52
S-4	**Nathanson Creek at Nathanson Park**	170	***233***	dry site
S-26	**Carriger Creek at Watmaugh Road**	98	160	dry site
S-22	**Sonoma Creek at Watmaugh Road**	280	150	dry site
S-3	**Nathanson Creek At Watmaugh Road**	110	dry site	dry site
S-25	**Rodgers Creek at Arnold Drive**	31	dry site	dry site
S-9	**Schell Creek at Highway 121**	230	*470*	dry site
S-8	**Sonoma Creek at Highway 121**	***323***	41	***823***

a. Values in bold type represent geometric means of five weekly samples; non-bold values represent single samples.
b. Values in italics represent exceedances of U.S. EPA recommended *E. coli* criteria.

4. NUMERIC TARGETS

In order to develop a TMDL, a desired or target condition must be established to provide measurable environmental management goals and a clear linkage to attaining the applicable water quality objectives. The numeric targets (desired future conditions for the Sonoma Creek watershed) proposed for this TMDL are as follows:

1. Geometric mean *E. coli* density of 126 CFU/100 mL;

2. Ninetieth percentile *E. coli* density of 320 CFU/100 mL; and

3. Zero discharge of untreated or inadequately treated human waste to Sonoma Creek and its tributaries or to groundwater with direct through flow to these surface waters.

The first two targets are based on U.S. EPA guidance (U.S. EPA; 1986, 2002,2003) and on the Basin Plan's fecal coliform-based water quality objectives (presented in Tables 2 and 3). As discussed in Section 3.1, *E. coli* are a subset of the fecal coliform group of bacteria. It has been established that *E. coli* typically constitute from 80% to more than 90% of fecal coliforms in fecally contaminated ambient water samples (Noble et al., 2000). Assuming the conservative 80% conversion factor, a geometric mean of 126 CFU/100 mL *E. coli* is equivalent to approximately 158 CFU/100 mL fecal coliform—lower than the Basin Plan water quality objective of 200 CFU/100 mL fecal coliform. Similarly, a 90th percentile value of 320 CFU/100mL *E. coli* is approximately equivalent to 400 CFU/100 mL fecal coliform, Thus these targets are at least as protective as existing fecal coliform-based water quality objectives. In addition, these targets can be considered more protective than existing water quality objectives because U.S. EPA has determined that *E. coli* densities are more strongly correlated to human illness than fecal coliform densities.

The third target, zero discharge of untreated human waste, is based on the knowledge that fecal bacteria are imperfect indicators of human pathogens. Since direct monitoring of human pathogens is not feasible (see Section 3.1), and since untreated human waste is the most serious potential source of these pathogens, a prohibition of raw or inadequately treated human waste discharge is proposed. This target is consistent with the Basin Plan's region-wide prohibition against the discharge of raw sewage.

These TMDL targets are consistent with water quality objectives or prohibitions included in the Basin Plan. Since these targets are based on conservatively established protective water quality objectives, they contain an inherent margin of safety. The targets are proposed as the desired long-term conditions this TMDL seeks to achieve.

5. POLLUTANT SOURCE ASSESSMENT

Data collected in the Sonoma Creek watershed, as well as similar work conducted elsewhere in the San Francisco Bay watershed, suggest a limited list of possible sources that may contribute significant pathogen loads to the system. Primary potential source categories are described briefly below.

- **Septic systems.** A significant portion of the total watershed population—especially in less densely developed areas—relies on septic systems. The most densely populated portion of the watershed utilizing septic systems includes the community of Kenwood and surrounding areas. The majority of soils in the watershed are classified as having severe restrictions for use as septic tank leach fields, due either to low permeability, slope, depth to bedrock, impermeable layers, or wetness (USDA, 1972). Septic systems—especially older systems—located in these areas are especially prone to failure, and may release pathogens to adjacent surface waters even when system failure is not evident.

- **Sanitary sewer system failures.** Failures occur when untreated sewage is not contained in the sanitary sewer collection system. Failures may be caused by grease buildup in the sewer pipes, structural problems (such as broken/cracked pipes), or increased pressure and flow resulting from infiltration and inflow. In the Sonoma Creek watershed, the more densely populated areas are served by sanitary sewers, with the exception of Kenwood and surrounding areas, which rely on septic systems. No major sewer line failures have been documented in the watershed in recent years. However, chronic minor leakage of sewer lines is often difficult to detect, but can result in sustained impairment of adjacent surface waters through bacterial and nutrient loading (U.S. EPA, 1993).

- **Municipal runoff.** Approximately 15% of the watershed is occupied by residential or commercial development (Association of Bay Area Governments, 2000). Urban runoff delivers pathogens to surface waters from domestic animal waste, trash, wildlife, failing septic systems, and in some cases human waste from homeless populations. Homeless encampments are readily observed at a number of locations along Sonoma Creek, and may be an important source of waterborne pathogens.

- **Livestock grazing.** Livestock (cattle, horse, and goat) grazing is widely distributed, occurring from the extreme upper end of the watershed to the most southern end. Grazing has been found to be a significant source of pathogens in nearby watersheds in the region (Water Board 2005a, 2005b).

- **Dairies.** Four dairies currently operate within the Sonoma Creek watershed, all in the southwest section of the watershed. Dairy operations potentially produce large quantities of fecal matter, and may be a significant source of pathogens if

appropriate management practices (MPs) are not in place. Currently, the Water Board regulates all dairies operating in the Sonoma Creek watershed.

- **Wildlife**. Much of the Sonoma Creek watershed remains undeveloped, providing habitat for abundant wildlife. Most warm-blooded animals are capable of carrying pathogen indicator bacteria as well as a wide range of actual human pathogens (U.S. EPA, 2001). Wildlife have been identified as significant pathogen sources in other TMDLs in California, but generally only in locations where there are concentrated populations of wildlife (Central Coast Water Board, 2002; Water Board, 2005a).

- **Domestic wastewater treatment facility discharge.** The Sonoma Valley County Sanitation District facility is the only permitted discharger of municipal wastewater to the surface waters in the Sonoma Creek watershed. The facility discharges to tidal Sonoma Slough in the extreme southern end of the watershed. The facility's National Pollutant Discharge Elimination System (NPDES) permit allows discharge only during the winter months, and limits effluent bacteria levels to a median of 23 CFU/100 mL total coliform.

The following sections examine the distribution and relative importance of these source categories in the Sonoma Creek watershed.

5.1 Analysis of Water Board/SFEI 2002-2003 Data

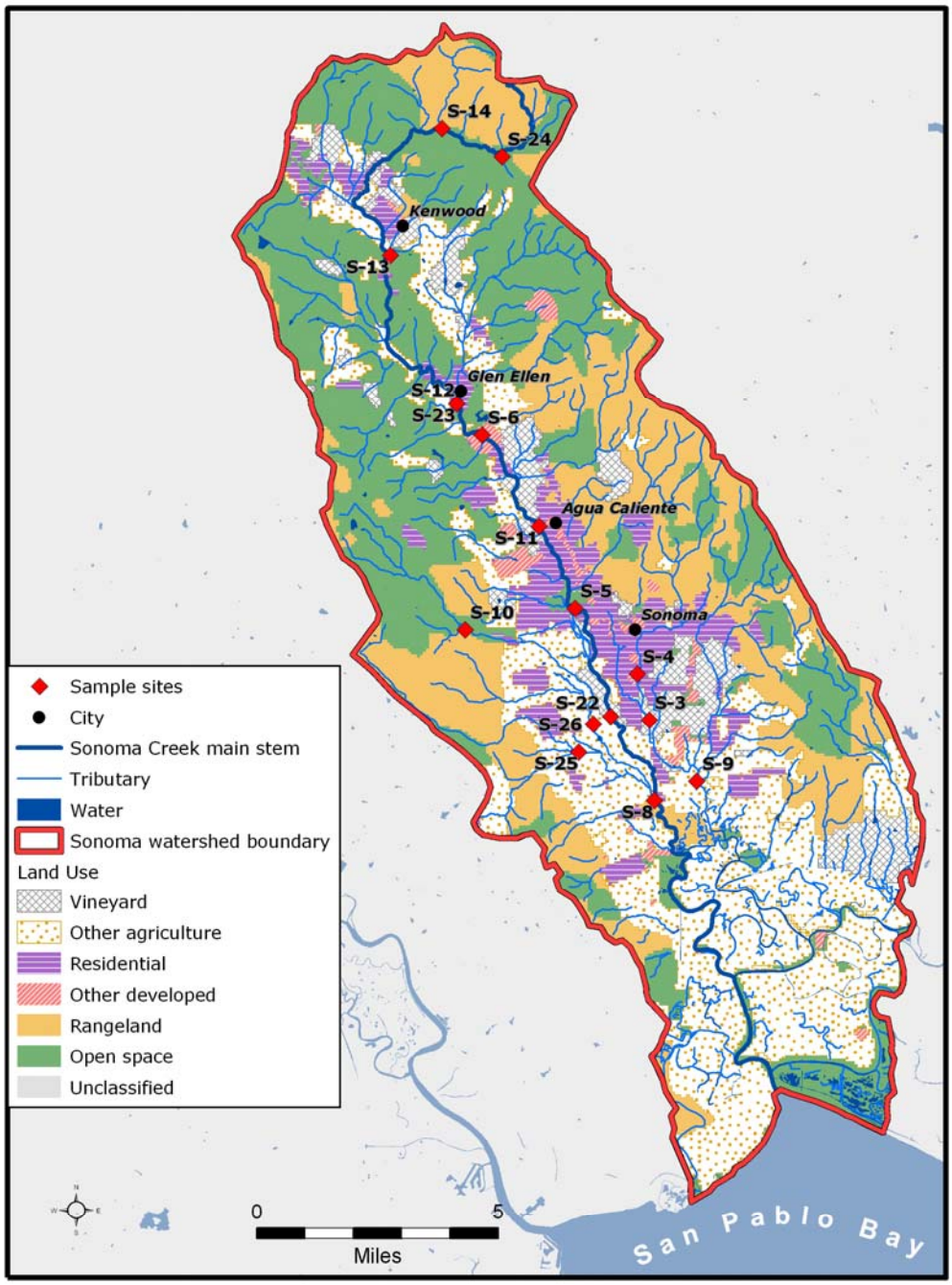
This discussion explores relationships between the bacteria data collected in the 2002–2003 Water Board/SFEI study (Table 5) and general land uses in the watershed (Figure 3). While the bacterial data are not sufficient in either spatial or temporal resolution to allow quantitative assessment of pathogen loads, the observations presented here support a relative assessment of the importance of different nonpoint source categories.

Bacteria densities were consistently low at the two uppermost sampling sites on Sonoma Creek (S-24 and S-14), both located in Sugarloaf State Park. Both of these sites receive water primarily from park and rangeland. Levels increase markedly at station S-13 below Kenwood, exceeding numeric targets during all sampling events. This station receives water from a mixture of land uses, including vineyards and residential development.

During the wet season, *E. coli* densities in the main stem generally remained elevated as far downstream as station S-5 at Maxwell Park in the city of Sonoma. In contrast, *E. coli* levels declined significantly between S-13 and S-5 during the dry season sampling events. Different pathogen delivery mechanisms during the wet and dry seasons may account for this seasonal difference. During the wet season, loading is primarily via precipitation-driven surface runoff, and secondarily through groundwater flow into stream channels. Surface runoff is largely absent in the dry season and pathogen delivery is predominantly though groundwater inflow (possibly including septic system leachate), direct deposition (e.g., animals in the creek), and low-volume runoff from

human activities (e.g., lawn and landscape watering, car washing, washing of animal holding areas, etc.). Lower dry season stream velocities also result in longer travel times, which, combined with higher levels of sunlight, result in greater bacterial die-off during the dry season. Thus, it appears that in the dry season bacterial loading is primarily from upstream of S-13, with die-off and dilution resulting in lower downstream bacteria levels. Additional downstream loading (likely via surface runoff) and reduced bacterial die-off appear to maintain relatively high bacteria levels downstream through the City of Sonoma during the wet season.

Figure 3. General Land Cover in the Sonoma Creek Watershed[4]



[4] Based on 1996 Association of Bay Area Governments GIS data (ABAG, 1996).

The upper Carriger Creek station (S-26) was consistently low in indicator bacteria, similar to the upper Sonoma Creek stations mentioned above. The contributing watersheds of all of these stations are notably free of development, and can be considered to represent reference conditions for the watershed. Wildlife would be expected to be abundant at these sites, and the consistently low *E. coli* values indicate that wildlife do not in general constitute a significant pathogen source in the watershed.

Bacteria levels were also consistently low at the Calabazas Creek station (S-23). Land use upstream of this station is a complex mixture of agriculture (mostly vineyards), residential development (mostly sewered), and open space.

Samples collected in the Nathanson Creek-Schell Creek watershed (S-4, S-3, S-9) showed moderately high *E. coli* levels both in wet and dry seasons. The S-4 catchment area is primarily in urban land use and is served by sanitary sewer. The S-3 and S-9 catchment areas consist of a mixture of urban, grazing, and agricultural land uses.

Station S-8, the most downstream sampling site on Sonoma Creek, generally receives flow from the town of Sonoma and from agricultural land, including two dairies. Wet season bacteria levels at this site were very modestly elevated relative to upstream stations, and the single July sample was quite low. October 2002 bacteria levels were quite high at this station. However, the October samples do not reflect upstream loading because Sonoma Creek was dry at the time of sampling from a short distance upstream of S-8 through station S-22 at Watmaugh Road. The October S-8 data therefore represent tidal water primarily from downstream of the sample site. The source of the elevated October bacteria levels at S-8 is unclear. Possible sources include wildlife or livestock grazing.

5.2 Supplemental Monitoring 2004-2005

The Water Board conducted supplemental sampling in May 2004 and April 2005 in order to investigate indicator bacteria sources near hotspots identified in the 2002-2003 study. Sampling focused on upper reaches of Sonoma Creek in the vicinity of Kenwood, the Nathanson/Schell Creek system, and on Sonoma Creek below the City of Sonoma (Figures 4 and 5). Samples were collected at additional stations located incrementally upstream (and where possible and appropriate, downstream) of the sites sampled in the earlier study. Samples were also collected in the middle reaches of Sonoma Creek in order to confirm data previously obtained from these sites.

Samples were collected weekly over a five week period. In order to conserve limited laboratory resources, an adaptive, tiered monitoring scheme was employed. All sites were sampled for the first two weeks and the results used to establish a subset of sites for three additional weeks of sampling. Sampling was discontinued at sites that were consistently very low or high for the first two weeks, or were very similar to either upstream or downstream sites.

Figure 4a. Supplemental Water Board/SFEI Monitoring Sites—Upper Watershed.

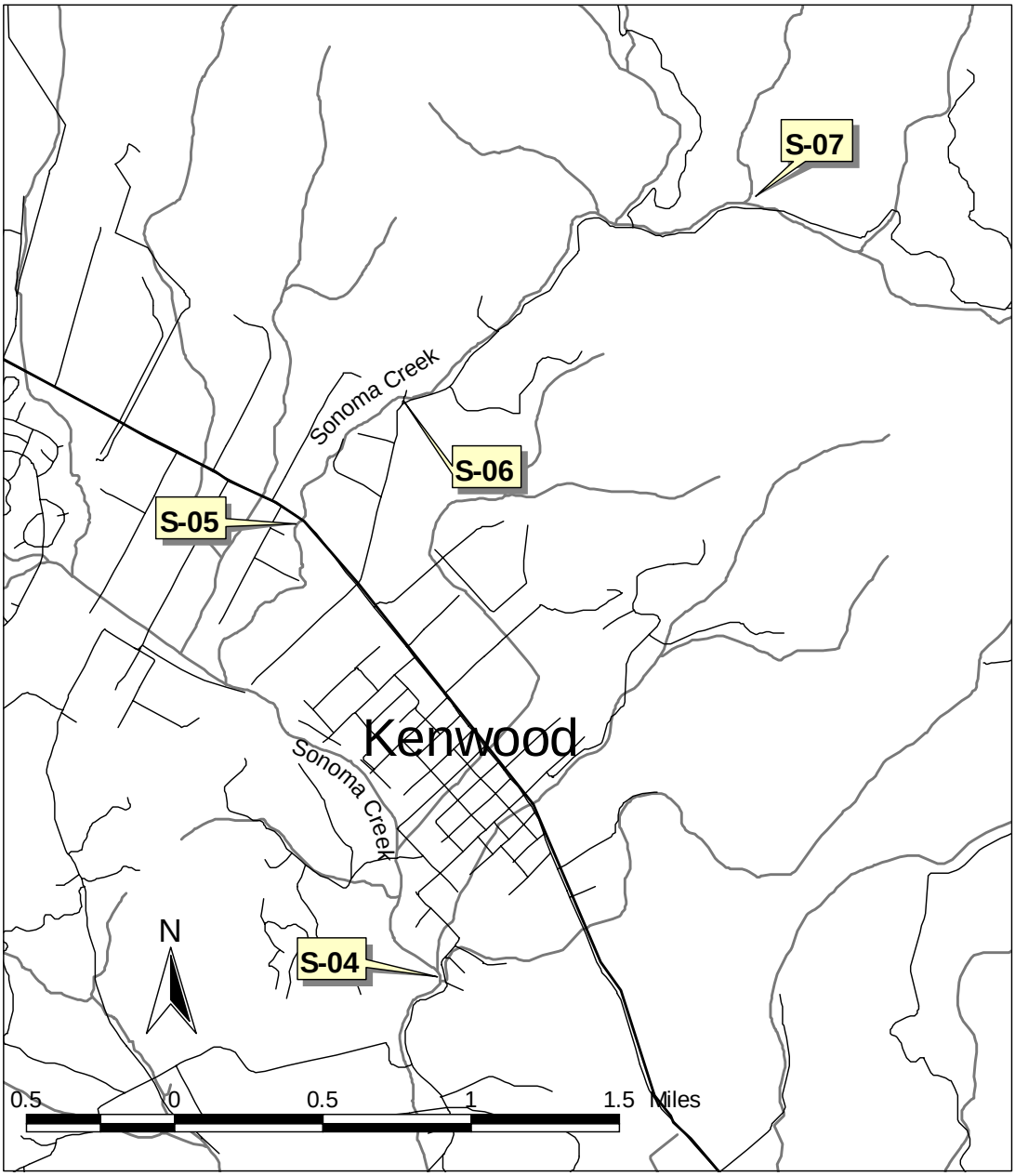


Figure 4b. Supplemental Water Board/SFEI Monitoring Sites—Lower Watershed.

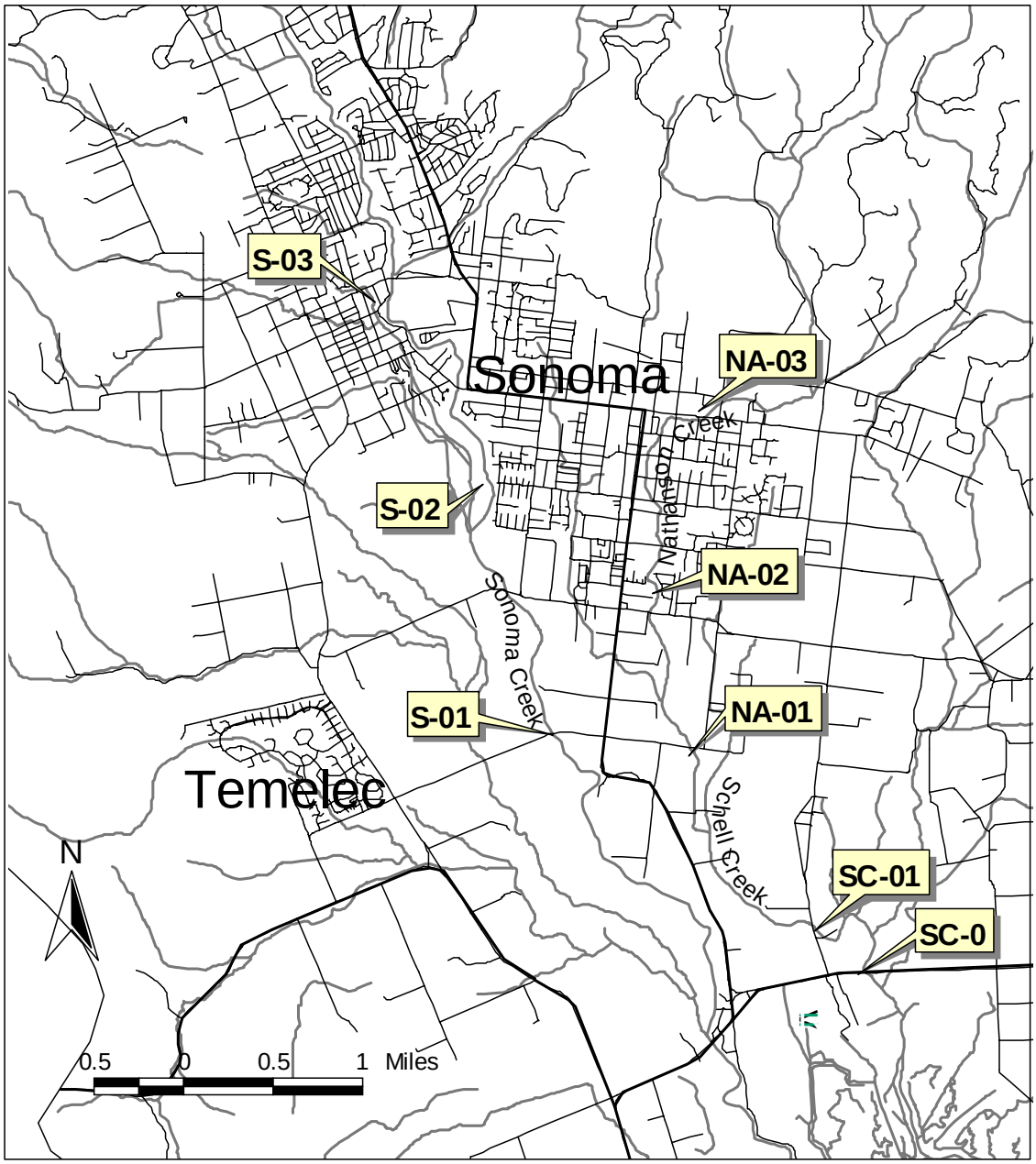


Table 6. May 2004 and April 2005 Supplemental *E. Coli* Sampling Results			
Site Location	**Site Number[a]**	***E. Coli* (CFU/100mL, geometric mean)**	**Number of Weeks Sampled**
May 2004			
Sonoma Creek @ Goodspeed Trail	S-07 (S-14)	10	2
Sonoma Creek @ Adobe Canyon Rd.	S-06	19	5
Sonoma Creek @ Highway 12	S-05	38	5
Sonoma Creek below Kenwood	S-04 (S-13)	147	5
Sonoma Creek @ Maxwell Park	S-03 (S-5)	132	5
Sonoma Creek @ Andrieux St.	S-02	188	3
Sonoma Creek @ Watmaugh Rd.	S-01 (S-22)	237	5
Nathanson Creek @ East Napa St.	NA-03	415	2
Nathanson Creek @ Nathanson Park	NA-02 (S-4)	483	5
Nathanson Creek @ Watmaugh Rd.	NA-01 (S-3)	275	3
April 2005			
Sonoma Creek @ Andrieux St.	S-02	94	5
Sonoma Creek @ Watmaugh Rd.	S-01 (S-22)	131	5
Nathanson @ Nathanson Park	NA-02 (S-4)	237	5
Nathanson @ Watmaugh Rd.	NA-01 (S-3)	206	5
Schell @ 8th St.	SC-01	193	5
Schell @ Highway 121	SC-0 (S-9)	322	5
a. Site numbers from original Water Board/SFEI study are in parentheses.			

May 2004 sampling in the upper Sonoma Creek watershed confirmed the primary observation from the 2002-2003 sampling: markedly elevated *E. coli* densities downstream of Kenwood. *E. coli* counts at the three stations upstream of Kenwood were uniformly low, with a statistically significant[5] increase at S-04 (Figure 4, Table 6). Bacteria densities downstream through Sonoma Creek at Watmaugh Road (S-01) remained above numeric targets, and were not significantly different from levels observed at S-04. If all loading were from upstream of S-04, downstream densities would be expected to decline due to dilution and/or die-off. The data suggest modest

[5] In contrast to the 2002-2003 study, the 2004 and 2005 monitoring involved at least two (and usually five) samples from each site, allowing statistical comparisons among sites. Comparisons were performed on log-transformed E. coli densities using Student's T-test, α=0.05. Since the intent of statistical analysis in this instance was to locate E. coli sources within sub-watersheds, rather than to compare sub-watersheds, comparisons were made only within sampling periods (i.e., May 2004 or April 2005) and within sub-watersheds (e.g. sites on Sonoma Creek were compared to other sites on Sonoma Creek, but not with sites on Nathanson Creek).

additional bacterial loading to Sonoma Creek from sources between Kenwood and Watmaugh Road.

Bacteria levels in the Nathanson/Schell Creek watershed were consistently above numeric targets both in 2004 and 2005, similar to the 2002-2003 data. There were no statistically significant differences among sites in this watershed. As with Sonoma Creek, bacteria levels would be expected to decline from upstream to downstream due to die-off and dilution if loading were exclusively from above the most upstream sampling site. Since no decline is seen, it appears that bacterial loading occurs at multiple locations in this watershed.

Station N-03, the uppermost sampling site in the Nathanson/Schell system, is in a highly urban, sewered location within the City of Sonoma. While the headwaters of Nathanson Creek are dominated by open space and rangeland north of Sonoma, streamflow was extremely low at the time of sampling, and it is unlikely that there was continuous flow from the upstream rangeland to the urban areas surrounding N-03. It therefore appears that the elevated *E. coli* levels observed at N-03 are of urban origin, the most likely source during this dry season sampling period being dry weather urban runoff or leakage from nearby sewer lines.

The areas surrounding the sampling sites in the lower portions of the Nathanson/Schell watershed (NA-01, SC-01, SC-0) are relatively free of residential development. Livestock grazing is a significant land use in this area and is a likely source of the elevated *E. coli* values seen at these stations.

5.3 Upper Sonoma Creek Nitrate Data

Failing or inappropriately sited septic systems are widely recognized to be major sources of nitrate pollution (LaPointe et al., 1990 ; U.S. EPA, 1999). Therefore, nitrate data collected by the San Francisco Estuary Institute during the 2002, 2003, and 2004 *E. coli* monitoring events sheds further light on pathogen sources in the upper reaches of Sonoma Creek. The data show a dramatic increase in nitrate concentrations below Kenwood in all seasons (Table 7). Nitrate levels decline downstream in the dry season sampling events, but remain elevated in the wet season. The dry season pattern is consistent with a single major source upstream of S-04 combined with nitrate uptake and dilution downstream, while wet season data suggest a major source above S-04 and additional (likely runoff-related) nitrate sources downstream.

Other common nitrate sources include agricultural runoff and livestock operations. Agricultural runoff is not generally a source of pathogens, and livestock operations do not currently occur in the upper reaches of Sonoma Creek. The simultaneous increases in *E. coli* and nitrate levels downstream of Kenwood therefore constitute overwhelming evidence that septic systems in this community are a major pathogen source. The Sonoma Creek watershed is also listed as impaired by nutrients, and these data indicate that septic systems in the vicinity of Kenwood constitute a significant source of nutrients as well.

Table 7. Nitrate Concentrations in Upper and Middle Sonoma Creek.					
Station	Location	Nitrate-N, µg/L			
		Oct-02	Jan-03	Jul-03	May-04
S-07	Sonoma Creek at Goodspeed Trail in S.P.	67	116	166	203
S-05	Sonoma Creek at Highway 12				72
S-04	Sonoma Creek below Kenwood	1,059	2,091	1,619	2,052
S-12	Sonoma Creek at Glen Ellen	29	960	1,612	
S-6	Sonoma Creek at Developmental Center	18	437	1,495	
S-11	Sonoma Creek at Agua Caliente	15	129	1,442	
S-5	Sonoma Creek at Maxwell Park	2	102	1,454	597

5.4 Source Assessment Summary

Due to data and resources limitations, this report does not quantitatively estimate loads for the different pathogen sources in the Sonoma Creek watershed. However, the data discussed above allow for general conclusions on the importance and magnitude of the different types of pathogen sources described at the beginning of this section. The following source categories potentially contribute significant controllable pathogen loads in the watershed, and these sources will be addressed in the preliminary implementation plan presented later in this report:

- **Septic systems**. This source category appears to be a significant source of pathogen loading, especially during the dry season. Bacteria and nitrate data combine to provide very strong evidence that faulty septic systems in the vicinity of Kenwood contribute to pathogen loading in upper Sonoma Creek.

- **Sanitary sewer system failures.** Elevated dry season indicator bacteria levels were observed in sewered areas of Nathanson Creek and Sonoma Creek. Due to these observations and the nationwide prevalence of sewer line exfiltration (U.S. EPA, 1993), sanitary sewer system failures are considered a potentially significant pathogen source in this watershed. Additional monitoring during the implementation phase of this TMDL will be required to further assess the importance of this source category.

- **Municipal runoff.** Data indicate that urban stormwater is a significant, widespread wet season pathogen source in the watershed. Urban areas in the watershed are associated with elevated wet season indicator bacteria densities.

- **Livestock grazing.** Elevated indicator bacteria levels may be associated with livestock grazing in the lower portions of the watershed. In view of this

observation and observations elsewhere in the region (Water Board 2005a, 2005c) livestock grazing is considered a potentially significant source of pathogens in this watershed. The extent and severity of this source category should be clarified through further monitoring during adaptive TMDL implementation.

- **Dairies.** Four dairies currently operate within the Sonoma Creek watershed, all located in the southwest section of the watershed. Currently, the Water Board via NPDES Permit or Waivers of Waste Discharge Requirements regulates all dairies operating in the Sonoma Creek watershed. If not properly managed, dairies have the potential to discharge pathogens to Sonoma Creek. Possible mechanisms of discharge include direct discharge by cows and failure of waste ponds.

- **Wildlife.** The low indicator bacteria levels observed at sampling sites that are not heavily affected by human activity indicates that wildlife are not, in general, a significant pathogen source in this watershed. Local problems may be present in certain areas where wildlife densities are particularly high.

- **Domestic wastewater treatment facility discharge.** Recent self-monitoring reports from the Sonoma Valley County Sanitation District treatment facility indicate that facility effluent is well below numeric targets and does not significantly contribute to pathogen loading under normal conditions.

6. TOTAL MAXIMUM DAILY LOAD AND LOAD ALLOCATIONS

6.1 General Approach

U.S. EPA guidelines (U.S. EPA, 1991) for developing TMDLs define the maximum allowable pollutant load as the total load of a particular pollutant that can be present in a waterbody while still attaining and maintaining designated beneficial uses. TMDLs for a waterbody are the sum of individual wasteload allocations for point sources and load allocations for nonpoint sources. The sum of these components must not result in the exceedance of water quality standards for that waterbody. In addition, the TMDL must include a margin of safety (MOS), either implicit or explicit, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody.

For most pollutants, TMDLs are expressed on a mass-loading basis (e.g., pounds per day, organisms per day). The Code of Federal Regulations (40 CFR § 130.2(1)) states that TMDLs do not need to be expressed as loads (mass per unit time), but may be expressed as “other appropriate measure.” For pathogen indicators, it is the number of organisms in a given volume of water (i.e., their density), and not their mass or total number that is significant with respect to public health and protection of beneficial uses. The density 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. Therefore, this TMDL plan establishes density-based TMDLs and pollutant load allocations, expressed in terms of indicator bacteria densities.

Establishment of a density-based, rather than a load-based TMDL carries the advantage of eliminating the need to conduct a complex and potentially error-prone analysis to link loads and expected densities. A load-based TMDL would require calculation of acceptable loads based on acceptable bacterial densities and expected flows, and then back-calculation of expected densities under various load reduction scenarios. Since flows in Sonoma Creek, and especially in its tributaries, are highly variable and difficult to measure, such an analysis would inevitably involve a great deal of uncertainty, with no increased water quality benefit.

6.2 Proposed Total Maximum Daily Loads

Proposed TMDLs for the Sonoma Creek watershed are listed in Table 8. These TMDLs will be applicable year-round. As shown, the TMDLs are the density-based REC-I water quality objectives and U.S. EPA-recommended water quality criteria for contact recreation (Tables 2 and 3 [water quality objectives tables from Section 3.2]). This TMDL represents the total number of fecal indicator bacteria that can be discharged from all sources while not causing the water quality in the tributaries to exceed the bacterial densities specified in the Basin Plan.

Table 8. Total Maximum Daily Loads for the Sonoma Creek Watershed	
Indicator	**TMDL (CFU/100 mL)[a]**
E. coli	Geometric mean < 126 90th percentile < 320
[a]Based on a minimum of five samples collected within a 30-day period.	

6.3 Proposed Load and Wasteload Allocations

Density-based load allocations are proposed for this TMDL. Unlike mass-based load allocations, the density-based load allocations do not add up to equal the TMDL, since the densities of individual pollution sources are not additive. Rather, in order to achieve the density-based TMDL, it is simply necessary to assure that each source meets the density-based overall load allocation (Santa Ana Water Board, 1998; Central Coast Water Board, 2002).

Table 9 presents the density-based pathogen load and wasteload allocations proposed for the Sonoma Creek watershed. These load allocations will apply year-round to the different source categories of pathogen pollution in the watershed. The attainment of these load allocations will ensure protection of the water quality and beneficial uses of Sonoma Creek and its tributaries.

Table 9. Density-Based Pollutant Load and Wasteload Allocations for Different Pollution Source Categories[a]		
Categorical Pollutant Source	*E. coli* Density, CFU/100 mL	
	Geometric Mean	90th Percentile
Sanitary Sewer System Overflows	0	0
Septic Systems	0	0
Municipal Runoff	<126	<320
Livestock Grazing	<126	<320
Municipal Wastewater Discharge- Sonoma Valley County Sanitation District	<126	<320
Dairies	<126	<320
Wildlife	<126	<320
a. The allocations in this table are not additive (see text).		

The one municipal wastewater discharger in the watershed, the Sonoma Valley County Sanitation District, is regulated by its NPDES discharge permit. The effluent limits of that NPDES permit are at least as protective as the proposed wasteload allocation.

In the case of allocations specified by source category, it is the responsibility of individual facility or property owners within a given source category to meet these allocations. In other words, individual facilities and property owners shall not discharge or release a load of pollution that will increase the density of *E. coli* in the downstream portion of the nearest waterbody above the proposed load allocations assigned to that source type. This allocation scheme assumes that the concentration of *E. coli* upstream from the discharge point is not in excess of the assigned load allocations. For example, the geometric mean of *E. coli* concentrations in stormwater runoff samples collected at a residential area's storm drain that discharges into a tributary shall not exceed the allocated loads listed for the urban runoff source category.

Septic systems and sewer line failure, the primary potential sources of untreated human waste to Sonoma Creek and its tributaries, are assigned load allocations of zero for the following reasons:

- As sources of human waste (as opposed to animal waste) they pose the greatest threat to the public health;
- The zero load allocation is consistent with the existing Basin Plan prohibition of release of untreated sewage;
- When operated properly and lawfully, septic systems and sanitary sewer systems should not cause any human waste discharges; and,
- Human waste discharges from these sources are fully controllable and preventable.

For these reasons, zero load allocations for these source categories are both feasible and warranted.

6.4 Margin of Safety

TMDLs are required to include a margin of safety (MOS) to account for data uncertainty, growth, critical conditions, and lack of knowledge. Virtually all pathogens have a limited ability to survive outside the human (or other host) body (U.S. EPA, 2001). Pathogen densities are therefore expected to only decrease in the outside environment over time, due to factors such as exposure to sunlight, chemical damage, and predation/competition by native nonpathogenic organisms. This effect provides an implicit MOS to the proposed TMDL.

Both numeric targets and load allocations are conservatively derived from U.S. EPA's *E. coli* recommendations and current water quality objectives, as described in Section 4 of this report. These *E. coli*-based targets and allocations are more protective of human health than current fecal coliform-based water quality objectives, thereby providing an additional implicit MOS. Therefore, no additional and/or explicit MOS is needed for this TMDL.

6.5 Seasonal Variation

While pathogen loads are typically greatest during the winter wet season due to high volumes of surface runoff, indicator bacteria densities can be high at any time of year. Dry season densities were higher than wet season densities at a number of sites monitored in the Water Board/SFEI study.

Recreational use of Sonoma Creek and its tributaries is most prevalent during the summertime, but can occur at any time of year. Therefore, no seasonal variations to the above-listed TMDLs and load allocations are proposed.

7. LINKAGE ANALYSIS

An essential component of developing a TMDL is to establish a relationship (linkage) between pollutant loadings from various sources and the numeric targets chosen to measure the attainment of beneficial uses. For this TMDL, the proposed load allocations protect the beneficial uses (the linkage is established) because:

- Fecal waste from warm-blooded animals can contain pathogens;
- Fecal coliform bacteria are present fecal waste from warm-blooded animals and are routinely used as a monitoring surrogate;
- The proposed density-based load allocations are the same as, or more stringent than proposed numeric water quality targets;
- The proposed numeric targets are the same as current U.S. EPA recommended bacterial water quality criteria for recreational waters; and
- The U.S. EPA recommended criteria are conservatively based on epidemiological studies (U.S. EPA, 2002) and are protective of beneficial uses.

Therefore, achievement of the proposed pollutant load allocations (listed in Section 6) will ensure the protection of the water quality and beneficial uses of Sonoma Creek and its tributaries.

There is no need to perform transport and fate analysis of pathogen loadings because numeric targets apply at all points in the watershed. That is, any potential pathogen source must meet numeric targets at the point at which the source enters Sonoma Creek or any of its tributaries. Since pathogen regrowth is very unlikely in this watershed, and net pathogen die-off is virtually certain, pathogen densities at any point downstream of the initial point of discharge will be lower than at the point of discharge (see Section 6.4, Margin of Safety).

8. PUBLIC PARTICIPATION

Public participation and stakeholder buy-in is vital to the success of implementing a TMDL. Release of this TMDL project report is an opportunity for the public to provide input to the Water Board. The TMDL will be formally established when it is adopted via a public process as an amendment to the Basin Plan.

8.1 Formal Process for Public Participation

The proposed basin plan amendment and this supporting staff report will be presented to the Water Board for review and adoption in the first half of 2006. Two public hearings, a testimony hearing (April 12, 2006) and an adoption hearing (June 14, 2006), will be held before the Water Board, which will consider adoption of the TMDL into the Basin Plan. This process will allow the public to formally comment on the TMDL. Public comment was also solicited at a CEQA scoping meeting and public meeting held in December 2005.

8.2 Informal Process for Public Participation

Our pathogen TMDL stakeholder process builds upon the existing sediment TMDL stakeholder framework. We have participated in combined sediment-nutrient-pathogen TMDL meetings since 2002, beginning with a public meeting in November of that year. We maintain continuing involvement with the Sonoma Creek TMDL Steering Committee, Sonoma Ecology Center, the Sonoma County Resource Conservation District, and with local, county, state, and federal agencies involved in the watershed. We are available to attend and/or conduct additional meetings as needed or requested.

9. IMPLEMENTATION PLAN

9.1 Overview

TMDLs are strategies to restore clean water. Implementation plans specify actions needed to solve the problem and are required under California Law. The following implementation plan describes existing regulatory controls and cites relevant sections of the California Water Code (CWC) establishing the Water Board's authority to enforce the provisions set forth in the Implementation Plan. Section 13242 of the CWC requires that an implementation plan be incorporated into the Basin Plan upon Water Board adoption of the final TMDL Basin Plan amendment.

The implementation plan presented in this report provides a general description of proposed actions necessary to achieve water quality objectives. Together, the proposed Basin Plan Amendment and this staff report provide descriptions of necessary actions, as well as a time schedule for these actions, and a description of the compliance monitoring and tracking to be undertaken to ensure successful implementation. Water Board staff will make an effort to discuss source control actions with all interested stakeholders and seek their input in regard to cost and feasibility.

The overall intent of this implementation plan is to restore and protect beneficial uses of Sonoma Creek and its tributaries by reducing pathogen loadings. Potential pathogen sources in the watershed include: septic systems, sanitary sewer system failures, municipal runoff, livestock grazing, and dairies. The Water Board recognizes the technical, institutional, and monetary challenges that each source category may face in designing and implementing measures to reduce their respective loading. As such, we are trying to be as flexible as possible in the implementation approach for reducing pathogen loading. We anticipate that enforcement mechanisms will only be needed where individuals have chosen not to assess and reduce their potential to impact water quality.

This implementation plan describes the Water Board's regulatory authority (Section 9.2) as well as other plans and policies in the Sonoma Creek watershed that affect pathogen source management activities (Sections 9.3 and 9.4). A description of the proposed implementation actions is provided in Section 9.5. Evaluation of progress toward attaining implementation goals is described in Section 9.6, and a long-term water quality monitoring program is discussed in Section 9.

9.2 Legal Authorities and Requirements

The Water Board has the responsibility and authority for regional water quality control and planning per the state's Porter-Cologne Water Quality Control Act. The Water Board regulates point source pollution by implementing a variety of programs, including the NPDES Program for point sources discharging into waters of the United States. The State also controls nonpoint source pollution as specified in the state's *Plan for California's Nonpoint Source Pollution Control Program* (State Board, 2000; hereafter referred to as the State NPS Management Plan). The State's Porter Cologne Water Quality Control Act gives the Water Board authority to issue Waste Discharge Requirements (WDRs) for point and nonpoint sources of contamination.

9.3 California Nonpoint Source Program

California's Nonpoint Source (NPS) Pollution Control Program has been in effect since 1988 (WMI Chapter, 2001). The NPS Program is a regulatory strategy aimed at addressing nonpoint source pollution throughout the State of California. The NPS program is being 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."

The State also has a Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program that requires current and proposed nonpoint source discharges to be regulated under waste discharge requirements (WDRs), waiver of waste discharge requirement, Basin Plan prohibition, or some combination of these tools (State Board, 2004). For each source category that is currently discharging but not yet regulated, a regulatory tool has been identified.

9.4 Plans & Policies in the Sonoma Creek Watershed

Below is a description of the current regulations, policies, and plans for each of the categorical pathogen sources in the Sonoma Creek watershed. Source categories of concern include:

- Faulty septic systems
- Sanitary sewer line failure
- Municipal runoff
- Livestock grazing
- Dairies

Septic systems

The Water Board's Basin Plan specifically addresses water quality issues related to onsite wastewater treatment and dispersal systems (onsite septic systems). In 1978, the Water Board adopted a Policy on Discrete Sewerage Facilities enumerating the following principles, which apply to all wastewater discharges:

- The system must be designed and constructed so as to be capable of preventing pollution or contamination of the waters of the State or creating a nuisance for the life of the development project;
- The system must be operated, maintained, and monitored so as to continually prevent pollution or contamination of the waters of the State and the creation of a nuisance;
- The responsibility for both of the above must be clearly and legally assumed by a public entity with the financial and legal capability to assure that the system provides protection to the quality of the waters of the State for the life of the development project.

The policy also makes the following requests of city and county governments:

- That the use of new discrete sewerage systems be prohibited where existing community sewerage systems are reasonably available;
- That the use of individual onsite systems for any subdivision of land be prohibited unless the governing body having jurisdiction determines that the use of the individual onsite systems is in the best public interest and that the existing quality of the waters of the State is maintained consistent with the State Water Board's Resolution 68-16; and,
- That the cumulative impacts of individual onsite system discharges be considered as part of the approval process for development.

The Water Board has conditionally delegated authority for permitting and regulation of individual onsite wastewater treatment systems in Sonoma County to the county government. Onsite systems in Sonoma County are regulated by the Sonoma County Permit and Resource Management Department, in accordance with County Code and associated Regulations. The Code and Regulations include specifications for on-site system siting, design, installation, inspection and repair, and provisions for permitting and enforcement of violations. Delegation was enacted in 1964 by means of the Water Board's Resolution No. 599, which waived the requirement for filing reports of waste discharge with the Water Board for systems that are appropriately permitted by the County.

Then, in 2000, the California Water Code (CWC) was amended to require the State Water Board to develop statewide regulations or standards for permitting and operation of septic systems by January 1, 2004 (CWC Sections 13290 to 13291.7). The regulations are required to address, in part, new systems, systems subject to major

repairs, systems adjacent to 303(d)-listed impaired waters, and minimum requirements for monitoring to determine system performance.
In 2002, the CWC was further amended to specify that all existing Waivers of Waste Discharge Requirements for septic systems would expire on June 30, 2004 in anticipation of the new State Water Board regulations (CWC Section 13269(b)(2)). This amendment also requires any new Regional Water Board septic system regulations to be consistent with the new State Water Board regulations. State Water Board regulations are currently being developed, with adoption projected for late 2006. Following adoption of the statewide regulations, on-site system programs at both the Regional Water Board and County level will need to be updated to incorporate and implement the new requirements.

Sanitary sewer system failures

An October 2003 Water Board resolution (No. R2-2003-0095) established a collaborative program between the Water Board and Bay Area Clean Water Agencies (BACWA) to reduce sanitary sewer overflows (SSOs). The collaborative program includes four key tasks:

- Establish SSO reporting guidelines,
- Develop an electronic reporting system,
- Establish guidelines for sewer system management plans (SSMP) and
- Conduct a series of regional workshops to provide training on the first three tasks.

Reporting guidelines, the electronic reporting system, and regional workshops were completed in 2004. The Water Board in cooperation with BACWA completed the Sewer System Management Plan (SSMP) Development Guide in July 2005. Some of the SSMP requirements direct wastewater agencies to:

- Develop an overflow emergency response plan to contain overflows and prevent wastewater from reaching surface waters,
- Develop a Fats, Oils, and Grease (FOG) Control Program if needed,
- Allocate adequate resources for the operation, maintenance, and repair of its collection system,
- Prioritize preventive maintenance activities, such as scheduled cleaning of sewers, root control, and investigation of customer complaints;
- Identity structural deficiencies and prioritize repair, and
- Monitor the effectiveness of each SSMP element.

The Water Board notified wastewater collection agencies of the requirements for preparing SSMPs in July 2005, and the notification included required completion dates for each SSMP element.

Livestock Grazing

The State Water Board and the California Coastal Commission have identified management measures to address nonpoint source pollution from grazing activities. In response to nonpoint source pollution concerns, the Range Management Advisory Committee composed of livestock industry representatives and public members was formed. The Committee developed a California Rangeland Water Quality Management Plan, which recommends that ranchers complete rangeland Water Quality Management Plans for their respective ranches. Three approaches for voluntary compliance with the plan include: letter of intent with local Resource Conservation District office; development of a nonpoint source management plan; or adoption of a recognized nonpoint source management plan.

In May, 2004 the State Water Resources Control Board adopted a *Policy for Implementation and Enforcement of the Nonpoint Source Control Program*. This policy requires that the Water Boards regulate all nonpoint sources of pollution by issuing waste discharge requirements or establishing conditions for waiving waste discharge requirements or discharge prohibitions that dischargers must comply with.

Dairy facilities

Minimum design and management standards for the protection of water quality from these animal operations are promulgated in Title 23, California Code of Regulations, Chapter 15, Article 6. These regulations prohibit the discharge of facility wash water, animal wastes, and stormwater runoff from animal confinement areas into waters of the state. They also specify minimum design and waste management standards for the:

- Collection of all wastewaters;
- Retention of water within manured areas during a 25-year, 24-hour storm event;
- Use of paving or impermeable soils in manure storage areas; and,
- Application of manures and wastewaters on land at reasonable rates.

The Water Board has the authority to enforce these regulations through Waste Discharge Requirements (WDRs). Dairies are the typical animal confinement operation within the Watershed. The Water Board issued a Waiver of Waste Discharge Requirements for dairies (Resolution No 83-3) that have proper waste control facilities in place and whose management practices conform with the California Code of Regulations: Title 23, Article 3, Chapter 15 (Discharge of Waste to Land). This waiver expired in January 2003. In 2004, the Water Board renewed the Waiver of Waste Discharge Requirements for Confined Animal Facilities (Resolution No. R2-2003-0094) and completed its assessment of each dairy's compliance with the waiver.

In 1990, the State Board established a Dairy Waste Task Force to look at the dairy industry statewide and develop standards for dairy regulation. The main emphases have been on developing better communication and guidance materials for the industry; developing a dairy survey form to help the Water Board determine if a dairy qualifies for a WDRs waiver; determining the number and location of dairies; developing more-uniform WDRs; and preparing an outreach program aimed at the dairy industry,

local government, and the public. The State Water Board members directed staff to continue the following activities:

- Work with the dairy industry through the local dairy waste committees, county farm bureaus, Resource Conservation Districts (RCDs), and other local/state agencies in obtaining cooperative correction of dairy waste problems.
- Recommend adoption of WDRs in those cases in which water quality objectives for waters within an agricultural watershed are consistently exceeded, or in which corrective action is unsuccessful in eliminating either the short- or long-term water quality problems or threats.
- Monitor compliance with animal waste guidelines and WDRs waiver.

Municipal runoff

The Water Board has a comprehensive runoff control program that is designed to be consistent with Federal regulations (40 CFR 122-24) and is implemented by issuing NPDES permits to owners and operators of large storm drain systems and systems discharging significant amounts of pollutants. Each stormwater permit requires that the entities responsible for the system to develop and implement comprehensive control programs. The County of Sonoma, Sonoma County Water Agency, and City of Sonoma, are covered by the general stormwater permit issued by the State Board and enforced by the Regional Water Board. The Sonoma Developmental Center is in the process of developing a storm water management plan and obtaining coverage.

Current municipal runoff program requirements include the following elements:

- Develop, implement, and enforce a stormwater management plan (SWMP) to reduce the discharge of the pollutants to the maximum extent practicable;
- Address specific program areas, including public education and outreach on stormwater impacts, public involvement, illicit discharge detection and elimination, construction site stormwater runoff control, post construction stormwater management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations;
- Evaluation and assessment of measures; and
- Monitoring and reporting.

9.5 Proposed Pathogen Reduction Implementation Actions

This section describes potential management measures for each source category in the Sonoma Creek watershed. In most cases, implementation efforts should focus on these source categories in those portions of the watershed associated with bacterial water quality impairment as identified through the data presented earlier in this report or through future monitoring activities discussed in Section 9.6.

To determine the appropriate level and type of source control and regulatory actions necessary to achieve water quality objectives, the Water Board will consider the following factors:

- The feasibility of achieving the required level of performance (assigned pollutant load allocations) for each source;
- The magnitude of the water quality impairment caused by each source; and
- The history of source control efforts and regulatory requirements.

Feasibility is a function of the technical capability and cost of management measure implementation. Water quality impairment is a function of the type of source (i.e. human

versus animal waste) and its potential for causing an exceedance of water quality objectives.

Discharging entities will not be held responsible for uncontrollable coliform discharges originating from wildlife. If wildlife contributions are determined to be the cause of exceedances, the TMDL targets and allocation scheme will be revisited as part of the adaptive implementation program.

Many implementation activities are already underway in the watershed. The Water Board strongly supports these activities and recommends that these efforts be continued. Implementation of pathogen control measures that also reduce sediment and nutrient loads are encouraged, as this may preclude the need for implementation of additional management measures for those sources.

All sources are required to identify potential pathogen sources on their facilities and develop a plan for reducing pathogen runoff. Sources must then implement site-specific management measures to reduce the pathogen run-off and document the measures taken.

Each source category will provide documentation on progress made toward implementation of control measures. In some cases it may be desirable to identify an appropriate third party with expertise in implementation that could help evaluate reports for each source category. Where a third party is not identified, the Water Board will independently assess compliance. In all cases, the discharger is ultimately responsible for implementing identified control measures.

Throughout the TMDL process, the Water Board and stakeholders in the Watershed will need to monitor compliance with management measure implementation and assess whether water quality is improving. The Implementation Plan includes steps for evaluation and follow-up for assessing compliance with the TMDL. Ultimately, the long-term success of the TMDL implementation plan will be measured by attaining the designated TMDL load allocations.

If reasonable progress toward implementing the management practices is not demonstrated, the Water Board will consider additional regulatory control or taking enforcement actions on those source categories and/or individual dischargers that are not participating in good faith. Examples of additional regulation include requiring permits for individual grazing lands or equestrian facilities or requiring operating permits for all septic systems.

If it is demonstrated that reasonable and feasible management measures have been implemented for a sufficient period of time and TMDL targets are still not being met, the TMDL will be reevaluated and revised accordingly.

Table 10 presents proposed implementation actions to be undertaken by the Water Board. These actions are applicable to all source categories. Tables 11-15 describe proposed actions for responsible parties for reduction of pathogen loading from each

major source category. Details of the implementation actions will be developed in close coordination with parties responsible for implementation actions and other interested stakeholders.

Table 10. Proposed Water Board Implementation Actions to Reduce Pathogen Loading
1. In coordination with responsible parties and interested third parties in the watershed, conduct monitoring program to measure progress toward, attainment of water quality objectives, meeting benchmarks, and compliance with TMDL implementation plan.
2. Assist in establishing funding mechanisms for implementation and monitoring.
3. Report to stakeholders on progress in meeting implementation of management measures and attainment of water quality objectives, including a discussion of options for regulatory action and follow-up, as needed.
4. Implement, as necessary, WDRs or waiver of WDRs related to pathogen reduction.

Table 11. Proposed Implementation Actions to Reduce Pathogen Loading from Septic Systems	
Implementing Party	**Action**
Sonoma County Permit and Resource Management Department	1. In cooperation with the Water Board and Sonoma Valley County Sanitation District, identify areas of greatest water quality concern from septic system failure based on proximity to impaired reaches, soil type, topography, and other factors.
	2. Submit a plan and implementation schedule to evaluate septic system performance for the watershed and to bring identified septic systems up to appropriate repair standards. Priority should be given to systems identified as posing water quality risks.
	3. Report progress on implementation of pathogen reduction measures.

Table 12. Proposed Implementation Actions to Reduce Pathogen Loading from Sanitary Sewer Systems	
Implementing Party	**Action**
Sonoma Valley County Sanitation District	1. In cooperation with the Water Board and Sonoma County Permit and Resource Management Department, identify areas of greatest water quality concern from collection system failure based on proximity to impaired reaches, soil type, topography, and other factors.
	2. Develop Sanitary Sewer Management Plan in accordance with Water Board/BACWA guidelines (see Section 9.4, pages 36-37). Plan should include provisions to identify and repair collection system failures. Priority should be given to areas identified as posing water quality risks.
	3. Report progress on implementation of pathogen reduction measures.

Table 13. Proposed Implementation Actions to Reduce Pathogen Loading from Municipal Runoff	
Implementing Party	**Action**
Sonoma County Water Agency, County of Sonoma, City of Sonoma, Sonoma Developmental Center, and other designated entities	1. Implement stormwater management plan.
	2. Update/amend stormwater management plan to include specific measures to reduce pathogen loading.
	3. Report progress on implementation of pathogen reduction measures.

Table 14. Proposed Implementation Actions to Reduce Pathogen Loading from Livestock Grazing	
Implementing Party	**Action**
Owners of Livestock Grazing Operations	1. Participate in ongoing RCD/NRCS conservation programs.
	2. Implement management measures that reduce pathogen runoff.
	3. Where water quality impacts are identified, implement site-specific source control measures and conservation practices.
	4. Submit report of Waste Discharge or comply with conditions of WDRs waiver or discharge prohibition.

Table 15. Proposed Implementation Actions to Reduce Pathogen Loading from Dairies	
Implementing Party	**Action**
Dairy Facility Owners	1. Participate in Sonoma-Marin Animal Resource Committee. The Committee supports dairy operators in their efforts to solve waste control problems and locate technical and financial assistance. The committee serves as a vehicle through which the Water Board and DFG can disseminate information on water quality regulations and requirements.
	2. Participate in an annual training program that identifies water quality concerns and site-specific management practices for reducing such water quality impacts (e.g., Dairy Quality Assurance Program Training).
	3. Ensure that facility is in full compliance with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs.
	4. Where water quality impacts are identified, implement site-specific source control measures and conservation practices.

9.6 Evaluating Progress Towards Attaining Implementation Goals

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;
- address any uncertainty in various aspects of TMDL development;
- oversee TMDL implementation to ensure that implementation measures are being carried out; 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.

A formal water quality monitoring program for pathogen indicator bacteria will be developed by Water Board staff in coordination with stakeholders. Monitoring should begin as soon as possible, and should initially focus on previously identified hot spots

and tributaries not assessed in previous work. Initial water quality monitoring objectives will be to:

- evaluate spatial and temporal water quality trends in the Creek and its tributaries
- further identify significant pathogen source areas
- collect sufficient data to prioritize implementation efforts and assess the effectiveness of implementation actions

9.7 Adaptive Implementation

Approximately every five years, the Water Board will review the Sonoma Creek Watershed Pathogens TMDL and evaluate new and relevant information from monitoring, special studies, and scientific literature. The reviews will be coordinated through the Water Board's continuing planning program and will provide opportunities for stakeholder participation. Any necessary modifications to the targets, allocations, or implementation plan will be incorporated into the Basin Plan. In evaluating necessary modifications, the Water Board will favor actions that reduce sediment and nutrient loads, pollutants for which the Sonoma Creek Watershed is also impaired. We are seeking input from stakeholders on the type of studies needed to further refine this TMDL and answer any outstanding questions. At a minimum, the following questions will be used to conduct the reviews.

- Are the Creek and the tributaries progressing toward TMDL targets as expected? If progress is unclear, how should monitoring efforts be modified to detect trends? If there has not been adequate progress, how might the implementation actions or allocations be modified?
- What are the pollutant loads for the various source categories (including naturally occurring background pathogen contributions and the contribution from open space lands), how have these loads changed over time, how do they vary seasonally, and how might source control measures be modified to further reduce loads?
- Is there new, reliable, and widely accepted scientific information that suggests modifications to targets, allocations, or implementation actions? If so, how should the TMDL be modified?

If after five years the Water Board determines that load and density reductions are being achieved as management measures are implemented, then the recommended appropriate course of action would be to continue management measure implementation and compliance oversight. If it is determined that all proposed control measures have been implemented, yet the TMDL is not achieved, further investigations will be made to determine whether: 1) the control measures are not effective; 2) the high levels of indicator bacteria are due to uncontrollable sources; or 3) the TMDL is unattainable.

10. REGULATORY ANALYSIS

10.1 Overview

This section includes the analyses required pursuant to the Administrative Procedures Act to adopt or modify a regulation. Many Basin Plan provisions are considered regulations, and many of the changes contained in the proposed Basin Plan Amendment (BPA) add regulatory provisions to the Basin Plan. To adopt these changes, the Water Board must complete an environmental checklist pursuant to the California Environmental Quality Act (CEQA), consider reasonable alternatives to the proposal, and consider economic factors relating to compliance with all new regulatory requirements.

10.2 Environmental Checklist

CEQA requires agencies to review the potential for their actions to result in adverse environmental impacts. CEQA further requires agencies to adopt feasible measures to mitigate potentially significant impacts. Chapter 11 contains the environmental checklist for the proposed Basin Plan amendment. An explanation follows the environmental checklist and provides details concerning the environmental impact assessment. The analysis concludes that adopting the proposed Basin Plan amendment will not have any significant adverse environmental effects.

10.3 Alternatives

To illustrate how some of the choices made in developing the proposed Basin Plan amendment affect its foreseeable outcomes, this analysis considers a range of alternatives to the Basin Plan amendment. It discusses how each alternative would affect foreseeable outcomes and the extent to which the alternative would achieve the goals of the proposed Basin Plan amendment. As discussed in Chapter 11, the Basin Plan amendment does not pose any significant adverse environmental impacts; therefore, the alternatives would not avoid or lessen any significant adverse impacts. The following alternative scenarios involve different targets, allocations, and implementation strategies: 1) proposed Basin Plan amendment; 2) no Basin Plan amendment; 3) higher TMDL targets and allocations; 4) lower TMDL targets and allocations; 5) seasonal TMDL; and 6) longer implementation.

Proposed Basin Plan Amendment

The proposed project is the adoption of the Basin Plan amendment discussed in Chapter 11. The Basin Plan amendment is based on the technical analyses described in Sections 2 through 9 of this report. The Basin Plan amendment includes target E.coli concentrations (geometric mean < 126 CFU/100mL and 90th percentile < 320 CFU/ 100mL) for Sonoma Creek and its tributaries, and assigns load allocations to the various pathogen source categories to achieve the targets.

No Basin Plan Amendment

Under this alternative, the Water Board would not amend the Basin Plan to adopt the proposed pathogen TMDL. Neither the proposed targets nor the proposed allocations would be adopted, and no new implementation activities would be initiated. In the event

that no actions were taken to address the Sonoma Creek watershed's pathogens impairment, pathogen concentrations would likely either stay the same or increase over time, due to the aging of waste management systems.

If the Water Board were to decline to adopt a pathogens TMDL, the Clean Water Act requires the U.S. Environmental Protection Agency (U.S. EPA) to complete a TMDL for the Sonoma Creek watershed. How U.S. EPA's TMDL would differ from the TMDL described in the proposed Basin Plan amendment is unknown. U.S. EPA would likely rely, at least in part, on analyses completed to date; however, U.S. EPA would be free to develop its own TMDL in any manner it deemed appropriate, within legal constraints. U.S. EPA would identify targets and allocate pathogen loads. U.S. EPA would not impose an implementation plan directly. However, the Water Board would be expected to incorporate U.S. EPA's TMDL and appropriate implementation actions into the Basin Plan through the continuing planning process.

This alternative would involve the Water Board declining to exercise the authority and responsibility delegated to it by U.S. EPA to implement Section 303(d) of the Clean Water Act. The Water Board would not maintain responsibility for developing and implementing the Sonoma Creek Pathogens TMDL. In addition, the U.S. Federal Government may not be as effective as the Water Board at developing a TMDL and encouraging stakeholder participation for this area given the regional expertise of the Water Board and local stakeholders.

Higher TMDL Targets/Allocations
Under this alternative, the TMDL targets would be set at a higher level than those proposed in the Basin Plan amendment, therefore raising the proposed pathogen load allocations.

This alternative would not protect the beneficial uses of the Sonoma Creek watershed (i.e., water contact recreation and non-contact water recreation) to the same extent as the proposed targets, and people who recreate in these waters would be at a greater risk of exposure to waterborne disease

Lower TMDL Targets/Allocations
Under this alternative, the TMDL targets would be set at a lower level than those proposed in the Basin Plan amendment. While the proposed targets are protective of human health, this alternative could ensure additional protection for the recreational users of the Sonoma Creek Watershed. The pathogen load allocations, however, would need to be reduced to achieve these lower TMDL targets. This could necessitate more stringent actions, in addition to those currently proposed.

Meeting the lower allocations could require substantial additional efforts to reduce pathogen loads. The costs of achieving these greater pathogen reductions may be disproportionately high compared to the costs of the proposed reduction. These increased costs would likely make this alternative less feasible to implement than the proposed TMDL.

Seasonal TMDL
Under this alternative, the TMDL for Sonoma Creek and its tributaries would be applicable only during certain periods of the year and not throughout the year, as proposed by the Basin Plan amendment.

This alternative would be easier to achieve. It would not, however, fully protect the beneficial uses of the Sonoma Creek watershed at all times. Recreational use of Sonoma Creek and its tributaries occurs year-round. Therefore, a seasonal TMDL would not fully protect recreational users.

Longer Implementation
Under this alternative, the allocations would be phased in over a longer period of time (i.e., longer than ten years) than what is proposed by the Basin Plan amendment. Therefore, attainment of the designated water quality objectives would be postponed, putting public health in jeopardy.

This alternative would not meet the Basin Plan amendment's objectives because it would delay, without any reasonable justification, attainment of the water quality objectives and protection of beneficial uses of the Sonoma Creek Watershed. Further, most of the proposed implementation actions are already required under various established regulatory programs. Therefore, their implementation should already be underway, and by the end of the identified implementation period should be fully completed.

Preferred Alternative
Because the proposed Basin Plan amendment will not pose any significant adverse environmental impacts, the alternatives would not avoid or lessen any significant impacts. Some alternatives could be considered environmentally superior because they could conceptually involve lower allocations and greater implementation efforts. In this way, they could result in lower pathogen concentrations in the Sonoma Creek Watershed. These alternatives are the lower TMDL targets and lower allocations scenarios. Both could be less feasible to implement than the proposed Basin Plan amendment. The proposed Basin Plan amendment is the preferred alternative.

10.4 Economic Considerations

Overview
The California Environmental Quality Act requires that whenever one of California's nine regional water boards, such as the San Francisco Bay Regional Water Quality Control Board (Water Board), adopts a rule that requires the installation of pollution control equipment or establishes a performance standard or treatment requirement, it must conduct an environmental analysis for reasonably foreseeable methods of compliance (Public Resource Code 21159 [a][3][c]). This analysis must take into account a reasonable range of factors, including economics. Furthermore, if the rule includes an agricultural control plan, then the total cost of the program must be estimated and potential sources of funding must be identified (Water Code 13141).

The proposed Sonoma Creek Pathogen Basin Plan amendment includes performance standards (i.e., targets and allocations), and therefore, requires the consideration of economic factors. The Total Maximum Daily Load (TMDL) implementation plan also proposes activities for agriculture, and therefore, the total cost of the implementation effort is estimated and potential funding sources are identified.

The objective of this analysis is to estimate the costs of implementing the TMDL for pathogen reduction in the Sonoma Creek watershed. It has been determined that pathogens originating from on-site sewage disposal systems (OSDS), sanitary sewer system failures, grazing lands, dairies, and municipal runoff can be reduced to achieve the goals of the TMDL. Wildlife and treated municipal wastewater discharges are also assigned pathogen allocations in the proposed Basin Plan Amendment (BPA), but are not believed to be significant sources of pathogens in this watershed under normal conditions. Contributions from Wildlife are considered natural background. In the proposed BPA, the Water Board has proposed implementation measures for each pathogen source, except wildlife. The implementation measures are composed primarily of monitoring, implementation of management practices (MPs), and reporting.

The TMDL implementation costs are estimated for each source category and for each of the proposed implementation actions contained in the BPA. Summary Tables 16 and 17 provide the cost estimates. We provide an upper and lower range of cost estimates since there is uncertainty about the exact costs. In most cases, the particular elements of the implementation action are required to be developed at some point in the future, and therefore, the specifics are unknown. For cases in which it is possible to make educated guesses about the likely elements of an implementation action, cost estimates are included. For other cases, estimating the elements of a program would be decidedly speculative, and therefore, no cost estimates are developed. Cost estimates are projected for a 10-year planning horizon. Costs of implementing existing requirements are not included.

Cost Estimates

Onsite Sewage Disposal Systems

The Basin Plan amendment requires the County to develop a plan and implementation schedule to evaluate Onsite Sewage Disposal Systems (OSDS) performance in the Sonoma Creek Watershed and to bring identified OSDS up to the County's repair standards. It anticipates that repairs will be made to failing systems. The specifics of the management program that will document and assess performance of OSDS have not yet been determined. The cost of system repairs will vary according to the type, age, and location of the system. The national average for failing systems ranges from 10–20% (US EPA, 2002).

Evaluation/Monitoring:

The specifics of the program that will evaluate and monitor performance of OSDS have not yet been determined. We assume that systems would be inspected once every 5-10 years. Inspections would likely include a visual survey of the tank, water level, and leach field. A hydraulic load and dye test would be necessary if the system is located near a waterway. This type of inspection could be performed by a qualified contractor and would cost approximately $500 per OSDS inspection (Smith, pers. comm.. 2005).

For calculating low-range cost estimates, we assumed that all septic systems in Kenwood and surrounding areas (where water quality data indicate relatively high pathogen loading) would be inspected once every ten years. We estimate, based on data available, there are approximately 428 septic systems in the Kenwood area. Therefore, the low-range cost estimate for evaluation/monitoring is $214,000 for a ten-year program. Annualized cost is $21,400.

For calculating a high-range estimate, we assumed that all parcels containing blue-line streams would be inspected once every 10 years. Within the Sonoma Creek Watershed, approximately 1165 parcels both contain blue-line streams and are likely served by septic systems. The high-range cost estimate is then $1,165,000 for a ten-year program, which equate to an annualized cost of $116,500.

Repair Program Implementation:

OSDS repair costs vary greatly depending upon the problem. As a low-range cost estimate, we assumed a minor system repair costing approximately $1,000 (Ng, pers. comm. 2006). As a high-range per unit cost estimate, a complete system replacement at $40,000 is assumed. For the low-range estimate, a 10% failure rate at a repair cost of $1,000 per system is calculated. For a high-range estimate, a 20% failure rate at $40,000 per system is calculated. The septic systems posing the greatest water quality concern will be determined by the County as a result of their evaluation and monitoring program. For the purpose of calculating cost estimates, the low-range cost estimate assumes 10% of the septic systems in the Kenwood area would require a simple repair. The high-range estimate assumes 20% of all parcels, within the watershed, containing a blue-line stream and served by septic systems would require replacement. The low- and

high-range estimates for septic system repair/replacement are $43,000 and $9.3 million, respectively.

Reporting:
The Basin Plan amendment also requires the County to report progress on implementation of the OSDS management program. Oversight of the inspection results and follow-up would vary according to the number of systems inspected, frequency of inspection, type of system, and economies of scale. A similar reporting/follow up program in Marin County involving biannual inspection of 1,300-3,500 septic systems has been estimated to cost $24,000/year (Economic Planning Systems, 2003). This value is used as a conservative high-range estimate for the Sonoma County program. The low-range estimate is one-quarter of the high-range estimate, or $6,000/year.

Sanitary Sewer System Failures

The Sonoma Valley County Sanitation District operates the sanitary sewer collection system in Sonoma Valley. An October 2003 Water Board resolution (No. R2-2003-0095) established a collaborative program between the Water Board and Bay Area Clean Water Agencies (BACWA) to reduce sanitary sewer overflows. As a result, sanitary sewer collection system agencies are required to prepare and implement a Sewer System Management Plan (SSMP). The SSMP requires measures to contain sanitary sewer overflows, identify structures needing repair, and develop a preventive maintenance program. The requirements also include monitoring the effectiveness of each SSMP element, and submitting annual reports. The Water Board's program to reduce sanitary sewer overflows would be implemented independent of the Basin Plan amendment. The Basin Plan amendment is not imposing any new requirements or actions for sanitary sewer systems, and therefore no cost estimates are calculated here.

Municipal Runoff

Municipal runoff in the Sonoma Creek watershed is subject to the Phase II Stormwater Requirements promulgated by the EPA, and regulated by the Water Board under *State Water Quality Control Board Order No. 2003-0005-DWQ, Waste Discharge Requirements for Small Municipal Separate Storm Sewer Systems* (MS4 General Permit). To meet the requirements of the MS4 General Permit, designated entities are required to prepare and implement Storm Water Management Plans (SWMPs). In the Sonoma Creek watershed, these designated entities are the County of Sonoma, Sonoma County Water Agency, City of Sonoma, and the Sonoma Developmental Center. These entities are required to implement SWMPs that address program areas such as public education and outreach, illicit discharge detection and elimination, construction and post-construction runoff control, and pollution prevention/good housekeeping for municipal operations. Within these program areas, activities designed to reduce pathogen loading include: posting pet waste signs, enforcing storm water requirements on new development projects, improving the detection and elimination of sewer and septic systems failures, and public education.

To meet the requirements of the TMDL, the entities will be required to develop additional management measures for pathogen reduction, identify measurable goals and time schedules of implementation, and assign responsibility for each task. The specifics of future storm water program efforts to reduce pathogens are not yet known. Review of current practices, new information, or monitoring data regarding pathogen sources may prompt modifications to the current SWMP, or the future SWMP may include new management measures to reduce pathogen loading. The County and Water Agency are required to submit the stormwater management plan to the Water Board for approval. The Water Board reviews this document for its adequacy in meeting the storm water requirements. An estimate of the storm water program efforts and their costs is provided below.

Inspections/Monitoring:
Currently, the storm water program is not implementing a water quality monitoring program involving bacterial concentrations. A pathogen-specific monitoring program may be implemented in the future. The specifics of the potential monitoring program are not known at this time, and would be determined in the future based on an assessment of data needs, and coordination with other groups in the watershed. As an estimate, 3-5 sites may be sampled 3-6 times per year. Costs would be expected to be in the range of $400 per sampling event for staff time and $60 per site for lab fees (Lewis, pers. comm., 2004a). The monitoring cost would be in the range of $1,740-$4,200 per year.

Stormwater Plan Implementation:
Development and implementation of a storm water program for this watershed is required independently of the Basin Plan amendment. Since this is an existing requirement under Phase II of the storm water program, no additional cost is estimated for implementation of the existing storm water management program. Some additional implementation measures or management programs may be needed for pathogen reductions. The specific measures are not known at this time. Potential future measures include: providing pet waste disposal bags at City or County-owned parks, and increasing public education activities. For the most part, these implementation measures would be extensions of existing programs. For example, an outreach program to local schools on runoff may be expanded to include a brief description of specific sources of pathogens in the Watershed (such as domestic animals or leaky septic tanks). Costs for stormwater management plan implementation are difficult to calculate because activities often overlap with other programs. As an estimate, additional measures may cost $2,000-$15,000 per year.

Reporting:
Reporting on the municipal storm water program is required independent of the TMDL under Phase II of the municipal storm water program. Therefore, no costs have been estimated for reporting.

Grazing Lands Runoff

The proposed Basin Plan amendment anticipates that the Water Board will develop waiver of Waste Discharge Requirements (WDRs) conditions (similar to the existing waiver conditions for Dairies) for grazing land operators. It also requires grazing operators to submit a Report of Waste Discharge that identifies site-specific grazing management measures and provides a schedule to implement measures to reduce animal runoff. At this point, the site-specific actions or general waiver conditions are unknown.

Staff estimates approximately 14,000 acres of land are grazed in the Sonoma Creek watershed, based on land cover information and the assumption that one-half of potential grazing land is actually grazed. Communications with Natural Resources Conservation Service (NRCS) staff indicate there are approximately 10 grazing operations in the watershed.

Inspection/Monitoring:

We assumed that all facilities would require an initial visit from technical assistance staff, with annual visits thereafter. Initial visits were assumed to be full-day (roughly $1000), with half-day ($500) annual visits.

Management Measures Implementation:

Based on information from the nearby Napa River watershed, we estimate that approximately 75% of grazing lands in the Sonoma Creek watershed currently have adequate MPs in place. This assumption is consistent with water quality data, which indicate moderate and relatively localized impairment.

The specific pathogen reduction implementation measures will vary with the geography, pattern of animal use, and management practices. Without knowing specific grazing practices or the geography of individual ranches, we assume that typical MP measures will include livestock rotation through pastures, fencing animals out of the waterways, and installing off-stream water troughs. Since fencing is likely to be the most costly MP, this was used as a conservative cost estimate. However, the Water Board acknowledges that there are other acceptable methods of managing livestock access to streams.

Fence installation (39 inches high with barb wire and galvanized posts) is estimated to cost approximately $4.80 per linear foot to install. Water troughs (224 gallon capacity, 2x2x8 feet) are estimated to cost $163/trough. As a high-range cost estimate, we assumed that 25% of the blue-line streams (as determined using GIS) within grazed lands would be fenced. Using GIS, we calculated approximately 260,000 linear feet of blue-line streams within grazed lands. With $4.80/foot to install and 260,000 x 25%(x2 for both sides) linear ft. of stream to be fenced, the high-range cost estimate for fencing is $623,000. The high-range cost for water troughs (one water trough per 20 acres for 25% of the grazed acreage) is approximately $29,000. Low range estimates for these costs are assumed to be one-fifth of the high range estimates. For both high- and low-

range estimates, annual maintenance costs equal to one-tenth of initial capital costs are assumed.

It is possible that fencing the creeks may reduce the amount of forage available to livestock, resulting in a decline in livestock productivity and/or causing a reduction in herd size. The extent and cost of these losses are considered too speculative to estimate, and are not considered in this analysis.

Reporting:
It is not know how the grazing land operators will choose to report on their compliance with the BPA requirements. Since these facilities will be operating under a waiver of Waste Discharge Requirements (WDR), we assumed that Water Board staff would inspect each of the 10 facilities. Both high- and low-range estimates assume that each facility will be inspected once every five years at $500 per inspection.

Dairies
Four dairies currently operate in the Sonoma Creek Watershed. Under existing law and regulations, all dairies are required to meet conditions of the Water Board's waiver of waste discharge requirements or the individual waste discharge requirements. The Basin Plan amendment is not imposing any new requirements or actions for the confined animal operations associated with dairies. Therefore, no cost estimates are calculated here. Dairies may incur some additional costs due to implementation of management practices associated with cow grazing on pasturelands. These costs are included in the above section entitled Grazing Lands Runoff.

Municipal Wastewater Discharge
The Sonoma Valley County Sanitation District is the only permitted discharger of municipal wastewater to the surface waters in the Sonoma Creek watershed. The facility discharges to tidal Sonoma Slough in the extreme southern end of the watershed during the winter months. The facility's NPDES permit limits effluent bacteria levels to a median of 23 MPN/100 mL total coliform. The proposed Basin Plan amendment echoes the same requirement, and therefore is not imposing any new requirements or actions. Therefore, no cost estimates are calculated here.

Table 16. Sonoma Creek Watershed Implementation Actions, Estimated Costs, and Timing								
Implementation Action	**Responsible Party**		**One-Time Cost**		**Annual Cost**		**10-Year Program Cost**	
	Name	No.	Low	High	Low	High	Low	High
Onsite Sewage Disposal Systems (OSDS)								
1. Evaluation/ Monitoring[1]	Sonoma County Permit Resource Management Department		$0	$0	$21,400	$116,500	$214,000	$1,165,000
2. Repair Program Implementation[2]	Homeowners		$42,800	$9,320,000	$0	$0	$42,800	$9,320,000
3. Reporting	Sonoma County Permit Resource Management Department		$0	$0	$6,000	$24,000	$60,000	$240,000
	Total		$42,800	$9,320,000	$27,400	$140,500	$316,800	$10,725,000
Sanitary Sewer System Failures								
1. Comply with applicable NPDES Permit and SSMP requirements	Sonoma Valley County Sanitation District		$0	$0	$0	$0	$0	$0
	Total		$0	$0	$0	$0	$0	$0
Municipal Runoff								
1. Inspection/ Monitoring	County of Sonoma, City of Sonoma, Sonoma County Water Agency, Sonoma Developmental Center		$0	$0	$1,740	$4,200	$17,400	$42,000
2. Stormwater Plan Implementation	County of Sonoma, City of Sonoma, Sonoma County Water Agency, Sonoma Developmental Center		$0	$0	$2,000	$15,000	$20,000	$150,000
3. Reporting	County of Sonoma, City of Sonoma, Sonoma County Water Agency, Sonoma Developmental Center		$0	$0	$0	$0	$0	$0
	Total		$0	$0	$3,740	$19,200	$37,400	$192,000
Grazing Lands								
1. Technical Assistance/ Stewardship	Dairies and Ranchers	10	$10,000	$10,000	$5,000	$5,000	$55,000	$55,000
2. Implement Management Measures	Dairies and Ranchers	10	$130,376	$651,882	$13,038	$65,188	$247,715	$1,238,576
3. Reporting	Dairies and Ranchers	10	$0	$0	$5,000	$5,000	$50,000	$50,000
	Total		$140,376	$661,882	$23,038	$75,188	$352,715	$1,343,576
Dairies								
1. Comply with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs	Dairies	4	$0	$0	$0	$0	$0	$0
	Total		$0	$0	$0	$0	$0	$0
Municipal Wastewater Discharge								
1. Comply with applicable NPDES permit	Sonoma Valley County Sanitation District		$0	$0	$0	$0	$0	$0
	Total		$0	$0	$0	$0	$0	$0
	GRAND TOTAL		**$183,176**	**$9,981,882**	**$54,178**	**$234,888**	**$706,915**	**$12,260,576**

Table 17. Summary of Estimated Costs for Sonoma Creek Watershed Pathogen TMDL Implementation (Year 0 through 10)						
Source Category	**One Time Cost (Site Development/Infrastructure)**		**Annual Costs**		**Ten-Year Program Cost**	
	Low	**High**	**Low**	**High**	**Low**	**High**
Onsite Sewage Disposal Systems (OSDS)	$42,800	$9,320,000	$27,400	$140,500	$316,800	$10,725,000
Sanitary Sewer System Failures	$0	$0	$0	$0	$0	$0
Municipal Runoff	$0	$0	$3,740	$19,200	$37,400	$192,000
Grazing Lands	$140,376	$661,882	$23,038	$75,188	$352,715	$1,343,576
Dairies	$0	$0	$0	$0	$0	$0
Municipal Wastewater Discharge	$0	$0	$0	$0	$0	$0
GRAND TOTAL	$183,176	$9,981,882	$54,178	$234,888	$706,915	$12,260,576

Potential Sources of Funding
Several state and federal grant programs are aimed at non-point source pollution control and implementing TMDL actions. Potential funding sources for pathogen reduction measures include Watershed Protection Programs (funded by CALFED, Prop. 13, Prop. 40, and Prop. 50) and Nonpoint Source Pollution Control Programs (funded by EPA via the 319 grant program, Prop. 13, Prop. 40, and Prop. 50). The State Water Resources Control Board administers a consolidated grant program to award and manage these funding sources. In addition, low-interest State Revolving Fund loans may be available. Small Community Wastewater Grants may be another source of funding for septic projects. Funds for improvements to agricultural lands are available through the Natural Resources Conservation Service.

Benefits of the Basin Plan Amendment
The benefit of implementing this TMDL would be overall water quality improvement of Sonoma Creek and its tributaries and achievement of the water quality objectives for contact recreational uses. Successful implementation of this TMDL would reduce pathogenic bacteria to levels deemed safe for water contact recreation. Implementation of this TMDL provides important human health benefits for which it would be speculative to assign a monetary benefit.

Sonoma Creek and its tributaries, with their many public parks, are important recreational resources. Successful implementation of the TMDL would provide improve water quality for many recreational uses including kayaking, swimming, wading, and other water activities. Improved water quality also contributes to tourism, which in turn benefits local businesses.

11. ENVIRONMENTAL CHECKLIST

1. Project Title:	Pathogens in Sonoma Creek Watershed Total Maximum Daily Load (TMDL) Basin Plan Amendment	
2. Lead Agency Name and Address:	California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, California 94612	
3. Contact Person and Phone Number:	Tina Low (510) 622-5682	Peter Krottje (510) 622-2382
4. Project Location:	Sonoma Creek watershed, San Francisco Bay Region	
5. Project Sponsor's Name and Address:	California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, California 94612	
6. General Plan Designation:	Not Applicable	
7. Zoning:	Not Applicable	

8. Description of Project:

The project is a proposed Basin Plan amendment to adopt a TMDL for pathogens in the Sonoma Creek Watershed. The project would involve numerous actions to reduce pathogen concentrations in Sonoma Creek and its tributaries. Additional details are provided in the explanation attached. The proposed Sonoma Creek Watershed TMDL applies to both Sonoma Creek and its tributaries.

9. Surrounding Land Uses and Setting:

The proposed Basin Plan amendment would affect all segments of the Sonoma Creek Watershed. Implementation would involve specific actions throughout the Watershed. The Sonoma Creek Watershed land uses include a mix of open space, grassland/rangeland, agriculture, and developed (residential, industrial, or commercial).

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

The California State Water Resources Control Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency must approve the proposed Basin Plan amendment.

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☒	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☒	☐
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. **Would the project:**				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒
III. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. **Would the project:**				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
III. AIR QUALITY—(cont.):				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
IV. BIOLOGICAL RESOURCES—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
IV. BIOLOGICAL RESOURCES—(cont.):				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒
V. CULTURAL RESOURCES—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☒	☐
b) Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to §15064.5?	☐	☐	☒	☐
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☒	☐
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☒	☐
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the state geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VI. GEOLOGY AND SOILS—(cont.):				
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS— Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☒
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VII. HAZARDS AND HAZARDOUS MATERIALS -- (cont.):				
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion of siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VIII. HYDROLOGY AND WATER QUALITY—(cont.):				
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures, which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation of seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	☒
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☒	☐
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XIII. PUBLIC SERVICES --				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:				
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒
XIV. RECREATION—				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION /TRAFFIC—Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☐	☐	☒
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XV. TRANSPORTATION /TRAFFIC–(cont.):				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☒	☐
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☒	☐
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☒	☐
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☒
b) Does the project have impacts that are individually limited, but cumulative considerable? ("Cumulative considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

11.1 Explanation

Project Description

The proposed project is a Basin Plan amendment to adopt a Total Maximum Daily Load (TMDL) for pathogens in the Sonoma Creek Watershed (see proposed Basin Plan amendment). The goal of the Basin Plan amendment is to improve environmental conditions. The Basin Plan amendment would include target density-based pathogen concentrations for Sonoma Creek and its tributaries, and assign wasteload allocations to achieve the targets. The TMDL implementation plan would involve numerous actions to achieve the targets and allocations. The Basin Plan amendment would affect all segments of the Sonoma Creek watershed, and implementation actions may occur throughout the Sonoma Valley in Sonoma County, California.

The proposed targets and allocations are measures of performance. The implementation plan outlines the Water Board's approach to meeting these measures of performance. To reduce pathogen concentrations in the Sonoma Creek Watershed, the plan describes actions the Water Board would take, actions expected of dischargers in the Watershed, and actions the Water Board might take to compel, as necessary, entities to comply with all applicable requirements. The Water Board would not directly undertake any actions that could physically change the environment, but adopting the proposed Basin Plan amendment could indirectly result in other parties (e.g., land owners, government entities, and special districts) undertaking projects to satisfy requirements derived from the Basin Plan amendment. These projects could physically change the environment. The adverse environmental impacts of such physical changes are evaluated below to the extent that they are reasonably foreseeable. Changes that are speculative in nature do not require environmental review.

Until the parties that must comply with requirements derived from the Basin Plan amendment propose specific projects, many physical changes cannot be anticipated. These specific projects could be subject to environmental review under the California Environmental Quality Act (CEQA), and CEQA compliance would be the responsibility of the lead agency for each project. The environmental reviews would identify any potentially significant adverse environmental impacts of the specific proposals, along with appropriate mitigation measures. Until such projects are proposed, however, identifying specific impacts and mitigation measures would require inappropriate speculation. Moreover, any mitigation deemed necessary by the lead agencies for those projects would not be within the jurisdiction of the Water Board to require.

<u>Direct and Indirect Physical Changes</u>

Table 18 summarizes the actions that could conceivably be undertaken if the proposed Basin Plan amendment were adopted, and explains the rationale for including them or not including them in this environmental review. The physical changes that require evaluation are those associated with (1) minor construction, (2) earthmoving and grading operations, and (3) waste handling and disposal. Although these activities are reasonably foreseeable, the implementation plan does not specify the nature of these

actions. Therefore, this analysis considers these actions in general programmatic terms. To illustrate the possible nature of these activities, some examples are described below.

Table 18. Implementation Actions Subject to Environmental Review

Possible Actions	Environmental Change Subject to Review
Pollution prevention/storm water management plan	Waste handling and disposal
Storm water treatment	Minor construction/waste handling and disposal
Storm sewer maintenance	Waste handling and disposal[1]
Inspections of existing septic systems, sewer systems, dairies, and grazing operations	None—No physical environmental change
Repair/Replace septic systems or sewer facilities	Earthmoving operations/waste handling and disposal[2]
Best Management Practices; fence construction, development of off-stream water sources	Minor Construction
Repair/Replace existing animal waste ponds	Earthmoving operations/waste handling and disposal[2]
Data collection and analysis	None—No physical environmental change

[1] The Basin Plan amendment may not increase maintenance, but maintenance activities may be targeted to maximize removal and disposal of collected waste.
[2] Earthmoving could include grading, sediment removal, capping, or other actions taken to prepare a site for wastewater treatment.

- *Minor Construction.* Basin Plan amendment-related construction activities would generally be small in scale. Most would relate to replacing or repairing existing wastewater treatment and disposal systems such as septic systems, dairy waste management ponds and/or manure stockpiles. In a few cases, new systems could be constructed, including sewer infrastructure and septic system leach fields. Animal facility operators could also choose to adopt best management practices (BMPs) that include retention or detention basins, separators, infiltration basins, or vegetated swales. Construction could also be undertaken to divert storm water flows. It is speculative to determine where these new systems will be located and whether any new system would require an independent review under CEQA. Individual landowners may also undertake minimal construction activities to reduce animal waste runoff including fence construction and off-creek water troughs. These would likely be limited to barbed wire fencing along portions of waterways.

- *Earthmoving Operations.* The Basin Plan amendment could result in the use of heavy equipment to move soils from one place to another. For example, construction or repair of sewer system or septic system facilities could include

grading, soil removal and disposal, soil containment, capping, slope stabilization, or landscaping. Recontouring animal facilities to redirect runoff flows could involve temporarily diverting creeks or other less disruptive soil movement.

- *Waste Handling and Disposal.* Human and animal waste requires disposal. Pollution prevention and outreach activities could encourage more collection of human and animal waste, which could increase the amount of waste requiring proper disposal. For example, programs could support the inspection of waste containment ponds or septic tanks, thereby increasing the need for maintenance and collection of such waste. In some cases, disposal could be arranged on site (e.g., by constructing a leach field or waste pond on site). In others, the waste could be transported to another site for disposal or further treatment. While implementation projects would reasonably collect more waste for proper disposal, the possible amount of this waste stream is unknown. The Basin Plan amendment would not affect the amount of waste generated, but additional waste could be collected.

These examples are not intended to be exhaustive or exclusive. As specific implementation proposals are developed and proposed, lead agencies will need to undertake environmental review and could identify specific environmental impacts and appropriate mitigation measures.

Changes Likely With or Without the Basin Plan Amendment

The implementation plan relies on some actions that will occur with or without the proposed Basin Plan amendment. Because these actions do not result from the Basin Plan amendment, environmental review is not included in this analysis. Some implementation actions for the Sonoma Creek Watershed are likely to occur with or without the proposed Basin Plan amendment because nutrient and sediment TMDLs are proposed to be developed for the Sonoma Creek watershed. Many of the actions intended to reduce nutrient and sediment loading to the Watershed will also reduce pathogen loading. Because the TMDLs are not yet developed, however, specific implementation details are unknown. Additional environmental review will occur as the nutrient and sediment TMDLs are completed.

Other actions likely to occur with or without the Basin Plan amendment include implementing Phase II of the storm water management plan pollution prevention program and implementation of existing programs such as technical assistance programs from the University of California Cooperative Extension, Southern Sonoma Resource Conservation District, Sonoma Ecology Center, and the Natural Resource Conservation Service. All these activities are already underway.

Changes Too Speculative to Evaluate

Several conceivable actions that could be taken as a result of the Basin Plan amendment require speculation and cannot be evaluated in this environmental review. Although the proposed Basin Plan amendment includes plans to implement management practices (MPs) for animal facilities, more site-specific information is needed before actual controls can be implemented. Therefore, specific actions are too

speculative to consider. Similarly, it would be speculative to determine whether implementation of MPs will cause any changes in the feasibility of maintaining the land in agricultural uses. Therefore, potential changes in land use are speculative and will not be evaluated. Lastly, as discussed above, even in cases in which some physical changes are foreseeable the exact nature of these changes is often speculative pending specific project proposals to be put forth by those subject to requirements derived from the Basin Plan amendment.

Environmental Analysis

The proposed Basin Plan amendment does not define the specific actions entities could take to comply with requirements derived from the Basin Plan amendment. As discussed above, physical changes resulting from the Basin Plan amendment are foreseeable, but the attributes of specific implementation actions (e.g., location, extent, etc.) are unknown, pending specific proposals to comply with Basin Plan amendment requirements. CEQA requires lead agencies to review the potential for their actions to result in adverse environmental impacts. CEQA further requires lead agencies to adopt feasible measures to mitigate potentially significant impacts. Therefore, the analysis below assumes that lead agencies would adopt mitigation measures necessary to address potentially significant impacts as long as appropriate measures are readily available. As explained below, mitigation measures are readily available to address all the foreseeable impacts of the Basin Plan amendment, including possible local agency actions to the extent that they can be anticipated. Therefore, the potential impacts of the proposed Basin Plan amendment would be less-than-significant.

An explanation for each box checked on the environmental checklist is provided below:

<u>I. Aesthetics</u>

a–b) Any physical changes to the aesthetic environment as a result of the Basin Plan amendment would be small in scale. Possible MPs that could be implemented on individual properties, such as fence construction or off-stream water troughs, are common practices that would have less-than-significant impact on the aesthetic environment. If specific construction projects were proposed to comply with requirements derived from the proposed Basin Plan amendment, local agencies would require environmental review and any necessary mitigation. Therefore, the proposed project would result in less-than-significant impact to scenic vistas and resources.

c–d) The Basin Plan amendment would not degrade the existing visual character or quality of any site or its surroundings. Potential minor construction (would be consistent with the open space and low density residential land uses in the area. It would not create any new source of light or glare.

II. Agriculture Resources

a–c) The Basin Plan amendment would not involve the conversion of farmland to non-agricultural use. It would not affect agricultural zoning or any Williamson Act contract.

III. Air Quality

a) Because the Basin Plan amendment would not cause any change in population or employment, it would not generate ongoing traffic-related emissions. It would also not involve the construction of any permanent emissions sources. For these reasons, no permanent change in air emissions would occur, and the Basin Plan amendment would not conflict with applicable air quality plans.

b) The Basin Plan amendment would not involve the construction of any permanent emissions sources or generate ongoing traffic-related emissions. Construction that would occur as a result of Basin Plan amendment implementation, including earthmoving operations, would be short-term. Fine particulate matter (PM_{10}) is the pollutant of greatest concern with respect to construction. PM_{10} emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved surfaces, and vehicle and equipment exhaust. If specific construction projects were proposed to comply with requirements derived from the proposed Basin Plan amendment, local agencies would require any necessary mitigation through their environmental reviews. The Bay Area Air Quality Management District has identified readily available measures to control construction-related air quality emissions (BAAQMD 1999). These measures include watering active construction areas; covering trucks hauling soil; paving, applying water, or applying soil stabilizers on unpaved areas; sweeping paved areas; and sweeping public streets. Lead agencies would ensure that appropriate emissions control measures are implemented. Therefore, the Basin Plan amendment would not violate any air quality standard or contribute substantially to any air quality violation, and its temporary construction-related air quality impacts would be less-than-significant.

c) Because the Basin Plan amendment would not generate ongoing traffic-related emissions or involve the construction of any permanent emissions sources, it would not contribute considerably to cumulative emissions.

d–e) Because the Basin Plan amendment would not involve the construction of any permanent emissions sources, it would not expose sensitive receptors to ongoing pollutant emissions posing health risks or creating objectionable odors.

IV. Biological Resources

a–d) The Basin Plan amendment is designed to benefit water quality. If, pursuant to the proposed Basin Plan amendment, specific projects were proposed that were to involve construction and earthmoving activities that could modify habitats, adversely affect special-status species, disturb riparian habitat or sensitive

natural communities, or affect federally protected wetlands or interfere substantially with movement of resident or migratory fish or wildlife species, these projects would be minor and temporary in nature. In such cases, local agencies would also conduct environmental review and identify necessary mitigation measures. Through the CEQA and permitting processes, lead agencies would ensure that readily available mitigation measures are implemented, such as avoiding or, if feasible, relocating or replacing sensitive habitat. Fences that may be constructed are designed to restrict cattle without impeding wildlife movement. Therefore, the Basin Plan amendment would not substantially affect habitats, special-status species, sensitive communities, wetlands, wildlife movement, migratory corridors, or nurseries and its review would ensure that readily available measures are implemented, such as avoiding construction during the breeding season, avoiding sensitive habitat areas, and minimizing disturbances. Therefore, the Basin Plan amendment would not substantially affect habitats, special-status species, sensitive communities, wetlands, migratory corridors, or nurseries, and its impacts would be less-than-significant.

e–f) If, pursuant to Basin Plan amendment requirements, specific projects were proposed that were to involve construction or earthmoving activities, then local agencies would develop such proposals in accordance with their own local policies and ordinances, including any applicable habitat conservation plans, natural community conservation plans, or other plans intended to protect biological resources. Therefore, the Basin Plan amendment would not conflict with local policies, ordinances, or adopted plans.

V. Cultural Resources

a–d) Local agencies could propose specific projects involving earthmoving or construction to comply with requirements derived from the proposed Basin Plan amendment. Construction would generally be small in scale, and earthmoving would likely occur in areas already disturbed by recent human activity. If necessary to protect historical, archaeological, or paleontological resources, local agencies would require mitigation through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as requiring a trained professional to observe major earthmoving work and stop the work if evidence of cultural resources is discovered. Therefore, the Basin Plan amendment would not substantially affect any cultural resource, and its impacts would be less-than-significant.

VI. Geology and Soils

a) The Basin Plan amendment would not involve the construction of habitable structures; therefore, it would not involve any human safety risks related to fault rupture, seismic ground-shaking, ground failure, or landslides.

b) Local agencies could propose specific projects involving earthmoving or construction activities to comply with requirements derived from the proposed Basin Plan amendment. To meet the proposed Basin Plan amendment targets, construction would be designed to reduce overall soil erosion and pathogen loads associated with erosion. However, temporary earthmoving operations could result in short-term erosion. Local agencies would require necessary mitigation measures through their environmental review and grading permit processes. Lead agencies would ensure that readily available measures are implemented, such as dust suppression (e.g., spraying water), use of erosion control BMPs, and proper construction site management. In addition, construction projects over one acre in size would require a general construction National Pollutant Discharge Elimination System permit and implementation of a storm water pollution prevention plan. Therefore, the Basin Plan amendment would not result in substantial soil erosion, and its impacts would be less-than-significant.

c–d) The Basin Plan amendment would not involve the construction of habitable structures, and any construction would be relatively small in scale. Local agencies proposing construction to comply with requirements derived from the Basin Plan amendment would undertake engineering and environmental studies to ensure that they do not locate structures on unsuitable soil, including expansive soil. Construction would be designed to minimize any potential for landslides, lateral spreading, subsidence, liquefaction, or collapse. Therefore, the Basin Plan amendment would not create safety or property risks due to unstable or expansive soil.

e) The purpose of the Basin Plan amendment is to ensure that existing wastewater systems are properly designed and functioning. Activities include increased inspections of such facilities and repair/replacement of existing facilities. Such activities would not place new septic tanks or other wastewater disposal systems in unsuitable soils. Therefore, the Basin Plan amendment would not affect the capability to adequately support wastewater disposal systems.

VII. Hazards and Hazardous Materials

a–h) This Basin Plan amendment would not affect the transportation or potential release of hazardous materials, nor create a significant public or environmental hazard beyond any hazards currently in existence. Basin Plan amendment-related activities would not interfere with any emergency response plans or emergency evacuation plans and would not affect the potential for wildland fires.

VIII. Hydrology and Water Quality

a) The project would amend the Basin Plan, which articulates applicable water quality standards; therefore, it would not violate standards or waste discharge requirements.

b) The Basin Plan amendment would not decrease groundwater supplies or interfere with groundwater recharge. Construction of facilities such as retention or detention basins, infiltration basins, or vegetated swales could increase groundwater recharge.

c) Local agencies could propose specific projects involving earthmoving or construction activities to comply with requirements derived from the proposed Basin Plan amendment. Such projects could affect existing drainage patterns. However, to meet the proposed Basin Plan amendment targets, they would be designed to reduce overall soil erosion and pathogen loads associated with erosion. Nevertheless, temporary earthmoving operations could result in short-term erosion. If necessary to address specific impacts, local agencies would require mitigation measures through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as dust suppression (e.g., spraying water), use of erosion control MPs, and proper construction site management. In addition, construction projects over one acre in size would require a general construction National Pollutant Discharge Elimination System permit and implementation of a storm water pollution prevention plan. Therefore, the Basin Plan amendment would not result in substantial erosion, and its impacts would be less-than-significant.

d) The Basin Plan amendment could involve some earthmoving operations that could affect existing drainage patterns, but Basin Plan amendment-related activities would not substantially increase the amount of impervious surfaces in any watershed. Therefore, the Basin Plan amendment would not increase the rate or amount of runoff, or result in flooding.

e–f) Basin Plan amendment-related activities would not substantially increase the amount of impervious surfaces in any watershed. Therefore, the Basin Plan amendment would not increase the rate or amount of runoff, or exceed the capacity of storm water drainage systems. Because the proposed Basin Plan amendment is intended to reduce pathogen-laden runoff, it would not be a source of new polluted runoff, or degrade water quality.

g–i) Basin Plan amendment-related construction would be small in scale and would not include housing or structures that would pose or be subject to flood hazards.

j) Basin Plan amendment-related construction would not be subject to substantial risks due to inundation by seiche, tsunami, or mudflow.

IX. Land Use and Planning

a) Basin Plan amendment-related construction would be limited to existing open space and grazing areas and would be too small in scale to divide any established community.

b–c) The Basin Plan amendment would not conflict with any land use plan, policy, or regulation, and would not conflict with any habitat conservation plan or natural community conservation plan.

X. Mineral Resources

a–b) Basin Plan amendment-related earthmoving (i.e., excavation) and construction would be relatively small in scale and would not result in the loss of availability of any known mineral resources.

XI. Noise

a) Earthmoving and construction could temporarily generate noise. Projects that local agencies propose to comply with requirements derived from the Basin Plan amendment would be consistent with the local agencies' own standards.

b) To comply with requirements derived from the Basin Plan amendment, local agencies could propose specific projects involving earthmoving or construction, which could result in temporary groundborne vibration or noise. If necessary, local agencies could require mitigation measures through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as restricting the hours of operations and ensuring that earthmoving equipment is equipped with mufflers to reduce noise. Therefore, the Basin Plan amendment would not result in substantial noise, and its impacts would be less-than-significant.

c) The Basin Plan amendment would not cause any permanent increase in ambient noise levels. Any noise would be short-term.

d) To comply with requirements derived from the Basin Plan amendment, local agencies could propose specific projects involving earthmoving or construction, which could result in temporary increases in ambient noise levels in excess of noise levels without the Basin Plan amendment. Noise-generating operations would comply with local noise minimization requirements, including local noise ordinances. If necessary, local agencies could require that noise reduction mitigation measures are implemented, such as restricting the hours of noise-generating operations. Therefore, the Basin Plan amendment would not result in substantial noise, and its impacts would be less-than-significant.

e–f) The Basin Plan amendment would not cause any permanent increase in ambient noise levels, including aircraft noise. Therefore, it would not expose people living within an area subject to an airport land use plan or in the vicinity of a private airstrip to excessive noise.

XII. Population and Housing

a–c) The Basin Plan amendment would not affect the population of the Sonoma Creek Watershed. It would not induce growth through such means as constructing new housing or businesses, or by extending roads or infrastructure. The Basin Plan amendment would also not displace any existing housing or any people that would need replacement housing.

XIII. Public Services

a) The Basin Plan amendment would not affect populations or involve construction of substantial new government facilities. The Basin Plan amendment would not affect service ratios, response times, or other performance objectives for any public services, including fire protection, police protection, schools, or parks.

XIV. Recreation

a–b) Because the Basin Plan amendment would not affect population levels, it would not affect the use of existing parks or recreational facilities. No recreational facilities would need to be constructed or expanded.

XV. Transportation /Traffic

a–b) Because the Basin Plan amendment would not increase population or provide employment, it would not generate any ongoing motor vehicle trips. Earthmoving and construction would be temporary, and related traffic would be of short-term duration. Therefore, the Basin Plan amendment would not substantially increase traffic in relation to existing conditions. Levels of service would be unchanged.

c) The Basin Plan amendment would not affect air traffic.

d) Because the Basin Plan amendment would not affect any roads or the uses of any roads, it would not result in hazardous design features or incompatible uses.

e) The small-scale construction that could occur as a result of the Basin Plan amendment would not likely restrict emergency access. Local agencies would confirm that specific proposals would not restrict emergency access through their environmental reviews.

f) Because the Basin Plan amendment would not increase population or provide employment, it would not affect parking demand or supply.

g) Because the Basin Plan amendment would not generate ongoing motor vehicle trips, it would not conflict with adopted policies, plans, or programs supporting alternative transportation.

XVI. Utilities and Service Systems

a) The project would amend the Basin Plan, which is the basis for wastewater treatment requirements in the Bay Area; therefore, the Basin Plan amendment would be consistent with such requirements.

b) Because the Basin Plan amendment would not affect water demands or supplies, it would not require the construction of new or expanded water facilities. To comply with requirements derived from the proposed Basin Plan amendment, local agencies could propose to repair older facilities or construct new facilities. However, such construction would not pose any adverse impacts not otherwise discussed in this analysis. Local agencies could require necessary mitigation measures through their environmental reviews, and as described throughout this analysis, all potential impacts can be mitigated to less-than-significant levels. Because lead agencies would ensure that readily available measures are implemented, the impacts of constructing storm water facilities would be less-than-significant.

c) To comply with requirements derived from the proposed Basin Plan amendment, local agencies could propose to construct some new or expanded urban runoff management facilities. However, such construction would not pose any adverse impacts not otherwise discussed in this analysis. Local agencies could require necessary mitigation measures through their environmental reviews, and as described throughout this analysis, all potential impacts can be mitigated to less-than-significant levels. Because lead agencies would ensure that readily available measures are implemented, the impacts of constructing storm water facilities would be less-than-significant.

d) Because the Basin Plan amendment would not increase population or provide employment, it would not require an ongoing water supply. It would also not require ongoing wastewater treatment services.

e) Basin Plan amendment implementation would comply with federal, state, and local wastewater treatment requirements. Pollution prevention and outreach activities could divert pathogen-containing waste from improper leaching into the environment toward proper disposal facilities. Therefore, it is possible that repair to existing wastewater facilities may be required or facility capacity may need to be expanded. However, such construction would not pose any adverse impacts not otherwise discussed in this analysis. Local agencies could require necessary mitigation measures through their environmental reviews, and as described throughout this analysis, all potential impacts can be mitigated to less-than-significant levels. Because lead agencies would ensure that readily available measures are implemented, the impacts of repairing or expanding wastewater facilities would be less-than-significant.

f–g) The Basin Plan amendment would not substantially affect municipal solid waste generation or landfill capacities.

XVII. Mandatory Findings of Significance

a) When taken as a whole, the Basin Plan amendment would not degrade the quality of the environment. The proposed Basin Plan amendment is intended to benefit human health by decreasing pathogen concentrations in the Sonoma Creek Watershed.

b) As discussed above, the Basin Plan amendment could pose some less-than-significant adverse environmental impacts related to earthmoving and construction operations. These impacts would be individually limited, and most would be short-term. As specific implementation proposals are developed and proposed, lead agencies would undertake environmental review and identify specific environmental impacts and appropriate mitigation measures. For cases in which potential impacts could be significant, local lead agencies would adopt readily available mitigation measures to ensure that possible impacts would be less-than-significant. Therefore, the incremental effects of the Basin Plan amendment are inconsequential. For this reason, the Basin Plan amendment's cumulative effects would be less-than-significant, and adopting the Basin Plan amendment would require no mandatory findings of significance.

c) The Basin Plan amendment would not cause any substantial adverse effects to human beings, either directly or indirectly. The Basin Plan amendment is intended to benefit human health by decreasing pathogen concentrations.

12. GLOSSARY

Bacteria: Single-celled microorganisms that lack a cell nucleus and contain no chlorophyll. Bacteria of the coliform and enterococcus groups are considered the primary indicators of fecal contamination and are often used to assess water quality.

Beneficial uses: Designated uses of water, including, but are not limited to, domestic, municipal, agricultural, and industrial water supply; power generation; recreation; aesthetic enjoyment; navigation; preservation and enhancement of fish, wildlife, and other aquatic resources and preserves. (California Water Code [CWC] section 13050[f])

Best management practices (BMPs): Methods, measures, or practices formally adopted by an agency to meet its nonpoint source control needs. BMPs include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. See management practices (MPs).

Catchment area: The area draining into a lake, reservoir, or stream; contributing watershed.

Coliform bacteria: See total coliform bacteria.

Colony-forming unit (CFU): A single bacterial cell capable of reproducing and giving a positive test response in the laboratory. As used in this document, CFU is functionally synonymous with “bacteria count.”

Discharge: Flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to the discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Effluent: Municipal sewage or industrial liquid waste (untreated, partially treated, or completely treated) that flows out of a treatment plant, septic system, pipe, and the like.

Enterococci: A subgroup of the fecal streptococci that includes S. faecalis and S. faecium. The enterococci are differentiated from other streptococci by their ability to grow in 6.5 percent sodium chloride, at pH 9.6, and at 10°C and 45°C. Enterococci are a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters.

Escherichia coli: A subgroup of the fecal coliform bacteria. *E. coli* is part of the normal intestinal flora in humans and animals and is therefore, a direct indicator of fecal contamination in a waterbody. The O157 strain, sometimes transmitted in contaminated

waterbodies, can cause serious infection, resulting in gastroenteritis. See also fecal coliform bacteria.

Fecal coliform bacteria: A subset of total coliform bacteria that are present in the intestines or feces of warm-blooded animals. They are often used as indicators of the sanitary quality of water. They are measured by running the standard total coliform test at an elevated temperature (44.5°C). Fecal coliform constitute up to approximately 20 percent of total coliform in fecally-contaminated samples. See also total coliform bacteria.

Gastroenteritis: An inflammation of the stomach and the intestines.

Geometric mean: Mathematically defined as the nth root of the product of *n* factors. Geometric mean can also be described as the antilog of the mean of the logs of a group of numbers—that is, calculate the logarithms of your original measured values, calculate the mean of the logarithms, and calculate the antilogarithm of the mean. Geometric mean is regarded as more meaningful for describing bacteria water quality data than the simpler arithmetic mean.

Indicator: Measurable quantity that can be used to evaluate the relationship between pollutant sources and their impact on water quality.

Indicator organism: Organism used to indicate the potential presence of other (usually pathogenic) organisms. Indicator organisms are typically associated with the other organisms, but are usually more easily sampled and measured.

Load allocation (LA): The portion of a receiving waterbody's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

Loading capacity (LC): The greatest amount of loading that a waterbody can receive without violating water quality standards. The LC equals the TMDL.

Management practices (MPs): Methods, measures, or practices designed to control nonpoint source pollution. MPs are distinguished from BMPs in that BMPs have been formally adopted by a regulatory agency to meet pollution control needs, while MPs may not have been formally adopted. MPs include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. MPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters.

Margin of safety (MOS): A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody (CWA section 303[d][1][C]).

Most probable number (MPN): A assay procedure that yields a statistically estimated bacterial count for a sample. MPN is often used as the reporting unit for these assays, in which case it is functionally synonymous with “bacteria count.”

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits for point sources, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Nonpoint source: Pollution sources that are diffused and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by stormwater runoff. Commonly used categories for nonpoint sources are agriculture, forestry, urban, mining, construction, land disposal, and saltwater intrusion.

Pathogen: A microorganism capable of causing disease.

Point source: Any discernible, confined, and discrete conveyance including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigation agriculture or agricultural stormwater runoff (40 CFR 122.2).

Protozoa: Single-celled organisms that reproduce by fission and occur primarily in the aquatic environment. Waterborne pathogenic protozoans of primary concern include Giardia lamblia and Cryptosporidium, both of which affect the gastrointestinal tract.

Septic system: An on-site system designed to treat domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent. Sludge that remains after decomposition of the solids by bacteria in the tank must be pumped out periodically.

Stakeholder: Those parties likely to be affected by, or that can affect, the TMDL.

Total coliform bacteria: A particular group of bacteria, found in the feces of warm-blooded animals that are used as indicators of possible sewage pollution. They are characterized as aerobic or facultative anaerobic, gram-negative, non spore-forming, rod-shaded bacteria that ferment lactose with gas formation within 48 hours at 35° C. Note that the total coliform group also includes many common soil bacteria, which do not indicate fecal contamination. See also fecal coliform bacteria.

Total Maximum Daily Load (TMDL): The pollutant load that a waterbody can receive and still meet water quality standards. The TMDL is the sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, and a margin of safety (MOS). TMDLs can be expressed in terms

of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standards.

Virus: Submicroscopic pathogen consisting of a nucleic acid core surrounded by a protein coat. Requires a host in which to replicate (reproduce).

Waste load Allocation (WLA): The portion of a receiving waterbody's loading capacity that is allocated to one of its existing or future point sources of pollution.

Wastewater treatment: Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

Water Quality Criteria: Elements of water quality standards expressed as constituent concentrations, levels, or a narrative statement, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use. In California, water quality criteria are referred to as water quality objectives (WQO).

Water quality objective (WQO): See water quality criteria.

Water Quality Standard (WQS): Provisions of state and federal law that consist of: 1) a designated use or uses for the waters of the United States; 2) water quality criteria for such waters to protect such uses; and 3) statements to prohibit degradation (antidegradation policy). Water quality standards are to protect public health or welfare, enhance the quality of the water, and serve the purpose of the Clean Water Act (40 CFR 131.3).

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

13. REFERENCES

Association of Bay Area Governments. 1996. Bay Area Spatial Information System (BASIS) files for existing land use in 1995 for the San Francisco Bay Area (GIS layer). Oakland, CA.

——— 2000. Bay Area Spatial Information System (BASIS) files for existing land use in 2000 for the San Francisco Bay Area (GIS layer). Oakland, CA.

American Public Health Association, 1998. *Standard Methods for the Examination of Water and Wastewater*. 20th Edition. Washington, DC.

Atwill, E.R. 1995. *Microbial Pathogens Excreted by Livestock and Potentially Transmitted to Humans Through Water*. Veterinary Medicine Teaching and Research Center. School of Veterinary Medicine. University of California, Davis.

California Environmental Protection Agency, State Water Resources Control Board. 2004. *Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program.*

California State Water Resources Control Board and California Coastal Commission. January 2000. *Plan for California's Nonpoint Source Pollution Control Program.*

California Regional Water Quality Control Board, Central Coast Region. 2002*. Support Document for Morro Bay Total Maximum Daily Load for Pathogens.*

California Regional Water Quality Control Board, Santa Ana Region. 1998. *Total Maximum Daily Load for Fecal Coliform Bacteria in Newport Bay, California.*

California Regional Water Quality Control Board, San Francisco Bay Region. 1995. *Water Quality Control Plan.* Oakland, Calif.

——— 2005a. *Pathogens in Tomales Bay Watershed: Total Maximum Daily Load (TMDL).* Proposed Basin Plan Amendment and Staff Report*.* Oakland, Calif.

——— 2005b. *Total Maximum Daily Load for Pathogens in the Napa River Watershed—Project Report.* Oakland, Calif.

California Regional Water Quality Control Board, San Francisco Region in Cooperation with Bay Area Clean Water Agencies, 2005. *Sewer System Management Plan (SSMP) Development Guide*

Economic and Planning Systems. 2003. *West Marin Septic Management Organizational Options and Feasibility Analysis* (Draft Report).

Havelaar A.H. 1993. Bacteriophages as models of human enteric viruses in the environment. Journal of American Society of Microbiology News 59, No. 12: 614–619.

Hymanson, Z., and G. Dombeck. 1997. Water quality. In *A Day on Sonoma Creek, March 1, 1997.* Proceedings of a seminar held in Sonoma, Ca on March 1, 1997. Sonoma Ecology Center, Glen Ellen, CA.

Lapointe, B.E., O'Connell, J.D., and Garrett, G.S., 1990. Nutrient couplings between on-site sewage disposal systems, groundwaters, and nearshore surface waters of the Florida Keys. Biogeochemistry 10, 289-307.

Lewis, L, 2004. Director of Marin County Stormwater Program, personal communication with Water Board staff, July 23.

Ng, R.. 2006. Well and Septic Supervisor, Sonoma County Permit and Resource Management Department. Personal communication with Water Board staff, January 17, 2006.

Noble, R.T., M.K. Leecaster, C. D. McGee, D.F. Moore, V. Orozco-Borbon, K. Schiff, P.M. Vainik, and S.B. Weisberg. 2000. *Southern California Bight Regional Monitoring Program: Storm Event Shoreline Microbiology.* Southern California Coastal Water Research Project. Westminster, CA.

Santa Domingo, J.W., S.B. Simpson, S.B. Weisberg, J. Griffith, G. Stelma, A.P. Dufour, G. Scott, and D. J. Reasoner. 2002. Microbiological Source Tracking: Where are we now and where are we going?"Paper presented at the National TMDL Science and Policy 2002 Specialty Conference.

SAS Institute, 1995. *JMP Statistics and Graphics Guide.* SAS Institute, Inc., Cary, N.C.

Smith, P.. 2004. Director, Marin County Environmental Health Services, personal communication with Water Board staff, July 9, 2004.

Sonoma Ecology Center, with Stillwater Sciences and UC Berkeley, Department of Earth and Planetary Sciences, 2004. Sonoma Creek Watershed Limiting Factors Analysis (Draft), December 2004, pgs. 1-11, ES-1 through ES-14.

Sonoma County Water Agency. 1977. *Surface Runoff Management Plan for the Petaluma River and Sonoma Creek Watershed Basins.* Sonoma County Water Agency. Santa Rosa, CA.

Stoeckel, D.M, M.V. Mathes, K.E. Hyer, C.Hagedorn, H. Kator, J. Lukasik, T.L. O'Brien, T.W. Fenger, M. Samadpour, K.M. Strickler, and B.A. Wiggins. 2004. *Comparison of Seven Protocols To Identify Fecal Contamination Sources Using Escherichia coli.* Environ. Sci. Technol., 38 (22), 6109 -6117.

U.S. Department of Agriculture, 1972. Soil Survey Sonoma County California. United States Department of Agriculture, Forest Service and Soil Conservation Service, May 1972. 188pp. plus maps and tables.

U.S. Environmental Protection Agency. 1986. *Ambient Water Quality Criteria for Bacteria—1986.* EPA-440/5-84-002. Washington, DC: Office of Water.

----------1993. *Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems.* EPA 600-R-92-238.

---------- 1999. *Protocol for Developing Nutrient TMDLs. First Edition.* EPA 841-B-99-007.

——— 2001. *Protocol for Developing Pathogen TMDLs*. 1st Edition. EPA-841-R-00-002. Washington, DC: Office of Water.

——— 2002. *Draft Implementation Guidance for Ambient Water Quality Criteria for Bacteria. May 2002 Draft*. EPA-8230-B-02-003. Washington, DC: Office of Water.

——— 2003. *Draft Implementation Guidance for Ambient Water Quality Criteria for Bacteria. November2003 Draft*. EPA-8230-B-02-XXX. Washington, DC: Office of Water.