# Peer Review Draft Staff Report

**for the**

**Action Plan**
**for the**
**Russian River Watershed**
**Pathogen Indicator Bacteria**
**Total Maximum Daily Load**


January 16, 2015
California Regional Water Quality Control Board
North Coast Region

Adopted by the
California Regional Water Quality Control Board
North Coast Region
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on __________, 201x
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on __________,201x
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on ___________. 201x

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## LIST OF ACRONYMS & SHORT HAND NAMES

| | |
|---|---|
| Basin Plan | Water Quality Control Plan for the North Coast Region |
| BMP | Best Management Practice |
| BAV | Beach Action Value |
| CAFO | Confined Animal Feeding Operation |
| Caltrans | California Department of Transportation |
| CDFW | California Department of Fish and Wildlife |
| CDHCD | California Department of Housing and Community Development |
| CDPH | California Department of Public Health |
| CEQA | California Environmental Quality Act |
| CIWQS | California Integrated Water Quality System |
| cfu | colony forming units |
| CSD | Community Service District |
| CWA | Clean Water Act |
| CWC | California Water Code |
| DNA | Deoxyribonucleic acid |
| EIR | Environmental Impact Report |
| I/I | inflow and infiltration |
| Impaired Waters Policy | California Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options |
| gpd | gallons per day |
| mgd | million gallons per day |
| MPN | Most Probably Number |
| MOS | Margin of Safety |
| MS4 | Municipal Separate Storm Sewer Systems |
| NGI | Near Gastrointestinal Illness (includes diarrhea without the requirement of a fever) |
| NOAA Fisheries | National Oceanic and Atmospheric Administration, National Marine Fisheries Service |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Non-point Source |
| NRCS | Natural Resources Conservation Service |
| OWTS | Onsite Wastewater Treatment Systems |
| qPCR | Quantitative Polymerase Chain Reaction |
| REC-1 | Water Contact Recreation Beneficial Use |
| REC-2 | Non-Contact Water Recreation Beneficial Use |
| Regional Water Board | North Coast Regional Water Quality Control Board |
| RCD | Resource Conservation District |
| rRNA | Ribosomal Ribonucleic Acid |
| ROWD | Report of Waste Discharge |
| SSO | Sanitary Sewer Overflow |
| State Water Board | State Water Resources Control Board |
| STV | Statistical Threshold Value |
| TMDL | Total Maximum Daily Load |

U.S. EPA ........................................ United States Environmental Protection Agency
USFS ............................................... United States Forest Service
USFWS........................................... United States Fish and Wildlife Service
WDRs............................................. Waste Discharge Requirements
WWTP........................................... Wastewater Treatment Plant

# CHAPTER 1
# INTRODUCTION

## 1.1 PURPOSE

The purpose of this Staff Report is to present the supporting information for the *Action Plan for the Russian River Watershed Pathogen Indicator Bacteria Total Maximum Daily Load* (Action Plan). The Action Plan will be presented as an amendment to the *Water Quality Control Plan for the North Coast Region*, which is also known as the Basin Plan.

The purposes of the Action Plan for the Russian River Total Maximum Daily Load (TMDL) are four-fold:

1. To improve the bacteriological quality of the surface waters in the Russian River Watershed so that water quality standards are attained and the beneficial use of water contact recreation is fully supported.

2. To set limits on the amount of bacterial discharges from non-natural controllable sources into the surface waters of the Russian River Watershed in order to attain water quality standards. *E. coli*, *Bacteroides*, and fecal coliform bacteria TMDLs are set at levels to attain the Bacteria Water Quality Objective and protect the water contact recreation use.

3. To describe the implementation actions that are necessary to reduce bacteria concentrations to levels that meet water quality standards.

4. To describe the monitoring actions that are necessary to ensure that implementation actions result in attainment of water quality standards.

## 1.2 REGULATORY FRAMEWORK

Several laws and regulations govern the development and implementation of TMDLs, most notably the federal Clean Water Act (CWA) and the state Porter-Cologne Water Quality Control Act. This section describes the framework and context of these laws and regulations for the Russian River TMDL.

### 1.2.1 IMPAIRED WATERBODIES

Section 303(d) of the CWA requires states to develop a list of waterbodies where required pollution control mechanisms (e.g., primary treatment of wastewater) are not sufficient or stringent enough to meet water quality standards applicable to such waters.

Data collected as part of this TMDL project indicate that all surface stream and river reaches in the Russian River Watershed are impaired by pathogen indicator bacteria. The watershed-wide pathogen indicator bacteria impairment does not apply to lakes and reservoirs, which were not sampled nor assessed as part of this TMDL project. Table 1.1

shows the waterbodies listed as impaired for indicator bacteria on the 2012 303(d) List[1], as well as impaired waterbodies that are not yet listed. All the waterbodies in the table are assigned TMDLs to address indicator bacteria impairments in this project. Waterbody-pollutant pairs that are not currently on the 2012 303(d) List will be proposed for addition to the 2018 303(d) List.

### 1.2.2 TMDL & BASIN PLAN AMENDMENT DEVELOPMENT

The federal Clean Water Act requires states to address impaired waters by developing a TMDL, fully implementing existing programs, or implementing additional water quality programs that will result in the attainment of water quality standards. Regional Water Board staff determined that development of TMDLs and an implementation plan are required to address the bacteriological impairment of the Russian River Watershed. The TMDLs and implementation plan are contained in the *Action Plan for the Russian River Watershed Pathogen Indicator Bacteria Total Maximum Daily Load,* which is proposed as a Basin Plan amendment.

The Basin Plan identifies the beneficial uses of water within the North Coast Region, the water quality objectives necessary to protect those uses, implementation programs that ensure objectives are attained, and monitoring programs. The specific requirements for basin plans are described in the California Water Code (also known as the Porter-Cologne Water Quality Control Act), Division 7, Article 3, sections 13240 to 13247.

A Basin Plan amendment is appropriate for the Russian River Watershed Pathogen Indicator Bacteria TMDL because attainment of the loading capacity and water quality standards will require multiple implementation actions. The California Administrative Procedures Act and the State's *Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options* (Impaired Waters Policy) require the use of a Basin Plan amendment to tie together numerous actions by the Regional Water Board to ensure that persons subject to regulations have the opportunity to participate in the process of developing the implementation plan.

Through the Basin Plan amendment process, the Regional Water Board meets the requirements of the California Environmental Quality Act (CEQA) to analyze and disclose environmental effects. Because the basin planning process is certified as an exempt regulatory program meeting the requirements of Public Resources Code section 21080.5 (Cal. Code Regs., tit.14, § 15251), the Regional Water Board is not required to prepare an initial study, a Negative Declaration, or an Environmental Impact Report. Instead, the basin planning process uses substitute environmental documentation. This Staff Report is a critical part of that documentation as it includes the required environmental analysis.

[1] The 2012 303(d) List is not final. The list has been adopted by the Regional Water Board, but needs to be considered by the State Water Board and the USEPA prior to taking effect.

**Table 1.1. Waterbodies Impaired by Indicator Bacteria Addressed by this TMDL Project**

| Count | Waterbody Name | | | 2012 303(d) Listed | Impairment Identified / Confirmed by the TMDL |
|---|---|---|---|---|---|
| | Hydrologic Area | Hydrologic Sub Area | Listing Extent | | |
| 1 | Upper Russian R. | Coyote Valley | Entire Waterbody | N | Y |
| 2 | Upper Russian R. | Forsythe Creek | Entire Waterbody | N | Y |
| 3 | Upper Russian R. | Ukiah | Entire Waterbody | N | Y |
| 4 | Middle Russian R. | Big Sulphur Creek | Entire Waterbody | N | Y |
| 5 | Middle Russian R. | Warm Springs | Entire Waterbody | N | Y |
| 6 | Middle Russian R. | Geyserville | Stream 1 (unnamed tributary) on Fitch Mountain | Y | Y |
| | | | Entire Waterbody | N | Y |
| 7 | Middle Russian R. | Laguna de Santa Rosa | Mainstem Laguna de Santa Rosa | Y | Y |
| 8 | Middle Russian R. | Laguna de Santa Rosa | Tributaries to the Laguna de Santa Rosa Except Santa Rosa Creek | Y | Y |
| 9 | Middle Russian R. | Santa Rosa Creek | Mainstem Santa Rosa Creek | Y | Y |
| 10 | Middle Russian R. | Santa Rosa Creek | Tributaries to Santa Rosa Creek | Y | Y |
| 11 | Middle Russian R. | Mark West Creek | Mainstem Mark West Creek Downstream of the Confluence with the Laguna de Santa Rosa | N | Y |
| 12 | Middle Russian R. | Mark West Creek | Mainstem Mark West Creek Upstream of the Confluence with the Laguna de Santa Rosa | N | Y |
| 13 | Middle Russian R. | Mark West Creek | Tributaries to Mark West Creek Except Windsor Creek | N | Y |
| 14 | Middle Russian R. | Mark West Creek | Windsor Creek and its Tributaries | N | Y |
| 15 | Lower Russian R. | Guerneville | Mainstem Russian River at Veterans Memorial Beach from the Railroad Bridge to Hwy 101 | Y | Y |
| | | | Mainstem Russian River from Fife Creek to Dutch Bill Creek | Y | Y |
| | | | Mainstem Dutch Bill Creek | Y | Y |
| | | | Green Valley Creek Watershed | Y | Y |
| | | | Entire Waterbody | N | Y |
| 16 | Lower Russian R. | Austin Creek | Entire Waterbody | N | Y |

The Staff Report, Action Plan, and substitute environmental documentation will be presented before the Regional Water Board at a public hearing for the purpose of adopting the Action Plan as an amendment to the Basin Plan. Should the Regional Water Board adopt the Action Plan, the State Water Resources Control Board (State Water Board) will hold a hearing to consider approving the decision of the Regional Water Board. California's Office of Administrative Law provides a final legal review before the TMDL Staff Report and Action Plan are forwarded to the U.S. EPA. The U.S. EPA approves only the technical TMDL, not the implementation plan components. The TMDL and implementation plan components take effect upon approval of the Action Plan by the Office of Administrative Law.

## 1.3 WATERSHED DESCRIPTION & ENVIRONMENTAL SETTING

The Russian River Watershed encompasses 1,484 square miles (949,600 acres) in Sonoma and Mendocino counties, California (Figure 1.1). Major municipalities within the watershed include Santa Rosa, Rohnert Park, Windsor, Healdsburg, Sebastopol, Cloverdale, and Ukiah. The watershed also includes numerous unincorporated communities such as, Forestville, Guerneville, Monte Rio, Hopland, and Calpella.

The Watershed Boundary Dataset (WBD) defines drainage areas in a multi-level, hierarchical drainage system. The Russian River Watershed is considered a "Subbasin" in the WBD as a Hydrologic Unit Code (HUC) 8 subbasin. The WBD defines the next hierarchical level as "Watersheds" (HUC 10), which are listed Table 1.2 and shown in Figure 1.2.

### 1.3.1 HYDROLOGY

The Russian River Watershed is hydrologically and geomorphologically diverse, containing 238 streams, 23 named springs, 14 natural lakes, 15 named reservoirs, all or portions of 13 groundwater basins, steep ridges, ephemeral streams, rolling hills, and wide alluvial valleys. The Russian River, in conjunction with Lake Mendocino and Lake Sonoma, serves as the primary water source for more than 500,000 residents in Mendocino, Sonoma and Marin counties, and for agricultural production in Mendocino and Sonoma counties. Lake Mendocino, located on the East Fork of the Russian River, has a capacity of 118,900 acre-feet and captures a drainage area of about 105 square miles. Lake Sonoma, located at the confluence of Warm Springs Creek and Dry Creek, about 14 miles northwest of the city of Healdsburg, has a capacity of 381,000 acre-feet and captures a drainage area of about 130 square miles.

The Russian River drainage basin includes all of the tributaries to the river and is affected by the interactions between the hillslopes, the channel, and its floodplain. Sediment produced in the headwaters of the Russian River basin is stored in the channel or in reservoirs, extracted as aggregate, or transported toward the Pacific Ocean. The main channel of the Russian River flows through a series of wide alluvial valleys separated by relatively narrow bedrock constrictions. These bedrock constrictions act as geologic controls such that each alluvial valley is relatively independent with respect to adjustments in slope, width and depth (Florsheim and Goodwin 1995).


Figure 1.1: Russian River Watershed Overview Map

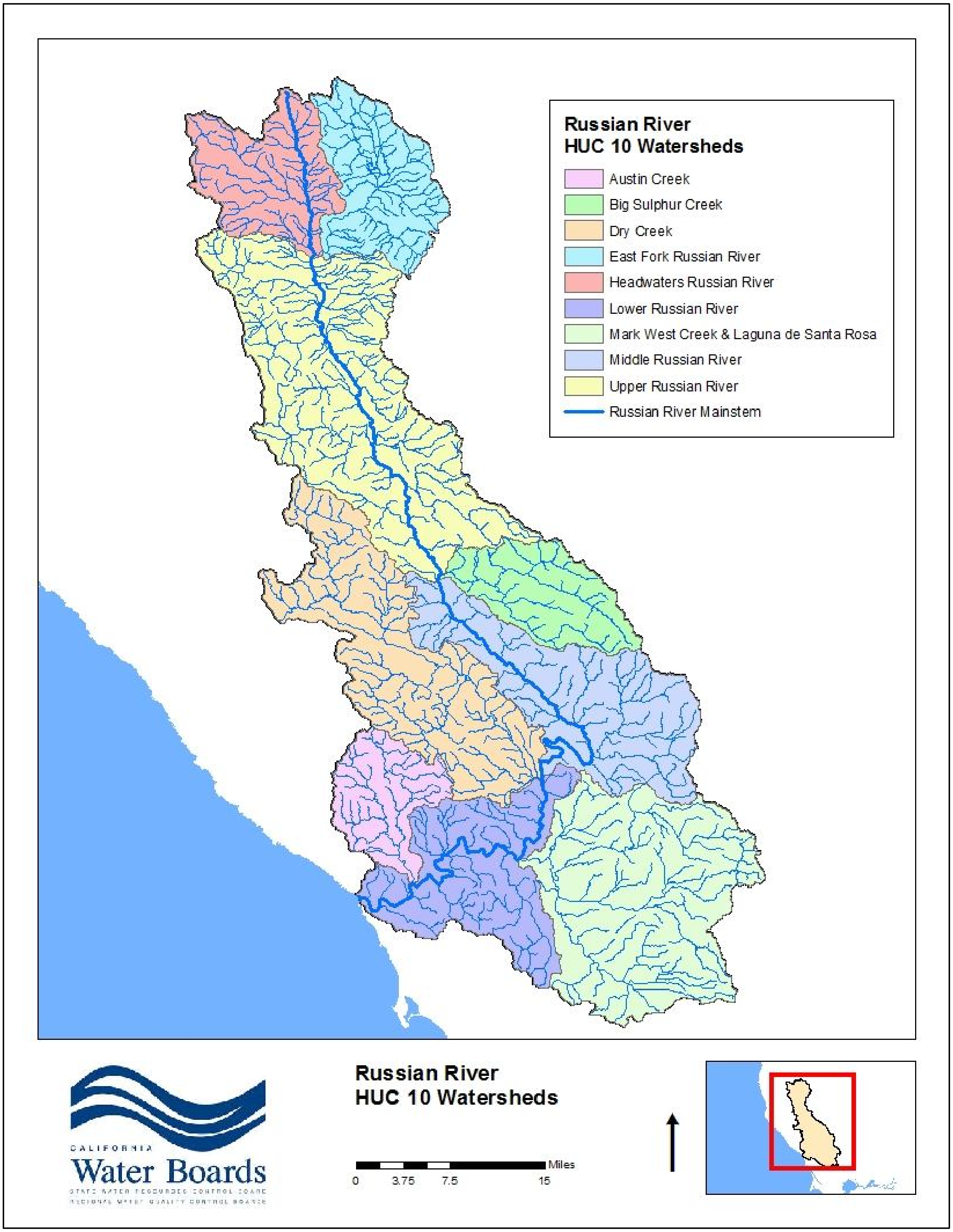



Figure 1.2: Hydrologic Unit Code 10 Watersheds of the Russian River Watershed

**Table 1.2. Hydrologic Unit Code 10 Watersheds of the Russian River**

| HUC 10 Watershed Name | Acres | Relative Area (%) |
|---|---|---|
| Upper Russian River | 204,029 | 21% |
| Mark West Creek (includes the Laguna de Santa Rosa) | 162,665 | 17% |
| Dry Creek | 139,516 | 15% |
| Middle Russian River | 117,642 | 12% |
| Lower Russian River | 94,419 | 10% |
| East Fork Russian River | 67,020 | 7% |
| Headwaters Russian River | 64,795 | 7% |
| Big Sulphur Creek | 54,688 | 6% |
| Austin Creek | 44,838 | 5% |
| Russian River Watershed | 949,611 | 100% |

The 110-mile mainstem channel of the Russian River originates in the Redwood Valley of central Mendocino County about 15 miles north of Ukiah. From its origin, the Russian River flows in a south to southeast direction to the Wohler Bridge area, where it changes to a southwest direction, crosses the Coast Range, and empties into the Pacific Ocean near the town of Jenner 20 miles west of Santa Rosa. Elevations range from zero at the Pacific Ocean to 4,343 feet at Mount St. Helena in the Mayacamas Mountains. Nine sub-basins containing fifty-seven valleys comprise the watershed.

The local geologic and structural variations in the Russian River Watershed create distinct reaches of channel characterized by wide alluvial valleys separated by narrow bedrock canyons. The length of the river mainstem can be divided into different reaches based on geological features (e.g., narrow constrictions alternated with wide valleys). The Russian River originates upstream of the Ukiah Valley and passes through the alluvial valley until the valley constricts at the Hopland Gage. The river again passes through another alluvial valley that contains the Town of Hopland before again being constricted in the Frog Woman Rock region.

Downstream of Ukiah and Hopland, in the Alexander Valley reach, the river enters a mountainous area east of Healdsburg known as the Fitch Mountain Constriction where it is confined by steep bedrock banks. The section of the river in the Healdsburg Valley downstream to Wohler Bridge, where another bedrock constriction occurs, is known as the middle reach. The middle reach contains several permanent in-stream structures including the Healdsburg Dam, two bridges in Healdsburg, Wohler Bridge, and Highway 101. The lower reach is a narrow alluvial valley that terminates at the Pacific Ocean, near the town of Jenner.

Three major reservoir projects provide water supply for the Russian River Watershed: Lake Pillsbury on the Eel River, Lake Mendocino on the East Fork of the Russian River, and Lake Sonoma on Dry Creek. Under agreements with the US Army Corps of Engineers, the Sonoma County Water Agency manages the stored water supply in Lake Mendocino and Lake Sonoma to provide water for agriculture, municipal, and industrial uses in accordance with its water-right permit. In addition, the Sonoma County Water Agency also releases water from these reservoirs to contribute the minimum stream flow requirements in the Russian River and Dry Creek established in 1986 by the State Water Board's Decision 1610. These minimum stream flows provide water for recreation and fish passage for salmon and steelhead in the mainstem Russian River and Dry Creek.

The Sonoma County Water Agency operates an inflatable dam on the Russian River in the Wohler Bridge area to increase water production capacity during peak demand months. The dam is inflated in the early spring to create pool conditions in the river. In the fall, the dam is deflated to provide passage for fish migration. Operation of the inflatable dam increases water production capacity in two important ways. First, surface water immediately behind the dam can be diverted to a series of infiltration ponds that are constructed adjacent to the three Mirabel collector wells. Second, infiltration to the underlying aquifer behind the dam is significantly improved by increasing the recharge area from the river.

### 1.3.2 LAND USES

Primary land uses in the Russian River Watershed include urban, rural, agricultural, and undeveloped lands as shown in Table 1.3 and Figure 1.3, which are based on Landsat satellite imagery (Fry et al. 2006). Most of the land in the watershed is privately owned (89.78%), with federal (5.41%), state (2.59%), local (2.15%), and tribal lands (0.08%) making up the remaining ownership. Land cover is primarily open space with fifty-one percent of the watershed having less than one housing unit per 160 acres (WCW 2007).

**Table 1.3: Land Cover in the Russian River Watershed**

| Land Cover Category | Acres |
|---|---|
| Shrub/Scrub | 260,269 |
| Evergreen Forest | 231,347 |
| Grassland/Herbaceous | 163,358 |
| Mixed Forest | 104,836 |
| Developed, Open Space | 57,173 |
| Cultivated Crops | 55,813 |
| Deciduous Forest | 23,096 |
| Developed, Low Intensity | 22,233 |
| Developed, Medium Intensity | 16,312 |
| Open Water | 7,130 |
| Woody Wetlands | 2,564 |
| Developed, High Intensity | 1,948 |
| Pasture/Hay | 1,719 |
| Barren Land | 1,469 |
| Herbaceous Wetlands | 343 |
| Total | 949,611 |

**Table 1.4. Population of Municipalities in the Russian River Watershed**

| Municipality | Population[1] |
|---|---|
| Santa Rosa | 171,990 |
| Rohnert Park | 41,398 |
| Windsor | 27,243 |
| Ukiah | 15,871 |
| Healdsburg | 11,517 |
| Sebastopol | 7,596 |
| Cloverdale | 8.738 |
| Guerneville | 4,534 |
| Forestville | 3,293 |
| Monte Rio | 1,152 |
| Hopland | 756 |
| Calpella | 679 |

[1] Per U.S. Census Bureau 2010 and U.S. Census Bureau 2013

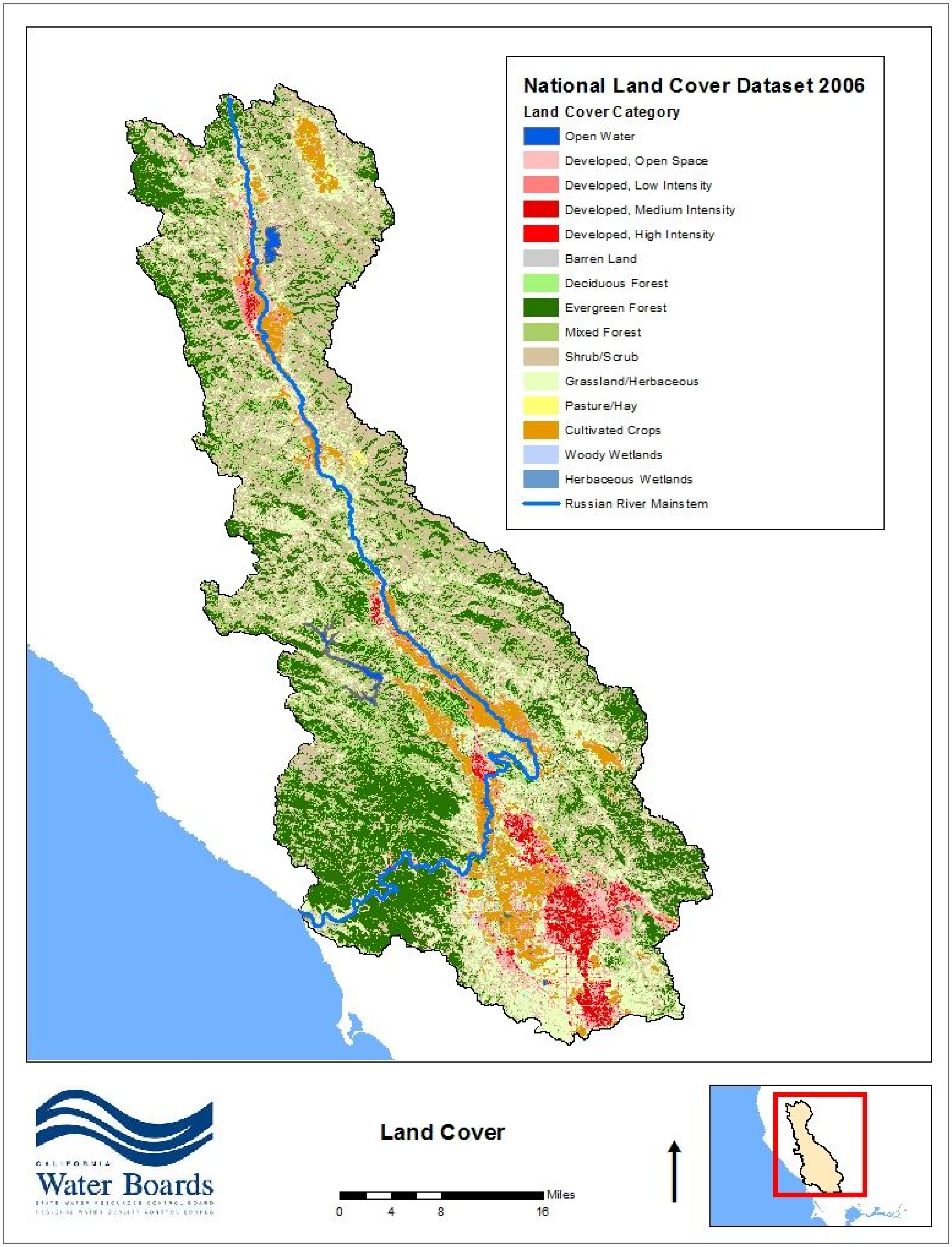



Figure 1.3: Land Cover in the Russian River Watershed

#### 1.3.2.1 Recreational Uses

The Russian River and tributary creeks are enjoyed by many swimmers, waders, canoers, kayakers, fishermen, and enthusiasts that partake in water contact and non-contact water recreation. The Russian River is one of the most intensively used rivers for recreation in the North Coast Region. On holiday weekends in the summer, beach visitors along the river number in the thousands. Several of the most popular beaches are listed in Table 1.5 and shown in Figure 1.4.

**Table 1.5. Popular Swimming Beaches along the Russian River**

| Recreational Beach Name | Location |
|---|---|
| Mill Creek Park | Potter Valley |
| Mariposa Swimming Hole | Redwood Valley |
| Vichy Springs Park | Ukiah |
| Mill Creek Park | Ukiah |
| Cloverdale River Park | Cloverdale |
| Alexander Valley Campground | Healdsburg |
| Veteran Memorial Beach | Healdsburg |
| Riverfront Park | Windsor |
| Mirabel Park Campground | Forestville |
| Steelhead Beach | Forestville |
| River Access Beach | Forestville |
| Sunset Beach | Forestville |
| Johnson's Beach | Guerneville |
| Monte Rio Beach | Monte Rio |
| Casini Ranch Campground | Duncans Mills |

### 1.3.3 CLIMATE

The Russian River Watershed has a Mediterranean climate with hot, dry summers and wet winters. Average precipitation varies across the watershed with generally wetter conditions in the north and west. Summer temperatures can reach over 100° F in inland valleys for weeks at a time, with coastal conditions cool and moist. Drought and severe storms occur periodically but mostly unpredictably; El Niño/ La Niña Southern Oscillation climatic conditions can exacerbate climatic extremes.

Precipitation in the Russian River Watershed is distinctly seasonal; about 80 percent of the total occurs during five months, November through March. The bulk of the precipitation occurs during moderately intense general storms of several days' duration. Snow falls in modest amounts at altitudes above 2,000 feet, but it seldom remains on the ground for more than a few days. Mean annual precipitation varies from about 30 inches in the flat valley lands north of Santa Rosa to more than 80 inches in parts of the mountains. Summers are dry, with total rainfall from June through August averaging less than 0.5 inch (Zhang and Johnson 2010).

**Table 1.6 Average Annual Precipitation**

| HUC 10 Watershed | Average Precipitation (inches/year) |
|---|---|
| Austin Creek | 64.6 |
| Big Sulphur Creek | 50.8 |
| Dry Creek | 48.6 |
| East Fork Russian River | 41.1 |
| Headwaters Russian River | 45.4 |
| Lower Russian River | 44.7 |
| Mark West Creek | 36.1 |
| Middle Russian River | 42.4 |
| Upper Russian River | 42.6 |
| Watershed Mean | 44.2 |

The spatial distribution of mean annual rainfall in the Russian River Watershed is shown in Figure 1.5. These precipitation zones were derived statewide by the California Department of Forestry and Fire Protection for the period 1900-1960. Table 1.6 presents the area weighted precipitation for each HUC 10 watershed.


Figure 1.4: Popular Swimming Beaches on the Russian River

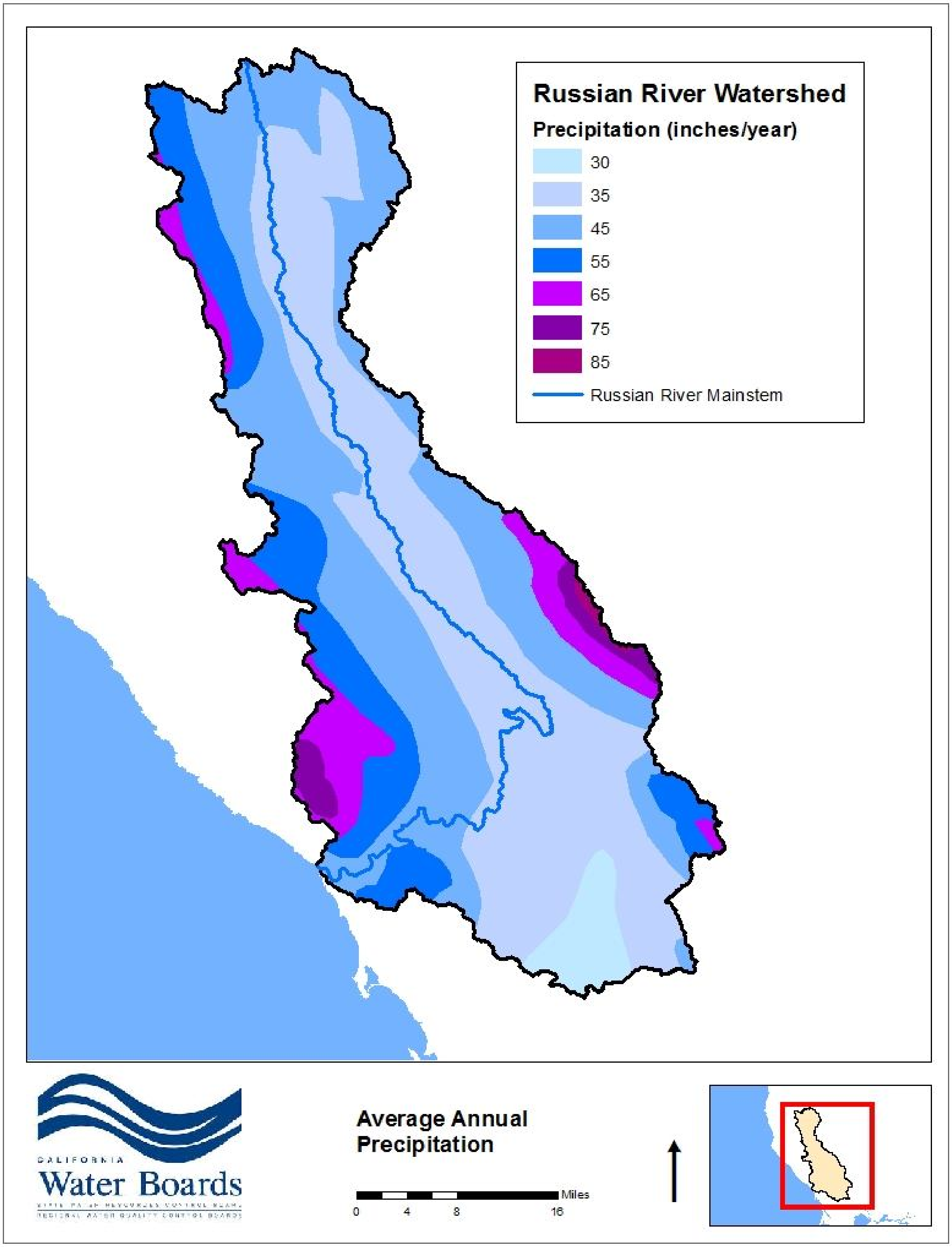



Figure 1.5: Average Annual Precipitation Patterns in the Russian River Watershed

### 1.3.4 GEOLOGY AND SOILS

The Russian River Watershed is underlain predominantly by the Franciscan Assemblage, which is a highly erodible mélange that formed during the Jurassic-Cretaceous age. The Franciscan Assemblage forms the bulk of the coast range; the sediment consists of muddy sandstones and cherts jumbled together and layered with basalt lava flow. This lithology is very unstable with landslides common throughout the mountainous regions of the basin. Many of the streams within the basin, including the upper mainstem Russian River, follow the northwest to southeast orientation of geologic faults. The Rodgers Creek Fault enters Sonoma County at San Pablo Bay and extends northward through the City of Santa Rosa, where it meets up with the Healdsburg Fault, which continues northward passing east of the Town of Windsor. The Mayacama Fault lies to the east of the Healdsburg Fault and continues northward, passing east of the City of Cloverdale.

The Russian River flows through a series of broad alluvial valleys and narrow bedrock constrictions. Historic photographs show that the historic river channel once meandered across a broad natural floodplain and that the elevation of the active channel was once close to the elevation of the floodplain. Traces of the channel remained on the irregular floodplain as a series of "sloughs" or side channels. Subsequent land use changes in the Russian River Basin have leveled the floodplain, filled the side channels, and constrained the river channel into a narrow and straighter course (Florsheim and Goodwin 1995).

The Russian River Watershed contains a large number of different soils types (NRCS 2013). Hydrologic soil characteristics influence the delivery of bacteria to surface waters. Identification of hydrologic soil groups is based on comparison of the characteristics of soil profiles, which include hydraulic conductivity, texture, bulk density, structure, strength, clay mineralogy, and organic matter content. Four hydrologic soil groups are categorized (NRCS 2007: Table 1.7 and Figure 1.6):

**Table 1.7. Hydrologic Soil Characteristics of the Russian River Watershed**

| Hydrologic Soil Group | Runoff Potential | Acres | Relative Watershed Area (%) |
|---|---|---|---|
| A | Low when thoroughly wet. Water is transmitted freely through the soil. | 1,756 | 0.2% |
| B | Moderately low when thoroughly wet. Water transmission through the soil is unimpeded. | 477,416 | 50% |
| C | Moderately high when thoroughly wet. Water transmission through the soil is somewhat restricted. | 218,774 | 23% |
| D | High when thoroughly wet. Water movement through the soil is restricted or very restricted. | 251,664 | 27% |
| | Total | 949,611 | 100% |

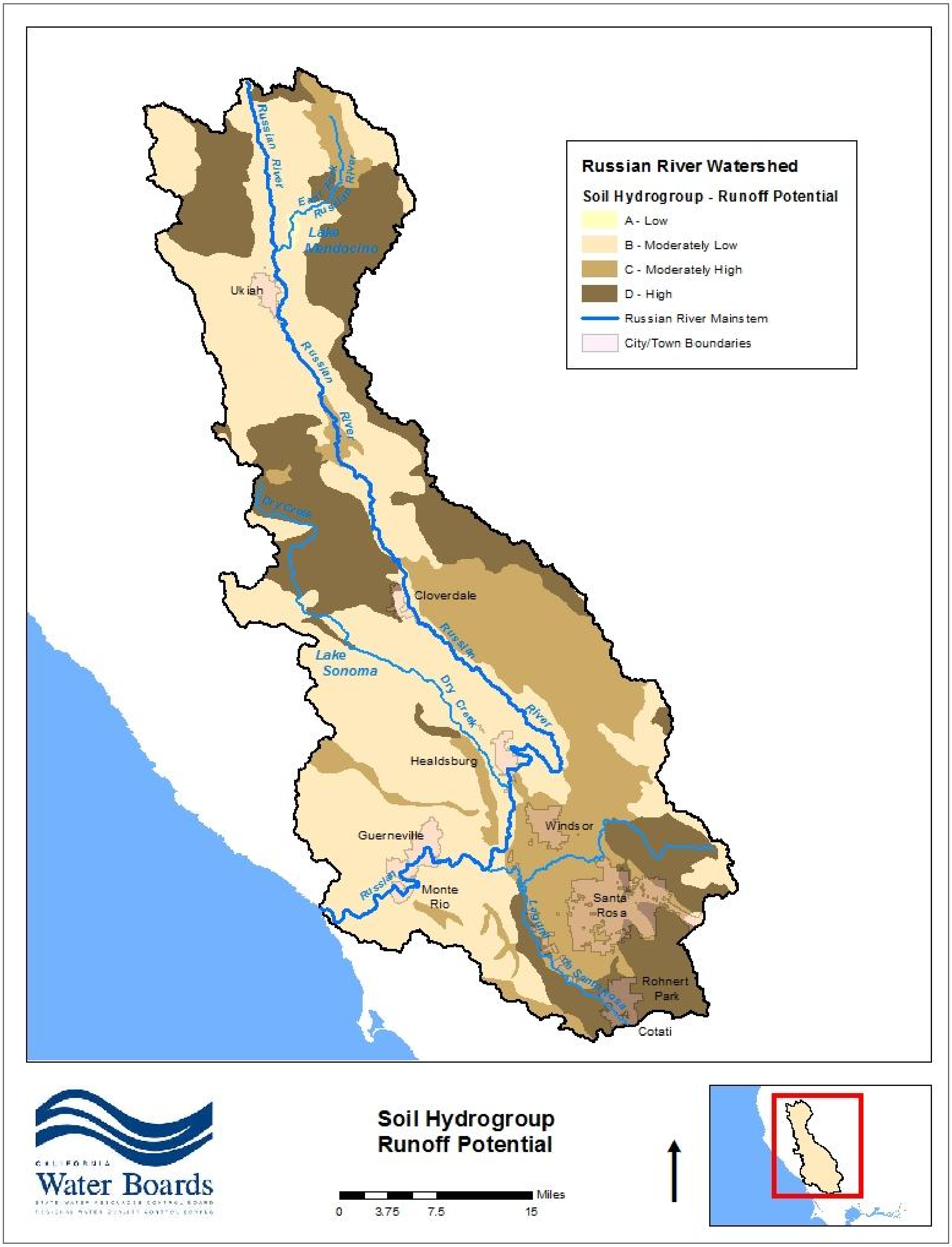



Figure 1.6: Hydrologic Soil Characteristics of the Russian River Watershed

# CHAPTER 2
# STANDARDS, INDICATORS & TARGETS

This chapter describes the water quality standards that are applicable to this TMDL project, the types of human pathogens most commonly associated with waterborne diseases, the types of bacteria used to indicate the presence of pathogens, and the numeric targets used to assess the extent of impairment in the Russian River Watershed.

## 2.1 WATER QUALITY STANDARDS

In accordance with the Clean Water Act, a TMDL is set at a level necessary to achieve applicable water quality standards. Water quality standards consist of four basic elements:

1. Designated uses of the waterbody, which are also known as beneficial uses
2. Water quality criteria to protect designated uses, which are known as water quality objectives in California
3. An antidegradation policy to maintain and protect existing uses and high quality waters
4. General policies addressing implementation issues.

This section describes the State of California's water quality standards applicable to the Russian River Pathogen Indicator Bacteria TMDL, which are found in the Basin Plan.

### 2.1.1 BENEFICIAL USES

An essential part of the Basin Plan is the assessment of designated beneficial uses of water. Tables 2.1 and 2.2 identify and define beneficial uses for each hydrologic area in the Russian River Watershed. Table 2.2 defines each beneficial use. The beneficial uses of any specifically identified water body generally apply to all its tributaries.

Beneficial uses relevant to this TMDL are defined below. The Basin Plan does not include explicit numeric pathogen indicator bacteria objectives for other beneficial uses.

- 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, white-water activities, fishing, or use of natural hot springs.

- Non-Contact Water Recreation (REC-2): Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

- Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

**Table 2.1. Beneficial Uses Designated for Protection in Surface Waters of the Russian River Watershed**

| Hydrologic Area (HA) | Hydrologic Sub Area (HSA) | Beneficial Uses | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MUN | AGR | IND | PRO | GWR | FRSH | NAV | POW | REC-1 | REC-2 | COMM | WARM | COLD | WILD | RARE | MIGR | SPWN | SHELL | EST | AQUA |
| Upper Russian River | Ukiah | E | E | E | P | E | E | E | N | E | E | E | E | E | E | E | E | E | P | N | P |
| | Coyote Valley | E | E | E | P | E | E | E | N | E | E | E | E | E | E | E | E | E | N | N | P |
| | Forsythe Creek | E | E | E | P | E | N | E | P | E | E | E | E | E | E | E | E | E | N | N | P |
| Middle Russian River | Laguna de Santa Rosa | P | E | E | P | E | E | E | N | E | E | E | E | E | E | E | E | E | P | N | P |
| | Santa Rosa Creek | E | E | E | P | E | N | E | P | E | E | E | E | E | E | E | E | E | P | N | P |
| | Mark West Creek | E | E | E | P | E | E | E | P | E | E | E | E | E | E | E | E | E | P | N | P |
| | Warm Springs | E | E | E | P | E | E | E | N | E | E | E | E | E | E | E | E | E | N | N | E |
| | Geyserville | E | E | E | P | E | E | E | P | E | E | E | E | E | E | E | E | E | P | N | P |
| | Sulphur Creek | E | E | E | P | E | N | E | P | E | E | E | E | E | E | E | E | E | N | N | P |
| Lower Russian River | Guerneville | E | E | E | P | E | E | E | P | E | E | E | E | E | E | E | E | E | P | E | P |
| | Austin Creek | E | E | E | P | E | N | E | P | E | E | E | E | E | E | E | E | E | N | N | P |

E = Existing Beneficial Use; P = Potential Beneficial Use; N = Beneficial Use not designated in the HSA

**Table 2.2. Beneficial Use Names Designated for Protection in Surface Waters of the Russian River Watershed**

| Beneficial Use | Beneficial Use Name |
|---|---|
| MUN | Municipal and Domestic Supply |
| AGR | Agricultural Supply |
| IND | Industrial Service Supply |
| PRO | Industrial Process Supply |
| GWR | Groundwater Recharge |
| FRSH | Freshwater Replenishment |
| NAV | Navigation |
| POW | Hydropower Generation |
| REC-1 | Water Contact Recreation |
| REC-2 | Non-Contact Water Recreation |
| COMM | Commercial and Sport Fishing |
| WARM | Warm Freshwater Habitat |
| COLD | Cold Freshwater Habitat |
| WILD | Wildlife Habitat |
| RARE | Rare, Threatened, or Endangered Species |
| MIGR | Migration of Aquatic Organisms |
| SPWN | Spawning, Reproduction, and/or Early Development |
| SHELL | Shellfish Harvesting |
| EST | Estuarine Habitat |
| AQUA | Aquaculture |

### 2.1.2 WATER QUALITY OBJECTIVES

The Bacteria Water Quality Objectives applies to all the impaired waterbodies that are part of this TMDL project. The following is the Bacteria Objective from the Basin Plan.

> **Bacteria Water Quality Objective**
>
> The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels.
>
> In no case shall coliform concentrations in waters of the North Coast Region exceed the following: In waters designated for contact recreation (REC-1), the median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50/100 mL, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 mL (State Department of Health Services).
>
> At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, Manual of Operation).

This TMDL project is set at levels to attain the Bacteria Water Quality Objective. It includes TMDLs/loading capacities for *Bacteroides* bacteria that interpret natural background conditions. It includes TMDLs/loading capacities for *E. coli* bacteria, which are a type of fecal coliform, to ensure protection of water contact recreational uses. And it includes a fecal coliform TMDL/loading capacity for the protection of human shellfish consumption.

The State Water Board is currently developing a statewide amendment to the Inland Surface Waters, Enclosed Bays, and Estuaries Plan to protect recreational users from the effects of pathogen in California waterbodies. The amendment may include new water quality objectives for freshwater to incorporate the latest science and information and the newly released U.S. EPA criteria. For example, the amendment may replace fecal coliform numeric values with *E. coli* numeric values for the protection of recreation uses. The amendment is currently scheduled for State Water Board consideration in the spring of 2016. Should this amendment affect the North Coast's Bacteria Objective, appropriate changes to this TMDL project will be considered.

#### 2.1.2.1 Interpretation of Natural Background

For this TMDL, natural background is interpreted to mean the quality of water that in the absence of significant human disturbance or alteration is in a minimally disturbed condition. This matches the definition of a "reference condition for biological integrity" or "minimally disturbed condition" as used by the Water Board's Surface Water Ambient Monitoring Program (Ode & Schiff 2009) and expressed by Stoddard et al. (2006). Natural background does not equal a pristine, unpolluted, or anthropogenically undisturbed state with zero human waste or domestic animal waste discharges to waterbodies. Humans are part of the natural landscape, both historically and today.

By interpreting natural background conditions as the quality of water that in the absence of significant human disturbance or alteration is in a minimally disturbed condition, this TMDL project corresponds with previous interpretations of bacteria standards by the Regional Water Board. In the 1967 Water Quality Control Plan for the Klamath Basin, the stated purpose of the Bacteria Water Quality Objective was to call attention to the fact that no increase in bacterial contamination of human origin or of public health concern will be permitted. In the 1971 Interim Water Quality Control Plan for the Klamath Basin, the Bacteria Objective stated that “The bacteriological quality of the waters of the Klamath River Basin shall not be degraded beyond background levels” and included specific total coliform and fecal coliform values as base-line, background levels. These values were collected from mainstem river locations in the Klamath, Trinity, and Smith rivers in the late 1960s. Interestingly, the 1971 Interim Water Quality Control Plan for the North Coast Basin, which includes the Russian River Watershed, did not include a background-based Bacteria Objective. It simply stated that “The bacteriological quality of the waters of the North Coastal Basin shall be maintained at levels deemed appropriate by State and local health authorities to protect public health and to assure their continued suitability for all present and foreseeable future beneficial uses.” The two interim plans were combined in the 1970s, and the 1975 Basin Plan included the three-part objective we have today.

Use of *Bacteroides* Bacteria to Determine Attainment of Natural Background

In this TMDL project, *Bacteroides* bacteria numeric targets, loading capacities, and load allocations are set at levels to attain the natural background portion of the Bacteria Objective. *Bacteroides* are a suitable indicator of a waterbody’s bacteriological quality since the bacteria come from the gastrointestinal systems of mammals, they degrade rapidly outside of the body, and technology is available to trace the bacteria back to specific types of mammals, including humans and domestic animals.

Waters are determined to not be in a minimally disturbed condition if *Bacteroides* bacteria are significant enough to be present in a water sample at levels above the laboratory reporting limit. The laboratory reporting limit is the level at which the laboratory is 95% confident that the *Bacteroides* bacteria are present in the sample and are accurately counted. If the bacteria are present and can be quantified with certainty, it is highly likely that fecal waste material is present and the bacteriological quality of the water has been degraded beyond a minimally disturbed condition. This is a conservative assumption. It is supported by data from the one minimally disturbed site measured in the Russian River Watershed[2]. It is also supported by U.S. EPA guidance which states that using conservative assumptions in derivation of numeric targets is an appropriate approach for providing a margin of safety, which is a required element of a TMDL.

[2] *Bacteroides* bacteria concentrations were less than the reporting limit from the sample collected in a stream which crosses Moscow Road near Duncans Mills and drains a small watershed with no human structures and few, if any, alterations. For more information, see Chapter 3.

Although it is appropriate to propose a TMDL based on a conservative assumption, it is preferable to have a more thorough understanding of the range of *Bacteroides* bacteria concentrations in minimally disturbed conditions, and to have greater accuracy than can be provided from one sample site. Therefore staff is arranging a freshwater bacteria reference study to further quantify and define natural background or minimally disturbed conditions in watersheds without significant human disturbance or alteration. The reference study is scheduled to begin in 2016. Following the completion of the study, staff will reconsider the *Bacteroides* bacteria numeric targets, loading capacities, and allocations for the Russian River Pathogen Indicator Bacteria TMDL.

#### 2.1.2.2 Protection of REC-1

The fecal coliform value described in the Bacteria Water Quality Objective for the protection of water contact recreation is based on outdated science thresholds from the 1970s. Since 1976, several key epidemiological studies evaluated the criteria for effectiveness at protecting public health from water contact recreation (Cabelli et al. 1982; Cabelli et al. 1983; Dufour 1983; Favero 1985; Seyfried et al. 1985a, Seyfreid et al. 1985b) The studies concluded that the 1976 U.S. EPA recommended fecal coliform bacteria criteria had no scientific basis. As a result, the U.S. EPA changed the criteria recommendation in 1986 to use the pathogen bacteria indicators of *E. coli* and *Enterococcus* bacteria, instead of fecal coliform bacteria. Additionally, detection of fecal coliform bacteria in recreational waters may overestimate the level of fecal contamination because this bacteria group contains a genus, *Klebsiella*, with species that are not necessarily fecal in origin. *Klebsiella* bacteria are commonly associated with soils and the surfaces of plants, so that areas with allochthonous organic debris may show high levels of fecal coliform bacteria that do not have a fecal-specific bacteria source.

*E. coli* is a species of fecal coliform that is specific to fecal material from humans and other warm-blooded animals. Epidemiological studies have demonstrate a link between *E. coli* concentrations and gastrointestinal illness and the U.S. EPA recommends *E. coli* bacteria criteria as the best indicator of health risk from water contact recreation (see Section 2.2.2.1 for more information).

Therefore, in this TMDL project, *E. coli* bacteria numeric targets, loading capacities, and load allocations are set at levels to attain the recreation-specific portion of the Bacteria Objective and protect and support contact and non-contact water recreation. *E. coli* is used in place of fecal coliform bacteria in order reflect current science and with the expectation that the State Water Board's current efforts to develop a statewide amendment to the Inland Surface Waters, Enclosed Bays, and Estuaries Plan will likely replace fecal coliform numeric values with *E. coli* numeric values for the protection of recreation uses.

#### 2.1.2.3 Protection of Shellfish Consumption

The fecal coliform numeric objective of 43/100 mL or 49/100mL applies to areas where filter-feeding freshwater shellfish (e.g., clams, mussels) may be harvested for human consumption in the Ukiah, Laguna de Santa Rosa, Santa Rosa Creek, Mark West Creek, Geyserville, and Guerneville HSAs. The SHELL use is identified in the Basin Plan as a potential use in these six HSAs. California's potential uses are equivalent to federal "designated uses" per 40 C.F.R. §131.3(f), and this TMDL project must be established at levels necessary to attain and maintain the SHELL use. Additionally, water quality standards should, wherever attainable, provide water quality for the protection and propagation of shellfish (*Id.,* §131.2).

Regional Water Board staff assed the extent of the SHELL use in the watershed and documented evidence of shellfish in several areas (Butkus 2015). Freshwater mussels (*Anodonata* spp., *Margaritifera falcate*, and other unidentified species) were observed in the mainstem Russian River, East Fork, Mark West Creek, and Green Valley Creek.

A limited staff survey of resource agency professionals, non-governmental organizations, and recreation sport fishing suppliers found no evidence of existing or historical harvesting of freshwater shellfish from the Russian River Watershed. A UC Davis survey of Native American tribal use found anecdotal evidence to historic traditional use of mussels from the river (Butkus 2015).

Although staff will continue to research and document tribal uses of freshwater shellfish, there remains the potential for any individual to use shellfish from the Russian River and its tributaries for human consumption. It is this potential use that is to be attained and maintained by this TMDL project. Therefore, the fecal coliform numeric target, loading capacity, and load allocations are set at levels equal to the shellfish-specific portion of the Bacteria Objective, applicable in the six HSAs with the designated potential SHELL use.

### 2.1.3 ANTIDEGRADATION

Both the state and federal governments have antidegradation policies for water quality. The state policy is formally referred to as the "Statement of Policy with Respect to Maintaining High Quality Waters in California" (State Board Resolution No. 68-16). This policy restricts degradation and protects waterbodies where the existing quality is higher than is necessary for the protection of beneficial uses. The federal Antidegradation Policy (40 C.F.R. §131.12) was developed under the Clean Water Act. Please refer to Chapter 12 for the TMDL's Antidegradation Analysis.

### 2.1.4 IMPLEMENTATION PLANS

Chapter 4 of the Basin Plan describes the program of implementation by which beneficial uses and water quality objectives are applied and enforced. It includes all the prohibitions, schedules of compliance, action plans, policies, and guidelines adopted by the Regional Water Board for that purpose.

Chapter 8 of this TMDL Staff Report describes the proposed implementation plan for the TMDL, which serves as the basis for the Action Plan for the Russian River Watershed Pathogen Indicator Bacteria TMDL.

## 2.2 PATHOGEN INDICATOR BACTERIA & TMDL TARGETS

Pathogens most commonly identified and associated with waterborne diseases can be grouped into three general categories: bacteria, protozoans, and viruses (U.S. EPA 2001). Bacteria are microscopic unicellular organisms that are ubiquitous in nature, including the intestinal tract of warm-blooded animals. Many types of harmless bacteria colonize the human intestinal tract and are routinely shed in feces. However, pathogenic (disease-causing) bacteria, are present in the feces of infected humans and animals and can contaminate surface water and groundwater as a result of inadequate waste treatment or disposal methods. Protozoans are unicellular organisms that are present primarily in the aquatic environment. Of the 35,000 known species of protozoans, almost 30 percent are pathogenic. Pathogenic protozoans can occur in humans and animals where they multiply in the intestinal tract of the infected individual or animal and are later excreted in feces as cysts. Viruses are obligate intracellular parasites, incapable of replication outside of a host organism. Viruses that are of a public health concern are viruses that replicate in the intestinal tract of humans, and are referred to as human enteric viruses.

Several groups of intestinal bacteria are used as indicators that a waterbody has been contaminated with human sewage and that pathogens are present. Most strains of pathogen indicator bacteria do not directly pose a health risk to swimmers and those recreating in the water, but indicator bacteria often co-occur with human pathogens and are easier to measure than the actual pathogens that may pose the risk of illness. It is impractical to directly measure the wide range of types of fecal-borne pathogens (bacteria, viruses, and protozoans) and the methods to detect human pathogens are characteristically expensive and inefficient, or may be not available.

*E. coli* bacteria, *Bacteroides* bacteria, fecal coliform, and the microbiome community are used in the Russian River Watershed as indicators of pathogens. Each indicator is described below and the TMDL numeric targets are listed in Table 2.4.

### 2.2.1 *BACTEROIDES* BACTERIA

*Bacteroides* bacteria are another group of pathogen indicator organisms that are used to measure fecal contamination in water. *Bacteroides* is the genus name of the bacteria from the phylum Bacteroidetes and order Bacteroidales. *Bacteroides* bacteria are anaerobic (i.e., they do not live or grow in the presence of oxygen) and make up a substantial portion of the gastrointestinal flora of mammals (Wexler 2007). *Bacteroides* bacteria are not found in ambient surface waters without sources of mammalian waste.

Due to their anaerobic-nature, *Bacteroides* bacteria have a low potential for survival and regrowth in the environment. In addition, water temperature has been shown to affect the persistence of *Bacteroides* in surface water. For water temperatures typically observed in the Russian River during the summer period (20-25°C or 68-77°F), *Bacteroides* bacteria survive one to two days. In cooler temperatures, *Bacteroides* bacteria likely survive for a week or more. Because of this short life span, *Bacteroides* bacteria concentrations are often used to indicate recent fecal contamination of surface waters.

**Table 2.3. Pathogenic Bacteria, Protozoan, and Virus of Concern to Water Quality**

| Pathogen Type | Disease | Effects |
|---|---|---|
| **Bacteria** | | |
| *Escherichia coli* | Gastroenteritis | Vomiting, diarrhea |
| *Salmonella typhi* | Typhoid fever | High fever, diarrhea, ulceration of the small intestine |
| *Salmonella* | Salmonellosis | Diarrhea, dehydration |
| *Shigella* | Shigellosis | Bacillary dysentery |
| *Vibrio cholera* | Cholera | Extremely heavy diarrhea, dehydration |
| *Yersinia enterolitica* | Yersinosis | Diarrhea |
| **Protozoan** | | |
| *Balantidium coli* | Balantidiasis | Diarrhea, dysentery |
| *Cryptosporidium* | Cryptosporidiosis | Diarrhea, death in susceptible populations |
| *Entamoeba histolytica* | Amebiasis (ameobic dysentery) | Prolonged diarrhea with bleeding, abscesses of the liver and small intestine |
| *Giardia lamblia* | Giardiasis | Mild to severe diarrhea, nausea, indigestion |
| **Virus** | | |
| Adenovirus | Respiratory disease, gastroenteritis | Various effects |
| Enterovirus | Gastroenteritis, heart anomalies, meningitis | Various effects |
| Hepatitus A | Infectious hepatitis | Jaundice, fever |
| Reovirus | Gastroenteritis | Vomiting, diarrhea |
| Rotavirus | Gastroenteritis | Vomiting, diarrhea |
| Calicivirus | Gastroenteritis | Vomiting, diarrhea |
| Astrovirus | Gastroenteritis | Vomiting, diarrhea |

Adapted from Metcalf & Eddy 1991 and Fout 2000; as cited in U.S. EPA 2001

**Table 2.4. Numeric TMDL Targets**

| Parameter | Portion of the Bacteria Objective the Target will Attain | Numeric Target |
|---|---|---|
| Human Host *Bacteroides* | Natural Background | No more than 10% of the daily median sample values shall exceed the laboratory quantitative reporting limit within a calendar year or permitted discharge period. The current human host reporting limit is 60 genes per 100mL. |
| Domestic Animal *Bacteroides* | Natural Background | No more than 10% of the daily median sample values shall exceed the laboratory quantitative reporting limit within a calendar year or permitted discharge period. The current bovine host reporting limit is 30 genes per 100mL. |
| *E. coli* Geometric Mean | Recreation | No more than 50% of the samples collected within a calendar year or permitted discharge period shall exceed 100 cfu/100mL*. |
| *E. coli* Statistical Threshold Value | Recreation | No more than 90% of the samples collected within a calendar year or permitted discharge period shall exceed 320 cfu/100mL*. |
| Fecal Coliform | Shellfish Consumption | None of the samples shall exceed 43 MPN/100mL. |

** Colony forming units (cfu) are equivalent to the most probable number (MPN) values derived from other analytical measurement methods approved by the U.S. EPA (IDEXX 2001).

*Bacteroides* bacteria are especially useful to as a tool to identify specific mammalian waste sources. The percentage of the *Bacteroides* bacteria population that originates from specific animal hosts can be determined using real-time quantitative polymerase chain reaction (qPCR) methods, which amplify specific DNA sequences of the 16S rRNA gene marker (Molina 2007). Water samples analyzed for this TMDL project were analyzed for both human-host and bovine-host *Bacteroides* bacteria. *Bacteroides* bacteria assay primers have been developed for most domestic animal hosts including cattle, swine, chicken, dog, and horse (Griffith et al. 2013). Commercial laboratories are available that conduct these animal host analyses.

#### 2.2.1.1 *Bacteroides* Bacteria Numeric Targets to Attain Natural Background

The *Bacteroides* bacteria numeric targets are expressed as 90 percentile values for human host and domestic animal host markers in Table 2.5. The numeric targets are used to determine if water quality conditions attain the natural background portion of the Bacteria Water Quality Objective and the extent of impairment by pathogen indicator bacteria in the Russian River Watershed. The *Bacteroides* bacteria numeric targets are equivalent to the *Bacteroides* TMDLs/loading capacities, as described in Chapter 7.

**Table 2.5. *Bacteroides* Bacteria Numeric Targets to Attain Natural Background**

| ***Bacteroides* Host Type** | **Numeric Target** |
|---|---|
| Human | No more than 10% of the daily median sample values shall exceed the laboratory quantitative reporting limit within a calendar year or permitted discharge period. The current human host reporting limit is 60 genes per 100mL. |
| Domestic Animal | No more than 10% of the daily median sample values shall exceed the laboratory quantitative reporting limit within a calendar year or permitted discharge period. The current bovine host reporting limit is 30 genes per 100mL. |

During the development of the TMDL, the quantitative reporting limits for human-host and bovine-host *Bacteroides* bacteria were 60 and 30 genes per 100mL, respectively. To account for improvements in detection methods for *Bacteroides* bacteria that are likely to occur during the implementation of this TMDL project, the numeric targets are the quantitative reporting limits at the time of the impairment assessment.

The *Bacteroides* bacteria numeric targets do not apply to disinfected waters, such as wastewater treated with chlorine, ozone, or UV light. While disinfection processes kill bacteria cells and eliminate the risk of illness to humans, pieces of the nucleic acids that comprise the bacterial DNA may persist in the water post-death in a non-viable state. These DNA pieces may be counted in molecular amplification methods like qPCR that rely on the detection of DNA or RNA gene sequences to quantify bacteria. Of note, to avoid false positive results, samples analyzed for *Bacteroides* bacteria for this TMDL project were collected only during periods when no disinfected wastewater was discharging.

The *Bacteroides* bacteria numeric targets are based on an interpretation of the narrative, natural background portion of the Bacteria Water Quality Objective. Exceedences of the target indicate human disturbance or alteration of the bacteriological quality of water and exceedence of natural background levels. See Section 2.1.2.1 for more detail. The allowable 10 percent frequency of exceeding the criteria is directly comparable to the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (SWRCB 2004).

The human host *Bacteroides* bacteria numeric target is also protective of recreational uses. According to the few epidemiological studies currently available for human *Bacteroides*, there is link between the bacteria and illness rates. Wade et al. (2010) estimated the probability of gastrointestinal illness due to increasing concentrations of *Bacteroides* bacteria, and found that a geometric mean of 60 genes/100mL corresponded to about 30 gastrointestinal illnesses per 1,000 swimmers. Ashbolt et al. (2010) compared human-specific *Bacteroides* bacteria concentration to *Norovirus* concentrations. From these estimates, a concentration of 860 genes/100mL corresponded to about 30 gastrointestinal illnesses per 1,000 swimmers. Soller et al. (2010a) identified *Norovirus* as the pathogen most responsible for a majority of gastrointestinal illness. Since the human *Bacteroides* numeric target is set at the reporting limit, which is currently 60 genes/100mL, it is equal to or less than the concentrations associated with approximately 30 illnesses per 1,000 swimmers and is protective of recreational uses.

#### 2.2.1.2 Host Marker Sensitivity & Specificity

Bernhard and Field (2000a) first identified species composition differences in *Bacteroides* bacteria populations by screening 16S rDNA from human and cow feces. Conventional host-specific PCR assays were then developed to detect these genetic markers in environmental samples (Bernhard and Field 2000b). Further technical advancements have allowed for the relative quantification of animal host-specific genetic markers. There have been more than a dozen human-host genetic markers developed over the last decade (Griffith et al. 2013). Studies have evaluated these genetic markers for sensitivity (does the marker detect human material when it is present in the sample) and specificity (does the marker cross-react with other animal sources).

Shilling et al. (2009) recommended use of the HuBac genetic marker of human-host *Bacteroides* bacteria and the BoBac marker for bovine-host *Bacteroides* bacteria for concentration measurements to support the Russian River Pathogen Indicator TMDL. Layton et al. (2006) found the HuBac genetic marker assay had 100% sensitivity, but it also had a 32% false-positive rate with potential for cross-sensitivity with swine feces. Shanks et al. (2010a) found the HuBac marker showed cross-sensitivity with feces from other animal hosts, most prominently with cats, dogs, and chickens. This leads staff to conclude that the HuBac marker was highly likely to correctly detect human waste material in samples from the watershed, but could have also counted other animal waste in the total concentration value.

In regards to bovine host markers, Layton et al. (2006) found the BoBac genetic marker assay was specific for bovine fecal samples with 100% sensitivity and 0% cross-sensitivity with the other animal hosts evaluated. Shanks et al. (2010b) found that the BoBac genetic marker showed cross-sensitivity with feces from many other animal hosts, most prominently with sheep and pig feces. The bovine-host genetic markers, CowM2 and CowM3, both showed 100% specificity with no detection of other animal host fecal wastes.

Staff recommends the use of the HF183 and HumM2 markers for future human-host *Bacteroides* analyses and CowM2 and Rum2Bac markers for bovine-host analyses, until such time that better technology becomes available. These recommendations are based on the research and review by Griffith et al. (2013) of studies on human-host and bovine-host genetic markers. Griffith et al. concluded that the HF183 and HumM2 markers should be used for measuring human fecal waste in environmental samples because they provide the best combination of sensitivity and specificity. Griffith et al. also suggests that bovine-host assays use both the CowM2 and the Rum2Bac genetic markers if non-cow ruminants are present in the watershed. Additionally, the U.S. EPA is in the process of approving the CowM2 method.

### 2.2.2 *E. COLI* BACTERIA

*E. coli* is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. U.S. EPA (2012) compiled numerous epidemiological studies and concluded that *E. coli* bacteria are the best indicator of human health risk from water contact in recreational freshwaters. The criteria are established for both the geometric mean and the statistical threshold value (STV) (Table 2.6). The geometric mean criterion is compared to the logarithmic average of the bacteria concentration distribution. The STV criterion is compared to the 90th percentile of the bacteria concentration distribution.

**Table 2.6. U.S. EPA's *E. coli* Recreational Water Quality Criteria & Beach Action Values**

| Estimated Illness Rate | Water Quality Criteria | | Beach Action Value |
|---|---|---|---|
| | Geometric Mean (cfu/100mL) | Statistical Threshold Value (cfu/100mL) | Single Sample Maximum (cfu/100mL) |
| 36 Illnesses per 1,000 Recreators | 126 | 410 | 235 |
| 32 Illnesses per 1,000 Recreators | 100 | 320 | 70 |

Note: The highlighted values are the Numeric Targets

Criteria were published for two different levels of illness risk. The first level of risk (36 estimated illnesses per 1,000 recreators) is the same risk level applied with the previous recreational criteria (i.e., U.S. EPA 1986). The 1986 U.S. EPA criteria correspond to the level of risk associated with an estimated illness rate of the number of highly credible gastrointestinal illnesses (HCGI) per 1,000 primary contact recreators. The information developed for the 2012 U.S. EPA criteria use a more comprehensive definition of GI illness, referred to as NEEAR-GI (NGI), which includes diarrhea without the requirement of a fever. Because NGI is broader than HCGI, more illness cases were reported and associated with recreation using the NGI definition of illness, at the same level of water quality observed using the previous illness definition (i.e., HCGI). The U.S. EPA (2012) also recommends criteria that correspond to an illness rate of 32 NGI per 1,000 primary contact recreators to "encourage an incremental improvement in water quality."

The 2012 U.S. EPA criteria are expressed as colony-forming units per sample volume (cfu/100mL) based on membrane filtration methods (U.S. EPA 2002a; U.S. EPA 2002b). Many laboratories, including the Regional Water Board Microbiology Laboratory, use a different analysis method to measure *E. coli* (and *Enterococcus*) bacteria concentrations (IDEXX 2001). These methods, (Colilert® and Enterolert® Quanti-Tray/2000) have been shown to produce equivalent results as the membrane filtration methods (Budnick et al. 1996; Yakub et al. 2002) and have been approved by the U.S. EPA in the Code of Federal Regulations (40 C.F.R. 136.3). Both methods are based on culturing the bacteria in the sample on nutrient media.

In addition to the 2012 U.S. EPA criteria, U.S. EPA suggests the use of the Beach Action Value (BAV) as a conservative, precautionary tool for making beach notification decisions. The BAV is not a component of EPA's recommended criteria, but a tool that states may choose to use, without adopting it into their water quality standards as a "do not exceed value" for beach notification purposes. The BAV is applied to single sample measurements: any single sample above the BAV could trigger a beach notification until another sample below the BAV is collected. States may also choose a qPCR-based BAV for beach notification purposes.

#### 2.2.2.1 *E. coli* Numeric Targets to Protect Recreational Uses

The *E. coli* bacteria numeric targets are expressed as a geometric mean and statistical threshold value in Table 2.7. The numeric targets are used to determine if water quality conditions attain the recreation-specific portion of the Bacteria Water Quality Objective and the extent of impairment by pathogen indicator bacteria in the Russian River Watershed. The *E. coli* numeric targets are equivalent to the *E. coli* TMDLs/loading capacities, as described in Chapter 6.

**Table 2.7. *E. coli* Bacteria Numeric Targets**

| Geometric Mean (cfu/100mL) | Statistical Threshold Value (cfu/100mL) |
|---|---|
| $\leq 100$ | $\leq 320$ |

Note: colony forming units (cfu) = most probable number (MPN)

The *E. coli* bacteria numeric targets are based on the U.S. EPA (2012) criteria that correspond to an illness rate of 32 NGI per 1,000 water contact recreators in order to provide additional protection. The *E. coli* bacteria concentration-based thresholds are calculated using a 30-day static averaging period, which is an unbiased method and the most appropriate approach for use in assessing *E. coli* bacteria concentration data (Butkus 2013b). Discrete 30-day periods for the static geometric mean calculations should be defined based on the Julian date of each year (i.e., 30-day period 1 for Julian days 1-30; 30-day period 2 for Julian days 31-60, etc.). The STV approximates the

90th percentile of the water quality distribution and is intended to be a value that should not be exceeded by more than 10% of the samples used to calculate the geometric mean.

### 2.2.3 FECAL COLIFORM BACTERIA

Fecal coliform bacteria are a subgroup of total coliform bacteria found mainly in the intestinal tracts of warm-blooded animals, and thus, are considered a more specific indicator of fecal contamination of water than the total coliform group.

While fecal coliform bacteria in a waterbody are not associated with illness during water contact recreation, fecal coliform bacteria are used to determine if a waterbody is a safe growing area for shellfish that will be consumed by humans.

The Basin Plan includes the following numeric values in the Bacteria Water Quality Objective for the protection of shellfish consumption.

> At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, Manual of Operation).

The objectives were derived from bacteriological standards that are still in use by the U.S. Food and Drug Administration, which maintains that water quality must meet the following standards in order for the waterbody to be classified as a growing area for commercially harvested shellfish (USFDA 2011, p. 40).

> The fecal coliform median or geometric mean MPN or MF of the water sample results shall not exceed fourteen (14) per 100 ml, and not more than ten (10) percent of the samples shall exceed an MPN or MF of:
>
> (a) 43 MPN per 100 ml for a five-tube decimal dilution test;
>
> (b) 49 MPN per 100 ml for a three-tube decimal dilution test . . .

Different criteria are provided to allow for flexibility for the analytical laboratory measurements. The two different numbers (i.e., 43 MPN/100mL and 49 MPN/100mL) are equivalent and represent the 90th percent confidence limits for different laboratory methods (*Standard Methods for the Examination of Water and Wastewater* 9221C).

The fecal coliform values in the Bacteria Water Quality Objective were established when multiple tube fermentation was the only analytical laboratory method available to measure fecal coliform bacteria concentrations. Improved technology has resulted in most (if not all) laboratories no longer using the multiple tube fermentation method. The U.S. EPA has approved IDEXX Colilert18 method for the measurement of fecal coliform bacteria in wastewater and ambient waters pending a future rulemaking process (U.S. EPA 2010). This analytical method has improved analytical precision over the multiple tube fermentation method. The IDEXX Colilert18 method is most similar to the five-tube decimal dilution test for the multiple tube fermentation method.

#### 2.2.3.1 Fecal Coliform Numeric Target to Protect Shellfish Consumption

The fecal coliform bacteria numeric target is expressed as a single sample maximum concentration of 43 MPN per 100 mL, applicable to Ukiah, Laguna de Santa Rosa, Santa Rosa Creek, Mark West Creek, Geyserville, and Guerneville HSAs. The numeric target is used to determine if water quality conditions attain the shellfish consumption portion of the Bacteria Water Quality Objective and the extent of impairment by pathogen indicator bacteria in the Russian River Watershed. The fecal coliform bacteria numeric target is equivalent to the fecal coliform bacteria TMDL/loading capacity, as described in Chapter 6.

The fecal coliform bacteria numeric target is based on and equal to the lower of the two values contained in the shellfish portion of the Bacteria Water Quality Objective. The lower value is used for this TMDL project as it is based on a five-tube decimal dilution test, which is most similar to the IDEXX Colilert18 laboratory method commonly used today.

### 2.2.4 MICROBIOME COMMUNITY

Analytical measurement technology has advanced to a point where entire bacterial communities are quantified instead of just specific pathogen indicator bacteria groups or species. High-throughput DNA sequence analysis can potentially identify all sources of microbial contaminants in a single test by measuring the total diversity of microbial communities. The PhyloChip™ (Second Genome, San Bruno CA) is a phylogenetic DNA microarray that has 16S rRNA gene probes that can quantify 59,316 different bacterial taxa in a single water sample. Analyzing the comprehensive suite of bacteria in a sample can help identify the major sources of fecal contamination in surface waters (Hazen et al. 2010).

Cluster analysis reveals strong differences in community composition among fecal wastes from human, birds, pinnipeds, and livestock. Differences in the diversity among fecal sources reveal hundreds of unique taxa that are specific to human, bird, and livestock feces (Dubinsky et al. 2012). Actinobacteria, Bacilli, and many Gammaproteobacteria taxa discriminated birds from mammalian sources. Families within the Clostridia and Bacteroidetes taxa discriminated between humans, livestock, and pinniped animal sources. Comprehensive interrogation of microbial communities for these diverse identifier taxa has great potential to improve the reliability of source detection in the environment. Phylogenetic microarrays are an effective tool for rapidly measuring the full assortment of microbial taxa that discriminate sources of fecal contamination. However, the technology is costly.

Numeric targets for the microbiome community are not proposed as epidemiological studies have not yet been conducted to link concentrations to illness rates. However, analysis of the microbiome community is used in the TMDL to understand sources of fecal waste, as described in Chapter 4.

# CHAPTER 3
# EVIDENCE OF IMPAIRMENT

This section describes the evidence of impairment of the Russian River and its tributaries by pathogen indicator bacteria, summarizes the basis for the current 303(d) impairment listings, and describes more recent data. This chapter is the problem statement.

All surface streams and river reaches in the Russian River Watershed are impaired by pathogen indicator bacteria, which are found in concentrations that exceed the Bacteria Water Quality Objective. The impairment is based on several lines of evidence.

1. Human-host and bovine-host *Bacteroides* bacteria are found in almost all sampling locations in the watershed at levels above the numeric targets for the attainment of natural background levels and recreational uses.
2. Concentrations of *E. coli* bacteria measured in several streams in the watershed exceed the numeric targets and indicate a potential risk of illness during water contact recreation.
3. Concentrations of fecal coliform bacteria measured in the mainstem Russian River and Santa Rosa Creek exceed numeric targets and indicate a potential risk of illness during human consumption of shellfish.
4. Bacteria species that are potential human pathogens are found at numerous locations in the watershed.
5. The 2012 Section 303(d) List of Impaired Waters identifies several reaches of the mainstem Russian River and several tributaries as impaired. The listings are based on data collected prior to August 2010.
6. Public health advisories warning of potential risk of illness from recreational water contact have been posted at mainstem Russian River beaches and along Santa Rosa Creek.

## 3.1 ASSESSMENT OF BACTEROIDES BACTERIA DATA

Regional Water Board staff collected water samples for measurement of human-host and bovine-host *Bacteroides* bacteria at numerous locations in the Russian River Watershed from 2011 to 2013 (NCRWQCB 2012; NCRWQCB 2013a; NCRWQCB 2013b). Sample locations are representative of the range of streams and rivers in the watershed. Samples were collected from waterbodies during both wet and dry periods and from a range of flows. Sample sites were located in waterbodies that drain the wide range of land uses (from urban to undeveloped) and geomorphic features (from bedrock to alluvial landscapes) in the watershed.

Human-host and bovine-host *Bacteroides* bacteria data were compared to the natural background numeric targets, which are centered around the current laboratory reporting limit of 60 genes/100mL for human-host and 30 genes/100mL for bovine-host *Bacteroides*. The median concentrations measured at each location in the Russian River Watershed are shown in Tables 3.1 through 3.4 and Figures 3.1 through 3.2.

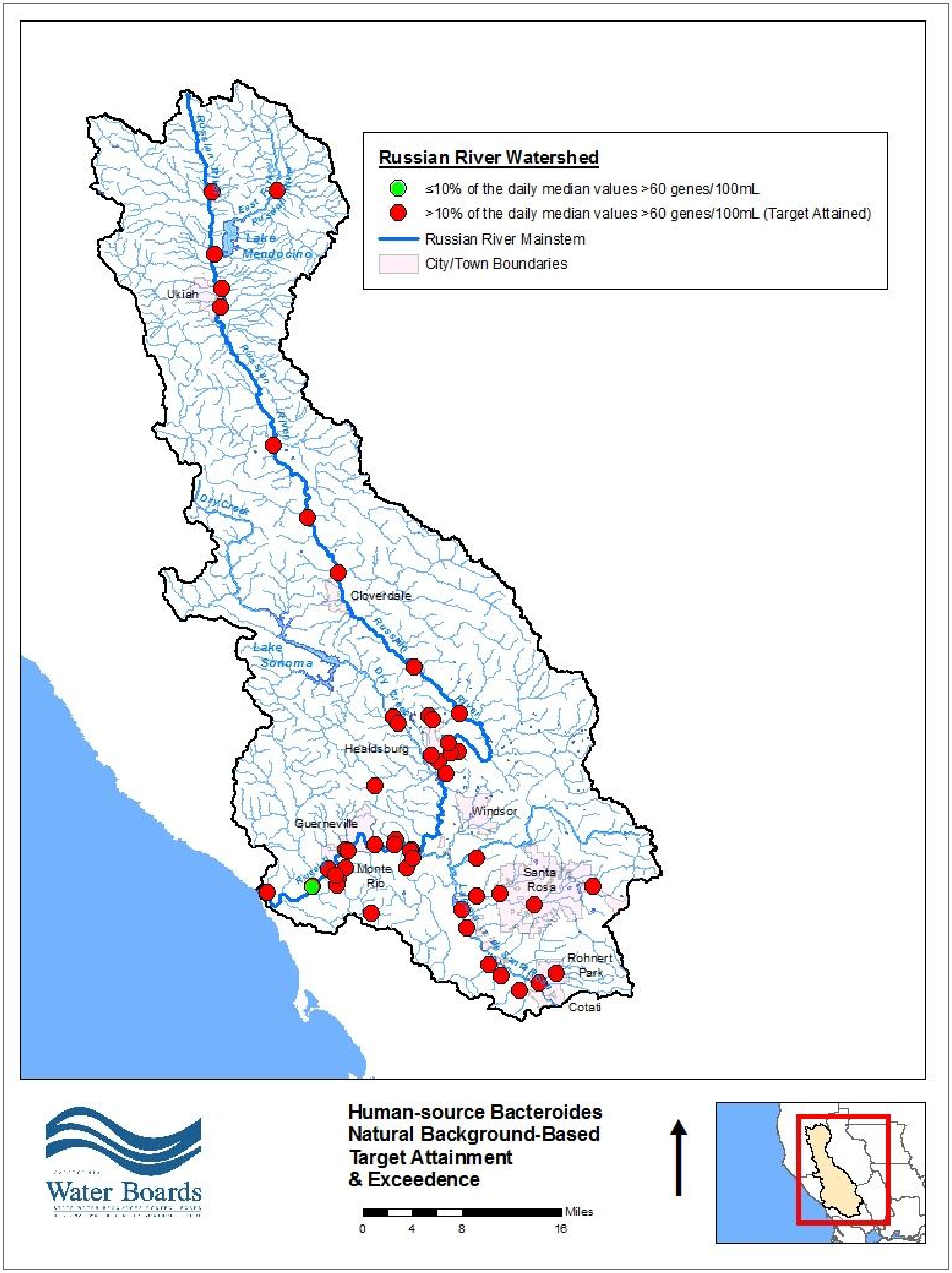



Figure 3.1. Human-host *Bacteroides* Natural Attainment & Exceedence

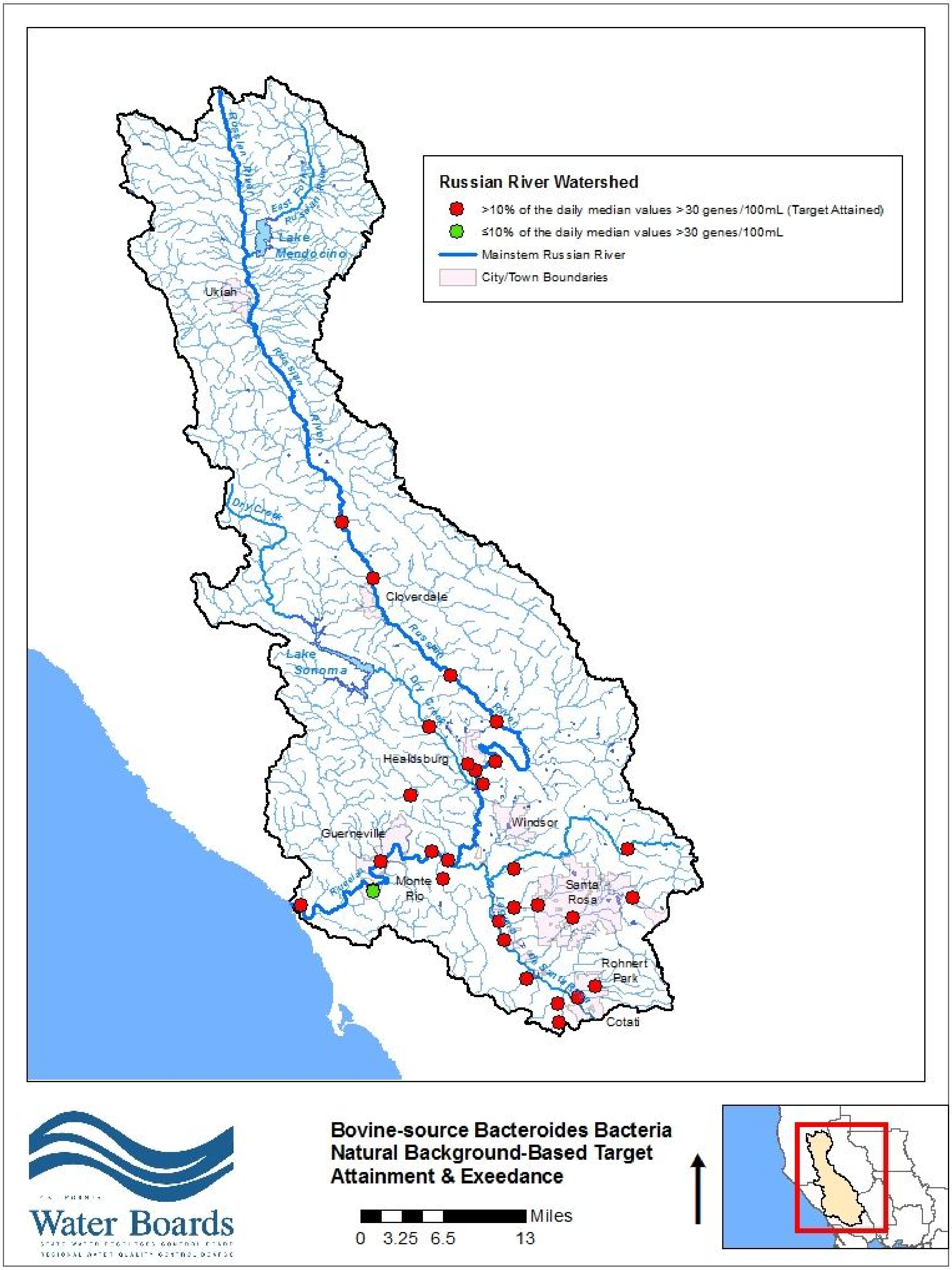



Figure 3.2 Bovine-Host *Bacteroides* Bacteria Attainment & Exceedence

Table 3.1. Human-Host *Bacteroides* Attainment & Exceedence in the Mainstem Russian River

| Russian River Location | Median Human-Host Bacteroides (genes/100mL) | Number of Measurements | | |
|---|---|---|---|---|
| | | | Number of Measurements > 60 | % Exceedence |
| East Fork at East Road, Potter Valley | 5,949 | 3 | 3 | 100% |
| East School Way, Redwood Valley | 979 | 3 | 3 | 100% |
| Lake Mendocino Drive, Ukiah | 3,275 | 3 | 3 | 100% |
| Vichy Springs Road, Ukiah | 11,803 | 3 | 3 | 100% |
| Talmadge Road, Ukiah | 9,293 | 3 | 3 | 100% |
| River Road, Hopland | 1,898 | 3 | 3 | 100% |
| Commisky Station Road, Cloverdale | 2,731 | 2 | 2 | 100% |
| River Park, Cloverdale | 1,087 | 2 | 2 | 100% |
| Hwy 128 Bridge, Geyserville | 13,501 | 2 | 2 | 100% |
| Jimtown Bridge, Healdsburg | 37,052 | 2 | 2 | 100% |
| Camp Rose Beach, Healdsburg | 31,055 | 2 | 2 | 100% |
| Veteran Memorial Beach, Healdsburg | 14,921 | 10 | 10 | 100% |
| Steelhead Beach, Forestville | 48,485 | 2 | 2 | 100% |
| River Access Beach, Forestville | 57,554 | 2 | 2 | 100% |
| Johnson's Beach, Guerneville | 1,677 | 10 | 10 | 100% |
| Monte Rio Beach, Monte Rio | 8,898 | 18 | 18 | 100% |
| Public Boat Ramp, Jenner | 4,837 | 2 | 2 | 100% |

Table 3.2. Bovine-Host *Bacteroides* Attainment & Exceedence in the Mainstem Russian River

| Russian River Location | Median Human-Host Bacteroides (genes/100mL) | Number of Measurements | Natural Background-Based Target | |
|---|---|---|---|---|
| | | | Number of Measurements > 60 | % Exceedence |
| Commisky Station Road, Cloverdale | 5,413 | 2 | 2 | 100% |
| River Park, Cloverdale | 710 | 2 | 2 | 100% |
| Hwy 128 Bridge, Geyserville | 236 | 2 | 2 | 100% |
| Jimtown Bridge, Healdsburg | 116 | 2 | 2 | 100% |
| Camp Rose Beach, Healdsburg | 286 | 2 | 2 | 100% |
| Veteran Memorial Beach, Healdsburg | 381 | 2 | 2 | 100% |
| Steelhead Beach, Forestville | 23,684 | 2 | 2 | 100% |
| River Access Beach, Forestville | 14,710 | 2 | 2 | 100% |
| Johnson's Beach, Guerneville | 85 | 7 | 7 | 100% |
| Monte Rio Beach, Monte Rio | 762 | 10 | 10 | 100% |
| Public Boat Ramp, Jenner | 2,682 | 2 | 2 | 100% |

Table 3.3. Human-Host *Bacteroides* Attainment & Exceedence in Tributary Streams

| Tributary | Location | Median Human-Host Bacteroides (genes/100mL) | Number of Measurements | Natural Background-Based Target | |
|---|---|---|---|---|---|
| | | | | Number of Measurements > 60 | % Exceedence |
| Abramson Creek | Willowside Rd Path, Santa Rosa | 273,401 | 4 | 4 | 100% |
| Blucher Creek | Lone Pine Road, Cotati | 18,022 | 2 | 2 | 100% |
| Copeland Creek | Commerce Blvd, Rohnert Park | 19,928 | 2 | 2 | 100% |
| Crane Creek | Snyder Ln., Rohnert Park | 26,703 | 2 | 2 | 100% |
| Dutch Bill Creek | Main Street, Monte Rio | 416 | 2 | 1 | 50% |
| Foss Creek | Matheson Street, Healdsburg | 37,346 | 2 | 2 | 100% |
| Gossage Creek | Stony Glen Lane, Cotati | 29,902 | 2 | 2 | 100% |
| Green Valley Creek | Martinelli Road, Forestville | 17,016 | 2 | 2 | 100% |
| Laguna de Santa Rosa | Community Center, Sebastopol | 7,469 | 2 | 2 | 100% |
| Mays Creek | Neeley Road, Guerneville | 1,325 | 2 | 2 | 100% |
| Palmer Creek | Palmer Creek Road, Healdsburg | 2,781 | 2 | 1 | 50% |
| Piner Creek | Fulton Road, Santa Rosa | 12,394 | 2 | 2 | 100% |
| Santa Rosa Creek | Hwy 12, Santa Rosa | 2,727 | 2 | 2 | 100% |
| Santa Rosa Creek | Railroad Street, Santa Rosa | 32,909 | 2 | 2 | 100% |
| Van Buren Creek | Erland Road, Santa Rosa | 2,089 | 2 | 1 | 50% |
| Unnamed Creek | Lambert Bridge Road, Healdsburg | 5,257 | 2 | 2 | 100% |
| Unnamed Creek | Fitch Mountain Road, Healdsburg | 238 | 6 | 5 | 83% |
| Unnamed Creek | Fredson Road, Healdsburg | 8,580 | 5 | 5 | 100% |
| Unnamed Creek | West Dry Creek Road, Healdsburg | 4,040 | 5 | 5 | 100% |
| Unnamed Creek | Alexander Valley Road, Healdsburg | 2,031 | 5 | 4 | 80% |
| Unnamed Creek | Redwood Drive, Healdsburg | 2,310 | 5 | 5 | 100% |
| Unnamed Creek | Limerick Road, Healdsburg | 20,000 | 4 | 4 | 100% |
| Unnamed Creek | Summerhome Park Rd, Forestville | 7,975 | 4 | 4 | 100% |
| Unnamed Creek | Trenton Road, Forestville | 48,200 | 5 | 5 | 100% |
| Unnamed Creek | Del Rio Court, Forestville | 3,460 | 3 | 3 | 100% |
| Unnamed Creek | River Road, Rio Nido | 3,600 | 3 | 2 | 67% |
| Unnamed Creek | Foothill Drive, Monte Rio | 371,000 | 1 | 1 | 100% |
| Unnamed Creek | Duncan Road, Monte Rio | 353 | 3 | 2 | 67% |
| Unnamed Creek | Old Monte Rio Road, Monte Rio | 25,100 | 4 | 4 | 100% |
| Unnamed Creek | Main Street, Monte Rio | 1,392 | 5 | 4 | 80% |
| Unnamed Creek | Moscow Road, Duncans Mills | <60 | 1 | 0 | 0% |
| Unnamed Creek | Lakeside Ave, Camp Meeker | 9,090 | 4 | 4 | 100% |
| Unnamed Creek | Sanford Road, Sebastopol | 1,576 | 4 | 4 | 100% |
| Unnamed Creek | Daywalt Road, Cotati | 37,632 | 2 | 2 | 100% |
| Unnamed Creek | River Road, Fulton | 2,759 | 4 | 4 | 100% |

Table 3.4. Bovine-Host *Bacteroides* Bacteria Attainment & Exceedence in Tributary Streams

| Tributary | Location | Median Human-Host Bacteroides (genes/100mL) | Number of Measurements | Number of Measurements > 60 genes/100mL | % Exceedence |
|---|---|---|---|---|---|
| Abramson Creek | Willowside Road Path, Santa Rosa | 425,164 | 4 | 4 | 100% |
| Blucher Creek | Lone Pine Road, Cotati | 177,248 | 2 | 2 | 100% |
| Copeland Creek | Commerce Blvd, Rohnert Park | 51,685 | 2 | 2 | 100% |
| Crane Creek | Snyder Ln., Rohnert Park | 23,602 | 2 | 2 | 100% |
| Dutch Bill Creek | Main Street, Monte Rio | 15 | 2 | 0 | 0% |
| Foss Creek | Matheson St., Healdsburg | 8,668 | 2 | 1 | 50% |
| Gossage Creek | Stony Glen Lane, Cotati | 76,895 | 2 | 2 | 100% |
| Green Valley Creek | Martinelli Rd., Forestville | 72 | 2 | 2 | 100% |
| Laguna de Santa Rosa | Community Center, Sebastopol | 514 | 2 | 1 | 50% |
| Mays Creek | Neeley Road, Guerneville | 608 | 2 | 2 | 100% |
| Palmer Creek | Palmer Creek Road, Healdsburg | 106 | 2 | 1 | 50% |
| Piner Creek | Fulton Road, Santa Rosa | 3,274 | 2 | 2 | 100% |
| Santa Rosa Creek | Hwy 12, Santa Rosa | 181 | 2 | 2 | 100% |
| Santa Rosa Creek | Railroad St., Santa Rosa | 7,765 | 2 | 2 | 100% |
| Van Buren Creek | Erland Road, Santa Rosa | 2,265 | 2 | 1 | 50% |
| Unnamed Creek | Sanford Road, Sebastopol | 482 | 4 | 4 | 100% |
| Unnamed Creek | Lambert Bridge Road, Healdsburg | 453 | 2 | 1 | 50% |
| Unnamed Creek | Limerick Rd., Healdsburg | 1,966 | 4 | 4 | 100% |
| Unnamed Creek | Daywalt Road, Cotati | 867,503 | 2 | 1 | 50% |
| Unnamed Creek | River Road, Fulton | 768 | 4 | 4 | 100% |

Assessment of the human-host *Bacteroides* bacteria data shows that bacteria from human waste are widespread throughout the Russian River Watershed. Human-host *Bacteroides* bacteria are present at levels that exceed the numeric target in all 17 mainstem locations, and in all but one of the 35 tributary locations sampled by Regional Water Board staff. Of the 179 samples collected in these 52 sites, 95% of the samples exceed the numeric target.

For bovine-host *Bacteroides* bacteria, quantifiable levels were found in all 11 mainstem locations, and in all but one of the 19 tributary locations. Of the 83 samples collected, 95% of the samples also exceed the numeric target.

These results demonstrate that human and domestic animal fecal wastes are present in amounts that indicate the bacteriological quality of the Russian River and its tributaries is degraded beyond minimally disturbed conditions in violation of the natural background portion of the Bacteria Water Quality Objective.

## 3.2 ASSESSMENT OF *E. COLI* BACTERIA DATA

*E. coli* bacteria data from the Russian River Watershed were compiled from three agencies: the Regional Water Board, the Sonoma County Water Agency, and the University of California (UC) Davis Aquatic Ecosystems Analysis Laboratory. As with the *Bacteroides* bacteria data, sample locations are representative of the range of streams and rivers in the watershed. Water samples were collected at 29 locations from 2001 to 2013 for analysis of *E. coli* bacteria concentrations (NCRWQCB 2012, 2013a, 2013b).

Water samples were analyzed by IDEXX Colilert and were either undiluted or serially diluted 1:10, resulting in a minimum reporting limit of 1 or 10 MPN/100mL and a maximum reporting limit of 2,419 or 24,196 MPN/100mL. Sample measurements below and above analytical reporting limits are called censored data. When bacteria concentration results were beyond any of these limits, the reporting limit was substituted for censored data.

Data were assessed using both the rolling 30-day averaging and static/discrete 30-day averaging approaches (Butkus 2013b); the discrete 30-day averaging period method is used when assessing bacteria concentrations for this TMDL project. More locations are identified as impaired using a rolling 30-day averaging period due to the inclusion of single sampling events with high bacteria concentrations into multiple averaging periods. However, the rolling 30-day averaging period violates the statistical assumption of independent samples required for the application of the binomial distribution of the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (SWRCB 2004), which is also known as the Listing Policy. Discrete 30-day periods were defined based on the Julian calendar date of each year (i.e., 30-day period 1 for Julian days 1-30; 30-day period 2 for Julian days 31-60, etc.).

Attainment of the recreation portion of the Bacteria Water Quality Objective was determined using *E. coli* bacteria concentrations measured at each specific sampling location using the *E. coli* numeric target and Table 3.2 of the Listing Policy. The Listing Policy uses a binomial distribution for listing decisions that minimizes error based on sample size and number of samples exceeding the numeric target. The results of the assessment for *E. coli* bacteria concentrations are presented in Figure 3.3 and Table 3.5 for discrete 30-day averaging periods.

The results verify there is evidence of impairment and non-attainment of the recreation portion of the Bacteria Objective from *E. coli* in the Russian River Watershed at Foss Creek, Green Valley Creek, the Laguna de Santa Rosa, Matanzas Creek, and Santa Rosa Creek.

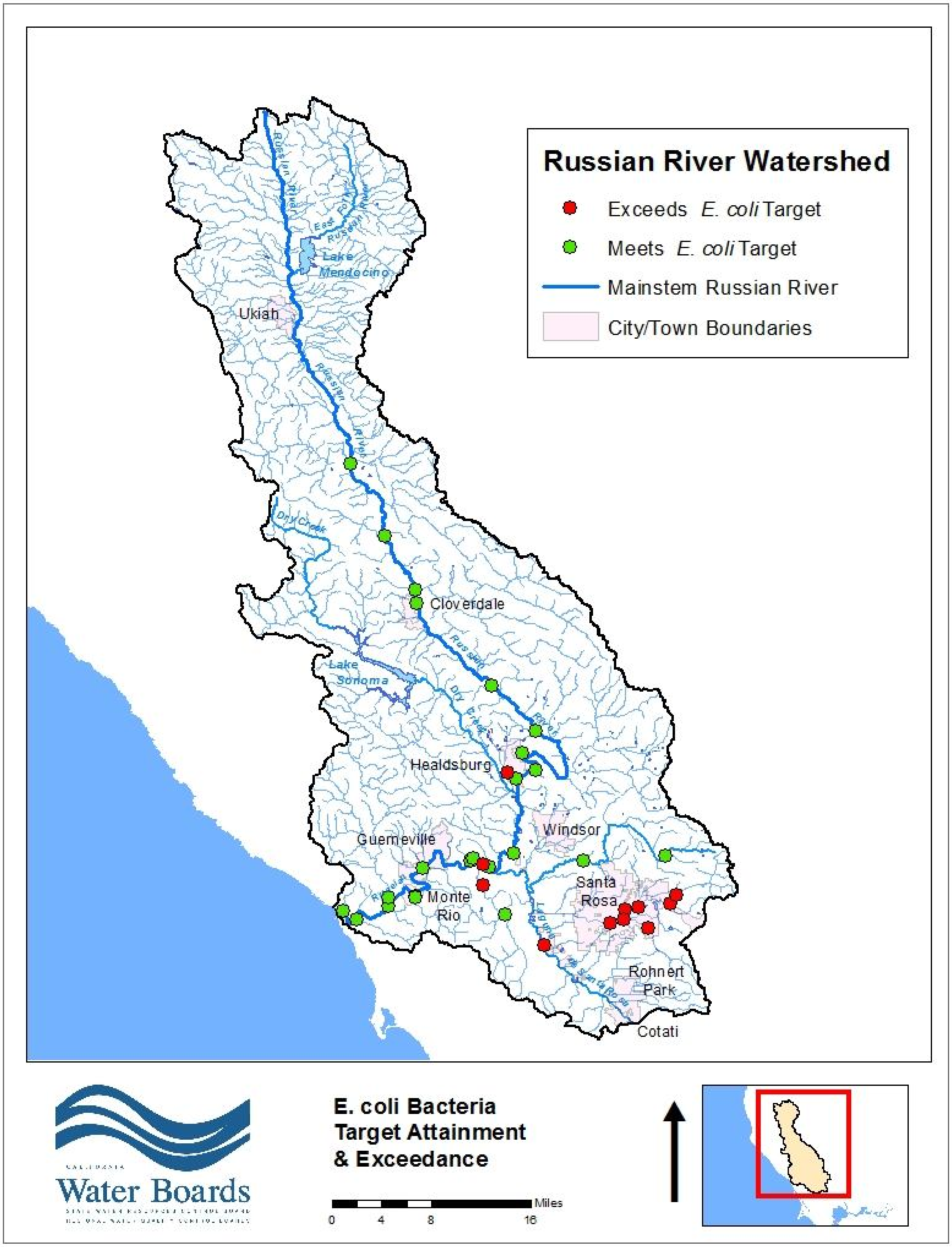



Figure 3.3. *E. coli* Bacteria Target Attainment & Exceedence

Table 3.5. *E. coli* Bacteria Target Attainment & Exceedence

| Location | Number of 30-day Periods Sampled | Number of Periods that Exceed Geomean or STV Targets[1] | Considered Impaired per 303(d) Listing Policy |
|---|---|---|---|
| Russian River at East School Way | 1 | 0 | * |
| Russian River at Lake Mendocino Drive | 1 | 0 | * |
| Russian River at Vichy Springs Road | 1 | 0 | * |
| Russian River at Talmadge Road | 1 | 0 | * |
| Russian River at River Road (Hopland) | 6 | 0 | No |
| Russian River at Commisky Station Rd | 18 | 1 | No |
| Russian River at Cloverdale River Park | 9 | 0 | No |
| Russian River at Crocker Rd | 4 | 0 | No |
| Russian River at Geyserville Bridge | 12 | 1 | No |
| Russian River at Jimtown Bridge | 23 | 0 | No |
| Russian River at Diggers Bend | 12 | 0 | No |
| Russian River at Camp Rose Beach | 49 | 0 | No |
| Russian River at Healdsburg Veteran Memorial Beach | 55 | 2 | No |
| Russian River at Riverfront Park | 18 | 0 | No |
| Russian River at Steelhead Beach | 52 | 1 | No |
| Russian River at River Access Beach | 28 | 1 | No |
| Russian River at Hacienda Bridge | 6 | 0 | No |
| Russian River at Johnson’s Beach | 49 | 0 | No |
| Russian River at Monte Rio Beach | 61 | 5 | No |
| Russian River at Casini Ranch Campground | 12 | 0 | No |
| Russian River at Bridgehaven Station | 12 | 2 | No |
| Russian River at Duncans Mills | 12 | 1 | No |
| Russian River at Jenner Boat Ramp | 17 | 2 | No |
| Atascadero Creek at Green Valley Road | 6 | 4 | No |
| Dutch Bill Creek | 6 | 0 | No |
| East Fork Russian River | 1 | 0 | * |
| Foss Creek at Matheson Street | 7 | 7 | Yes |
| Green Valley Creek at Martinelli Road and River Road | 5 | 4 | Yes |
| Laguna de Santa Rosa at Sebastopol Community Park | 11 | 6 | Yes |
| Matanzas Creek at Doyle Park and Bethards Drive | 8 | 7 | Yes |
| Mark West Ck at Old Redwood Hwy & Trenton Healdsburg Rd | 11 | 3 | No |
| Santa Rosa Creek at Wildwood Drive, Highway 12, upstream of Rincon Creek, at Alderbrook Drive, and at Railroad Street | 61 | 59 | Yes |

[1] Number of periods that exceed either the numeric target geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL)
* Inadequate sample size for 303(d) Listing Policy decision on stream reach

## 3.3 ASSESSMENT OF FECAL COLIFORM BACTERIA DATA

Fecal coliform bacteria data from the Russian River Watershed were compiled from samples collected from 1980 to 2001 by Regional Water Board staff. Samples were collected from the mainstem Russian River at Camp Rose Beach, Veteran Memorial Beach, Johnson’s Beach, and Monte Rio Beach, and from Santa Rosa Creek at Railroad Street along the Prince Memorial Greenway.

Attainment of the shellfish consumption portion of the Bacteria Water Quality Objective was determined using the fecal coliform numeric target (samples shall not exceed 43 MPN / 100mL) and Table 3.2 of the Listing Policy. The Listing Policy uses a binomial distribution for listing decisions that minimizes error based on sample size and number of samples exceeding the numeric target. The results of the assessment for fecal coliform bacteria concentrations are presented in Table 3.6. The table also indicates whether the number of exceedences of the numeric target was high enough for the beach to be considered impaired per Section 3.3 of the Listing Policy.

The results verify there is evidence of impairment and non-attainment of the shellfish consumption portion of the Bacteria Objective from fecal coliform in the Russian River Watershed at all sampled locations.

Table 3.6. Fecal Coliform Bacteria Target Attainment & Exceedence

| Location | Number of Measurements | Number of Measurements > 43 MPN/100mL | % Exceedence | Considered Impaired per 303(d) Listing Policy |
|---|---|---|---|---|
| Russian R. at Camp Rose Beach | 91 | 15 | 16% | Yes |
| Russian R. at Veteran Memorial Beach | 143 | 117 | 82% | Yes |
| Russian R. at Johnson's Beach | 86 | 38 | 44% | Yes |
| Russian R. at Monte Rio Beach | 71 | 38 | 54% | Yes |
| Santa Rosa Creek at Railroad Street | 16 | 16 | 100% | Yes |

## 3.4 ASSESSMENT OF PATHOGENIC SPECIES

Pathogenic bacteria and protozoans are occasionally measured directly without relying on indicator bacteria species, and the ability to do so is increasing with continuing advances in DNA technology. This section describes detections of pathogenic organisms and provides additional evidence of impairment.

### 3.4.1 PATHOGENIC BACTERIA DETECTIONS

Regional Water Board staff collected water samples for development of this TMDL project from 2011 to 2013 (NCRWQCB 2012, 2013a, 2013b). The monitoring focused on microbiological source identification in the middle and lower Russian River Watershed. Over one hundred samples were analyzed by the Lawrence Berkeley National Laboratory using the PhyloChip™ phylogenetic DNA microarray, which evaluates 16S rRNA gene sequences to identify different bacteria taxa. Taxa were identified, but not quantified. The analysis results (Dubinsky and Anderson 2014) are summarized in this section and in a memo to the file record (Butkus 2014a).

Over 10,000 different bacteria taxa were identified in the samples from the Russian River Watershed. Most of the taxa detected are in the Actinobacteria phylum, Flavobacteria order, and Proteobacteria phylum of bacteria, which are naturally abundant in freshwater and soil, and do not likely originate from animal fecal sources. However, a substantial number of taxa in the Bacteroidia class, Clostridia class, Bacilli class, and Verrucomicrobia phylum of bacteria were also found in the samples. These taxa likely originate from fecal sources and individual pathogenic species are found within these taxa groups.

The human health risk associated with the presence of pathogenic bacteria is unknown since detection of a pathogenic species does not necessarily indicate that illness will occur. Some pathogenic bacteria are only pathogenic under certain circumstances, such as contact with an open wound. Additionally, there can be more than one strain of a particular bacterium species, and not all strains are pathogenic. Therefore, the results of the PhyloChip™ analysis, as presented in Table 3 .6, show a list of bacteria species found in the Russian River Watershed that have the potential to be human pathogens and cause illness.

**Table 3.7. Potential Human Pathogens Detected in the Russian River Watershed**

| Pathogenic Bacteria Species | Health Impact | Number of Locations with Detected Species | | Percent of Samples with Detected Bacteria |
|---|---|---|---|---|
| | | Mainstem | Tributaries | |
| *Klebsiella pneumoniae* | Pneumonia | 10 | 23 | 42% |
| *Proteus mirabili* | Urinary Tract Infections | 1 | 10 | 11% |
| *Salmonella enterica* | Gastroenteritis | 1 | 9 | 10% |
| *Serratia marcescens* | Infections, Pneumonia, Meningitis | 3 | 27 | 41% |
| *Shigella flexneri* | Gastroenteritis | 0 | 15 | 16% |
| *Staphylococcus epidermidis* | Infections | 3 | 13 | 22% |
| *Staphylococcus haemolyticus* | Infections | 2 | 0 | 2% |
| *Streptococcus sp.* | Infections | 0 | 8 | 8% |
| *Vibrio cholerae* | Cholera | 0 | 1 | 1% |
| *Yersinia sp.* | Plague | 4 | 7 | 15% |

### 3.4.2 CRYPTOSPORIDIUM AND GIARDIA DETECTIONS

The Sonoma County Water Agency conducted monitoring for *Cryptosporidium* and *Giardia* oocysts in the Russian River near Wohler Bridge from 2004 through 2006 as part of their Sanitary Survey (Palencia & Archibald 2013). The SCWA found three *Giardia* cysts and five *Cryptosporidium* oocysts out of 660 L of water from 48 samples. *Giardia lamblia* and *Cryptosporidium parvum* are pathogens that can cause gastrointestinal illness. The low number of *Cryptosporidum* oocysts detected meant no additional treatment is needed for the drinking water collected from the Russian River near Wohler Road (71 FR 775).

## 3.5 303(D) IMPAIRED WATER LISTINGS

The 2012 Section 303(d) List of Impaired Waters was approved by the USEPA on [Date Pending – expected late 2015]. The List identifies six water body-pollutant pairs in the Russian River Watershed as not supporting the REC-1 beneficial use or not attaining the Bacteria Water Quality Objective. These waterbodies are the Russian River at Veterans Memorial Beach, Russian River between the confluences of Fife Creek in Guerneville and

Dutch Bill Creek in Monte Rio, an unnamed stream near Healdsburg at Fitch Mountain, Laguna de Santa Rosa, Santa Rosa Creek , Green Valley Creek, and Dutch Bill Creek.

The data assessment that supports the official 2012 303(d) listings was valid, and the listings provide a line of evidence of pathogen impairment in the Russian River Watershed. Since that assessment was completed, additional data have been collected, criteria have been updated, and assessment methods have improved. *E. coli* data used in the listing process were also used for this TMDL project. Data were reassessed in accordance with improved criteria and methods, and the results are described in the previous section.

The following explains the differences in data assessment in the listing process vs. this TMDL project. In order to determine whether a water body should be listed as impaired on the 303(d) List, instream measurements of *E. coli* and fecal coliform bacteria concentrations collected and submitted prior to August 2010 were assessed. Data collected both before and after 2010 are assessed in this TMDL project. In this TMDL project, fecal coliform data are not assessed to determine attainment of recreational uses due to the superiority of *E. coli* over fecal coliform. For the 303(d) List assessment, *E. coli* data were compared against the draft California Department of Health Services (CDHS 2006) guidance for posting advisories at fresh water beaches. The draft guidance identifies a single sample concentration level of 235 MPN/100 mL as a threshold for posting a beach advisory to inform swimmers of potential risk. The draft guidance also recommends a 30-day average value of 126 MPN/100 mL applied on a rolling basis. Since assessment of the 2012 Section 303(d) List data began, the U.S. EPA established their 2012 Recreational Water Quality Criteria. The U.S. EPA's criteria are the basis for the numeric targets used in this TMDL project.

Detailed information on listing decisions and respective lines of evidence can be found at: http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/303d/.

## 3.6 PUBLIC HEALTH ADVISORIES

Local agencies use information on pathogen indicator concentrations to post streams with public health advisories that warn against swimming and water recreation. The City of Santa Rosa posts a permanent advisory for swimming in Santa Rosa Creek at Prince Memorial Greenway. This advisory is based on pathogen indicator concentrations measured in the stream near the Railroad Street Bridge. The Sonoma County Department of Health Services uses indicator bacteria data to temporarily post Russian River beaches when concentrations exceed thresholds during the summer recreation season. Table 3.3 lists the number of days with posted advisories each year since 2001 (Tyler 2013; SCDHS 2014). Since 2001, Russian River beaches have been posted with advisories 157 days.

*E. coli* data used by the City of Santa Rosa and the County of Sonoma for posting advisories are assessed by the TMDL, and the results are described in Section 3.2.

Table 3.8. Russian River Beach Advisories Issued by the Sonoma Co. Department of Health Services

| Year | Number of Beaches Sampled | Number of Posted Advisories (Days) |
|---|---|---|
| 2001 | 6 | 0 |
| 2002 | 6 | 1 |
| 2003 | 6 | 1 |
| 2004 | 6 | 0 |
| 2005 | 6 | 0 |
| 2006 | 6 | 1 |
| 2007 | 6 | 3 |
| 2008 | 6 | 11 |
| 2009 | 10 | 80 |
| 2010 | 6 | 5 |
| 2011 | 7 | 7 |
| 2012 | 9 | 36 |
| 2013 | 8 | 9 |
| 2014 | 9 | 3 |
| Total Days Posted Since 2001 | | 157 |

# CHAPTER 4
# SOURCE ANALYSIS

This chapter identifies the major sources of pathogenic indicator bacteria found in the surface waters of Russian River Watershed.

Sources are analyzed in three ways:

1. By assessing the type of animal fecal waste, including human waste, found in the Russian River and its tributaries and identifying areas of higher and lower DNA matches in the watershed.
2. By assessing indicator bacteria concentrations from different types of land uses.
3. By identifying the types of point source and nonpoint source facilities and activities that discharge or have the potential to discharge fecal waste to surface waters.

## 4.1 HUMAN, GRAZER, & BIRD FECAL WASTE SOURCES & DISTRIBUTION

Regional Water Board staff collected water samples for development of this TMDL project from 2011 to 2013 (NCRWQCB 2012, 2013a, 2013b). The monitoring included microbiological source identification in the middle and lower Russian River Watershed. Over one hundred samples were analyzed by the Lawrence Berkeley National Laboratory using the PhyloChip™ phylogenetic DNA microarray, which evaluates 16S rRNA gene sequences to estimate the percentage of the bacteria DNA gene sequences found in a water sample that match a specific DNA profile of a reference fecal source. The analysis results (Dubinsky and Anderson 2014) are summarized in this section and in a memo to the file record (Butkus 2014a).

Specific DNA profiles of fecal waste from humans, grazing mammals, and birds were collected, composited, and cataloged by the laboratory. The library of DNA profiles includes human waste samples from raw sewage, septic waste, and feces. The DNA profile for grazing mammals includes samples of droppings from cows, horses, deer, and elk. The profile for birds includes samples of droppings from gulls and pelicans.

Water samples from the Russian River Watershed were compared to the library of DNA profiles from known human, grazer, and bird wastes to determine the percentage of the bacteria DNA gene sequences that match the known profiles.

### 4.1.1 RESULTS

The results for human fecal waste are mapped in Figure 4.1. The ten locations with the highest human fecal waste measured are shown in Table 4.1. There is a wide range of human fecal waste DNA matches found in the Russian River and its tributaries. Within the watershed, 0% to 89% of the bacteria DNA gene sequences in the water samples match known human waste gene sequences. Higher percent matches are found in the Laguna de Santa Rosa Watershed and in the Lower Russian River area.

The results for grazer fecal waste are mapped in Figure 4.2. The ten locations with the highest grazer fecal waste measured are shown in Table 4.1. Within the watershed, 1% to 36% of the bacteria DNA gene sequences in the water samples match known grazing mammal gene sequences. The majority of the sites with highest percent matches are in the Laguna de Santa Rosa Watershed.

The results for bird fecal waste are mapped in Figure 4.3. The ten locations with the highest bird fecal waste measured are shown in Table 4.1. Within the watershed, 1% to 19% of the bacteria DNA gene sequences in the water samples match known bird gene sequences. Higher percent matches are fairly evenly distributed throughout the tributaries in the watershed.

**Table 4. 1. Locations with the Highest Percent of Matches Between Bacteria DNA Sequences in Russian River Watershed Samples and Known Human, Grazer, and Bird Fecal Waste**

| Sample Location | Gene Sequences Percent Match |
|---|---|
| **Human Fecal Waste Top Ten Sites** | |
| Unnamed stream in Monte Rio at Foothill Drive | 89 |
| Russian River at Monte Rio Beach | 59 |
| Unnamed stream in Forestville at Trenton Road | 54 |
| Russian River at Johnson's Beach (Oct. 6, 2011) | 54 |
| Limerick Creek at Old Redwood Highway | 52 |
| Russian River at Johnson's Beach (Sept. 26, 2011) | 50 |
| Unnamed stream in Forestville at Trenton Road | 41 |
| Piner Creek at Fulton Road | 32 |
| Copeland Creek at Commerce Drive | 24 |
| Crane Creek at Snyder Lane | 21 |
| **Grazer Fecal Waste Top Ten Sites** | |
| Abramson Creek at Willowside Road Levy | 36 |
| Unnamed Stream near Sebastopol at Daywalt Road | 34 |
| Crane Creek at Snyder Lane | 34 |
| Copeland Creek at Commerce Drive | 33 |
| Blucher Creek at Lone Pine Road | 33 |
| Gossage Creek at Gilmore Avenue | 30 |
| Unnamed Stream in Monte Rio at Foothill Drive | 23 |
| Russian River at Monte Rio Beach | 20 |
| Limerick Creek at Old Redwood Highway | 20 |
| Russian River at Forestville Access Beach | 19 |
| **Bird Fecal Waste Top Ten Sites** | |
| Piner Creek at Fulton Road | 19 |
| Abramson Creek at Willowside Road Levy | 14 |
| Palmer Creek at Palmer Creek Road | 12 |
| Limerick Creek at Old Redwood Highway | 11 |
| Lambert Creek at Lambert Bridge Road | 11 |
| Unnamed Stream in Monte Rio at River Road | 10 |
| Crane Creek at Synder Lane | 10 |
| Woolsey Creek at River Road | 10 |
| Unnamed Stream near Monte Rio at Foothill Drive | 10 |
| Dutch Bill Creek at Fir Road | 10 |

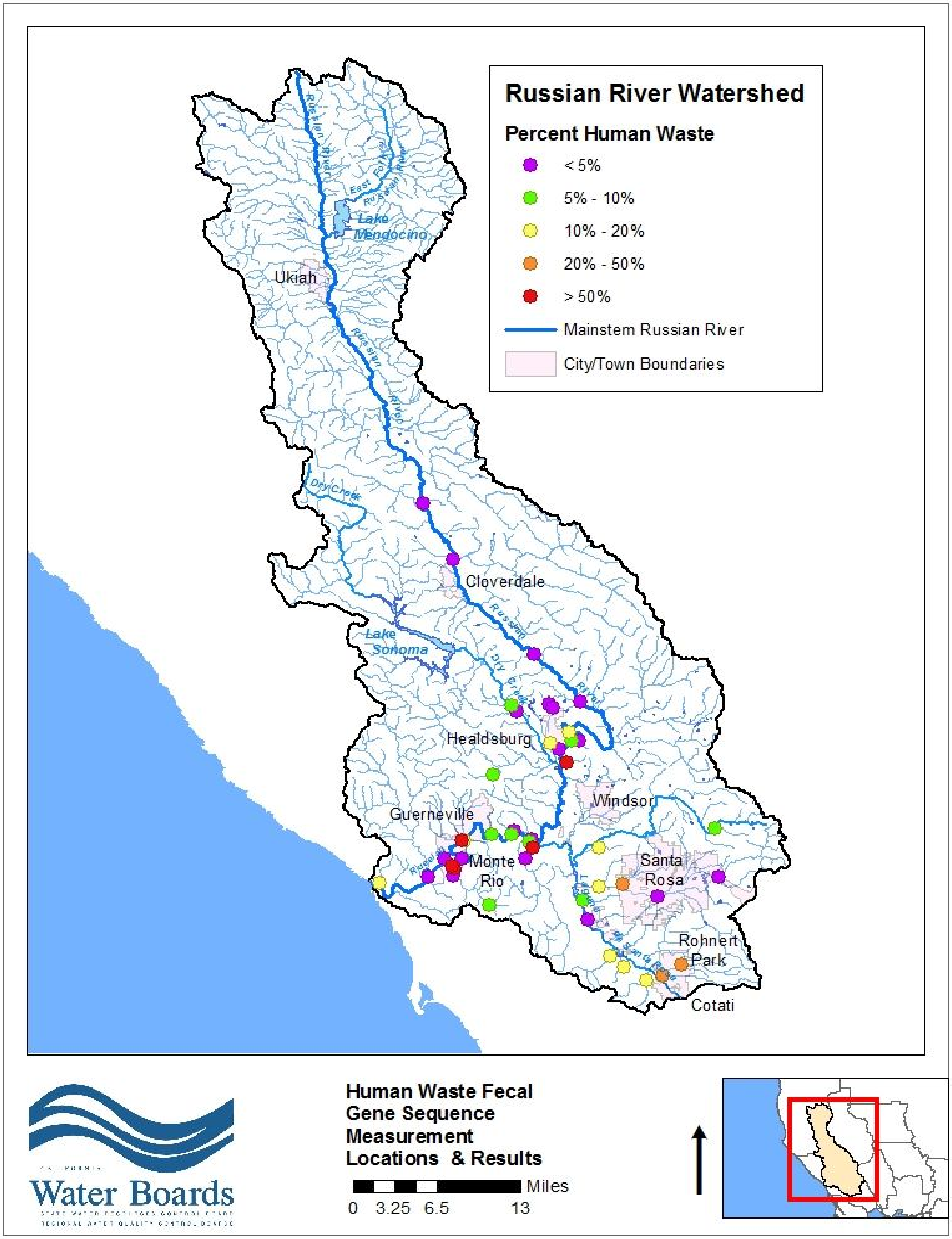



Figure 4.1. Human Waste Fecal Gene Sequence Measurement Locations and Results

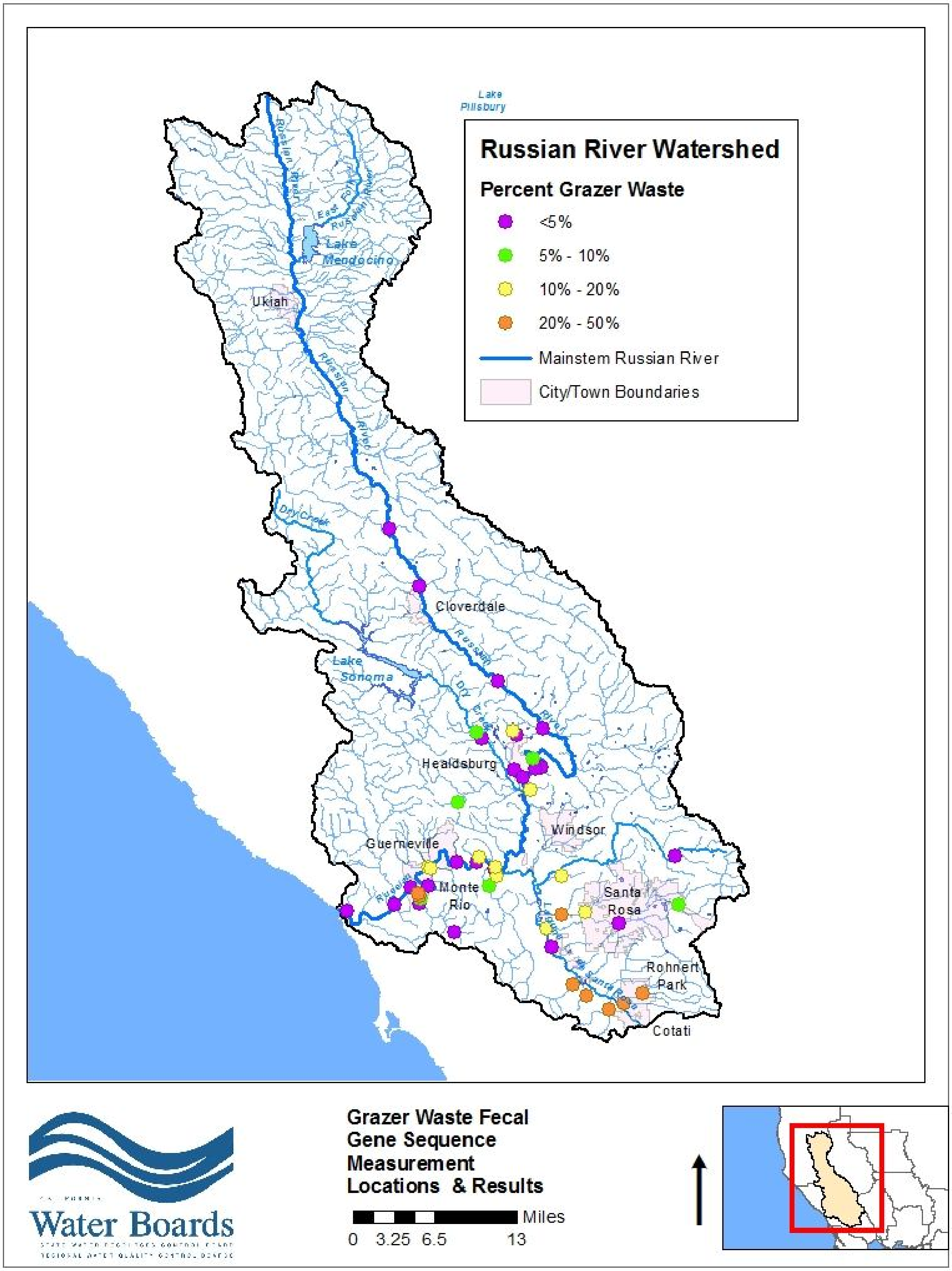



Figure 4.2. Grazer Waste Fecal Gene Sequence Measurement Locations and Result

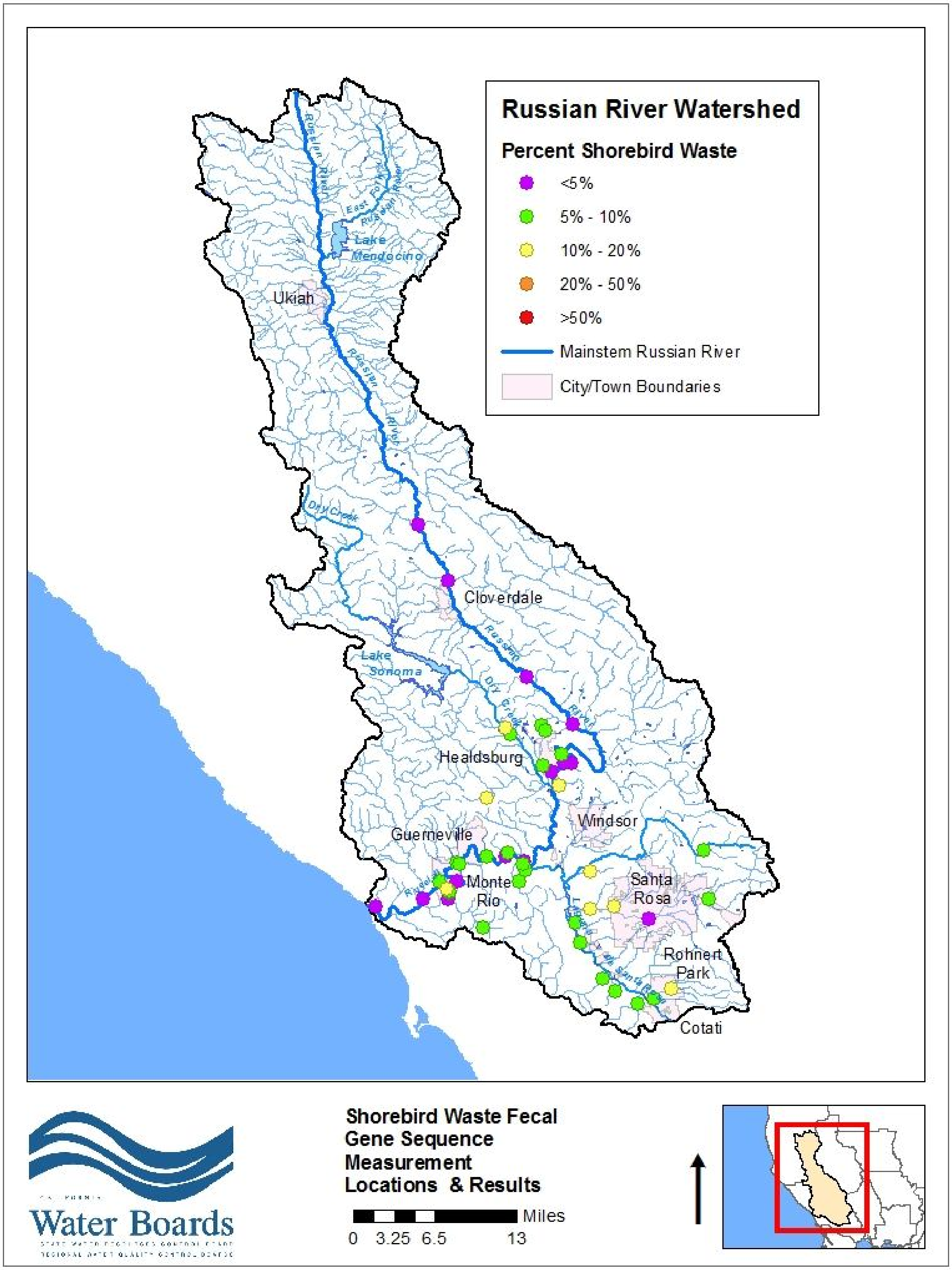



Figure 4.3. Bird Waste Fecal Gene Sequence Measurement Locations and Results

**Table 4.2 Percent Human, Grazer, and Bird Fecal Gene Sequence Measurement Results in the Mainstem Russian River**

| Mainstem Sampling Locations | % Human | | % Grazer | | % Bird | |
|---|---|---|---|---|---|---|
| | Dry Period | Wet Period | Dry Period | Wet Period | Dry Period | Wet Period |
| Russian River at Commisky Station Rd (n. of Cloverdale) | 1 | 0 | 3 | 1 | 3 | 2 |
| Russian River at Cloverdale River Park (Coverdale) | 1 | 1 | 2 | 1 | 3 | 3 |
| Russian River at Hwy 128 Bridge (Geyserville) | 2 | 1 | 2 | 1 | 1 | 3 |
| Russian River at Alexander Valley Campground (Geyserville) | 2 | 1 | 2 | 3 | 3 | 3 |
| Russian River at Camp Rose (Healdsburg) | 2 | 1 | 2 | 1 | 3 | 3 |
| Russian River at Veteran Memorial Beach (Healdsburg) | 2 | 0 | 1 | 1 | 3 | 4 |
| Russian River at Steelhead Beach (Forestville) | 0 | 2 | 1 | 12 | 3 | 5 |
| Russian River at Forestville Access Beach (Hacienda) | 1 | 4 | 2 | 19 | 3 | 6 |
| Russian River at Johnson's Beach (Guerneville) | 0 | 54 | 2 | 17 | 3 | 4 |
| Russian River at Johnson's Beach (Guerneville) | 1 | | 4 | | 6 | |
| Russian River at Johnson's Beach (Guerneville) | 0 | | 2 | | 2 | |
| Russian River at Johnson's Beach (Guerneville) | 1 | | 3 | | 3 | |
| Russian River at Johnson's Beach (Guerneville) | 14 | | 2 | | 2 | |
| Russian River at Johnson's Beach (Guerneville) | 50 | | 18 | | 5 | |
| Russian River at Monte Rio Beach (Monte Rio) | 1 | 59 | 2 | 20 | 2 | 7 |
| Russian River at Monte Rio Beach (Monte Rio) | 2 | | 3 | | 2 | |
| Russian River at Monte Rio Beach (Monte Rio) | 1 | | 2 | | 2 | |
| Russian River at Monte Rio Beach (Monte Rio) | 1 | | 1 | | 2 | |
| Russian River at Monte Rio Beach (Monte Rio) | 1 | | 1 | | 3 | |
| Russian River at Monte Rio Beach (Monte Rio) | 0 | | 1 | | 2 | |
| Russian River at Jenner Boat Ramp (Jenner) | 2 | 16 | 4 | 3 | 4 | 3 |

**Table 4.3 Percent Human, Grazer, and Bird Fecal Gene Sequence Measurement Results in Tributary Streams**

| Tributary Sampling Locations | % Human | | % Grazer | | % Bird | |
|---|---|---|---|---|---|---|
| | Dry Period | Wet Period | Dry Period | Wet Period | Dry Period | Wet Period |
| Palmer Ck at Palmer Creek Road (Healdsburg) | 6 | 2 | 8 | 8 | 12 | 3 |
| Limerick Ck at Old Redwood Highway (Healdsburg) | 52 | 6 | 11 | 20 | 8 | 11 |
| Foss Ck at Matheson Street (Healdsburg) | 3 | 16 | 2 | 3 | 4 | 6 |
| Unnamed Stream at Fitch Mtn Road (Healdsburg) | | 6 | | 3 | | 4 |
| Unnamed Stream at Fitch Mtn Road (Healdsburg) | | 2 | | 1 | | 3 |
| Lambert Ck @ Lambert Bridge Road (Healdsburg) | 5 | 6 | 6 | 5 | 11 | 4 |
| Unnamed Stream at Fredson Road (Healdsburg) | | 5 | | 14 | | 8 |
| Unnamed Stream at Fredson Road (Healdsburg) | | 2 | | 2 | | 7 |
| Unnamed Stream at West Dry Creek Road (Healdsburg) | | 1 | | 3 | | 6 |
| Unnamed Stream at Alexander Valley Road (Healdsburg) | | 2 | | 1 | | 5 |
| Unnamed Stream at Alexander Valley Road (Healdsburg) | | 2 | | 3 | | 5 |
| Unnamed Stream at Redwood Drive (Healdsburg) | | 10 | | 6 | | 4 |
| Unnamed Stream at Redwood Drive (Healdsburg) | | 7 | | 7 | | 8 |
| Gossage Ck at Gilmore Ave (Cotati) | 2 | 14 | 2 | 30 | 6 | 8 |
| Copeland Ck at Commerce Drive (Rohnert Park) | 2 | 24 | 1 | 33 | 2 | 8 |
| Crane Ck at Snyder Lane (Rohnert Park) | 5 | 21 | 7 | 34 | 7 | 10 |
| Van Buren Ck at St. Helena Road (n. of Santa Rosa) | 2 | 5 | 2 | 4 | 6 | 5 |
| Santa Rosa Ck at Los Alamos Rd (Santa Rosa) | 5 | 1 | 6 | 1 | 7 | 2 |
| Santa Rosa Ck at Railroad St (Santa Rosa) | 1 | 1 | 4 | 1 | 4 | 5 |
| Piner Ck at Fulton Road (Santa Rosa) | 3 | 32 | 2 | 13 | 6 | 19 |
| Abramson Ck at Willowside Road Levy (w. of Santa Rosa) | 9 | 16 | 9 | 36 | 7 | 14 |
| Irwin Ck at Sanford Road (w. of Santa Rosa) | 1 | 9 | 2 | 17 | 6 | 4 |
| Blucher Ck at Lone Pine Road (Sebastopol) | 1 | 12 | 1 | 33 | 4 | 6 |

**Table 4.3 Percent Human, Grazer, and Bird Fecal Gene Sequence Measurement Results in Tributary Streams**

| Tributary Sampling Locations | % Human | | % Grazer | | % Bird | |
|---|---|---|---|---|---|---|
| | Dry Period | Wet Period | Dry Period | Wet Period | Dry Period | Wet Period |
| Turner Ck at Daywalt Road (Sebastopol) | 9 | 11 | 15 | 34 | 9 | 8 |
| Laguna at Sebastopol Community Center (Sebastopol) | 1 | 1 | 3 | 1 | 7 | 3 |
| Green Valley Ck at Martinelli Road (Forestville) | 1 | 1 | 5 | 1 | 8 | 4 |
| Woolsey Ck at River Rd (Forestville) | 1 | 12 | 2 | 18 | 3 | 10 |
| Mays Ck at Neeley Road (Forestville) | 7 | 16 | 5 | 11 | 6 | 6 |
| Unnamed Stream at Summerhome Park Road (Forestville) | | 2 | | 1 | | 3 |
| Unnamed Stream at Summerhome Park Road (Forestville) | | 9 | | 2 | | 4 |
| Unnamed Stream at Summerhome Park Road (Forestville) | | 10 | | 2 | | 3 |
| Unnamed Stream at Summerhome Park Road (Forestville) | | 2 | | 2 | | 4 |
| Unnamed Stream at Trenton Road (Forestville) | | 7 | | 2 | | 4 |
| Unnamed Stream at Trenton Road (Forestville) | | 41 | | 7 | | 4 |
| Unnamed Stream at Trenton Road (Forestville) | | 54 | | 14 | | 9 |
| Unnamed Stream at Del Rio Court (Forestville) | | 5 | | 4 | | 7 |
| Unnamed Stream at Del Rio Court (Forestville) | | 6 | | 2 | | 4 |
| Unnamed Stream at River Road (Rio Nido) | | 9 | | 3 | | 9 |
| Unnamed Stream at River Road (Rio Nido) | | 1 | | 1 | | 4 |
| Unnamed Stream at Lakeside Avenue (Camp Meeker) | | 8 | | 2 | | 5 |
| Unnamed Stream at Lakeside Avenue (Camp Meeker) | | 3 | | 2 | | 7 |
| Dutch Bill Ck at Fir Road (Monte Rio) | 5 | 1 | 6 | 3 | 10 | 6 |
| Unnamed Stream at River Road (Monte Rio) | | 1 | | 1 | | 8 |
| Unnamed Stream at River Road (Monte Rio) | | 2 | | 1 | | 10 |
| Unnamed Stream at River Road (Monte Rio) | | 2 | | 2 | | 6 |
| Unnamed Stream at Old Monte Rio Road (Monte Rio) | | 4 | | 1 | | 3 |
| Unnamed Stream at Main Street (Monte Rio) | | 2 | | 2 | | 5 |
| Unnamed Stream at Main Street (Monte Rio) | | 1 | | 3 | | 4 |
| Unnamed Stream at Foothill Drive (Monte Rio) | | 89 | | 23 | | 10 |
| Unnamed Stream at Moscow Road (Duncan's Mills) | | 2 | | 2 | | 3 |

## 4.2 SOURCES BY LAND COVER TYPE

Regional Water Board staff assessed the relative contributions, magnitude, and variability of pathogenic indicator bacteria in the Russian River Watershed based on different land cover types during both dry and wet weather periods. Methods and sample concentrations are documented in a monitoring report by the NCRWQCB (2012). An assessment of the data, including a statistical analysis, is documented in a memorandum from Steve Butkus (2013a). A summary is provided here.

Water samples were collected from streams that drain watersheds primarily composed of one type of land use to evaluate the influence of different land uses on pathogenic indicator bacteria concentrations[3]. Five land cover categories were selected. These land cover

[3] All the sampling locations drained watersheds with 50% or more of their area in one type of land cover category, except for sampling locations representing the developed non-sewered category. There was a relatively low percentage of land in this category as developed non-sewered areas are interspersed with other categories, especially agricultural lands.

categories are based on the National Land Cover Dataset (Fry et al. 2011) and Urban Service Areas (PRMD 2010). The land cover categories are defined through remote sensing by Anderson et al. (1976), and are summarized as follows:

- **Forest Land** – Areas with a 10 percent or more tree-crown areal density (crown closure percentage).
- **Shrubland** – Areas where the potential natural vegetation is predominantly grasses, grass-like plants, forbs, or shrubs. Anderson et al. (1976) previously defined this land cover as “Rangeland.” These areas do not include animal pastures or dry croplands.
- **Agriculture** – Areas were defined by visual indications of agricultural activity through distinctive geometric field or road patterns and the traces produced by livestock or mechanized equipment.
- **Developed Sewered** - Urban and residential areas identified by Fry et al. (2011) where much of the land is covered by structures including cities, towns, villages, strip developments along highways, transportation, power, and communications facilities. Residential land uses range from low density (where houses are on lots of more than an acre) to high density, multiple-unit structures. The boundaries of the Urban Service Areas (PRMD 2010) were used to identify those urban and residential areas that are sewered to receive domestic wastewater treatment.
- **Developed Non-Sewered** – Residential land uses identified by Fry et al. (2011) where the houses are outside of the boundaries of the Urban Service Areas (PRMD, 2010) and assumed to use individual septic systems for disposal of domestic waste.

For each of the five land cover categories, six water samples were collected at three different locations during both wet and dry periods. Samples were analyzed for *E. coli*, human-host *Bacteroides*, and bovine-host *Bacteroides* bacteria. Visual comparison and statistical hypothesis tests were made between different data groupings. More information on the assessment methods is available in Butkus (2013a).

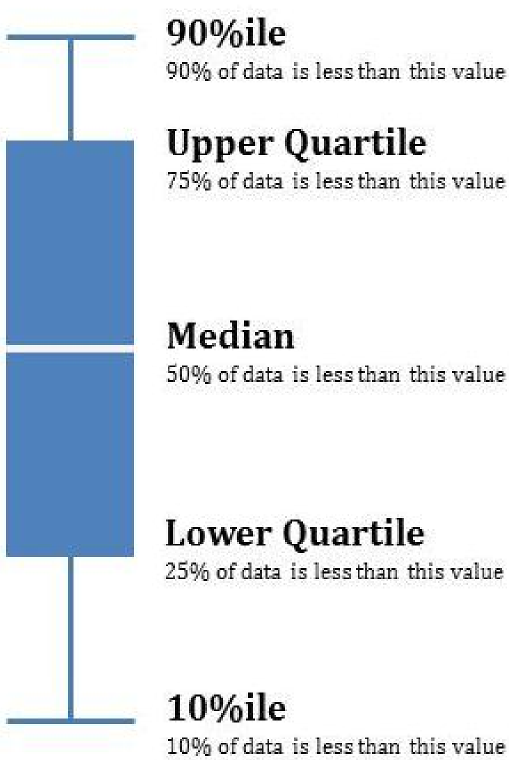
### 4.2.1. Results

The results of the land cover analysis are presented in Figures 4.4 through 4.9. Results indicate that human-source *Bacteroides* bacteria are present in all locations and in all land use categories. Pathogenic indicator bacteria concentrations in wet periods have statistically-significant higher concentrations than dry periods.

Runoff from forest lands has statistically-significant lower concentrations of pathogenic indicator bacteria than runoff and base flow in all other land cover categories assessed. Runoff from shrubland, agricultural areas, and forested areas have statistically-significant lower pathogenic indicator bacteria concentrations than runoff from developed areas (both sewered and non-sewered areas).

A stable isotope analysis, which measures oxygen and nitrogen in the water sample, was also conducted on samples from different land use categories to help identify the source of the water associated with the bacteria in samples. The results show that most of the nitrate measured in the samples was from soil, which was likely carried into the water column through rainfall-induced erosion. The results also show that several of the samples collected during wet weather in both sewered and non-sewered developed areas were likely derived from domestic wastewater, which suggests that storm events may be transporting untreated domestic wastewater from sanitary sewer overflows and exfiltration, failing sanitary sewer pipelines and sewer laterals, and failing septic systems into streams. Discharges from municipal wastewater treatment facilities are not sources as sample locations were upstream of their discharge locations.

**Reading a Box & Whisker Plot**



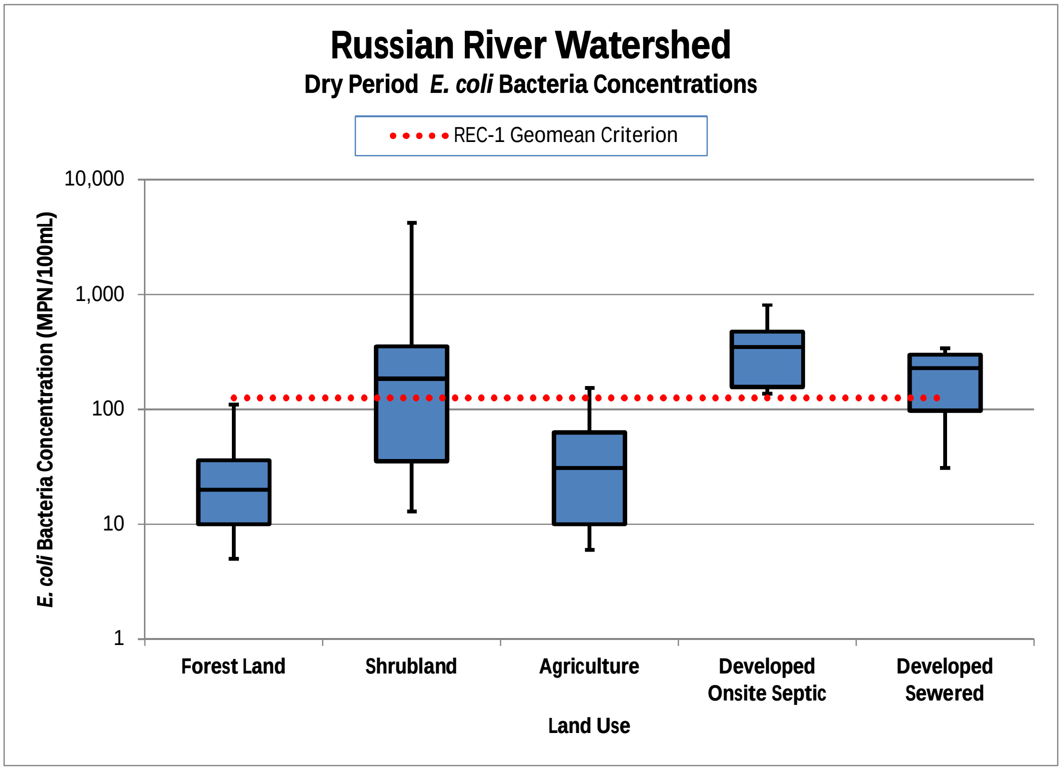



Figure 4.4. *E. coli* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.

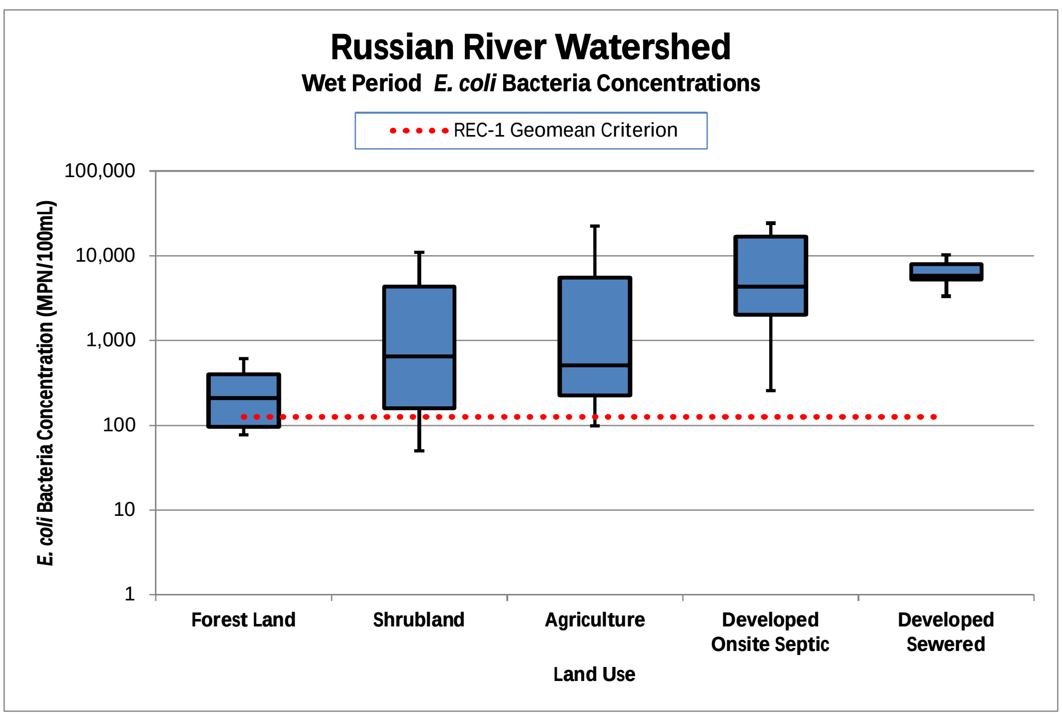



Figure 4.5. *E. coli* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category

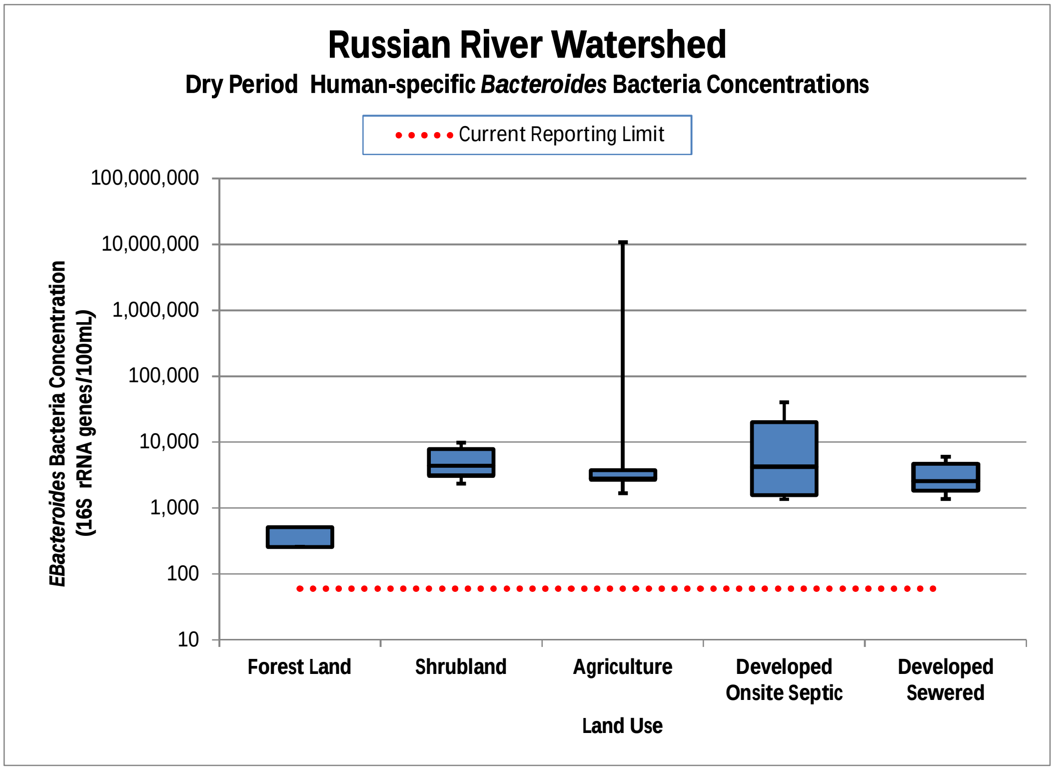



Figure 4.6. Human-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.

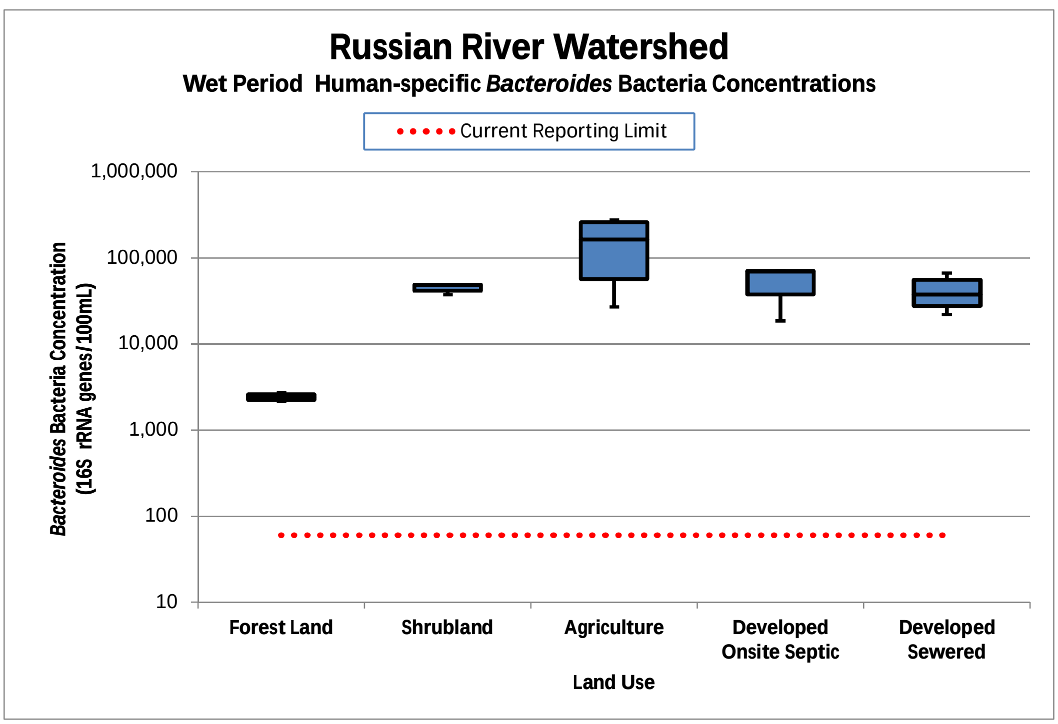



Figure 4.7. Human-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category.

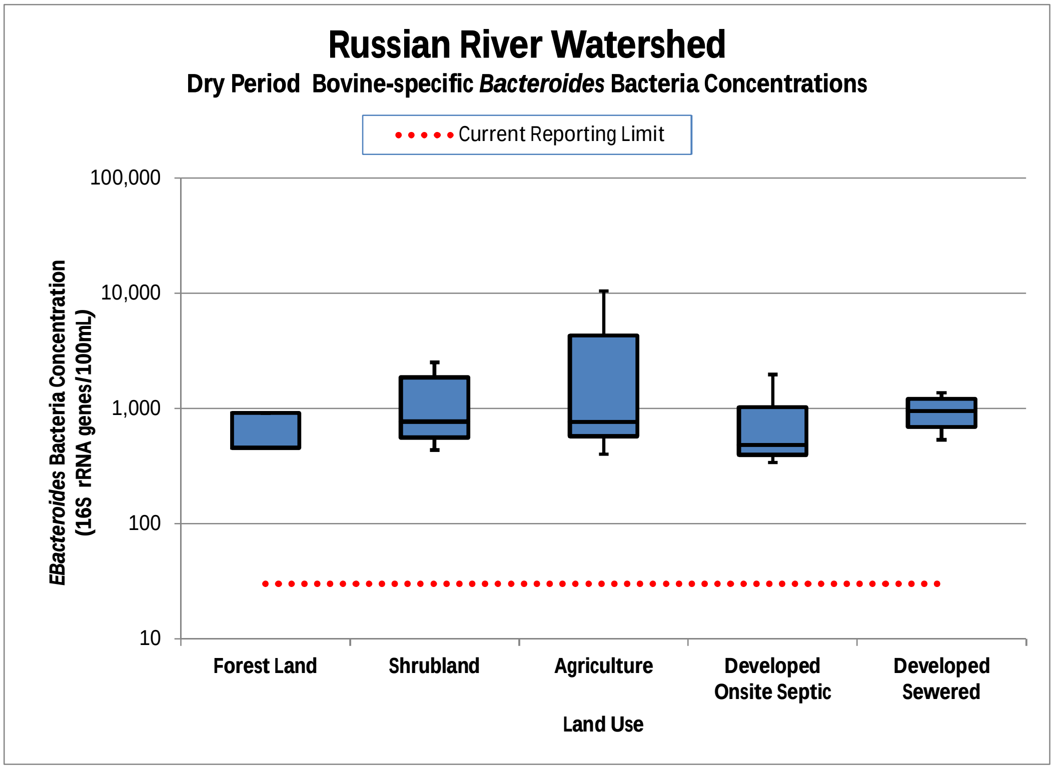



Figure 4.8. Bovine-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.

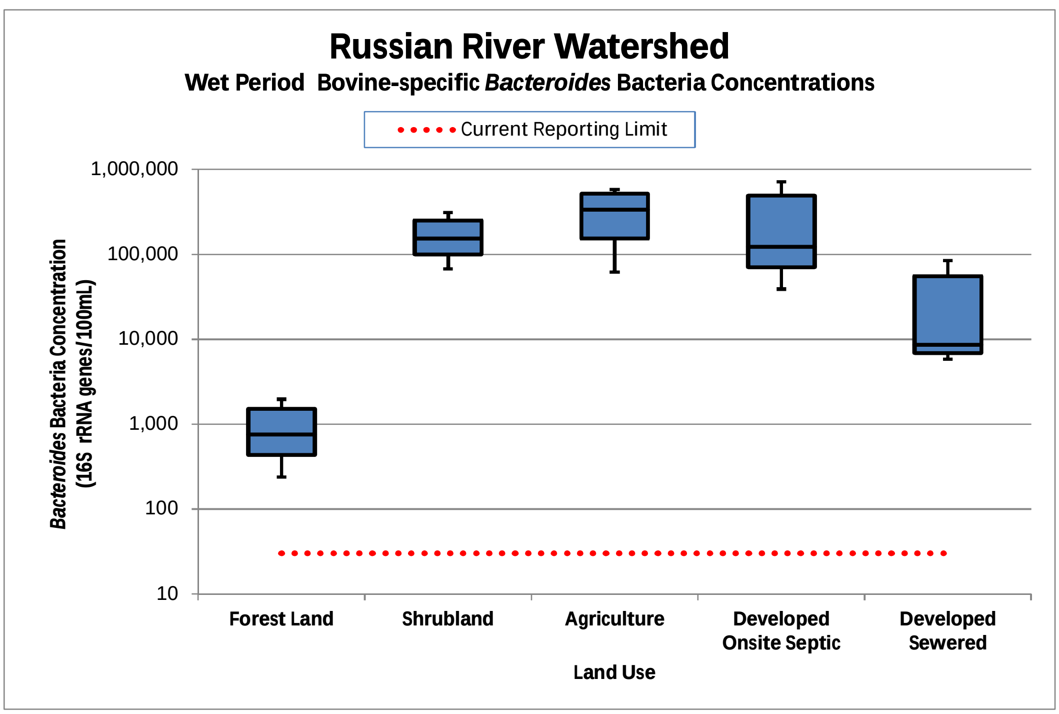



Figure 4.9. Bovine-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category.

## 4.3 POINT SOURCE FACILITIES AND ACTIVITIES

This section describes existing and potential point sources of pathogens to surface waters in the Russian River Watershed. Clean Water Act section 402 addresses direct discharges of waste into navigable waters. Direct discharges or "point source" discharges of pollutants come from 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, or vessel or other floating craft. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

Point source discharges to waters of the United States are regulated under the federal National Pollutant Discharge Elimination System (NPDES) program. Point source discharges to waters of the state are regulated under waste discharge requirements (WDRs). The point sources described in this section were identified by querying the California Integrated Water Quality System (CIWQS) database for existing facilities regulated by a NPDES permit.

### 4.3.1 WASTEWATER DISCHARGES TO SURFACE WATERS

Wastewater discharges to surfaces waters in the Russian River Watershed occur from both direct permitted discharges and from unpermitted spills and leaks. The following sections identify sources in the watershed.

#### 4.3.1.1 Municipal Wastewater Discharges To Surface Waters

The watershed contains nine municipal wastewater treatment facilities that are authorized under NPDES permits to discharge treated domestic wastewater into surface waters. Table 4.1 summarizes these facilities (per information obtained from CIWQS in Nov. 2013) and describes their level of treatment. Figure 4.1 shows the locations of these facilities in the watershed. All facilities in the watershed treat to secondary or tertiary levels. Secondary treatment refers to physical, chemical, and biological unit processes used to meet federal standards in 40 C.F.R. §133.102 for biochemical oxygen demand (BOD), total suspended solids (TSS), and pH. Tertiary treatment is generally defined as treatment beyond secondary levels to achieve a higher level of BOD or TSS removal or to remove constituents of concern such as nutrients or toxic compounds.

To achieve water quality objectives, protect beneficial uses, protect public health, and prevent nuisance, surface water discharges are prohibited from May 15 through September 30. During the remainder of the year, discharges are limited to one percent of the flow volume in the receiving water unless specifically exempted in the NPDES permit. For authorized discharges of wastewater to the Russian River and its tributaries during October 1 through May 14, the Basin Plan requires that discharges of municipal waste "*shall be of advanced treated wastewater in accordance with effluent limitations contained in NPDES permits for each affected discharger, and shall meet a median coliform level of 2.2 MPN/100 mL.*" The Regional Water Board has defined advanced wastewater treatment in individual permits as treated effluent meeting, in part, disinfection standards, including total coliform thresholds, consistent with tertiary treated recycled water requirements set forth in title 22 of the California Code of Regulations.

Disinfection standards in municipal NPDES permits consist of effluent limitations for total coliform bacteria and other process requirements to ensure adequate effluent disinfection. For surface water discharges, municipal NPDES permits in the Russian River Watershed prescribe uniform effluent limitations for total coliform bacteria that require:

- The 7-day median concentration not exceed an MPN of 2.2 per 100 mL;
- The number of coliform bacteria not exceed an MPN of 23 per 100 mL in more than one sample in any 30-day period; and
- No single sample exceed an MPN of 240 total coliform bacteria per 100 mL.

In addition to effluent limitations for total coliform bacteria, municipal NPDES permits also require compliance with disinfection process requirements depending on the permitted facility's method of disinfection. For wastewater treatment facilities that employ an ultraviolet (UV) disinfection process, permittees are required to ensure a minimum UV dose, maintain a minimum UV transmittance, and perform appropriate operation and maintenance activities specified by Division of Drinking Water of the State Water Resources Control Board. For wastewater treatment facilities that utilize chlorine as a means of disinfection, permittees must demonstrate a continuous chlorine residual after treatment or provide a minimum CT (the product of total chlorine residual and modal contact time) value of not less than 450 mg-min/L at all times.

Regional Water Board staff used discharger-specific effluent monitoring data from self-monitoring reports to assess total coliform bacteria concentrations in the effluent from these facilities. Table 4.4 shows that disinfection methods are highly effective at meeting effluent limitations for total coliform bacteria.

#### 4.3.1.2 Recycled Water Holding Ponds

The beneficial reuse of treated wastewater, which is also known as recycled water, is common in the Russian River Watershed as a means to conserve scarce potable water supply and to comply with stringent discharge requirements imposed in NPDES permits in the watershed, including the Basin Plan's prohibition against summertime discharges of waste to the Russian River and its tributaries. For these and other reasons, many wastewater treatment facilities temporarily store recycled water in large holding ponds for later distribution to recycled water users or until conditions are suitable and permitted for discharge to surface waters.

Although advanced wastewater treatment systems in the Russian River Watershed are operated to produce recycled water that is essentially pathogen-free and suitable for water recycling, this same recycled water, when stored in open-air holding ponds, may become contaminated as a result of regrowth of bacteria or through contribution of fecal matter from wildlife, particularly birds that frequent the storage ponds. Thus, the original bacterial water quality of the recycled water demonstrated immediately after disinfection cannot be guaranteed during storage.

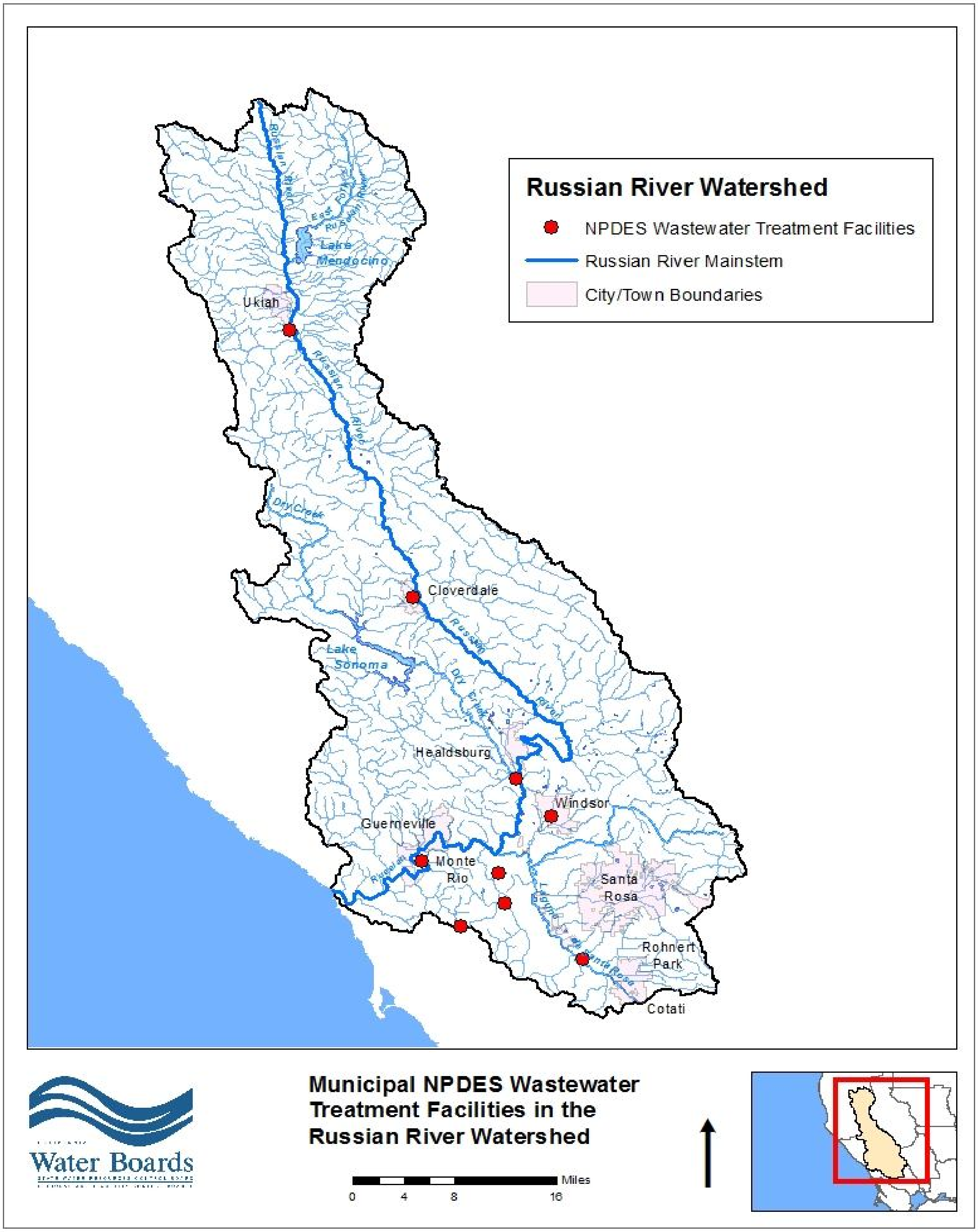



Figure 4.10. Municipal NPDES Wastewater Treatment Facilities in the Russian River Watershed

**Table 4.4: Municipal NPDES Wastewater Treatment Facilities in the Russian River Watershed and Percent Compliance with Total Coliform Effluent Limitations**

| Permit No. | Facility Name | Capacity (mgd) | Treatment Type | Percent Compliance | | |
|---|---|---|---|---|---|---|
| | | | | Daily Max. | 7-Day Median | Monthly Max. |
| CA0022888 | City of Ukiah Wastewater Treatment Plant | 3.01 | Tertiary | 100.0% | 93.9% | 100.0% |
| CA0022977 | City of Cloverdale Wastewater Treatment Plant | 1.0 | Secondary | 100.0% | 100.0% | 100.0% |
| CA0025135 | City of Healdsburg Water Reclamation Facility | 1.4 | Tertiary | 100.0% | 98.4% | 100.0% |
| CA0022764 | Santa Rosa Subregional Water Reclamation System | 21.34 | Tertiary | 99.9% | 100.0% | 99.9% |
| CA0023345 | Town of Windsor Wastewater Treatment, Reclamation, and Disposal Facility | 1.9 | Tertiary | 100.0% | 96.1% | 100.0% |
| CA0023639 | Graton Community Services District Wastewater Treatment, Reclamation, and Disposal Facility | 0.397 | Tertiary | 100.0% | 100.0% | 100.0% |
| CA0023043 | Forestville Water District Wastewater Treatment, Reclamation, and Disposal Facility | 0.130 | Tertiary | 99.9% | 83.6% | 99.7% |
| CA0024058 | Russian River County Sanitation District Wastewater Treatment Facility | 0.71 | Tertiary | 100.0% | 100.0% | 100.0% |
| CA0023051 | Occidental County Sanitation District Wastewater Treatment Facility | 0.05 | Secondary | 100.0% | 97.6% | 100.0% |

Many studies document the occurrence of fecal indicator bacteria and other opportunistic pathogens in open-air reservoirs, but the public health risk associated with pathogens in recycled water storage ponds has not been well-documented. Regional Water Board staff evaluated monitoring data for treated effluent discharges from the open-air, recycled water storage ponds at Vintage Greens used by the Town of Windsor. Monitoring results from 2007-2011 indicate measureable concentrations of *E. coli*, sometimes at levels exceeding the U.S. EPA (2012) Beach Action Value of 235 cfu/100 mL. These results are shown in Figure 4.2.

In the Russian River Watershed, municipal wastewater treatment facilities that discharge to surface waters directly or indirectly after storage employ either chlorine or ultraviolet light as a means of wastewater disinfection. Research assessing the regrowth or photoreactivation of bacteria or pathogens in storage ponds is sparse; most recent work has focused on photoreactivation after exposure to ultraviolet light. One study reviewed by Regional Water Board staff used biochemical fingerprinting to show that the fecal contamination in a golf course pond supplied with chlorine-disinfected recycled water was not related to the recycled water and that the fecal indicator bacteria did not regrow in the ponds (Casanovas-Massana 2012). Another case study (Basu 2007) of fecal coliform regrowth in a full-scale operating wastewater treatment facility using ultraviolet disinfection concluded that bacterial regrowth in recycled water systems is a concern, but that exceedances of effluent limitations for fecal coliform in this study could be attributed to poor effectiveness of the ultraviolet disinfection system. The report also summarized recent research on the topic, indicating that photoreactivation of bacteria diminishes drastically with dosages of ultraviolet radiation above 50 MJ/cm2.

Based on studies reviewed by Regional Water Board staff, discharges of treated wastewater from recycled water holding ponds will likely contain *E. coli* and other fecal indicator bacteria in concentrations above the TMDL targets. However, it is not clear whether the sources of detected *E. coli* bacteria are of human origin and therefore pose a more significant threat to public health or whether their presence is a result of contamination by birds and other wildlife that frequent the storage pond.

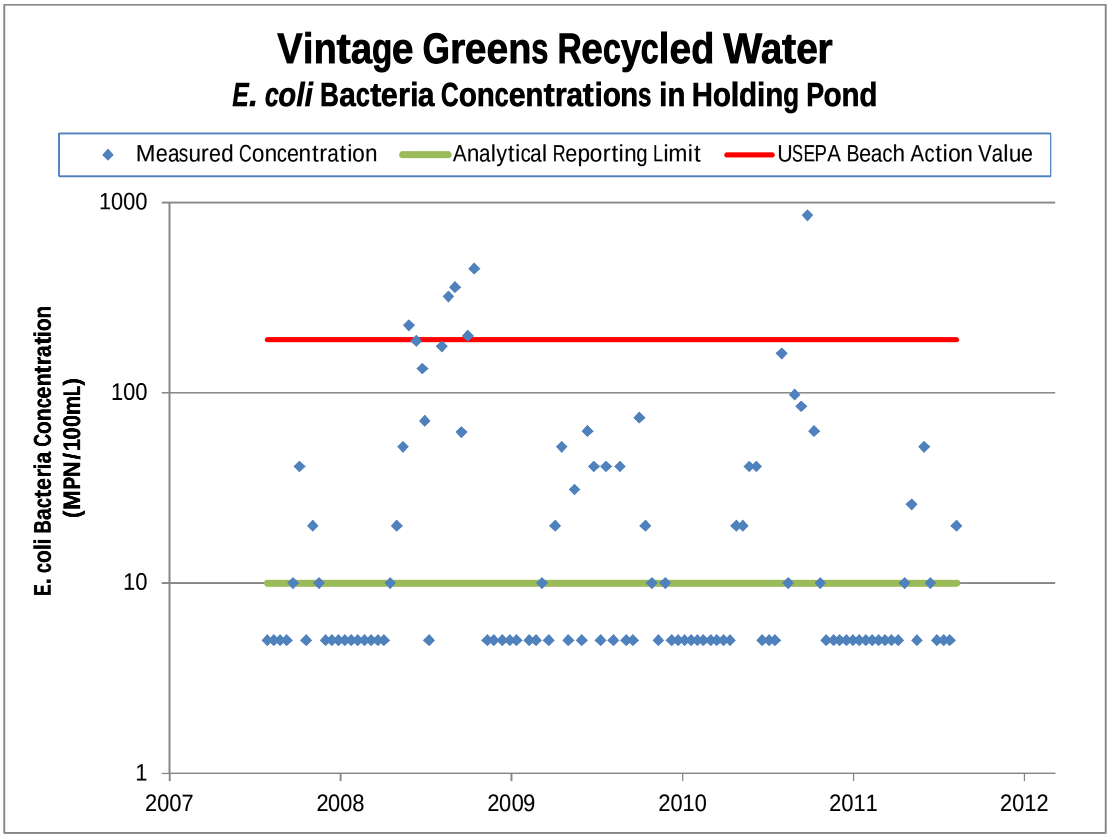



Figure 4.11: *E. coli* Bacteria Concentrations in a Recycled Water Holding Pond at Vintage Greens in Windsor

### 4.3.1.3 Sanitary Sewer Systems

Sanitary sewer systems collect and transport municipal wastewater from private residences, commercial buildings, industrial facilities, and institutional buildings to a wastewater treatment facility for treatment and disposal and/or reuse. Some sanitary sewer systems also convey stormwater and groundwater that may inadvertently enter the system. Sanitary sewer infrastructure is comprised of some or all of the following components: service laterals, collector sewers, connection wyes between laterals and collector sewers, interceptor sewers, manholes and cleanouts, pump stations, and force mains. Typically a public entity (e.g., municipality or county sanitation district) owns and is responsible for maintaining all components of the system except the service laterals, which connect the individual building to the sewer system and are located on private property. Where sewers are installed on private property such as a mobile home park or apartment complex, ownership and maintenance responsibility, including the connection point, is the responsibility of the property owners unless there are subdivision covenants or written agreements and easements which clearly indicate otherwise.

There are twenty-one public sanitary sewer systems in the watershed, as shown in Table 4.3 and based on CIWQS data from November 2013 and sanitary sewer management plans submitted by municipalities.

**Table 4.5. Sanitary Sewer Systems in the Russian River Watershed**

| Sanitary Sewer System | Population Served | Number of Service Connections | Miles of Force Main | Miles of Gravity Sewer | Miles of Laterals |
|---|---|---|---|---|---|
| Calpella County Water District | 450 | 100 | 0.3 | 2.9 | 1 |
| City of Cotati | 7,265 | 2,300 | 1 | 32 | 26.6 |
| City of Rohnert Park | 40,794 | 8,427 | 7.5 | 77 | 71.8 |
| City of Santa Rosa | 167,815 | 48,396 | 6.3 | 582 | 355 |
| City of Sebastopol | 7,750 | 2,800 | 2 | 25 | 53 |
| City of Cloverdale | 8,500 | 3,200 | 0.1 | 32.3 | 21 |
| Forestville Water District | 865 | 438 | 1.5 | 6 | 3.4 |
| Graton Community Services District | 1,815 | 445 | 0.3 | 6.5 | 4 |
| City of Healdsburg | 11,700 | 4,600 | 2.9 | 53.1 | 87 |
| Hopland Public Utility District | 1,200 | 288 | 0.6 | 4.4 | 6 |
| Airport/Larkfield/Wikiup Sanitation Zone | 9,306 | 1,937 | 1 | 10 | 9.2 |
| Geyserville Sanitation Zone | 809 | 267 | 1 | 4.3 | 1.3 |
| Occidental County Sanitation District | 636 | 71 | 1.5 | 1 | 0.3 |
| Russian River County Sanitation District | 7,377 | 2,467 | 5 | 35 | 11.7 |
| Sonoma State University | 10,000 | 18 | 0 | 2.5 | 1.2 |
| South Park County Sanitation District | 10,400 | 1,717 | 0 | 18.3 | 25.3 |
| Ukiah Valley Sanitation District | 5,000 | 4,971 | 1 | 43 | 44 |
| City of Ukiah | 16,500 | 5,642 | 0 | 44 | 44 |
| Town of Windsor | 26,950 | 8,250 | 1 | 92 | 60 |
| **Totals** | 343,179 | 100,040 | 34 | 1,151 | 863 |

Overflows of wastewater from the sanitary sewer can be caused by grease blockages, root blockages, sewer line flood damage, pump station power or mechanical failures, and surcharged pipe conditions from excessive stormwater or groundwater inflow and infiltration (I/I). Releases of wastewater from the sanitary sewer can also occur as a result of poor sewer design, pipe or material failures, construction-related damage, or lack of a preventive maintenance program, which includes sufficient planning for system rehabilitation and replacement. Private building laterals can crack, become disjointed or displaced, and blocked with roots or other debris and result in an overflow. Untreated sewage from sanitary sewer system releases can contain high levels of pathogenic microorganisms and other pollutants.

All federal and state agencies, municipalities, counties, districts and other public entities that own or operate sanitary sewer systems greater than one mile in length that collect and/or convey untreated or partially treated wastewater to a wastewater treatment facilities are required to enroll for coverage under General Waste Discharge Requirements for Sanitary Sewer Systems, Water Quality Order No. 2006-0003-DWQ (General Order). The General Order establishes minimum requirements to prevent sanitary sewer overflows (SSOs). Reporting requirements are included to ensure adequate and timely notifications are made to appropriate local, state, and federal authorities in the event of SSOs from publicly-owned sewer infrastructure. Table 4.6 lists the details for SSOs reported to the CIWQS SSO database since 2007 that equaled or exceeded 1,000 gallons, resulted in a discharge to a drainage channel and/or surface waters, or discharged to a storm drain and were not fully captured and returned to the sanitary sewer system. These data are based on information retrieved from CIWQS in November 2013.

Private sewer laterals are owned and maintained by the property owner. Private sewer laterals are not regulated under the General Order and, therefore, owners of private laterals are not required by permit to report SSOs that occur as a result of a failure or blockage in the lateral. Because of the sheer number of private laterals connected to a municipal sewer system and the limited jurisdiction that municipalities have over sewer laterals on private property, SSOs from private sewer laterals often go unreported and corrective actions to stop the SSO may be delayed. Most municipalities have established local ordinances that require property owners connected to the municipal system to design and install new laterals in accordance with local standards and maintain existing service laterals and cleanouts in good working order at the owner's expense. Local ordinances that require property owners to inspect their private service laterals at a property transfer, in response to chronic SSOs, or changes in use are rare in the Russian River Watershed. At least one public sanitation district within the Russian River Watershed offers a program that enables eligible ratepayers to replace leaky or deteriorating service laterals at the expense of the municipality.

**Table 4.6. Sanitary Sewer Overflows in the Russian River Watershed from 2007 to Nov 2013**

| Responsible Agency | Number of SSOs | Volume of SSO (gallons) | Volume that Reached Surface Water (gallons) | % that Reached Surface Water |
|---|---|---|---|---|
| Calpella County Water District | 1 | 1,500 | 990 | 66% |
| Forestville Water District | 2 | 155 | 70 | 45% |
| Graton Community Services District | 2 | 600 | 198 | 33% |
| City of Healdsburg | 3 | 1,887 | 1,774 | 94% |
| City of Rohnert Park | 2 | 305 | 241 | 79% |
| City of Santa Rosa | 7 | 24,213 | 19,855 | 82% |
| City of Sebastopol | 10 | 41,991 | 33,024 | 79% |
| Airport/Larkfield/Wikiup Sanitation Zone | 1 | 60 | 50 | 83% |
| Occidental County Sanitation District | 2 | 316 | 215 | 68% |
| Russian River County Sanitation District | 3 | 1,704 | 699 | 41% |
| City of Ukiah | 9 | 2,045 | 1,677 | 82% |
| Ukiah Valley Sanitation District | 3 | 1,750 | 1,085 | 62% |
| Town of Windsor | 7 | 6,612 | 4,298 | 65% |
| Total SSOs since 2007 | 52 | 216,638 | 196,112 | 91% |

#### 4.3.1.4 Sanitary Sewer Exfiltration

Exfiltration is different from SSOs. Overflows from sanitary sewer systems are usually caused by I/I leading to surcharged pipe conditions. This results in direct overflows to receiving water or land or causes sewer backups into residential or commercial buildings. Exfiltration is generally described as a sewer leaking from its inside to its surrounding outside and occurs primarily at defective joints and cracks in service laterals, local mains and trunk sewer lines. Factors that contribute to exfiltration include: size and length of sewer lines, age of sewer lines, construction materials, and depth of flow in the sewer. Geological and climatic conditions that contribute to exfiltration include groundwater depth, soil type, faults, and rainfall.

Exfiltration from sanitary sewer systems is not explicitly regulated in the North Coast Region. However, compliance with requirements for proper operation and maintenance of public sanitary sewer systems set forth in the Sanitary Sewer Systems General Order may help reduce or eliminate exfiltration over time. The occurrence of exfiltration is thought to be limited to those areas where sewer elevations lie above the groundwater table. Since groundwater elevations near surface waterbodies are typically near the ground surface, sewers near surface waterbodies generally are below the groundwater table and infiltration (rather than exfiltration) might be expected to dominate the mode of sewer leakage in these areas.

#### 4.3.1.5 Other NPDES Facilities

<u>Fish Hatcheries</u>

There is one fish hatchery within the Russian River Watershed: Warm Springs Dam Fish Hatchery. The facility is owned by the U.S. Army Corps of Engineers and is operated by the California Department of Fish and located at the base of Warm Springs Dam in Healdsburg. The facility is regulated under Waste Discharge Requirements Order No. 97-61 (NPDES Permit No. CA0024350).

The facility is designed to raise approximately 161,000 pounds (800,000 fish) per year for release to the Russian River, and it feeds up to 40,000 pounds of feed during the month of maximum feeding. Influent to the facility comes from Warm Springs Dam (Lake Sonoma) and, if necessary, from a series of wells adjacent to Dry Creek. Influent flow is aerated and routed to twenty ponds/raceways, which discharge to a single, full flow pollution control pond with a minimum detention time of 2.5 hours. Treated wastewater from the pollution control pond is discharged to Dry Creek, which is tributary to the Russian River, and also is used for landscape irrigation on less than five acres at an adjacent visitor center and day use area.

Waste Discharge Requirements Order No. 97-61 contains effluent limitations and monitoring requirements for effluent flow, suspended solids, settleable solids, and chloride. *E. coli* and *Bacteroides* bacteria are found in the intestinal tracts of warm-blooded animals. Because they are not warm-blooded animals, salmon and other fish do not contribute these bacteria to streams. Fish intestines have been shown to contain *E. coli* bacteria, but the bacteria comes from ingestion of the bacteria from other sources and are not produced within the fish. Fish simply serve as a vector for *E. coli* transmission from other sources (Hansen et al. 2008). Therefore, fish hatcheries are not considered a source of *E. coli* and *Bacteroides* bacteria for this TMDL.

Other Permittees

There are a number of permittees in the Russian River Watershed that are regulated under NPDES permits for waste discharges to surface waters, but do not receive, treat or discharge domestic wastewater under conditions of the permit (Table 4.5). These permitted discharges are not expected to be a source of pathogens in amounts that contribute to the pathogen impairment in the watershed.

**Table 4.7: Other NPDES Facilities in the Russian River Watershed**

| Permit No. | Permittee Name | Facility Type |
|---|---|---|
| CA0023655 | Sonoma West Holdings Plant #2 Facility | Food Processing |
| CAG911001 | JDS Uniphase | Laboratory |
| CA0005843 | Mendocino Forest Products Ukiah Sawmill | Saw Mill |
| CAG990002 | AT&T Statewide Cable System | Utility Structure |
| CAG990002 | Pacific Bell (AT&T) | Utility Structure |
| CAG990002 | Pacific Gas & Electric Company | Utility Structure |
| CAG990002 | Sprint | Utility Structure |
| CAG990002 | Verizon California | Utility Structure |
| CAG990005 | Sonoma County Water Agency | Aquatic Herbicide |
| CAG990004 | Marin/Sonoma Mosquito and Vector Control District | Pesticide/Vector Control |
| CAG990005 | Potter Valley Irrigation District | Aquatic Herbicide |
| CAG990005 | City of Santa Rosa | Aquatic Herbicide |
| CAG990005 | Sonoma County Regional Parks | Aquatic Herbicide |

### 4.3.2 WASTEWATER DISCHARGES TO LAND

The following sections identify known wastewater discharges to land in the Russian River Watershed and discuss the likelihood that discharges are sources of pathogens to surface waters.

#### 4.3.2.1 Municipal Wastewater Discharges to Land

The Russian River Watershed contains five municipal wastewater treatment facilities that are authorized under WDRs to discharge treated domestic wastewater to land (Figure 4.12). Table 4.8 summarizes these facilities (based on information obtained from CIWQS in November 2013) and describes their treatment capabilities and methods of effluent disposal or reuse.

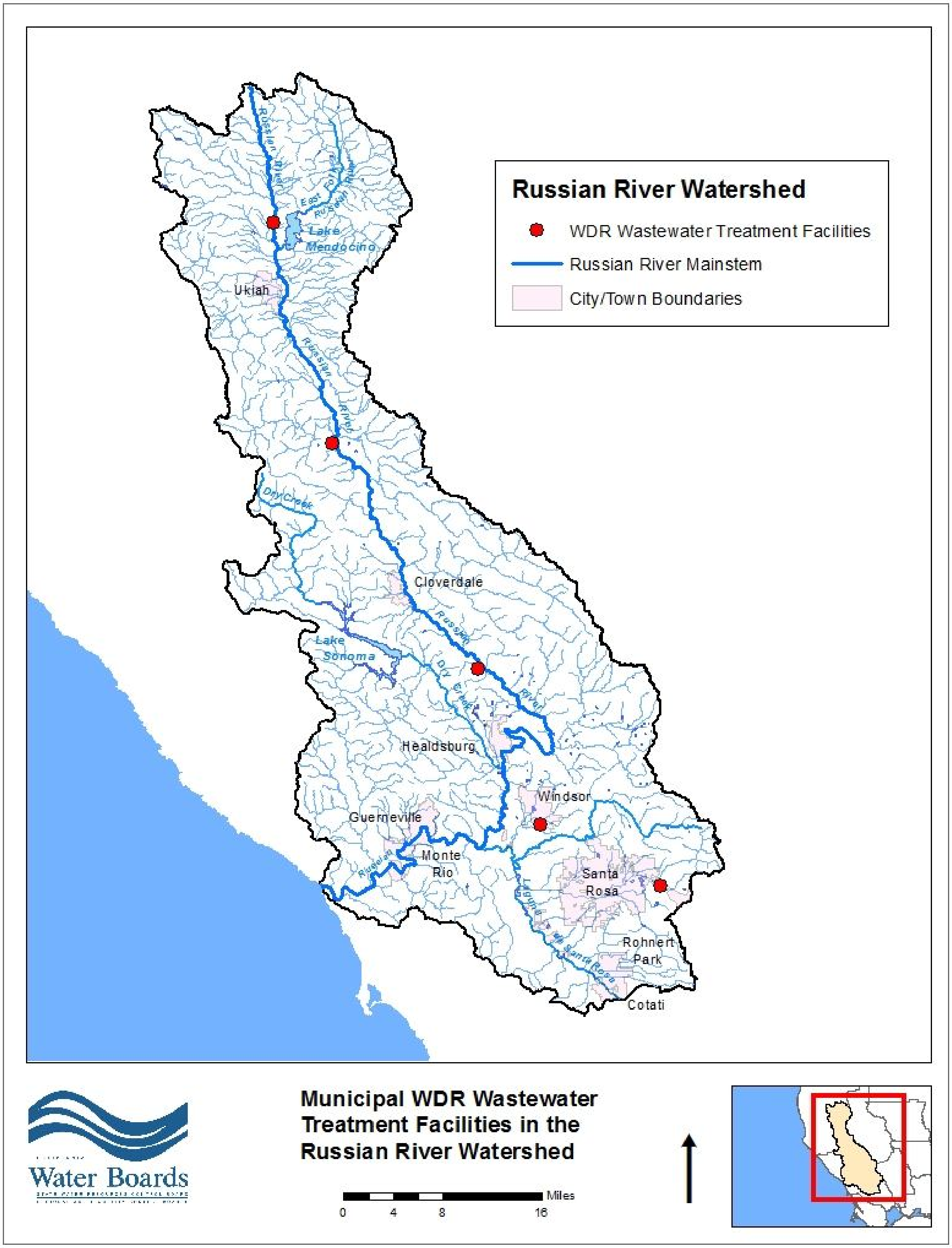



Figure 4.12. Municipal WDR Wastewater Treatment Facilities in the Russian River Watershed

**Table 4.8. Municipal WDR Wastewater Treatment Facilities in the Russian River**

| Permit No. | Facility Name | Capacity (mgd) | Treatment Type/Disposal Method |
|---|---|---|---|
| 86-16 | Calpella County Water District | 0.04 | Aerated pond treatment, disinfection and percolation disposal |
| R1-2008-0003 | Hopland Public Utility District | 0.09 | Aerated pond treatment, disinfection, and percolation disposal |
| 88-52 | Santa Rosa Oakmont Wastewater Treatment Plant | 0.065 | Activated sludge, filtration, disinfection, spray irrigation or transfer to Laguna Treatment Plant |
| R1-2001-0069 | Airport/Larkfield/Wikiup Sanitation Zone | 0.9 | Aerated pond treatment, microfiltration, disinfection, and spray irrigation disposal |
| 97-67 | Geyserville Sanitation Zone | 0.092 | Aerated pond treatment, disinfection, and percolation disposal |

Municipal wastewater treatment facilities discharging to land in the watershed rely primarily on aerobic pond systems for waste treatment to achieve the effluent quality necessary to protect groundwater quality. Disinfection using chlorine is commonly used to comply with an average monthly effluent limitation for total coliform of 23 MPN/100 mL. Final disposal of treated effluent is through percolation to groundwater or spray irrigation to pasture land.

Municipal wastewater disposed of through spray irrigation from facilities that are operating properly and whose discharge conforms to conditions prescribed in waste discharge requirements is not expected to cause bacterial contamination of groundwateror surface waters. Municipal wastewater discharged to percolation ponds that are proximate to surface waters have the potential to contribute to bacterial loading in surface waters, depending on site specific conditions.

#### 4.3.2.2 Land Application of Municipal Biosolids

Both Class A (Exceptional Quality) and Class B municipal biosolids contain pathogens, including bacteria, parasites, and viruses. Exposure to these pathogens may occur through direct contact with biosolids, through inhalation, ingestion of food that has come into contact with biosolids or through contact with vectors (flies, mosquitos, birds, rodents, etc.) that can transport from biosolids to humans. Federal regulations at 40 CFR 503 establish minimum standards for the regulation of biosolids using various risk assessment methodologies. Compliance with these regulations is assumed to minimize the human health risk associated with the land application of municipal biosolids.

In July 2004, the State Water Board adopted General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities, Water Quality Order No. 2004-12-DWQ (General Order). The General Order incorporates the minimum standards established by the Part 503 Rule and expands upon them to fulfill requirements of the California Water Code.

When biosolids are applied to ground surfaces where there is an increased risk that biosolids may migrate off the application site (e.g., where ground slopes are greater than 10 percent), the Regional Water Board Executive Officer may require an Erosion Control Plan to assure containment of the biosolids on the application site.

#### 4.3.2.3 Private Domestic Wastewater Discharges to Land > 1,500 GPD

Land discharges of large and medium-sized domestic wastewater or combined industrial/domestic wastewater systems are regulated under state-issued WDRs. Large systems have the capacity to treat more than 20,000 gallons per day (gpd) and are regulated by the Regional Water Board through individual WDRs. Medium-sized systems, which have a capacity of 1,500 gpd to 20,000 gpd, are typically regulated by individual or general WDRs.

In the Russian River Watershed, small volume domestic wastewater systems (e.g., septic systems with design flows less than 1,500 gpd and with subsurface effluent disposal) are typically regulated by local permits issued by the Sonoma County Permit and Resource Management Department or the County of Mendocino Department of Public Works. Small systems are treated as nonpoint sources in this TMDL project due to their generally diffuse occurrence in the watershed; see Section 4.2.1 for more information.

There are nineteen large and medium-sized domestic wastewater treatment facilities in the Russian River Watershed currently regulated under WDRs that discharge to land through conventional septic tank/leachfield systems, subsurface drip irrigation systems, percolation ponds, or spray irrigation. Table 4.9 summarizes these facilities and describes their treatment capabilities and methods of disposal.

WDRs for large wastewater discharges include effluent limitations, discharge prohibitions, and other conditions established to protect water quality and beneficial uses. Septic systems are designed in accordance with minimum standards for siting, design, and operation contained in the Basin Plan and other requirements set forth by the applicable local regulatory agency. Minimum standards that are critical to effective onsite treatment and disposal of waste include adequate separation to groundwater and drinking water sources, favorable soil characteristics and geology to maximize soil treatment, and suitable waste application rates. Land disposal systems conforming to prescribed minimum standards and operating properly are not expected to cause bacterial contamination of groundwater and surface waters. Land disposal through percolation ponds that are proximate to surface waters have the potential to contribute to bacterial loading in surface waters, depending on site specific conditions.

**Table 4.9. Private Domestic WDR Wastewater Treatment Facilities in the Russian River Watershed**

| Permit No. | Facility Name (Location) | Capacity (gpd) | Treatment Type/ Disposal Method |
|---|---|---|---|
| 97-10-DWQ | Old Crocker Inn (Cloverdale) | 1,875 | Conventional septic tank/leachfield system |
| 97-10-DWQ | The Farmhouse Inn (Forestville) | 3,285 | Aerobic pretreatment and subsurface drip irrigation |
| 97-10-DWQ | Kendall-Jackson Wine Center (Fulton) | 5,850 | Aerobic pretreatment with subsurface drip irrigation |
| 97-10-DWQ | Gurdjieff Foundation (Guerneville) | 2,490 | Aerobic pretreatment with subsurface drip irrigation and at-grade disposal system |
| 97-10-DWQ | Sonoma-Cutrer Vineyards (Santa Rosa) | 1,800 | Aerobic pretreatment with subsurface drip irrigation |
| 97-10-DWQ | Coppola Winery (Geyserville) | 12,000 | Aerobic pretreatment, disinfection, and subsurface drip irrigation |
| 97-10-DWQ | Jordan Vineyard and Winery (Healdsburg) | 3,500 | Aerobic pretreatment and mound disposal |
| 88-064 | Rodney Strong Vineyard (Healdsburg) | 60,000 | Aerated pond treatment, disinfection, and percolation disposal |
| 97-10-DWQ | Camp Newman (Santa Rosa) | 20,000 | Aerobic pretreatment with subsurface drip irrigation |
| 97-10-DWQ | Camp Royaneh (Cazadero) | 16,600 | Aerated pond treatment and percolation disposal |
| 97-10-DWQ | Camp Wente (Ukiah) | 10,875 | Conventional septic tank/leachfield system |
| R1-2006-0053 | Bohemian Grove (Monte Rio) | 2,250,000 | Aerated pond treatment, disinfection, and spray irrigation disposal |
| 98-125 | Odd Fellows Recreation Club (Forestville) | 45,000 | Clustered, conventional septic tank/leachfield system |
| 97-10-DWQ | Salvation Army-Lytton Springs Rehabilitation Facility (Healdsburg) | 11,000 | Aerated pond treatment, disinfection, and spray irrigation disposal |
| R1-2012-0099 (waiver) | EJ Gallo Winery (Healdsburg) | 3,060 | Conventional septic tank/leachfield system |
| R1-2003-0068 | Humane Society of Sonoma County | 2,423 | Aerobic pretreatment and mound disposal |
| R1-2003-0029 | Mayacamas Golf Club (Santa Rosa) | 4,900 | Aerated pond, microfiltration, disinfection, spray irrigation |
| R1-2002-0087 | Vintner's Inn (Santa Rosa) | 32,000 | Activated sludge system with surface drip irrigation |
| 87-094 | Rio Lindo Academy (Healdsburg) | 75,000 | Solids separation with evaporation/percolation disposal |

#### 4.3.2.4 Wineries and Food Processors

The Russian River Watershed is home to more than 100 small and large commercial wineries. Winery waste includes pomace (grape skins, stems, and seeds), lees (dead and residual yeast cells, and other grape solids that settle to the bottom of a wine barrel or fermentation tank), bottle and barrel rinse water, and equipment/floor wash water. Disposal of winery process wastewater through subsurface disposal (i.e., septic systems) is the common practice for small wineries. Larger wineries may use aerated pond systems to treat process wastewater prior to disposal or reuse through vineyard irrigation. Domestic, human waste is commonly disposed of in individual septic systems separate from the process wastewater disposal systems. However, there are some wineries in the Russian River Watershed that combine domestic and process wastewater streams and dispose of wastewater in septic systems, percolation ponds, or through vineyard irrigation. Winery process wastewater is not expected to contain a bacteria at levels of public health concern. Disposal of combined domestic and process wastewater through percolation and vineyard irrigation is a potential source of pathogen indicator bacteria unless treatment includes disinfection.

Wineries whose waste discharges may affect waters of the state are required to obtain coverage under Order No. R1-2002-0012 (General Waste Discharge Requirements for Discharges of Winery Waste to Land) or under individual WDRs for large volume discharges or combined domestic and process wastewater systems. Wineries whose discharge is a low threat to water quality may qualify for a waiver of WDRs.

There are five food processing facilities in the watershed that discharge process wastewater to land and are regulated under individual WDRs or a waiver of WDRs. These facilities were identified as a result of a query of the CIWQS database in November 2013. None of these permits contain effluent limitations. Other food processing facilities in the watershed have been identified by Regional Water Board staff. It is expected many of these facilities will enroll under a general waste discharge requirement permit or waiver of WDRs that are under development.

Generally, Good Manufacturing Practices (GMPs) and Sanitation Standard Operating Procedures (SSOPs) are the foundations for food safety programs for food processors. GMP regulations are designed to control the risk of contaminating foods with chemicals and microbes during their manufacture, and include practices for the cleaning and sterilization of equipment, pest control, and quality assurance assessment. SSOPs are specific, written procedures necessary to ensure sanitary conditions in the facility. SSOPs are required in all meat and poultry processing plants, in accordance with CFR Title 9 Part 416. Compliance with these practices and procedures will prevent contamination or adulteration of food products and will minimize the bacterial load discharged from the facility.

Although the level of bacteria associated with food processors is not currently known, given the nature of these discharges and the product sanitation safeguards, these facilities are not expected to be a source of pathogens in amounts that contribute to the pathogen impairment in the watershed.

**Table 4.10. Private Domestic WDR Wastewater Treatment Facilities in the Russian River Watershed**

| Permit No. | Facility Name (Location) | Design or Permitted Flow | Treatment Type/ Disposal Method |
|---|---|---|---|
| No. 79-019 | Santa Rosa Meat and Poultry Company (Santa Rosa) | 1,000 gpd | Specialty meat shop where industrial and domestic wastewater flows through a septic tank, one tank for industrial waste and one tank for domestic waste, the flows are then combined and chlorinated before disposal into an evaporation/percolation pond. |
| No. 80-047 | Timber Crest Farms (Healdsburg) | 10,000 gpd | Discharges wash water from the five individual wineries and one food processor renting space from the former dehydrated fruit processing facility to a spray irrigation system during the processing season (June-September). |
| No. 85-079 | Manzana Products Company (Graton) | 25,000 gpd | Apple processing and canning plant that discharges wash water to a spray irrigation system during seasonal operations. |
| No. 88-071 | Sonoma West Holdings-South (Sebastopol) | 50,000 gpd | Multi-tenant food and beverage processing facility that generates wash water. During dry weather, wash water is spray irrigated on 2.6 acres. Runoff from the spray fields is collected and re-irrigated, discharged to percolation beds, and/or retained in storage tanks. During wet weather, all wash water is directed to the percolation ponds and/or to storage tanks. Domestic wastewater is disposed of through an OWTS. |
| R1-2012-0116 (Waiver) | Olive Leaf Press (Sebastopol) | 120,000 gallons storage capacity | Organic farm that produces olive oil from Sonoma County-grown olives. The facility is used for both the pressing of olives and grapes along with the manufacturing of olive oil. The facility is covered by the categorical waiver policy as an agricultural commodity. Wash water is stored in tanks and land applied to 50 acres of agricultural land. |

#### 4.3.2.5 Mobile Home Parks & Campgrounds

There are 133 mobile home and special occupancy (RV) parks in the Russian River Watershed (CDHCD 2014). Most of these mobile home parks, RV Parks, and campgrounds are located within municipal sewer districts and discharge domestic wastewater to treatment facilities. However, forty-one of these parks are located outside of sewered areas and consequently dispose of domestic waste onsite via an individual septic system. Because these septic systems are commonly large capacity, located adjacent to surface waterbodies, and often poorly maintained or overloaded, they have the potential to be a source of pathogenic bacteria. Figure 4.13 shows the locations of these facilities and provides an estimate of their wastewater flow volume based on the assumption that 250 gallons per day of wastewater is produced per mobile home or campground space (U.S. DHEW 1972).

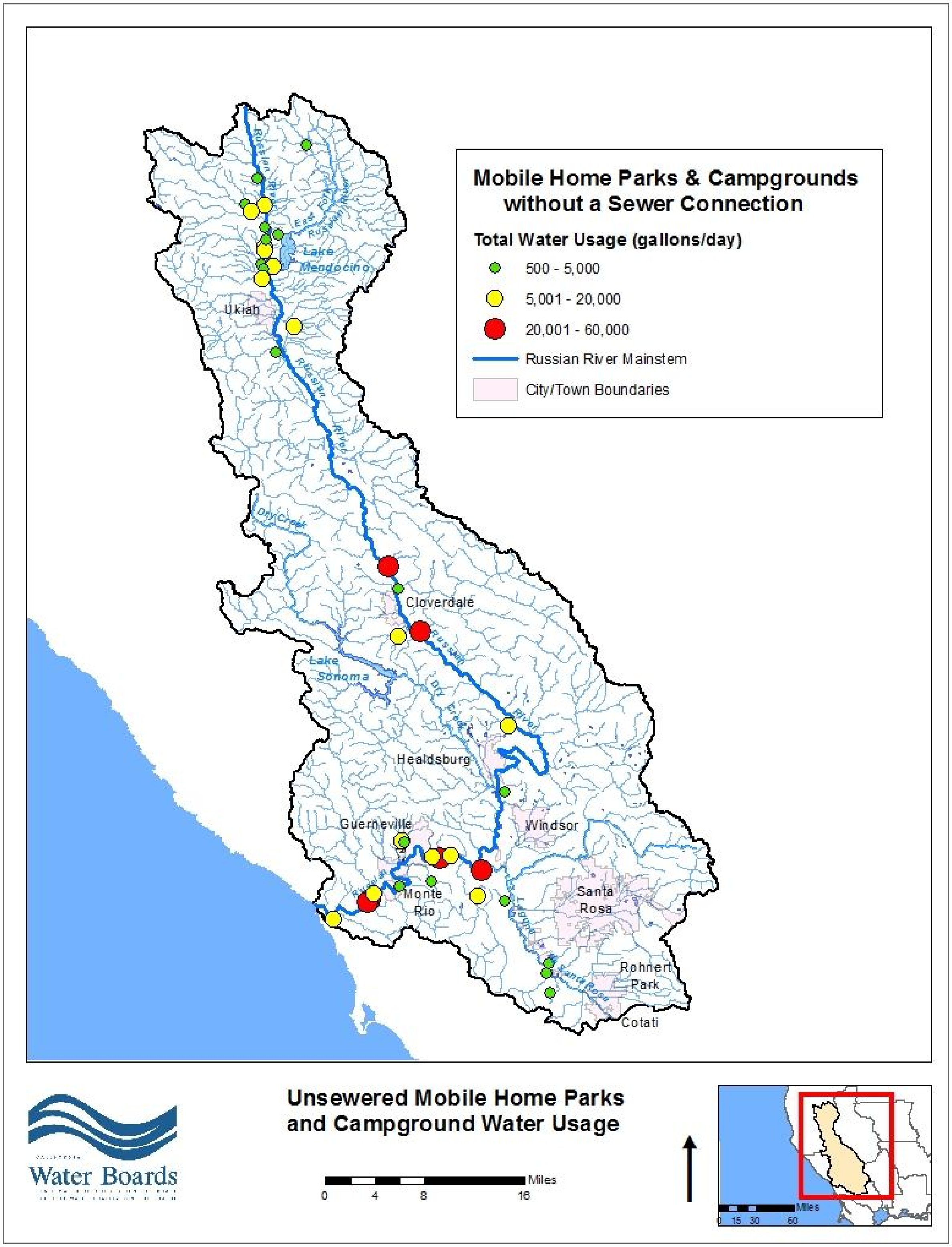



Figure 4.13. Unsewered Mobile Home Parks and Campgrounds

### 4.3.3 STORMWATER

Bacteria sources contained in stormwater runoff include failing septic tanks, sewer and sewer lateral overflows, decaying organic material, and the improper disposal of household pet waste.

The NPDES Stormwater Program regulates stormwater discharges from municipal separate storm sewer systems (MS4s), construction activities, industrial facilities, and state highways. Permitted facilities in the watershed are listed in Table 4.11. Most stormwater discharges are considered point sources, and operators of these sources may be required to receive an NPDES permit before they can discharge. In 1987, the U.S. Congress broadened the definition of "point source" to include construction and industrial stormwater discharges and municipal separate storm sewer systems (CWA §402(p)).

**Table 4.11. Permitted Stormwater Facilities in the Russian River Watershed**

| Program | Number of Enrollees |
|---|---|
| Municipal Phase I MS4 | 3 |
| Municipal Phase II MS4 | 6 |
| Stormwater Construction | 83 |
| Stormwater Industrial | 169 |
| Caltrans | 1 |
| Total | 260 |

#### 4.3.3.1 Municipal Stormwater

The 1987 amendments to the Clean Water Act required the U.S. EPA to address stormwater runoff in two phases. Phase I of the NPDES Storm Water Program began in 1990 and applied to large (serving 250,000 people or more) and medium (serving between 100,000 and 250,000 people) municipal separate storm sewer systems (MS4) and eleven industrial categories including construction sites disturbing five acres of land or more. Phase II of the NPDES Storm Water Program began in 2003 and applies to small MS4s (serving less than 100,000 people) including non-traditional small MS4s, which are facilities such as military bases, public campuses, prison and hospital complexes and construction sites disturbing from one up to five acres of land. The CWA requires that MS4 permits must “require controls to reduce the discharge of pollutants to the maximum extent practicable (MEP), including management practices, control techniques and systems, design engineering methods and such other provisions as the [U.S. EPA] Administrator or the state determines appropriate for the control of such pollutants.”

Within the Russian River Watershed’s urban boundaries, stormwater runoff and non-stormwater runoff is regulated under a Phase I MS4 Permit. The current Phase I MS4 Permit, Order No. R1-2009-0050 (NPDES Permit No. CA0025054), names the City of Santa Rosa, County of Sonoma, and the Sonoma County Water Agency as permittees. However, a number of communities within the Russian River Watershed that are enrolled under the Phase II Small MS4 Permit (Order No. 2013-0001- DWQ effective July 1, 2013) are meeting their Phase II MS4 requirements by voluntarily complying with the Phase I MS4 Permit. These communities are the City of Cotati, the City of Rohnert Park, the Town of Windsor, the City of Sebastopol, the City of Ukiah, the City of Healdsburg, and the unincorporated communities of Guerneville, Monte Rio, Forestville, Graton, and Occidental.

Under terms of the Phase I MS4 Permit, permittees are required to possess the legal authority to prohibit discharges of non-stormwater from dumping and disposal of materials such as litter, household refuse, and other materials that have the potential to become sources of pathogenic bacteria. . Permittees are also required to implement, in coordination with other public entities, as appropriate, a Public Information and Participation Program (PIPP) that includes education materials to inform the public on the proper disposal and storage of animal wastes.

Sources of pathogen indicator bacteria in urbanized areas (areas within MS4 boundaries) include SSOs, combined sewer overflows, illicit discharges to storm sewer systems (e.g., power washing), failing OWTS, wastewater treatment plants, urban wildlife, domestic pets, and agriculture (UWRRC 2014). The UWRRC report found that indicator bacteria concentrations in wet weather, urban discharges from MS4s were orders of magnitude above primary contact recreation standards. The report also found that epidemiological studies were limited, particularly during wet weather, and inconclusive regarding the human health risk associated with recreational activities in receiving waters impacted by urban runoff.

#### 4.3.3.2 Industrial Stormwater

The most common pollutants of concern in industrial stormwater are suspended solids, oxygen-demanding substances (BOD), nutrients, and heavy metals. Most industrial categories are related to heavy industry and certain light industrial facilities and are unlikely to discharge a significant level of bacteria or other pathogens found in human domestic waste. However, some facilities that require coverage under a stormwater permit, such as concentrated animal feeding operations, solid waste transfer stations, sewage treatment plants, and composting operations, are potential sources of pathogenic bacteria and other public health-related pollutants.

Currently, stormwater discharges associated with industrial activities, unless otherwise excluded, are regulated under NPDES Industrial General Permit (Order 97-03-DWQ, NPDES No. CAS000001). Beginning on July 1, 2015, stormwater discharges associated with industrial activities, unless otherwise excluded, will be regulated under a new NPDES Industrial General Permit (Order 2014-0057-DWQ). Industrial facilities obtain permit coverage based on whether or not their Standard Industrial Classification (SIC) code is included in those specific categories. The Industrial General Permit requires the implementation of Best Conventional Treatment Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or prevent pollutants in stormwater discharges and authorized non-stormwater discharges. .

Compliance with requirements in the General Permit will ensure that stormwater discharges from industrial sites are not a significant source of pathogenic bacteria. No WLAs are needed for industrial stormwater discharges. However, the need for WLAs may be reevaluated in future TMDLs in the event there is new information implicating industrial stormwater as a significant source.

#### 4.3.3.3 Construction Stormwater

Construction activities that result in a land disturbance equal to or greater than one acre are required to have coverage under the Construction General Permit (Order 2009-0009-DWQ, as amended by Order 2010-0014-DWQ and Order 2012-006-DWQ). The objective of the Construction General Permit is to prevent or minimize the discharge of construction-related pollutants from work sites.

The primary potential sources of pathogens at construction sites are temporary sanitary facilities on work sites that are poorly designed or maintained and thus are a potential source of pathogenic bacteria. Operators of construction sites where there are no permanent sanitary facilities or where permanent facilities are too far from the construction site will provide sanitary facilities for construction personnel in one or more locations throughout the work site. A well-designed and maintained work site will include BMPs for portable sanitary facilities that include setbacks from waterbodies, storm drains, and gutters, location of toilets on surface areas that will absorb spills instead of transporting contamination to surface waters, and provisions to prevent vandalism and toppling of the enclosures due to exposure to high winds. Recommended maintenance activities include establishment of an appropriate cleaning and maintenance schedule, and inspection schedules to detect damage, leaks, and spills, and disposal for rinse water from cleaning activities into a sanitary sewer system.

Compliance with requirements in the Construction General Permit will ensure that stormwater discharges from construction sites are not a significant source of pathogenic bacteria. No WLAs are needed for construction stormwater discharges. However, the need for WLAs may be reevaluated in future TMDLs in the event there is new information implicating construction stormwater as a significant source.

#### 4.3.3.4 Caltrans Stormwater

The California Department of Transportation (Caltrans) is responsible for the design, construction, management, and maintenance of the state highway system, including freeways, bridges, tunnels, and associated properties. Major state highways in the Russian River Watershed include Highways 101, 116, 128, and 12.

Caltrans is subject to the stormwater permitting requirements of Clean Water Act section 402(p). Caltrans is currently operating under a statewide stormwater permit (Order 2012-011-DWQ) that regulates all stormwater and non-stormwater discharges from Caltrans MS4s and maintenance facilities. Caltrans' Storm Water Management Plan, which is updated annually, describes the procedures and practices used to reduce or eliminate the discharge of pollutants to storm drainage systems and receiving waters. Construction activities associated with Caltrans projects are covered by Order 2009-0009-DWQ, as amended.

The State Water Board adopted Order 2014-0077-DWQ as an amendment to the Caltrans permit to add requirements related to completed TMDLs. Under the statewide permit and TMDL amendment, Caltrans is required to prioritize reaches across the state and then to implement best management practices and control measures to achieve 1,650 Compliance Units each year in the highest priority reaches. One Compliance Unit is equal to one acre of Caltrans right-of-way from which runoff is retained, treated, or otherwise controlled prior to discharge to the relevant reach. Caltrans is encouraged to establish cooperative implementation agreements with other parties that have responsibility to attain a TMDL.

Also under the statewide stormwater permit, Caltrans is required to prepare a TMDL Status Review Report to be submitted with each Annual Report. The TMDL Status Review Report includes (1) a summary of the effectiveness of the control measures installed for each reach that has been addressed, as a result of BMP effectiveness assessment, (2) a determination as to whether the control measures have been or will be sufficient to achieve WLAs and other performance standards by the final compliance deadlines, (3) where the control measures are determined not to be sufficient to achieve WLAs or other performance standards by the final compliance deadlines, a proposal for improved control measures to address the relevant pollutants, and (4) a summary of the estimated amount of pollutants that were prevented from entering into the receiving waters. The TMDL Progress Report is subject to public review and comment.

Homeless encampments within the Caltrans right-of-way are a source of both trash and pollutants in waterways. As described in a 2013 study for the Contra Costa County Flood Control and Water Conservation District, larger, well-established encampments usually have a designated "toilet area," but it is likely that occupants also use the water to dispose of waste (DeVuono-Powell 2013). Where the disposal of urine and human fecal matter in water occurs, there is a high potential that this is a source of pathogenic indicator bacteria. In areas within Caltrans rights-of-way that do not contain bacteria-generating sources such as homeless encampments, restroom facilities, garbage binds, etc., the contribution of pathogen indicator bacteria to waterbodies is not believed to be a significant source of pathogens that present a human health risk (Caltrans 2012).

## 4.4 NONPOINT SOURCES

The term "nonpoint source" is defined as any source of water pollution that is not from a discernible, confined, and discrete conveyance. Per definitions in the Clean Water Act, agricultural discharges are also considered nonpoint sources even when conveyed through a pipe. Nonpoint source pollution comes from many diffuse sources and is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into streams and other waters.

This section primarily focuses on controllable nonpoint sources in developed areas and agricultural areas, since the runoff from these areas show the highest concentrations of pathogenic indicator bacteria.

### 4.4.1 ONSITE WASTEWATER TREATMENT SYSTEMS

About one-fourth of all American households rely on onsite wastewater treatment systems (OWTS) to dispose of their wastewater, which translates to about 20 million individual systems nationwide (Wilhelm et al. 1994). Table 4.12 presents estimates of the houses and population that are connected to sanitary sewers in the Russian River Watershed. The estimates show that about 31% of the houses in the watershed are not connected to a sanitary sewer and are assumed to use OWTS for treatment of domestic waste. The estimates were made from the 2010 U.S. Census.

**Table 4.12. Estimates of Houses, Population & Acres of Sewered and Non-Sewered Areas in the Russian River Watershed**

| Areas | Houses | | Population | | Acres | |
|---|---|---|---|---|---|---|
| | Count | Percent | Count | Percent | Count | Percent |
| Sewered | 113,631 | 69% | 288,225 | 72% | 83,644 | 9% |
| Non-sewered | 51,537 | 31% | 111,147 | 28% | 866,608 | 91% |
| Total within Russian River Watershed | 165,168 | 100% | 399,372 | 100% | 950,252 | 100% |

Conventional OWTS operate simply: after solids are trapped in a septic tank, typically a 1,000 to 1,500-gallon concrete or fiberglass tank, wastewater is distributed to a subsurface drain field and allowed to percolate through the soil. Bacteria in the wastewater are effectively removed by filtering and straining water through the soil profile. Viruses are not effectively filtered in soil because of their small size. Instead viruses are removed through adsorption to soil particles and by inactivation in the soil.

Effective pathogen removal in OWTS is dependent on proper siting and installation of the OWTS components, proper maintenance, and operation of the system within design specifications. OWTS can fail when wastewater rises to the ground surface, is intercepted by high groundwater, or passes through the soil profile without adequate treatment.

The results of the land cover-based source analysis (see Section 4.2) indicate that human-source *Bacteroides* bacteria concentrations are higher in areas with OWTS as compared to urban sewered areas. The analysis indicated that OWTS are a contributing source of pathogenic indicator bacteria. In order to confirm this finding, Regional Water Board staff conducted a more focused study on the potential influence of OWTS on pathogenic indicator bacteria concentrations in receiving surface waters. The sampling methods, results, and an analysis of the data are presented in the "Onsite Wastewater Treatment System Impact Study Report" (NCRWQCB 2013a). The study compared water samples collected downstream of small watersheds that drain areas with densely situated OWTS and watersheds that drain areas with a relatively low density of OWTS. Results show that a higher parcel density in areas with only OWTS is directly associated with higher concentrations of both *Bacteroides* and *E. coli* bacteria, confirming that OWTS contribute to pathogenic indicator bacteria in surface waters. Figure 4.14 shows the distribution of these concentrations by parcel densities. High parcel densities range from 0.76 to 3.99 parcels per acre (0.25 to 1.3 acres/parcel). Low parcel densities ranged from 0.01 to 0.11 parcels per acre (9.1 to 100 acres/parcel).

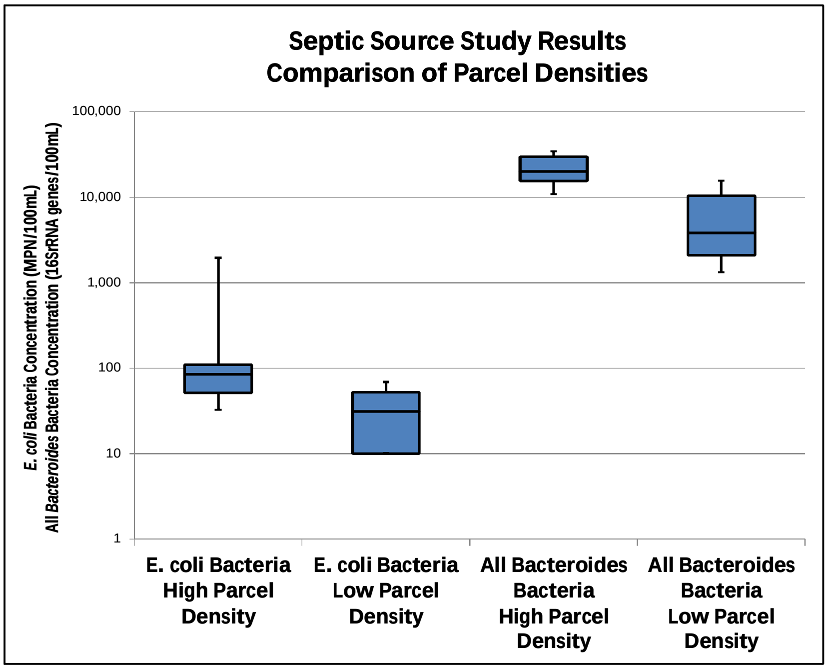



Figure 4.14. Comparison of the distribution of *E. coli* and *Bacteroides* bacteria concentrations by parcel densities

### 4.4.2 RECREATION AT PUBLIC BEACHES

There are many public swimming beaches along the mainstem Russian River. Several of the most popular beaches are shown in Table 4.13 and Figure 4.15. Swimming and other water contact recreation in the river can be a source of bacteria and other pathogens through direct human urination or defecation in the water or along the shore. Pathogens may also be washed off the body during immersion.

Regional Water Board staff conducted a focused study on the potential influence of intensive recreation on pathogenic indicator bacteria concentrations at public beaches (NCRWQCB 2013b). Water samples were collected for analysis of pathogen indicator bacteria at Veterans Memorial Beach and Monte Rio Beach during the week of the Independence Day holiday in 2013.

**Table 4.13. Popular Swimming Beaches along the Russian River**

| Recreational Beach Name | Location |
|---|---|
| Mill Creek Park | Potter Valley |
| Mariposa Swimming Hole | Redwood Valley |
| Vichy Springs Park | Ukiah |
| Mill Creek Park | Ukiah |
| Cloverdale River Park | Cloverdale |
| Alexander Valley Campground | Healdsburg |
| Veteran Memorial Beach | Healdsburg |
| Riverfront Park | Windsor |
| Mirabel Park Campground | Forestville |
| Steelhead Beach | Forestville |
| River Access Beach | Forestville |
| Sunset Beach | Forestville |
| Johnson's Beach | Guerneville |
| Monte Rio Beach | Monte Rio |


Figure 4.15: Popular Swimming Beaches along the Russian River

Water samples were collected during the afternoon when human recreational use was the highest. Sonoma County Park staff counted recreators on the beach and in the water at Veterans Memorial Beach each day at 14:00 hours (Figure 4.16). Recreator counts were not available for Monte Rio Beach. Figures 4.17 through 4.19 show photographs of both beaches on Independence Day. Figures 4.20 and 4.21 show *E. coli* concentrations measured at those beaches during the study.

The study found that the percentage of human-host *Bacteroides* showed a relatively strong positive association with swimming recreation, with the higher percentages of human-host *Bacteroides* observed on days with a larger number of people swimming. A moderately positive association was found for *E. coli* concentrations with swimming recreation. The results indicate that intensive human contact recreation at public beaches on the most popular hot summer days contributes to pathogenic indicator bacteria concentrations in surface waters. The less intensive recreation that is more common during summer weekdays and throughout the non-summer season results in lower pathogenic indicator bacteria concentrations.

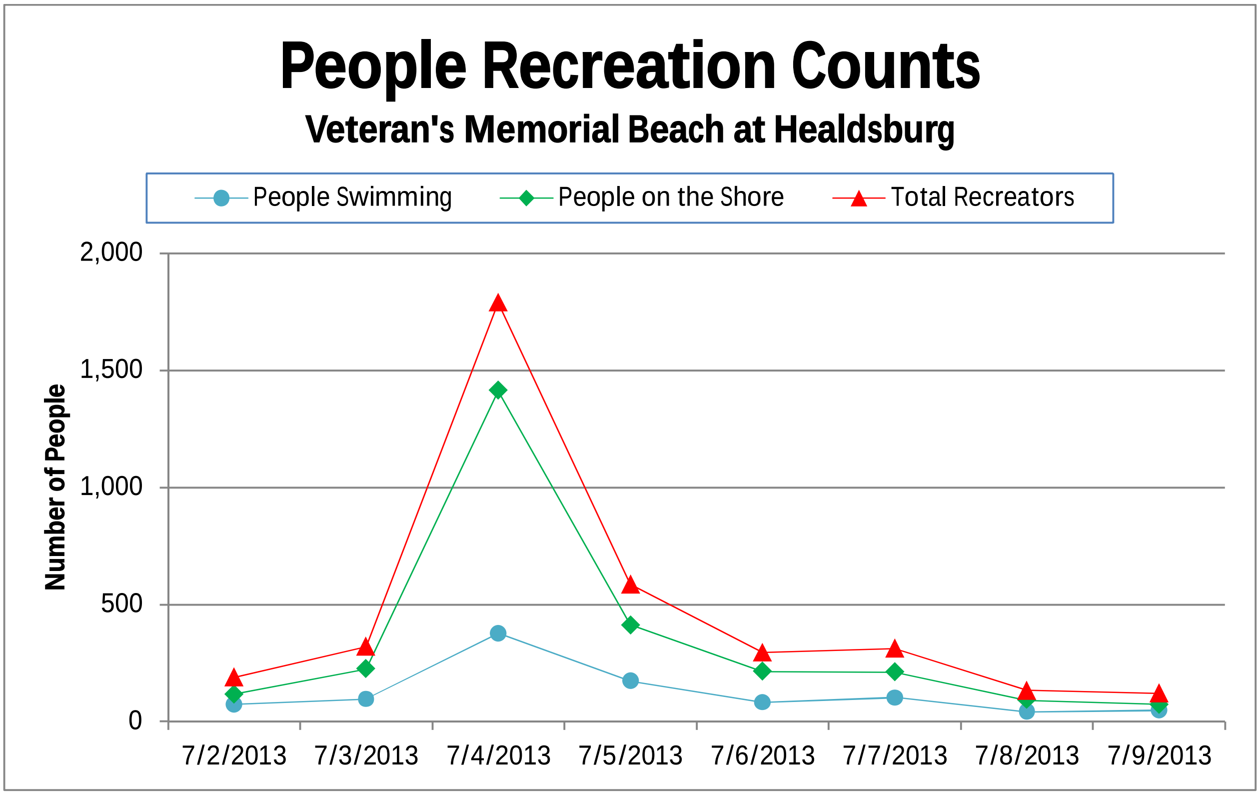



Figure 4.16. Counts of People Recreating at Veteran Memorial Beach in Healdsburg.


Figure 4.17. Veteran Memorial Beach on Thursday, July 4, 2013 at 12:30

Figure 4.18. East Monte Rio Beach on Thursday, July 4, 2013 at 14:00

Figure 4.19. West Monte Rio Beach on Thursday, July 4, 2013 at 14:00

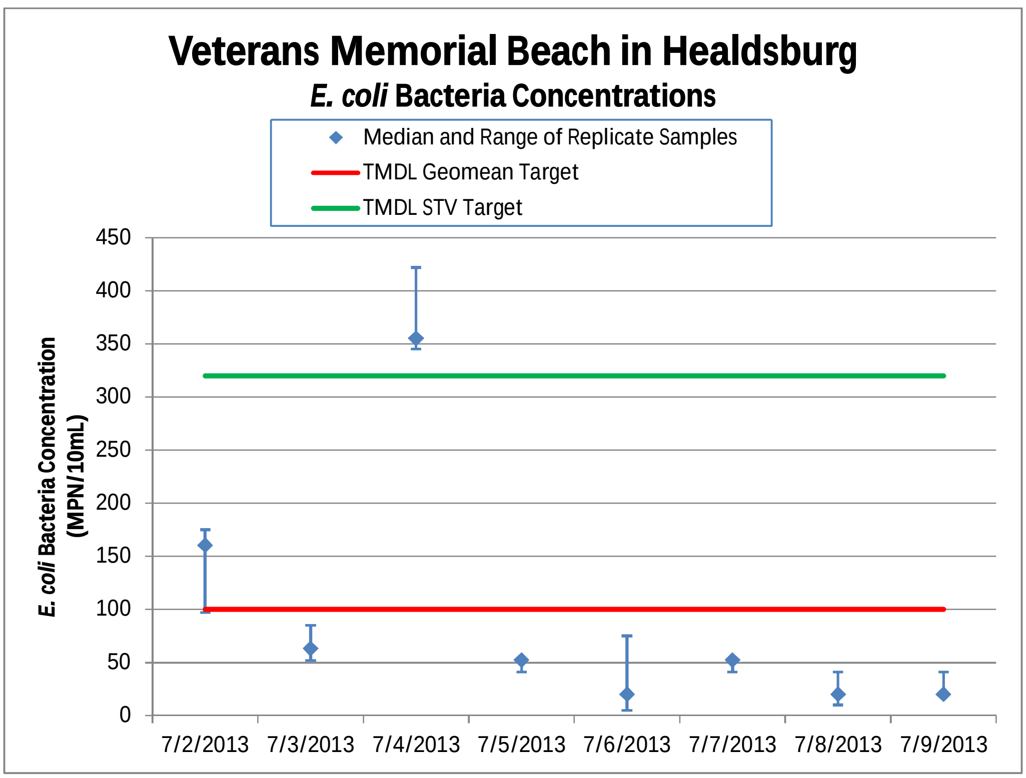



Figure 4.20. *E. coli* Bacteria Concentrations Measured at Veteran Memorial Beach in Healdsburg

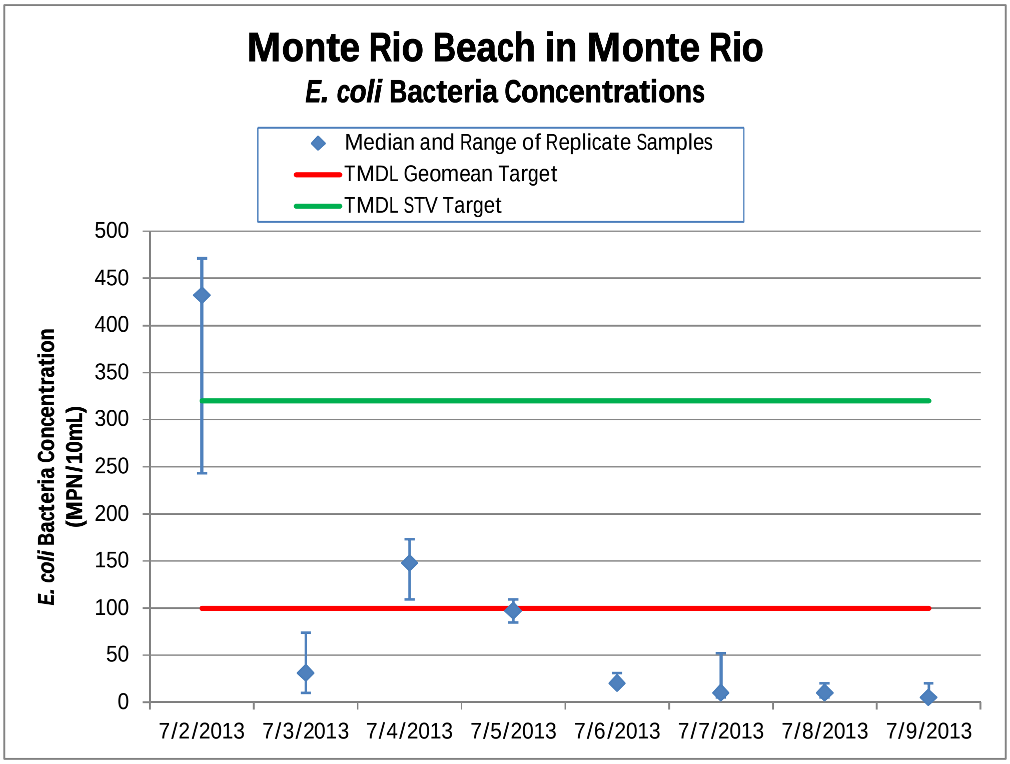



Figure 4.21. *E. coli* Bacteria Concentrations Measured at Monte Rio Beach in Monte Rio

### 4.4.3 HOMELESS ENCAMPMENTS

Homeless encampments are potential, but unconfirmed, sources of bacteria. Many riparian areas within the Russian River Watershed serve as temporary shelter for homeless people and these areas most often do not have sanitary disposal facilities. The discharge of untreated human waste directly to surface waters within these riparian corridors from homeless encampments likely explains the presence of human-source indicator bacteria found in undeveloped areas.

The Russian River Watershed covers large areas of Mendocino and Sonoma counties. Applied Survey Research (2005) estimates that 5,335 people were homeless in Mendocino County and 78% of those were unsheltered. This represents 6% of the overall population of 90,816 people in Mendocino County. Applied Survey Research also estimates that 9,749 people were homeless in Sonoma County and 77% of those were unsheltered. This represents 2% of the overall population of 484,102 people in Sonoma County.

Information about farmworkers, both permanent and itinerant, in the Russian River Watershed is similarly difficult to obtain. Based on estimates for Napa County (BAE 2013), which has a similar agricultural profile to Sonoma County, it can be similarly estimated that agriculture employers in Sonoma County hire as many as 7,000 workers during peak farm employment periods, which correspond to the May-June growing season and the August-October harvest period. While many of these seasonal workers obtain permanent or semi-permanent lodging in private accommodations or in County-subsidized housing, many other farmworkers seek temporary lodging in encampments where restroom facilities are not available. Where itinerant farmworker encampments are located near water courses, there is an increased opportunity for human waste contamination.

### 4.4.4 RECYCLED WATER DISCHARGES FROM LANDSCAPE IRRIGATION

Although advanced wastewater treatment systems in the Russian River Watershed are operated to produce recycled water that is essentially pathogen-free and suitable for water recycling, this same recycled water, when stored in open-air holding ponds, may become contaminated as a result of regrowth of bacteria or through contribution of fecal matter from wildlife, particularly birds that frequent the storage ponds.

Most major municipalities in the watershed are either actively participating in water recycling programs or are contemplating becoming involved. The largest water recycling program in the region, the Santa Rosa Subregional Water Reclamation System, accepts and treats municipal wastewater from the communities of Santa Rosa, Cotati, Rohnert Park, and Sebastopol for use as recycled water for urban and agricultural irrigation on over 6,400 acres of land. Other communities, such as the Town of Windsor, the Russian River Community Services District in Guerneville, and the Airport-Larkfield-Wikiup communities also use recycled water for local irrigation projects. Currently, there is no recycled water used for landscape irrigation in Mendocino County. Recycled water producers are regulated under General Waste Discharge Requirements (Order 2014-0090-DWQ) or individual waste discharge requirements.

The Santa Rosa Non-Storm Water Discharge Best Management Practices (BMP) Plan was required by NPDES MS4 Permit Order No. R1-2009-0050 and sets forth approved protective measures that are required of all applicable discharges in order to minimize or prevent the effects of non-stormwater discharges (City of Santa Rosa 2013). The BMP Plan describes runoff control measures to be implemented for both landscape irrigation in urban settings and agricultural irrigation in rural settings. By controlling runoff from recycled water use areas, these BMPs will also help reduce human-source bacteria entering receiving waters. The non-stormwater BMP Plans for Sonoma County Water Agency and Sonoma County are in development or are being reviewed by Regional Water Board staff.

Although local recycled water programs are generally well-managed, unintentional spills of recycled water occur periodically. Large volume spills are typically the result of broken recycled water lines in rural properties, but often occur as a result of operator error or inattention. Large volume spills of recycled water have the potential to adversely impact water quality, but are a low risk to contribute pathogenic indicator bacteria because the recycled water has been disinfected to meet tertiary treatment standards prior to entering the recycled water distribution system. Small volume spills occur more frequently, often as a result of unintentional overspray, mechanical breaks, vandalism, or other unforeseen conditions. The contribution of pathogen indicator bacteria from small volume spills and other incidental runoff events is de minimus and not expected to be a source of pathogens in amounts that contribute to the pathogen impairment in the watershed.

### 4.4.5 PET WASTE

Domesticated pets can be a major source of pathogenic indicator bacteria, especially dogs and cats. Domesticated dogs can be a significant source of fecal material based on their population density, high defecation rate, and pathogen infection rates (Schueler 2000). A single gram of dog feces contains 23 million fecal coliform bacteria (van der Wel 1995). Dogs have been found to be significant hosts for *Giardia, Salmonella*, and *Pseudomonas* bacteria (Pitt 1998). Lim and Oliveri (1982) concluded that dog feces were the single greatest source contributing fecal coliform and fecal streptococcus bacteria in urbanized Baltimore catchments. Trial et al. (1993) reported that cats and dogs were the primary source of fecal coliform bacteria in urban catchments in the Seattle area.

Improper pet waste disposal has the potential to deliver pathogenic indicator bacteria to surface waters through stormwater discharges. Since storm drains do not always connect to treatment facilities, untreated animal feces often end up in surface waters.

Most pet waste management programs focus on increasing public awareness. Many communities implement pet waste management programs by posting signs in parks or other pet-frequented areas, by mass mailings, and by broadcasting public service announcements. Sign posting is one of the most common outreach strategies. Signs can designate areas where dog walking is prohibited, where waste must be recovered, or where dogs can roam freely. A "pooper-scooper" ordinance is an effective solution. Many communities have pooper-scooper laws that mandate pet waste cleanup. Because pet waste management is focused toward individual pet owners, the program is dependent on the participation and cooperation of all pet owners, and pet waste management programs must be enforced. With an increase in public knowledge of stormwater regulations, proper disposal of pet wastes can lead to a significant reduction of bacteria discharged in stormwater.

All MS4 permits issued in the Russian River Watershed require the implementation of a Public Information and Participation Program (PIPP). The PIPP involves using effective mechanisms and programs, guided by a detailed outreach strategy, to engage the public's interest in preventing stormwater pollution.

### 4.4.6 LIVESTOCK WASTE

A large number of bacterial pathogens found in manure from livestock have the potential to cause illness in humans. These organisms include, but are not limited to, *Salmonella*, *Campylobacter*, *E. coli*, *Leptospira*, and *Clostridium* bacteria (U.S. EPA 2009). Several viruses found in livestock waste have the potential to cross from animals to humans, and thus have the potential to cause disease in humans (Mattison et al. 2007; McAllister and Topp 2012). Pathogens can be discharged directly to watercourses when livestock have access to streams. They can also be carried to surface waters in stormwater runoff or in runoff resulting from over-application of liquefied manure to pasture land.

The estimated number of different types of animals in Sonoma and Mendocino counties is shown in Table 4.11. The Russian River Watershed covers large areas of both counties. Data presented in this table were obtained from several sources, as described below.

**Table 4.14. Inventory of Livestock Animals in Mendocino and Sonoma Counties**

| Animal Type | Mendocino County | | Sonoma County | |
|---|---|---|---|---|
| | Number of Animals | Citation | Number of Animals | Citation |
| Laying Hens and Pullets | 8,973 | USDA (2007) | 5,764,700 | Linegar (2013) |
| Cattle and calves | 18,800 | Morse (2012) | 68,762 | Linegar (2013) |
| Horses | 2,509 | USDA (2007) | 17,794 | Benito (2005) |
| Sheep and lambs | 9,200 | Morse (2012) | 22,543 | Linegar (2013) |
| Goats | 1,454 | USDA (2007) | 2,146 | Linegar (2013) |
| Hogs | 1,450 | Morse (2012) | 1,029 | Linegar (2013) |

### 4.4.7 DAIRIES, MANURE HOLDING PONDS, & LANDSCAPE APPLICATIONS OF MANURE

Any release of manure to surface waters from holding ponds and landscape application from confined animal facilities has a significant potential to impact bacterial water quality due to the large amount of stored and land-applied manure and the high concentration of fecal bacteria in raw manure (up to 100 million fecal coliform per gram). Most large-scale dairies in the Russian River Watershed store manure in massive lagoons that can hold millions of gallons of liquid manure. Waste lagoons can break, spill, leak, or fail. Lagoon linings can crack and allow liquefied manure to seep into surface waters or shallow groundwater. Pipes and hoses connecting to lagoons or spray fields may fail or leak (Marks 2001). In addition, many dairies spread or spray liquefied manure on pasture land. When liquid waste is over-applied or inappropriately applied to farm fields through irrigation, runoff of manure to surface waters can result.

The Regional Water Board implements the Water Quality Compliance Program for Cow Dairies and Concentrated Animal Feeding Operations (CAFOs). Initiated in 2012, this program includes a NPDES permit for CAFOs that discharge directly to surface waters, a General GWDR permit for dairies that do not meet minimum standards for the protection of surface water and groundwater, and a Conditional Waiver for dairies that meet minimum standards in Title 27 of the California Code of Regulations for confined animal facilities. These regulatory tools require management of process water, manure, and other organic materials at dairy operations including holding ponds and the application of such materials to cropland.

**Table 4.15. Dairies in the Russian River Watershed**

| Dairy Name | Location |
|---|---|
| Aggio Dairy Inc. | Santa Rosa |
| Amos Brothers Dairy | Santa Rosa |
| Beretta Dairy | Santa Rosa |
| Bucher Farms | Healdsburg |
| Buttke Dairy | Sebastopol |
| Carinalli Dairy | Sebastopol |
| Cunningham Dairy | Santa Rosa |
| Dotti Brothers LLC | Santa Rosa |
| Jack Dei Dairy | Sebastopol |
| Joe Matos Cheese Factory | Santa Rosa |
| Joe Pinheiro Dairy | Santa Rosa |
| Jones Dairy | Santa Rosa |
| Mello Dairy | Santa Rosa |
| Mello Farms | Santa Rosa |
| Morrison Brothers Dairy | Santa Rosa |
| Rancho Laguna Dairy | Santa Rosa |
| Steve Riebli Dairy | Sebastopol |
| Terra Linda Dairy | Santa Rosa |

In accordance with Title 27, the dairy permits require retention ponds and manured areas at confined animal facilities in operation on or before November 27, 1984, to be protected from inundation or washout by overflow from any stream channel during 20-year peak stream flows. Retention ponds are required to be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or artificial materials of equivalent impermeability. While these permit requirements will protect against a significant amount of manure discharges from holding ponds, discharges are likely when streams exceed the 20-year peak stream flow rate. The dairy permits specify that waste storage facilities constructed after January 19, 2012 should be located outside of floodplains, unless site restrictions require location within a floodplain, in which case, the waste storage facility shall be protected from inundation or damage from a 100-year flood event. Manure ponds constructed after January 19, 2012, must include a pond liner that does not exceed a unit seepage rate of $1X\ 10^{-6}$ centimeters per second.

The dairy permits also authorize the application of manure and process waters to land only if such application is at rates that are reasonable for the crop, soil, climate, special local situations management systems, and type of manure.

# CHAPTER 5
# SEASONAL VARIATION AND CRITICAL CONDITIONS

This chapter describes the seasonal variation of pathogen indicator bacteria throughout the year and describes the critical or extreme condition for the purposes of setting allocations to meet water quality standards.

## 5.1 SEASONAL VARIATION

### 5.1.1 Wet Periods vs. Dry Periods

Regional Water Board staff collected water samples for measurement of pathogenic indicator bacteria at numerous locations in the Russian River Watershed from 2011 to 2013 (NCRWQCB 2012; NCRWQCB 2013a; NCRWQCB 2013b). Water samples were collected in both dry and wet periods for analysis of *E. coli*, human-host *Bacteroides*, and bovine-host *Bacteroides* bacteria concentrations. Dry period samples were collected after 72 hours of no rainfall. Wet period samples were collected during storm events of at least 0.1 inches of rainfall that were preceded by 72 hours of no rainfall.

Figures 5.1 through 5.3 compare the distribution of pathogenic indicator bacteria concentrations sampled during wet and dry weather periods. All three indicator bacteria show significantly higher concentrations measured during wet weather compared to dry weather samples. This finding indicates that higher pathogenic indicator bacteria levels are associated with higher flows that are associated with storm events.

### 5.1.2 Effects of Low Mainstem Flows

Regional Water Board staff also evaluated the relationship between *E. coli* bacteria concentrations and dry season stream flows in the mainstem Russian River (Butkus 2014b). The assessment found that there is not a statistically significant correlation between summer daily mean stream flow rates and *E. coli* bacteria concentrations at Camp Rose Beach, Veteran Memorial Beach, Steelhead Beach, Johnson's Beach, or Monte Rio Beach, as shown in Figures 5.4 through 5.8. In other words, *E. coli* levels do not vary significantly due to flows in the mainstem during dry summer periods.

This conclusion is supported by an additional analysis undertaken to evaluate if *E. coli* concentrations are different in years with lower flows under a Temporary Urgency Change Petition (TUCP)[4] than in years without a petition (Butkus 2014b). There is no statistically

[4] The Sonoma County Water Agency (SCWA) controls and coordinates water supply releases from Coyote Valley and Warm Springs dams in accordance with minimum instream flow requirements specified by the State Water Board. These minimum instream flow requirements vary based on water supply conditions. Since 2002, SCWA has requested temporary changes to the Decision 1610 minimum instream flow requirements from the State Water Board. SCWA filed Temporary Urgency Change Petitions (TUCP) in 2002, 2004, 2007, and 2009 to request reductions in Russian River instream flows to address low storage levels in Lake Mendocino. TUCPs filed from 2010 through 2014 were required by the Russian River Biological Opinion

significant difference in *E. coli* concentrations in years with reduced stream flows due to TUCPs in the Russian River at Camp Rose Beach, Veteran Memorial Beach, Steelhead Beach, and Johnson's Beach. Only data from Monte Rio beach showed a statistically significant difference in that *E. coli* concentrations were lower in TUCP years with reduced flows. The reason for the lower *E. coli* levels in lower flows at Monte Rio beach are unknown, but could include less rainfall and runoff or changes in management practices that reduced inputs in years with TUCPs.

## 5.2 CRITICAL CONDITIONS

The critical condition can be thought of as the "worst case" scenario of environmental conditions in the waterbody, a condition where the pollutant loading is greatest, but the waterbody continues to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., stream flow, temperature, etc.) that result in the attainment of standards with an acceptably low frequency of occurrence (U.S. EPA 1999).

Pathogenic indicator bacteria concentrations do not have a specific period of time that could be considered a critical condition. During wet weather periods, pathogenic indicator bacteria concentrations are much higher than during dry periods, and often exceed the numeric targets. Therefore, wet weather conditions can be considered a critical condition for bacteria levels. However, during the summer, low-flow period there is much more exposure to pathogenic indicator bacteria through recreation. Therefore, summer recreation periods can also be considered a critical period. Since both wet and dry periods are critical conditions, the same loading capacities apply throughout the year and should not vary according to season.

under the Endangered Species Act to reduce instream flow conditions to improve habitat for the threatened and endangered salmonid species.

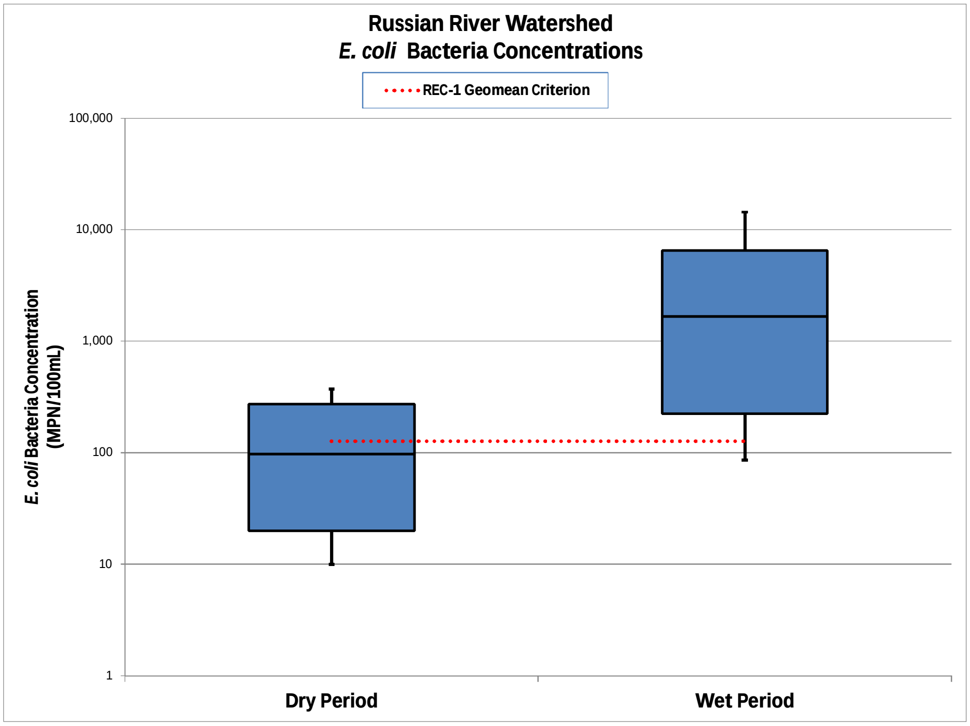



Figure 5.1. Distribution of *E. coli* Bacteria Concentrations collected during Dry and Wet Weather Periods

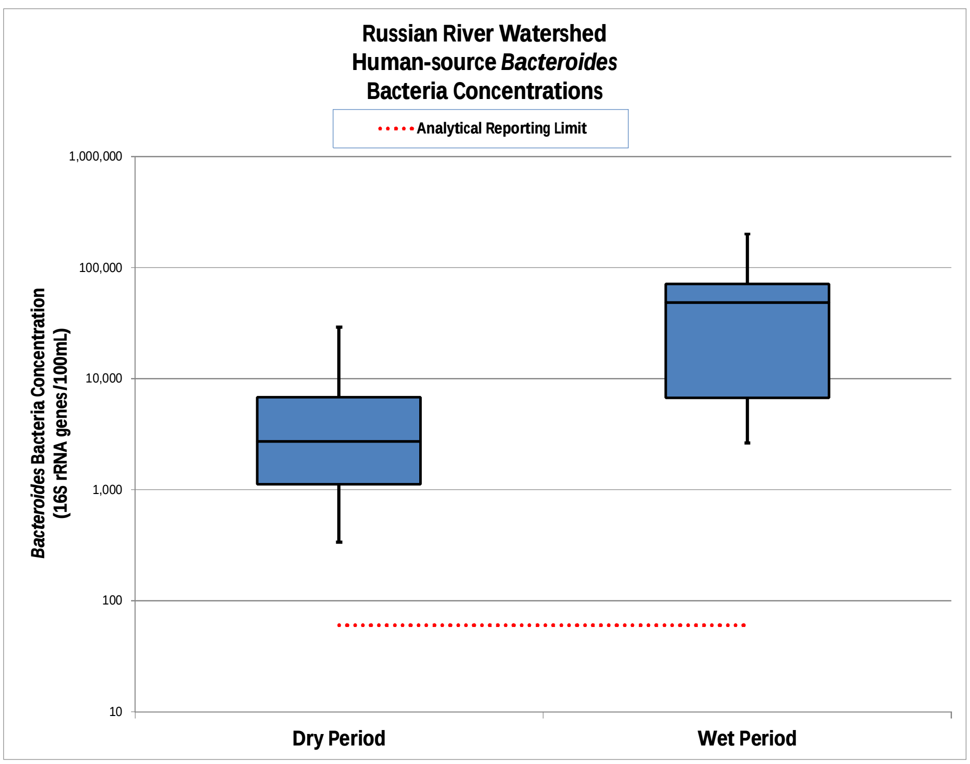



Figure 5.2. Distribution of Human-host *Bacteroides* Bacteria Concentrations collected during Dry and Wet Weather Periods

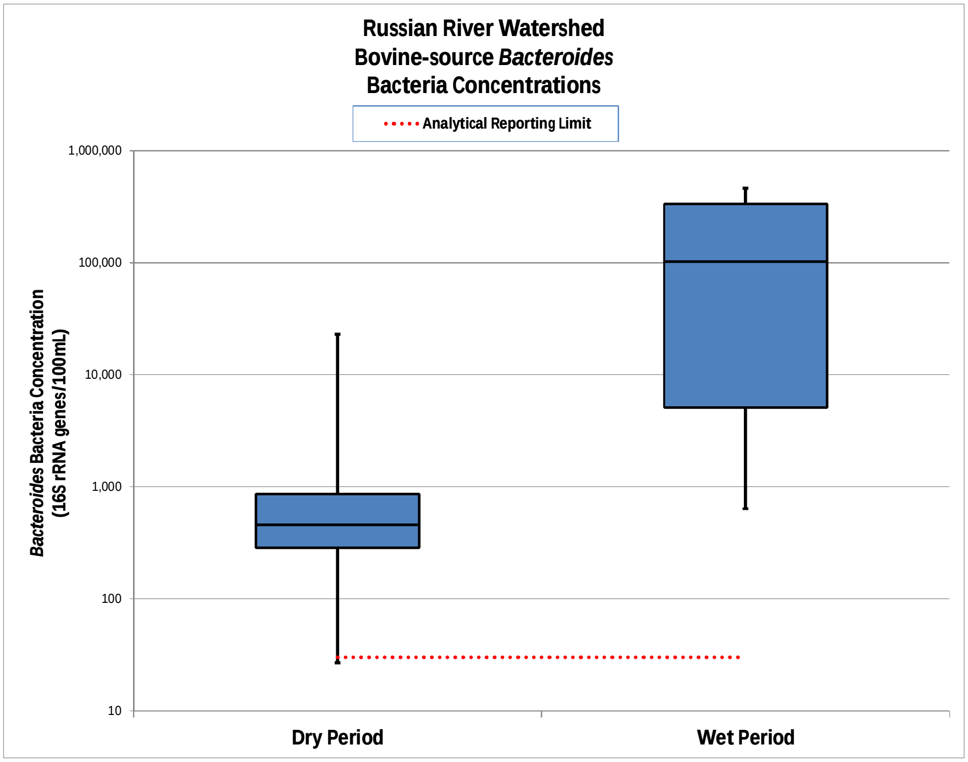



Figure 5.3. Distribution of Bovine-host *Bacteroides* Bacteria Concentrations collected during Dry and Wet Weather Periods

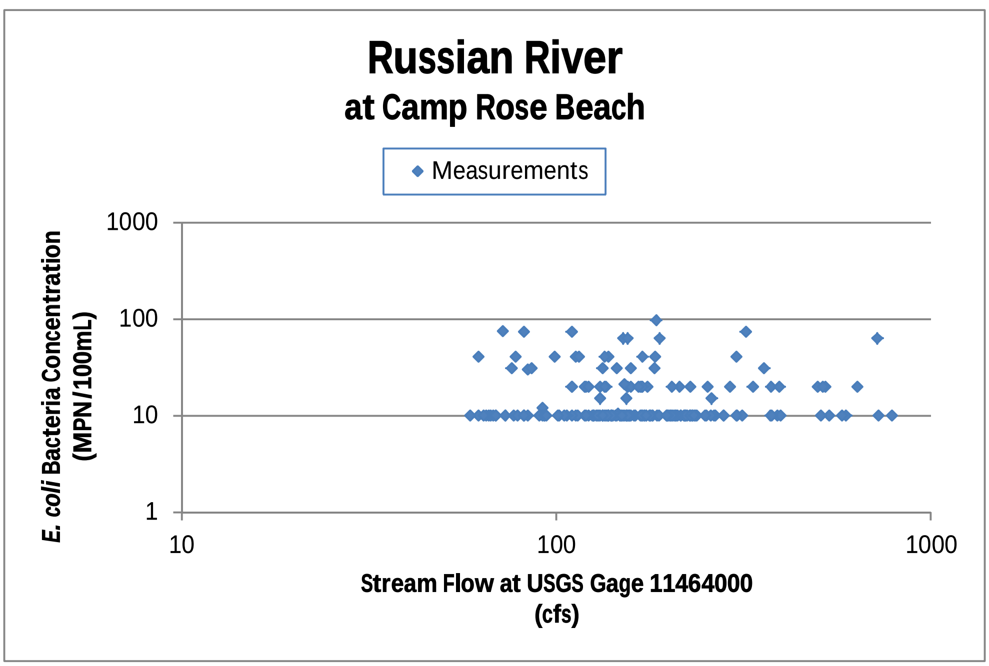



Figure 5.4. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Camp Rose Beach during the dry season

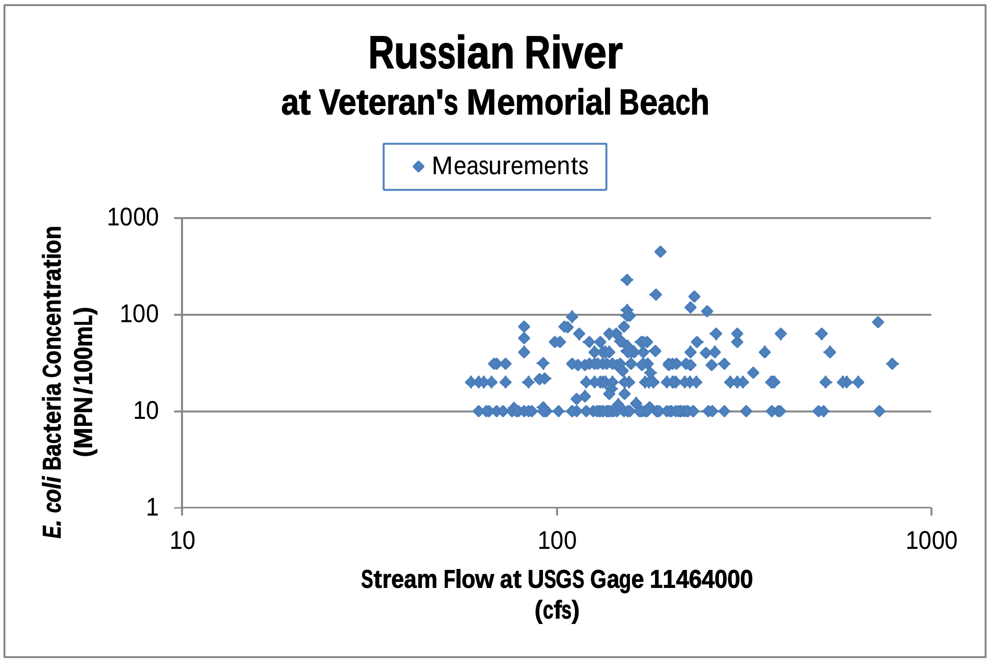



Figure 5.5. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Veteran Memorial Beach during the dry season

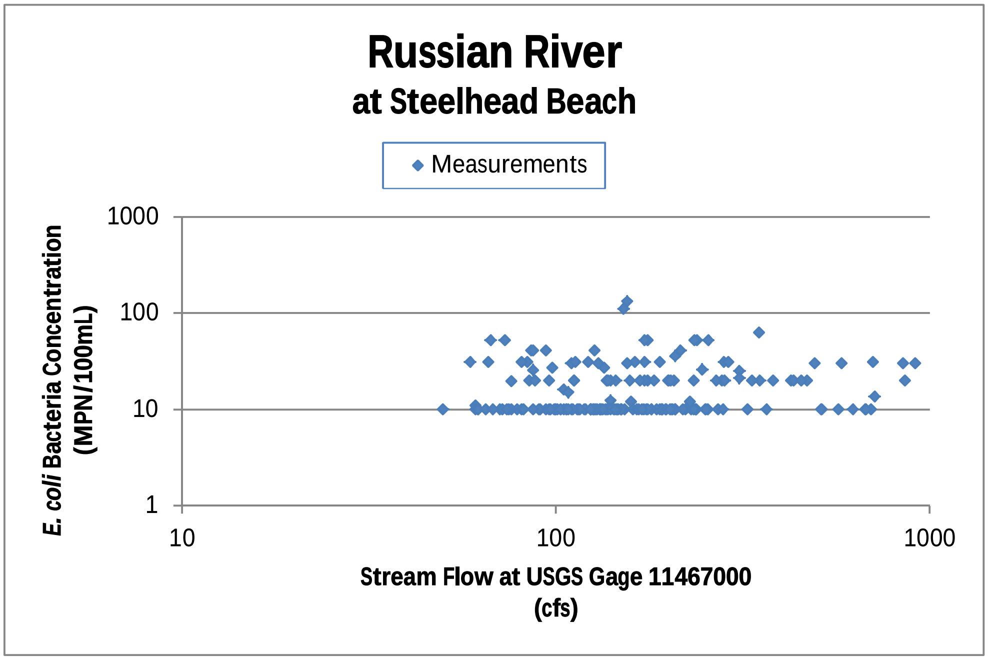



Figure 5.6. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Steelhead Beach during the dry season

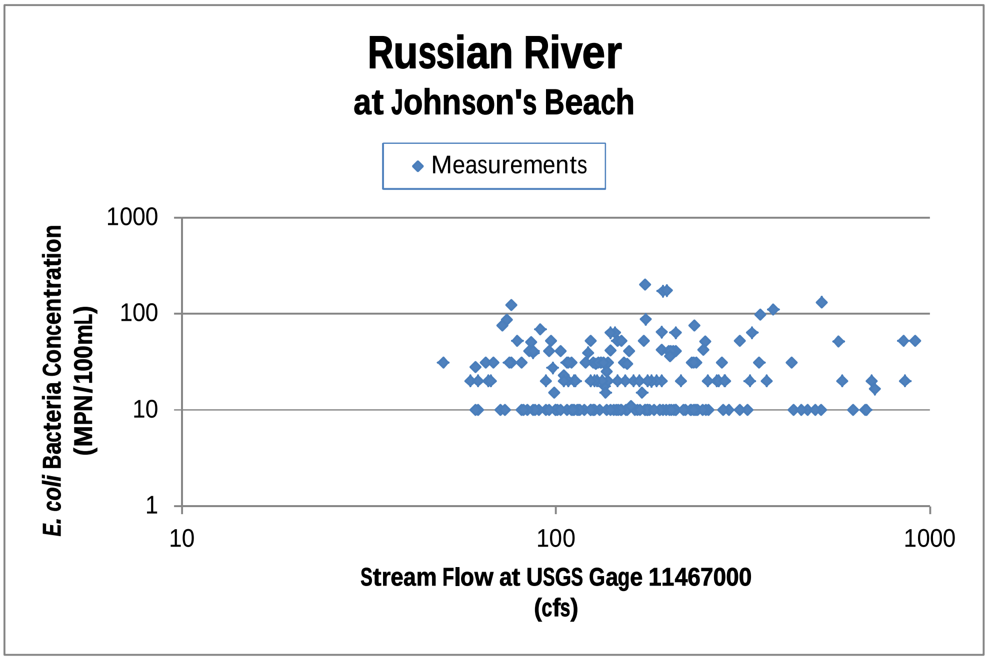



Figure 5.7. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Johnson's Beach during the dry season

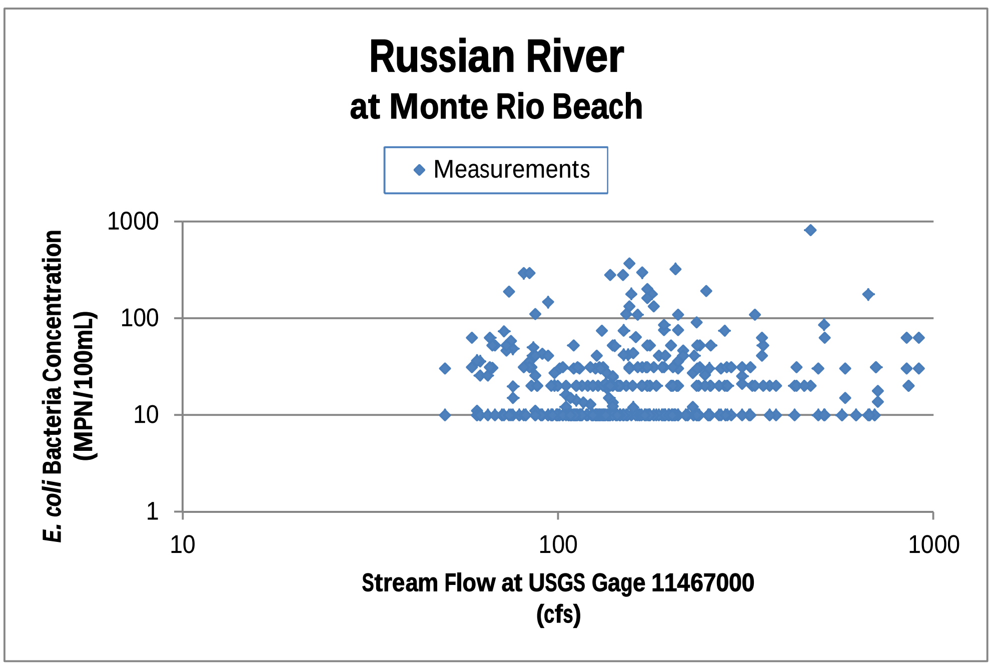



Figure 5.8. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Monte Rio Beach during the dry season

# CHAPTER 6
# LINKAGE ANALYSIS

This chapter describes the link between the *Bacteroides, E. coli*, and fecal coliform bacteria numeric targets, loading capacities, and load allocations used in this TMDL project and attainment of the Bacteria Water Quality Objective. If *Bacteroides, E. coli*, and fecal coliform bacteria measures are met, applicable standards will be attained. This section includes information previously discussed in Section 2.1 on water quality standards.

## 6.1 BACTEROIDES BACTERIA LINKAGE

*Bacteroides* bacteria numeric targets, loading capacities, and load allocations are used in this TMDL project as measures to show attainment of the natural background portion of the Bacteria Water Quality Objective.

For this TMDL project, natural background is interpreted to mean the quality of water that in the absence of significant human disturbance or alteration is in a minimally disturbed condition. Waters are determined to not be in a minimally disturbed condition if *Bacteroides* bacteria are significant enough to be present in a water sample at levels above the laboratory reporting limit. The laboratory reporting limit is the level at which the laboratory is 95% confident that the *Bacteroides* bacteria are present in the sample and are accurately counted. If bacteria are present and can be quantified with certainty, it is highly likely that fecal waste material is present and the bacteriological quality of the water has been degraded beyond natural background or minimally disturbed levels. This is a conservative assumption. It is supported by data from the one minimally disturbed site measured in the Russian River Watershed. It is also supported by U.S. EPA guidance which states that using conservative assumptions in derivation of numeric targets is an appropriate approach for providing a margin of safety, which is a required element of a TMDL.

The human host *Bacteroides* bacteria numeric target is protective of recreational uses. This target is based on epidemiological studies that link *Bacteroides* concentrations to illness rates. Wade et al. (2006) found a relationship between *Bacteroides* bacteria concentrations and gastrointestinal illness. Wade et al. (2010) estimated the probability of gastrointestinal illness due to increasing concentrations of *Bacteroides* bacteria. Based on this probability, a *Bacteroides* bacteria geometric mean of 60 genes/100mL corresponded to about 30 gastrointestinal illnesses per 1,000 swimmers. Ashbolt et al. (2010) compared human-specific *Bacteroides* bacteria concentration to *Norovirus* concentrations. From these estimates, a *Bacteroides* bacteria concentration of 860 genes/100mL corresponded to about 30 gastrointestinal illnesses per 1,000 swimmers. Soller et al. (2010a) identified *Norovirus* as the pathogen most responsible for a majority of gastrointestinal illness. Since the human *Bacteroides* numeric target is set at the reporting limit, which is currently 60 genes/100mL, it is equal to or less than the concentrations associated with approximately 30 illnesses per 1,000 swimmers and is protective of recreational uses.

## 6.2 *E. COLI* BACTERIA LINKAGE

*E. coli* bacteria numeric targets, loading capacities, and load allocations are used in this TMDL project as the measures to show attainment of the recreation portion of the Bacteria Water Quality Objective and support of the Water Contact Recreation Beneficial Use.

*E. coli* is a species of the fecal coliform group, and it is specific to fecal material from humans and other warm-blooded animals. The U.S. EPA recommends *E. coli* bacteria criteria as the best indicator of health risk from water contact in freshwater. The U.S. EPA published criteria under Section 104(v) of the federal Clean Water Act for the purpose of protecting human health in waters designated by states for use for swimming, bathing, surfing, or similar water contact activities (U.S. EPA 2012). Development of the criteria includes epidemiological studies, quantitative microbial risk assessment, site characterization studies, methods development and validation studies, modeling, assessment of levels of public health protection, and literature reviews. The U.S. EPA also considered relevant studies conducted by independent researchers.

The epidemiological investigations were conducted at U.S. beaches between 2003 and 2009. As a group, these investigations are referred to as the National Epidemiological and Environmental Assessment of Recreational Water (NEEAR) study. The NEEAR study enrolled 54,250 participants, encompassed nine locations, and collected and analyzed numerous samples from a combination of beaches (U.S. EPA 2010). The NEEAR study defined a case of illness as “any of the following within ten to 12 days after swimming: (a) diarrhea (three or more loose stools in a 24-hour period), (b) vomiting, (c) nausea and stomachache, or (d) nausea or stomachache and impact on daily activity” (U.S. EPA 2010). Of all the adverse health effects considered, the NEEAR epidemiological studies found the strongest association between *E. coli* bacteria and gastrointestinal illnesses. Other health issues that could have been caused by pathogens from fecal matter include upper respiratory illness, rashes, eye ailments, earaches, and infected cuts. The U.S. EPA (2012) concluded that criteria based on protecting the public from gastrointestinal illness using pathogenic indicator bacteria concentration will prevent most types of recreational waterborne illnesses.

An increase in *E. coli* bacteria concentrations correlated well with an increase in illness rate, verifying the linkage between the *E. coli* bacteria concentration-based numeric targets, loading capacities, and load allocations in this TMDL project and risk of illness during water contact recreation and non-contact water recreation (i.e., REC-1 and REC-2 beneficial uses).

## 6.3 FECAL COLIFORM BACTERIA LINKAGE

A fecal coliform bacteria numeric target, loading capacity, waste load allocation, and load allocation are used in this TMDL project to show attainment of the shellfish portion of the Bacteria Water Quality Objective. In order to protect and maintain the potential use of an individual to harvest and consume filter-feeding freshwater shellfish from the Russian

River Watershed, the fecal coliform numeric target, loading capacity, and load allocations are based on and equal to the lower of the two values contained in the shellfish portion of the Bacteria Water Quality Objective.

# CHAPTER 7
# TMDL CALCULATIONS AND ALLOCATIONS

A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The TMDL equals the loading capacity of the waterbody for the pollutant plus a margin of safety to account for any uncertainties. For this TMDL project, an implicit margin of safety is included in the determination of the loading capacities so the loading capacities are equivalent to the TMDL values. The loads are allocated among the various sources of that pollutant. Anthropogenic pollutant sources are characterized as either point sources that receive a wasteload allocation or nonpoint sources that receive a load allocation. Point sources include all sources subject to regulation under the NPDES program (e.g., wastewater treatment facilities and some stormwater discharges). Nonpoint sources include a variety of diffuse sources transported by water moving over and through the ground.

## 7.1 TMDLs, LOADING CAPACITIES & MARGIN OF SAFETY

The TMDLs for the Russian River Watershed are shown in Table 7.1 and are expressed as concentrations of human host and domestic animal *Bacteroides* bacteria, *E. coli*, and fecal coliform bacteria in surface waters and discharges. In accordance with 40 CFR §130.2(i), the TMDLs are be expressed as concentrations instead of loads. This is appropriate since public health risks associated with recreation are based on concentrations of pathogen indicator bacteria in water and not the total load of bacteria passing through the Russian River in a day.

The TMDLs are set to equal the loading capacities for each parameter and attain standards. The TMDLs are equivalent to the numeric targets and the wasteload and load allocations.

Table 7.1 TMDLs, Loading Capacities, Wasteload Allocations, and Load Allocations

| Parameter | Portion of the Bacteria Objective the Target will Attain | TMDL, Loading Capacity,<br>Wasteload Allocation & Load Allocation |
|---|---|---|
| Human Host *Bacteroides* | Natural Background | No more than 10% of the daily median sample values shall exceed the laboratory quantitative reporting limit within a calendar year or permitted discharge period. The current human host reporting limit is 60 genes/100mL. |
| Domestic Animal *Bacteroides* | Natural Background | No more than 10% of the daily median sample values shall exceed the laboratory quantitative reporting limit within a calendar year or permitted discharge period. The current bovine host reporting limit is 30 genes/100mL. |
| *E. coli* Geometric Mean | Recreation | No more than 50% of the samples collected* within a calendar year or permitted discharge period shall exceed 100 cfu/100mL**. |
| *E. coli* Statistical Threshold Value | Recreation | No more than 10% of the samples collected* within a calendar year or permitted discharge period shall exceed 320 cfu/100mL**. |
| Fecal Coliform | Shellfish Consumption | None of the samples shall exceed 43 MPN/100mL. |

* No fewer than 5 samples collected within a calendar year or permitted discharge period should be used to calculate the Geometric Mean and Statistical Threshold Value
** Colony forming units (cfu) are equivalent to the most probable number (MPN) values.

### 7.1.1 BACTEROIDES BACTERIA TMDLS/LOADING CAPACITIES

The human-host and domestic animal *Bacteroides* bacteria TMDLs/loading capacities are the same as the *Bacteroides* bacteria numeric targets. They are set to attain the natural background portion of the Bacteria Water Quality Objective.

The *Bacteroides* bacteria TMDLs are set at the minimum laboratory quantitative reporting limits of the standard calibration curves derived for qPCR human-host and bovine-host analyses levels. During the development of the TMDL the quantitative reporting limits for human-host and bovine-host *Bacteroides* bacteria were 60 and 30 genes per 100mL, respectively. The reporting limits will likely change in the future due to technological improvements in laboratory methods. If so, the revised lower quantitative reporting limits will become the TMDL/loading capacity values.

Current recommended genetic markers and protocols for *Bacteroides* bacteria analysis are described by Griffith et al. (2013). Additional markers may also be appropriate in the future as technology advances to improve assay sensitivity and performance[5]. The intent behind the allowable 10 percent frequency of exceeding the criteria is to be consistent with the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (SWRCB 2004), which is also known as the Listing Policy, when comparing data results to the reporting limit. The Listing Policy describes the process for making non-attainment decisions for conventional pollutants (e.g., pathogen indicator bacteria) where more than 10 percent of the samples exceed applicable water quality standards.

### 7.1.2 *E. COLI* BACTERIA TMDLs/LOADING CAPACITIES

The *E. coli* geometric mean and statistical threshold value (STV) TMDLs/loading capacities are the same as the *E. coli* bacteria numeric targets. They are set to attain the recreation protection portion of the Bacteria Water Quality Objective.

A minimum of five samples collected within a year or permitted discharge period should be used to calculate the geometric mean and STV. An averaging period longer than 30 days was selected for the loading capacity to provide a larger and more representative sample of the true distribution of *E. coli* bacteria concentrations. The geometric mean and STV should be calculated in a static, not rolling, fashion.

[5] For example, measurement of *Bacteroides* bacteriophages may provide additional information on animal hosts. *Bacteroides* bacteria are rapidly inactivated by environmental oxygen levels, but *Bacteroides* bacteriophages are resistant to degradation. One group of phages that specifically uses *B. fragilis* strain HSP40 as host is found only in human feces and not in feces of other animals.

### 7.1.3 FECAL COLIFORM BACTERIA TMDL/LOADING CAPACITY

The fecal coliform bacteria TMDL/loading capacity is the same as the fecal coliform bacteria numeric target. It is set to attain the shellfish consumption portion of the Bacteria Water Quality Objective.

### 7.1.4 MARGINS OF SAFETY

The Clean Water Act and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between the load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). U.S. EPA (1991) guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

Implicit margins of safety are used for *Bacteroides* and *E. coli* bacteria TMDLs. For human-host and domestic animal-host *Bacteroides*, the conservative assumption used to set the numeric targets provides an MOS in favor of water quality protection. The conservative assumption is that fecal waste material is present and the bacteriological quality of water has been degraded beyond natural background if *Bacteroides* bacteria are present and can be quantified above laboratory reporting limits with certainty. For the *E. coli* bacteria TMDLs, the implicit margins of safety are due to the selection of the U.S. EPA criteria (2012) associated with 32 illnesses per 1,000 recreators, instead of 36 illnesses per 1,000 recreators. By selecting the values linked to fewer illnesses, an additional MOS is provided for those partaking in water contact recreation in the watershed.

## 7.2 WASTELOAD ALLOCATIONS

Regulations require that a TMDL include wasteload allocations (WLAs), which identify the portion of the loading capacity allocated to individual existing and future point sources (40 C.F.R. §130.2(h); 40 C.F.R. §130.2(i)).

The concentration-based WLAs for *Bacteroides*, *E. coli,* and fecal coliform bacteria are shown in Table 7.1 and apply to all existing and new point source discharges that are likely to include pathogens or pathogen indicator bacteria in the Russian River Watershed. Examples of point sources include but are not limited to discharges from wastewater treatment facilities, municipal separate storm sewer systems, and confined animal feeding operations. Table 7.2 lists the existing point sources of pathogens in the watershed. The *Bacteroides*, *E. coli,* and fecal coliform bacteria WLAs shall be incorporated into permits for discharges of pathogen or pathogen indicator bacteria point sources at the time of permit adoption or permit renewal. The compliance point for the WLAs shall be at the point of effluent discharge from the point source to the receiving water, or at a location where sample results are representative of the targeted waste stream.

Table 7.2 NPDES Permittees with WLAs in the Russian River Watershed

| Facility Name | Facility Type | NPDES Permit No. | Applicable WLAs* | | |
|---|---|---|---|---|---|
| | | | *E. coli* | *Bacteroides* | Fecal Coliform |
| City of Cotati | Phase II MS4 Stormwater | CAS0000004 | Y | Y | Y |
| City of Healdsburg | Phase II MS4 Stormwater | CAS0000004 | Y | Y | Y |
| City of Rohnert Park | Phase II MS4 Stormwater | CAS0000004 | Y | Y | Y |
| City of Ukiah | Phase II MS4 Stormwater | CAS0000004 | Y | Y | Y |
| Sonoma State University | Phase II MS4 Stormwater | CAS0000004 | Y | Y | Y |
| Town of Windsor | Phase II MS4 Stormwater | CAS0000004 | Y | Y | Y |
| Cloverdale City WWTP | Municipal Wastewater | CA0022977 | Y | N | Y |
| Forestville Water District | Municipal Wastewater | CA0023043 | Y | N | Y |
| Healdsburg City WWTP | Municipal Wastewater | CA0025135 | Y | N | Y |
| Occidental CSD | Municipal Wastewater | CA0023051 | Y | N | Y |
| Santa Rosa Subregional Facility | Municipal Wastewater | CA0022764 | Y | N | Y |
| SCWA Graton CSD | Municipal Wastewater | CA0023639 | Y | N | Y |
| SCWA Russian River CSD | Municipal Wastewater | CA0024058 | Y | N | Y |
| Ukiah City WWTP | Municipal Wastewater | CA0022888 | Y | N | Y |
| Windsor Town WWTP | Municipal Wastewater | CA0023345 | Y | N | Y |

* *Bacteroides* WLAs do not apply to several facilities because the facilities disinfect their wastewater.

The *Bacteroides* bacteria WLAs do not apply to disinfected point sources in order to avoid false positive results. Disinfected waters include, but are not limited to, wastewater treated with chlorine, ozone, or UV light. While disinfection processes kill bacteria cells and eliminate the risk of illness to humans, pieces of the nucleic acids that make up the bacterial DNA may persist in the water post-death in a non-viable state. These DNA pieces may be counted in molecular amplification methods like qPCR which rely on the detection of DNA or RNA gene sequences to quantify bacteria.

Several NPDES permit holders in the Russian River Watershed are not a source of pathogens or pathogenic indicator bacteria. These include, but are not limited to, discharges from waterway modification permits related to aquatic pesticide application, discharges from log deck sprinkler water runoff, and discharges of highly treated groundwater that was previously contaminated with petroleum hydrocarbons and volatile organic compounds. Consequently, WLAs have not been assigned to these facility types in this TMDL.

## 7.3 LOAD ALLOCATIONS

Regulations require that a TMDL include load allocations (LAs), which identify the portion of the loading capacity allocated to existing and future nonpoint sources. LAs may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)).

The concentration-based LAs for *Bacteroides*, *E. coli,* and fecal coliform bacteria are shown in Table 7.1 and apply to all existing and new non-natural background, nonpoint sources in the Russian River Watershed. Examples of nonpoint sources include but are not limited to domestic wastewater discharges < 1,500 gpd, discharges from homeless encampments, pet waste, and livestock waste. The *Bacteroides*, *E. coli,* and fecal coliform bacteria LAs shall be incorporated into nonpoint source permits at the discretion of the Regional Water Board at the time of adoption of a new or renewed nonpoint source permit. Additional, non-permit implementation actions to attain the LAs are described in Chapter 8. These include efforts to identify, cleanup, and prevent nonpoint source discharges through the use of public outreach and education, best management practices, assessment, and adaptive management.

## 7.4 ESTIMATED REDUCTIONS NEEDED

Regional Water Board staff conducted an analysis of the reductions likely needed to achieve the TMDLs for *Bacteroides* and *E. coli* bacteria concentrations at numerous locations in the watershed (Butkus 2013c). The estimated percent reductions needed are provided here to highlight priorities for implementation actions; they are not the load allocations.

Human-host and bovine-host *Bacteroides* bacteria measurements collected between 2011 and 2013 were used to estimate the percent reduction needed to meet the TMDL values, as shown in Table 7.3. Most locations measured in the tributaries do not meet the LAs and will require controls to reduce bacteria loads. Percent reductions of human-host *Bacteroides* bacteria concentrations needed to meet the TMDLs range from 83% to 99%. Percent reductions of bovine-host *Bacteroides* bacteria concentrations needed to meet the LAs range from 16% to 99%.

*E. coli* bacteria measurements collected since 2001 were used to estimate the percent reduction needed to meet both TMDL values, as shown in Table 7.4. In all cases, a larger percent reduction is needed to meet the STV as opposed to the geometric mean. All locations in the mainstem Russian River met the TMDLs for *E. coli* bacteria concentrations and require no reductions. However, most of the tributaries do not meet the LAs for *E. coli* bacteria and will require controls to reduce bacteria loads. Percent reductions of *E. coli* bacteria concentrations needed to meet the TMDLs in tributaries range from 49% to 99%.

Percent reductions needed to attain the TMDLs are also presented by land cover type in Table 7.5. Additional information is available in a memorandum to the file by Butkus (2013c).

**Table 7.3 Percent Reductions Needed to Meet *Bacteroides* Bacteria TMDLs**

| Location | Human Host *Bacteroides* | | Bovine Host *Bacteroides* | |
|---|---|---|---|---|
| | Median *Bacteroides* in genes per 100mL | Reduction Needed to Attain 60 genes per 100mL | Median *Bacteroides* in genes per 100mL | Reduction Needed to Attain 30 genes per 100mL |
| East Fork Russian River at East Road, Potter Valley | 5,949 | 99.0% | No Data | No Data |
| Russian River at East School Way, Redwood Valley | 979 | 93.9% | No Data | No Data |
| Russian River at Lake Mendocino Drive, Ukiah | 3,275 | 98.2% | No Data | No Data |
| Russian River at Vichy Springs Road, Ukiah | 11,803 | 99.5% | No Data | No Data |
| Russian River at Talmadge Road, Ukiah | 9,293 | 99.4% | No Data | No Data |
| Russian River at River Road, Hopland | 1,898 | 96.8% | No Data | No Data |
| Russian River at Commisky Station Road, Cloverdale | 2,731 | 97.8% | 5,413 | 99.4% |
| Russian River at River Park, Cloverdale | 1,087 | 94.5% | 710 | 95.8% |
| Russian River at Hwy 128 Bridge, Geyserville | 13,501 | 99.6% | 236 | 87.3% |
| Russian River at Jimtown Bridge, Healdsburg | 37,052 | 99.8% | 116 | 74.1% |
| Russian River at Camp Rose Beach, Healdsburg | 31,055 | 99.8% | 286 | 89.5% |
| Russian River at Veteran Memorial Beach, Healdsburg | 14,921 | 99.6% | 381 | 92.1% |
| Russian River at Steelhead Beach, Forestville | 48,485 | 99.9% | 23,684 | 99.9% |
| Russian River at River Access Beach, Forestville | 57,554 | 99.9% | 14,710 | 99.8% |
| Russian River at Johnson’s Beach, Guerneville | 1,677 | 96.4% | 85 | 64.7% |
| Russian River at Monte Rio Beach, Monte Rio | 8,898 | 99.3% | 762 | 96.1% |
| Russian River at Public Boat Ramp, Jenner | 4,837 | 98.8% | 2,682 | 98.9% |
| Abramson Creek at Willowside Road Path, Santa Rosa | 273,401 | 99.9% | 425,164 | 99.9% |
| Blucher Creek at Lone Pine Road, Cotati | 18,022 | 99.7% | 177,248 | 99.9% |
| Copeland Creek at Commerce Blvd, Rohnert Park | 19,928 | 99.7% | 51,685 | 99.9% |
| Crane Creek at Snyder Lane, Rohnert Park | 26,703 | 99.8% | 23,602 | 99.9% |
| Dutch Bill Creek at Main Street, Monte Rio | 416 | 85.6% | 15 | 0.0% |
| Foss Creek at Matheson Street, Healdsburg | 37,346 | 99.8% | 8,668 | 99.7% |
| Gossage Creek at Stony Glen Lane, Cotati | 29,902 | 99.8% | 76,895 | 99.9% |
| Green Valley Creek at Martinelli Road, Forestville | 17,016 | 99.6% | 72 | 58.3% |
| Laguna de Santa Rosa at Community Center, Sebastopol | 7,469 | 99.2% | 514 | 94.2% |
| Mays Creek at Neeley Road, Guerneville | 1,325 | 95.5% | 608 | 95.1% |
| Palmer Creek at Palmer Creek Road, Healdsburg | 2,781 | 97.8% | 106 | 71.7% |
| Piner Creek at Fulton Road, Santa Rosa | 12,394 | 99.5% | 3,274 | 99.1% |
| Santa Rosa Creek at Hwy 12 Bridge, Santa Rosa | 2,727 | 97.8% | 181 | 83.4% |
| Santa Rosa Creek at Railroad Street, Santa Rosa | 32,909 | 99.8% | 7,765 | 99.6% |
| Van Buren Creek at Erland Road, Santa Rosa | 2,089 | 97.1% | 2,265 | 98.7% |
| Unnamed Creek at Lambert Bridge Road, Healdsburg | 5,257 | 98.9% | 453 | 93.4% |
| Unnamed Creek at Fitch Mountain Road, Healdsburg | 238 | 74.8% | No Data | No Data |
| Unnamed Creek at Fredson Road, Healdsburg | 8,580 | 99.3% | No Data | No Data |
| Unnamed Creek at West Dry Creek Road, Healdsburg | 4,040 | 98.5% | No Data | No Data |
| Unnamed Creek at Alexander Valley Road, Healdsburg | 2,031 | 97.0% | No Data | No Data |
| Unnamed Creek at Redwood Drive, Healdsburg | 2,310 | 97.4% | No Data | No Data |
| Unnamed Creek at Limerick Road, Healdsburg | 20,000 | 99.7% | 1,966 | 98.5% |
| Unnamed Creek at Summerhome Park Road, Forestville | 7,975 | 99.2% | No Data | No Data |
| Unnamed Creek at Trenton Road, Forestville | 48,200 | 99.9% | No Data | No Data |
| Unnamed Creek at Del Rio Court, Forestville | 3,460 | 98.3% | No Data | No Data |
| Unnamed Creek at River Road, Rio Nido | 3,600 | 98.3% | No Data | No Data |
| Unnamed Creek at Foothill Dive, Monte Rio | 371,000 | 100.0% | No Data | No Data |
| Unnamed Creek at Duncan Road, Monte Rio | 353 | 83.0% | No Data | No Data |

**Table 7.3 Percent Reductions Needed to Meet *Bacteroides* Bacteria TMDLs**

| Location | Human Host *Bacteroides* | | Bovine Host *Bacteroides* | |
|---|---|---|---|---|
| | Median *Bacteroides* in genes per 100mL | Reduction Needed to Attain 60 genes per 100mL | Median *Bacteroides* in genes per 100mL | Reduction Needed to Attain 30 genes per 100mL |
| Unnamed Creek at Old Monte Rio Road, Monte Rio | 25,100 | 99.8% | No Data | No Data |
| Unnamed Creek at Main Street, Monte Rio | 1,392 | 95.7% | No Data | No Data |
| Unnamed Creek at Moscow Road, Duncans Mills | <60 | 0% | No Data | No Data |
| Unnamed Creek at Lakeside Ave, Camp Meeker | 9,090 | 99.3% | No Data | No Data |
| Unnamed Creek at Sanford Road, Sebastopol | 1,576 | 96.2% | 482 | 93.8% |
| Unnamed Creek at Daywalt Road, Cotati | 37,632 | 99.8% | 867,503 | 99.9% |
| Unnamed Creek at River Road, Fulton | 2,759 | 97.8% | 768 | 96.1% |

**Table 7.4 Percent Reductions Needed to Meet *E. coli* Bacteria TMDLs in Tributaries**

| Tributary Location | *E. coli* Reduction Needed To Attain | |
|---|---|---|
| | Geometric Mean $\leq 100$ cfu/100mL | STV $\leq 320$ cfu/100mL |
| Atascadero Creek at Green Valley Road | 80% | 91% |
| Foss Creek at Matheson Street | 97% | 99% |
| Green Valley Creek at Martinelli Road | 12% | 49% |
| Laguna de Santa Rosa at Sebastopol Community Center | 42% | 92% |
| Santa Rosa Creek at Highway 12 | 60% | 66% |
| Santa Rosa Creek at Railroad Street | 79% | 84% |

**Table 7.5 Percent Reductions Needed to Meet TMDLs by Land Cover Category**

| Land Cover Category | *E. coli* | | | Human-Host *Bacteroides* | | | Bovine-Host *Bacteroides* | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dry Period | Wet Period | Wet & Dry Periods | Dry Period | Wet Period | Wet & Dry Periods | Dry Period | Wet Period | Wet & Dry Periods |
| Developed Non-Sewer | 82% | 99% | 98% | 98.6% | 99.9% | 99.3% | 93.8% | 99.9% | 96.5% |
| Developed Sewer | 46% | 98% | 98% | 97.7% | 99.8% | 99.5% | 93.1% | 99.9% | 99.1% |
| Shrubland | 57% | 98% | 96% | 98.6% | 99.9% | 99.7% | 96.1% | 99.9% | 99.9% |
| Agriculture | 0% | 96% | 87% | 97.9% | 99.9% | 99.8% | 95.5% | 99.9% | 99.6% |
| Forest Land | 0% | 56% | 33% | 0% | 97.5% | 94.9% | 0% | 96.1% | 89.3% |
| | | | | | | | | | |

# CHAPTER 8
# IMPLEMENTATION

The purpose of the Implementation Plan is to describe the steps necessary to reduce pathogen concentrations and achieve the TMDLs. The Implementation Plan identifies:

1. Actions that staff expects will reduce pathogens
2. Parties responsible for taking these actions
3. Regulatory mechanisms by which the Regional Water Board will ensure that these actions are taken
4. A timeline for completion of actions.

## 8.1 WASTE DISCHARGE PROHIBITIONS

Discharges of fecal material from humans or from domestic animals to waters of the state are controllable water quality factors that shall conform to the Bacteria Water Quality Objective. Controllable water quality factors are those actions, conditions, or circumstances resulting from man's activities that may influence the quality of waters of the state and that may be reasonably controlled.

In accordance with Water Code section 13243 and in order to achieve the Bacteria Water Quality Objective, protect present and future beneficial uses of water, protect public health, and prevent nuisance, this TMDL sets forth the following discharge prohibition:

> *Discharges of waste containing fecal material from humans or domestic animals to waters of the state within the Russian River Watershed that cause or contribute to an exceedance of the Bacteria Water Quality Objectives not authorized by waste discharge requirements or other order or action of the Regional or State Water Board are prohibited.*

Examples of domestic animals include, but are not limited to, horses, cattle, goats, sheep, dogs, cats, or any other animal(s) in the care of any person(s). Exceptions to the prohibition include discharges in accordance with waste discharge requirements or other provisions of the Water Code, Division 7, as amended. Compliance with this Waste Discharge Prohibition implies compliance with the wasteload and load allocations for this TMDL.

Sources of human fecal material identified in this TMDL project include:

- Discharges of municipal wastewater directly to surface waters
- Discharges of non-municipal wastewater directly to surface waters
- Discharges of untreated sewage from sanitary sewer systems
- Discharges of wastewater from percolation ponds and through spray irrigation
- Discharges of runoff from land application of municipal biosolids
- Discharges to land from water recycling projects

- Discharges from onsite wastewater treatment systems
- Discharges from recreational water uses and users
- Discharges from homeless encampments
- Discharges of stormwater to MS4s and from areas outside MS4 boundaries.

Sources of domestic animal and farm animal waste identified in this TMDL project include:

- Discharges of pet waste
- Discharges from non-dairy livestock and farm animals
- Discharges of manure from dairy cows.

## 8.2 IMPLEMENTATION ACTIONS

The implementation actions included in this TMDL address pathogens from specific controllable pathogen sources, including humans and other domesticated animals. Each probable source, its responsible parties, and its implementation actions are described in the following sections and summarized in Table 8.1.

### 8.2.1 MUNICIPAL WASTEWATER DISCHARGES TO SURFACE WATERS

There are four municipal wastewater treatment facilities in the Russian River Watershed that collect, treat, and discharge fully-treated effluent directly to the Russian River or its tributaries. These facilities are operated by:

- City of Ukiah
- City of Healdsburg
- City of Santa Rosa
- Occidental County Sanitation District

The waste discharges are regulated under existing NPDES permits that include effluent limitations and disinfection specifications to ensure treatment processes achieve effective and reliable pathogen reduction. Disinfection requirements in these permits are derived from standards for tertiary-treated recycled water contained in title 22 of the CCR. The limitations are consistent with Basin Plan requirements for advanced treated wastewater for such discharges. When a disinfection system operates properly and attains the effluent limitations, direct discharges of treated wastewater to surface waters will also attain *E. coli* wasteload allocations.

**Table 8.1. Summary of Implementation Actions**

| Source | Responsible Party | Allocations (WLAs & LAs) & Effluent Limitations (ELs) | Plan Required | Regulatory Mechanism | Time Schedule |
|---|---|---|---|---|---|
| Direct Wastewater Discharges to Surface Waters | • NPDES Municipalities | • *E. coli* WLAs<br>• Fecal Coliform WLA<br>• Total Coliform ELs | None | Permit Revision | • Update Permits as soon as practicable |
| Holding Pond Discharges to Surface Waters | • NPDES Municipalities | • *E. coli* WLAs & ELs<br>• Fecal Coliform WLA & EL | Bacteria Load Reduction Plan | Permit Revision | • 1 year to submit evidence of no contribution or BLRP<br>• 3 years to update Permit<br>• Up to 10 years for compliance schedule |
| Percolation Pond Discharges to Land | • Special Sanitary Districts<br>• Private WWTPs | • Total Coliform EL<br>• Fecal Coliform WLA & EL | None | Permit Revision | • Update Permits as soon as practicable |
| Sanitary Sewer Systems | • GWDR Permittees | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Sanitary Sewer Management Plan | 13267 Order | • 1 year to submit updated SSMP to Regional Water Board |
| Land Application of Biosolids | • GWDR and WDR Permittees | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Erosion Control Plan | 13267 Order | • 1 year to develop and submit an Erosion Control Plan to Regional Water Board |
| Recycled Water Use | • Recycled Water Producers<br>• Recycled Water Users | • *E. coli* WLAs<br>• Fecal Coliform WLA | Non-Stormwater BMP Plan | 13267 Order | • 1 year to prepare and submit an updated Non-Stormwater BMP Plan to Regional Water Board |
| OWTS – High Priority | • Sonoma County<br>• Mendocino County | • *E.* coli LAs & Performance Standards<br>• *Bacteroides* LAs<br>• Fecal Coliform LA & Performance Standards<br>• TSS Performance Standards | Advance Protection Mgmt Plan | Basin Plan Amendment | • 5 years to develop and submit APMP |
| OWTS – Medium Priority | • Sonoma County<br>• Mendocino County | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Advance Protection Mgmt Plan | Basin Plan Amendment | • 5 years to develop and submit APMP |
| OWTS – Low Priority | • Sonoma County<br>• Mendocino County | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Advance Protection Mgmt Plan | Basin Plan Amendment | • 5 years to develop and submit APMP |
| Private Large OWTS | • Owners of large OWTS | • *E.* coli LAs & Performance Standards<br>• *Bacteroides* LAs | Report of Waste Discharge | 13267 Order & Permit Adoption or | • 6 months to prepare and submit a ROWD |

**Table 8.1. Summary of Implementation Actions**

| Source | Responsible Party | Allocations (WLAs & LAs) & Effluent Limitations (ELs) | Plan Required | Regulatory Mechanism | Time Schedule |
|---|---|---|---|---|---|
| | | • Fecal Coliform LA & Performance Standards<br>• TSS Performance Standards | | Revision | |
| Recreation Uses | • Sonoma County<br>• Mendocino County | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Bacteria Load Reduction Plan | 13267 Order | • 1 year to submit BLRP |
| Homeless & Illegal Camping | • Sonoma County<br>• Mendocino County<br>• Municipalities | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Bacteria Load Reduction Plan | 13267 Order | • 1 year to submit BLRP |
| Stormwater – Municipal | • MS4 Permittees | • *E. coli* WLAs<br>• *Bacteroides* WLAs<br>• Fecal Coliform WLA | Possible ROWD | Revision to Phase I MS4 Permit or Revision to Attachment G for Phase II Permit | • Submit Phase I Permit revision as soon as practicable |
| Stormwater – Caltrans | • Caltrans | • *E. coli* WLAs<br>• *Bacteroides* WLAs<br>• Fecal Coliform WLA | Bacteria Load Reduction Plan | Revision of MS4 Permit | • |
| Pet Waste | • Sonoma County<br>• Mendocino County<br>• Municipalities | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Bacteria Load Reduction Plan | 13267 Order | • 1 year to submit BLRP |
| Livestock & Farm Animals | • Ranch and farm owners | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | None | Revision of Dairy Permits | • 2 years to establish and implement BMPs to qualify for waiver of need to submit ROWD<br>• Revision of Dairy Program Conditional Waiver of WDRs to accommodate non-dairy livestock and farm animals |
| Dairies - NPDES | • NPDES Dairies | • *E. coli* WLAs<br>• *Bacteroides* WLAs<br>• Fecal Coliform WLA | Bacteria Load Reduction Plan | Permit Revision | • 2 years to prepare and submit a BLRP<br>• Permit revision anticipated for 2017 |
| Dairies – Waiver & WDRs | • Waiver and WDR Dairies | • *E. coli* LAs<br>• *Bacteroides* LAs<br>• Fecal Coliform LA | Bacteria Load Reduction Plan | Permit Revision | • 2 years to prepare and submit a BLRP<br>• Permit revision anticipated for 2017 |

In order to ensure that direct discharges of treated wastewater from municipal wastewater treatment facilities to the Russian River and its tributaries maintain existing performance, and thus remain in compliance with Basin Plan standards, these permittees are required to attain the following effluent limitations:

1. The median concentration of total coliform bacteria shall not exceed 2.2 MPN/ 100 mL, using the daily bacteriological results of the last 7 days for which analyses have been completed
2. The number of total coliform bacteria shall not exceed 23 MPN/ 100 mL in more than one daily result in any 30-day period
3. No daily total coliform result shall exceed 240 MPN/ 100 mL.

To demonstrate compliance with limitations, direct dischargers of treated wastewater shall conduct daily effluent monitoring at a location or locations where a representative sample of the effluent can be collected. Direct dischargers shall provide to the Regional Water Board monthly discharge monitoring reports and other reports, as necessary, to demonstrate compliance with effluent limitations and with the *E. coli* and fecal coliform wasteload allocations. The Regional Water Board will include the above effluent limitations and requirements in applicable waste discharge requirements as soon as is practicable, but no later than at the time of the facility's next permit renewal.

### 8.2.2 WASTEWATER HOLDING POND DISCHARGES TO SURFACE WATERS

There are six municipal wastewater treatment facilities in the Russian River Watershed that collect, treat, dispose, or recycle municipal wastewater and discharge treated effluent from a wastewater holding pond to the Russian River or its tributaries. These facilities are operated by:

- City of Santa Rosa
- Forestville Water District
- Graton Community Services District
- Occidental County Sanitation District
- Russian River County Sanitation District
- Town of Windsor

Each municipality and special district authorized to discharge treated wastewater from wastewater holding ponds to the Russian River or its tributaries shall maintain compliance with the following effluent limitations (which equal the *E. coli* and fecal coliform wasteload allocations) using the bacteriological results of holding pond effluent samples collected at least weekly for the calendar month for which analyses have been completed:

1. The geometric mean concentration of *E.coli* bacteria shall not exceed 100 MPN/ 100 mL, and
2. The STV for *E. coli* bacteria shall not exceed 320 MPN/ 100 mL, and
3. No daily fecal coliform result in any calendar month shall exceed 43 MPN/ 100 mL.

Within one year of the effective date of this TMDL, each municipality and district permitted to discharge treated wastewater from wastewater holding ponds to surface waters shall provide evidence that its discharge is in compliance with the *E. coli* and fecal coliform WLAs in this TMDL or prepare and submit to the Regional Water Board a Bacteria Load Reduction Plan (BLRP) (further described in Section 8.3). The BLRP shall provide a description and a time schedule up to three years for actions that will bring the municipality into compliance with the *E. coli* and fecal coliform WLAs. Possible compliance actions could include any combination of the following:

- Upgrades to existing disinfection systems to a process more completely destructive of wastewater pathogens (e.g., ozone, heat sterilization, ultrafiltration)
- Initial or additional disinfection of holding pond effluent immediately prior to discharge
- Zero discharge through expansion of recycled water use or enlargement of wastewater holding ponds

If studies or other evidence demonstrate that human-source bacteria are effectively killed or removed from the waste stream and are not present in the holding pond discharge, the municipality or district will be considered to be in compliance with the waste load allocations.

Within three years of the effective date of this TMDL, the Regional Water Board will include the above effluent limitations and requirements in applicable waste discharge requirements. Following the inclusion of effluent limitations and requirements, affected facilities shall conduct effluent monitoring for *E. coli* bacteria at least weekly at a location or locations where a representative sample of the effluent can be collected. Affected facilities shall provide to the Regional Water Board monthly discharge monitoring reports and other reports, as necessary, to demonstrate compliance with effluent limitations.

### 8.2.3 PERCOLATION PONDS AND DISPOSAL BY SPRAY IRRIGATION

There are six municipal wastewater treatment facilities and seven privately-owned wastewater treatment facilities in the Russian River Watershed that collect, treat, and dispose of or recycle treated effluent to land via percolation ponds or by spray irrigation. These facilities are operated by:

- Bohemian Grove (private)
- Calpella County Water District (public)
- Camp Royaneh (private)
- City of Cloverdale (public)
- City of Ukiah (public)
- Geyserville County Sanitation Zone (public)
- Hopland County Water District (public)
- Mayacamas Golf Club (private)
- Rio Lindo Academy (private)

- Russian River County Sanitation District (public)
- Rodney Strong Vineyards (private)
- Salvation Army Lytton Springs Rehabilitation Facility (private)
- Vintner's Inn (private)

Each municipality, district, and private wastewater treatment facility permitted to discharge treated municipal or domestic wastewater to a percolation pond within the Russian River Watershed shall use a treatment process designed to meet the following effluent limitations:

1. The geometric mean concentration of total coliform bacteria shall not exceed 23 MPN/100 mL in any calendar month.
2. No daily fecal coliform result in any calendar month shall exceed 43 MPN/ 100 mL.

The effluent limitation for total coliform bacteria is derived from standards for disinfected secondary-23 treated recycled water contained in California Code of Regulations, title 22, chapter 3, article 1, section 60301.225. Disinfection systems that are designed to consistently achieve this level of disinfection are effective in reducing most wastewater pathogens to non-detectable or very low levels. Use of an effluent disinfection system to meet this total coliform bacteria effluent limitation will ensure compliance with load allocations for *E. coli* bacteria in this TMDL. The effluent limitation for fecal coliform implements the load allocation in this TMDL for fecal coliform.

For percolation ponds where it can be demonstrated that wastewater at no time contributes pathogen indicator bacteria to flow in surface waterbodies, alternative effluent limitations, discharge specifications, or permit requirements may be established in individual waste discharge requirements at the discretion of the Regional Water Board, and based on site specific conditions. Where wastewater disinfection systems are not used as a means to attain bacteria load allocations, the load allocations applicable to these discharges include *Bacteroides*, in addition to *E. coli* bacteria and fecal coliform bacteria effluent limitations.

For disposal of wastewater to land through spray disposal, attainment of bacteria load allocations is achieved through proper treatment plant design and siting and through compliance with waste discharge requirements that contain discharge specifications and other requirements that prevent the creation of runoff that could impact surface water.

To demonstrate compliance with these bacteria limitations, facilities shall conduct effluent monitoring at a location or locations where a representative sample of the effluent can be collected, and provide discharge monitoring reports to Regional Water Board staff. The frequency of effluent monitoring for bacteria established in waste discharge requirements is at the discretion of the Regional Water Board, but shall be sufficient to ensure demonstrate compliance with effluent limitations. Waste discharge requirements shall provide justification for the frequency of monitoring. Justification shall be based on factors such as discharge flow, proximity of the discharge to surfaces waters or other site conditions, and effluent variability.

The Regional Water Board shall include the above effluent limitations and requirements in applicable waste discharge requirements as soon as is practicable.

### 8.2.4 SANITARY SEWER SYSTEMS

There are eighteen sanitary sewer systems in the Russian River Watershed that collect and convey domestic wastewater to wastewater treatment facilities for treatment, and disposal or recycling. These facilities are operated by:

- Airport/Larkfield/Wikiup Sanitation Zone
- Calpella County Water District
- City of Cloverdale
- City of Cotati
- City of Healdsburg
- City of Rohnert Park
- City of Santa Rosa
- City of Sebastopol
- City of Ukiah
- Forestville Water District
- Geyserville County Sanitation Zone
- Graton Community Services District
- Hopland County Water District
- Occidental County Sanitation District
- Russian River County Sanitation District
- Sonoma State University
- South Park County Sanitation District
- Town of Windsor
- Ukiah Valley Sanitation District

In order to comply with this TMDL, each municipality and district shall (1) maintain compliance with General Waste Discharge Requirements for Sanitary Sewer System, Water Quality Order No. 2006-0003-DWQ (General Order) and all amendments and subsequent updates to the General Order.

In addition, within one year of the effective date of this TMDL, the municipality or district shall submit an amendment to its approved Sanitary Sewer Management Plan (SSMP) that describes actions with time schedules that it takes or plans to take to further minimize sanitary sewer overflows, spills, and exfiltration from its sanitary sewer system. Possible actions might include:

- Increasing the frequency and method of surveillance of sanitary sewer pipes, pump stations, siphons, and other sewer infrastructure that are located where overflows, spills, and exfiltration may adversely impact the Russian River or its tributaries.
- Accelerating schedules for pipeline rehabilitation and/or replacement.

- Revising sewer design standards to specify construction materials and methods that will ensure a water-tight sanitary sewer system for new and replacement sewer components in areas adjacent to the Russian River and its tributaries.
- Establishing local ordinances to require property owners to inspect their private sewer lateral upon property transfer, in response to chronic SSOs, or after significant changes in property use
- Developing programs to enable and help finance ratepayers to voluntarily inspect and repair deteriorating private service laterals.

The Regional Water Board will require submission of the SSMP amendment under authority of section 13267 subdivision (b) of the California Water Code.

### 8.2.5 LAND APPLICATION OF BIOSOLIDS

Currently, the City of Santa Rosa is the only public or private entity permitted for the land application of biosolids as a soil amendment in the Russian River Watershed. In order to comply with this TMDL, the City of Santa Rosa shall maintain coverage for its biosolids land application projects under General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities, Water Quality Order No. 2004-12-DWQ (General Order), and all amendments and subsequent updates to the General Order, or equivalent individual waste discharge requirements.

In addition, within one year of the effective date of this TMDL, the City of Santa Rosa shall prepare and submit an Erosion Control Plan that describes actions and time schedules for enhanced protections to prevent the movement of biosolids from the application area. Enhanced protections might include:

- Increasing minimum allowable setbacks
- Installing vegetation buffer strips between the application area and gullies, washes, and other areas that are vulnerable to erosion and washout
- Decreasing the pathogen concentration of land-applied biosolids.

The Regional Water Board will require submission of the Erosion Control Plan under authority of section 13267 subdivision (b) of the Water Code. Applicants seeking permit coverage for future projects involving the land application of municipal biosolids shall be required to prepare and submit an Erosion Control Plan, as described above, with the Notice of Intent.

### 8.2.6 RECYCLED WATER

There are six municipal wastewater treatment facilities and districts responsible for water reclamation projects in the Russian River Watershed that recycle treated effluent through spray irrigation. These facilities are operated by:

- Airport/Larkfield/Wikiup Sanitation Zone
- City of Cotati
- City of Healdsburg
- City of Rohnert Park
- City of Santa Rosa
- City of Sebastopol
- City of Ukiah
- Forestville Water District
- Graton Community Services District
- Occidental County Sanitation District.
- Russian River County Sanitation District, and
- Sonoma State University
- Town of Windsor

Each municipality and district that is permitted to beneficially reuse treated wastewater for landscape irrigation, agricultural irrigation, or other use allowable under California Code of Regulations, title 22, chapter 3, article 3, section 60303 through 60307 shall maintain compliance with water recycling requirements in State Water Resources Control Board Order WQ 2014-0090-DWQ, General Waste Discharge Requirements for Recycled Water Use, subsequent general orders, individual waste discharge requirements, or Master Water Reclamation Permits.

In addition, within one year of the effective date of this TMDL, each responsible party shall submit to the Regional Water Board a Non-Storm Water Best Management Plan that provides a description and a time schedule for actions that will bring the municipality into compliance with the *E. coli* and fecal coliform WLAs. The Non-Storm Water Best Management Plan shall describe actions that prevent recycled water spills and incidental runoff from reuse areas adjacent to the Russian River and its tributaries. Possible actions might include:

- Evaluating and, when necessary, improving BMPs to prevent overspray, spills, and incidental runoff
- Increasing setbacks from recycled water points of use to waterbodies, curbs, pavement and stormwater inlets
- Improving compliance with recycled water user requirements through increased public outreach and, when necessary, through progressive enforcement.

The Regional Water Board will require the submission of a Non-Storm Water Best Management Plan under authority of section 13267 subdivision (b) of the Water Code.

### 8.2.7 INDIVIDUAL ONSITE WASTEWATER TREATMENT SYSTEMS

An Advanced Protection Management Program (APMP) is the minimum required management program for all OWTS located in the Russian River Watershed. Based on evidence of exceedances of the *E. coli* objectives and the presence of human-source pathogenic indicator bacteria in the tributaries and in association with areas with a high density of OWTS, this TMDL prescribes a risk-based management approach for the regulation of individual OWTS in the Russian River Watershed. This management approach mandates special requirements for OWTS whose operation is likely to pose the greatest threat to public health and water quality.

In its APMP, each county shall identify priority areas based on the threat to water quality from OWTS discharges. The priority ranking scheme must consist of at least three threat ranks: High Priority, Medium Priority, and Low Priority. Although the rough boundaries of the High, Medium, and Low Priority Areas are described below, each county's APMP must include a procedure to further define and rank communities and other areas based on the threat to water quality from OWTS within these areas.

<u>High Priority Areas</u>

High Priority Areas include:

- Areas with a high density of OWTS in the lower Russian River Watershed, including the communities of Jenner, Cazadero, Monte Rio, Camp Meeker, Guerneville, Rio Nido, Summer Home Park, Hacienda, Mirabel, and Fitch Mountain near Healdsburg
- Other high density areas identified by the county
- Areas within 600 lineal feet in the horizontal (map) direction of the mainstem Russian River and the following tributaries: Austin Creek, Dutch Bill Creek, Fife Creek, Green Valley Creek, Laguna de Santa Rosa, Santa Rosa Creek, and Mark West Creek.

In High Priority Areas, each county shall ensure that all existing, new, and replacement OWTS include supplemental treatment components for pathogens in accordance with requirements in sections 10.10.2 through 10.15 of the Basin Plan's OWTS Policy for impaired areas. Supplemental treatment components shall ensure effluent does not exceed a 30-day average of 30 mg TSS/L and can achieve an effluent *E. coli* bacteria concentration of less than or equal to 100 MPN/100 mL.

In addition, to ensure that OWTS in high risk areas are properly managed, each county shall create or facilitate the creation of a local On-Site Wastewater Zone pursuant to Division 6, Part 2, Chapter 3, sections 6950 through 6982 of California Health and Safety Code or other OWTS Management Program that achieves the following goals:

1. Ensures that individual OWTS work properly and do not threaten public health, local water resources, or the environment
2. Identifies all existing OWTS, assesses their performance, and corrects problems
3. Ensures that all new OWTS and replacement OWTS are correctly designed, sited, constructed, and installed
4. Extends the lifespan of OWTS through ongoing maintenance, reducing potential costs of repair and replacement
5. Educates homeowners about the importance of good system operation and maintenance practices

6. Encourages water conservation and graywater reuse
7. Provides ongoing monitoring of and record keeping for OWTS.

The establishment of an On-Site Wastewater Zone is not required for the following:

1. OWTS within an established municipal sewer district or county sanitation district, and
2. OWTS that are permitted or operating on or prior to the effective date of this TMDL and whose owners: (a) commit by way of a legal document within 4 years of the effective date of this TMDL to connect to the sanitary sewer system of a permitted municipal wastewater treatment facility; and (b) the specified date for the connection to the centralized wastewater collection and treatment system does not extend beyond 10 years from the effective date of this TMDL.

In areas where the establishment of an On-Site Wastewater Zone is required, the APMP should describe the critical components of an effective OWTS management program. Critical components should include:

- Legal authority and mechanism for funding the program
- Authority to inspect and monitor individual OWTS within the program boundary
- Authority to conduct routine operations and maintenance activities and issue operational permits
- Authority and expertise to review and approve OWTS designs
- Enforcement authority for noncompliance with rules, requirements, and/or standards
- Public education and training.

In areas within established municipal sewer districts, county sanitation districts, community service districts with sewer authority, or future expanded sewer districts, the responsible local agency shall require that each existing, new, and replacement OWTS within its jurisdiction connect to the sanitary sewer system or shall require that each existing or replacement OWTS comply with the performance standards in sections 10.10.2 through 10.15 of the Basin Plan's OWTS Policy for impaired areas. Thereafter, the responsible local agency shall comply with an Advanced Protection Management Program in accordance with section 10 of the Basin Plan's OWTS Policy.

<u>Medium Priority Areas</u>

Medium Priority Areas include:

- Areas with a high density of OWTS in the middle and upper Russian River Watershed (including Oakmont in East Santa Rosa, North Cloverdale, Talmage, and Redwood Valley)
- Other high density areas identified by the county
- Areas and communities not in High Risk Areas, but where OWTS are within 600 lineal feet in the horizontal (map) direction of the mainstem Russian River and the following tributary streams: Big Sulphur Creek, Little Sulphur Creek, Commisky Creek, Dry Creek, Feliz Creek, Forsythe Creek, Franz Creek, Maacama Creek, Mill Creek, Pieta Creek, East Fork Russian River, Sausal Creek, and York Creek

In Medium Priority Areas, each county shall comply with minimum responsibilities of a local agency administering a Local Agency Management Program in accordance with section 9 of the Basin Plan's OWTS Policy.

To ensure that OWTS in medium priority areas are properly managed, the responsible agency shall create or facilitate the creation of a local On-Site Wastewater Zone or other OWTS Management Program, as described in section on High Priority Areas above.

<u>Low Priority Areas</u>

Low Priority Areas include:

- Areas within the Russian River Watershed that have not been designated as high or medium risk by the county.

In Low Priority Areas, each county shall implement requirements consistent with Tier 0, Tier 2, and Tier 4 of the Basin Plan's OWTS Policy.

Within six months of the effective date of this TMDL, Sonoma County and Mendocino County must each prepare and submit a BLRP to the Regional Water Board that provides a schedule for developing or updating its APMP for OWTS in the Russian River Watershed. In addition to the BLRP requirements described in Section 8.3, the BLRP may also include:

- A time schedule to investigate whether a community is contributing to impairment
- A period of time for owners of individual OWTS to demonstrate that their existing OWTS meets performance standards or is protective of water quality by means of adequate system design and site conditions
- A time schedule to develop a local grant or loan program that would provide funding to owners of individual OWTS to help them comply with program requirements.

### 8.2.8 LARGE ONSITE WASTEWATER TREATMENT SYSTEMS

Within six months of the effective date of this TMDL, owners of existing, new, and replacement OWTS with a project flow greater than 10,000 gpd or large OWTS not regulated by the local agency shall submit a Report of Waste Discharge containing information about their OWTS. Based on the Report of Waste Discharge, the Regional Water Board may issue WDRs or Waivers for the OWTS.

OWTS subject to this subsection that are identified in this TMDL as being located in High and Medium Priority Areas shall include supplemental treatment components for pathogens in accordance with requirements in sections 10.10.2 through 10.15 of the Basin Plan's OWTS Policy for impaired areas. Supplemental treatment components shall ensure OWTS effluent does not exceed a 30-day average of 30 mg TSS/L and can achieve an effluent *E. coli* bacteria concentration of less than or equal to 100 MPN/100 mL. In Low Priority Areas, appropriate discharge requirements shall be prescribed by the Regional Water Board.

For large OWTS permitted, constructed, or operating prior to the effective date of this TMDL and regulated by existing waste discharge requirements, the Regional Water Board shall include in the waste discharge requirements, as soon as is practicable, effluent limitations and other requirements to demonstrate compliance with the above discharge specifications. For permitted large OWTS, the Regional Water Board shall require the submission of the report of waste discharge under authority of section 13267 subdivision (b) of the Water Code.

For large OWTS constructed after the effective date of this TMDL, effluent limitations and other requirements shall be established in waste discharge requirements as the permits are adopted.

### 8.2.9 RECREATIONAL WATER USE

Within two years of the effective date of this TMDL, Sonoma County and Mendocino County shall prepare and submit a BLRP that describes actions to reduce bacteria loading associated with activities at recreational beaches and other known swimming areas within their jurisdiction to attain load allocations. Potential implementation actions could include:

- Installing temporary or permanent restroom facilities, including diaper changing stations, near the recreation use areas and signage to effectively direct recreators to restroom facilities
- Establishing interagency agreements with local sanitation districts to provide maintenance and waste disposal for temporary restroom facilities
- Developing and distributing educational & outreach materials (fliers, brochures) to inform river recreators about proper waste disposal and sanitation at beaches and access points along the Russian River and tributaries
- Conducting outreach to private recreational beach operators and commercial river outfitters to improve beach housekeeping and provide adequate sanitation facilities for customers
- Publicizing locations of public restroom facilities on the county website and at recreational outfitters' headquarters
- Improving restroom facilities at popular private beaches
- Limiting availability of parking along county roads near beach areas where waste collection is difficult.

The Regional Water Board will require submission of a BLRP under authority of section 13267 subdivision (b) of the Water Code. Regional Water Board staff will review the BLRP and determine the appropriate program actions to regulate the implementation actions proposed in the BLRP.

### 8.2.10 HOMELESS AND FARMWORKER ENCAMPMENTS AND ILLEGAL CAMPING

To comply with this TMDL, Sonoma County, Mendocino County, and municipalities within the Russian River Watershed shall prepare and submit a BLRP that describes actions to: (1)

correct noncompliance with existing ordinances pertaining to illegal camping and farmworker housing; and (2) provide waste disposal for homeless persons currently residing along watercourses and other areas within the public space. The BLRP must include an implementation schedule that ensures attainment of load allocations in the shortest time practicable, milestones to achieve compliance, a commitment to provide periodic status reports to the Regional Water Board to monitor progress toward completing the BLRP and compliance milestones, and a monitoring plan through which compliance with WLAs can be assessed.

Implementation actions might include:

- Providing or improving options for shelters, transitional housing, affordable housing, and other homeless services
- Conducting public outreach to owners of private property in the Russian River Watershed to inform and assist them on how best to prevent illegal camping and trespassing on their property, including how to report illegal use to local law enforcement
- Establishing a program, including a hotline, for reporting homeless encampments and facilitating camp cleanup activities
- Installing physical barriers to prevent illegal camping and habitation under bridges and overpasses
- Initiating and participating in pilot programs that provide public restroom facilities along public trails and upgraded restroom facilities at public parks.

Options to reduce water quality impacts of homeless and farmworker encampments can also be combined with efforts to reduce homelessness. Sonoma County, Mendocino County, and municipalities are encouraged to fully fund and implement goals, objectives, and policies contained in their general plans for homeless and farmworker populations. More affordable, available housing will result in fewer residents seeking shelter along waterways, away from adequate sanitation facilities.

Where suitable housing for homeless persons and farmworkers exists or is planned, and the housing unit is served by an individual septic system, community septic system, or other approved waste treatment and disposal system, the design, installation, and operation of the system shall comply with the Local Agency Management Program for the local agency with jurisdiction over individual septic systems.

The Regional Water Board will require submission of a BLRP under authority of section 13267 subdivision (b) of the Water Code. Regional Water Board staff will review the BLRP and determine the appropriate program actions to regulate the implementation actions proposed in the BLRP.

### 8.2.11 URBAN STORMWATER RUNOFF

Within the Russian River Watershed's urban boundaries, stormwater runoff and non-stormwater runoff is regulated under a Phase I Municipal Separate Storm Sewer Systems

(MS4) Permit. The current Phase I MS4 Permit, Order No. R1-2009-0050 (NPDES Permit No. CA0025054) became effective on October 1, 2009, and continues in force until a new permit is issued. Small MS4s within the watershed are enrolled under Water Quality Order No. 2013-0001-DWQ, National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000004, Waste Discharge Requirements (WDRs) for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (Phase II MS4 General Permit).

Permittees currently named under the Phase I MS4 Permit are:

- City of Santa Rosa
- County of Sonoma
- Sonoma County Water Agency

Small MS4s in the Russian River Watershed currently enrolled under the Phase II MS4 General Permit are:

- City of Cloverdale
- City of Cotati.
- City of Healdsburg
- County of Sonoma
- Sonoma County Water Agency
- Sonoma State University
- Town of Windsor

In order to comply with this TMDL, discharges of urban stormwater from MS4s in the Russian River Watershed shall attain the *Bacteroides, E. coli*, and fecal coliform bacteria waste load allocations.

Upon renewal of the Phase I MS4 permit or as soon as is practicable, the Regional Water Board will establish effluent limitations for MS4s at end-of-pipe, or other locations where representative samples of effluent from the MS4 can be collected, to comply with wasteload allocations and a compliance schedule to achieve final limitations.

For Phase II MS4 permittees, TMDL-specific permit requirements shall be submitted to the State Water Board for inclusion in Attachment G of the Phase II MS4 General Order, as soon as practicable.

### 8.2.12 CALTRANS STORMWATER RUNOFF

The California Department of Transportation (Caltrans) is regulated under General Storm Water Permit (NPDES Permit No. CAS000003), Waste Discharge Requirements Order No. 2012-0011-DWQ and Order 2014-xxxx-DWQ, which is an amendment to include TMDL-specific permit implementation requirements. The statewide permit regulates stormwater and non-stormwater discharges from the Department's properties and facilities, and discharges associated with operation and maintenance of the state highway system.

In order to comply with this TMDL, stormwater and non-stormwater discharges from Caltrans' facilities and properties in the Russian River Watershed shall attain the waste load allocations identified in Table 8.1. Upon renewal of the statewide stormwater permit or as soon as is practicable, Regional Water Board staff will work with the State Water Board to include the Russian River Pathogen Indicator Bacteria TMDL in the TMDL requirements of the permit to ensure compliance with wasteload allocations. Permit renewal is likely in 2017 or 2018.

Implementation actions might include:

- Managing irrigation to ensure overwatering and runoff does not occur
- Identifying and fixing broken sprinklers and irrigation pipes
- Increasing infiltration by improving soil structure and texture
- Adding structural management practices such as biofiltration strips, biofiltration swales, bioretention and biodetention basins
- Diverting stormwater runoff to bioretention/biodetention/infiltration basins
- Sweeping
- Cleaning up illegal dumping
- Limiting or excluding access for camping under bridges and in the right-of-way
- Developing and implementing a program, in collaboration with local jurisdictions, to report, respond to, and remove homeless encampments.

### 8.2.13 PET WASTE

Sonoma County, Mendocino County, and municipalities within the Russian River Watershed shall prepare and submit a BLRP that describes actions to reduce the deposition of pet waste on public property. Possible actions may include:

- Improving or establishing a pet waste program that could include more widespread availability of pet waste collections systems and a higher profile outreach program to educate the public about proper disposal of pet waste and the environmental consequences of improper disposal, and
- Partnering with local businesses and organizations to sponsor the installation, operation, and maintenance of pet waste collection systems.

The Regional Water Board will require submission of a BLRP under authority of section 13267 subdivision (b) of the Water Code. Regional Water Board staff will review the BLRP and determine the appropriate program actions to regulate the implementation actions proposed in the BLRP.

### 8.2.14 NON-DAIRY LIVESTOCK AND FARM ANIMALS

Owners and operators of animal facilities, inclusive of animal husbandry, livestock production, other similar agriculture operations, and commercial animal boarding facilities, shall implement best management practices to properly contain and dispose of waste, and mitigate for potential water quality impacts resulting from surface runoff of animal waste. Possible actions may include:

- Regular cleanup of manure and soiled bedding in animal habitation areas
- Use of impermeable surfaces for storage of manure

- Use of onsite composting to stabilize and reuse manure
- Siting of manure storage areas away from water courses and off slopes
- Reduction of stormwater contacting manure storage areas, paddocks, and kennel areas
- Use of vegetated buffers to encourage uptake of pollutants
- Limiting of animals' access to waterways.

The requirement of owners and operators of animal facilities to submit a Report of Waste Discharge for discharges from these operations is waived for animal facilities that implement these or similar best management practices. To implement this waiver, the Regional Water Board shall revise, as soon as practicable, the Conditional Waiver of Waste Discharge Requirements for Existing Cow Dairies in the North Coast Region, to include animal facilities as described above.

### 8.2.15 DAIRIES & CAFOs

Each cow dairy and CAFO in the Russian River Watershed is required to maintain compliance with the prohibition against the discharge of animal waste and with WLAs for the Russian River Watershed included in this TMDL. WLAs for CAFOs will be incorporated into the NPDES permit as effluent limitations.

Within one year of the effective date of this TMDL, in order to prevent discharges of animal waste to surface water, each enrollee under the Conditional Waiver of Waste Discharge Requirements, Waste Discharge Requirements, or NPDES Permit, or the holder of an individual dairy WDR is required to prepare a BLRP for their dairy facility to control manure, litter, and process water from the dairy production and pasture areas. The BLRP is intended to complement existing requirements in Nutrient Management Plans already required for enrollees under Waste Discharge Requirements and the NPDES permit. However, BLRPs must include actions beyond what is currently required in Nutrient Management Plans.

At a minimum, the BLRPs shall include:

- Actions, such as riparian fencing, that prevent animal access to water courses and provide a vegetated buffers to reduce manure runoff.
- A surface water monitoring plan that includes routine monitoring for pathogen indicator bacteria to demonstrate attainment of WLAs. Coordination between dairies and CAFOs, including but not limited to group monitoring, is encouraged.
- An implementation schedule, with a commencement date not exceeding two years from the effective date of this TMDL.

The Regional Water Board will incorporate the requirement to prepare and implement a BLRP into renewed Conditional Waiver of Waste Discharge Requirements, Waste Discharge Requirements, or NPDES Permit when these order come up for renewal, and into new dairy WDRs as they are proposed and adopted.

## 8.3 BACTERIA LOAD REDUCTION PLAN

The goal of the BLRP is to describe and ensure effective implementation of actions that will reduce pathogens and indicator bacteria to attain the WLAs and LAs in the Russian River Watershed. The BLRP should be designed to identify, eliminate, reduce and clean up existing sources to the maximum extent practicable, prevent and control new sources, monitor, and implement additional actions as necessary.

The BLRPs can be developed cooperatively with other responsible parties or individually. A responsible party that is required to submit BLRPs for more than one source type may combine the individual BLRPs into one master document.

### 8.3.1 TIME SCHEDULE FOR PLAN DEVELOPMENT, REVIEW, AND APPROVAL

The following is the development, review, and approval process for a BLRP:

A. The responsible party or parties develops a draft BLRP.

B. The responsible party or parties submits its BLRP to the Regional Water Board in accordance with Table 8.1. Additional time to submit a BLRP may be granted by the Regional Water Board's Executive Officer upon the request of the responsible party or parties if necessary due to the complexity or level of public involvement in the BLRP.

C. Regional Water Board staff reviews the BLRP and recommends approval of the BLRP once it is complete.

D. Within 9 months of the submittal of a complete BLRP, Regional Water Board staff will publicly notice a Memorandum of Recommended BLRP Approval for 21 days.

E. For BLRPs approved at the Executive Officer level, the Board will be informed of BLRP approvals via the monthly Executive Officer's Report.

F. Any BLRP approved at the Executive Officer level may be petitioned to the Regional Water Board for its consideration.

### 8.3.2 PLAN ORGANIZATION

The BLRP shall contain the following elements in order to be deemed complete and approvable. Should an element not apply, the responsible party or parties should provide a brief explanation of its inapplicability.

A. Party Information and Legal Authority

   1. The BLRP shall include the name of the responsible party or parties.

   2. For a municipality, state, federal, or other public agency, the BLRP shall include the name of the duly authorized representative(s). A duly authorized representative is either a principal executive officer or ranking elected official, or a duly authorized representative of that person. A duly authorized representative is also a person who has responsibility for the overall operation of the subject facility or activity.

3. The BLRP shall include a map of the responsible party's or parties' jurisdictional boundary along with the receiving waters and sub-watershed boundaries that overlap the jurisdictional boundary to facilitate planning, assessment, and collaborative decision-making.
4. The BLRP shall include a demonstration that the responsible party or parties or duly authorized representative(s) possess the legal authority to implement the actions contained in the BLRP, such as through ordinances, service agreements, or other legally binding procedures.

B. Sources

1. The BLRP shall include the sources of pathogens and indicator bacteria most likely causing exceedances of the WLAs or LAs within the jurisdiction of the responsible party or parties.
2. The sources shall be identified on a map.
3. The BLRP shall describe how sources are determined and characterized.

C. Description of Actions

1. The BLRP shall include a description of specific actions or treatment facilities that are being implemented or will be implemented to reduce the concentration of pathogens and indicator bacteria from identified sources.
2. The locations of the actions shall be identified on a map if appropriate. For example, it is appropriate to map new restroom facilities, but not appropriate to map public outreach efforts.
3. The BLRP shall include scientific and technical documentation used to conclude that the actions, once fully implemented, are expected to achieve compliance with the WLAs and LAs.
4. If the BLRP is a cooperative document among multiple responsible parties, the BLRP shall indicate which party is responsible for each action.

D. Schedule

1. The BLRP shall include a schedule for implementing the actions within the shortest time practicable.

E. Monitoring, Reporting, and Adaptive Management

1. The BLRP shall describe the frequency of periodic status reports, which shall be submitted to Regional Water Board staff. Reports shall include the status of the actions taken and to be taken, and any other necessary content.
2. The BLRP shall describe how, when, and where the effectiveness of actions will be monitored and assessed. The BLRP shall describe the frequency of effectiveness monitoring reports and assessments, which shall be submitted to Regional Water Board staff. The purpose of effectiveness monitoring is to understand if actions are improving pathogen and indicator bacteria concentrations (or loads) in the Russian River and its tributaries.

3. All instream water quality data collected to satisfy the BLRP shall be collected in accordance with a Quality Assurance and Project Plan developed per U.S. EPA (2002c). Additionally, such data shall be uploaded by the responsible party or parties into the California Environmental Data Exchange Network.
4. The BLRP shall describe how the BLRP will be updated based on monitoring and performance assessments. It is expected that, in some cases, additional actions will be required if data from effectiveness monitoring shows exceedances of allocations. It is expected that the BLRP will be assessed and revised at least every 5 years.

# CHAPTER 9
# MONITORING

Monitoring provides data and information that allows for assessment and adaptive management. By monitoring discharges and receiving waters, it is possible to evaluate the progress toward completion of implementation actions. By identifying the actions that work best, monitoring data enables more efficient distribution of funds and resources and subsequent improvements in BLRPs and permit requirements. By assessing implementation actions and instream data, it is possible to evaluate the progress toward attainment of the TMDLs/loading capacities. And finally, monitoring data provides the feedback that indicates if modifications of the TMDL targets and water quality standards are necessary.

This chapter describes TMDL requirements and responsible parties for monitoring, assessment, and adaptive management, while also providing an umbrella stewardship approach for cooperation and collaboration in the Russian River Watershed.

## 9.1 STEWARDSHIP & THE RUSSIAN RIVER WATERSHED MONITORING PROGRAM

There are many opportunities for cooperation and collaboration in regards to monitoring in the Russian River Watershed. Residents, recreators, cities, counties, state agencies, federal agencies, and other stakeholders have a vested interest and/or specific TMDL requirements to address sources of pathogens and indicator bacteria and monitor the effect of those actions. By forming a monitoring coalition to identify problems, develop and implement solutions, coordinate monitoring, evaluate progress, and make adjustments, more progress toward a healthy watershed can be made with less cost. These elements are keys to the concept of watershed stewardship.

Regional Water Board staff will work to form a Russian River Watershed monitoring coalition to help coordinate and conduct required monitoring. The watershed-wide monitoring program will be modeled on the Klamath Basin Monitoring Program and San Francisco Bay Regional Water Board's Regional Monitoring Program. It will likely include:

- Coordinating instream sampling efforts to reduce duplication of efforts and costs
- Coordinating sampling methods, protocols, and Quality Assurance/Quality Control requirements so data from multiple entities are comparable
- Compiling and sharing data with possible upload of data to the California Environmental Data Exchange Network
- Assessing and interpreting data to inform load reduction actions
- Reporting and sharing data and information with stakeholders and the public
- Conducting regular meetings to share and discuss implementation activities, data results, research, and other information critical to water quality and the health of the Russian River Watershed

## 9.2 MONITORING & REPORTING OF IMPLEMENTATION ACTIONS

As described in Chapter 8, dischargers and parties responsible for sources of pathogens and indicator bacteria are required to develop and implement a BLRP. The BLRP includes requirements to report the status of individual implementation actions to the Regional Water Board. Dischargers and responsible parties are also required to monitor, assess, and report on the effectiveness of their implementation actions required under a BLRP. The purpose is to understand if actions are improving pathogen and indicator bacteria concentrations (and loads) in the Russian River and tributaries. Regional Water Board staff will evaluate this information on a responsible-party-by-responsible-party basis to ensure implementation actions are executed as planned and on schedule, and are being maintained and working as expected. If this is not the case, staff shall work with responsible parties to revise the BLRP and use alternative implementation actions.

Regional Water Board staff shall compile the above information, assess progress and effectiveness on a watershed or sub-watershed scale, and provide a report on a regular basis, likely every five years. The report may be accomplished through an informational presentation to the Regional Water Board or as part of a larger stewardship report.

## 9.3 MONITORING & REPORTING OF TMDL ATTAINMENT

In order to assess changes in in-stream conditions and attainment of the TMDLs/loading capacities, indicator bacteria data shall be collected in mainstem Russian River and tributary sites.

The County of Sonoma, the County of Mendocino, City of Healdsburg, City of Sebastopol, and the City of Santa Rosa shall sample *E. coli*, *Bacteroides*, and fecal coliform bacteria concentrations at the mainstem Russian River beaches shown in Figure 9.1 and listed in Table 9.1 at least weekly from May 15 through September 30. The monitoring can be conducted by the monitoring coalition, or individually. All instream water quality data collected shall be collected in accordance with a Quality Assurance and Project Plan developed per U.S. EPA (2002c). Additionally, such data shall be uploaded by the coalition or individual into the California Environmental Data Exchange Network.

The Sonoma County Department of Health Services, Environmental Health and Safety Section currently conducts this monitoring at several of the beaches listed in Table 9.1. In past years, the Regional Water Board has provided funding and staffing. There may be future opportunities for the Regional Water Board and other stakeholders to partner with the counties to ensure this monitoring is funded and executed. Additionally, this monitoring effort may be used to satisfy effectiveness monitoring requirements in the counties' BLRPs. The Regional Water Board's authority to require this monitoring is found in section 13267 subdivision(b) of the Water Code.


Mariposa Swimming Hole
Mckee Parkway
Vichy Springs Park
Mill Creek Park
Ukiah
Cloverdale River Park
Cloverdale
Veteran's Memorial Beach
Foss Creek
Riverfront Park
Windsor
Sunset Beach
Green Valley Creek
Johnson's Beach
Monte Rio
Highway 12
Monte Rio Beach
Doyle Park
River Access Beach
Rohnert Park
Cotati
Railroad Street
Steelhead Beach
Laguna de SR
Pacific Ocean
Water Boards
TMDL Attainment
Monitoring Locations
Miles
0
5
10
20

**Table 9.1 TMDL Attainment Monitoring Locations**

| Responsible Party | Russian River Beach | Location |
|---|---|---|
| County of Mendocino | Russian River at Mill Creek Park | Potter Valley |
| | Russian River at Mariposa Swimming Hole | Redwood Valley |
| | Russian River at Vichy Springs Park | Ukiah |
| | Russian River at Mill Creek Park | Ukiah |
| County of Sonoma | Russian River at Cloverdale River Park | Cloverdale |
| | Russian River at Veteran Memorial Beach | Healdsburg |
| | Russian River at Riverfront Park | Windsor |
| | Russian River at Steelhead Beach | Forestville |
| | Russian River at River Access Beach | Forestville |
| | Russian River at Sunset Beach | Forestville |
| | Russian River at Johnson's Beach | Guerneville |
| | Russian River at Monte Rio Beach | Monte Rio |
| | Green Valley Creek at Martinelli Road and River Road | Forestville |
| City of Healdsburg | Foss Creek at Matheson Street | Healdsburg |
| City of Sebastopol | Laguna de Santa Rosa at Sebastopol Community Park | Sebastopol |
| City of Santa Rosa | Matanzas Creek at Doyle Park and Bethards Drive | Santa Rosa |
| | Santa Rosa Creek at Highway 12 | Santa Rosa |
| | Santa Rosa Creek at Railroad Street | Santa Rosa |

The assessment of *E. coli*, *Bacteroides*, and fecal coliform concentrations and TMDL target attainment in tributary streams and creeks shall be assessed by Regional Water Board staff by compiling available instream data. High priority tributary sites to sample are listed in Table 9.1, although others may be appropriate. Available data may include effectiveness monitoring data submitted by the monitoring coalition or by individual responsibility parties under their BLRPs, data collected by other watershed stakeholders, and data collected by the Surface Water Ambient Monitoring Program and other Regional Water Board efforts if needed. These data could be shared and coordinated via a cooperative Russian River Watershed monitoring coalition.

Regional Water Board staff will assess progress toward attainment of the TMDLs/loading capacities on a watershed or sub-watershed scale, and provide a report on a regular basis, likely every five years. The report may be accomplished through an informational presentation to the Regional Water Board or as part of a larger stewardship report.

## 9.4 POST TMDL-ATTAINMENT OR NON-ATTAINMENT PROCEDURES

When reaches of the Russian River and/or its tributaries attain the TMDLs/loading capacities, it is assumed that wasteload and load allocations are attained in the watersheds, and the following procedures shall take place in those reaches. Should instream data again identify impairment after TMDL attainment, these procedures shall not apply.

1. Effluent limitations will remain in place.
2. Implementation actions already in place shall be maintained by the responsible party or parties.

3. Implementation actions that are described in a BLRP but have not yet been put into place shall not be required.
4. Status reports shall no longer be required.
5. Effectiveness monitoring shall continue to ensure water quality does not degrade, although the monitoring and reporting frequency can be reduced if requested of the Executive Officer by the responsible party or parties.

If all sources identified in the BLRPs are reasonably controlled and the TMDLs/loading capacities are not met, then a revision of the TMDL, Water Contact Recreation Beneficial Use, or Bacteria Water Quality Objective may be appropriate.

# CHAPTER 10
# CEQA ANALYSIS

To be developed.

# CHAPTER 11
# ECONOMIC ANALYSIS

To be developed.

# CHAPTER 12
# ANTIDEGRADATION ANALYSIS

To be developed.

# CHAPTER 13
# PUBLIC PARTICIPATION SUMMARY

To be developed.

# CHAPTER 14
# NINE KEY NONPOINT SOURCE ELEMENTS

To be developed.

# APPENDIX A
# TYPES OF PATHOGENS & TYPES OF PATHOGEN INDICATOR BACTERIA

## A.1 TYPES OF BACTERIA

Pathogens most commonly identified and associated with waterborne diseases can be grouped into the three general categories: bacteria, protozoans, and viruses (U.S. EPA 2001).

### A.1.1 Bacteria

Bacteria are microscopic unicellular organisms ranging from approximately 0.2 to 10 micrometers (µm) in length. They are distributed ubiquitously in nature, including the intestinal tract of warm-blooded animals. Many types of harmless bacteria colonize the human intestinal tract and are routinely shed in feces. In addition, pathogenic (disease-causing) bacteria, such as verotoxigenic *E. coli* (including serotype 0157:H7), *Salmonella*, and *Campylobacter*, are present in the feces of infected humans and animals and can contaminate surface water and groundwater as a result of inadequate waste treatment or disposal methods. Many groups of intestinal bacteria, including the coliform and enterococcus groups, have historically been used as an indication that an environment has been contaminated with human sewage.

### A.1.2 Protozoans

Protozoans are unicellular organisms that are present primarily in the aquatic environment. Of the 35,000 known species of protozoans, almost 30 percent are pathogenic. Pathogenic protozoans can occur in humans and animals where they multiply in the intestinal tract of the infected individual or animal and are later excreted in feces as cysts. Protozoan cysts do not reproduce in the environment, but are capable of surviving dormant in the soil and surface water for extended periods of time, which makes them a prominent public health concern.

Two waterborne protozoans of major public health concern are *Giardia lamblia* and *Cryptosporidium parvum*. The *Giardia* organism inhabits the digestive tract of a wide variety of domestic and wild animal species, as well as humans. Once shed in feces, G*iardia* cysts are frequently found in rivers and lakes. Infection by *Giardia* can result in giardiasis in humans, which is characterized by gastroenteritis, particularly among the young and elderly. *Giardia* is considered nonpathogenic in cattle because it is usually found in animals that have normal feces and no sign of disease. However, among the human population, giardiasis affects approximately 200 million people worldwide and is one of the most prevalent waterborne diseases in the United States. *Cryptosporidium* species are a group of parasitic protozoa that are recognized as pathogens of domesticated livestock, poultry, and wildlife and are readily transmitted to humans. *Cryptosporidium* oocysts are about 4-6 µm in diameter, slightly larger than bacteria, and relatively unaffected by conventional methods of wastewater disinfection, such as chlorination. Infection by *Cryptosporidium* can cause cryptosporidiosis, whose symptoms include loss of appetite, nausea, and abdominal pain followed by acute or persistent diarrhea. Although *Cryptosporidium* infections are usually of short duration and self-limiting in individuals with an intact immune system, there is no specific treatment available and the infection can be life threatening in patients with profound impairment of immune function.

### A.1.3 Viruses

Viruses are obligate intracellular parasites, incapable of replication outside of a host organism. They are very small, ranging from 0.02 to 0.2 µm. Viruses that are of a public health concern are viruses that replicate in the intestinal tract of humans, and are referred to as human enteric viruses. Sewage overflows and improperly functioning sewage systems are considered to be primarily responsible for water contamination. Individuals can become infected through consumption of contaminated water, swimming in contaminated water, or through person-to-person contact with an infected person. Symptoms of infection include vomiting and diarrhea, with the severity of disease and mortality increasing in older age groups. The most significant human enteric viruses include hepatitis A, rotaviruses, noroviruses, adenoviruses, enteroviruses, and reoviruses.

## A.2 TYPES OF PATHOGEN INDICATOR BACTERIA

Several groups of intestinal bacteria have been used as indicators that a waterbody has been contaminated with human sewage and that pathogens are present. Most strains of pathogen indicator bacteria do not directly pose a health risk to swimmers and those recreating in the water, but indicator bacteria often co-occur with human pathogens and are easier to measure than the actual pathogens that may pose the risk of illness. It is impractical to directly measure the wide range of types of fecal-borne pathogens (bacteria, viruses, and protozoans) and the methods to detect human pathogens are characteristically expensive and inefficient, or may be not available.

*E. coli* bacteria, *Bacteroides* bacteria, and the microbiome community are used in the Russian River Watershed as indicators of pathogens. These indicators are described in Chapter 2.

Although total coliform, fecal coliform, and *Enterococcus* bacteria have been historically used as indicators, they do not indicate potential pathogen presence as well as *E. coli* bacteria or *Bacteroides* bacteria, and are not used for this TMDL project. More information on these parameters is found in this Appendix.

### A.2.1 Total Coliform Bacteria

Total coliforms are a group of bacteria that are widespread in nature. All members of the total coliform group can occur in human feces, but some can also be present in animal manure, soil, submerged wood, and other places outside the human body. Thus, the usefulness of total coliforms as an indicator of fecal contamination depends on the extent to which the bacteria species found are fecal and human in origin. Because total coliforms can come from non-fecal sources, they are no longer recommended as an indicator for assessing the support of recreation beneficial uses (U.S. EPA 1986). However, total coliform is still recommended for use in assessing support of shellfish consumption based on criteria adopted in 1925. The shellfish criteria are based on investigations made by the U.S. Public Health Service that assessed the occurrence of typhoid fever or other enteric diseases attributed to shellfish harvesting (U.S. FDA 2011).

### A.2.2 Fecal Coliform Bacteria

Fecal coliform bacteria are a subgroup of total coliform bacteria found mainly in the intestinal tracts of warm-blooded animals, and thus, are considered a more specific indicator of fecal contamination of water than the total coliform group. Fecal coliform bacteria concentration criteria were initially recommended by U.S. EPA (1976) for assessing support of recreational use. However, since 1976, several key epidemiological studies were conducted to evaluate the criteria for effectiveness at protecting public health from water contact recreation (Cabelli et al. 1982; Cabelli et al. 1983; Dufour 1983; Favero 1985; Seyfried et al. 1985a, Seyfreid et al. 1985b) The studies concluded that the U.S. EPA (1976) recommended fecal coliform bacteria criteria had no scientific basis. As a result of the new information derived from epidemiological studies, the U.S. EPA (1986) changed the criteria recommendation to use the pathogen bacteria indicators of *E. coli* and *Enterococcus* bacteria, instead of fecal coliform bacteria.

In addition, detection of fecal coliform bacteria in recreational waters may overestimate the level of fecal contamination because this bacteria group contains a genus, *Klebsiella*, with species that are not necessarily fecal in origin. *Klebsiella* bacteria are commonly associated with soils and the surfaces of plants, so that areas with allochthonous organic debris may show high levels of fecal coliform bacteria that do not have a fecal-specific bacteria source.

### A.2.3 Enterococcus Bacteria

*Enterococcus* bacteria are a subgroup within the fecal streptococcus bacteria group. *Enterococcus* bacteria are distinguished by their ability to survive in salt water, and therefore more closely mimic more pathogens than the other indicators in marine environments. U.S. EPA (2012) recommends enterococcus bacteria concentration as the best indicator of human health risk in salt water for recreation.

U.S. EPA (2012) states that *Enterococcus* bacteria concentrations may also be used as an indicator of human health risk in fresh water. Similar to *E. coli* bacteria, the *Enterococcus* bacteria criteria are established for both the geometric mean and the STV for protection of water contact recreation. The criteria are based on epidemiological studies at U.S. beaches. The studies enrolled participants at a number of beach study sites and followed them to compare incidence of illness between the exposed (swimmers) and unexposed groups.

Exposed groups involved swimmers with exposure to waters known to be impacted by domestic wastewater. Additional epidemiological studies were conducted in waters impacted by urban runoff sources but no domestic wastewater sources and found low illness rates after exposure (U.S. EPA 2010). Not all epidemiological studies show clear or consistent correlations between indicator levels and health outcomes. For example, in an epidemiological study at marine beaches impacted by sewage outfalls and stormwater overflows in Sydney, Australia, gastrointestinal symptoms did not increase with increasing counts of fecal coliform or enterococci; however, swimmers did exhibit increasing respiratory, ear, and eye symptoms with increasing levels of FIB (Corbett et al., 1993).

Concerns have been identified for application of the *Enterococcus* bacteria concentration criteria (U.S. EPA 2012) as an indicator of fecal contamination in freshwater. First, there is concern about applying the *Enterococcus* bacteria concentration criteria in freshwater when some *Enterococcus* bacteria can come from non-fecal sources. The criteria are based on epidemiological studies that found association between illness and *Enterococcus* bacteria concentrations in surface waters with known sources of human fecal waste, specifically *Enterococcus faecalis* and *Enterococcus faecium*. Most research has found that the bacteria species *Enterococcus faecalis* is found mostly in humans, dogs, and chickens, and may or may not come from other warm-blooded animals (Wheeler et al. 2002). *Enterococcus faecium* is commonly found in production animals (Fisher and Philips 2003). *Enterococcus hirae* is frequently found to originate from domestic animals (Devriese et al. 2002). However, sources of *Enterococcus* bacteria in many surface waters may also be from non-fecal, natural sources. *Enterococcus mundtii* and *Enterococcus casseliflavus* are associated with plant sources, for example (Ferguson et al. 2005; Ferguson et al. 2011).

Second, using *Enterococcus* bacteria concentrations to assess whether there is potential for sewage and human pathogens assumes that bacteria do not persist or regrow in the environment. Studies have shown that these bacteria persist in benthic sediment and can regrow when re-suspended into the water column. Hartel et al. (2005) found that *Enterococcus* bacteria survived desiccation and regrew in rewetted sediment. Sediment collected in the riparian habitat and from naturally occurring drain surface biofilms in fresh water urban streams were found to be significant reservoirs of *Enterococcus* bacteria (Roberts 2012). Anderson et al. (1997) found that a large portion of *Enterococcus* bacteria load in urban and rural waterways came from non-human sources, including large loads from senescing algae. Urban runoff samples have been found to contain relatively higher proportions of *Enterococcus mundtii* and *Enterococcus casseliflavus* suggesting runoff sources are associated with plant species (Ferguson et al. 2013). Bacterial growth of *Enterococcus casseliflavus* on drain surfaces has been found to serve as a chronic low-level source of *Enterococcus* bacteria measurements collected in urban runoff (Ferguson et al. 2013). These studies indicate that elevated *Enterococcus* bacteria concentrations in water samples might be due to instream conditions that lead to regrowth and not due to contributions from fecal matter. Thus, the source exposure assumptions used to develop the *Enterococcus* bacteria criteria may not be applicable to the sources found in the Russian River Watershed.

Finally, the IDEXX Enterolert® method is reported to be subject to a high rate of false positive results from measurements in freshwater samples. It has been shown that several factors can cause interference with the test methods resulting in the over-estimation of *Enterococcus* bacteria concentrations, including suspended sediment in the water (Hartel et al. 2006). Other bacteria types (*Vibrio*, *Shewanella*, *Bacteroides* and *Clostridium*) have also been found to be enumerated as *Enterococcus* bacteria with the method (Sercu et al. 2010). Also, bacterial cultural methods for *Enterococcus* (e.g., the IDEXX Enterolert® or membrane filter methods) measure all species of the genus *Enterococcus*, including species that are not of fecal origin. False positive results would be unacceptable if the Regional Water Board uses these results as the basis for decisions regarding listing of waterbodies, compliance with water quality criteria, and compliance with numeric TMDL targets.

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