CHAPTER 5
SOURCE ANALYSIS

This chapter identifies the major sources of fecal waste contributing to elevated concentrations of fecal indicator bacteria found in the surface waters of Russian River Watershed.

Sources of fecal waste are analyzed in three ways:

1. By assessing the type of human and animal fecal 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.

5.1 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, 2013c). The monitoring included microbiological source identification in the 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 waste source. The analysis results (Dubinsky and Anderson 2014) are summarized in this section and in a memo to the file record (Butkus 2014a), which can be found on the Regional Water Board website.

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.

Multiple water samples were collected concurrently during the wet and dry season to analyze for *E. coli*, enterococci, and *Bacteroides* bacteria, as well as DNA profile. Due to cost, not all waters samples were immediately analyzed using the phylogenetic DNA microarray. Instead, a set of all water samples collected was frozen to be analyzed later using the phylogenetic DNA microarray. However, sets of all samples were analyzed for E*. coli*, enterococci, or *Bacteroides* bacteria. Around 100 frozen water samples were thawed and analyzed using the phylogenetic DNA microarray when any of the other measured metrics were shown to be elevated. This allowed for an assessment of the source, based on DNA profile, of each of the samples otherwise shown to have elevated concentrations of *E. coli*, enterococci, or *Bacteroides* bacteria.

5.1.1 RESULTS

The results for human fecal waste are mapped in Figure 5.1. The ten locations with the highest human fecal waste measured are shown in Table 5.1. There is a wide range of human fecal waste DNA matches found in the Russian River and its tributaries. The highest percent matches are found in the Laguna de Santa Rosa Watershed and in the Lower Russian River area. For example, in water samples collected in an unnamed stream in Monte Rio at Foothill Drive, 89% of the measured bacteria DNA gene sequences match known human waste gene sequences.

The results for grazer fecal waste are mapped in Figure 5.2. The ten locations with the highest grazer fecal waste measured are shown in Table 5.1. The majority of the sites with elevated percent matches are in the Laguna de Santa Rosa Watershed.

The results for bird fecal waste are mapped in Figure 5.3. The ten locations with the highest bird fecal waste measured are shown in Table 5.1. Elevated percent matches are fairly evenly distributed throughout the tributaries in the watershed.

This space is left blank intentionally

Table 5.1
Locations with the Highest Percent of Matches between Bacteria DNA Sequences in Russian River Watershed Samples and Known Human, Grazer, and Bird Fecal Waste

Hydrologic Area Name	Hydrologic SubAreas	Sample Location	Gene Sequences Percent Match
		Human Fecal Waste Top Ten Sites	
Middle Russian River	Laguna	Copeland Creek at Commerce Drive	24
		Crane Creek at Snyder Lane	21
	Santa Rosa	Piner Creek at Fulton Road	32
Lower Russian River	Guerneville	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
		Unnamed Creek at Old Redwood Highway	52
		Russian River at Johnson's Beach (Sept. 26, 2011)	50
		Unnamed stream in Forestville at Trenton Road	41
		Grazer Fecal Waste Top Ten Sites	
Middle Russian River	Laguna	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
	Santa Rosa	Abramson Creek at Willowside Road Levy	36
Lower Russian River	Guerneville	Unnamed Stream in Monte Rio at Foothill Drive	23
		Russian River at Monte Rio Beach	20
		Unnamed Creek at Old Redwood Highway	20
		Russian River at Forestville Access Beach	19
		Bird Fecal Waste Top Ten Sites	
Middle Russian River	Warm Springs	Palmer Creek at Palmer Creek Road	12
		Lambert Creek at Lambert Bridge Road	11
	Laguna	Crane Creek at Synder Lane	10
	Santa Rosa	Piner Creek at Fulton Road	19
		Abramson Creek at Willowside Road Levy	14
	Mark West	Unnamed Creek at River Road	10
Lower Russian River	Guerneville	Limerick Creek at Old Redwood Highway	11
		Unnamed Stream in Monte Rio at River Road	10
		Unnamed Stream near Monte Rio at Foothill Drive	10
		Dutch Bill Creek at Fir Road	10

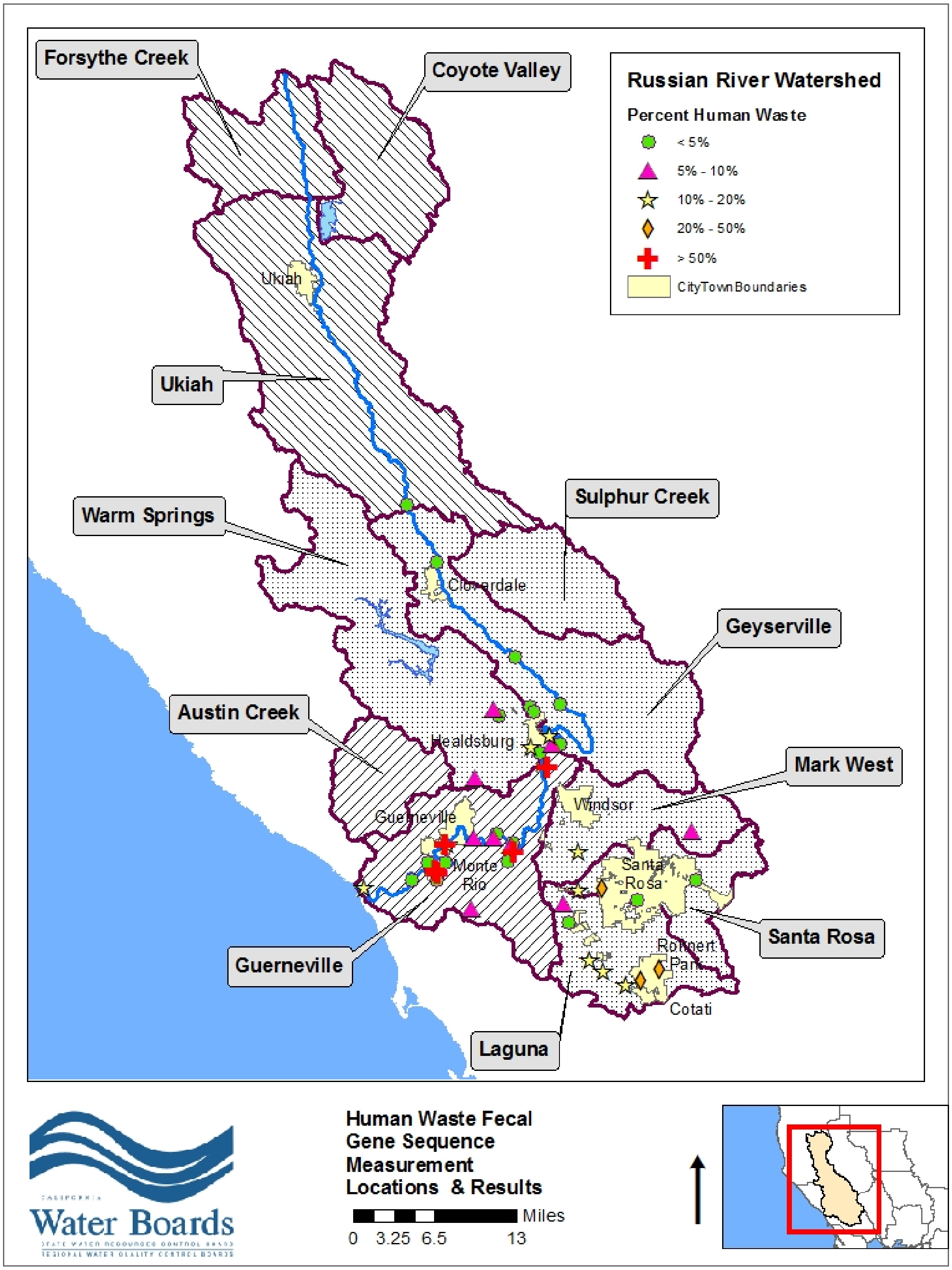


Figure 5.1: Human Fecal Waste Gene Sequence Measurement Locations and Results

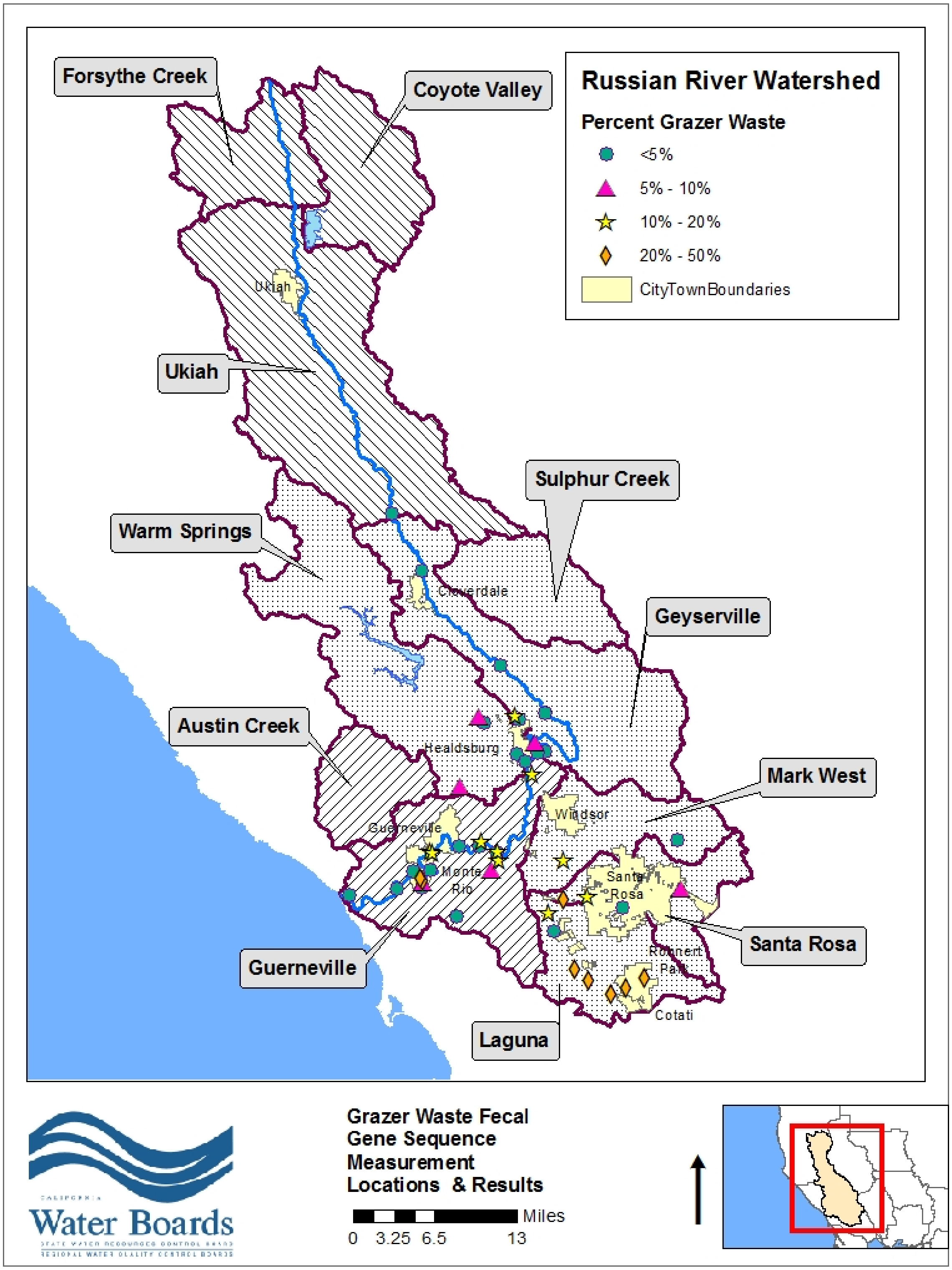


Figure 5.2: Grazer Fecal Waste Gene Sequence Measurement Locations and Result

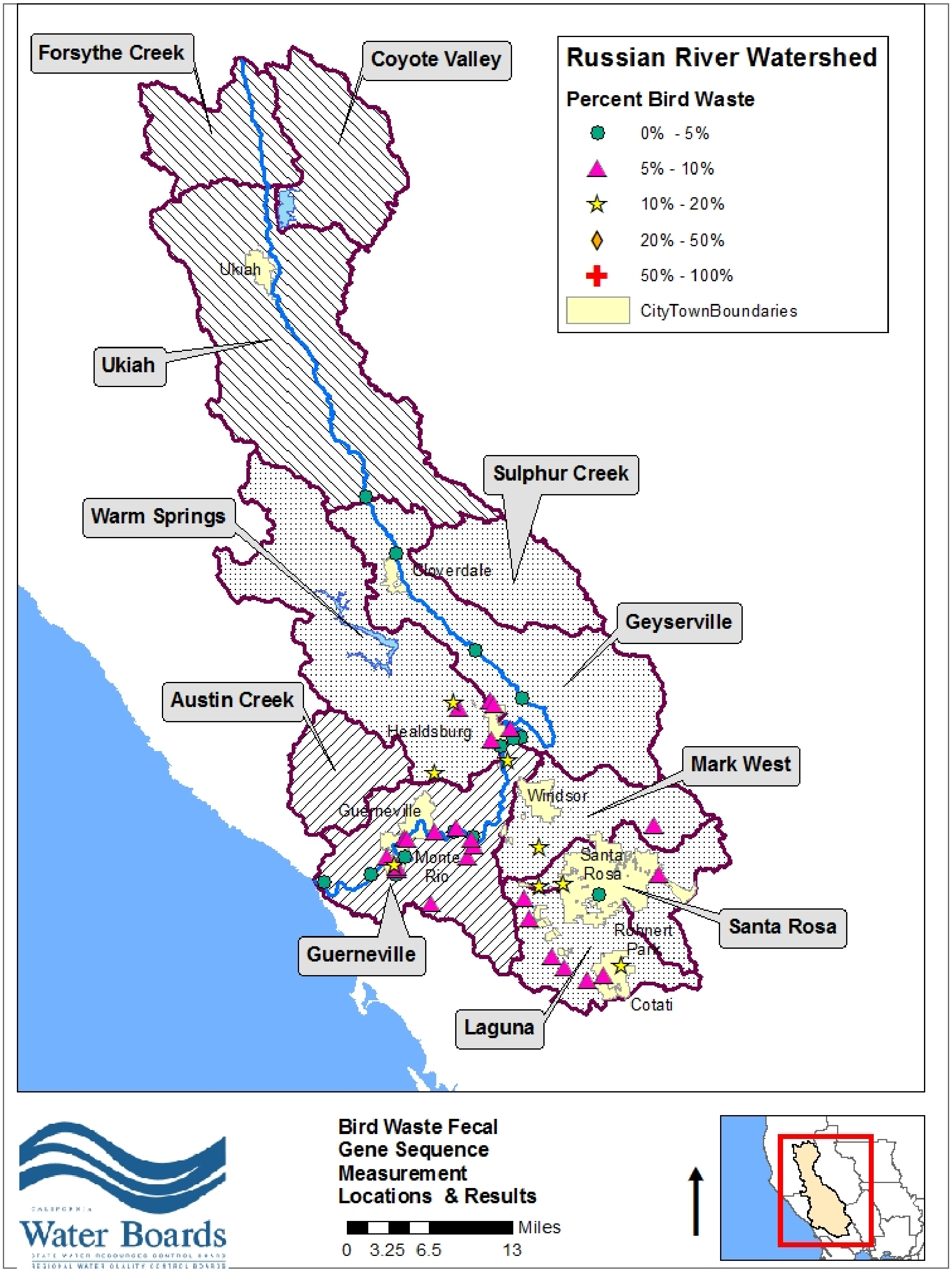


Figure 5.3: Bird Fecal Waste Gene Sequence Measurement Locations and Results

5.2 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 Regional Water Board staff (NCRWQCB 2012). An assessment of the data, including a statistical analysis, is documented in a memorandum (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[1]. Five land cover categories were selected. These land cover 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 onsite wastewater treatment systems, cesspools, or direct discharges 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-specific *Bacteroides*, and bovine-specific *Bacteroides* bacteria. Visual comparison

[1] 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.

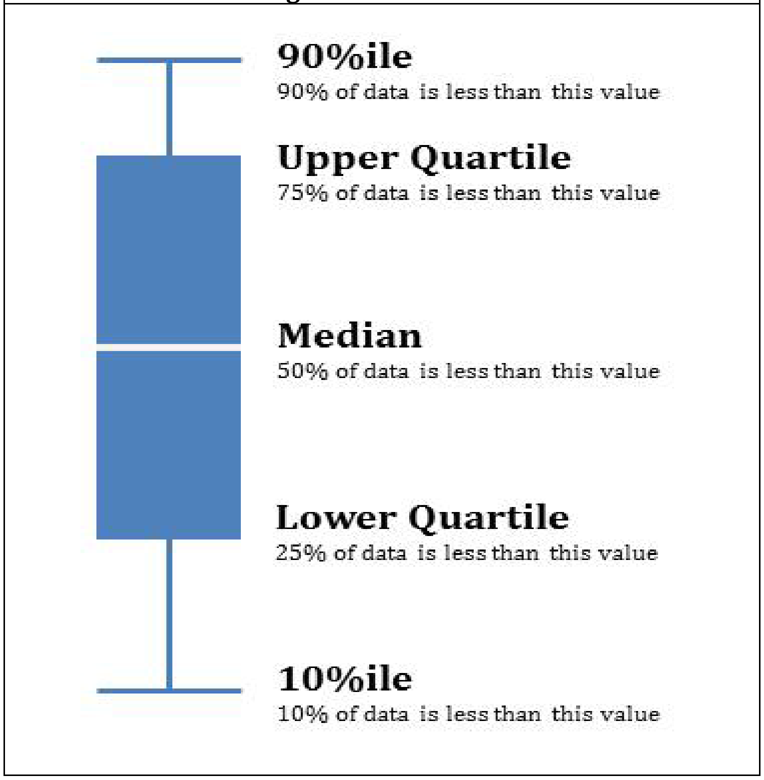
and statistical hypothesis tests were made between different data groupings. More information on the assessment methods is available in Butkus (2013a).

5.2.1 RESULTS

The results of the land cover analysis are presented in box-and-whisker plots in Figures 5.4 through 5.11. An explanation of how to interpret box-and-whisker plots precedes the figures. Human-source *Bacteroides* bacteria were present in all locations and in all land use categories. *E. coli*, enterococci, and Bacteroides bacteria concentrations in wet periods had statistically-significant higher concentrations than dry periods. Runoff from forest lands had statistically-significant lower concentrations of fecal indicator bacteria than runoff in all other assessed land cover categories. Runoff from shrubland, agricultural areas, and forested areas had statistically-significant lower *E. Coli*, enterococci, and Bacteroides indicator bacteria concentrations than runoff from developed areas (both sewered and non-sewered areas). Bacteroides bacteria concentrations were statistically the same for wet and dry period runoff draining from developed sewered areas, developed areas on Onsite Wastewater Treatment Systems (OWTS), agricultural areas and shrublands. *E. Coli*, enterococci, and Bacteroides bacteria concentrations were statistically the same for wet and dry period runoff draining from developed sewered areas and developed areas on Onsite Wastewater Treatment Systems (OWTS).

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. Sampling under this study was conducted in such a manner as to prevent capture of surface water discharges from municipal wastewater treatment facilities, by locating sample collection upstream of their discharge locations.

Data Example
Reading a Box & Whisker Plot



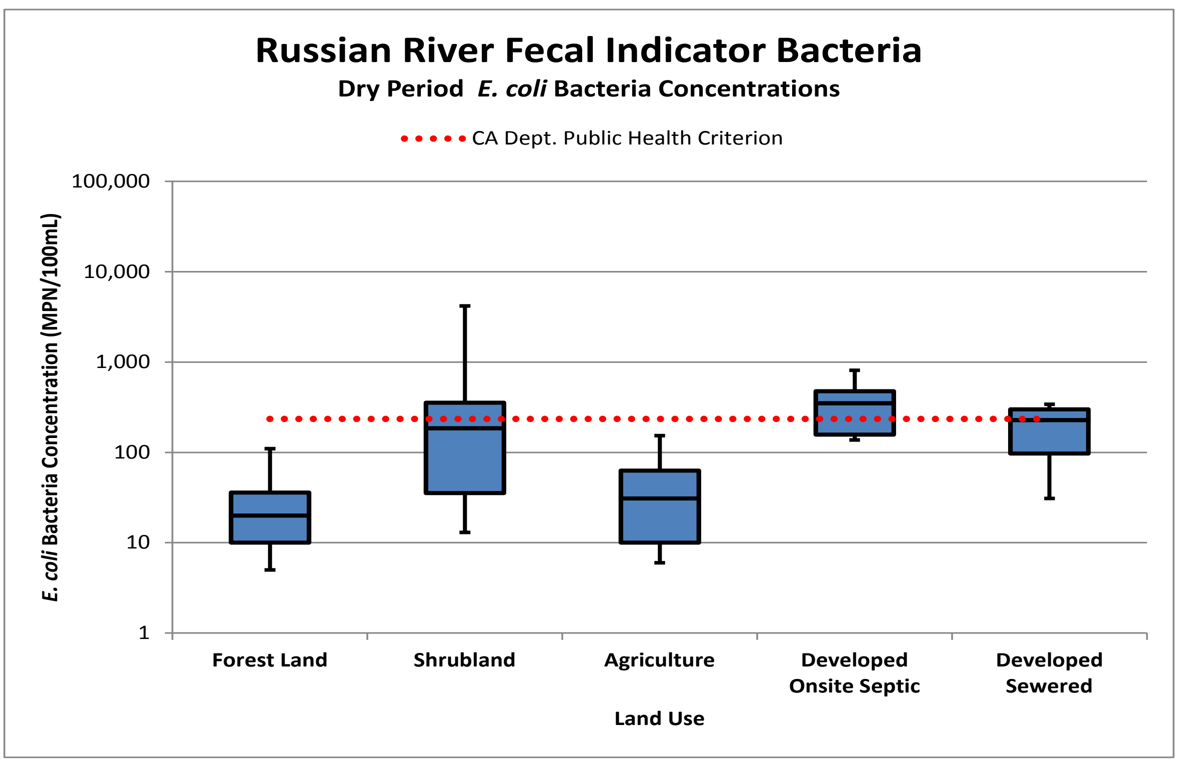


Figure 5.4: *E. coli* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board

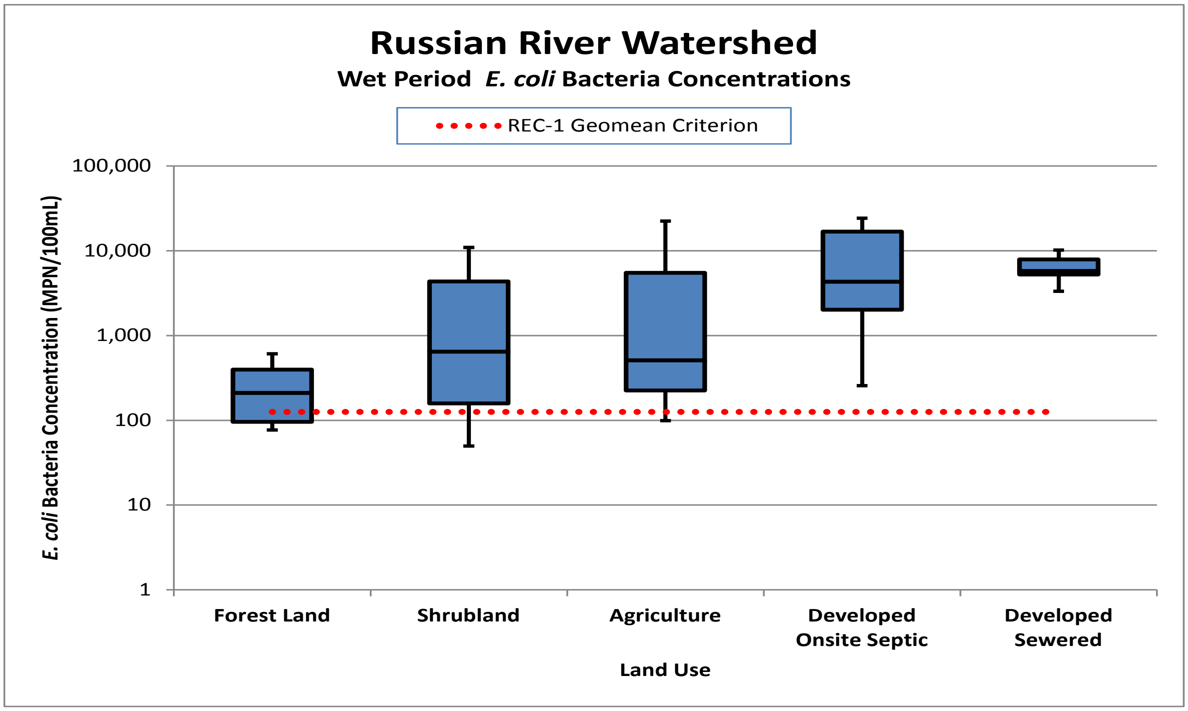


Figure 5.5: *E. coli* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category
Source: North Coast Regional Water Quality Control Board

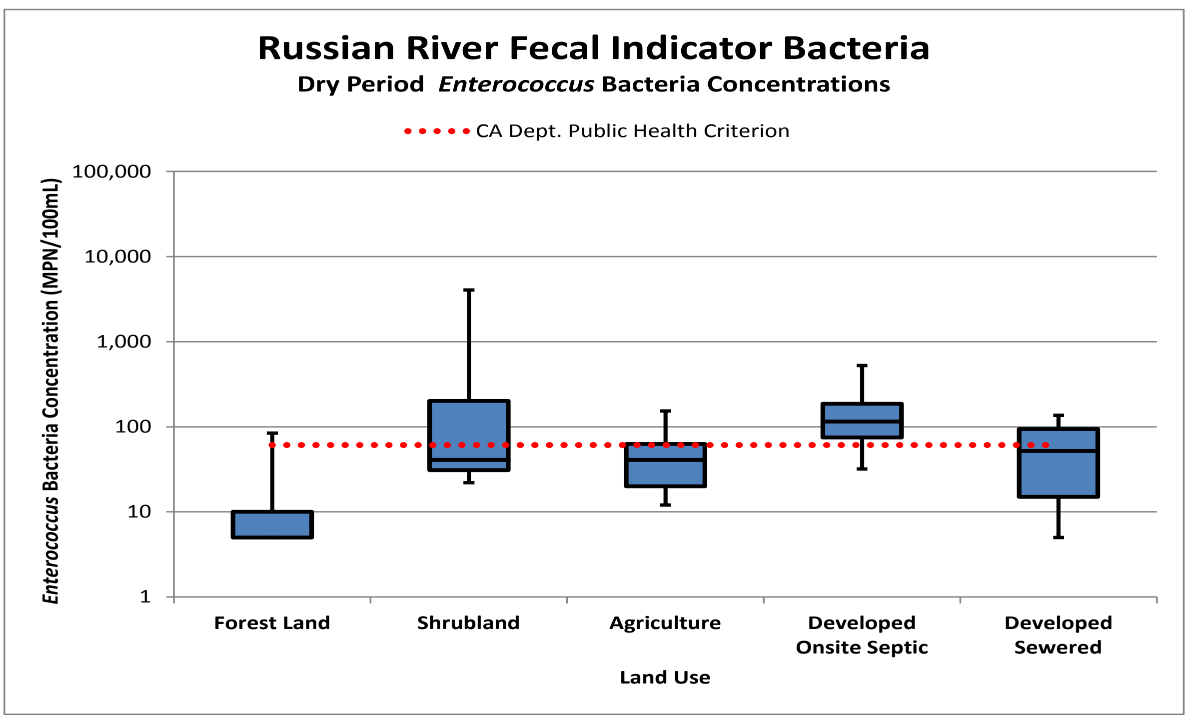


Figure 5.6: Enterococci Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category
Source: North Coast Regional Water Quality Control Board

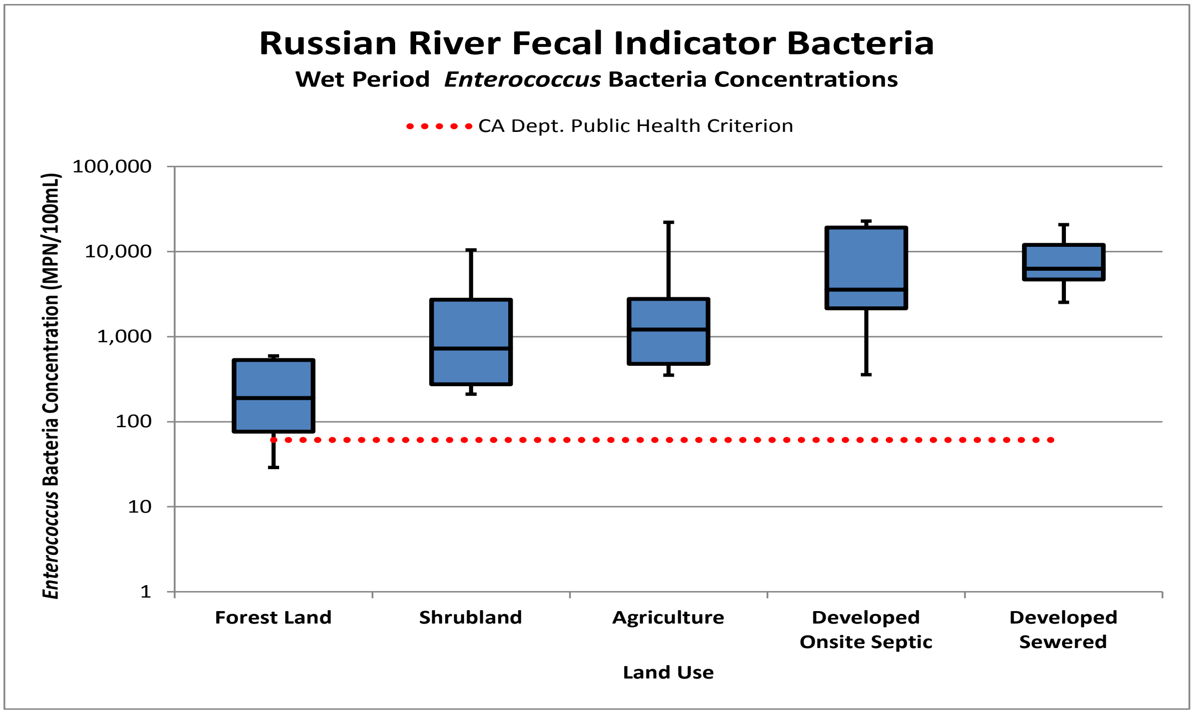


Figure 5.7: Enterococci Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category
Source: North Coast Regional Water Quality Control Board

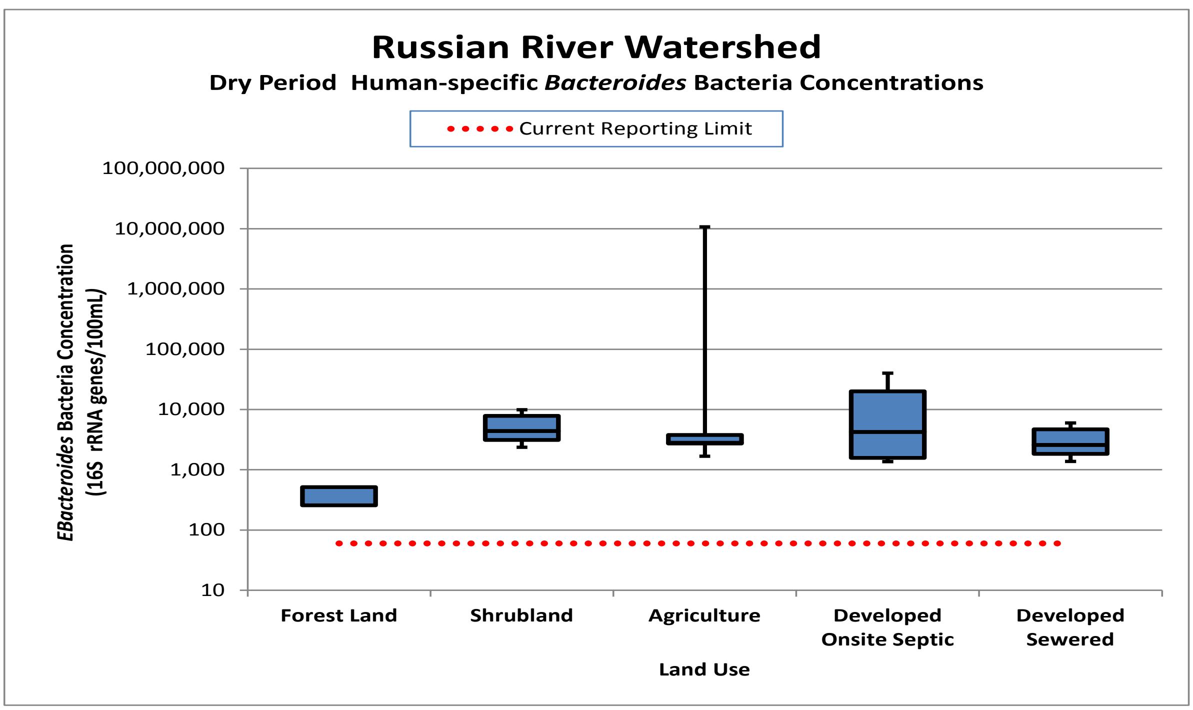


Figure 5.8: Human-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

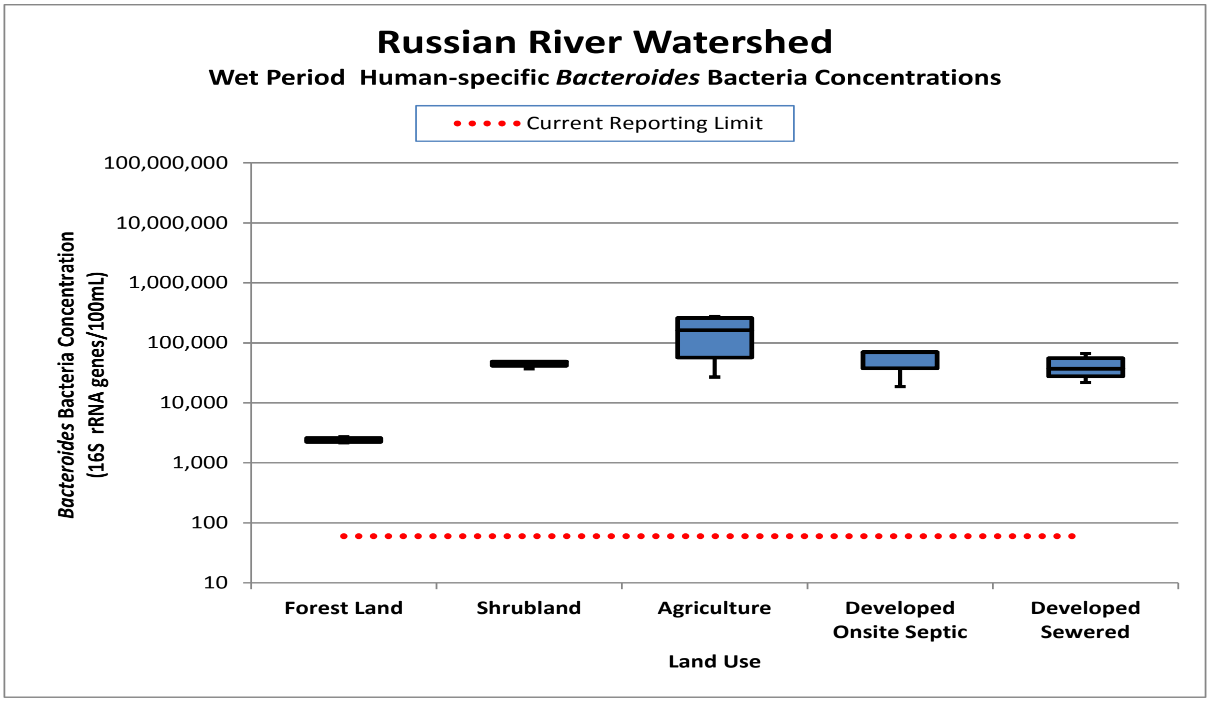


Figure 5.9: Human-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

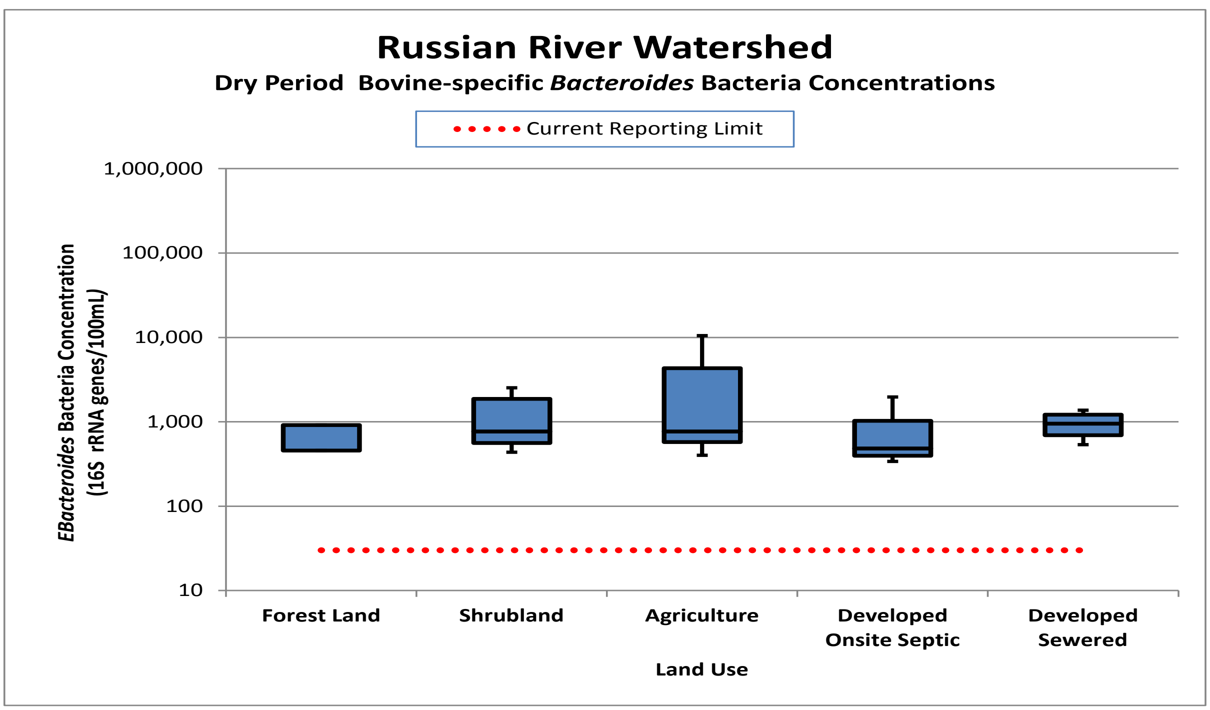


Figure 5.10. Bovine-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

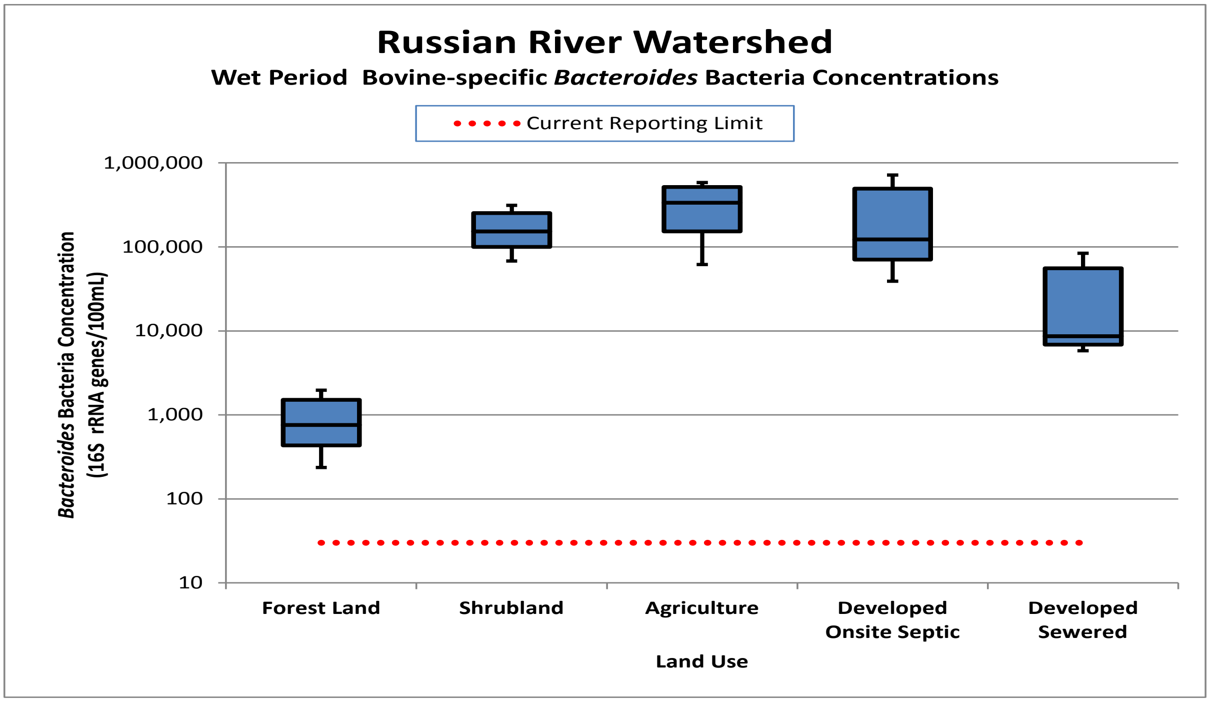


Figure 5.11: Bovine-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

5.3 POINT SOURCE FACILITIES AND ACTIVITIES

This section describes potential point sources of pathogens in the Russian River Watershed. Clean Water Act section 402 addresses direct discharges of waste into navigable waters. "Point source", as defined in the Clean Water Act, means 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 storm water discharges and return flows from irrigated agriculture. (33 U.S.C. §1362). Point source discharges to waters of the United States are regulated under the federal National Pollutant Discharge Elimination System (NPDES) program, through NPDES permits. Point source discharges to waters of the state are regulated under waste discharge requirements (WDRs) that also serve as NPDES permits.

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.

5.3.1 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 potential sources in the watershed.

5.3.1.1 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 5.2 summarizes these facilities (per information obtained from CIWQS in Nov. 2013) and describes their level of treatment. Figure 5.12 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 within the Russian River 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.

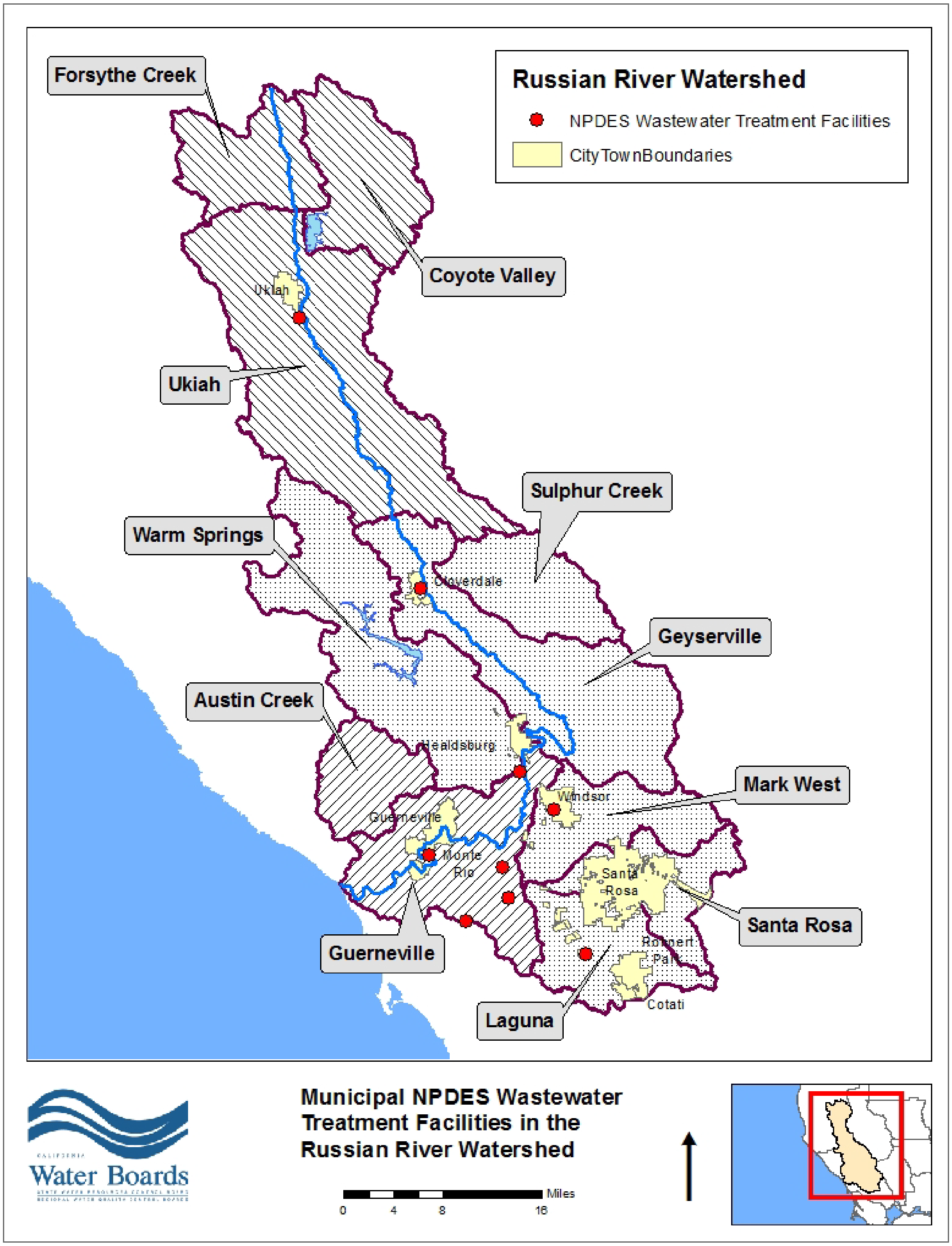


Figure 5.12: Municipal NPDES Wastewater Treatment Facilities in the Russian River Watershed

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 5.2 shows that disinfection methods are highly effective at meeting effluent limitations for total coliform bacteria. Consequently, direct discharges to surface water of treated municipal wastewater that meet effluent limitations for bacteria and discharge specifications for disinfection are not considered a significant source of bacteria. See Section 5.3.1.2 for discussion of the potential for bacterial contamination from discharges from holding ponds.

5.3.1.2 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, storage ponds for many wastewater treatment facilities serve a dual purpose: 1) to temporarily store recycled water in large holding ponds for later distribution to recycled water users or 2) to temporarily store treated wastewater until conditions are suitable and permitted for discharge to surface waters. It is the experience of Regional Water Board staff that discharges from holding ponds to surface waters outside of the prescribed discharge season or as a result of rain-induced pond overflows are rare, and are not considered a significant source of pathogen indicator bacteria in the Russian River Watershed.

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, compliance with effluent limitations for bacteria has been historically measured at municipal treatment plants at a point immediately after completion of the disinfection process. The point at which disinfection is complete, for example, at the end of a chorine contact chamber, may be separated from the surface water discharge by both distance and time. As a result, 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 waste 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.

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 the Town of Windsor for the period 2007-2011 indicate measureable concentrations of *E. coli* recycled water storage ponds after completion of disinfection. These results are shown in Figure 5.13.

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 bacteria 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 after exposure to dosages of ultraviolet radiation above 50 MJ/cm^2.

Table 5.2
Municipal NPDES Wastewater Treatment Facilities in the Russian River Watershed and Percent Compliance with Total Coliform Effluent Limitations

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

Based on these studies reviewed by Regional Water Board staff, discharges of treated wastewater from recycled water holding ponds may contain *E. coli* and in concentrations above the TMDL targets. However, the studies indicate that the sources of detected *E. coli* bacteria in recycled water storage ponds are not necessarily of human origin and therefore may not pose a more significant threat to public health or be relevant to protection of the REC-1 beneficial use. More site-specific information is necessary to determine the sources of *E. coli* or other fecal indicator bacteria in recycled water storage ponds and whether the discharge from a recycled water storage pond contains human pathogens before the holding pond can be eliminated as a pathogen source.

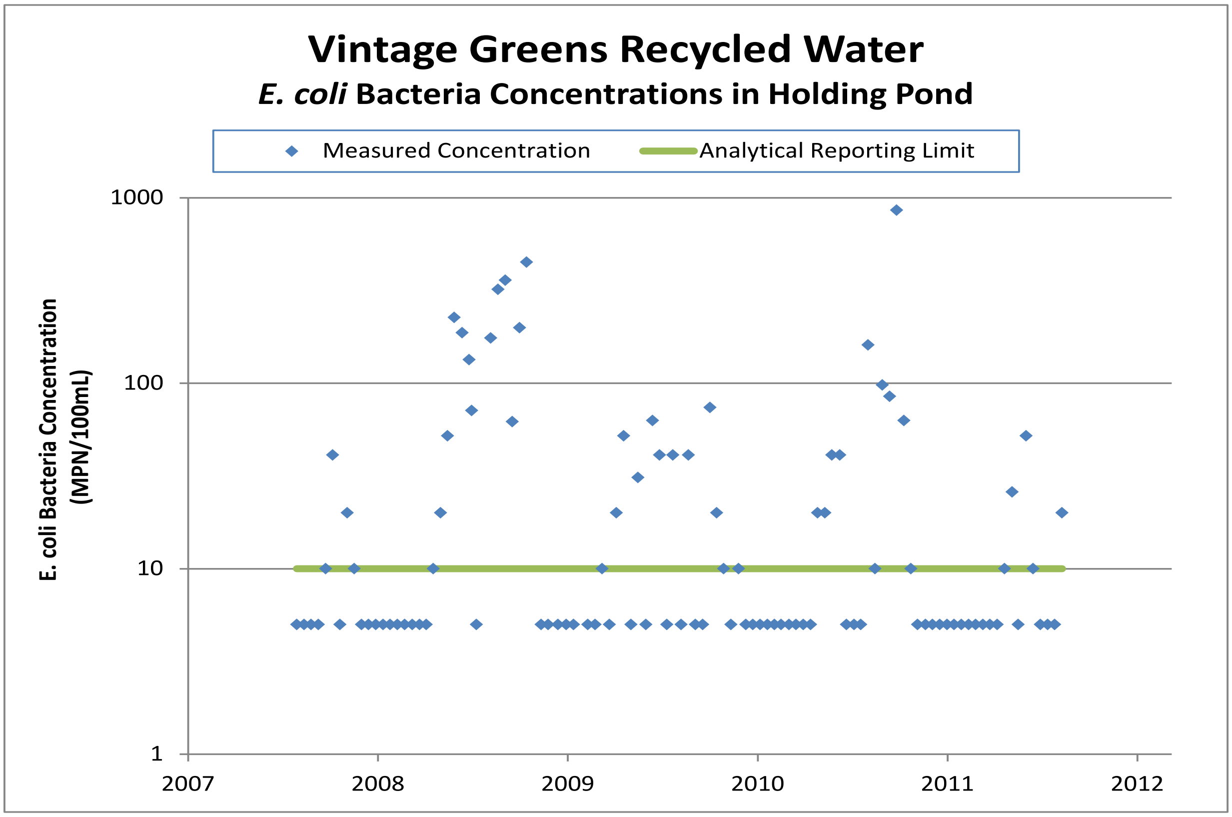


Figure 5.13: ***E. coli*** **Bacteria Concentrations in a Recycled Water Holding Pond at Vintage Greens in Windsor**
Source: Town of Windsor / North Coast Regional Water Quality Control Board

5.3.1.3 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 storm water 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, connections 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 5.3 and based on CIWQS data from November 2013 and sanitary sewer management plans submitted by municipalities.

This space is intentionally left blank.

Table 5.3
Sanitary Sewer Systems in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Sanitary Sewer System	Population Served	Number of Service Connections	Miles of Force Main	Miles of Gravity Sewer	Miles of Laterals
Upper Russian River	Ukiah	Calpella County Water District	450	100	0.3	2.9	1
		Hopland Public Utility District	1,200	288	0.6	4.4	6
		Ukiah Valley Sanitation District	5,000	4,971	1	43	44
		City of Ukiah	16,500	5,642	0	44	44
Middle Russian River	Geyserville	City of Cloverdale	8,500	3,200	0.1	32.3	21
		City of Healdsburg	11,700	4,600	2.9	53.1	87
		Geyserville Sanitation Zone	809	267	1	4.3	1.3
	Laguna	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 Sebastopol	7,750	2,800	2	25	53
		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
	Santa Rosa	City of Santa Rosa	167,815	48,396	6.3	582	355
	Mark West	Airport/Larkfield/Wikiup Sanitation Zone	9,306	1,937	1	10	9.2
		Town of Windsor	26,950	8,250	1	92	60
Lower Russian River	Guerneville	Forestville Water District	865	438	1.5	6	3.4
		Graton Community Services District	1,815	445	0.3	6.5	4
		Occidental County Sanitation District	636	71	1.5	1	0.3
		Russian River County Sanitation District	7,377	2,467	5	35	11.7
		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 storm water 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. Though any SSO is a violation of permit conditions, the reported levels shown in Table 5.4 indicate that SSOs are not a large source of bacterial contamination of the Russian River Watershed.

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 leaking or deteriorating service laterals at the expense of the municipality.

Although number of SSOs per mile of sanitary sewer line is relatively low, SSOs are potentially a significant source of pathogenic indicator bacteria in surface waters within the Russian River Watershed.

Table 5.4
Sanitary Sewer Overflows in the Russian River Watershed from 2007 to November 2013

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

5.3.1.4 SANITARY SEWER EXFILTRATION

Exfiltration is different from SSOs. Sanitary sewer overflows from small diameter pipelines are usually caused by pipe blockages. In larger diameter pipelines, excessive infiltration and inflow (I/I) can lead to surcharged pipe conditions. These conditions can result in direct overflows to receiving water or land or cause sewer backups into residential or commercial buildings. In contrast, 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.

Where conditions and other factors are present that could result in exfiltration of untreated wastewater from sanitary sewer system, sanitary sewers systems are potential sources of pathogens, measured as fecal indicator bacteria to surfaces waters in the Russian River Watershed.

5.3.1.5 OTHER NPDES FACILITIES

Fish Hatcheries

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 Wildlife 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 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. 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. A study of the role of fish as contributors of *E. coli* bacteria showed that the source of the *E. coli* in fish feces were likely from ingested bacteria from sediments, Canada geese, mallard ducks, and wastewater. Fish simply serve as a transport vehicle for *E. coli* bacteria transmission from other sources (Hansen et al. 2008). The fish themselves are not a direct source of bacteria. Therefore, fish hatcheries are not considered a source of *E. coli* bacteria for this TMDL.

Other Permittees

There are a number of other 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 5.5). Domestic wastewater from the Sonoma West Holdings Food Processing Facility is treated in a lined aerated pond, then filtered and disinfected before application to land. Treated discharges are required to meet effluent limitations for total coliform bacteria as a condition of discharge. Discharges permitted under the aquatic herbicide and aquatic pesticide general NPDES permits and for JDS Uniphase, which is covered under an individual NPDES permit, are not expected to contain human or animal waste, and are therefore not probable sources of pathogen indicator bacteria. Utility structures may contain pathogens as measured by fecal indicator bacteria from natural sources or as a result of pass-through from municipal separate storm sewer systems. Even though there is a potential for bacteria to be present in these discharge, these permitted discharges are not expected to be an original source of pathogens that contribute to the pathogen impairment in the watershed.

Table 5.5
Other NPDES Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Permittee Name	Permit No.	Facility Type
Upper Russian River	Coyote Valley	Potter Valley Irrigation District	CAG990005	Aquatic Herbicide
	Ukiah	Mendocino Forest Products Ukiah Sawmill	CA0005843 (terminated)	Sawmill
Middle Russian River	Laguna	Sonoma West Holdings Plant #2 Facility	CA0023655	Food Processing
		JDS Uniphase	CAG911001	Laboratory
Upper, Middle and Lower Russian River	Multiple HSAs	AT&T Statewide Cable System	CAG990002	Utility Structure
		Pacific Bell (AT&T)	CAG990002	Utility Structure
		Pacific Gas & Electric Company	CAG990002	Utility Structure
		Sprint	CAG990002	Utility Structure
		Verizon California	CAG990002	Utility Structure
		Sonoma County Water Agency	CAG990005	Aquatic Herbicide
		Marin/Sonoma Mosquito and Vector Control District	CAG990004	Pesticide/Vector Control
		City of Santa Rosa	CAG990005	Aquatic Herbicide
		Sonoma County Regional Parks	CAG990005	Aquatic Herbicide

5.3.3 STORM WATER

The NPDES Storm Water Program regulates storm water discharges from municipal separate storm sewer systems (MS4s), construction activities, industrial facilities, and state highways. Permitted facilities in the watershed are listed in Table 5.6. Most storm water 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 storm water discharges and municipal separate storm sewer systems (CWA §402(p)). As described below, storm water discharges to the Russian River Watershed are considered an important source of fecal waste in the watershed.

Table 5.6
Permitted Storm Water Facilities in the Russian River Watershed

Program	Number of Enrollees
Municipal Phase I MS4	3
Municipal Phase II MS4	6
Storm Water Construction	83
Storm Water Industrial	169
Caltrans	1
Total	260

5.3.3.1 MUNICIPAL STORM WATER

The 1987 amendments to the Clean Water Act required the U.S. EPA to address storm water 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."

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-storm water to the MS4 from dumping and disposal of materials such as litter, household refuse, and other materials that have the potential to impact water quality, including 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.

Pathogens in Urban Storm water Systems was prepared by Urban Water Resources Research Council (UWRRC 2014). The report describes potential sources of pathogen indicator bacteria in urbanized areas (areas within MS4 boundaries) to include SSOs, illicit discharges to storm sewer systems (e.g., power washing), failing OWTS, wastewater treatment plants, urban wildlife, domestic pets, and agriculture. Further, the report found fecal indicator bacteria concentrations in wet weather discharges from urban MS4s orders of magnitude above primary contact recreation standards. Storm water samples are also collected as a requirement of the MS4 permit for the City of Santa Rosa, County of Sonoma, and Sonoma County Water Agency. Single storm water samples were collected from Santa Rosa Creek upstream and downstream of the urban area. These single samples cannot be directly assessed with the Basin Plan water quality objective for fecal coliform bacteria which requires 5 samples collected in a 30-day period. However, the fecal coliform concentrations measured in Santa Rosa Creek during storm events range from 170 – 5,000,000 MPN/100mL. These very high concentrations supplement other evidence that Santa Rosa Creek is impaired due to high bacterial loads, especially during wet weather.

Additionally, the wet weather measurements of *E. coli* and enterococci bacteria concentrations draining from developed and sewered areas described in Section 4.2 were much higher than the U.S. EPA (2012) criteria. *E. coli* bacteria concentration measurements showed a geometric mean of 5,372 MPN/100mL, as compared to the numeric target of 100 MPN/100mL. Enterococci bacteria concentrations measurements showed a geometric mean of 6,860 MPN/100mL, as compared to the numeric target of 30 MPN/100mL. These results confirm that municipal storm water is an existing source of bacteria.

5.3.3.2 INDUSTRIAL STORM WATER

The most common pollutants of concern in industrial storm water 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 storm water 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.

Storm water discharges associated with industrial activities, unless otherwise excluded, are regulated under NPDES Industrial General Permit (Order 2014-0057-DWQ, NPDES No. CAS000001). Beginning on July 1, 2015, storm water discharges associated with industrial activities, unless otherwise excluded, will be regulated under the 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 Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges. .

Compliance with requirements in the General Permit will ensure that storm water discharges from industrial sites are not a significant source of pathogenic bacteria.

5.3.3.3 CONSTRUCTION STORM WATER

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 sites during and after construction.

The primary potential sources of pathogens at construction sites are temporary sanitary facilities on 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 site. A well-designed and maintained 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 storm water discharges from construction sites are not a significant source of pathogenic bacteria.

5.3.3.4 CALTRANS STORM WATER

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 storm water permitting requirements of Clean Water Act section 402(p). Caltrans is currently operating under a statewide storm water permit (Order 2012-011-DWQ) that regulates all storm water and non-storm water 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 storm water 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 Status Review 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 waste 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., Caltrans finds that 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).

5.4 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.

5.4.1 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 5.7 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 5.7
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.

Regional Water Board staff conducted a focused study on the potential influence of OWTS on the discharges of pathogens, as measured by fecal 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 the potential for pathogens, as measured by fecal indicator bacteria in surface waters of the Russian River Watershed. Figure 5.15 shows the distribution of these concentrations by parcel densities. High parcel densities range from 0.8 to 4 parcels per acre (0.2 to 1.3 acres/parcel). Low parcel densities ranged <0.1 parcels per acre (9 to 100 acres/parcel).

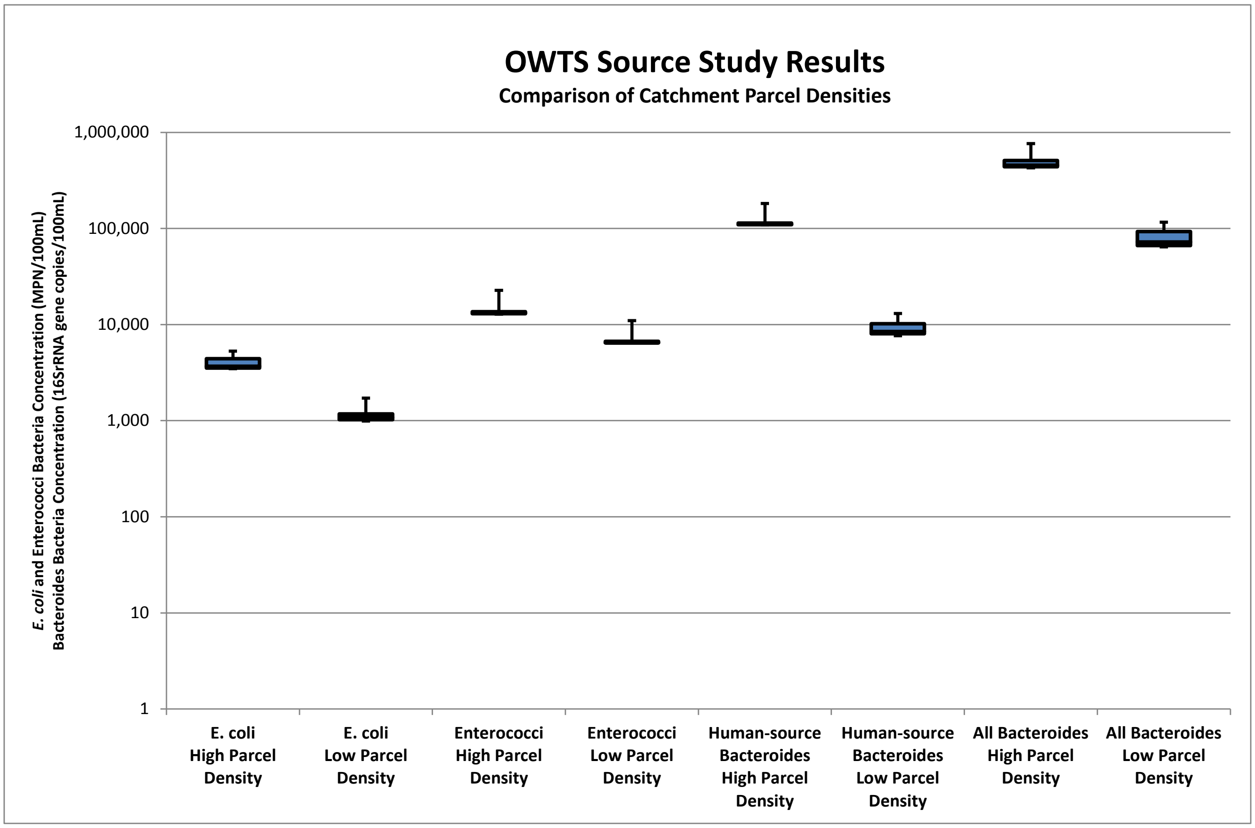


Figure 5.14. Comparison of the distribution of *E. coli,* Enterococci and *Bacteroides* bacteria concentrations by parcel densities.
Source: North Coast Regional Water Quality Control Board*. Bacteroides* bacteria were analyzed with the AllBac and HuBac genetic marker following U.S. EPA (2010) Method B.

5.4.2 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 5.8 and Figure 5.16. 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; Appendix B). Water samples were collected for analysis of *E. coli*, enterococci, and human-source *Bacteroides* bacteria at Veterans Memorial Beach and Monte Rio Beach during the week of the Independence Day holiday in 2013.

Table 5.8
Popular Swimming Beaches along the Russian River

Hydrologic Area Name	Hydrologic Subarea Name	Recreational Beach Name	Location
Upper Russian River	Coyote Valley	Mill Creek Park	Potter Valley
	Forsythe Creek	Mariposa Swimming Hole	Redwood Valley
	Ukiah	Vichy Springs Park	Ukiah
		Mill Creek Park	Ukiah
Middle Russian River	Geyserville	Cloverdale River Park	Cloverdale
		Alexander Valley Campground	Healdsburg
Lower Russian River	Guerneville	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

Figure 5.15: 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 5.17). Recreator counts were not available for Monte Rio Beach. Figures 5.18 through 5.20 show photographs of both beaches on Independence Day. Figures 5.21 and 5.22 show that *E. coli* concentrations measured at those beaches were elevated above the *E. coli* bacteria targets on Independence Day and generally below the targets measured on other days during the study.

Relationships between these variables were investigated using the Spearman's rank correlation coefficient (ρ) (Helsel and Hirsch 2002). Spearman's rank correlation coefficient is a nonparametric statistical measure of the dependence between two variables. Spearman correlation coefficients approach either plus one ($\rho \sim +1.0$) or minus one ($\rho \sim -1.0$), as the relationship become stronger. A small correlation coefficient (between -0.5 and 0.5) indicates a weak relationship between the variables.

The study found that the percentage of human-specific *Bacteroides* showed a relatively strong positive correlation (Spearman Correlation Coefficient = 0.72) with swimming recreation, with the higher percentages of human-specific *Bacteroides* observed on days with a larger number of people swimming (Figure 5.23). Moderately positive correlations were found for *E. coli* bacteria concentrations (Spearman Correlation Coefficient = 0.55) and enterococci bacteria concentrations (Spearman Correlation Coefficient = 0.51) with swimming recreation (Figures 5.24 and 5.25). The results indicate that intensive human contact recreation at public beaches on the most popular hot summer days contributes to *E. coli,* enterococci and *Bacteroides* 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 *E. coli,* enterococci and *Bacteroides* indicator bacteria concentrations.

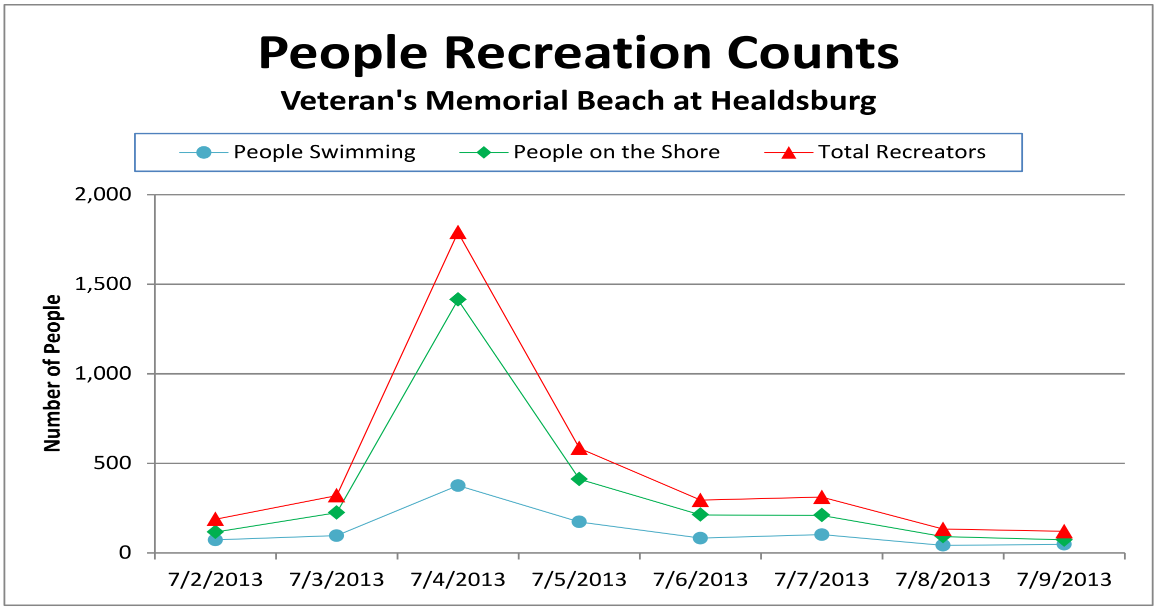


Figure 5.16: Counts of People Recreating at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

Figure 5.17: Veteran Memorial Beach on Thursday, July 4, 2013 at 12:30
Source: North Coast Regional Water Quality Control Board.

Figure 5.18: East Monte Rio Beach on Thursday, July 4, 2013 at 14:00
Source: North Coast Regional Water Quality Control Board.

Figure 5.19: West Monte Rio Beach on Thursday, July 4, 2013 at 14:00
Source: North Coast Regional Water Quality Control Board.

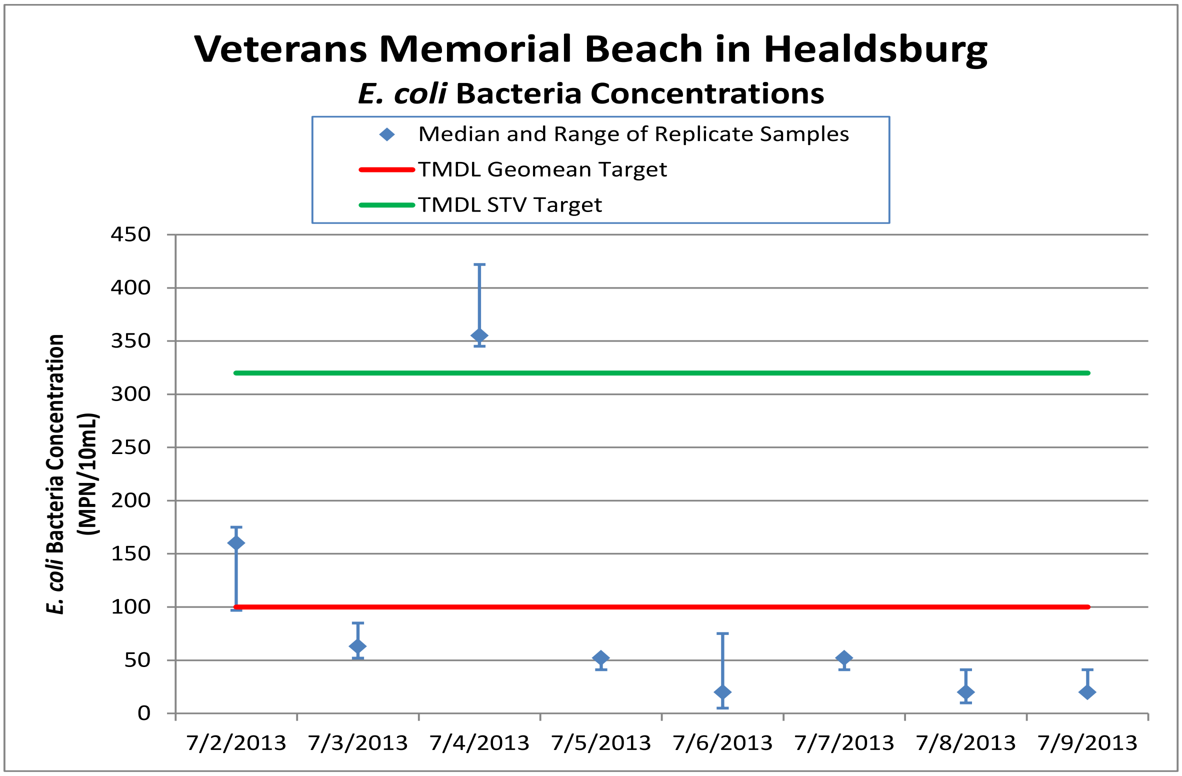


Figure 5.20: ***E. coli*** **Bacteria Concentrations Measured at Veteran Memorial Beach in Healdsburg**
Source: North Coast Regional Water Quality Control Board.

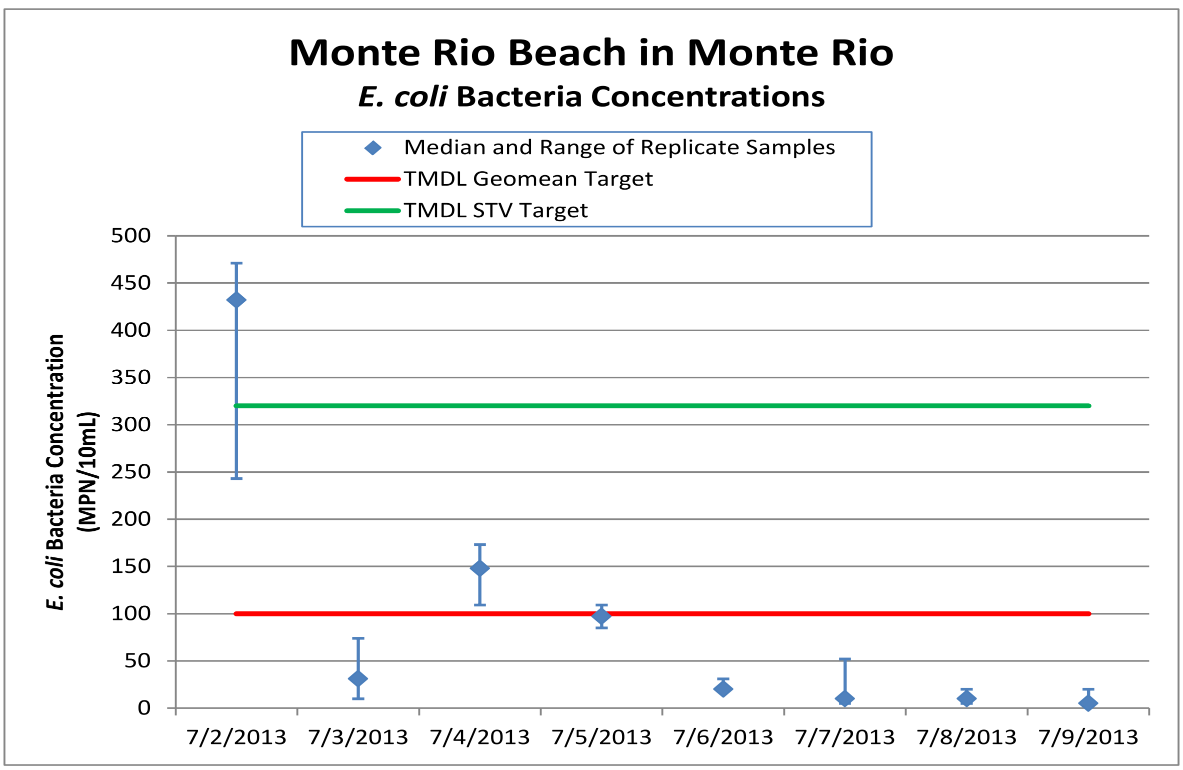


Figure 5.21: ***E. coli*** **Bacteria Concentrations Measured at Monte Rio Beach in Monte Rio**
Source: North Coast Regional Water Quality Control Board.

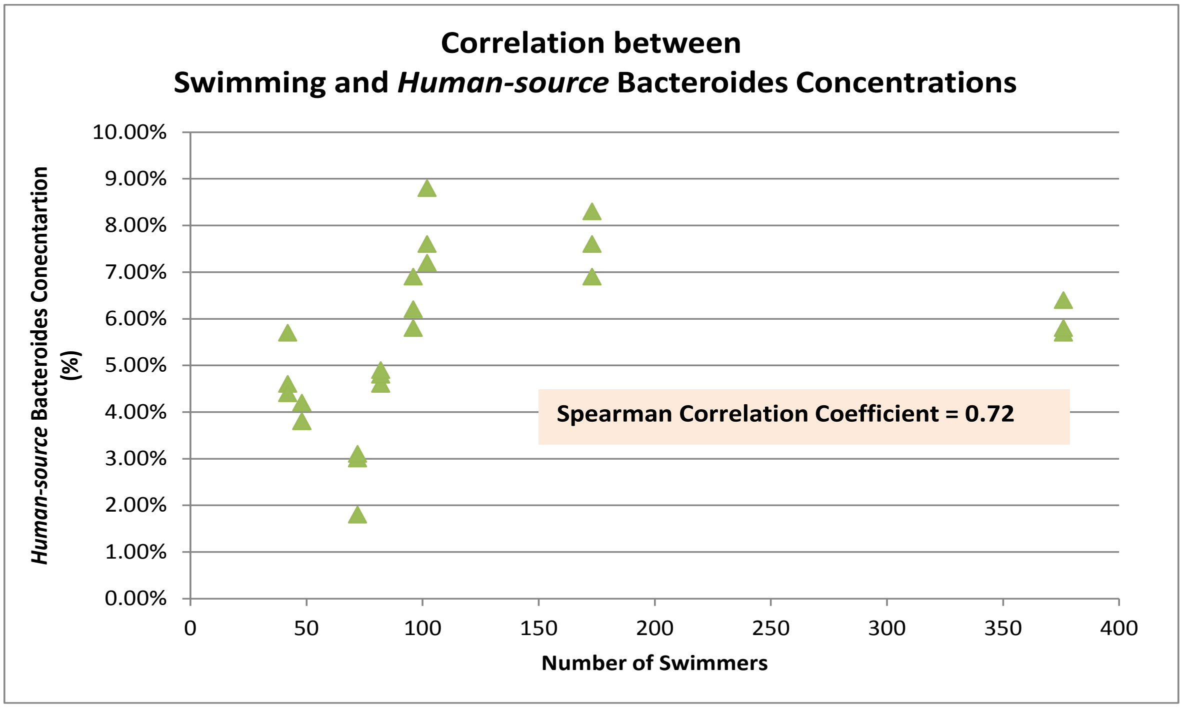


Figure 5.22. Correlation between Number of Swimmers and the Percentage of Human-source *Bacteroides* Bacteria Concentrations at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

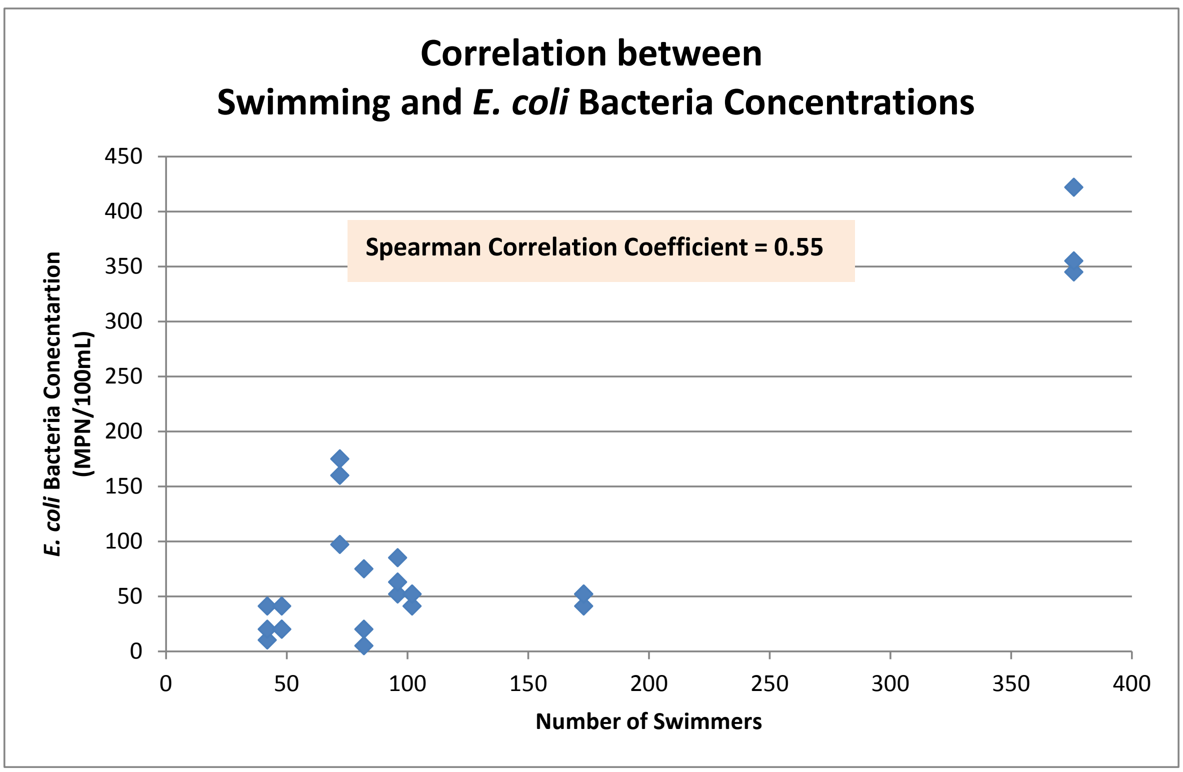


Figure 5.23: Correlation between Number of Swimmers and *E. coli* Bacteria Concentrations at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

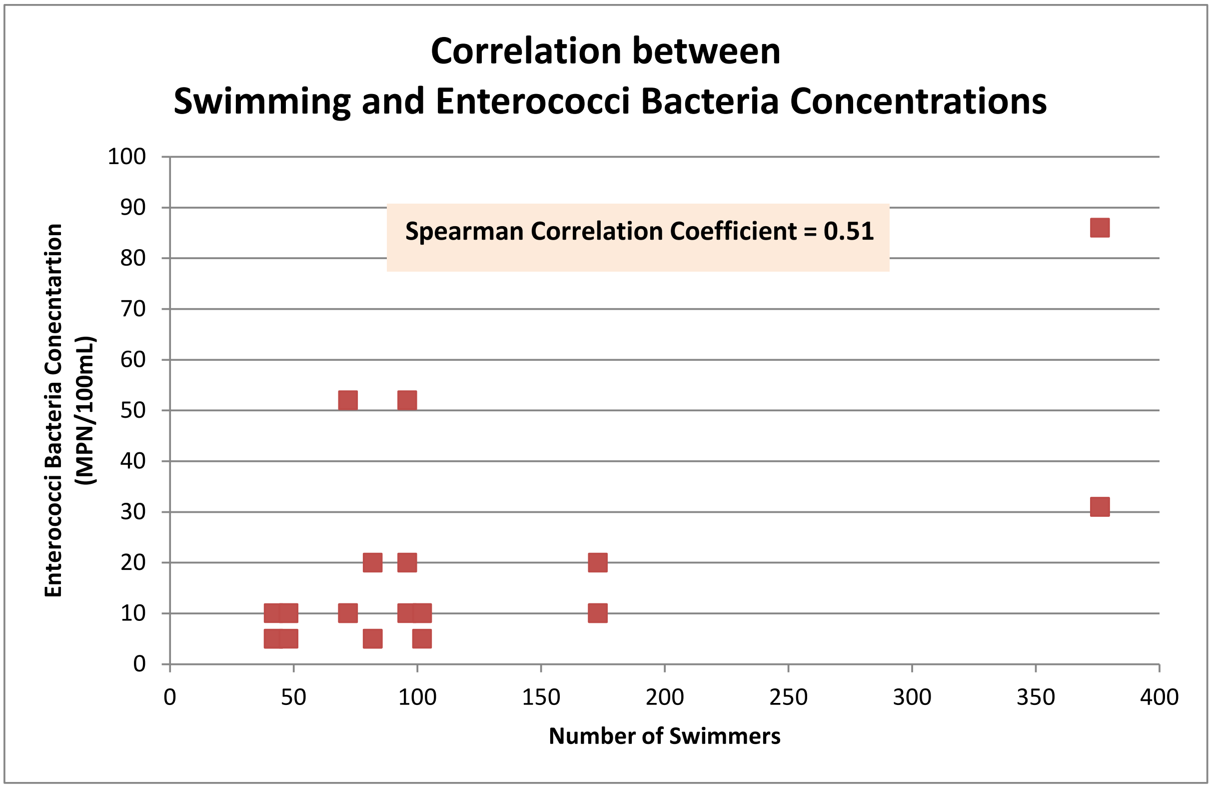


Figure 5.24: Correlation between Number of Swimmers and *E. coli* Bacteria Concentrations at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

5.4.3 HOMELESS ENCAMPMENTS

Homeless encampments are potential sources of bacteria. Many riparian areas within the Russian River Watershed attract 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 could be one of the causes of 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 in 2005 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 in 2005 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 adequate restroom facilities are not available. Where itinerant farmworker encampments are located near water courses, there is an increased opportunity for human waste contamination.

5.4.4 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 waste 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, 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 recycled water uses in order to minimize or prevent the effects of non-storm water 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-storm water 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 well-managed, unintentional spills of recycled water occur periodically. Large volume spills are rare, but when they occur are typically the result of broken recycled water lines in rural properties, but can 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, though not common, 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.

5.4.5 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 waste 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 pathogens to surface waters through storm water discharges. Since storm drains do not normally 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 storm water regulations, proper disposal of pet wastes can lead to a significant reduction of bacteria discharged in storm water.

The monitoring and source assessment completed for the Russian River Watershed did not explicitly evaluate the contribution of pet waste to bacteria concentrations in surface waters. However, given the human population density in the watershed, it is assumed that pet waste is a source of indicator bacteria in the watershed.

5.4.6 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). Human-infectious pathogens relevant to livestock sources in the Russian River Watershed also include *Giardia* (cattle), *Campylobacter jejuni* (chickens), and hepatitis E serogroup C (hogs). 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 storm water 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 5.9. The Russian River Watershed covers large areas of both counties. Data presented in this table were obtained from several sources, as described below. Discussion of categories of livestock animals as potential sources of fecal waste to the Russian River Watershed is provided in greater detail in the following sections.

Table 5.9
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)
Cows	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)

5.4.7 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 bacteria in raw manure (up to 100 million fecal coliform per gram). Most commercial dairies in the Russian River Watershed store manure in large 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 WDR 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.

In accordance with Title 27, the dairy permits require retention ponds and manured areas at confined animal facilities in operation on or after 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. 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. While these permit requirements protect against manure discharges from holding ponds, discharges can occur when streams exceed the 20-year peak stream flow rate. The dairy permits specify that waste storage facilities constructed after January 19, 2012 shall be located outside of 100-year 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. 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.

As described in Section 5.2, wet weather measurements of *E. coli* and enterococci bacteria concentrations of draining from agricultural areas were much higher than the U.S. EPA (2012) criteria. *E. coli* bacteria concentrations measurements showed a geometric mean of 880 MPN/100mL, as compared to the numeric target of 100 MPN/100mL. Enterococci bacteria concentrations measurements showed a geometric mean of 1,556 MPN/100mL, as compared to the numeric target of 30 MPN/100mL. These results confirm that runoff from agricultural areas is an existing source of bacteria. Additionally, the results for grazer fecal waste are mapped in Figure 5.2. The ten locations with the highest grazer fecal waste measured are shown in Table 5.1. The majority of the sites with highest percent matches are in the Laguna de Santa Rosa Watershed.

Figure 5.26 shows the results of the Bovine-source *Bacteroides* bacteria concentration measurements and the locations of dairies in the Middle Russian River Hydrologic Area. Visual comparison show that higher concentrations of Bovine-source *Bacteroides* bacteria are near or downstream of the dairies. Figure 5.27 shows the results of the grazer fecal waste gene sequence measurements and the locations of dairies in the Middle Russian River Hydrologic Area. Visual comparison shows that higher levels of grazer fecal waste gene sequence measurements are near or downstream of the dairies. This source analysis approach does not distinguish between the various types of grazers, and in particular between cattle and dairy cows. However, based on an assessment of the data and the known distribution of cattle versus dairy operations, general assumptions regarding the relative contribution from cattle versus dairy cows are appropriate.

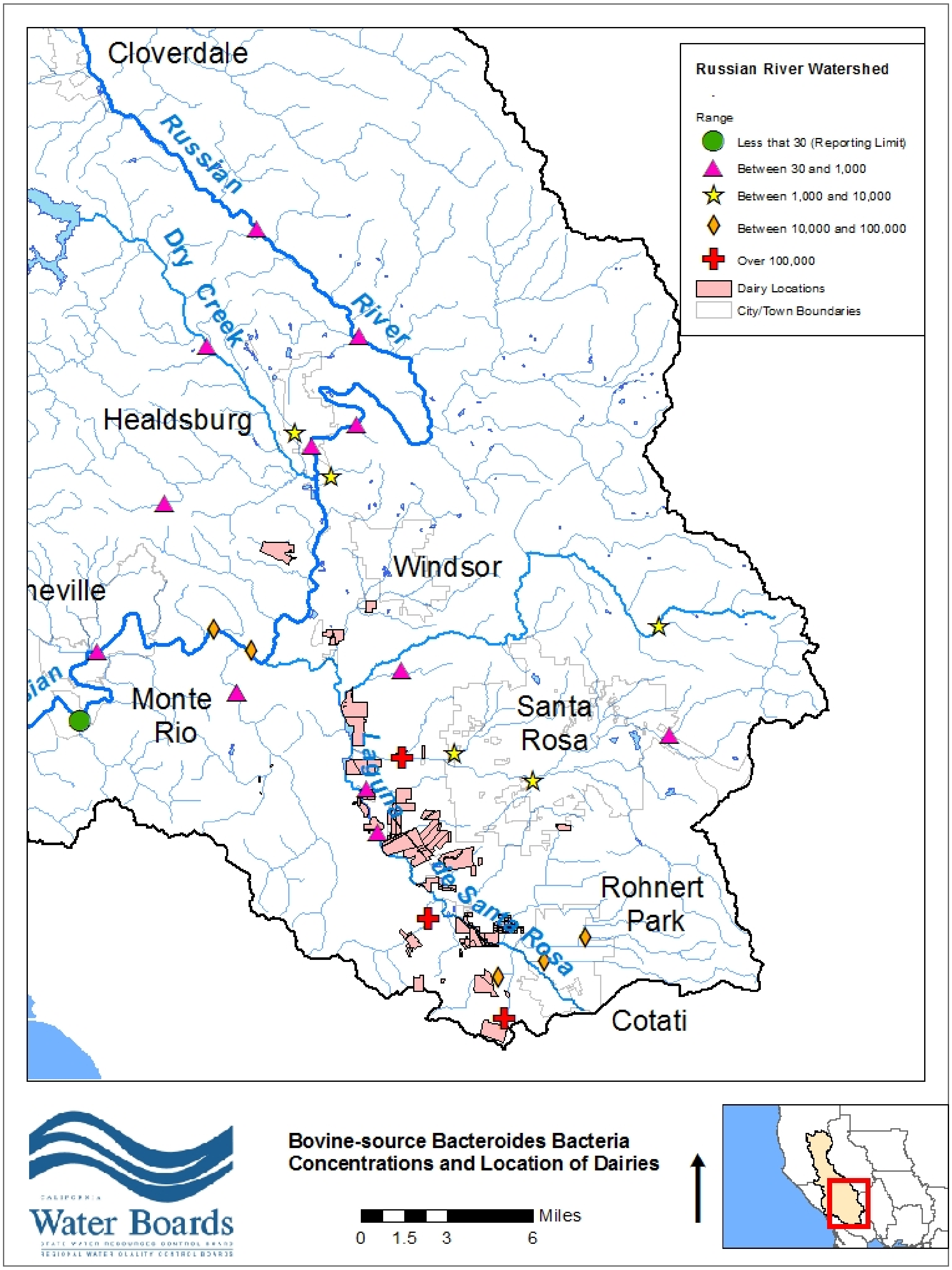


Figure 5.25: Locations of the Bovine-source *Bacteroides* Results and Dairies in the Middle Russian River Watershed.

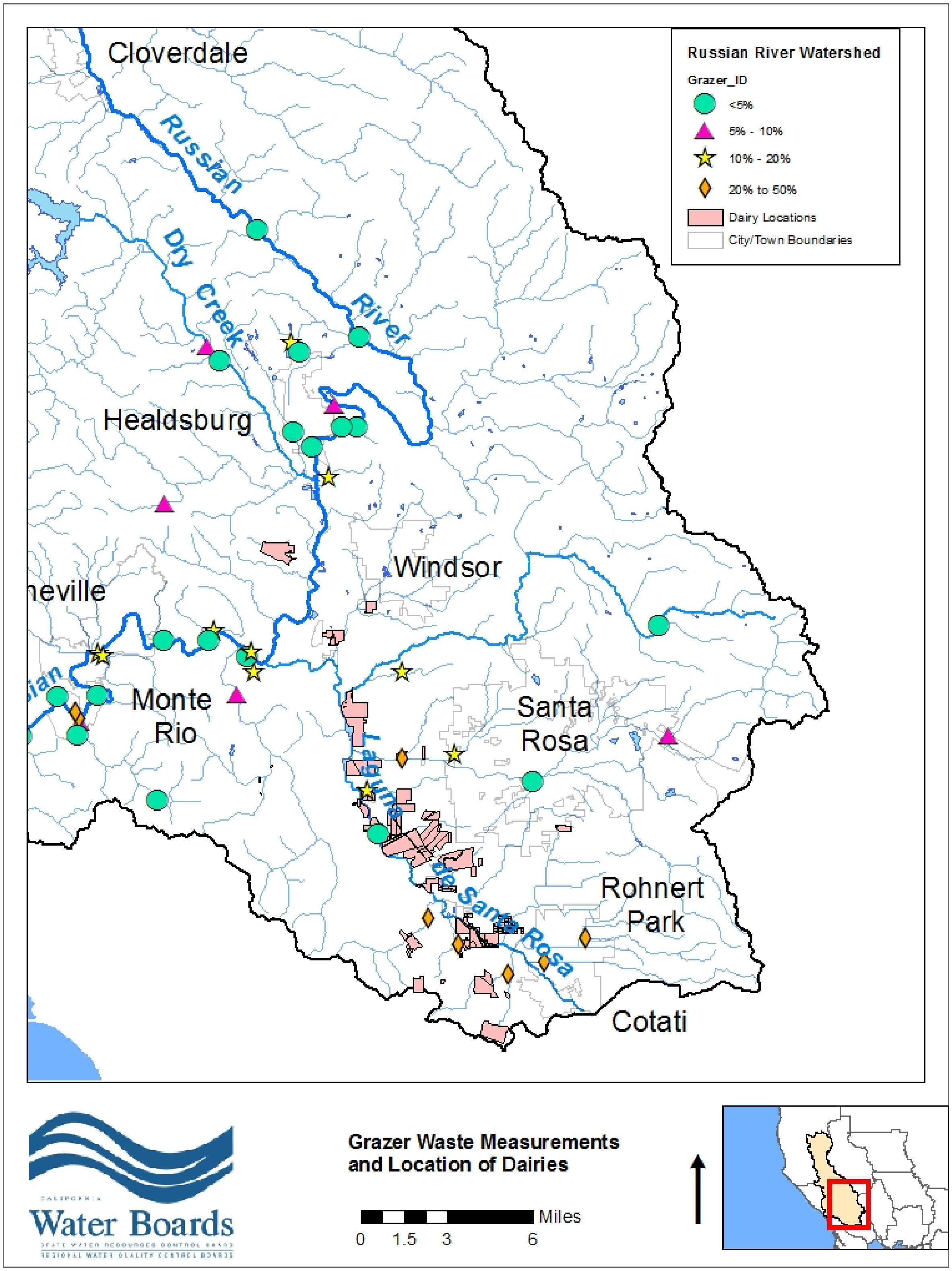


Figure 5.26: Locations of the Grazer Waste Results and Dairies in the Middle Russian River Watershed.

5.5.1 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 the Russian River and its tributaries via indirect discharge.

5.5.1.1 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 5.28). Table 5.10 summarizes these facilities (based on information obtained from CIWQS in November 2013) and describes their treatment capabilities and methods of effluent disposal or reuse.

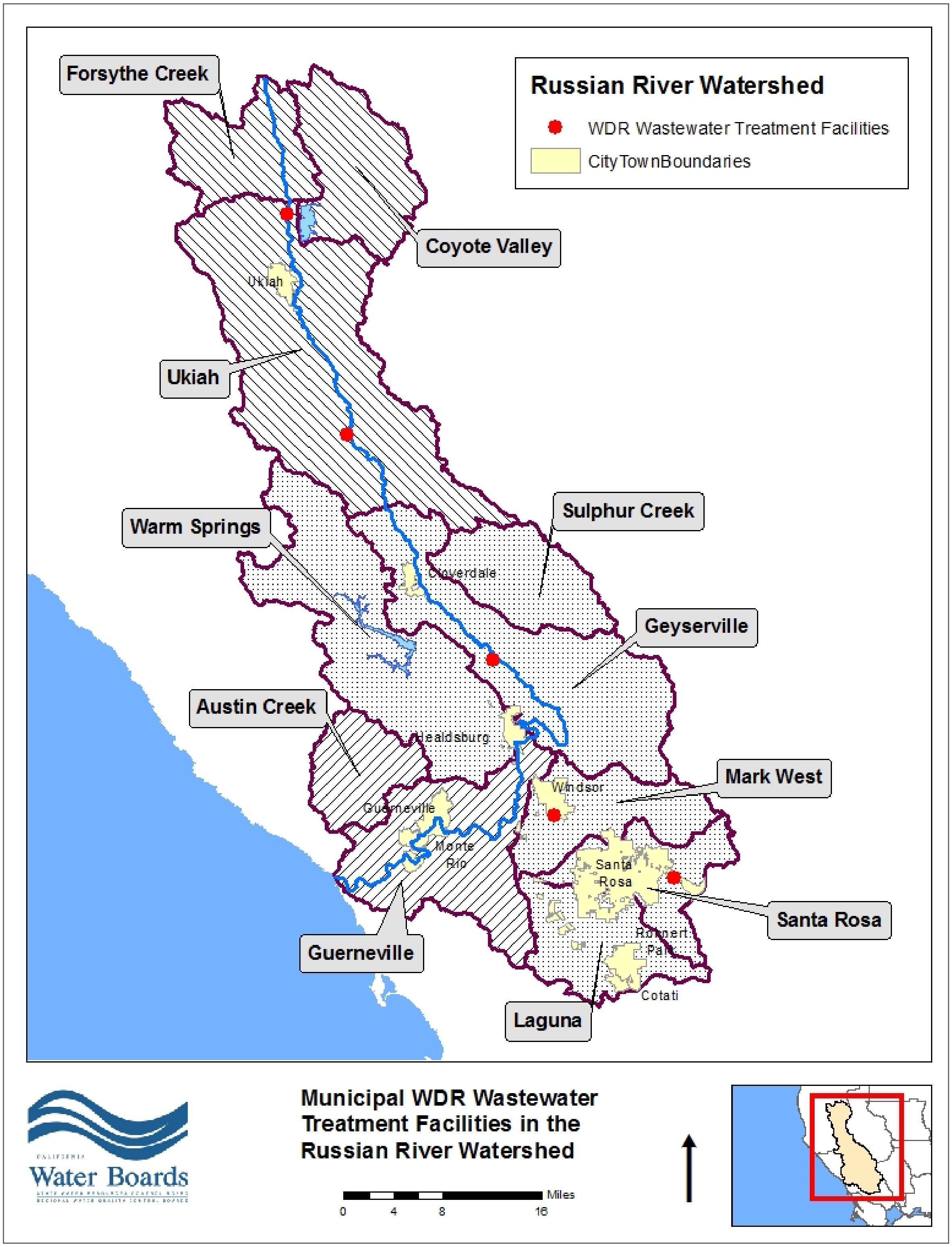


Figure 5.27: Municipal WDR Wastewater Treatment Facilities in the Russian River Watershed

Table 5.10
Municipal WDR Wastewater Treatment Facilities in the Russian River

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name	Permit No.	Capacity (mgd)	Treatment Type/Disposal Method
Upper Russian River	Ukiah	Calpella County Water District	86-16	0.04	Aerated pond treatment, disinfection and percolation disposal
		Hopland Public Utility District	R1-2008-0003	0.09	Aerated pond treatment, disinfection, and percolation disposal
Middle Russian River	Geyserville	Geyserville Sanitation Zone	97-67	0.092	Aerated pond treatment, disinfection, and percolation disposal
	Santa Rosa	Santa Rosa Oakmont Wastewater Treatment Plant	88-52	0.065	Activated sludge, filtration, disinfection, spray irrigation or transfer to Laguna Treatment Plant
	Mark West	Airport-Larkfield-Wikiup Sanitation Zone	R1-2001-0069	0.9	Aerated pond treatment, microfiltration, disinfection, and spray irrigation 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 or irrigation to pasture land. The eventual receiving water for these discharges is groundwater. Through adequate treatment and disposal system design, which includes disinfection units and separation of the disposal area from streams, lakes, and reservoirs, the risk of transport of pathogens to surface waters is low.

Municipal wastewater disposed through surface 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 groundwater or 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 via shallow groundwater connection to surface water and unpermitted releases, depending on site specific conditions. Importantly, groundwater monitoring data to assess the water quality impact of wastewater discharges to land in the Russian River Watershed is currently lacking and should be addressed in future permit updates.

5.5.1.2 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 establish minimum standards for the regulation of biosolids using various risk assessment methodologies. (40 C.F.R. part 503.) 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, the Regional Water Board Executive Officer may require an Erosion Control Plan to assure containment of biosolids on the application site. Site specific conditions that may require submission of an Erosion Control Plan include, but are not limited to: sites where ground slopes are greater than 10 percent and areas with minimal riparian buffer between the biosolids application area and surface waters.

The City of Santa Rosa is the only public or private entity that is permitted to apply municipal biosolids to land in the Russian River Watershed. The City of Santa Rosa is currently land applies Class B biosolids at three city-owned properties: Alpha Farm, Brown Farm, and Stone Farm, all of which are located within the Laguna Hydrologic Subarea.

5.5.1.3 PRIVATE DOMESTIC WASTEWATER DISCHARGES TO LAND GREATER THAN 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. Typically, medium-sized systems, which have a capacity of 1,500 gpd to 20,000 gpd, have been 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 relatively diffuse occurrence in the watershed.

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 5.11 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. Importantly, groundwater monitoring data to assess the water quality impact of wastewater discharges to land in the Russian River Watershed is currently lacking and should be addressed in future permit updates.

Table 5.11
Private Domestic WDR Wastewater Treatment Facilities in the Russian River Watershed

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

Table 5.11 Private Domestic WDR Wastewater Treatment Facilities in the Russian River Watershed					
Hydrologic Area Name	**Hydrologic Subarea Name**	**Facility Name (Location)**	**Permit No.**	**Capacity (gpd)**	**Treatment Type/ Disposal Method**
		Rodney Strong Vineyard (Healdsburg)	88-064	60,000	Aerated pond treatment, disinfection, and percolation disposal
		The Farmhouse Inn (Forestville)	97-10-DWQ	3,285	Aerobic pretreatment and subsurface drip irrigation
	Austin Creek	Camp Royaneh (Cazadero)	97-10-DWQ	16,600	Aerated pond treatment and percolation disposal

5.5.1.4 WINE BEVERAGE AND FOOD PROCESSORS

Wine, beverage, and food (WBF) processing facilities located within the Russian River Watershed include, but are not limited to alcoholic (e.g., wineries, breweries, cider houses) and non-alcoholic beverage producers, fruit and vegetable processors, meat wrapping, and dairy product manufacturers. These facilities range in size from small in-home operated, non-commercial establishments to large, industrial or commercial establishments. The Regional Water Board currently regulates discharges to land from WBF processing facilities that could affect the quality of waters of the state through the issuance of facility-specific WDRs, enrollment under a general WDR for wineries, or issuances of conditional waivers of WDRs.

Process wastewater from these facilities is not expected to contain human pathogenic bacteria, and not considered a source of pathogenic bacteria in this TMDL. Domestic, human waste is commonly disposed of in individual onsite wastewater treatment systems (OWTS) separate from the process wastewater disposal systems and regulated by the local regulatory agency or by the Regional Water under WDRs. WBF processing facilities that combine process and domestic wastewater streams and dispose of the effluent through land application are potential sources of pathogen indicator bacteria in surface waters unless permit conditions contain disinfection requirements or disposal requirements to prevent the migration of pathogenic organisms in the effluent to groundwater and surface water.

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 (Table 5.12). 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 for WBF processors 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.

The concentration of bacteria associated with process wastewater effluent from food processors is not currently known. However, proper and appropriate sanitation safeguard implemented during food processing will ensure that bacterial contaminants do not enter the waste stream from the food processing stream. Domestic wastes discharges related to the operation of food processing facilities are separate from the process wastewater stream and treated in domestic waste treatment system permitted by the State or authorized by local permits or programs. Consequently, Regional Water Board staff has determined that these facilities are not expected to be a source of pathogens that contributes to the pathogen impairment in the watershed.

Table 5.12
Private Food Processors WDR Wastewater Treatment Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name (Location)	Permit No.	Design or Permitted Flow	Treatment Type/ Disposal Method
Middle Russian River	Warm Springs	Timber Crest Farms (Healdsburg)	No. 80-047	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).
	Laguna	Olive Leaf Press (Sebastopol)	R1-2012-0116 (Waiver)	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.
		Santa Rosa Meat and Poultry Company (Santa Rosa)	No. 79-019	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.
		Sonoma West Holdings-South (Sebastopol)	No. 88-071	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.
Lower Russian River	Guerneville	Manzana Products Company (Graton)	No. 85-079	25,000 gpd	Apple processing and canning plant that discharges wash water to a spray irrigation system during seasonal operations.

5.5.1.5 MOBILE HOME PARKS AND CAMPGROUNDS

There are 133 mobile home and special occupancy (RV) parks in the Russian River Watershed (CDHCD 2014). About two-thirds 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 individual septic systems. Figure 5.29 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). Septic systems associated with mobile home parks and campgrounds are commonly large capacity, located adjacent to surface water bodies, and often poorly maintained or overloaded. Consequently Regional Water Board staff has determined that these facilities, when they are poorly sited and inadequately operated and maintained, are a probable source of pathogenic bacteria in surface waters in the Russian River Watershed.

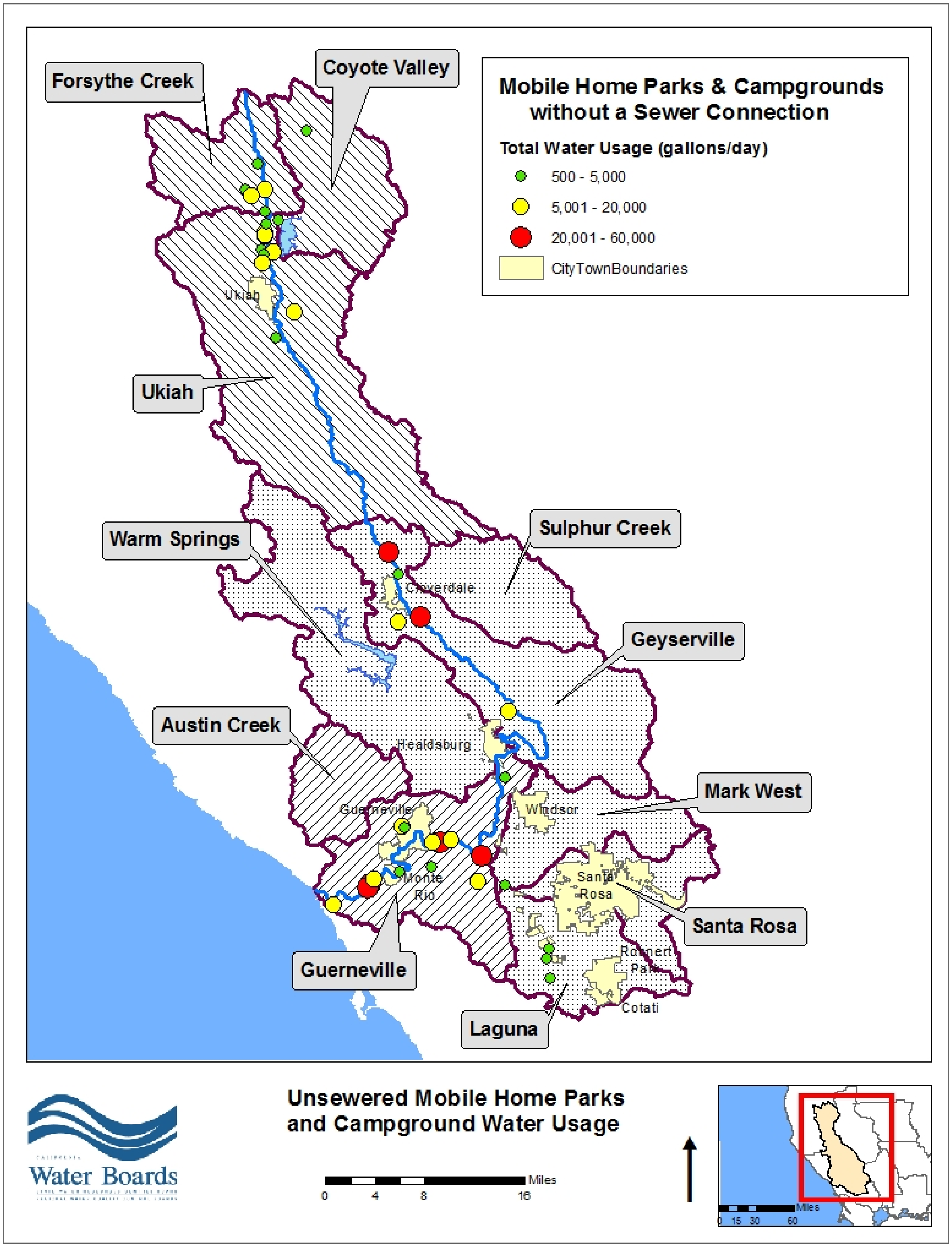


Figure 5.28: Unsewered Mobile Home Parks and Campgrounds

In summary, sources of fecal waste with the potential to enter the Russian River or its tributaries were analyzed in three different ways:

- By using DNA profiles to identify human, grazer or bird contributions where elevated fecal indicator bacteria were measured;
- By assessing indicator bacteria concentrations associated with different types of land uses; and
- 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.

The source analysis does not estimate the volume of fecal waste entering the Russian River Watershed from any given potential source, nor does it stratify the sources based on order of magnitude. But, the multiple lines of evidence provide an understanding of the locations within the watershed with greatest risk from pathogenic waste, the landuses of most concern, and the point and nonpoint sources deserving further evaluation. For example, with respect to the discharge of human-source fecal waste, the locations of greatest concern are within the Guerneville, Laguna, and Santa Rosa hydrologic subareas. With respect to the discharge of grazer-source fecal waste (e.g., livestock), the locations of greatest concern are also the Laguna, Guerneville, and Santa Rosa hydrologic subareas.

There is evidence of human and bovine fecal waste entering the waters of the Russian River Watershed during all times of the year, though higher during wet weather. Sewered and non-sewered developed areas are associated with exceedances of numeric targets for *E. coli* and enterococci bacteria, indicating a threat to recreational use. Similarly, agricultural areas are associated with exceedances of numeric targets for *E. coli* and enterococci bacteria.

Point and nonpoint sources of fecal waste within the Russian River Watershed are many and widespread. A significant number of potential sources are already covered under an individual or general permit and are controlled through use of treatment or best management practices.

From these multiple lines of inquiry, it is possible to determine several sources of fecal waste that have the potential to enter the Russian River and its tributaries and require site specific study/survey and management. Chapter 9 (Implementation) describes the implementation plan by which these site specific studies/surveys will be completed and new or upgraded management plans developed and implemented, including the existing and new regulatory mechanisms applicable to each source category.