CHAPTER 3
EVIDENCE OF IMPAIRMENT

This chapter describes the evidence of beneficial use impairment in the Russian River and its tributaries by pathogen indicator bacteria, summarizes the basis for the current Section 303(d) impairment listings, and describes more recent data.

In summary, all surface streams and river reaches in the Russian River Watershed are impaired by pathogen indicator bacteria, which are found in concentrations that exceed the bacteria water quality objective and U.S. EPA's national bacteria criteria for protection of recreation. Water contact recreation is a beneficial use of the Russian River Watershed throughout the year. Though, it is recognized that the greatest public use of the Russian River occurs during the summer months. The beneficial use impairment is based on data collected in both the wet and dry season, with the following findings:

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

3.1 ASSESSMENT OF FECAL COLIFORM BACTERIA DATA

Measured fecal coliform bacteria concentrations were used to assess whether the waterbody is supporting recreational (i.e., REC-1) beneficial use. North Coast Regional Water Board staff has collected water samples to measure fecal coliform bacteria concentrations at several beaches and streams in the Russian River Watershed since 1980. Measured fecal coliform bacteria concentrations were compiled from four (4) recreation beaches on the Russian River (i.e., Camp Rose Beach, Healdsburg Veteran's Memorial

Beach, Johnsons Beach, and Monte Rio Beach) and one tributary stream along a public park (i.e., Santa Rosa Creek at Railroad Street along the Prince Memorial Greenway).

Measured fecal coliform bacteria concentrations were compiled and compared to the numeric Basin Plan water quality objectives (WQOs) (Butkus 2013c). Only 15 percent of the 30-day periods within the data record have adequate fecal coliform concentrations measurements for application of the two-part Basin Plan water quality objective (i.e., median and 90th percentile from a 30-day period), since the objective requires 5 samples collected within a 30-day period. Water samples were simply not collected frequently enough to provide a complete assessment of impairment to REC-1 using the Basin Plan WQO. For example, adequate water samples were not collected in Santa Rosa Creek to assess exceedance of the Basin Plan WQO. Based on those available data, all four beaches assessed showed at least one 30-day period that exceeded the water quality objective, with 37% of the measurements overall exceeding the water quality objective (Butkus 2013c).

Fecal coliform bacteria storm water samples are also collected as a requirement of the Municipal Separate Storm Sewer Systems (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.

3.2 ASSESSMENT OF E. COLI BACTERIA DATA

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

Water samples were analyzed by IDEXX Colilert and were either undiluted or serially diluted 1:10, resulting in a minimum reporting limit of 1 or 10 MPN/100mL and a maximum reporting limit of 2,419 or 24,196 MPN/100mL. Sample measurements below and above analytical reporting limits are called censored data. When bacteria concentration results were beyond any of these limits, the reporting limit was substituted for censored data. Data were assessed using discrete 30-day periods were defined based on the Julian calendar date of each year (i.e., 30-day period 1 for Julian days 1-30; 30-day period 2 for Julian days 31-60, etc.).

Impairment was determined using *E. coli* bacteria concentrations measured at each specific sampling location using U.S. EPA's *E. coli* Recreational Water Quality Criteria of the geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL) for 32 illnesses per 1000 recreators The results of the assessment for *E. coli* bacteria concentrations are presented in Figure 3.1 and Table 3.1 for discrete 30-day averaging periods.

The results of the studies as referenced above verify there is evidence of impairment of REC-1 from *E. coli* in the Russian River Watershed at Foss Creek, Green Valley Creek, the Laguna de Santa Rosa, Matanzas Creek, and Santa Rosa Creek.

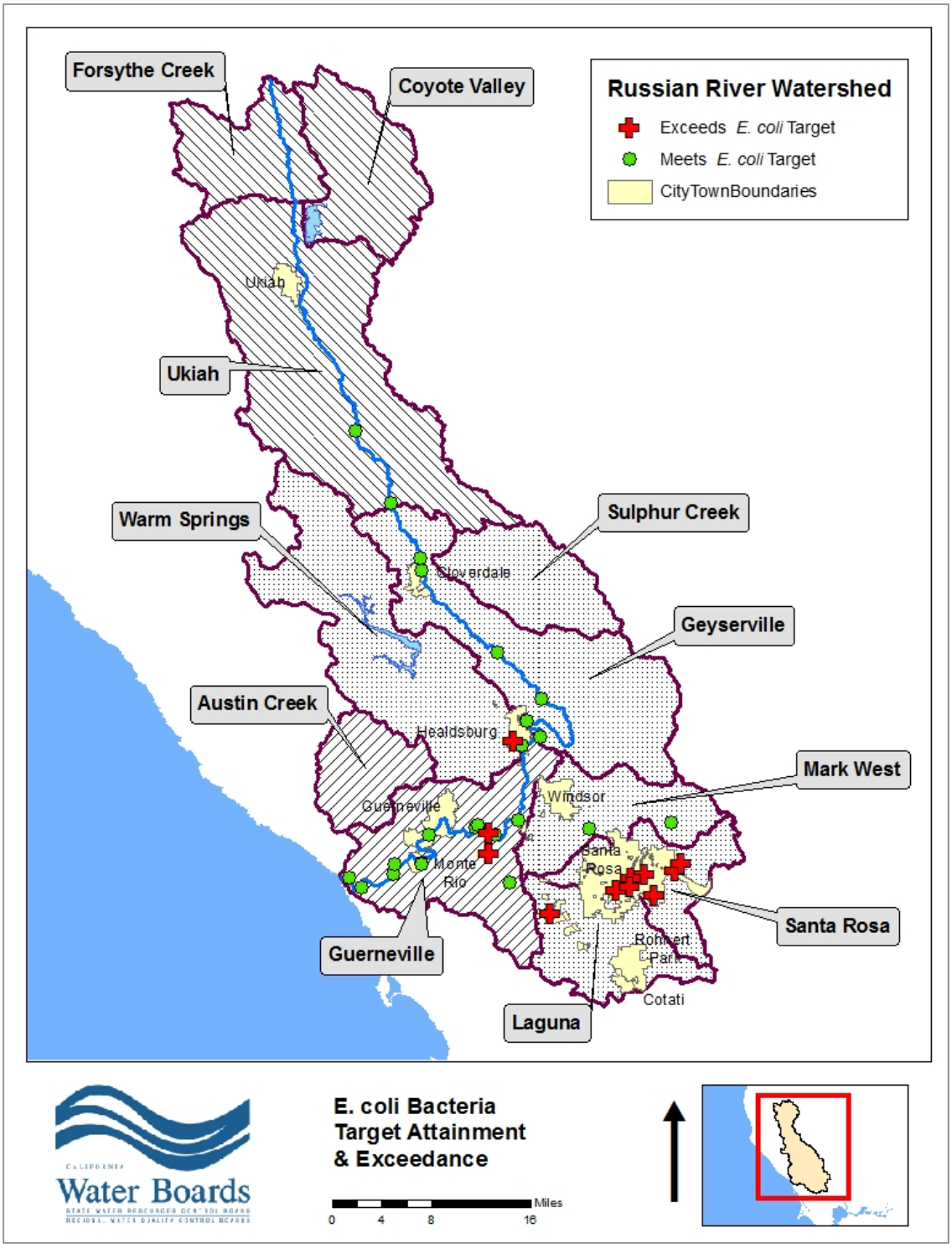

Figure 3.1: *E. coli* Bacteria Target Attainment & Exceedance

Table 3.1
***E. coli* Bacteria Target Attainment & Exceedance**

Hydrologic Area Name	Hydrologic Subarea Name	Location	Number of 30-day Periods Sampled	Number of Periods that Exceed Geomean or STV Targets[1]
Upper Russian River	Coyote Valley	East Fork Russian R.	1	0
	Forsythe Creek	Russian R. at East School Way	1	0
	Ukiah	Russian R. at Lake Mendocino Drive	1	0
		Russian R. at Vichy Springs Road	1	0
		Russian R. at Talmadge Road	1	0
		Russian R. at River Road (Hopland)	6	0
Middle Russian River	Geyserville	**Russian R. at Commisky Station Rd**	**18**	**1**
		Russian R. at Cloverdale River Park	9	0
		Russian R. at Crocker Rd	4	0
		Russian R. at Hwy 128 Bridge	**12**	**1**
		Russian R. at Jimtown Bridge	23	0
		Russian R. at Diggers Bend	12	0
		Russian R. at Camp Rose Beach	49	0
		Foss Creek at Matheson Street	**7**	**7**
	Laguna	**Laguna de Santa Rosa at Sebastopol Community Park**	**11**	**6**
	Santa Rosa	**Matanzas Creek at Doyle Park and Bethards Drive**	**8**	**7**
		Santa Rosa Creek at Wildwood Drive, Highway 12, upstream of Rincon Creek, at Alderbrook Drive, and at Railroad Street	**61**	**59**
	Mark West	**Mark West Ck at Old Redwood Hwy & Trenton Healdsburg Rd**	**11**	**3**
Lower Russian River	Guerneville	**Russian R. at Veterans Memorial Beach**	**55**	**2**
		Russian R. at Riverfront Park	18	0
		Russian R. at Steelhead Beach	**52**	**1**
		Russian R. at River Access Beach	**28**	**1**
		Russian R. at Hacienda Bridge	6	0
		Russian R. at Johnson's Beach	49	0
		Russian R. at Monte Rio Beach	**61**	**5**
		Russian R. at Casini Ranch Campground	12	0
		Russian R. at Bridgehaven Station	**12**	**2**
		Russian R. at Duncans Mills	**12**	**1**
		Russian R. at Jenner Boat Ramp	**17**	**2**
		Atascadero Creek at Green Valley Road	**6**	**4**
		Dutch Bill Creek	6	0
		Green Valley Creek at Martinelli Road and River Road	**5**	**4**

[1] Number of periods that exceed either the geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL)

* Locations that exceed the U.S. EPA criteria are shown in **BOLD** font

3.3 ASSESSMENT OF ENTEROCOCCI BACTERIA DATA

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

Water samples were analyzed by IDEXX Enterolert and were either undiluted or serially diluted 1:10, resulting in a minimum reporting limit of 1 or 10 MPN/100mL and a maximum reporting limit of 2,419 or 24,196 MPN/100mL. Sample measurements below and above analytical reporting limits are called censored data. When bacteria concentration results were beyond any of these limits, the reporting limit was substituted for censored data. Data were assessed using a static/discrete 30-day averaging approach (Butkus 2013b). Discrete 30-day periods were defined based on the Julian calendar date of each year (i.e., 30-day period 1 for Julian days 1-30; 30-day period 2 for Julian days 31-60, etc.).

Impairment was determined using enterococci bacteria concentrations measured at each specific sampling location using the enterococci criteria of the geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL) for 32 illnesses per 1000 recreators. The results of the assessment for enterococci bacteria concentrations are presented in Figure 3.2 and Table 3.2 for discrete 30-day averaging periods.

The results verify there is evidence of impairment of REC-1 from enterococci bacteria in the Russian River Watershed at Foss Creek, Green Valley Creek, the Laguna de Santa Rosa, and Santa Rosa Creek, and at the flowing location in the mainstem: Commisky Station Road, Cloverdale River Park, Jimtown bridge, Camp Rose Beach, Steelhead Beach, Monte Rio Beach, and Jenner Boat Ramp.

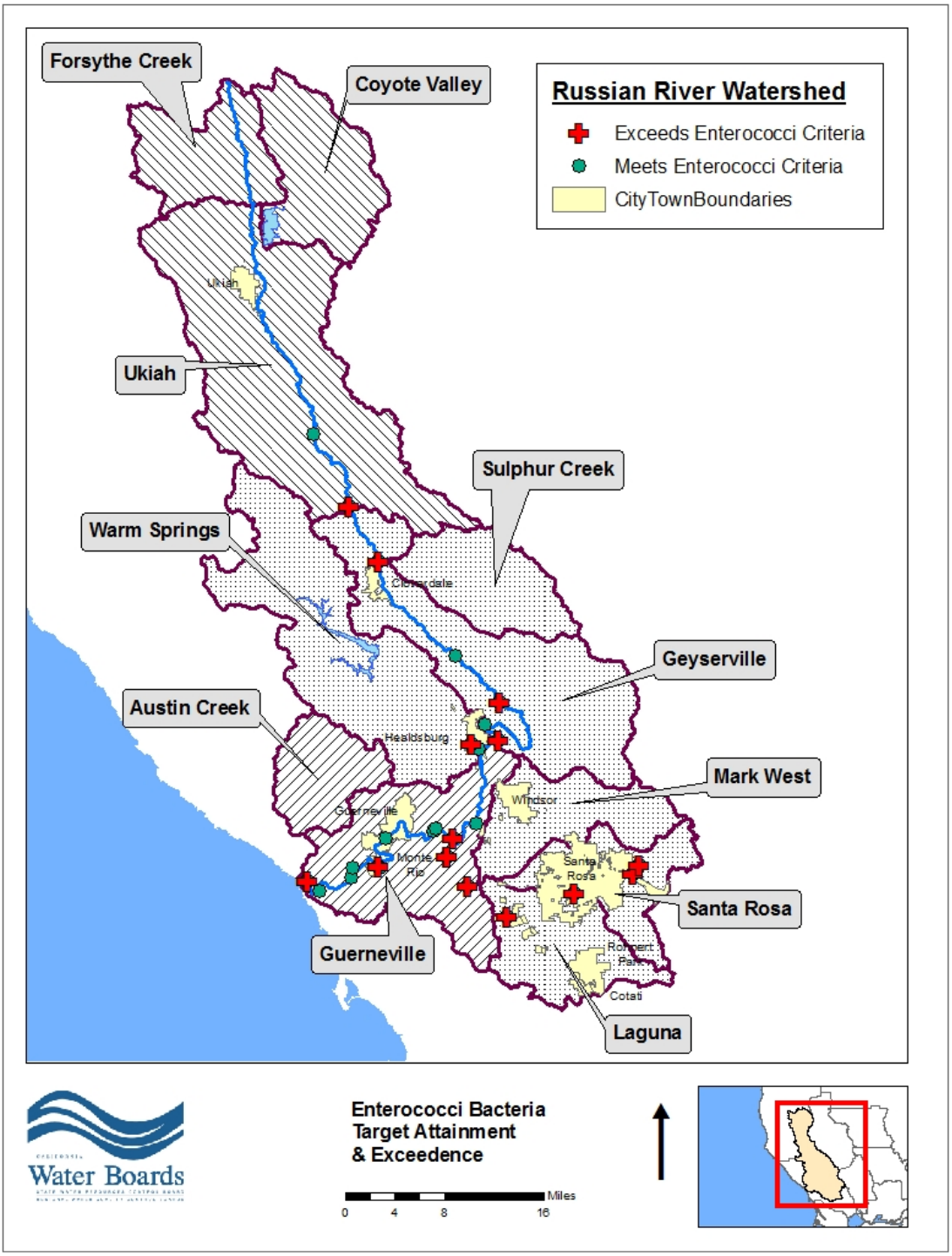

Figure 3.2: Enterococci Bacteria Criteria Attainment & Exceedance

Table 3.2
Enterococci Bacteria Target Attainment & Exceedance

Hydrologic Area Name	Hydrologic Subarea Name	Location	Number of 30-day Periods Sampled	Number of Periods that Exceed Geomean or STV Targets[1]
Upper Russian River	Coyote Creek	**East Fork Russian R.**	**1**	**1**
	Forsythe Creek	**Russian R. at East School Way**	**1**	**1**
	Ukiah	**Russian R. at Lake Mendocino Drive**	**1**	**1**
		Russian R. at Vichy Springs Road	1	0
		Russian R. at Talmadge Road	1	0
		Russian R. at River Road (Hopland)	**6**	**1**
Middle Russian River	Warm Springs	**Foss Creek at Matheson Street**	**5**	**5**
	Geyserville	**Russian R. at Commisky Station Rd**	**18**	**7**
		Russian R. at Cloverdale River Park	**27**	**9**
		Russian R. at Crocker Rd	**4**	**3**
		Russian R. at Hwy 128 Bridge	**12**	**2**
		Russian R. at Jimtown Bridge	**23**	**8**
		Russian R. at Diggers Bend	**11**	**3**
		Russian R. at Camp Rose Beach	**35**	**6**
	Laguna	**Laguna de Santa Rosa at Sebastopol Community Park**	**11**	**9**
	Santa Rosa	**Santa Rosa Creek at Wildwood Drive, Highway 12, and at Railroad Street**	**41**	**37**
	Mark West	**Mark West Creek at Trenton Healdsburg Rd**	**3**	**3**
Lower Russian River	Guerneville	**Russian R. at Veterans Memorial Beach**	**41**	**5**
		Russian R. at Steelhead Beach	**41**	**8**
		Russian R. at River Access Beach	28	0
		Russian R. at Hacienda Bridge	6	0
		Russian R. at Johnson's Beach	**25**	**1**
		Russian R. at Monte Rio Beach	**46**	**9**
		Russian R. at Casini Ranch Campground	**11**	**2**
		Russian R. at Bridgehaven Station	**11**	**2**
		Russian R. at Duncans Mills	**11**	**4**
		Russian R. at Jenner Boat Ramp	**17**	**6**
		Atascadero Creek at Green Valley Road	**5**	**3**
		Dutch Bill Creek	**6**	**2**
		East Fork Russian River	**1**	**1**
		Green Valley Creek at Martinelli Road and River Road	**11**	**10**

[1] Number of periods that exceed either the numeric target geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL)
* Locations that exceed the U.S. EPA criteria are shown in **BOLD** font

3.4. ASSESSMENT OF BACTEROIDES BACTERIA DATA

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

Bacteroides bacteria are a suitable indicator of a waterbody's bacteriological quality since the bacteria come from the gastrointestinal systems of mammals, they degrade rapidly outside of the body, and technology is available to trace the bacteria back to specific types of animals, including humans and domestic animals. For the purpose of this assessment, waters are determined not to be in a minimally disturbed condition if *Bacteroides* bacteria 16S rRNA gene copies are significant enough to be present in a water sample at levels above the laboratory reporting limit. The laboratory reporting limit is the level at which the laboratory is 95% confident that the *Bacteroides* bacteria 16S rRNA gene copies are present in the sample and are accurately counted. If the bacteria 16S rRNA gene copies are present and can be quantified with certainty, it is highly likely that fecal waste material is present and the bacteriological quality of the water has been degraded beyond a minimally disturbed condition.

Human-specific and bovine-specific *Bacteroides* bacteria data were compared to the current laboratory reporting limit of 60 gene copies/100mL for human-specific *Bacteroides* and 30 gene copies/100mL for bovine-specific *Bacteroides*. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker and the Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B. The median concentrations measured at each location in the Russian River Watershed are shown in Tables 3.3 through 3.6 and Figures 3.3 through 3.4.

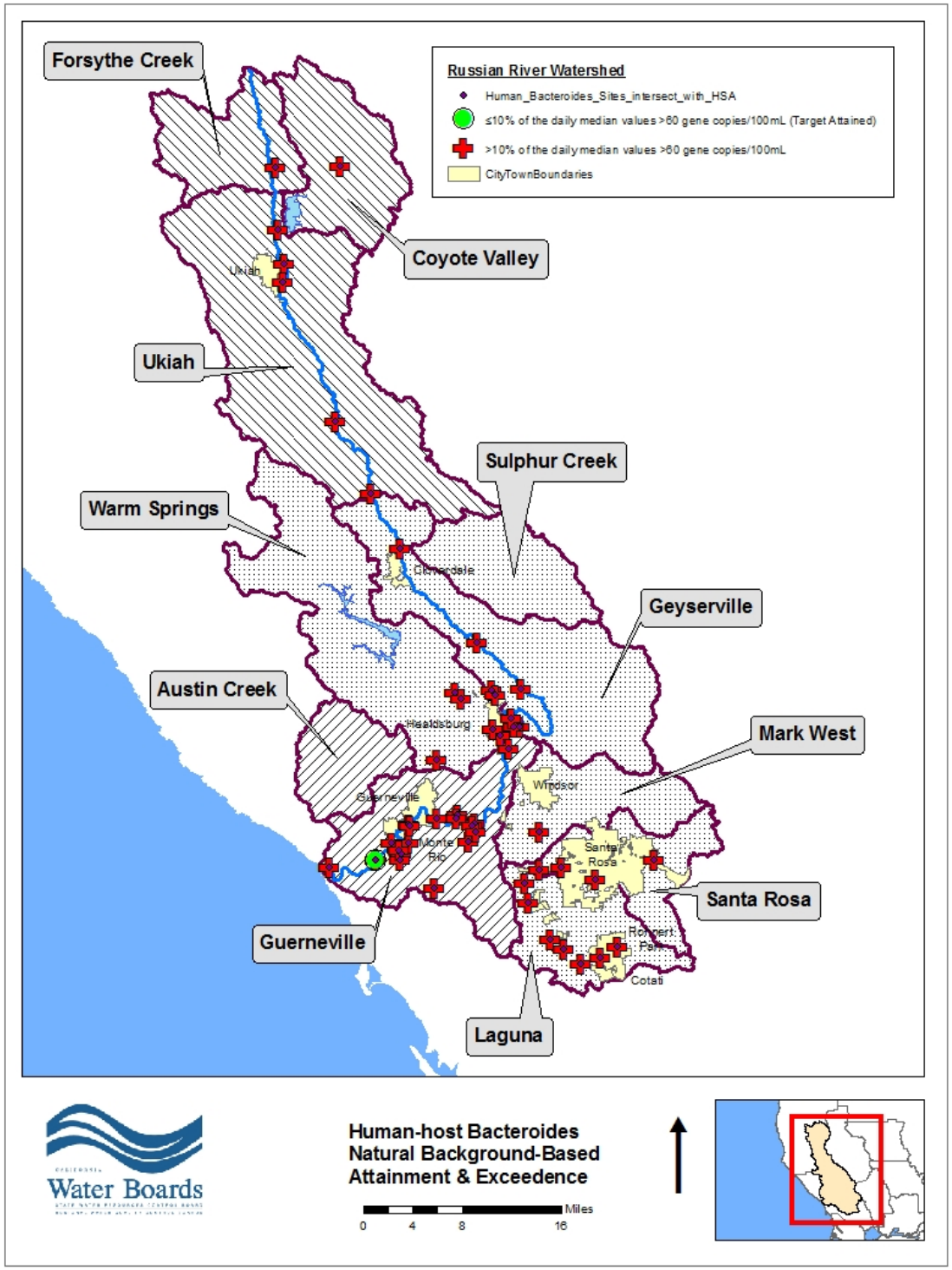

Figure 3.3: Human-specific *Bacteroides* Natural Background-based Target Attainment & Exceedance. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

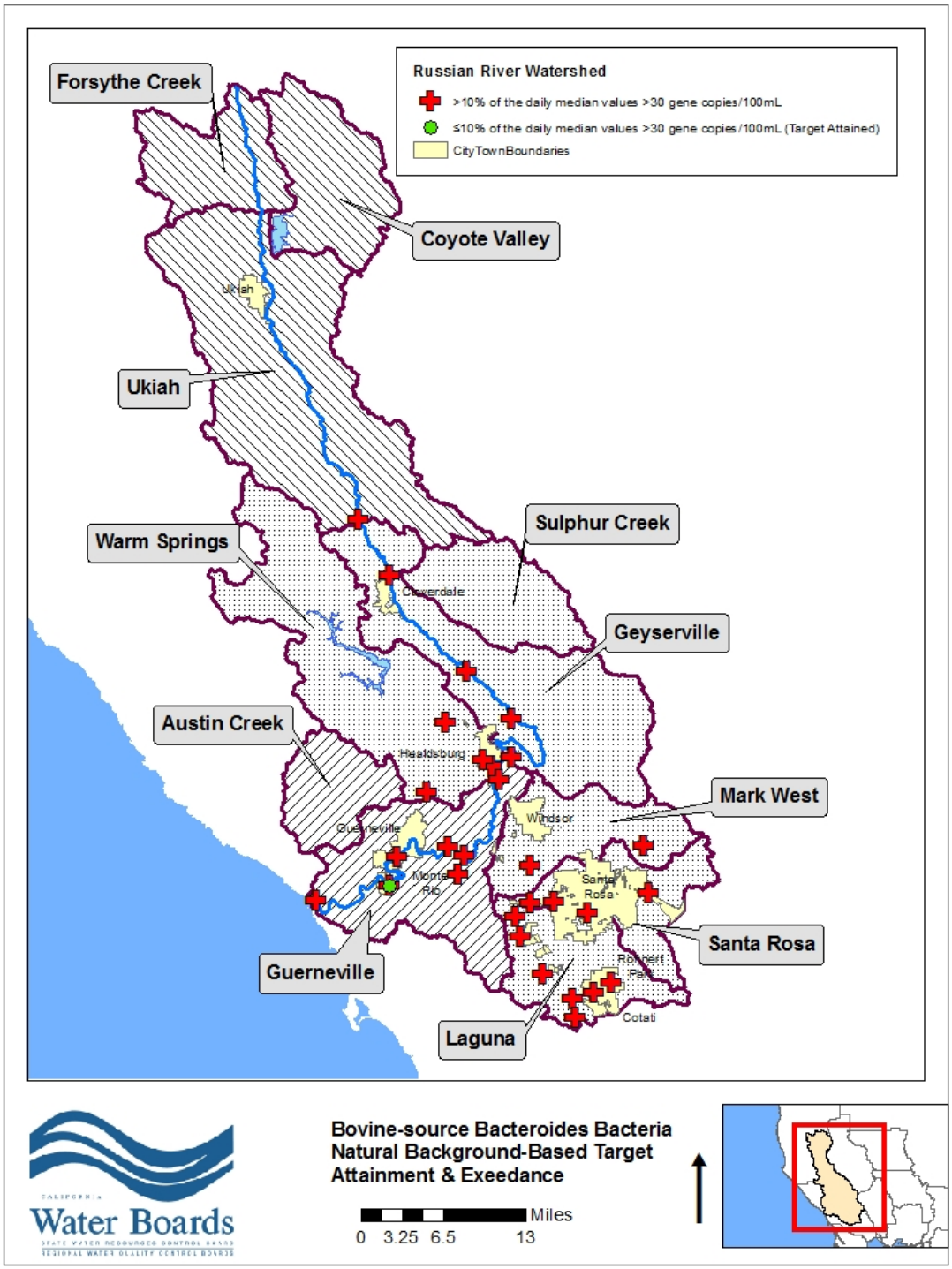

Figure 3.4: Bovine-specific Bacteroides Bacteria Natural Background-based Target Attainment & Exceedance. Bovine-specific Bacteroides were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

Table 3.3
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River
Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B

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

Table 3.4
Bovine-specific *Bacteroides* Attainment & Exceedance in the Russian River
Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Russian River Location	Median Bovine-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 30 gene copies/100mL
Middle Russian River	Geyserville	Commisky Station Road, Cloverdale	5,413	2	2
		River Park, Cloverdale	710	2	2
		Hwy 128 Bridge, Geyserville	236	2	2
		Jimtown Bridge, Healdsburg	116	2	2
Lower Russian River	Guerneville	Camp Rose Beach, Healdsburg	286	2	2
		Veteran Memorial Beach, Healdsburg	381	2	2
		Steelhead Beach, Forestville	23,684	2	2
		River Access Beach, Forestville	14,710	2	2
		Johnson's Beach, Guerneville	85	7	7
		Monte Rio Beach, Monte Rio	762	10	10
		Public Boat Ramp, Jenner	2,682	2	2

Table 3.5
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River Tributaries
Human-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Name	Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Middle Russian River	Geyserville	Foss Creek	Matheson Street, Healdsburg	37,346	2	2
		Unnamed Creek	Lambert Bridge Road, Healdsburg	5,257	2	2
		Unnamed Creek	Fitch Mountain Road, Healdsburg	238	6	5
		Unnamed Creek	Fredson Road, Healdsburg	8,580	5	5
		Unnamed Creek	West Dry Creek Road, Healdsburg	4,040	5	5
		Unnamed Creek	Alexander Valley Road, Healdsburg	2,031	5	4
		Unnamed Creek	Redwood Drive, Healdsburg	2,310	5	5
		Unnamed Creek	Limerick Road, Healdsburg	20,000	4	4
	Warm Springs	Palmer Creek	Palmer Creek Road, Healdsburg	2,781	2	1
	Laguna	Blucher Creek	Lone Pine Road, Cotati	18,022	2	2
		Copeland Creek	Commerce Blvd, Rohnert Park	19,928	2	2
		Crane Creek	Snyder Ln., Rohnert Park	26,703	2	2
		Gossage Creek	Stony Glen Lane, Cotati	29,902	2	2

Table 3.5
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River Tributaries
Human-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Name	Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Middle Russian River	Laguna	Laguna de Santa Rosa	Community Center, Sebastopol	7,469	2	2
		Unnamed Creek Unnamed Creek	Sanford Road, Sebastopol	1,576	4	4
		Unnamed Creek	Daywalt Road, Cotati	37,632	2	2
	Santa Rosa	Abramson Creek	Willowside Rd Path, Santa Rosa	273,401	4	4
		Piner Creek	Fulton Road, Santa Rosa	12,394	2	2
		Santa Rosa Creek	Hwy 12, Santa Rosa	2,727	2	2
		Santa Rosa Creek	Railroad Street, Santa Rosa	32,909	2	2
		Unnamed Creek	River Road, Fulton	2,759	4	4
	Mark West	Van Buren Creek	Erland Road, Santa Rosa	2,089	2	1
Lower Russian River	Guerneville	Dutch Bill Creek	Main Street, Monte Rio	416	2	1
		Green Valley Creek	Martinelli Road, Forestville	17,016	2	2
		Mays Creek	Neeley Road, Guerneville	1,325	2	2
		Unnamed Creek	Summerhome Park Rd, Forestville	7,975	4	4
		Unnamed Creek	Trenton Road, Forestville	48,200	5	5
		Unnamed Creek	Del Rio Court, Forestville	3,460	3	3
		Unnamed Creek	River Road, Rio Nido	3,600	3	2

Table 3.5
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River Tributaries
Human-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Name	Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Lower Russian River	Guerneville	Unnamed Creek	Foothill Drive, Monte Rio	371,000	1	1
		Unnamed Creek	Duncan Road, Monte Rio	353	3	2
		Unnamed Creek	Old Monte Rio Road, Monte Rio	25,100	4	4
		Unnamed Creek	Main Street, Monte Rio	1,392	5	4
		Unnamed Creek	Moscow Road, Duncans Mills	<60	1	0
		Unnamed Creek	Lakeside Ave, Camp Meeker	9,090	4	4

Table 3.6
Bovine-specific *Bacteroides* Bacteria Attainment & Exceedance in Russian River Tributaries. Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary	Location	Median Bovine-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 30 gene copies/100mL
Middle Russian River	Geyserville	Foss Creek	Matheson St., Healdsburg	8,668	2	1
		Unnamed Creek	Lambert Bridge Road, Healdsburg	453	2	1
		Unnamed Creek	Limerick Rd., Healdsburg	1,966	4	4
	Warm Springs	Palmer Creek	Palmer Creek Road, Healdsburg	106	2	1
	Laguna	Blucher Creek	Lone Pine Road, Cotati	177,248	2	2
		Copeland Creek	Commerce Blvd, Rohnert Park	51,685	2	2
		Crane Creek	Snyder Ln., Rohnert Park	23,602	2	2
		Gossage Creek	Stony Glen Lane, Cotati	76,895	2	2
		Laguna de Santa Rosa	Community Center, Sebastopol	514	2	1
		Unnamed Creek	Sanford Road, Sebastopol	482	4	4
		Unnamed Creek	Daywalt Road, Cotati	867,503	2	1
	Santa Rosa	Abramson Creek	Willowside Road Path, Santa Rosa	425,164	4	4
		Piner Creek	Fulton Road, Santa Rosa	3,274	2	2
		Santa Rosa Creek	Hwy 12, Santa Rosa	181	2	2
		Santa Rosa Creek	Railroad St., Santa Rosa	7,765	2	2
		Unnamed Creek	River Road, Fulton	768	4	4
	Mark West	Van Buren Creek	Erland Road, Santa Rosa	2,265	2	1
Lower Russian River	Guerneville	Dutch Bill Creek	Main Street, Monte Rio	15	2	0
		Green Valley Creek	Martinelli Rd., Forestville	72	2	2
		Mays Creek	Neeley Road, Guerneville	608	2	2

Assessment of the human-specific *Bacteroides* bacteria data shows that bacteria from human waste are widespread throughout the Russian River Watershed. Human-specific *Bacteroides* bacteria are present at levels that exceed the current laboratory reporting limit (60 gene copies/100mL for human-specific *Bacteroides*) in all 17 mainstem locations, and in all but one of the 35 tributary locations sampled by Regional Water Board staff. Of the 179 samples collected in these 52 sites, 95% of the samples exceed the analytical reporting limit, meaning that 95% of the samples contain detectable levels of human waste.

For bovine-specific *Bacteroides* bacteria, quantifiable levels were found in all 11 mainstem locations, and in all but one of the 19 tributary locations. Of the 83 samples collected, 95% of the samples also exceed the analytical reporting limit (30 gene copies/100mL for bovine-specific *Bacteroides*), meaning that 95% of the samples contain detectable levels of bovine waste.

These results demonstrate that human and domestic animal fecal wastes are present in amounts that indicate the bacteriological quality of the Russian River and its tributaries is degraded beyond minimally disturbed conditions exceeding the natural background narrative bacteria water quality objective.

3.5 ASSESSMENT OF PATHIGENIC SPECIES

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

3.5.1 PATHOGENIC BACTERIA DETECTIONS

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

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

originate from fecal waste sources and individual pathogenic species are found within these taxa groups.

The human health risk associated with the presence of pathogenic bacteria is unknown since detection of a pathogenic species does not necessarily indicate that illness will occur. Some pathogenic bacteria are only pathogenic under certain circumstances, such as contact with an open wound. Additionally, there can be more than one strain of a particular bacterium species, and not all strains are pathogenic. The results of the PhyloChip™ analysis, as presented in Table 3.7, show a list of bacteria species found in the Russian River Watershed that have the potential to be human pathogens and cause illness.

Table 3.7
Potential Human Pathogens Detected in the Russian River Watershed

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

3.5.2 CRYPTOSPORIDUM AND GIARDIA DETECTIONS

The Sonoma County Water Agency conducted monitoring for *Cryptosporidium* and *Giardia* oocysts in the Russian River near Wohler Bridge from 2004 through 2006 as part of their Sanitary Survey (Table 3.8)(Palencia & Archibald 2013). The SCWA found three *Giardia* cysts and five *Cryptosporidium* oocysts out of 660 L of water from 48 samples. *Giardia lamblia* and *Cryptosporidium parvum* are pathogens that can cause gastrointestinal illness. The low number of *Cryptosporidium* oocysts detected meant no additional treatment is needed for the drinking water collected from the Russian River near Wohler Road (71 FR 775).

Table 3.8
***Cryptosporidium* and *Giardia* Detections in the Russian river near Wohler Bridge (data from Palencia and Archibald, 2013)**

Collection Date	*Cryptosporidium* (oocysts/L)	*Giardia* (cysts/L)
3/9/2004	0.1	-
5/18/2004	-	0.1
12/26/2004	0.2	-
3/2/2005	0.1	0.1
3/23/2005	0.1	-
8/8/2005	0.1	0.1
1/10/2006	-	0.1

3.6 SECTION 303(D) IMPAIRED WATER LISTINGS

The 2012 Section 303(d) List of Impaired Waters was approved by the Regional Water Board on August 14, 2014 and State Water Board on April 8, 2015. The list was approved by U.S. EPA on July 30, 2015.[1] The List identifies six waterbody-pollutant pairs in the Russian River Watershed as not attaining the Bacteria Water Quality Objective and therefore, not supporting the REC-1 beneficial use. In order to determine whether a waterbody should be listed as impaired on the 2012 Section 303(d) List, instream measurements of *E. coli* and fecal coliform bacteria concentrations collected and submitted prior to August 2010 were assessed. The data used in the listing decisions available online at http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/table_of_contents.shtml. The data assessment that supports the official 2012 Section 303(d) listings was valid, and the listings provide a line of evidence of pathogen impairment in the Russian River Watershed. The listed waterbodies are the Russian River at Veterans Memorial Beach, Russian River between the confluences of Fife Creek in Guerneville and Dutch Bill Creek in Monte Rio, an unnamed stream near Healdsburg at Fitch Mountain, Laguna de Santa Rosa, Santa Rosa Creek , Green Valley Creek, and Dutch Bill Creek.

For the Section 303(d) List assessment, *E. coli* data were compared against the draft California Department of Health Services (CDHS 2006) guidance for posting advisories at fresh water beaches. The draft guidance identifies a single sample concentration level of 235 MPN/100 mL as a threshold for posting a beach advisory to inform swimmers of

[1] The list was partially approved by U.S. EPA on June 26, 2015.

potential risk. The draft guidance also recommends a 30-day average value of 126 MPN/100 mL applied on a rolling basis.

State Water Board staff determined that the 2012 U.S. EPA Recreational Water Quality Criteria (U.S. EPA 2012) would not be applied to data submitted for the 2012 Integrated Report cycle, as the data had already been assessed and lines of evidence developed by the time the criteria were finalized. In the interest of expedience, State Water Board staff directed the Regional Water Boards to move forward with the existing lines of evidence and to utilize the 2012 U.S. EPA criteria for the next Integrated Report cycle. Thus, the evaluation guideline for *E. coli* utilized to interpret the Basin Plan objective is cited from the "California Department of Health Services Draft Guidance for Fresh Water Beaches" (CADHS 2011), which is the same as that recommended in the U.S. EPA document "Ambient Water Quality Criteria for Bacteria-1986" (U.S. EPA 1986).

Since that assessment was completed, additional data have been collected, criteria have been updated, and assessment methods have improved. *E. coli* data used in the listing process were also used for this TMDL project. Data were reassessed in accordance with improved criteria and methods, and the results are described in Section 3.2. Data collected both before and after 2010 are assessed in this TMDL project.

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

3.7 PUBLIC HEALTH ADVISORIES

Local agencies use information on pathogen indicator concentrations to post streams with public health advisories that warn against swimming and water recreation. The City of Santa Rosa posts a permanent advisory for swimming in Santa Rosa Creek at Prince Memorial Greenway. This advisory is based on pathogen indicator concentrations measured in the stream near the Railroad Street Bridge. The Sonoma County Department of Health Services uses indicator bacteria data to temporarily post Russian River beaches when concentrations exceed thresholds during the summer recreation season. Table 3.9 lists the number of days with posted advisories each year since 2001 (Tyler 2013; SCDHS 2014). Since 2001, Russian River beaches have been posted with advisories 157 days.

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

Table 3.9
Russian River Beach Advisories Issued by the Sonoma Co. Department of Health Services

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

In summary, the potential risk of illness to recreational users of the Russian River and its tributaries has been assessed using a variety of fecal indicator bacteria, including genetic markers that indicate whether fecal contributions to the water column are from human or animal sources. Each fecal indicator has its strengths and its weaknesses. As such, this assessment uses multiple lines of evidence to determine the spatial and temporal extent of beneficial use impairment. In conclusion, there is evidence of fecal waste entering the waters of the Russian River Watershed at locations throughout the whole watershed. The recreational beneficial use exists in the Russian River Watershed throughout the year, not only during summer months. The discussion presented in Chapter 5 (Source Analysis) further elaborates on the spatial and temporal extent of the impairment, as derived from an assessment of source categories, their presence throughout the watershed, and the discharge mechanism (e.g., storm water discharge).