

# **TECHNICAL REPORT**

## **Coastal Pathogen Project Synthesis Report**

**Planning Unit**

**Planning and Stewardship Division**

**North Coast Regional Water Quality Control Board**

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# 1. Introduction

The purpose of this Synthesis Report is to provide an overview of the Coastal Pathogen Project and present the findings of the various studies conducted to support the Coastal Pathogen Implementation Plan.

## 1.1. Coastal Pathogen Project Background

Section 303(d) of the Clean Water Act requires states to develop a list of waterbodies where required pollution control mechanisms are not sufficient or stringent enough to meet water quality standards applicable to such waters (known as the Section 303(d) List). The Coastal Pathogen Project (CPP) was developed after 17 waterbodies in Humboldt, Mendocino, and Sonoma Counties were placed on the Section 303(d) List in 2012 for impairment of Water Contact Recreation (REC-1) and/or Shellfish Harvesting (SHELL) beneficial use (Table 1) (State Water Resources Control Board, 2022). The CPP was conducted from 2016 to 2023.

**Table 1 Coastal Pathogen Project Impaired Waterbodies**

Impaired Waterbody	Waterbody ID (WBID)	Impaired Beneficial Use
Eureka Plain HU, Elk River Watershed, Lower Elk River and Martin Slough <sup>a</sup>	CAR1100004020140113044906	REC-1
Eureka Plain HU, Gannon Slough <sup>a</sup>	CAR1100005219990617095337	REC-1
Eureka Plain HU, Jolly Giant Creek <sup>a</sup>	CAR1100005119990617151229	REC-1
Mad River HU, Norton Creek <sup>a</sup>	CAR1091002019990617100545	REC-1
Trinidad HU, Little River HA <sup>a</sup>	CAR1082001219990617111952	REC-1
Clam Beach (near Mad River mouth) <sup>a</sup>	CAC1091001120110712113517	SHELL
Clam Beach (near Strawberry Creek) <sup>a</sup>	CAC1091002020070319150720	REC-1 & SHELL

<b>Impaired Waterbody</b>	<b>Waterbody ID (WBID)</b>	<b>Impaired Beneficial Use</b>
Luffenholtz Beach <sup>a</sup>	CAC1081001220070319155307	REC-1 & SHELL
Moonstone County Park <sup>a</sup>	CAC1081001220070319154339	SHELL
Old Home Beach <sup>a</sup>	CAC1081001220120426090438	SHELL
Trinidad State Beach <sup>a</sup>	CAC1081001220070319161337	REC-1 & SHELL
Big River Beach at Mendocino Bay <sup>b</sup>	CAC1133004520081013235216	SHELL
Caspar Headlands State Beach <sup>b</sup>	CAC1133004520081029154329	SHELL
Hare Creek Beach <sup>b</sup>	CAC1132004120081013222913	SHELL
MacKerricher State Park (near Virgin Creek) <sup>b</sup>	CAC1132005720110712144923	SHELL
Pudding Creek Beach <sup>b</sup>	CAC1132005020081013224604	SHELL
Campbell Cove <sup>c</sup>	CAC1152100020070319132228	REC-1 & SHELL

<sup>a</sup>Impaired Waterbody is located in Humboldt County

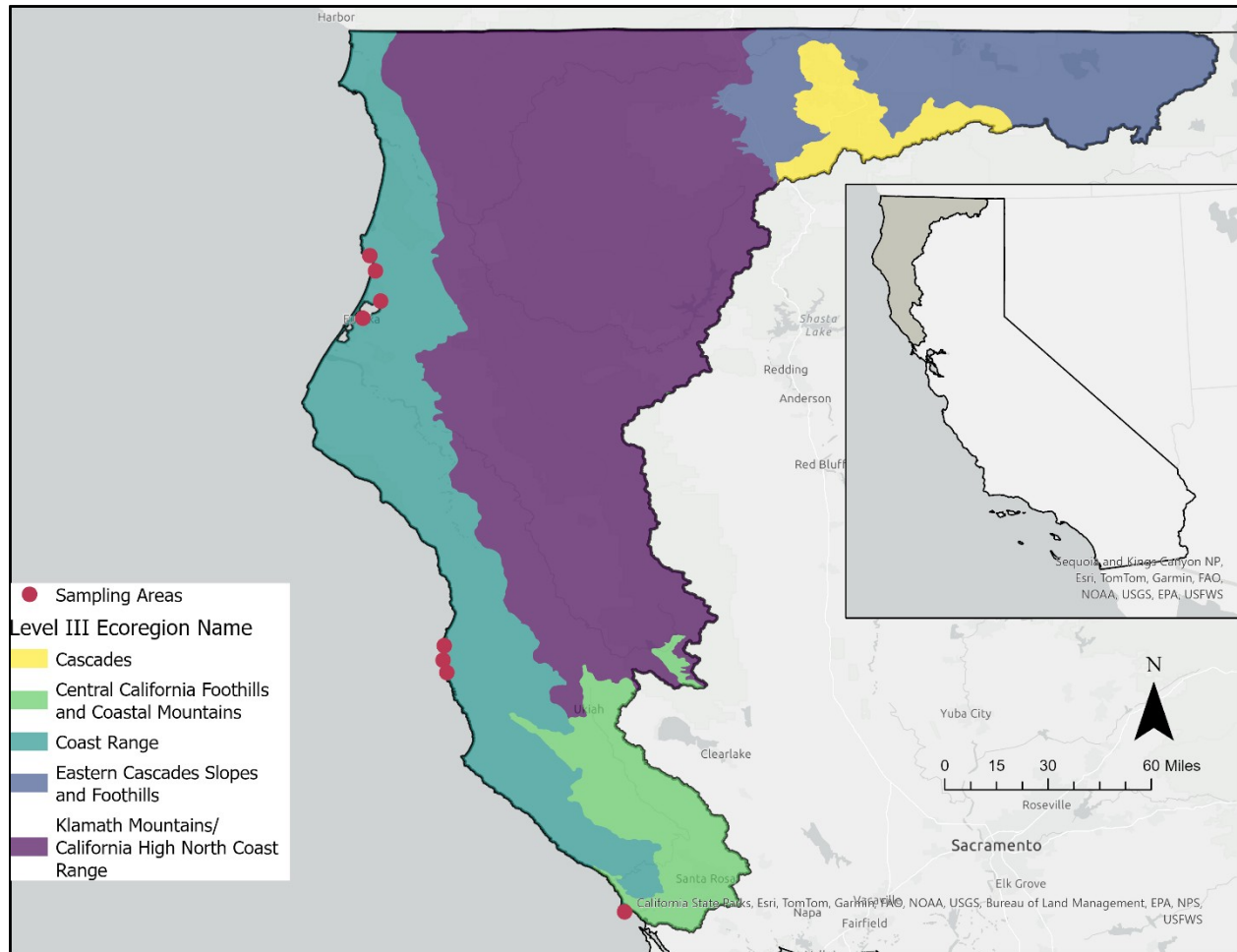
<sup>b</sup>Impaired Waterbody is located in Mendocino County

<sup>c</sup>Impaired Waterbody is located in Sonoma County

## **1.2. Coastal Pathogen Project Setting**

All the waterbodies sampled under the CPP are in the Coast Range Ecoregion (Figure 1). Within the North Coast Region of California the Coast Range ecoregion lies within

100 km (62 miles) of the coast and encompasses the entire coast extending from the border of Del Norte County with the State of Oregon in the North to Bodega Bay in Sonoma County at the southernmost tip of the North Coast region. Ecoregions are areas with generally similar ecosystems, and are identified by analyzing the patterns and composition of geology, landforms, soils, vegetation, climate, land use, wildlife, and hydrology (United States Environmental Protection Agency, 2021).



**Figure 1 The Coast Range Ecoregion in the North Coast Region with the Coastal Pathogen Project Sampling Areas Displayed**

### **1.2.1. Climate**

The climate in the areas sampled in Humboldt, Mendocino, and Sonoma Counties is influenced by the Pacific Ocean as well as the topography of the Coast Range Ecoregion which is characterized by coastal mountain ranges and valleys ranging from sea level to 1000 meters in elevation (Sohl, 2012). The areas sampled in Humboldt County have a maritime climate which is characterized by mild temperatures with cool summers and cool winters with most of the precipitation occurring in winter with an

average mean annual precipitation ranging from 32 to 98 inches (North Coast Regional Water Quality Control Board, 2005). The areas sampled in Mendocino County have a Mediterranean climate with moderate temperatures and are characterized by a pattern of low-intensity rainfall in the winter and cool, dry summers with coastal fog (North Coast Regional Water Quality Control Board, 2005). The sampled area receives an average annual rainfall of 40-65 inches and snowfall is rare and hydrologically insignificant. The waterbody sampled in Sonoma County is in an area with Mediterranean climate and receives approximately 34 inches of precipitation per year (North Coast Regional Water Quality Control Board, 2005).

### **1.2.2. Hydrology**

In Humboldt County the waterbodies sampled are in an area that encompasses tributary waterbodies to the Pacific Ocean from Humboldt Bay north to, and including, Redwood Creek and all groundwater within that area. Major river systems in this area are the Mad River and Redwood Creek. Other major waterbodies include Humboldt Bay and Mad River Slough, numerous coastal lagoons (Big Lagoon, Stone Lagoon, Freshwater Lagoon), and coastal streams (Elk River, Freshwater, Jacoby, and Maple Creek, and Little River) (North Coast Regional Water Quality Control Board, 2005). The terrain is elevated hillslope in the east with coastal plain to the west with surface water flowing from the elevated areas in the east via the coastal plain to Humboldt Bay and the Pacific Ocean in the west. In Mendocino County the waterbodies sampled are in a region that drains from east to west and major hydrological systems in the area are Pudding Creek, the Noyo River, Hare Creek, Mill Creek, Big River, and the Big River estuary (North Coast Regional Water Quality Control Board, 2005). The waterbody sampled in Western Sonoma County in the Bodega Harbor area with the main waterbodies being Salmon Creek, Americano Creek, and Stemple Creek along with their associated estuaries and summertime flows in these waterbodies are low to non-existent (North Coast Regional Water Quality Control Board, 2005).

### **1.2.3. Land Use**

In the areas sampled in Humboldt County the main land use is timber production, with agricultural uses in the non-forested areas consisting primarily of grazing and dairies. Areas around Humboldt Bay are predominantly pastureland with limited cultivation and Humboldt Bay is an important commercial and recreational shellfish growing and harvesting area (North Coast Regional Water Quality Control Board, 2005). Urbanized areas include Trinidad, McKinleyville, and Blue Lake in the northern portion of the areas sampled and Arcata and Eureka in the southern portion, closer to Humboldt Bay. Rural residential developments are scattered throughout the timber/grazing interface and the upper hillslope areas of predominant timber production are populated to varying degrees (North Coast Regional Water Quality Control Board, 2005). The waterbodies sampled in Mendocino County are all in State Parks in areas that are sparsely

populated with most of the land use being timber growth and harvesting with other smaller areas used for ranching (North Coast Regional Water Quality Control Board, 2005). The waterbody sampled in Sonoma County is in a State Park in a protected area surrounded by other State or Regional Parks. Upstream areas contain rangeland grazing and dairies and some timber production with minimal urban development (North Coast Regional Water Quality Control Board, 2005).

## 2. Coastal Pathogen Project Monitoring Studies

Once a waterbody is identified on the Section 303(d) List as impaired, a more detailed assessment of existing data is conducted, including assessment of sources of pollution. Studies are conducted to assess existing data, and any additional data collected to obtain additional information and to identify pollution sources. The REC-1 and SHELL beneficial use impairments are caused by pathogen pollution from feces. To address this, several studies under the CPP evaluated bacterial water quality and identified controllable sources of fecal pollution in the impaired waterbodies.”. These studies involved the collection of fecal indicator bacteria (FIB), microbial source tracking (MST), land cover, and land use data from the 17 impaired waterbodies as well as 26 additional streams representing known sources of fecal pollution in the impaired waterbody areas.

FIB are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. Although they are generally not harmful themselves, they indicate the possible presence of pathogenic bacteria, viruses, and protozoans that also live in human and animal digestive systems (United States Environmental Protection Agency, 2012). Therefore, their presence in streams suggests that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk (United States Environmental Protection Agency, 2012). MST identifies fecal sources of water contamination by detecting microbes found in the feces of humans, cattle, pigs, birds, poultry, or other animals (United States Geological Survey, 2024). Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Land use shows how people use the landscape – whether for development, conservation, or mixed uses (National Oceanic and Atmospheric Administration, 2024). Together, land cover and land use provide information on the impacts of natural phenomenon and human use of the landscape on water quality.

A list of the studies of the Coastal Pathogen Project is provided below followed by a brief description and key findings of water quality and source assessment analysis conducted for each study.

- Impaired Streams Monitoring Study
- Impaired Beaches Monitoring Study
- Source Assessment Study
- Jolly Giant Creek Monitoring Study
- Humboldt County Advanced Protection Management Program (APMP) Study
- Humboldt Waterkeeper Study



## 2.1. Impaired Streams Monitoring Study

The Impaired Streams Monitoring Study was conducted by the North Coast Regional Water Quality Control Board (North Coast Water Board) to calculate exceedances of the REC-1 and SHELL water quality objectives (objectives) and to identify sources of fecal waste sources to the six Humboldt County impaired streams. All streams were sampled from February 2016 to January 2018 during both wet and dry weather periods. FIB (*Escherichia coli* [*E. coli*] and enterococci) and MST (dog-, gull-, human-, and ruminant-specific markers) data were collected from all six impaired streams. In 2023 North Coast Water Board staff analyzed the following data to determine the percent coverage of land cover and land use, and the presence of dairy or non-dairy cattle grazing within a 5-kilometer radius above each impaired stream sampling station – 1) land cover data from the National Land Cover Database (NLCD), 2) land use data from the most recent publicly available county parcel data, publicly available assessor parcel number (APN) parcel ownership information, and 3) facility information for dairies under the dairy permit provided in the California Integrated Water Quality System Project (CIWQS) database. A list of impaired stream sampling stations, their station codes, and salinity type is provided below.

- Elk River at Highway 101 (110EL1278) - Saline
- Martin Slough at Pine Hill Road (110MS1481) - Saline
- Gannon Slough a Highway 101 (110GS1625) - Saline
- Jolly Giant Creek at Samoa Boulevard (110JG0264) - Freshwater
- Norton Creek at Highway 101 (109NR1488) - Freshwater
- Little River at Highway 101 (108LR0663) - Saline

All samples were collected under the Coastal Pathogen Project Quality Assurance Project Plan (QAPP) which details the standard operating procedures, and quality assurance and quality control procedures used during sample collection and analysis (North Coast Regional Water Quality Control Board, 2015). FIB and MST data collected under this study are available in the California Environmental Data Exchange Network (CEDEN) database ([https://ceden.org/about\\_us.shtml](https://ceden.org/about_us.shtml)).

Samples collected from five of the six impaired streams had at least one exceedance of the Statistical Threshold Value (STV) element of the REC-1 objective in both the summer and winter assessment periods. However, samples collected from the Little River at Highway 101 sampling station had zero exceedances of the STV element of the REC-1 objective in either assessment period. Insufficient data were collected from all sampling locations to calculate exceedances of the geometric mean element of the REC-1 objective. Impairment assessments or listing or de-listing decisions for these impaired streams were not conducted. These decisions will be made by the Integrated Report during the next applicable data assessment cycle. An assessment of available land cover, land use, and wet and dry MST marker data pointed to the following controllable anthropogenic sources of fecal waste detected in the impaired stream stations evaluated

- Elk River at Highway 101 - Dog, Human, and Dairy Cattle fecal waste
- Gannon Slough at Highway 101 - Dog and Human fecal waste
- Jolly Giant Creek at Highway 101 - Dog and Human fecal waste
- Martin Slough at Highway 101 - Dog and Human fecal waste
- Little River at Highway 101 - Dog and Non-dairy Cattle fecal waste
- Norton Creek at Highway 101 - Dog fecal waste

The numeric exceedances of the REC-1 objective, percent coverage of land cover and land use, and percent detection of MST markers calculated for each sampling station in this study are detailed in Sections 3 and 4. Detailed background information on the Impaired Streams Monitoring Study, as well as sample collection and analysis details are provided in the reports entitled “Assessment of Fecal Indicator Bacteria Data from 21 Humboldt County Coastal Streams”, which provides the findings of REC-1 objective exceedance assessments, and “Assessment of Land Cover, Land Use, and Microbial Source Tracking Data from 28 Coastal Streams, and 12 Ocean Beaches in the North Coast Region” which provides the information on the potential sources of fecal pollution to these streams as a result of the assessment of the MST, land cover, and land use data collected (North Coast Regional Water Quality Control Board, 2023c, 2024). Both these reports are available on the Coastal Pathogen Project website ([https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/tmdls/coastal\\_pathogen/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/coastal_pathogen/))

## **2.2. Impaired Beaches Monitoring Study**

The Impaired Beaches Monitoring Study was conducted by the North Coast Water Board to calculate exceedances of the REC-1 and SHELL objectives and to identify sources of fecal waste sources to the 12 REC-1 and/or SHELL impaired beaches in Humboldt, Mendocino, and Sonoma Counties. North Coast Water Board staff collected FIB (enterococcus, and total coliform) and MST (dog-, gull-, human-, and ruminant-specific markers) data from July 2016 to October 2017 in the summer/dry weather period only. In addition, North Coast Water Board staff also evaluated FIB (enterococcus and total coliform) data collected from May 2015 to May 2022 collected from these impaired beaches under the BeachWatch program. All BeachWatch program sampling was conducted in the dry weather period only, and no MST data were collected under the BeachWatch program. In 2023 North Coast Water Board staff analyzed land cover data from the NLCD, land use data from the most recent publicly available county parcel data, publicly available APN parcel ownership information, and facility information for dairies under the dairy permit provided in the CIWQS database to determine the percent coverage of land cover and land use, and the presence of dairy or non-dairy cattle grazing within a 5-kilometer radius above each impaired beach sampling station. A list of impaired beach sampling stations, their station codes, and impaired beneficial use is provided below.

- Humboldt County
  - Clam Beach at Mad River (109MA0001) - SHELL
  - Clam Beach at Strawberry Creek (109SW0001) - REC-1 & SHELL
  - Luffenholtz Beach at Luffenholtz Creek (108LF0001) - REC-1 & SHELL
  - Moonstone Beach at Little River (108LR0001) - SHELL
  - Old Home Beach at Scenic Drive (108HBOHB1) - SHELL
  - Trinidad State Beach at Mill Creek (108ML0001) - REC-1 & SHELL
- Mendocino County
  - Caspar Beach at Caspar Creek (113CA0001) - SHELL
  - Hare Beach at Hare Creek (113HC0001) - SHELL
  - MacKerricher State Park at Virgin Creek (113VR0001) – SHELL
  - Mendocino Bay at Big River (113BI0001) - SHELL
  - Pudding Beach at Pudding Creek (113PD0001) - SHELL
- Sonoma County
  - Campbell Cove at Bodega Bay (115BBCCB1) - REC-1 & SHELL

All samples were collected under the CPP QAPP or the County's QAPP for BeachWatch sampling. The QAPPs detail standard operating procedures, and quality assurance and quality control procedures used during sample collection and analysis (North Coast Regional Water Quality Control Board, 2015; State Water Resources Control Board, 2022). FIB and MST data collected under this study are available in the CEDEN database ([https://ceden.org/about\\_us.shtml](https://ceden.org/about_us.shtml)).

Since samples were only collected in the summer/dry sampling period, only exceedances of the REC-1 and SHELL objectives in the summer assessment period could be calculated. Sufficient data were collected to evaluate exceedances of the geometric mean element of the REC-1 objective. All five Humboldt County beach sampling stations, two of the Mendocino County beach sampling stations, and the Sonoma County beach station had at least one exceedance of the REC-1 objective. Caspar Beach at Caspar Creek, MacKerricher State Park at Virgin Creek, and Mendocino Bay at Big River had zero exceedances of the geometric mean element of the REC-1 objective. All twelve impaired beach sampling stations had at least one exceedance of both the Median and 10% thresholds of the SHELL objective. Impairment assessments or listing or de-listing decisions for these impaired beaches were not conducted. These decisions will be made by the Integrated Report during the next applicable data assessment cycle. An assessment of available land cover, land use, and dry period MST marker data pointed to the following controllable anthropogenic sources of fecal waste detected in the impaired beach stations evaluated

- Humboldt County
  - Clam Beach at Mad River - No Controllable Anthropogenic fecal sources
  - Clam Beach at Strawberry Creek - Dog and Human fecal waste
  - Luffenholtz Beach at Luffenholtz Creek - Dog fecal waste
  - Moonstone Beach at Little River - Dog and Non-dairy Cattle fecal waste

- Old Home Beach at Scenic Drive - No Controllable Anthropogenic fecal sources
- Trinidad State Beach at Mill Creek - Dog fecal waste
- Mendocino County
  - Caspar Beach at Caspar Creek - Dog fecal waste
  - Hare Beach at Hare Creek - Dog and Human fecal waste
  - MacKerricher State Park at Virgin Creek - No Controllable Anthropogenic fecal sources
  - Mendocino Bay at Big River - Dog fecal waste
  - Pudding Beach at Pudding Creek - Human fecal waste
- Sonoma County
  - Campbell Cove at Bodega Bay - Dog fecal waste

The numeric exceedances of the REC-1 objective, percent coverage of land cover and land use, and percent detection of MST markers calculated for each sampling station in this study are detailed in Sections 3 and 4. Detailed background information on the Impaired Beaches Monitoring Study, as well as sample collection and analysis details are provided in the reports entitled “Assessment of Fecal Indicator Bacteria Data from 19 North Coast Ocean Beaches”, which provides the findings of REC-1 and SHELL objective exceedance assessments, and “Assessment of Land Cover, Land Use, and Microbial Source Tracking Data from 28 Coastal Streams, and 12 Ocean Beaches in the North Coast Region” which provides the information on the potential sources of fecal pollution to these beaches as a result of the assessment of the MST, land cover, and land use data collected (North Coast Regional Water Quality Control Board, 2023b, 2024). Both these reports are available on the Coastal Pathogen Project website ([https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/tmdls/coastal\\_pathogen/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/coastal_pathogen/))

### **2.3. Source Assessment Study**

The Source Assessment Study was conducted by the North Coast Water Board and the Humboldt Waterkeeper Organization to collect data from 17 coastal Humboldt County streams draining watersheds with suspected sources of fecal pollution in the area. The study was conducted in order to calculate exceedances of the REC-1 objective and to identify sources of fecal waste sources to the six impaired streams and six REC-1 and/or SHELL impaired beaches in Humboldt County. The suspected source categories are cattle, onsite wastewater treatment systems (OWTS)/septic systems, sewerage areas, and wildlife. The 17 streams, which have not been evaluated for impairment, were sampled from February 2016 to January 2018 during both wet and dry weather periods. FIB (*E. coli* and enterococci) and MST (dog-, gull-, human-, and ruminant-specific markers) data were collected from all 17 streams. In 2023 North Coast Water Board staff also analyzed land cover data from the NLCD, land use data from the most recent publicly available county parcel data, publicly available APN parcel ownership information, and facility information for dairies under the dairy permit provided in the

CIWQS database to determine the percent coverage of land cover and land use, and the presence of dairy or non-dairy cattle grazing within a 5-kilometer radius above each impaired stream sampling station.

A list of the 20 stations sampled in the 17 streams, their station codes, and salinity type is provided below.

- Campbell Creek at 14th Street & Union Street (110GS6500) - Freshwater
- Campbell Creek at 7th Street (110GS5000) - Freshwater
- Cooper Gulch at Myrtle Avenue & 8th Street (110CG5000) - Freshwater
- Elk River at Zanes Road (110ER6642) - Freshwater
- Elk River South Fork at Headwaters Forest (110SF1612) - Freshwater
- Freshwater Creek at County Park (110FR4642) - Freshwater
- Graham Gulch at Pacific Lumber Camp Road (110GG0100) - Freshwater
- Grotzman Creek at Bayside Road (110GR0500) - Freshwater
- Jacoby Creek at Jacoby Creek Road (110JC6316) - Freshwater
- Jacoby Creek at Old Arcata Road (110JC0966) - Freshwater
- Liscom Slough at Jackson Road (110UNSJXN) - Saline
- Martin Slough at Campton Street & Fern Street (110MS6750) - Freshwater
- McDaniel Slough at Q Street (110MD3750) - Freshwater
- Mill Creek at Stagecoach Road (108MC1250) - Freshwater
- Salmon Creek at Eel River Drive (110SA1720) - Freshwater
- Strawberry Creek at Highway 101 (108SC0550) - Freshwater
- Swain Slough at Elk River Road (110SS9000) - Saline
- Unnamed Slough at Lanphere Road (110UNSLPHR) - Freshwater
- Unnamed Slough at Ranch Road (110UNSRNCH) - Freshwater
- Unnamed Stream at Anker Road (109UNTANKR) – Freshwater

All samples were collected under the Coastal Pathogen Project QAPP which details the standard operating procedures, and quality assurance and quality control procedures used during sample collection and analysis (North Coast Regional Water Quality Control Board, 2015). FIB and MST data collected under this study are available in the CEDEN database ([https://ceden.org/about\\_us.shtml](https://ceden.org/about_us.shtml)).

Samples collected from thirteen sampling stations had at least one exceedance of the STV element of the REC-1 objective in both the summer and winter assessment periods. Seven sampling stations had zero exceedances of the STV element of the REC-1 objective in either assessment period. Insufficient data were collected from all sampling locations to calculate exceedances of the geometric mean element of the REC-1 objective. Impairment assessments or listing or de-listing decisions for these impaired streams were not conducted. These decisions will be made by the Integrated Report during the next applicable data assessment cycle. An assessment of available land cover, land use, and wet and dry MST marker data pointed to the following

controllable anthropogenic sources of fecal waste detected in the stations evaluated having at least one exceedance of the REC-1 objective

- Campbell Creek at 14th Street & Union Street - Dog and Human fecal waste
- Campbell Creek at 7th Street - Dog and Human fecal waste
- Cooper Gulch at Myrtle Avenue & 8th Street - Dog and Human fecal waste
- Elk River at Zanes Road - Dog and Dairy Cattle fecal waste
- Grotzman Creek at Bayside Road - Dog and Human fecal waste
- Jacoby Creek at Old Arcata Road - Dog fecal waste
- Liscom Slough at Jackson Road - Dog, Human, and Dairy Cattle fecal waste
- Martin Slough at Campton Street & Fern Street - Dog and Human fecal waste
- McDaniel Slough at Q Street - Dog and Human fecal waste
- Salmon Creek at Eel River Drive - Dog, Dairy Cattle, and Non-dairy Cattle fecal waste
- Swain Slough at Elk River Road - Dog, Human, and Dairy Cattle fecal waste
- Unnamed Slough at Lanphere Road - Dog, Human, and Dairy Cattle fecal waste
- Unnamed Slough at Ranch Road –Dairy Cattle fecal waste

The numeric exceedances of the REC-1 objective, percent coverage of land cover and land use, and percent detection of MST markers calculated for each sampling station in this study are detailed in Sections 3 and 4. Detailed background information on the Source Assessment Study, as well as sample collection and analysis details are provided in the reports entitled “Assessment of Fecal Indicator Bacteria Data from 21 Humboldt County Coastal Streams”, which provides the findings of REC-1 objective exceedance assessments, and “Assessment of Land Cover, Land Use, and Microbial Source Tracking Data from 28 Coastal Streams, and 12 Ocean Beaches in the North Coast Region” which provides the information on the potential sources of fecal pollution to these streams as a result of the assessment of the MST, land cover, and land use data collected (North Coast Regional Water Quality Control Board, 2023c, 2024). Both these reports are available on the Coastal Pathogen Project website ([https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/tmdls/coastal\\_pathogen/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/coastal_pathogen/)).

## **2.4. Jolly Giant Creek Monitoring Study**

The Jolly Giant Creek Monitoring Study was conducted by the North Coast Water Board, City of Arcata Environmental Services Department, and the Humboldt Waterkeeper Organization to identify the source of human waste detected in the Jolly Giant Creek at Samoa Boulevard sampling station sampled under the Impaired Streams Monitoring Study. The study was also conducted to calculate exceedances of the REC-1 objective from all the Jolly Giant Creek stations sampled and other sources of fecal pollution to Jolly Giant Creek. Samples were collected from October 2021 to November 2022 in the wet and dry periods from Jolly Giant Creek at the Samoa Boulevard station



as well as four upstream stations at locations along Jolly Giant Creek suspected of being sources of human fecal waste (leaking sewage pipes, illegal sewage dumping and/or houseless population inputs). North Coast Water Board staff also analyzed land cover data from the NLCD, land use data from the most recent publicly available county parcel data, publicly available APN parcel ownership information and facility information for dairies under the dairy permit provided in the CIWQS database to determine the percent coverage of land cover and land use, and the presence of dairy or non-dairy cattle grazing within a 5-kilometer radius above the Jolly Giant Creek at Samoa Boulevard sampling station since all four additional stations sampled fall within this radius. Only the Jolly Giant Creek at Samoa Boulevard station has been analyzed for impairment of REC-1 beneficial use. A list of impaired stream sampling stations, their station codes, and salinity type is provided below.

- Jolly Giant Creek at Alliance Road near 17th Street (110JG0580) - Freshwater
- Jolly Giant Creek at 14th Street near M Street (110JG0516) - Freshwater
- Jolly Giant Creek at 9th and J Street (110JG0378) - Freshwater
- Jolly Giant Creek at 7th and J Street (110JG0331) - Freshwater
- Jolly Giant Creek at Samoa Boulevard (110JG0264) - Freshwater

All samples were collected under the Coastal Pathogen Project QAPP and the Jolly Giant Creek Monitoring Plan which details the standard operating procedures, and quality assurance and quality control procedures used during sample collection and analysis (North Coast Regional Water Quality Control Board, 2015, 2021). FIB and MST data collected under this study are available in the CEDEN database ([https://ceden.org/about\\_us.shtml](https://ceden.org/about_us.shtml)).

Samples collected from all five sampling stations had at least one exceedance of the STV element of the REC-1 objective in both the summer and winter assessment periods. Insufficient data were collected from all sampling locations to calculate exceedances of the geometric mean element of the REC-1 objective. Impairment assessments or listing or de-listing decisions for these impaired streams were not conducted. These decisions will be made by the Integrated Report during the next applicable data assessment cycle. An assessment of available land cover, land use, and wet and dry MST marker data pointed to the following controllable anthropogenic sources of fecal waste detected in the stations evaluated

- Jolly Giant Creek at Alliance Road near 17th Street - Dog and Human fecal waste
- Jolly Giant Creek at 14th Street near M Street - Dog and Human fecal waste
- Jolly Giant Creek at 9th and J Street - Dog and Human fecal waste
- Jolly Giant Creek at 7th and J Street - Dog and Human fecal waste
- Jolly Giant Creek at Samoa Boulevard - Dog and Human fecal waste

The numeric exceedances of the REC-1 objective, percent coverage of land cover and land use, and percent detection of MST markers calculated for each sampling station in

this study are detailed in Sections 3 and 4. Detailed background information on the Jolly Giant Creek Monitoring Study, sample collection and analysis details, REC-1 objective exceedance findings, and source assessment findings are provided in the report entitled “Assessment of Fecal Indicator Bacteria and Microbial Source Tracking Data from Jolly Giant Creek” (North Coast Regional Water Quality Control Board, 2023a). This report is available on the Coastal Pathogen Project website ([https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/tmdls/coastal\\_pathogen/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/coastal_pathogen/)).

## **2.5. Humboldt County Advanced Protection Management Program (APMP) Study**

The Humboldt County APMP Study was developed by the Humboldt County Department of Environmental Health “to assess the extent to which groundwater and local surface water quality may be adversely impacted by OWTS as a component of their water quality assessment program.” (personal communication, J. Whittlesey, February 7, 2023). FIB (*E. coli* and enterococcus) and MST (dog-, gull-, human-, and ruminant-specific markers) data were collected from “watersheds upstream of 303(d) impaired beaches to determine where in these watersheds contamination is originating from and better evaluate the extent of OWTS impact to water quality impairment.” (personal communication, J. Whittlesey, February 7, 2023). Under this study, FIB and MST data collected between April 2019 and November 2022 were provided to the North Coast Water Board by Humboldt County Department of Environmental Health (DEH) for assessment. All samples were collected “after the first rain of the year and during the wet weather season” (personal communication, M. Kalson, March 23, 2023). No dry weather samples were collected. A QAPP for the Humboldt County APMP Study was not available at the time of data assessment. In 2023 North Coast Water Board staff also analyzed land cover data from the NLCD, land use data from the most recent publicly available county parcel data, publicly available APN parcel ownership information and facility information for dairies under the dairy permit provided in the CIWQS database to determine the percent coverage of land cover and land use, and the presence of dairy or non-dairy cattle grazing within a 5-kilometer radius above each sampling station of this study. A list of the 13 stations sampled in the eight streams and their station codes is provided below.

- Joland Creek (JOLANDSCENIC)
- Little River (LITTLERIVER101)
- Luffenholtz Creek at City of Trinidad (LUFFHLTZSWTP)
- Luffenholtz Creek at Mouth (LUFFHLTZSCENIC)
- Mill Creek at Mouth (MILLCRWOODBRIDGE)
- Parker Creek at Mouth (PARKERCRBEACH)
- Parker Creek at Westhaven Drive (PARKERCRWSTHVN)



- Patrick Creek (PATRICKCLAM)
- Strawberry Creek at Dows Prairie (STRAWDOWSPRAIRIE)
- Strawberry Creek at Duke Creek (DUKECREEK)
- Strawberry Creek at Rose Creek (STRAWARTHUR)
- Strawberry Creek East of Highway 101 (STRAWCENTRAL)
- Two Creeks (TWO CREEKSSCENIC)

FIB data collected from these sampling stations were not evaluated to determine exceedances of the REC-1 objective due to the unavailability of a QAPP for this study when data assessment was conducted. Quality assurance and quality control data are required when calculating exceedances of Water Quality objective since exceedance information is used to determine impairments, and to make listing and de-listing decisions. All available land cover, land use, grazing presence, and MST data were evaluated to determine the controllable anthropogenic sources of fecal waste to these stations as listed below

- Joland Creek - Dog and Human fecal waste
- Little River - Dog and Non-dairy Cattle fecal waste
- Luffenholtz Creek at City of Trinidad - Dog fecal waste
- Luffenholtz Creek at Mouth - Dog fecal waste
- Mill Creek at Mouth - Dog fecal waste
- Parker Creek at Mouth - Dog fecal waste
- Parker Creek at Westhaven Drive - Dog fecal waste
- Patrick Creek - Dog, Human, and Non-dairy Cattle fecal waste
- Strawberry Creek at Dows Prairie - Dog fecal waste
- Strawberry Creek at Duke Creek - Dog fecal waste
- Strawberry Creek at Rose Creek - No Controllable Anthropogenic fecal sources
- Strawberry Creek East of Highway 101 - Dog fecal waste
- Two Creeks - Dog and Human fecal waste

The numeric exceedances of the REC-1 Objective, percent coverage of land cover and land use, and percent detection of MST markers calculated for each sampling station in this study are detailed in Sections 3 and 4. Detailed information data analysis and source assessment findings are provided in the report entitled “Assessment of Land Cover, Land Use, and Microbial Source Tracking Data from 28 Coastal Streams, and 12 Ocean Beaches in the North Coast Region” (North Coast Regional Water Quality Control Board, 2024). This report is available on the Coastal Pathogen Project website ([https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/tmdls/coastal\\_pathogen/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/coastal_pathogen/)).

## **2.6. Humboldt Waterkeeper Study**

North Coast Water Board staff analyzed MST data collected by Humboldt Waterkeeper from March 2016 to October 2016 from four sampling stations in Little River, one sampling station in Janes Creek and four sampling stations in McDaniel Slough. All sampling stations are in Humboldt County. The sampling stations were located in areas influenced by agricultural, forest, industrial, residential, septic, and transient camp sources. The weather period during which these samples were collected was not provided. However, North Coast Water Board staff used historic precipitation data available for the nearest weather station (Eureka – Woodley Island, ERK) operated by the National Weather Service (California Department of Water Resources, 2023) to determine that samples were mainly collected in the wet period with one sample from each station collected in the dry period. A QAPP for this study was not available at the time of data assessment. FIB data associated with these sampling stations were not submitted during data assessment, therefore exceedances of the REC-1 objective at these sampling stations were not evaluated. MST data collected from these sampling stations were evaluated to determine the detection percent of each species-specific marker detected in the samples collected from each sampling station. These data were submitted after the completion of the Land Cover, land use, and grazing presence assessment conducted by North Coast Water Board staff, therefore the land cover and land use coverage in the watershed upstream from each sampling station of this study were not evaluated. However, several stations in this study were in streams that were also sampled under the Impaired Streams Monitoring Study and the Source Assessment Study, therefore land cover, land use and grazing presence information is available for a majority of the streams sampled in this study. A list of the streams sampled, and the major MST markers detected at each sampling station are provided below

- Little River at Crannel Road - Ruminant-specific marker
- Little River at Highway 101 - Dog-specific marker
- Little River Tributary at Highway 101 - Dog-, and Human-specific markers
- McDaniel Slough at Foster Avenue and Heather Lane - Dog-specific marker
- McDaniel Slough at Highway 101 - Dog-specific marker
- McDaniel Slough at Hilfiker Drive - Dog-specific marker
- McDaniel Slough at Samoa Boulevard - Dog-, and Human-specific markers

The numeric percent detection of MST markers calculated for each sampling station in this study are detailed in Section 4. Detailed information data analysis and source assessment findings are provided in the report entitled “Assessment of Land Cover, Land Use, and Microbial Source Tracking Data from 28 Coastal Streams, and 12 Ocean Beaches in the North Coast Region” (North Coast Regional Water Quality Control Board, 2024). This report is available on the Coastal Pathogen Project website ([https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/tmdls/coastal\\_pathogen/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/coastal_pathogen/)).

### 3. Exceedances of Water Quality Objectives

To evaluate water quality, North Coast Water Board staff analyzed FIB data collected from streams and beaches sampled under studies with QAPPs, comparing the results to the numeric thresholds of the REC-1 and/or SHELL objective to calculate exceedances of the applicable Objective. QAPPs provide quality assurance and quality control data associated with sample collection and analysis. These data are required when calculating exceedances of Water Quality Objectives since exceedance information is used to determine impairments, and to make listing and de-listing decisions.

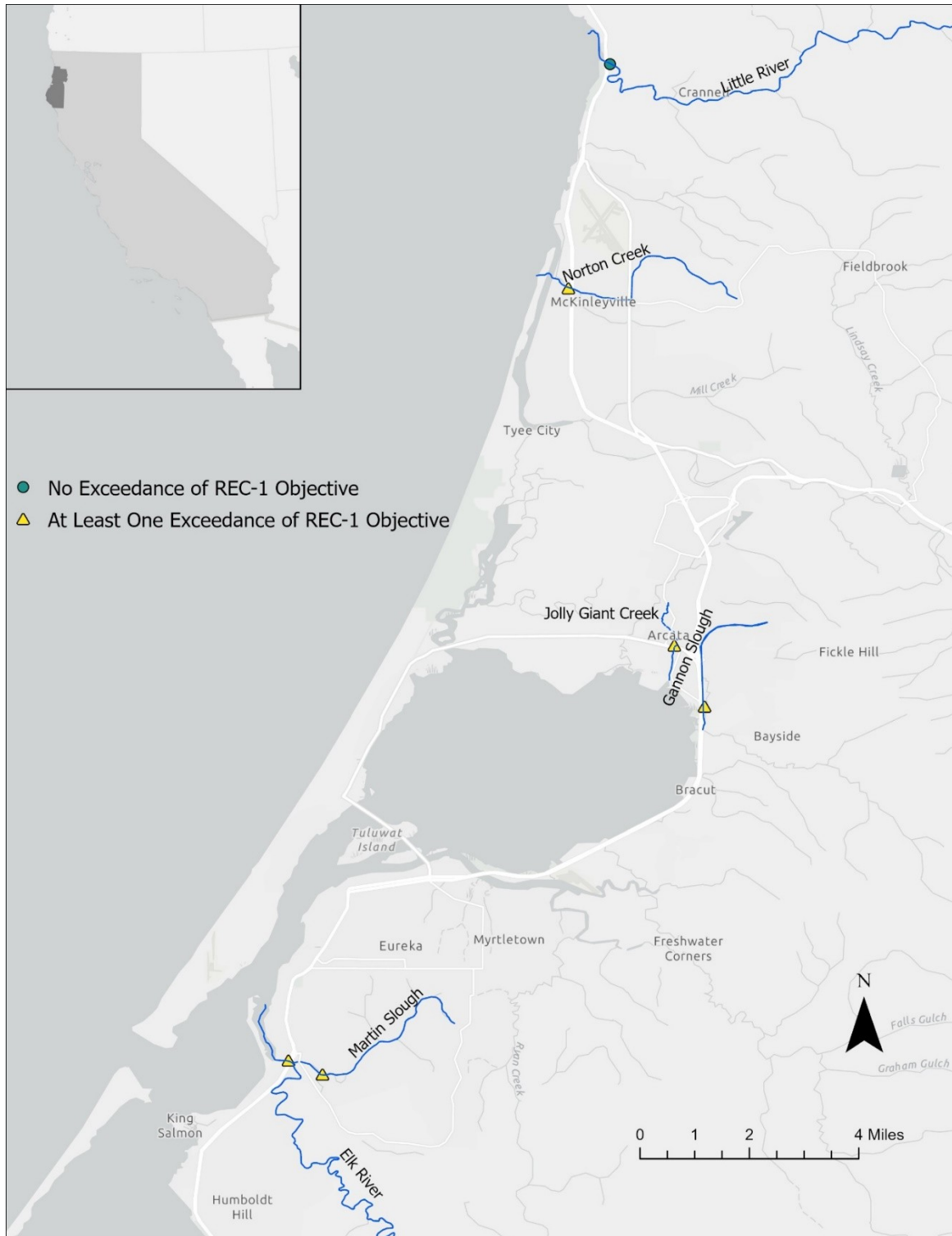
#### 3.1. Exceedances Calculated at Stream Sampling Stations

FIB data collected from streams sampled under studies with QAPPs were compared to either the saline (*enterococcus*) or freshwater (*E. coli*) threshold of the STV element of the REC-1 objective to calculate exceedances of the relevant REC-1 objective. Only exceedances of the STV element of the REC-1 threshold were evaluated since insufficient data were collected from all streams to evaluate exceedance of the geometric mean element of the REC-1 objective. Exceedances were calculated for the summer, winter, and year-round assessment periods. Table 2 provides the exceedances calculated for the stream stations evaluated under the Impaired Stream Study. Figure 2 illustrates the stations sampled under the Impaired Streams Monitoring Study with at least one exceedance of the REC-1 objective or zero exceedances of the REC-1 objective. Table 3 provides the exceedances calculated for the stream stations evaluated under the Source Assessment Study. Table 4 provides the exceedances calculated for the stream stations evaluated under the Jolly Giant Creek Monitoring Study. Figures 3 and 4 illustrate the stations sampled under the Source Assessment Study and Jolly Giant Creek Monitoring Study with at least one exceedance of the REC-1 objective or zero exceedances of the REC-1 objective in sampling locations north of Humboldt Bay and in sampling stations south of Humboldt Bay respectively.

**Table 2 Exceedances of the REC-1 Objective Calculated at Sampling Stations of the Impaired Streams Monitoring Study**

Station Name	Exceedance of the STV element of the REC-1 Objective (Number of Exceedances/Number of Calculations)		
	Year-round	Summer	Winter
Elk River at Highway 101 <sup>a</sup>	6/11	3/5	3/6

Station Name	Exceedance of the STV element of the REC-1 Objective (Number of Exceedances/Number of Calculations)		
	Year-round	Summer	Winter
Gannon Slough at Highway 101 <sup>a</sup>	3/11	1/5	2/6
Jolly Giant Creek at Samoa Boulevard <sup>a</sup>	9/11	3/5	6/6
Little River at Highway 101 <sup>a</sup>	0/11	0/5	0/6
Martin Slough at Pine Hill Road <sup>a</sup>	6/11	3/5	3/6
Norton Creek at Highway 101 <sup>a</sup>	4/11	1/5	3/6



**Figure 2 Exceedances of the REC-1 Objective for sampling stations of the Impaired Streams Monitoring Study**

**Table 3 Exceedances of the REC-1 Objective Calculated at Stations sampled under the Source Assessment Study**

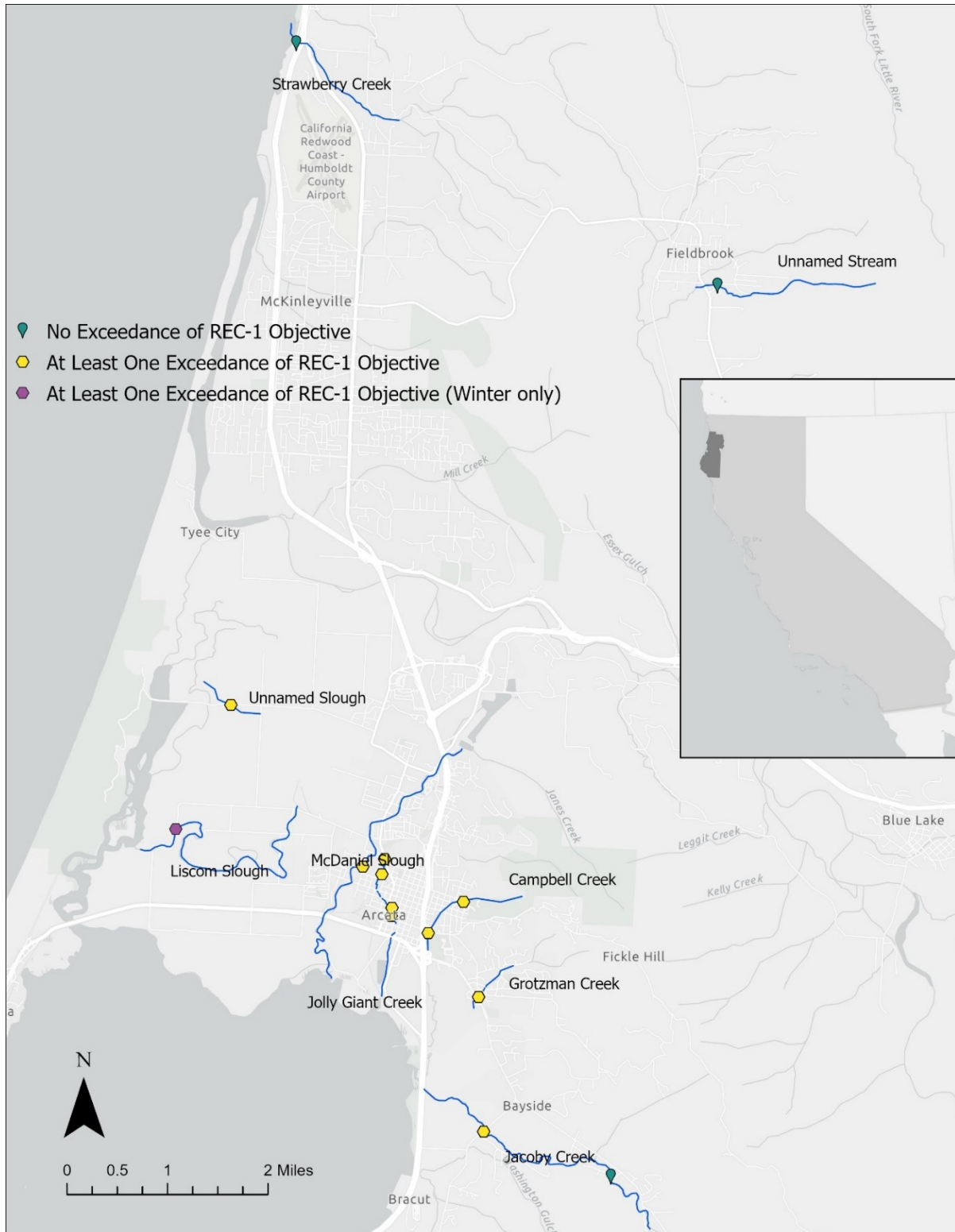
Station Name	Exceedance of the STV element of the REC-1 Objective (Number of Exceedances/Number of Calculations)		
	Year-round	Summer	Winter
Campbell Creek at 14th Street & Union Street	1/4	1/5	3/6
Campbell Creek at 7th Street	2/4	1/3	1/1
Cooper Gulch at Myrtle Avenue & 8th Street	4/4	2/2	2/2
Elk River at Zanes Road	2/4	0/2	2/2
Elk River South Fork at Headwaters Forest	0/4	0/2	0/2
Freshwater Creek at County Park	0/4	0/2	0/2
Graham Gulch at Pacific Lumber Camp Road	0/4	0/2	0/2
Grotzman Creek at Bayside Road	2/4	1/2	1/2
Jacoby Creek at Jacoby Creek Road	0/4	0/2	0/2
Jacoby Creek at Old Arcata Road	2/4	1/2	1/2
Liscom Slough at Jackson Road	3/4	3/3	0/1

Station Name	Exceedance of the STV element of the REC-1 Objective (Number of Exceedances/Number of Calculations)		
	Year-round	Summer	Winter
Martin Slough at Campton Street and Fern Street	1/4	0/2	1/2
McDaniel Slough at Q Street	2/4	1/3	1/1
Mill Creek at Stagecoach Road	0/4	0/2	0/2
Salmon Creek at Eel River Drive	1/4	1/2	0/2
Strawberry Creek at Highway 101	0/4	0/2	0/2
Swain Slough at Elk River Road	2/4	1/2	1/2
Unnamed Slough at Lanphere Road	3/4	2/3	1/1
Unnamed Slough at Ranch Road	2/4	1/2	1/2
Unnamed Stream at Anker Road	0/4	0/2	0/2

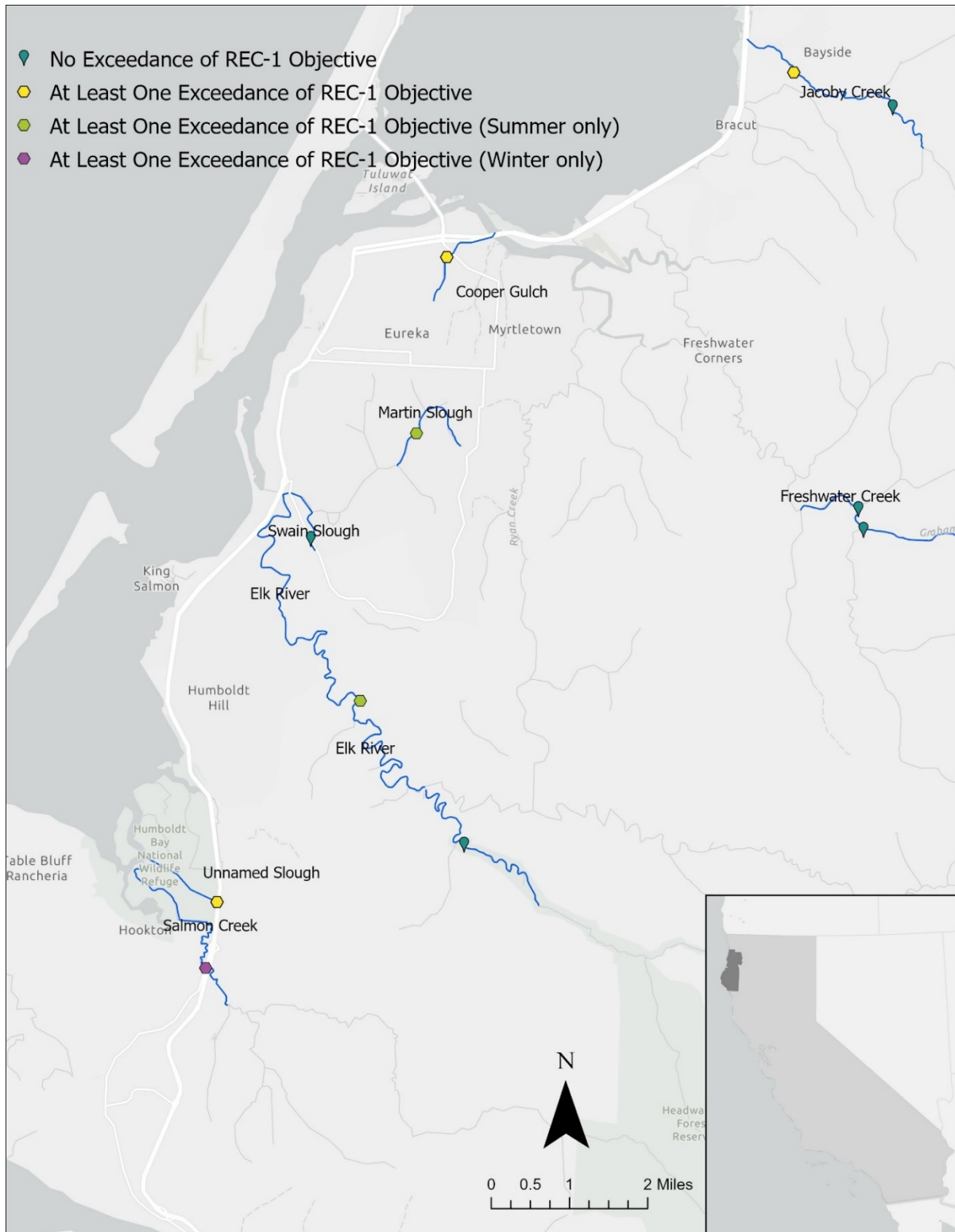
**Table 4 Exceedances of the REC-1 Objective Calculated at Stations sampled under the Jolly Giant Creek Monitoring Study**

Station Name	Exceedance of the STV element of the REC-1 Objective (Number of Exceedances/Number of Calculations)		
	Year-round	Summer	Winter
Jolly Giant Creek at 14th Street & M Street <sup>c</sup>	3/6	1/3	2/3
Jolly Giant Creek at 7th Street & J Street <sup>c</sup>	5/6	3/3	2/3
Jolly Giant Creek at 9th Street & J Street <sup>c</sup>	3/6	1/3	2/3
Jolly Giant Creek at Alliance Road & 17th Street <sup>c</sup>	2/6	1/3	1/3
Jolly Giant Creek at Samoa Boulevard <sup>c</sup>	5/6	3/3	2/3





**Figure 3 Exceedances of the REC-1 Objective for sampling stations of the Source Assessment Study and Jolly Giant Creek Study (Northern Humboldt Bay region)**



**Figure 4 Exceedances of the REC-1 Objective for sampling stations of the Source Assessment Study (Southern Humboldt Bay region)**

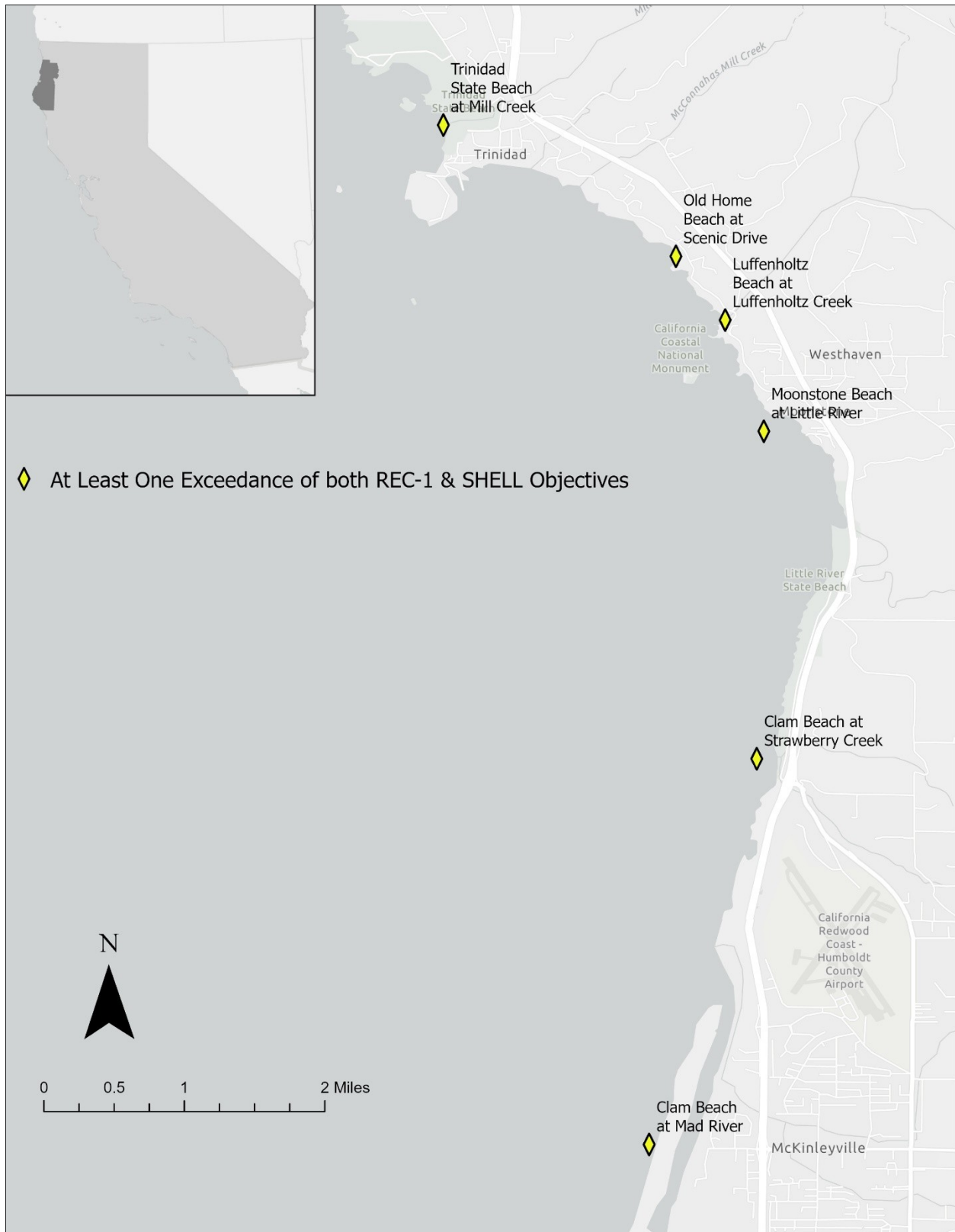
### 3.2. Exceedances Calculated at Beach Sampling Stations

FIB data collected from beaches sampled under studies with QAPPs were compared to the REC-1 objective (enterococcus) or SHELL objective (total coliform) thresholds to calculate the exceedances of each objective. Sufficient data were collected to calculate exceedances of the Geometric Mean and STV thresholds of the REC-1 objective and the Median and 10% thresholds of the SHELL objective. Exceedances were calculated only for the summer assessment periods since data were only collected in the summer/dry period. Tables 5, 6, and 7 provide the REC-1 and SHELL objective exceedances calculated for the beach stations evaluated in Humboldt, Mendocino and Sonoma Counties respectively. Figures 5, 6, and 7 display the stations with at least one exceedance of the REC-1 and/or SHELL objective or zero exceedances of the REC-1 and/or SHELL objective in Humboldt, Mendocino, and Sonoma Counties respectively.

**Table 5 Exceedances of the REC-1 and SHELL Objectives Calculated at Humboldt County Beach Sampling Stations for the Summer Assessment Period**

Sampling Station	Exceedance of the REC-1 and SHELL Objective (Number of Exceedances/Number of Calculations)			
	REC-1		SHELL	
	Geometric Mean	STV	Median	10%
Clam Beach near Mad River mouth	6/158	3/44	730/7170	1109/7170
Clam Beach near Strawberry Creek	129/159	21/44	1697/8520	1649/8520
Luffenholtz Beach at Luffenholtz Creek	103/160	19/44	1696/8370	1689/8370
Moonstone Beach at Little River	32/161	11/44	1537/8100	1638/8100
Old Home Beach at Scenic Drive	4/14	2/4	149/480	129/480

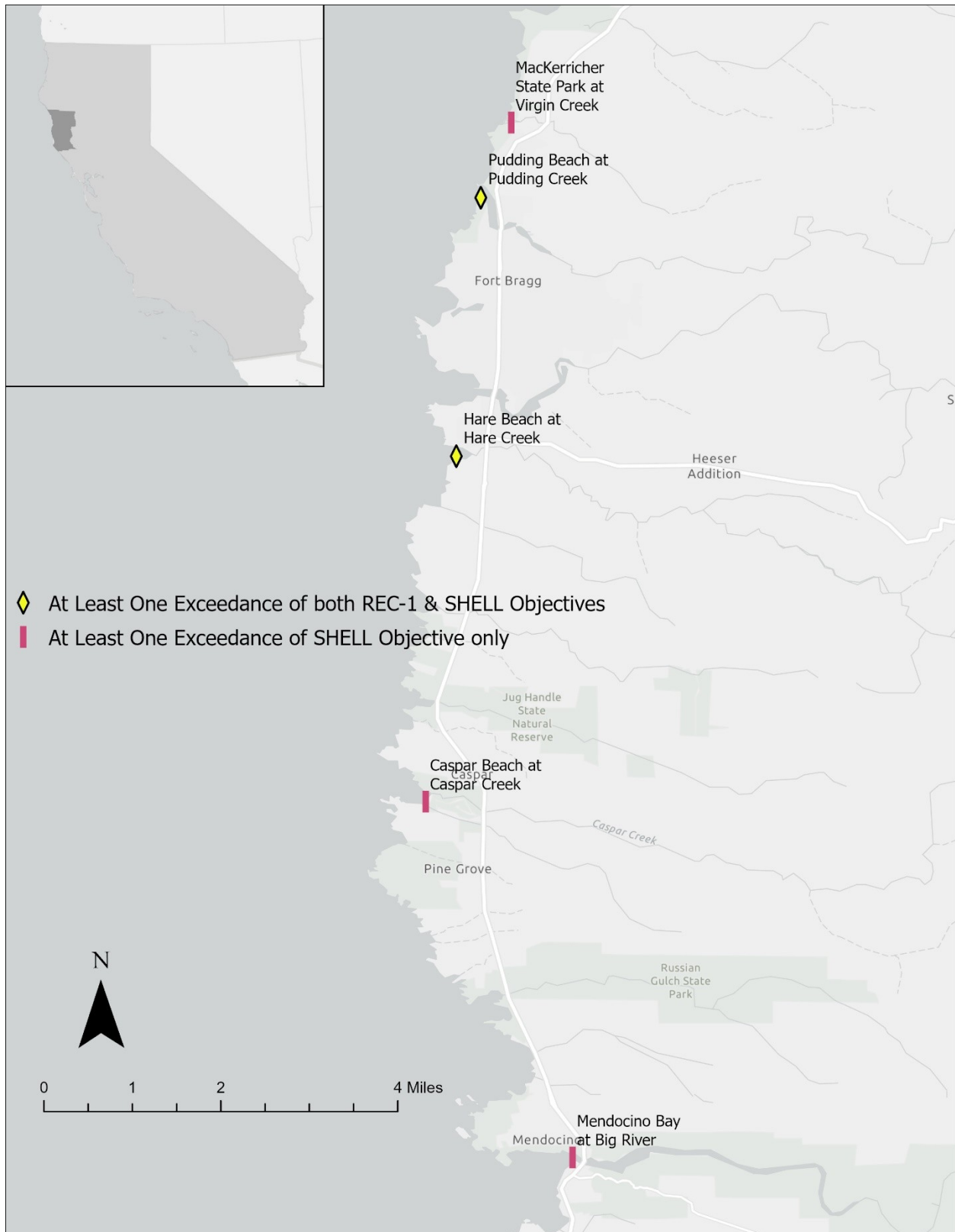
Sampling Station	Exceedance of the REC-1 and SHELL Objective (Number of Exceedances/Number of Calculations)			
	REC-1		SHELL	
	Geometric Mean	STV	Median	10%
Trinidad State Beach at Mill Creek	50/159	19/44	1515/8100	1464/8100



**Figure 5 Exceedances of the REC-1 and/or SHELL Objective calculated at Humboldt County Beaches sampled**

**Table 6 Exceedances of the REC-1 and SHELL Objectives Calculated at Mendocino County Beach Sampling Stations for the Summer Assessment Period**

Sampling Station	Exceedance of the REC-1 and SHELL Objective (Number of Exceedances/Number of Calculations)			
	REC-1		SHELL	
	Geometric Mean	STV	Median	10%
Big River Beach at Mendocino Bay	0/181	1/50	235/6720	425/6720
Caspar Headlands State Beach	0/181	1/50	830/6810	782/6810
Hare Beach at Hare Creek	16/178	7/50	1118/6690	1107/6690
MacKerricher State Park near Virgin Creek	0/89	0/33	332/3690	317/3690
Pudding Beach at Pudding Creek	8/182	5/50	471/6750	8000/6750



**Figure 6 Exceedances of the REC-1 and/or SHELL Objective calculated at Mendocino County Beaches sampled**

**Table 7 Exceedances of the REC-1 and SHELL Objectives Calculated at the Sonoma County Beach Sampling Station for the Summer Assessment Period**

Sampling Station	Exceedance of the REC-1 and SHELL Objective (Number of Exceedances/Number of Calculations) in the Summer Assessment Period			
	REC-1		SHELL	
	Geometric Mean	STV	Median	10%
Campbell Cove at Bodega Bay	10/170	7/49	171/6240	321/6240





**Figure 7 Exceedances of the REC-1 and/or SHELL Objective calculated at the Sonoma County Beach sampled**

## 4. Fecal Waste Source Identification and Assessment

Fecal waste can enter waterbodies directly from point sources or in runoff from nonpoint sources or subsurface flow. During events of heavy rainfall fecal waste can be transported to waterbodies via sanitary sewer overflow events, stormwater runoff which can transport feces associated with particulate matter, and the remobilization and transport of sediment contaminated with fecal waste and associated pathogens (United States Environmental Protection Agency, 2023). The key point sources of fecal waste discharge examined by staff in the areas sampled include aging or failing sewer infrastructure and sanitary sewer overflows. The key nonpoint sources of fecal waste discharge examined by staff in the areas sampled include septic tank leachate, runoff from land which includes agricultural runoff, and the feces of domestic pets and wildlife, and waste from transient or unhoused populations.

Potential sources of fecal pollution to the streams and ocean beaches sampled were characterized using three lines of evidence – land cover data, land use data, and MST data where available. All stream and beach samples analyzed were collected in areas which are mainly influenced by forested regions in the upstream portions of their respective watersheds, giving way to more urban developed areas in the downstream portions of the watersheds, closer to the mouths of the streams and rivers near Humboldt Bay and the Pacific Ocean. Dairy, as well as beef cattle grazing operations are also present in the downstream areas of the watersheds of some of the sampling stations analyzed. Therefore, the major land covers associated with fecal waste in the areas sampled are forests, urban/developed areas, and grassland/shrubs, and the major land uses contributing to fecal waste in the areas sampled are developed sewer use, developed unsewered use (OWTS/septic systems), undeveloped, and grazing.

For all the sampling stations with available data, the following calculations were conducted 1) the percentage of the watershed covered by each of the three major land cover categories in the area (forest, grassland/shrub, and urban/developed), 2) the percentage of the watershed covered by each of the four major land use categories in the sampling areas (developed sewer use, developed unsewered [OWTS], grazing, and undeveloped), and 3) the percentage of samples collected from each sampling station in which each of the four species-specific markers (dog-, gull-, human-, and ruminant-specific markers) were detected. Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%. Since the ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste (Griffith et al., 2013) land cover, land use and grazing presence in the sampling station watershed was used to determine whether the ruminant specific-marker detections were potentially driven by ruminant wildlife or cattle.

The results of the pollutant source analysis conducted on samples collected under the Impaired Streams Monitoring Study, Impaired Beaches Monitoring Study, Source

Assessment Study, Humboldt County APMP Study, and Humboldt Waterkeeper Study are described below.

#### **4.1. Impaired Streams Monitoring Study**

The results from the analysis of land cover, land use and grazing presence, and MST data collected from the sampling stations of the Impaired Streams Monitoring Study are presented in Tables 8, 9, and 10 respectively.

**Table 8 The Percentage of the Impaired Stream Study Sampling Station Watersheds Covered by the Land Cover Categories**

<b>Station Name</b>	<b>Forest</b>	<b>Grassland/Shrub</b>	<b>Urban/Developed</b>	<b>Other</b>
Elk River at Highway 101	39.4	20.8	31.7	8.1
Gannon Slough at Highway 101	46.1	14.3	37.9	1.7
Jolly Giant Creek at Samoa Boulevard	34.5	8.1	56.5	0.9
Little River at Highway 101	84.8	7.4	3.3	4.5
Martin Slough at Pine Hill Road	41.1	6.9	47.5	4.5
Norton Creek at Highway 101	39.1	10.2	50.6	0.1

**Table 9 The Percentage of the Impaired Stream Study Sampling Station Watersheds Covered by the Land Use Categories**

Station Name	Developed Sewered	Developed Unsewered	Grazing	Undeveloped
Elk River at Highway 101 <sup>a</sup>	61.3	8.7	14.8	15.2
Gannon Slough at Highway 101	36.8	27.2	6.4	29.6
Jolly Giant Creek at Samoa Boulevard	44.6	8.3	0	47.1
Little River at Highway 101 <sup>b</sup>	1	2.7	6	90.3
Martin Slough at Pine Hill Road	38.7	29.3	0.6	31.4
Norton Creek at Highway 101	54.4	0	5	40.6

<sup>a</sup>The watershed of the Elk River at Highway 101 sampling station contains dairy cattle grazing

<sup>b</sup>The watershed of the Little River at Highway 101 sampling station contains non-dairy cattle grazing

**Table 10 The Detection Percentage of MST markers in the Impaired Stream Study Sampling Station samples collected<sup>a</sup>**

<b>Station Name</b>	<b>Sampling Season</b>	<b>Dog</b>	<b>Gull</b>	<b>Human</b>	<b>Ruminant<sup>b</sup></b>
Elk River at Highway 101	Dry	50	83.3	0	66.7
Elk River at Highway 101	Wet	40	80	20	100
Gannon Slough at Highway 101	Dry	40	60	20	80
Gannon Slough at Highway 101	Wet	83.3	83.3	83.3	100
Jolly Giant Creek at Samoa Boulevard	Dry	80	0	60	0
Jolly Giant Creek at Samoa Boulevard	Wet	50	33.3	100	33.3
Little River at Highway 101	Dry	20	20	0	100
Little River at Highway 101	Wet	16.7	16.7	16.7	50
Martin Slough at Pine Hill Road	Dry	50	16.7	16.7	33.3
Martin Slough at Pine Hill Road	Wet	100	20	80	100

Station Name	Sampling Season	Dog	Gull	Human	Ruminant <sup>b</sup>
Norton Creek at Highway 101	Dry	0	0	0	100
Norton Creek at Highway 101	Wet	83.3	0	0	100

<sup>a</sup>Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%.

<sup>b</sup>The ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste

## 4.2. Impaired Beaches Monitoring Study

The results from the analysis of land cover, land use and grazing presence, and MST data collected from the sampling stations of the Impaired Beaches Study are presented in Tables 11, 12, and 13 respectively.

**Table 11 The Percentage of the Impaired Beach Study Sampling Station Watersheds Covered by the Land Cover Categories**

Station Name	Forest	Grassland/Shrub	Urban/Developed	Other
Clam Beach at Mad River <sup>a</sup>	10.5	23.1	53	13.4
Clam Beach at Strawberry Creek <sup>a</sup>	51	27.3	21.4	0.3
Luffenholtz Beach at Luffenholtz Creek <sup>a</sup>	91.1	3.8	5.1	0
Moonstone Beach at Little River <sup>a</sup>	82.2	7.1	5.3	5.4

<b>Station Name</b>	<b>Forest</b>	<b>Grassland/Shrub</b>	<b>Urban/Developed</b>	<b>Other</b>
Old Home Beach at Scenic Drive <sup>a</sup>	86.8	0.3	12.9	0
Trinidad State Beach at Mill Creek <sup>a</sup>	85.9	5.4	8.7	0
Caspar Beach at Caspar Creek <sup>b</sup>	80.4	3.9	13.8	1.9
Hare Beach at Hare Creek <sup>b</sup>	65.5	3.7	30	0.8
MacKerricher State Park at Virgin Creek <sup>b</sup>	33.3	37.1	29.5	0.1
Mendocino Bay at Big River <sup>b</sup>	81.3	4	8.2	6.5
Pudding Beach at Pudding Creek <sup>b</sup>	38.4	7.9	52.7	1
Caspar Beach at Caspar Creek <sup>b</sup>	80.4	3.9	13.8	1.9
Campbell Cove at Bodega Bay <sup>c</sup>	2.6	76.6	17.3	3.5

<sup>a</sup>Impaired Beach is in Humboldt County

<sup>b</sup>Impaired Beach is in Mendocino County

<sup>c</sup>Impaired Beach is in Sonoma County

**Table 12 The Percentage of the Impaired Beach Study Sampling Station Watersheds Covered by the Land Use Categories**

<b>Station Name</b>	<b>Developed Sewered</b>	<b>Developed Unsewered</b>	<b>Grazing</b>	<b>Undeveloped</b>
Clam Beach at Mad River <sup>a</sup>	63.3	6.6	13.4	16.7
Clam Beach at Strawberry Creek <sup>a</sup>	64.6	0.4	13.2	21.8
Luffenholtz Beach at Luffenholtz Creek <sup>a</sup>	0	20.7	0	79.3
Moonstone Beach at Little River <sup>a,d</sup>	0.2	5.7	7.2	86.9
Old Home Beach at Scenic Drive <sup>a</sup>	0	51.5	0	48.6
Trinidad State Beach at Mill Creek <sup>a</sup>	0	15.3	0.4	84.4
Caspar Beach at Caspar Creek <sup>b</sup>	0	8.5	1.2	90.4
Hare Beach at Hare Creek <sup>b</sup>	0	49.1	0.1	50.8
MacKerricher State Park at Virgin Creek <sup>b,d</sup>	0	58.8	33	8.2



Station Name	Developed Sewered	Developed Unsewered	Grazing	Undeveloped
Mendocino Bay at Big River <sup>b</sup>	2.1	29.9	0	68
Pudding Beach at Pudding Creek <sup>b</sup>	0	78.7	1.7	19.6
Campbell Cove at Bodega Bay <sup>c,d</sup>	0	20.7	60.6	18.7

<sup>a</sup>Impaired Beach is in Humboldt County

<sup>b</sup>Impaired Beach is in Mendocino County

<sup>c</sup>Impaired Beach is in Sonoma County

<sup>d</sup>The watersheds of the Moonstone Beach at Little River, MacKerricher State Park at Virgin Creek, and Campbell Cove at Bodega Bay stations contain non-dairy cattle grazing

**Table 13 The Detection Percentage of MST markers in the Impaired Beach Study Sampling Station samples collected<sup>a</sup>**

Station Name	Sampling Season <sup>e</sup>	Dog	Gull	Human	Ruminant <sup>f</sup>
Clam Beach at Mad River <sup>b</sup>	Dry	0	83.3	0	16.7
Clam Beach at Strawberry Creek <sup>b</sup>	Dry	50	83.3	33.3	16.7
Luffenholtz Beach at Luffenholtz Creek <sup>b</sup>	Dry	50	100	0	33.3
Moonstone Beach at Little River <sup>b</sup>	Dry	83.3	100	0	50

Station Name	Sampling Season <sup>e</sup>	Dog	Gull	Human	Ruminant <sup>f</sup>
Old Home Beach at Scenic Drive <sup>b</sup>	Dry	16.7	83.3	0	0
Trinidad State Beach at Mill Creek <sup>b</sup>	Dry	50	83.3	0	0
Caspar Beach at Caspar Creek <sup>c</sup>	Dry	20	80	0	0
Hare Beach at Hare Creek <sup>c</sup>	Dry	20	100	20	0
MacKerricher State Park at Virgin Creek <sup>c</sup>	Dry	0	100	0	0
Mendocino Bay at Big River <sup>c</sup>	Dry	20	100	0	0
Pudding Beach at Pudding Creek <sup>c</sup>	Dry	0	100	20	0
Campbell Cove at Bodega Bay <sup>d</sup>	Dry	25	87.5	0	0

<sup>a</sup>Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%.

<sup>b</sup>Impaired Beach in Humboldt County

<sup>c</sup>Impaired Beach in Mendocino County

<sup>d</sup>Impaired Beach in Sonoma County

<sup>e</sup>Samples were only collected during the dry weather period. No samples were collected during the wet weather period

<sup>f</sup>The ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste.

### **4.3. Source Assessment Study**

The results from the analysis of land cover, land use and grazing presence, and MST data collected from the sampling stations of the Source Assessment Study are presented in Tables 14, 15, and 16 respectively. There are four sampling stations for which watersheds could not be delineated because of level topography around the sampling station, or the sampling station being in a channelized or partially underground drain system. These sampling stations are: Grotzman Creek at Bayside Road, Liscom Slough at Jackson Road, Unnamed Slough at Lanphere Road, and Unnamed Slough at Ranch Road. Although the lack of a watershed delineation results in the absence of numeric information on the land cover and land use categories for these sampling stations, local knowledge, field assessments, and publicly available aerial imagery was used to identify the land cover and land use proximal to these sampling stations.

**Table 14 The Percentage of the Source Assessment Study Sampling Station Watersheds Covered by the Land Cover Categories**

<b>Station Name</b>	<b>Forest</b>	<b>Grassland/Shrub</b>	<b>Urban/Developed</b>	<b>Other</b>
Campbell Creek at 14th Street & Union Street	87.9	0.2	11.9	0
Campbell Creek at 7th Street	53.9	0.2	45.8	0.1
Cooper Gulch at Myrtle Avenue & 8th Street	5.3	3.2	82.8	8.7
Elk River at Zanes Road	88.8	6.2	4.4	0.6
Elk River South Fork at Headwaters Forest	96.4	1	2.6	0

<b>Station Name</b>	<b>Forest</b>	<b>Grassland/Shrub</b>	<b>Urban/Developed</b>	<b>Other</b>
Freshwater Creek at County Park	93.6	4.9	1.5	0
Graham Gulch at Pacific Lumber Camp Road	92	4.3	3.7	0
Jacoby Creek at Jacoby Creek Road	89.9	3.8	6.2	0.1
Jacoby Creek at Old Arcata Road	82.1	9.4	8.1	0.4
Martin Slough at Campton Street & Fern Street	23.8	3.7	69.5	3
McDaniel Slough at Q Street	52.1	6.2	41.1	0.6
Mill Creek at Stagecoach Road	89.4	5.3	5.3	0
Salmon Creek at Eel River Drive	60.8	32.2	5.9	1.1
Strawberry Creek at Highway 101	61.2	16.4	22.3	0.1
Swain Slough at Elk River Road	13.9	66.6	10.7	8.8

Station Name	Forest	Grassland/Shrub	Urban/Developed	Other
Unnamed Stream at Anker Road	89.6	5.8	4.6	0

**Table 15 The Percentage of the Source Assessment Study Sampling Station Watersheds Covered by the Land Use Categories**

Station Name	Developed Sewered	Developed Unsewered	Grazing	Undeveloped
Campbell Creek at 14th Street & Union Street	27.8	2.6	0	69.9
Campbell Creek at 7th Street	53.8	1.7	0	34.6
Cooper Gulch at Myrtle Avenue & 8th Street	94.8	0	0	5.2
Elk River at Zanes Road <sup>a</sup>	0	15.2	7.2	77.7
Elk River South Fork at Headwaters Forest	0	0	0	100
Freshwater Creek at County Park	0	8.9	0	91.1
Graham Gulch at Pacific Lumber Camp Road	0	10.2	0	89.8

Station Name	Developed Sewered	Developed Unsewered	Grazing	Undeveloped
Jacoby Creek at Jacoby Creek Road	0	18.4	0	81.6
Jacoby Creek at Old Arcata Road	0	29.8	3.2	67
Martin Slough at Campton Street & Fern Street	80.3	0	0	19.7
McDaniel Slough at Q Street	43.7	2.9	3.6	49.8
Mill Creek at Stagecoach Road	0	11.6	0	88.4
Salmon Creek at Eel River Drive <sup>b</sup>	0	11	31.7	57.2
Strawberry Creek at Highway 101	76.5	0	0	23.5
Swain Slough at Elk River Road <sup>a</sup>	13.9	0	65.3	20.8
Unnamed Stream at Anker Road	20	0	0	80

<sup>a</sup>The watersheds of the Elk River at Zanes Road and Swain Slough at Elk River sampling stations contain dairy cattle grazing

<sup>b</sup>The watershed of the Salmon Creek at Eel River Drive sampling station contains both dairy cattle and non-dairy cattle grazing.

**Table 16 The Detection Percentage of MST markers in the Source Assessment Study Sampling Station samples collected<sup>a</sup>**

<b>Station Name</b>	<b>Sampling Season</b>	<b>Dog</b>	<b>Gull</b>	<b>Human</b>	<b>Ruminant<sup>b</sup></b>
Campbell Creek at 14th Street & Union Street	Dry	0	0	0	0
Campbell Creek at 14th Street & Union Street	Wet	100	0	33.3	33.3
Campbell Creek at 7th Street	Dry	0	0	100	100
Campbell Creek at 7th Street	Wet	100	33.3	66.7	33.3
Cooper Gulch at Myrtle Avenue & 8th Street	Dry	100	0	50	0
Cooper Gulch at Myrtle Avenue & 8th Street	Wet	100	50	0	50
Elk River at Zanes Road	Dry	50	0	0	100
Elk River at Zanes Road	Wet	50	0	0	100
Elk River South Fork at Headwaters Forest	Dry	50	50	0	0
Elk River South Fork at Headwaters Forest	Wet	0	0	0	0

<b>Station Name</b>	<b>Sampling Season</b>	<b>Dog</b>	<b>Gull</b>	<b>Human</b>	<b>Ruminant<sup>b</sup></b>
Freshwater Creek at County Park	Dry	0	0	0	50
Freshwater Creek at County Park	Wet	0	0	0	100
Graham Gulch at Pacific Lumber Camp Road	Dry	0	0	0	0
Graham Gulch at Pacific Lumber Camp Road	Wet	0	0	0	100
Grotzman Creek at Bayside Road	Dry	0	0	100	0
Grotzman Creek at Bayside Road	Wet	50	50	50	50
Jacoby Creek at Jacoby Creek Road	Dry	0	0	0	50
Jacoby Creek at Jacoby Creek Road	Wet	50	0	50	50
Jacoby Creek at Old Arcata Road	Dry	100	0	0	0
Jacoby Creek at Old Arcata Road	Wet	50	0	0	50



Station Name	Sampling Season	Dog	Gull	Human	Ruminant <sup>b</sup>
Liscom Slough at Jackson Road	Dry	0	100	0	0
Liscom Slough at Jackson Road	Wet	100	100	66.7	100
Martin Slough at Campton Street & Fern Street	Dry	100	0	0	100
Martin Slough at Campton Street & Fern Street	Wet	100	0	50	100
McDaniel Slough at Q Street	Dry	0	0	100	0
McDaniel Slough at Q Street	Wet	66.7	33.3	0	66.7
Mill Creek at Stagecoach Road	Dry	0	0	0	0
Mill Creek at Stagecoach Road	Wet	50	0	50	0
Salmon Creek at Eel River Drive	Dry	50	0	0	100
Salmon Creek at Eel River Drive	Wet	50	0	0	100

Station Name	Sampling Season	Dog	Gull	Human	Ruminant <sup>b</sup>
Strawberry Creek at Highway 101	Dry	50	0	0	100
Strawberry Creek at Highway 101	Wet	50	0	50	50
Swain Slough at Elk River Road	Dry	0	0	0	100
Swain Slough at Elk River Road	Wet	50	100	50	100
Unnamed Slough at Lanphere Road	Dry	0	0	0	0
Unnamed Slough at Lanphere Road	Wet	66.7	0	66.7	100
Unnamed Slough at Ranch Road	Dry	0	0	0	100
Unnamed Slough at Ranch Road	Wet	50 <sup>c</sup>	0	0	100
Unnamed Stream at Anker Road	Dry	0	0	0	0
Unnamed Stream at Anker Road	Wet	50	50	0	50

<sup>a</sup>Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%.

<sup>b</sup>The ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste.

<sup>c</sup>Dogs are prohibited in the Humboldt Bay National Wildlife Refuge and U.S. Fish and Wildlife Service staff enforce this prohibition when any dogs are detected on refuge land (J. Storlie, personal communication, February 7, 2025). North Coast Water Board staff used the dog-specific marker DogBact to identify dog fecal waste in the water samples collected (North Coast Regional Water Quality Control Board, 2015). This marker is known to cross-react with other species and this marker is also found in wild canines such as coyote and fox (Griffith et al., 2013; Teaf et al., 2017). “Native canids such as coyote and gray fox occur on the refuge, with coyotes being commonly observed on the Salmon Creek Unit” (J. Storlie, personal communication, February 7, 2025). Therefore, the “likely source of contamination is native canids such as coyote and gray fox. Similar to other canid species, coyotes frequently use human constructed corridors such as roads and trails as travel routes. Driven by intraspecific and interspecific species competition and population dynamics, canids will regularly defecate along these travel routes, including the refuge access road” (J. Storlie, personal communication February 7, 2025). This sampling station is located near the refuge access road. Since the fecal waste identified at this sampling station is most likely to be from a wildlife source (coyote and/or gray fox) and not an anthropogenic source

#### **4.4. Jolly Giant Creek Monitoring Study**

The results from the analysis of land cover, land use and grazing presence, and MST data collected from the sampling stations of the Impaired Streams Monitoring Study are presented in Tables 17, 18, and 19 respectively. The four sampling stations upstream of the Samoa Boulevard sampling station all fall within the 5-km upstream watershed of the Samoa Boulevard sampling station.

**Table 17 The Percentage of the Jolly Giant Creek Monitoring Study Sampling Stations Watershed Covered by the Land Cover Categories**

<b>Forest</b>	<b>Grassland/Shrub</b>	<b>Urban/Developed</b>	<b>Other</b>
34.5	8.1	56.5	0.9

**Table 18 The Percentage of the Jolly Giant Creek Monitoring Study Sampling Stations Watershed Covered by the Land Use Categories<sup>a</sup>**

<b>Developed Sewered</b>	<b>Developed Unsewered</b>	<b>Grazing</b>	<b>Undeveloped</b>
44.6	8.3	0	47.1

<sup>a</sup>Grazing is not present in the Jolly Giant Creek sampling station watershed

**Table 19 The Detection Percentage of MST markers in the Jolly Giant Creek Monitoring Study Sampling Station samples collected<sup>a</sup>**

<b>Station Name</b>	<b>Sampling Season</b>	<b>Dog</b>	<b>Gull</b>	<b>Human</b>	<b>Ruminant<sup>b</sup></b>
Jolly Giant Creek at 14th Street near M Street	Dry	66.7	0	0	0
Jolly Giant Creek at 14th Street near M Street	Wet	66.7	66.7	33.3	33.3
Jolly Giant Creek at 7th and J Streets	Dry	0	0	0	0
Jolly Giant Creek at 7th and J Streets	Wet	100	66.7	66.7	33.3
Jolly Giant Creek at 9th and J Streets	Dry	66.7	0	100	33.3
Jolly Giant Creek at 9th and J Streets	Wet	100	66.7	100	100
Jolly Giant Creek at Alliance Road near 17th Street	Dry	66.7	0	100	0

Station Name	Sampling Season	Dog	Gull	Human	Ruminant <sup>b</sup>
Jolly Giant Creek at Alliance Road near 17th Street	Wet	100	66.7	100	66.7
Jolly Giant Creek at Samoa Boulevard	Dry	66.7	33.3	100	0
Jolly Giant Creek at Samoa Boulevard	Wet	100	66.7	100	66.7

<sup>a</sup>Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%.

<sup>b</sup>The ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste.

#### 4.5. Humboldt County APMP Study

The results from the analysis of land cover, land use and grazing presence, and MST data collected from the sampling stations of the Humboldt County DEH Study are presented in Tables 20, 21, and 22 respectively.

**Table 20 The Percentage of the Humboldt County APMP Study Sampling Station Watersheds Covered by the Land Cover Categories**

Station Name	Forest	Grassland/Shrub	Urban/Developed	Other
Joland Creek	66.7	0	33.3	0
Little River	84.8	7.4	3.3	4.5
Luffenholtz Creek at City of Trinidad	95.3	4	0.7	0

Station Name	Forest	Grassland/Shrub	Urban/Developed	Other
Luffenholtz Creek at Mouth	91.6	3.6	4.7	0.1
Mill Creek at Mouth	86.3	5.3	8.4	0
Parker Creek at Mouth	63.1	2.1	34.8	0
Parker Creek at Westhaven Drive	72.4	3.3	24.3	0
Patrick Creek	22.2	62.4	13	2.4
Strawberry Creek at Dows Prairie	69.6	14.3	16	0.1
Strawberry Creek at Duke Creek	71.5	16.4	12	0.1
Strawberry Creek at Rose Creek	83	9.7	7.2	0.1
Strawberry Creek East of Highway 101	61.9	16.4	21.7	0
Two Creeks	48.8	2	49.2	0

**Table 21 The Percentage of the Humboldt County APMP Study Sampling Station Watersheds Covered by the Land Use Categories**

<b>Station Name</b>	<b>Developed Sewered</b>	<b>Developed Unsewered</b>	<b>Grazing</b>	<b>Undeveloped</b>
Joland Creek	0	92.6	0	7.4
Little River <sup>a</sup>	1	2.7	6	90.3
Luffenholtz Creek at City of Trinidad	0	20.2	0	79.8
Luffenholtz Creek at Mouth	0	20.2	0	79.8
Mill Creek at Mouth	0	14.6	0.4	85.1
Parker Creek at Mouth	0	45.9	0	54.1
Parker Creek at Westhaven Drive	0	25.9	0	74.1
Patrick Creek <sup>a</sup>	24.8	1.9	65.7	7.5
Strawberry Creek at Dows Prairie	72.7	0	0	27.3

Station Name	Developed Sewered	Developed Unsewered	Grazing	Undeveloped
Strawberry Creek at Duke Creek	96	0	0	4
Strawberry Creek at Rose Creek	59.6	0	0	40.4
Strawberry Creek East of Highway 101	76.4	0	0	23.6
Two Creeks	0	77.9	0	22.1

<sup>a</sup>The watersheds of the Little River and Patrick Creek sampling stations contain non-dairy cattle grazing.

**Table 22 The Detection Percentage of MST markers in the Humboldt County APMP Study Sampling Station samples collected<sup>a</sup>**

Station Name	Sampling Season <sup>b</sup>	Dog	Gull	Human	Ruminant <sup>c</sup>
Joland Creek	Wet	60	20	40	20
Little River	Wet	50	33.3	0	66.7
Luffenholtz Creek at City of Trinidad	Wet	50	0	16.7	0
Luffenholtz Creek at Mouth	Wet	33.3	0	16.7	16.7



Station Name	Sampling Season <sup>b</sup>	Dog	Gull	Human	Ruminant <sup>c</sup>
Mill Creek at Mouth	Wet	50	16.7	16.7	16.7
Parker Creek at Mouth	Wet	33.3	33.3	16.7	16.7
Parker Creek at Westhaven Drive	Wet	66.7	16.7	16.7	33.3
Patrick Creek	Wet	40	20	33.3	60
Strawberry Creek at Dows Prairie	Wet	20	40	0	20
Strawberry Creek at Duke Creek	Wet	25	25	0	25
Strawberry Creek at Rose Creek	Wet	0	40	0	0
Strawberry Creek East of Highway 101	Wet	20	40	16.7	20
Two Creeks	Wet	60	20	40	40

<sup>a</sup>Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%.

<sup>b</sup>No dry weather samples were collected under the Humboldt County APMP Study.

<sup>c</sup>The ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste.

#### 4.6. Humboldt Waterkeeper Study

The results from the analysis of MST data collected from the sampling stations of the Humboldt Waterkeeper Study are presented in Table 23. Land cover, and land use analysis results are unavailable since these data were submitted after land cover and land use assessment for the CPP was complete.

**Table 23 The Detection Percentage of MST markers in the Humboldt Waterkeeper Study Sampling Station samples collected<sup>a</sup>**

Station Name	Sampling Season	Dog	Gull	Human	Ruminant <sup>b</sup>
Little River at Crannel Road	Dry	0	0	0	100
Little River at Crannel Road	Wet	0	0	0	100
Little River at Highway 101	Dry	0	0	0	100
Little River at Highway 101	Wet	100	0	0	100
Little River Tributary at Highway 101	Dry	33.3	0	33.3	0
Little River Tributary at Highway 101	Wet	100	0	100	0
Janes Creek at Arcata Community at Forest Trail 12	Dry	0	0	0	0
Janes Creek at Arcata Community at Forest Trail 12	Wet	0	0	0	0

<b>Station Name</b>	<b>Sampling Season</b>	<b>Dog</b>	<b>Gull</b>	<b>Human</b>	<b>Ruminant<sup>b</sup></b>
McDaniel Slough at Foster Avenue and Heather Lane	Dry	66.7	0	0	33.3
McDaniel Slough at Foster Avenue and Heather Lane	Wet	100	100	0	100
McDaniel Slough at Highway 101	Dry	33.3	0	0	0
McDaniel Slough at Highway 101	Wet	100	0	0	100
McDaniel Slough at Hilfiker Drive	Dry	33.3	0	0	66.7
McDaniel Slough at Hilfiker Drive	Wet	100	0	0	100
McDaniel Slough at Samoa Boulevard	Dry	33.3	0	33.3	0
McDaniel Slough at Samoa Boulevard	Wet	100	100	0	100

<sup>a</sup>Since more than one marker can be detected in one sample the sum of the detection percentage of each marker at a sampling station can exceed 100%.

<sup>b</sup>The ruminant-specific marker used (Rum2Bac) detects both bovine (cattle-associated) and non-bovine (associated with other ruminants such as deer, elk, etc.) fecal waste.

## **5. Identification of Major Controllable Anthropogenic Fecal Waste Sources**

North Coast Water Board staff categorized and then further analyzed land cover, land use, and MST data collected from stations sampled under studies with QAPPs to determine the major controllable anthropogenic fecal waste sources to these sampling stations. As a result of the assessment sampling stations with controllable anthropogenic contributors were identified as having either one or a combination of dog, human, and cattle contributors, even if the assessment showed that these stations also had major fecal contributions from wildlife sources such as deer, elk and shorebirds. North Coast Water Board staff are focusing on addressing controllable anthropogenic fecal waste sources since human, dog, and cattle waste are more harmful to public health than ruminant wildlife (deer, elk), or gull and shorebird waste (Griffith et al., 2013; Koskey et al., 2014; Wright et al., 2009). North Coast Water Board staff only analyzed those stations sampled under studies with QAPPs (available at the time of data assessment) since exceedances of the REC-1 and/or SHELL objectives could only be calculated for these sampling stations. Regional Board staff developed a source control strategy based on information provided by water quality assessment (exceedances of the REC-1 and/or SHELL objective) as well as the controllable anthropogenic fecal waste sources identified. Therefore, data collected under the following studies was evaluated - the Impaired Streams Monitoring Study, the Impaired Beaches Monitoring Study, the Source Assessment Study and the Jolly Giant Creek Monitoring Study.

### **5.1. Categorization and Identification Process**

The following lines of evidence were used to identify major controllable anthropogenic fecal waste sources at the stations evaluated:

1. The land cover and land use coverage and MST marker detection for each sampling station with available data were categorized as “high”, “medium”, “low”, “negligible” and “none” using on thresholds based on reviews of published literature, and through the use of best professional judgement (Table 24).
2. The MST markers (dog-, gull-, human-, or ruminant-specific markers) with a high or medium percent detection in either the wet or dry period were identified for each sampling station analyzed
3. The three most prevalent land cover categories (forest, grassland/shrubs, or urban/developed) with a high or medium percent coverage in the sampling station watershed were identified for each sampling station analyzed
4. The land use categories (developed sewer, developed unsewered [OWTS], grazing, or undeveloped) with a high or medium percent coverage in the sampling station watershed were identified for each sampling station analyzed
5. The presence or absence of dairy cattle and/or non-dairy cattle operations within the sampling station watershed was noted for each sampling station analyzed

6. All four lines of evidence described above (MST markers, land cover, land use, and grazing presence) were then evaluated together to identify the major anthropogenic or wildlife contributor to fecal pollution at the sampling station evaluated.
7. For the four sampling stations for which a watershed could not be delineated, land cover and land use information obtained using desktop and field assessment was used to identify major anthropogenic or wildlife contributors of fecal waste.
8. Sampling stations with no controllable anthropogenic contributors were classified as having “no anthropogenic contributors identified” since available data analysis indicated that fecal pollution detected at these locations was most likely due to wildlife sources (gulls, shorebirds, deer, and elk).

North Coast Water Board staff are focusing on only those land cover, land use and MST categories and markers with high or medium percent coverage and detection since these categories and markers are most likely to contribute to fecal pollution detected in the waterbodies analyzed. At all 12 beach stations sampled, the gull-specific marker was detected at the highest rate, however staff recommends that the source control focus will be on any anthropogenic sources of fecal waste detected at these beaches (dog, human, and cattle) and not the wildlife sources of fecal waste detected at these beaches (shorebirds, deer, elk etc.) since fecal waste from humans, dogs, and cattle are more harmful to public health than shorebird or ruminant wildlife fecal sources (Griffith et al., 2013; Koskey et al., 2014; Wright et al., 2009).

**Table 24 Source Assessment Data Categories**

<b>Category</b>	<b>Percent Coverage of Land Use or Land Cover Category or Percent Detection of MST Marker (%)</b>
High	$\geq 50$ to $\leq 100$
Medium	$\geq 20$ to $< 50$
Low	$\geq 5$ to $< 20$
Negligible	$>0$ to $<5$

Category	Percent Coverage of Land Use or Land Cover Category or Percent Detection of MST Marker (%)
None	0

## 5.2. Major Controllable Anthropogenic Fecal Sources Identified at Sampling Stations Evaluated

North Coast Water Board staff used available FIB, land cover, land use, grazing presence and MST data and the method described in Section 5.1 to identify the major controllable anthropogenic sources to the waterbodies sampled under the Impaired Streams Monitoring Study, the Impaired Beaches Monitoring Study, the Source Assessment Study and the Jolly Giant Creek Monitoring Study. The Impairment/Exceedance status of the waterbodies evaluated along with the major controllable anthropogenic fecal sources identified for each waterbody are listed in Table 25.

**Table 25 Waterbody Impairment/Exceedance Status and Major Controllable Anthropogenic Fecal Source**

Station Name	Impairment/Exceedance Status	Major Controllable Anthropogenic Fecal Waste Source(s)
Elk River at Highway 101	Currently Listed as REC-1 Impaired	Dog + Human + Dairy Cattle
Gannon Slough at Highway 101	Currently Listed as REC-1 Impaired	Dog + Human
Jolly Giant Creek at Samoa Boulevard	Currently Listed as REC-1 Impaired	Dog + Human
Little River at Highway 101	Currently Listed as REC-1 Impaired	Dog + Non-dairy Cattle

<b>Station Name</b>	<b>Impairment/Exceedance Status</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Martin Slough at Pine Hill Road	Currently Listed as REC-1 Impaired	Dog + Human
Clam Beach at Mad River	Currently Listed as SHELL Impaired	No Controllable Anthropogenic Sources Identified
Clam Beach at Strawberry Creek	Currently Listed as REC-1 & SHELL Impaired	Dog + Human
Luffenholtz Beach at Luffenholtz Creek	Currently Listed as REC-1 & SHELL Impaired	Dog
Old Home Beach at Scenic Drive	Currently Listed as SHELL Impaired	No Controllable Anthropogenic Sources Identified
Moonstone Beach at Little River	Currently Listed as SHELL Impaired	Dog + Non-dairy Cattle
Trinidad State Beach at Mill Creek	Currently Listed as REC-1 & SHELL Impaired	Dog
Caspar Beach at Caspar Creek	Currently Listed as SHELL Impaired	Dog
Hare Beach at Hare Creek	Currently Listed as SHELL Impaired	Dog + Human
MacKerricher State Park at Virgin Creek	Currently Listed as SHELL Impaired	No Controllable Anthropogenic Sources Identified

<b>Station Name</b>	<b>Impairment/Exceedance Status</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Mendocino Bay at Big River	Currently Listed as SHELL Impaired	Dog
Pudding Beach at Pudding Creek	Currently Listed as SHELL Impaired	Human
Campbell Cove at Bodega Bay	Currently Listed as REC-1 & SHELL Impaired	Dog
Campbell Creek at 14th Street & Union Street	At least one exceedance of the REC-1 objective	Dog + Human
Campbell Creek at 7th Street	At least one exceedance of the REC-1 objective	Dog + Human
Cooper Gulch at Myrtle Avenue & 8th Street	At least one exceedance of the REC-1 objective	Dog + Human
Elk River at Zanes Road	At least one exceedance of the REC-1 objective	Dog + Dairy Cattle
Grotzman Creek at Bayside Road	At least one exceedance of the REC-1 objective	Dog + Human
Jacoby Creek at Old Arcata Road	At least one exceedance of the REC-1 objective	Dog
Jolly Giant Creek at 14th Street near M Street	At least one exceedance of the REC-1 objective	Dog + Human



<b>Station Name</b>	<b>Impairment/Exceedance Status</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Jolly Giant Creek at 7th Street and J Street	At least one exceedance of the REC-1 objective	Dog + Human
Jolly Giant Creek at 9th Street and J Street	At least one exceedance of the REC-1 objective	Dog + Human
Jolly Giant Creek at Alliance Road near 17th Street	At least one exceedance of the REC-1 objective	Dog + Human
Liscom Slough at Jackson Road	At least one exceedance of the REC-1 objective	Dog + Human + Dairy Cattle
Martin Slough at Campton Street & Fern Street	At least one exceedance of the REC-1 objective	Dog + Human
McDaniel Slough at Q Street	At least one exceedance of the REC-1 objective	Dog + Human
Salmon Creek at Eel River Drive	At least one exceedance of the REC-1 objective	Dog + Dairy Cattle + Non-dairy Cattle
Unnamed Slough at Lanphere Road	At least one exceedance of the REC-1 objective	Dog + Human + dairy cattle
Unnamed Slough at Ranch Road	At least one exceedance of the REC-1 objective	Dairy Cattle + Non-dairy Cattle
Jacoby Creek at Jacoby Creek Road	Zero Exceedances of the REC-1 objective	Dog + Human

<b>Station Name</b>	<b>Impairment/Exceedance Status</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Mill Creek at Stagecoach Road	Zero Exceedances of the REC-1 objective	Dog + Human
South Fork Elk River at Headwaters Forest	Zero Exceedances of the REC-1 objective	Dog
Strawberry Creek at Highway 101	Zero Exceedances of the REC-1 objective	Dog + Human
Swain Slough at Elk River Road	Zero Exceedances of the REC-1 objective	Dog + Human + Dairy cattle + Non-dairy Cattle
Unnamed Stream at Anker Road	Zero Exceedances of the REC-1 objective	Dog

## 6. Source Control and Implementation Plan Overview

North Coast Water Board Staff developed a source control plan based on the impairment of beneficial uses or exceedance of water quality objectives for each waterbody sampling station, along with the major controllable anthropogenic sources identified for each waterbody sampling station. Details of this source control plan, known as the Coastal Pathogen Implementation Plan (Implementation Plan), are provided in the document entitled “Category 4b Demonstration for Pathogen Impaired Waterbodies along the North Coast”.

The Implementation Plan relies on the use of existing regulatory mechanisms, in the areas sampled, to address fecal pollution originating from humans, dogs, and cattle. In the case of dog waste and human fecal waste source control will focus on the implementation of the Phase II Municipal Separate Storm Sewer Systems (MS4) Permit, local Waste Discharge Requirement (WDR) Permits, the Sanitary Sewer Systems General Order, Local Area Management Program (LAMP) Requirements, and other existing local (County- and City-level) regulatory mechanisms in use to address dog and human fecal waste. Dairy cattle fecal waste source control will employ existing dairy permit requirements while prioritizing compliance in watersheds of stations with identified dairy cattle fecal waste sources, and in the case of non-dairy cattle fecal waste, source control will rely on enforcement action as needed.

Source control will be prioritized first for impaired streams and beaches (sampled under studies with QAPPs) that have been placed on the “Impaired Waterbody Action List” (Action List [Table 26]), with a goal to address the impairment of beneficial use identified for these waterbodies. Streams (sampled from studies with QAPPs) with at least one exceedance of the REC-1 objective have been placed on the “Waterbody Watch List” (Watch List [Table 27]). Source control for the Action List will be prioritized first for source control. Watch List streams will be prioritized after the Action List waterbodies are addressed because addressing the Watch List streams now will prevent them from becoming impaired in the future. The three impaired beaches that did not show evidence of anthropogenic fecal sources are not addressed in the Implementation Plan.

**Table 26 Impaired Waterbody Action List**

<b>Station Name</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Elk River at Highway 101	Dog + Human + Dairy Cattle

Station Name	Major Controllable Anthropogenic Fecal Waste Source(s)
Gannon Slough at Highway 101	Dog + Human
Jolly Giant Creek at Samoa Boulevard	Dog + Human
Little River at Highway 101	Dog + Non-dairy Cattle
Martin Slough at Pine Hill Road	Dog + Human
Clam Beach at Strawberry Creek	Dog + Human
Luffenholtz Beach at Luffenholtz Creek	Dog
Moonstone Beach at Little River	Dog + Non-dairy Cattle
Trinidad State Beach at Mill Creek	Dog
Caspar Beach at Caspar Creek	Dog
Hare Beach at Hare Creek	Dog + Human

<b>Station Name</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Mendocino Bay at Big River	Dog
Pudding Beach at Pudding Creek	Human
Campbell Cove at Bodega Bay	Dog

**Table 27 Waterbody Watch List**

<b>Station Name</b>	<b>Major Controllable Anthropogenic Fecal Waste Source(s)</b>
Campbell Creek at 14th Street & Union Street	Dog + Human
Campbell Creek at 7th Street	Dog + Human
Cooper Gulch at Myrtle Avenue & 8th Street	Dog + Human
Elk River at Zanes Road	Dog + Dairy Cattle
Grotzman Creek at Bayside Road	Dog + Human
Jacoby Creek at Old Arcata Road	Dog

Station Name	Major Controllable Anthropogenic Fecal Waste Source(s)
Jolly Giant Creek at 14th Street near M Street	Dog + Human
Jolly Giant Creek at 7th Street and J Street	Dog + Human
Jolly Giant Creek at 9th Street and J Street	Dog + Human
Jolly Giant Creek at Alliance Road near 17th Street	Dog + Human
Liscom Slough at Jackson Road	Dog + Human + Dairy Cattle
Martin Slough at Campton Street & Fern Street	Dog + Human
McDaniel Slough at Q Street	Dog + Human
Salmon Creek at Eel River Drive	Dog + Dairy Cattle + Non-dairy Cattle
Swain Slough at Elk River Road	Dog + Human + Dairy Cattle
Unnamed Slough at Lanphere Road	Dog + Human + Dairy Cattle

Station Name	Major Controllable Anthropogenic Fecal Waste Source(s)
Unnamed Slough at Ranch Road	Dairy Cattle

## 7. References

- California Department of Water Resources. (2023). *CDEC Station Locator*. California Data Exchange Center. <https://cdec.water.ca.gov/cdecstations>
- Griffith, J. F., Layton, B. A., Boehm, A. B., Holden, P. A., Jay, J. A., Hagedorn, C., McGee, C. D., & Weisberg, S. B. (2013). *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches*.
- Koskey, A. M., Fisher, J. C., Traudt, M. F., Newton, R. J., & McLellan, S. L. (2014). Analysis of the Gull Fecal Microbial Community Reveals the Dominance of *Catellibacterium marimammali* in Relation to Culturable Enterococci. *Applied and Environmental Microbiology*, 80(2), 757–765. <https://doi.org/10.1128/AEM.02414-13>
- National Oceanic and Atmospheric Administration. (2024). *What is the difference between land cover and land use?* Ocean Facts. <https://oceanservice.noaa.gov/facts/lclu.html#:~:text=Land cover data documents how,%2C conservation%2C or mixed uses.>
- North Coast Regional Water Quality Control Board. (2005). *North Coast Regional Water Quality Control Board Watershed Planning Chapter*.
- North Coast Regional Water Quality Control Board. (2015). *Coastal Watershed Pathogen Indicator Study Quality Assurance Project Plan*.
- North Coast Regional Water Quality Control Board. (2021). *Jolly Giant Creek Monitoring Plan*.
- North Coast Regional Water Quality Control Board. (2023a). *Assessment of Fecal Indicator Bacteria and Microbial Source Tracking Data from Jolly Giant Creek*.
- North Coast Regional Water Quality Control Board. (2023b). *Assessment of Fecal Indicator Bacteria Data from 19 North Coast Ocean Beaches*.
- North Coast Regional Water Quality Control Board. (2023c). *Assessment of Fecal Indicator Bacteria Data from 21 Humboldt County Coastal Streams*.
- North Coast Regional Water Quality Control Board. (2024). *Assessment of Land Cover, Land Use, and Microbial Source Tracking Data from 26 Coastal Streams, and 12 Ocean Beaches in the North Coast Region*.
- Sohl, T. L. (2012). Chapter 1: Coast Range Ecoregion. In B. M. Sleeter, T. S. Wilson, & W. Acevedo (Eds.), *Status and Trends of Land Change in the Western United States - 1973 to 2000* (pp. 1794-A). United States Geological Survey. <http://pubs.usgs.gov/pp/1794/a/>
- State Water Resources Control Board. (2022). *2020-2022 California Integrated Report*. [https://www.waterboards.ca.gov/water\\_issues/programs/water\\_quality\\_assessment/2020\\_2022\\_integrated\\_report.html](https://www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/2020_2022_integrated_report.html)



- United States Environmental Protection Agency. (2012). *Fecal Bacteria*. Water Monitoring and Assessment.  
<https://archive.epa.gov/water/archive/web/html/vms511.html>
- United States Environmental Protection Agency. (2021). *Ecoregions* | US EPA.  
<https://www.epa.gov/eco-research/ecoregions>
- United States Environmental Protection Agency. (2023). *Water Quality Topics: Pathogens*. Water Quality and Climate Literature Review.  
[https://www.epa.gov/wqclr/water-quality-topics-pathogens#:~:text=Surface water and groundwater are,2010](https://www.epa.gov/wqclr/water-quality-topics-pathogens#:~:text=Surface water and groundwater are,2010))).
- United States Geological Survey. (2024). *Microbial source tracking*. Laboratory for Infectious Disease and the Environment - Capabilities.  
[https://www.usgs.gov/labs/laboratory-for-infectious-disease-and-the-environment/microbial-source-tracking#:~:text=Microbial source tracking \(MST\) identifies,humans%2C livestock%2C and wildlife](https://www.usgs.gov/labs/laboratory-for-infectious-disease-and-the-environment/microbial-source-tracking#:~:text=Microbial source tracking (MST) identifies,humans%2C livestock%2C and wildlife).
- Wright, M. E., Solo-Gabriele, H. M., Elmir, S., & Fleming, L. E. (2009). Microbial Load from Animal Feces at a Recreational Beach. *Marine Pollution Bulletin*, 58(11), 1649–1656. <https://doi.org/0.1016/j.marpolbul.2009.07.003>