Report

Surface Water Monitoring Conducted October 2021 through January 2022

Investigation of Cattle Waste Impacts on Surface Water Quality

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Prepared for
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EXECUTIVE SUMMARY

This report documents the results of surface water monitoring conducted October 2021 through January 2022 in the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds in Point Reyes National Seashore, Marin County, CA. The monitoring included collection of 125 surface water samples at 14 locations (Figure ES1). Fourteen monitoring events were conducted during the rainy season (Figure ES2). Although monitoring began following a 2-year recurrence frequency precipitation event, the results obtained from the October 2021-January 2022 monitoring are representative of surface water quality that should be expected on an annual basis during the rainy season.

The monitoring revealed frequent and significant exceedances of surface water quality objectives for the beneficial uses of Water Contact Recreation, Non-Contact Water Recreation, and Shellfish Harvesting (Table ES1).

The predominant source of contamination is cattle manure (Figure ES3).

Kehoe Watershed

Surface water quality in the Kehoe Watershed is severely impaired by cattle manure, primarily from the J-Ranch (Kehoe) and L-Ranch (McClelland) active dairies. Surface water at Kehoe Lagoon exhibits significant exceedances of bacteria objectives for Water Contact Recreation and Non-Contact Water Recreation beneficial uses, with multiple months exhibiting bacteria concentrations more than 10 times the objectives. North Kehoe Creek and South Kehoe Creek are similarly impaired.

Kehoe Lagoon receives frequent visitors year-round, including the rainy season. It is likely that visitors to Kehoe Lagoon and Kehoe Beach have contracted gastrointestinal illness from exposure to cattle manure pathogens. By 2010 (and likely earlier), the National Park Service's monitoring of surface water quality had definitively identified excessive, imminent human health risks to park visitors from exposure to cattle manure pathogens in the Kehoe Watershed. Despite full knowledge of these risks, the National Park Service has not posted warnings in the field or on its website.

For the Kehoe Watershed, the National Park Service's claim that conventional cattle manure management practices will adequately protect surface water quality is false. Adequate protection of surface water quality in the Kehoe Watershed requires reduction of the dairy herds, especially reduction of the J-Ranch (Kehoe) herd.

The October 2021-January 2022 monitoring, along with historical data in the Kehoe Watershed, have definitively established severe impairment during the rainy season. However, additional monitoring is needed during spring and summer to determine seasonal attenuation of surface water contamination. Additional spatial monitoring is also needed to determine contamination source locations more precisely.

Abbotts Watershed

Current surface water quality in the Abbotts Watershed does not frequently or significantly exceed objectives for Water Contact Recreation and Non-Contact Water Recreation beneficial uses. Substantial protection of water quality objectives is a consequence of liquidation of the I-Ranch (McClure) milking herd. Compared to the various cattle waste management practices (fencing, water supply, loafing barns) previously implemented in the Abbotts Watershed, liquidation of the I-Ranch milking herd has, by far, resulted in the most significant water quality improvement.

Drakes Estero Watershed

Surface water quality in the upstream reaches of Schooner Bay and Home Bay, including Home Ranch Lagoon, is severely impaired by cattle manure from seven beef cattle ranches. Significant exceedances of bacteria objectives for Water Contact Recreation and Shellfish Harvesting beneficial uses were documented during the October 2021-January 2022 monitoring, with multiple months exhibiting bacteria concentrations more than 10 times the objectives. The upstream reaches of Schooner Bay and Home Bay receive frequent visitors who water contact recreate (canoeing, kayaking, paddleboarding, wading, etc.) year-round, including the rainy season.

Additional monitoring is needed in the upstream reaches of Schooner Bay and Home Bay during spring and summer to determine seasonal attenuation of surface water contamination.

Drakes Bay Watershed

Surface water quality in the A-Ranch (Nunes) and B-Ranch (Double M, Mendoza) drainages of the Drakes Bay Watershed are significantly impaired by dairy cattle manure; both A-Ranch and B-Ranch are active dairies. For Water Contact Recreation beneficial use, bacteria concentrations were more than 10 times the objectives; and for Non-Contact Water Recreation beneficial use, bacteria concentrations were up to 2 times the objectives. Where the A-Ranch and B-Ranch drainages empty to Drakes Bay, Elephant Seals and Harbor Seals rest, mate, birth, and nurse and rear their young. While bacteria criteria are not available for seals, the measured concentrations are of particular concern because these areas are seal nurseries.

Hazardous Algal Blooms (HABs) and Hazardous Cyanobacteria Blooms (HCBs)

Macronutrient (nitrogen, phosphorus) loading from cattle manure in Kehoe Lagoon, Kehoe Marsh, South Kehoe Creek Marsh, Upper Abbotts Lagoon, Middle Abbotts Lagoon, and the upstream reaches of Drakes Estero are sufficient to cause Hazardous Algal Blooms and Hazardous Cyanobacteria Blooms. Climate change will increasingly proliferate these blooms. To date there has been no hazardous algal or hazardous cyanobacteria monitoring in the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds. Monitoring should be performed.

Table ES1 (page 1 of 3)

Exceedances of Surface Water Objectives for the Beneficial Uses of Water Contact Recreation, Non-Contact Water Recreation, and Shellfish Harvesting

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Watershed	Location ID	Location Description	Monitoring Period	Exceedances of Water Contact Recreation Objectives	Exceedances of Non-Contact Water Recreation Objectives	Exceedances of Shellfish Harvesting Objectives	Comments
Kehoe	PAC1S	South Kehoe Creek Downstream of I-Ranch and L-Ranch	25 Oct 21 to 12 Jan 22 (79 days)	• *E. coli* was **up to 8 times the objectives**. The objectives were exceeded for the duration of monitoring.			
	PAC1Z	South Kehoe Creek Downstream of L-Ranch	29 Dec 21 to 26 Jan 22 (28 days)	• *E. coli* was **up to 2 times the objectives**. The objectives were exceeded for the duration of monitoring.			
	PAC2	North Kehoe Creek at Pierce Point Road	25 Oct 21 to 12 Jan 22 (79 days)	• *E. coli* was **up to 34 times the objectives**. The objectives were exceeded for the duration of monitoring.	• Fecal Coliform was **up to 3 times the objectives**. The objectives were exceeded for the duration of monitoring.		• PAC2 is located at the parking area for Kehoe Beach/Kehoe Lagoon. The area receives frequent visitors year-round, including the rainy season. • Based on the exceedances at PAC2, it is likely that North Kehoe Creek, from PAC2 upstream to the J-Ranch milking complex, also exceeded objectives for Water Contact Recreation and Non-Contact Water Recreation.
	PAC3	Kehoe Lagoon	26 Oct 21 to 26 Jan 22 (91 days)	• *E. coli* was **up to 21 times the objectives**. The objectives were exceeded for the duration of monitoring.	• Fecal Coliform was **up to 6 times the objectives**. The objectives were exceeded from 26 Oct 21 to 22 Dec 21.		• The Kehoe Beach/Kehoe Lagoon area receives frequent visitors who wade in Kehoe Lagoon and the intermittent outlet stream from Kehoe Lagoon to the ocean. Water contact activities occur year-round, including the rainy season. • Visitors to the Kehoe Beach/Kehoe Lagoon area have likely contracted gastrointestinal illness from exposure to cattle manure.
Abbotts	ABB2/3	North Abbotts Creek Downstream of I-Ranch	25 Oct 21 to 12 Jan 22 (79 days)	• *E. coli* was **up to 4 times the objectives**. The objectives were exceeded for the duration of monitoring.			
	ABB4	Outflow from Middle Abbotts Lagoon	26 Oct 21 to 26 Jan 22 (92 days)	• Enterococci was **up to 2 times the objectives**. The objectives were exceeded from 26 Oct 21 to 22 Nov 21.			

Table ES1 (page 2 of 3)

Exceedances of Surface Water Objectives for the Beneficial Uses of Water Contact Recreation, Non-Contact Water Recreation, and Shellfish Harvesting

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Watershed	Location ID	Location Description	Monitoring Period	Exceedances of Water Contact Recreation Objectives	Exceedances of Non-Contact Water Recreation Objectives	Exceedances of Shellfish Harvesting Objectives	Comments
Drakes Estero	DES3*	Home Ranch Creek Downstream of Ranch Buildings	26 Oct 21 to 12 Jan 22 (78 days)	• *E. coli* was **up to 2 times the objectives**. The objectives were exceeded for the duration of monitoring.			
	DES6B*	Schooner Creek at Sir Francis Drake Blvd	25 Oct 21 to 12 Jan 22 (79 days)	• Enterococci was **up to 18 times the objectives**. The objectives were exceeded for the duration of monitoring.	• Fecal Coliform was **up to 2 times the objectives**. The objectives were exceeded from 25 Oct 21 to 14 Dec 21.	• Total Coliform was **up to 76 times the objectives** and Fecal Coliform was **up to 174 times the objectives**. The objectives were exceeded for the duration of monitoring.	• Upper Schooner Bay is a popular destination for canoeing, kayaking, paddleboarding, and wading. Except during the seal protection closure (1 March – 30 June), these activities occur year-round, including the rainy season.
	DES7*	Home Ranch Lagoon at Estero Trail Bridge	26 Oct 21 to 12 Jan 22 (78 days)	• Enterococci was **up to 10 times the objectives**. The objectives were exceeded for the duration of monitoring.		• Total Coliform was **up to 75 times the objectives** and Fecal Coliform was **up to 31 times the objectives**. The objectives were exceeded for the duration of monitoring.	• DES7 is located at the footbridge along the Estero Trail. The Estero Trail receives frequent visitors. DES7 is on the boundary of the Phillip Burton Wilderness. Upper Home Bay is a popular destination for canoeing, kayaking, paddleboarding, and wading. Except during the seal protection closure (1 March – 30 June), these activities occur year-round, including the rainy season.
Drakes Bay	DBY1*	C-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• *E. coli* was **up to 6 times the objectives**. The objectives were exceeded for the duration of monitoring.			• Visitors frequent Drakes Beach near the mouth of C-Ranch unnamed creek year-round, especially during the rainy season to observe seals.
	DBY2*	B-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• *E. coli* was **up to 11 times the objectives**. The objectives were exceeded for the duration of monitoring.	• Fecal Coliform was **up to 2 times the objectives**. The objectives were exceeded for the duration of monitoring.		• Visitors frequent Drakes Beach near the mouth of B-Ranch unnamed creek year-round, especially during the rainy season to observe seals. • See note "a" regarding potential ecological impacts to seals.
	DBY3	A-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• *E. coli* was **up to 13 times the objectives**. The objectives were exceeded for the duration of monitoring.	• Fecal Coliform was **up to 2 times the objectives**. The objectives were exceeded for the duration of monitoring.		• See note "a" regarding potential ecological impacts to seals.

Table ES1 (page 3 of 3)

Exceedances of Surface Water Objectives for the Beneficial Uses of Water Contact Recreation, Non-Contact Water Recreation, and Shellfish Harvesting

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

General Notes

(a) Where the A-Ranch and B-Ranch drainages empty to Drakes Bay, Elephant Seals and Harbor Seals rest, mate, birth, and nurse and rear their young. Seal pups are frequently observed within the outlet channels of the creeks. While bacteria criteria are not available for seals, the measured concentrations are of particular concern because these areas are seal nurseries.

(b) * = potential impact from Tule Elk manure.

For the entire Drakes Estero Watershed, the ratio of cattle manure discharge to land/elk manure discharge to land = 24; on a watershed wide basis, approximately 4% of the manure impacts result from elk. For monitoring locations DES3, DES6B, and DES7, elk manure impacts are greater because the Limantour Tule Elk herd grazes upstream of these locations.

For the entire Drakes Bay Watershed, the ratio of cattle manure discharge to land/elk manure discharge to land = 22; on a watershed wide basis, approximately 5% of the manure impacts result from elk. For monitoring locations DBY1 and DBY2, the elk manure impacts are greater because the Drakes Beach herd grazes upstream of these locations.

(c) Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

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

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries. Central Coast Regional Board (Region 3).

Beneficial Use definitions are verbatim from https://www.waterboards.ca.gov/about_us/performance_report_1314/plan_assess/docs/bu_definitions_012114.pdf

Monitoring Location (October 2021-January 2022)

Historical monitoring location

Actively Milking Dairy Ranch

Beef Ranch

Dairy Ranch Not Actively Milking (I-Ranch)

I-Ranch historically operated as an actively milking dairy. Circa June 2021, prior to the October 2021-January 2022 monitoring, I-Ranch liquidated the milking herd. A herd of approximately 125 heifers was maintained during the October 2021-January 2022 monitoring.

0 5,000 10,000

Approximate Scale - Feet

0 1 2

Approximate Scale - Miles

POINT REYES NATIONAL SEASHORE

GOLDEN GATE NATIONAL RECREATION AREA

PACIFIC OCEAN

J-Ranch

Kehoe Watershed

PAC2
North Kehoe Creek at Pierce Point Road

North Kehoe Creek

Kehoe Lagoon

PAC3
Kehoe Lagoon

PAC1S
South Kehoe Creek Downstream of I-Ranch and L-Ranch

I-Ranch

South Kehoe Creek

L-Ranch

North Abbotts Creek

ABB2/3
North Abbotts Creek Downstream of I-Ranch

PAC1Z
South Kehoe Creek Downstream of L-Ranch

ABB5
Outflow from Upper Abbotts Lagoon

ABB1
Abbotts Creek at Pierce Point Road

ABB4
Outflow from Middle Abbotts Lagoon

Abbotts Creek

Upper Abbotts Lagoon

Middle Abbotts Lagoon

Abbotts Watershed

North Schooner Creek

Lower Abbotts Lagoon

East Schooner Creek

RCA Meterological Station

DES2
East Schooner Creek at Sir Frances Drake Blvd

DES6B
Schooner Creek at Sir Francis Drake Blvd

Home Ranch Creek

Schooner Bay

DES7
Home Ranch Lagoon at Estero Trail Bridge

DES3
Home Ranch Creek Downstream of Ranch Buildings

Drakes Estero Watershed

Home Ranch Lagoon

Drakes Estero

Home Bay

C-Ranch

DBY1
C-Ranch Unnamed Creek

Estero de Limantour Watershed

Drakes Bay Watershed

B-Ranch

Except for the northern ±1/2 mile of Schooner Bay, the waters of Drakes Estero (including Home Bay) are part of the Phillip Burton Wilderness.

Drakes Bay

DBY2
B-Ranch Unnamed Creek

A-Ranch

DBY3
A-Ranch Unnamed Creek

POINT REYES NATIONAL SEASHORE

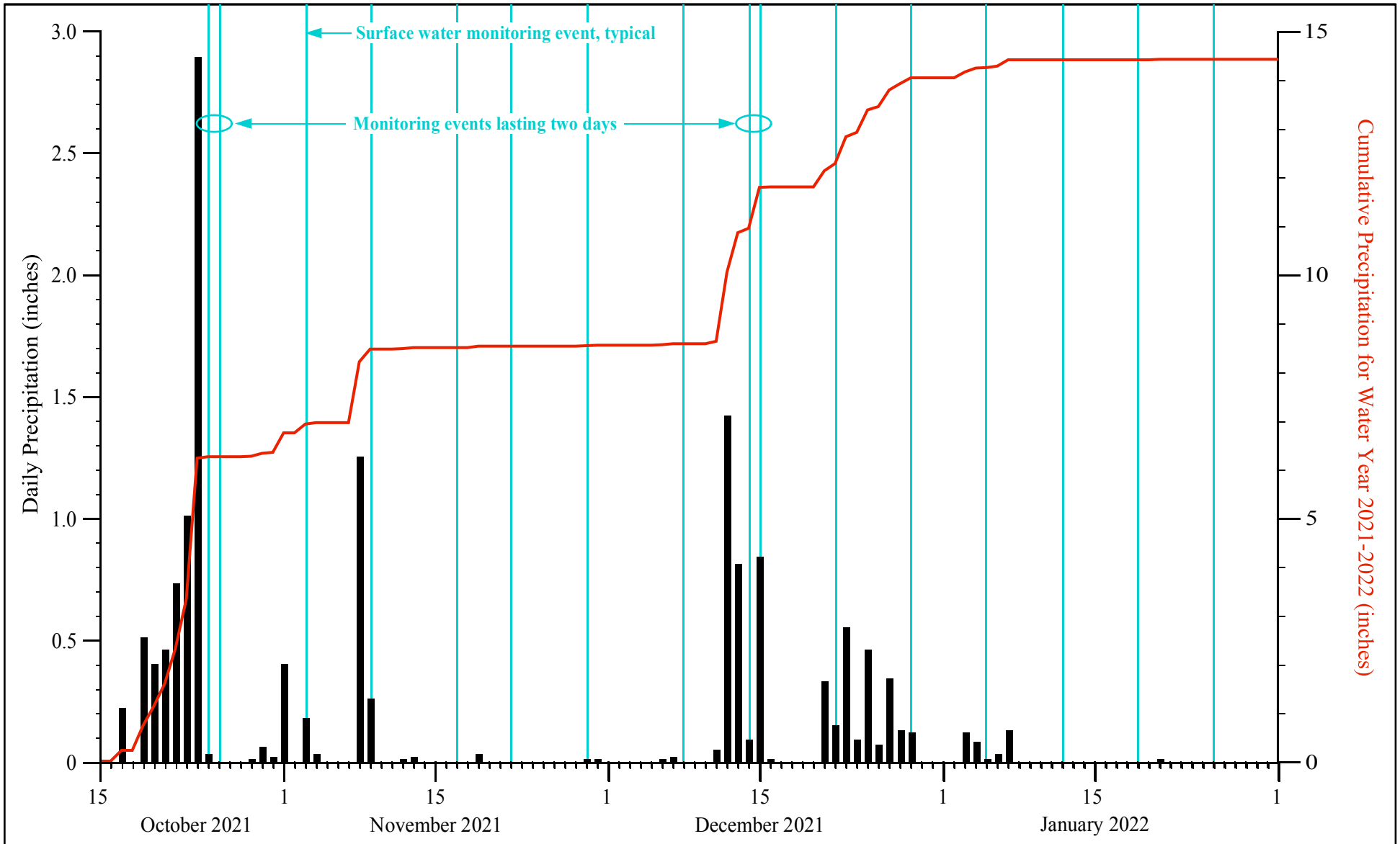
POINT REYES NATIONAL SEASHORE

POINT REYES NATIONAL SEASHORE

Figure ES1

Monitoring Locations (Topographic Basemap)

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds Point Reyes National Seashore Marin County CA



Notes

(a) Precipitation data from the RCA Meterological Station. (https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nvprca)

(b) All monitoring locations were within 7 miles of the RCA Meterological Station.

(c) Water Year runs from 1 October through 30 September.

(d) Cumulative precipitation for Water Year 2020-2021 = 9.6 inches.

Figure ES2

Daily and Cumulative Precipitation

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

- Monitoring Location (October 2021-January 2022)
- Historical monitoring location
- Actively Milking Dairy Ranch
- Beef Ranch
- Dairy Ranch Not Actively Milking (I-Ranch)

  I-Ranch historically operated as an actively milking dairy. Circa June 2021, prior to the October 2021-January 2022 monitoring, I-Ranch liquidated the milking herd. A herd of approximately 125 heifers was maintained during the October 2021-January 2022 monitoring.

Notes

(1) Annual Cattle Manure Loading = Total Cattle Manure Discharge to Land/Watershed Land Area.
(2) **The mass of cattle manure cited in this figure corresponds to circa October 2021, after liquidation of the I-Ranch milking herd.**
(3) The mass of Tule Elk manure cited in this figure corresponds to the National Park Service census for 2021.
(4) Manure Mass = wet weight, as excreted.
(5) **The (absolute) mass of manure cited on this figure is approximate. Relative comparisons are more accurate (between watersheds, dairy cattle versus beef cattle, cattle versus elk).**

0 5,000 10,000
Approximate Scale - Feet
0 1 2
Approximate Scale - Miles

J-Ranch
I-Ranch
L-Ranch
C-Ranch
B-Ranch
A-Ranch
Estero de Limantour Watershed

Kehoe Watershed
Annual Cattle Manure Loading = 8.6 tons/acre
Watershed Total Area = 2,380 acres
Watershed Land Area = 2,350 acres
Contained Dairy Ranch Leases = 1,030 acres
Contained Beef & Inactive Dairy Ranch Leases = 1,061 acres
Dairy Manure Discharge to Land = 18,760 tons/year
Beef Manure Discharge to Land = 1,516 tons/year
Tule Elk Manure Discharge to Land = ±0 tons/year

Abbotts Watershed
Annual Cattle Manure Loading = 1.3 tons/acre
Watershed Total Area = 3,640 acres
Watershed Land Area = 3,420 acres
Contained Dairy Ranch Leases = 315 acres
Contained Beef & Inactive Dairy Ranch Leases = ±2,214 acres
Dairy Manure Discharge to Land = ±0 tons/year
Beef Manure Discharge to Land = 4,418 tons/year
Tule Elk Manure Discharge to Land <73 tons/year

Drakes Estero Watershed
Annual Cattle Manure Loading = 1.3 tons/acre
Watershed Total Area = 11,100 acres
Watershed Land Area = 9,010 acres
Contained Dairy Ranch Leases = 0 acres
Contained Beef Ranch Leases = ±7,312 acres
Dairy Manure Discharge to Land = 0 tons/year
Beef Manure Discharge to Land = 12,092 tons/year
Tule Elk Manure Discharge to Land = 501 tons/year

Drakes Bay Watershed
Annual Cattle Manure Loading = 7.1 tons/acre
Watershed Total Area = 2,840 acres
Watershed Land Area = 2,760 acres
Contained Dairy Ranch Leases = 1,638 acres
Contained Beef Ranch Leases = ±436 acres
Dairy Manure Discharge to Land = 19,089 tons/year
Beef Manure Discharge to Land = 606 tons/year
Tule Elk Manure Discharge to Land = 909 tons/year

Figure ES3

Annual Manure Discharge to Land Circa October 2021

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds Point Reyes National Seashore Marin County CA

INTRODUCTION

This report documents the results of surface water monitoring conducted 25 October 2021 through 26 January 2022 at locations within Point Reyes National Seashore, Marin County CA. This report also includes January 2021 monitoring results that were previously reported (Lovell 2021). This report supersedes previous reports by Douglas Lovell (Lovell 2021, Lovell 2022a).

During the October 2021-January 2022 monitoring, fourteen locations were monitored in four watersheds (Figures 1 and 2, Table 1, Appendix A):

- Kehoe Watershed - including the north and south branches of Kehoe Creek, plus Kehoe Lagoon.
- Abbotts Watershed - including North Abbotts Creek, Abbotts Creek, the outflow from Upper Abbotts Lagoon, and the outflow from Middle Abbotts Lagoon.
- Drakes Estero Watershed - including Home Ranch Creek, the confluence of Schooner Creek with Schooner Bay, and the outflow of Home Ranch Lagoon to Home Bay.
- Drakes Bay Watershed - including three unnamed creeks.

The monitored locations are within watersheds containing dairy cattle and beef cattle operations that "contribute to poor water quality through bacteria and nutrient loading from animal waste and runoff" (Pawley and Lay 2013).

During the October 2021-January 2022 monitoring period, 14 monitoring events were conducted and 125 samples were collected (additional field duplicates and field blanks were collected) (Figure 3). Twelve of the events were performed during a single day; two of the events were 2-day events. For the October 2021-January 2022 monitoring, the typical frequency for many locations was weekly.

Environmental Action Committee of West Marin has performed surface water monitoring at two locations: (1) Drakes Bay near the Kenneth C. Patrick Visitor Center, and (2) Drakes Estero near the location of the former Drakes Bay Oyster Company (MEHS 2022); the monitoring has only recently included rainy season sampling. Surface water monitoring of several locations in the Kehoe, Abbotts, and Drakes Estero watersheds was conducted in January 2021 (Lovell 2021). The National Park Service monitored several locations in the Kehoe, Abbotts, and Drakes Estero watershed circa December 2021-January 2022 (National Park Service 2022c). Apart from these efforts, the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds have not been monitored since 2013 when the National Park Service suspended surface water monitoring. The National Park Service suspended surface water monitoring despite significant and frequent exceedances of water quality objectives. For the fourteen monitoring locations described in this report, the October 2021-January 2022 monitoring, along with the National Park Service's December 2021-January 2022 monitoring, provide the first set of Fecal Indicator Bacteria measurements allowing valid comparisons to current-day water quality objectives.

BACKGROUND

For surface water in the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds, concerns regarding cattle manure discharge include, but are not limited to:

- Human health and wildlife (aquatic and terrestrial) endangerment from exposure to Fecal Indicator Bacteria.
- Hazardous algal blooms (HABs) and hazardous cyanobacteria blooms (HCBs) from macronutrient (nitrogen and phosphorus) loading.

This report focuses on human health endangerment and macronutrient loading. Wildlife endangerment from cattle manure discharge is not addressed.

Macronutrient loading from cattle manure in Kehoe Lagoon, Kehoe Marsh, South Kehoe Creek Marsh, Upper Abbotts Lagoon, Middle Abbotts Lagoon, and the upstream areas of Drakes Estero (upper Schooner Bay, Home Ranch Lagoon, and upper Home Bay) is sufficient to cause Hazardous Algal Blooms (HABs) and Hazardous Cyanobacteria Blooms (HCBs). Climate change will increasingly proliferate these blooms (ITRC 2021, ITRC 2022, Gobler 2020, Schulhof and Shore 2020, Anderson-Abs et al. 2016, US Environmental Protection Agency 2022). To date there has been no hazardous algal or hazardous cyanobacteria monitoring in the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds. Monitoring should be performed.

Assessment of human health endangerment from exposure to Fecal Indicator Bacteria has been based on surface water beneficial uses and associated water quality objectives promulgated by the San Francisco Bay Regional Water Quality Control Board (Table 6). For comparison to water quality objectives, suitable surface water monitoring locations (Table 1, Figures 1 and 2, Appendix A) were selected using the following considerations:

- Cattle manure sources, including localized sources such as dairy cow milking complexes, confined cattle feeding areas, and manure retention ponds.
- Public access and public use.
- Compliance monitoring requirements for confined animal facilities (CAFs - dairy ranches) (SFBRWQCB 2016).

Historical monitoring locations were preferred unless other considerations were more important. Locations with well-mixed (unstratified) water, along with locations that could be sampled without disturbing the substrate, were preferred. The selection of monitoring locations was constrained by the National Park Service's access closures for areas surrounding the dairy ranch milking complexes (Appendix A), which precluded monitoring of strategic locations in the North Kehoe Creek drainage and Drakes Bay Watershed.

Practice norms and confined animal facility regulations require monitoring of the first significant runoff event of the rainy season. For water year 2021-2022, this occurred 19-24 October 2021 with a 2-year recurrence interval precipitation event (Table 2). Surface water monitoring began on 25 October 2021. Thereafter, monitoring was performed at the frequencies required to compare Fecal Indicator Bacteria concentrations to surface water quality objectives (at least 5 samples over 42-day and/or 30-day periods). Monitoring was performed by volunteers trained and directed by Douglas Lovell, PE. Monitoring was performed Monday-Wednesday to facilitate normal laboratory turnaround for Fecal Indicator Bacteria analyses.

FIELD MONITORING

Table 3 and Appendix G summarize the field observations and field measurements.

Field observations included estimated flowrate, visual turbidity, visual color, odor, and visual particulates (sand size or larger). A full suite of field parameters (temperature, pH, specific conductance, salinity, oxidation-reduction potential, dissolved oxygen, numeric turbidity) was measured during monitoring events that included macronutrient analyses. During other monitoring events, selected field parameters were measured subject to time constraints. Field meters were calibrated prior to each monitoring event and calibration checks were performed upon return from the field. When unusual pH measurements were observed, field calibration checks were performed.

Particular attention was directed toward collecting samples without disturbing the substrate at each monitoring location. Appendix A describes the specific sampling procedures for each monitoring location.

Appendix F provides photographs of the surface water monitoring.

LABORATORY ANALYSES

Tables 4 and 5 summarize the laboratory analytical results. Appendix I provides the laboratory certifications and laboratory reports.

Fecal Indicator Bacteria analyses consisted of Total Coliform, Fecal Coliform, *E. coli*, and Enterococci. All four Fecal Indicator Bacteria were not needed at each location; Table 1 shows the Fecal Indicator Bacteria analyses required for comparison to the appropriate beneficial use objectives. Macronutrient analyses consisted of ammonia, nitrate, nitrite, Total Kjeldahl Nitrogen, dissolved nitrogen, total nitrogen, orthophosphate, dissolved phosphorus, and total phosphorus. Total Suspended Solids analyses were performed on selected samples to further help evaluate the relative proportion of nitrogen and phosphorus in the particulate and dissolved phases. Quality Assurance/Quality Control is discussed in Appendix H.

PRECIPITATION AND HYDROLOGY

The mobilization, transport, and fate of cattle manure contaminants is directly dependent on precipitation and subsequent runoff, along with creek and lagoon hydrology. In addition, numerous stock ponds exist in the four watersheds. Evaluation of precipitation and hydrology is necessary to accurately interpret surface monitoring results. Apart from a 1998-2000 study by the US Geological Survey of the Abbotts Lagoon system (Kratzer et al. 2006), historical reports regarding surface water monitoring in the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds lack precipitation and hydrologic information.

Figure 3 and Table 2 summarize precipitation and hydrologic conditions during the October 2021-January 2022 monitoring. Appendix E contains detailed precipitation and hydrologic information. Meteorological information, including precipitation, is from the RCA Meteorological Station (Figures 1 and 2); this station is within 7 miles of the surface water monitoring locations.

The October 2021-January 2022 monitoring began immediately following a precipitation event with an average recurrence frequency of approximately 2 years. This "2-year storm" occurred 19-24 October 2021 and deposited 6.00 inches of precipitation. Significant precipitation events occurred in November 2021 and December 2021, but not January 2022. The November and December precipitation events would be expected to occur several times each rainy season. Precipitation frequency estimates are based on industry standard practices (NOAA 2014).

Based on soil moisture measurements at the RCA Station, the initial half of the precipitation from the 19-24 October 2021 event (3 inches) was sorbed by the soil without producing significant runoff; prior to the 19-24 October 2021 event, surface soil was parched from the lack of precipitation. As of the afternoon of 21 October 2021, North Kehoe Creek at Pierce Point Road (monitoring location PAC2) was dry, as was Abbotts Creek at Pierce Point Road (monitoring location ABB1). As of 25 October 2021, stock ponds upstream of many of the monitoring locations had not spilled (had not produced flow-through). In essence, the runoff-producing potential of the 19-24 October 2021 event was equivalent to approximately 3 inches of precipitation falling on saturated soil.

Stock ponds began spilling during the 8-9 November 2021 precipitation event, facilitating transport of suspended particulates, including bacteria, from the upper watersheds to many of the monitoring locations.

During the October 2021-January 2022 monitoring, creek locations were monitored on the falling (decreasing) portion of the hydrograph.

CONTAMINANT SOURCES

Several lines of evidence are available for source apportionment of the Fecal Indicator Bacteria and macronutrient contamination observed at the surface water monitoring locations, including:

- Quantitative Polymerase Chain Reaction (qPCR)

  qPCR can quantify, by species, sources of homeothermic bacteria (Fecal Indicator Bacteria) (Microbial Insights 2022). qPCR can quantify Fecal Indicator Bacteria from humans versus other species, which will be useful to assess the impacts of improperly maintained cattle ranch septic systems on surface water quality. Standardized qPCR methods cannot distinguish between different ruminants (cannot distinguish between cattle, elk, deer, etc.). Research grade qPCR may be available to distinguish Fecal Indicator Bacteria from cattle versus Fecal Indicator Bacteria from elk.

- Isotope Analyses

  Standardized isotope analyses can distinguish biogenic nitrogen and phosphorus from other nitrogen and phosphorus sources.

- Reference Site/Reference System

  Surface water monitoring of Fecal Indicator Bacteria and macronutrients upstream and downstream of cattle ranches can quantify localized cattle contamination impacts and help segregate impacts from cattle manure versus impacts from elk manure.

  A reference site/system is not needed for the Kehoe and Abbotts watersheds because significant numbers of elk do not graze the watersheds.

  A suitable reference site is not available for the Drakes Bay Watershed because cattle ranches encompass the entire watershed.

  Suitable reference sites are available in the Drakes Estero Watershed, including Home Ranch Creek and East Schooner Creek at the upstream boundaries of the cattle ranches.

- Manure Mass Production

  Standardized calculations can estimate cattle manure production (NRCS 2008, NRCS 2009, UMass Extension undated). These calculations can be adapted for elk manure production. Using relative precipitation catchment areas (runoff areas), manure production can be apportioned by watershed.

  Detailed calculations (Appendix D) were performed to apportion cattle and elk manure by watershed.

Manure production was estimated using data from:

- National Park Service's census for beef ranches (National Park Service 2020).
- Annual reports submitted to the San Francisco Bay Regional Water Quality Control Board documenting the census for dairy ranches (Annual Reports 2020, Annual Reports 2021).
- National Park Service's 2021 Tule Elk census. For the three Tule Elk Herds (Tomales Point, Drakes Beach, Limantour), elk distribution was determined using the National Park Service's map of herd land use (National Park Service 2020).

Using literature cited (NRCS 2008, UMass Extension undated) values of per animal manure production for the various types of cattle, annual cattle manure production was estimated for each cattle ranch. Using assumed values of per animal manure production for elk, annual elk manure production was similarly estimated.

The precipitation catchment areas (runoff areas) were calculated by watershed for each cattle ranch using the US Geological Survey topographic map (Figure 2, "true scale map"). The annual cattle manure mass was apportioned by watershed using the relative catchment areas. Annual elk manure mass was similarly apportioned. Cattle manure was assessed circa October 2020 (prior to liquidation of the I-Ranch milking herd) and circa October 2021 (after liquidation of the I-Ranch milking herd).

The results of the detailed calculations are summarized in Table 8 and on Figure 4. The (absolute) mass of manure presented in Appendix D, in Table 8, and on Figure 4 should be considered approximate. Relative comparisons are more accurate (between watersheds, temporal comparisons, dairy cattle versus beef cattle, cattle versus elk).

Circa October 20221 (after liquidation of the I-Ranch milking herd), the annual cattle manure discharge to land in dairy impacted watersheds (Kehoe, Drakes Bay) was approximately 6 times that of the other watersheds, with the Kehoe Watershed receiving the greatest density of cattle manure discharge to land. For freshwater monitoring locations in the four watersheds, exceedances of Fecal Indicator Bacteria objectives generally reflect this ratio.

Tule Elk manure discharge to land is significantly less than cattle manure discharge to land. In the Drakes Estero Watershed, the ratio of cattle manure discharge to land/elk manure discharge to land = ±24; on a watershed wide basis, approximately 4% of the manure impacts result from elk. In the Drakes Bay Watershed, the ratio of cattle manure discharge to land/elk manure discharge to land = 22; on a watershed wide basis, approximately 5% of the manure impacts result from elk.

For the Abbotts Watershed, comparisons of the cattle manure discharge to land before (circa October 2020) and after (circa October 2021) liquidation of the I-Ranch milking herd show a significant reduction. Current-day protection of water quality objectives in the Abbotts Watershed is a consequence of liquidating the I-Ranch (McClure) milking herd. Compared to the various cattle waste management practices (fencing, water supply, loafing barns) previously implemented in the Abbotts Watershed, liquidation of the I-Ranch milking herd has, by far, resulted in the most significant water quality improvement.

EXCEEDANCES OF OBJECTIVES FOR FECAL INDICATOR BACTERIA

The current-day water quality objectives for Fecal Indicator Bacteria in surface water (Table 6) were promulgated by the San Francisco Bay Regional Water Quality Control Board and State Water Resources Control Board in 2019, and by the US Environmental Protection Agency in 2012. To compare Fecal Indicator Bacteria analytical results with water quality objectives, all three agencies require (1) the collection of at least 5 samples over 42-day and/or 30-day intervals and (2) calculation of Fecal Indicator Bacteria statistics (mean/median and Statistical Threshold Value) for the 42-day and/or 30-day intervals.

Historical surface water monitoring by the National Park Service was periodically performed from 1999-2013 at many of the locations that were also monitored October 2021-January 2022. Most of the National Park Service's monitoring was conducted quarterly. For some monitoring locations and events, laboratory analyses did not include the requisite Fecal Indicator Bacteria analyses (*E. coli* in freshwater and Enterococci in saltwater). The 1999-2013 monitoring was not performed at a frequency facilitating valid comparisons to the current-day Fecal Indicator Bacteria objectives. Despite this limitation, the National Park Service's Final Environmental Impact Statement (National Park Service 2020), along with a journal article by Park Service employees (Voeller et al. 2021), used the historical data set to conclude that the frequency of exceeding water quality objectives had decreased six-fold from 1999-2013 because of the implementation of conventional cattle waste management practices (fencing, water supply, loafing barns). The Fecal Indicator Bacteria data set employed by the National Park Service is not capable of supporting these findings because the requisite number of samples were not collected for the requisite intervals.

To compare measured Fecal Indicator Bacteria concentrations with water quality objectives, two statistical parameters were calculated:

- An "averaging" parameter. Either geometric mean, arithmetic mean, or median, with calculation intervals of either 42 days (geometric mean) or 30 days (arithmetic mean and median).
- An "upper limit" parameter. Representing the 90^{th} percentile upper limit, termed the Statistical Threshold Value (STV), with a calculation interval of 30 days. The calculation of a numeric Statistical Threshold Value implicitly assumed normality of the mean; an assumption that is generally supported by the data.

Protection of water quality objectives requires the "averaging" parameter be less than the "averaging" objective and the "upper limit" parameter be less than the "upper limit" objective. If either or both parameters exceed the companion objective, surface water beneficial use is impaired.

For each monitoring location, rolling values of the two statistical parameters were calculated using sequential 42-day and/or 30-day intervals. A minimum of 5 samples were employed for each interval. To comply with the 5-sample minimum, some calculation intervals exceeded the stipulated 42 days or 30 days, which generally resulted in a lower estimate of the parameter. Each rolling value was then compared to the companion objective. Plots of Fecal Indicator Bacteria measurements, including the calculated statistical parameters, were made for selected monitoring locations. Appendix B presents the calculations, comparisons, and plots.

Table 7 presents a compilation of the comparisons for each monitoring location that exceeded water quality objectives. The comparison reveals:

- Surface water quality in the Kehoe Watershed is severely impaired. Surface water at Kehoe Lagoon exhibits significant exceedances of bacteria objectives for Water Contact Recreation and Non-Contact Water Recreation beneficial uses, with multiple months exhibiting bacteria concentrations more than 10 times the objectives. North Kehoe Creek and South Kehoe Creek are similarly impaired.
- Surface water quality in the Abbotts Watershed does not frequently or significantly exceed objectives for Water Contact Recreation and Non-Contact Water Recreation beneficial uses.
- Surface water quality in the upstream reaches of Schooner Bay and Home Bay, including Home Ranch Lagoon, is severely impaired. Significant exceedances of bacteria objectives for Water Contact Recreation and Shellfish Harvesting beneficial uses were documented during the October 2021-January 2022 monitoring, with multiple months exhibiting bacteria concentrations more than 10 times the objectives.
- Surface water quality in the A-Ranch and B-Ranch drainages of the Drakes Bay Watershed is significantly impaired. For Water Contact Recreation beneficial use, bacteria concentrations were more than 10 times the objectives; for Non-Contact Water Recreation beneficial use, bacteria concentrations were up to 2 times the objectives.

Figure 5 presents *E. coli* measurements and calculated statistics for the Kehoe and Abbotts watersheds during the October 2021-January 2022 monitoring. Kehoe Lagoon and Upper Abbotts Lagoon are hydrologically similar (similar surface areas, volumes, precipitation catchment areas). *E. coli* in Kehoe Lagoon (monitoring location PAC3) was approximately ten times that in Upper Abbotts Lagoon (monitoring location ABB5). The presence of active dairies in the Kehoe Watershed, versus no active dairies in the Abbotts Watershed, largely explains the difference; the cattle manure discharge to land in the Kehoe Watershed was approximately seven times greater than the cattle manure discharge in the Abbotts Watershed (Kehoe = 8.6 tons/acre, Abbotts = 1.3 tons/acre) (Table 8, Figure 4).

Figure 6 presents *E. coli* measurements in January 2021, before liquidation of the I-Ranch milking herd, and October 2021-January 2022, after liquidation of the I-Ranch milking herd. The figure also shows cumulative 5-day precipitation in for the January 2021 and October 2021-January 2022 monitoring. Cumulative 5-day precipitation represents a reasonable estimate of the potential for Fecal Indicator Bacteria mobilization and transport for the creeks (mobilization and

transport for lagoons is more complex). Given the significantly greater precipitation during the post liquidation monitoring, post liquidation concentrations would be expected to be significantly greater than pre-liquidation, especially for creek monitoring locations PAC1S and ABB2/3. However, the opposite was observed because the I-Ranch milking herd was liquidated. This further demonstrates the effectiveness of herd reduction for improving water quality.

Table 1 (page 1 of 3)

Monitoring Locations

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location ID	Location Name	Watershed	Description	Cattle Manure Sources	Beneficial Uses of Surface Water	Required Fecal Indicator Bacteria Analytes	Public Use	Wildlife Use	Comments
PAC1S	South Kehoe Creek Downstream of I-Ranch and L-Ranch	Kehoe	PAC1S was within a marshy area with abundant terrestrial and aquatic vegetation, including emergent aquatic macrophytes.	I-Ranch CFA, GL. L-Ranch MC, CFA, GL, MP.	WET, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation.	Tule Elk (3-4 animals), various birds including shorebirds, small-medium mammals.	Freshwater.
PAC1Z	South Kehoe Creek Downstream of L-Ranch	Kehoe	South Kehoe Creek immediately downstream of the confluence of the watercourses impacted by the L-Ranch milking complex.	L-Ranch MC, CFA, GL, MP.	WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation.	Tule Elk (3-4 animals), coyotes, various bird species, small-medium mammals.	Freshwater.
PAC2	North Kehoe Creek at Pierce Point Road	Kehoe	Upstream end of the culvert.	J-Ranch MC, CFA, GL, MP, SMP.	WET, WARM, WILD, RE REC-1, REC-2	Fecal Coliform, *E. coli*	Frequent vehicle parking immediately adjacent to PAC2. Public restroom. PAC2 located at the trailhead for Kehoe Lagoon/Beach. Frequent use year-round, including the rainy season.	Various bird species, including owls at the Kehoe Beach parking area, small-medium mammals.	Freshwater.
PAC3	Kehoe Lagoon	Kehoe	Immediately downstream of Kehoe Marsh, at the upstream end of the standing/quiescent lagoon water.	I-Ranch CFA, GL. J-Ranch MC, CFA, GL, MP, SMP. L-Ranch MC, CFA, GL, MP. K-Ranch GL.	WET, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Frequent public use year-round, including the rainy season. Hiking, wildlife observation, wading within Kehoe Lagoon, wading in the outflow from Kehoe Lagoon, and swimming at Kehoe Beach. Shellfish harvesting at Kehoe Beach.	River otters, coyotes, bobcats, weasels, rabbits, gophers, reptiles, amphibians, various bird species, including Great Blue and other herons, Giant and Snowy Egrets.	Freshwater.
ABB1	East Abbotts Creek at Pierce Point Road	Abbotts	Downstream end of the culvert.	I-Ranch GL.	WET, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation.	Deer, coyotes, bobcats, rabbits, various bird species, reptiles, amphibians, small-medium mammals.	Freshwater.
ABB2/3	North Abbotts Creek Downstream of I-Ranch	Abbotts	Immediately upstream of Upper Abbotts Lagoon. ABB2/3 is downstream of the confluence of the three drainages exiting the I-Ranch milking complex.	I-Ranch MC, CFA, GL, MP.	WET, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation.	Deer, coyotes, rabbits, reptiles, amphibians, various bird species including shorebirds, small-medium mammals.	Freshwater.
ABB4	Outflow from Middle Abbotts Lagoon	Abbotts	Abbotts Lagoon trail footbridge at the downstream end of Middle Abbotts Lagoon (upstream end of Lower Abbotts Lagoon).	I-Ranch MC, CFA, GL, MP. H-Ranch GL.	MAR, WILD, REC-1, REC-2	Fecal Coliform, Enterococci	Frequent public use of the Abbotts Lagoon trail year-round, including the rainy season. Hiking, wildlife observation, wading in Middle and Lower Abbotts lagoons, and wading and swimming at Abbotts Beach.	River otters, deer, coyotes, rabbits, reptiles, amphibians, various bird species including shorebirds, small-medium mammals.	Saltwater. Depending on tide stage, water flowed to/from Lower Abbotts Lagoon or from/to Middle Abbotts Lagoon.
ABB5	Outflow from Upper Abbotts Lagoon	Abbotts	Outflow from Upper Abbotts Lagoon to Middle Abbotts Lagoon.	I-Ranch MC, CFA, GL, MP.	MAR, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Frequent public use of the Abbotts Lagoon trail year-round, including the rainy season. Hiking, wildlife observation, wading in Middle Abbotts Lagoon.	River otters, deer, coyotes, rabbits, reptiles, amphibians, various bird species including shorebirds, small-medium mammals.	Freshwater.
DES2	East Schooner Creek at Sir Frances Drake Blvd	Drakes Estero	Upstream end of the culvert.	M/N/D Rogers Ranches GL.	SHELL, COLD, MIGR, RARE, SPWN, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation. Salmon/steelhead observation.	Various bird species, reptiles, amphibians, small-medium mammals. Salmon and steelhead spawning and rearing in East Schooner Creek.	Freshwater.

Table 1 (page 2 of 3)

Monitoring Locations

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location ID	Location Name	Watershed	Description	Cattle Manure Sources	Beneficial Uses of Surface Water	Required Fecal Indicator Bacteria Analytes	Public Use	Wildlife Use	Comments
DES3	Home Ranch Creek Downstream of Ranch Buildings	Drakes Estero	Downstream of the ranch building complex and upstream of the mouth of Home Ranch Creek (where Home Ranch Creek discharges to Home Ranch Lagoon).	Home Ranch GL.	COLD, MIGR, RARE, SPWN, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation. Salmon/steelhead observation. Home Ranch Creek in the immediate vicinity of DES3 receives infrequent visitors. The road that crosses Home Ranch Creek ±100 yards upstream of DES3 receives occasional visitors.	Tule Elk, deer, small-medium mammals, reptiles, amphibians, bird species including shorebirds.	Freshwater.
DES6B	Schooner Creek at Sir Francis Drake Blvd	Drakes Estero	Schooner Creek at the Sir Francis Drake Blvd Bridge.	H/M/N/D Rogers Ranches GL.	COMM, SHELL, MAR, MIGR, RARE, SPWN, WILD, REC-1, REC-2	Total Coliform, Fecal Coliform, Enterococci	DES6B is located at a parking area with wildlife display. Frequent public use year-round, including the rainy season. Hiking, wildlife observation. Wading and kayaking/canoeing/paddleboarding in Schooner Bay (Drakes Estero) immediately downstream of DES6B. Designated launch area for watercraft ±1/2 mile south of DES6B at the location of the former Drakes Bay Oyster Company. Watercraft can be launched at DES6B.	River otters, Tule Elk, deer, small-medium mammals, reptiles, amphibians, various bird species including Great Blue and other herons, Giant and Snowy Egrets, other shorebirds, ducks.	Saltwater.
DES7	Home Ranch Lagoon at Estero Trail Bridge	Drakes Estero	Footbridge along the Estero Trail, downstream end of Home Ranch Lagoon.	Home Ranch GL.	COMM, SHELL, MAR, MIGR, RARE, SPWN, WILD, REC-1, REC-2	Total Coliform, Fecal Coliform, Enterococci	The Estero Trail receives frequent public use year-round, including the rainy season. Hiking, wildlife observation. The footbridge contains benches for resting/eating/drinking. Wading and kayaking/canoeing/paddleboarding in Home Ranch Lagoon and Home Bay (both part of Drakes Estero).	River otters, Tule Elk, deer, small-medium mammals, reptiles, amphibians, various bird species including Great Blue and other herons, Giant and Snowy Egrets, other shorebirds, ducks.	Saltwater. Home Ranch lagoon (saltwater marsh) immediately upstream of the bridge. Home Bay (of Drakes Estero) immediately downstream of the bridge. DES7 located at the edge of the Phillip Burton Wilderness.
DBY1	C-Ranch Unnamed Creek	Drakes Bay	±100 yards downstream of the stock pond.	C-Ranch MC, CFA, GL, MP.	WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation along C-Ranch unnamed creek. Various water contact activities in Drakes Bay near the mouth of C-Ranch unnamed creek. Visitors frequent Drakes Beach near the mouth of C-Ranch unnamed creek year-round, especially during the rainy season to observe seals.	Tule Elk, deer, small-medium mammals, reptiles, amphibians, various bird species including shorebirds.	Freshwater.
DBY2	B-Ranch Unnamed Creek	Drakes Bay	Metal culvert discharge. ±150 feet upstream of the beach at Drakes Bay.	B-Ranch MC, CFA, GL, MP.	WET, WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Hiking, wildlife observation along B-Ranch unnamed creek. Various water contact activities in Drakes Bay near the mouth of B-Ranch unnamed creek. Visitors frequent Drakes Beach near the mouth of B-Ranch unnamed creek year-round, especially during the rainy season to observe seals.	Tule Elk, deer, coyotes, small mammals, various bird species. At DBY2, and Drakes Beach ±150 feet downstream of DBY2, Northern Elephant Seal and Harbor Seal resting, mating, birthing, and pup rearing. Seals (including pups) observed in the creek channel at DBY2.	Freshwater.
DBY3	A-Ranch Unnamed Creek	Drakes Bay	Immediately downstream of a set of rocky cascades. ±100 yards upstream of the beach at Drakes Bay.	A-Ranch MC, CFA, GL, MP.	WARM, WILD, REC-1, REC-2	Fecal Coliform, *E. coli*	Various water contact activities in Drakes Bay near the mouth of A-Ranch unnamed creek.	Deer, coyotes, bobcats, rabbits, various bird species, reptiles, amphibians, small-medium mammals.	Freshwater.

Table 1 (page 3 of 3)

Monitoring Locations

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

General Notes

(a) Required Fecal Indicator Bacteria Analytes = analyses needed to evaluate compliance with the objectives promulgated by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB 2022).

(b) Wildlife Use = observations by members of the surface water monitoring team.

(c) Salinity classified according to the State Water Resources Control Board (SWRCB 2019a): Freshwater = "salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time during the CALENDAR YEAR." Saltwater = "salinity is greater than 1 ppth more than 5 percent of the time during the CALENDAR YEAR."

(d) A-Ranch, B-Ranch, C-Ranch, J-Ranch, L-Ranch = active dairy. I-Ranch historically operated as an actively milking dairy. Circa June 2021, prior to the October 2021-January 2022 monitoring, I-Ranch liquidated the milking herd. A herd of approximately 125 heifers was maintained during the October 2021-January 2022 monitoring.

(e) MC = dairy cow milking complex (including loafing barn(s) at some dairy ranches). CFA = confined cattle feeding area(s) (including dairy cattle feeding stations/troughs). GL = cattle grazing land. MP = cattle manure retention pond(s). Cattle manure land-applied using tanker trucks; however, documentation regarding land application was not available.

(f) Beneficial Use Definitions are verbatim from (SWRCB Undated).

COLD Cold Freshwater Habitat - Uses of water that support cold water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

COMM Commercial and Sport Fishing - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

MAR Marine Habitat - Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

MIGR Fish Migration - Uses of water that support habitats necessary for migration, acclimatization between fresh water and salt water, and protection of aquatic organisms that are temporary inhabitants of waters within the region.

RARE Rare, Threatened, or Endangered Species - Uses of waters that support habitats necessary for the survival and successful maintenance of plant or animal species established under state and/or federal law as rare, threatened, or endangered.

REC-1 Water Contact Recreation - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

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

SHELL Shellfish Harvesting - Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries. Central Coast Regional Board (Region 3).

SPWN Spawning, Reproduction, and/or Early Development - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

WARM Warm Freshwater Habitat - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

WET Wetland Habitat - Uses of water that support natural and man-made wetland ecosystems, including, but not limited to, preservation or unique wetland functions, fish, shellfish, invertebrates, insects, and wildlife habitat (North Coast Regional Board - Region 1).

WILD Wildlife Habitat - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Table 2 (page 1 of 2)

Precipitation and Hydrology

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Date	Precipitation Narrative	Hydrologic Narrative	Comments
22-28 January 2021	• Cumulative precipitation for this 7-day period = 1.98 inches. • Daily precipitation greater than 0.10 inches: 22 Jan = 0.12 inches, 24 Jan = 0.11 inches, 26 Jan = 1.41 inches, 27 Jan = 0.40 inches. • First precipitation event for Water Year 2020-2021 with more than 1 inch of cumulative precipitation. • The average recurrence frequency for this precipitation event <1 year.	• Soil moisture measurements began rising late 26 Jan and spiked on 27-28 Jan, indicating runoff likely began late 26 Jan. • First significant runoff of Water Year 2020-2021 began late 26 Jan. • On 27-28 Jan, stock ponds visible from Pierce Point Road had standing water but were not spilling.	• Monitoring Event: mornings of 27-28 Jan.
30 September 2021	• Cumulative precipitation for Water Year 2020-2021 was 9.60 inches. • From 19 Apr 2021 through 30 Sep 2021, 0.72 inches of precipitation were recorded.		
17 October 2021	• Cumulative precipitation for this 1-day period = 0.22 inches.	• Except for paved surfaces, the precipitation infiltrated and did not produce significant runoff. • Soil moisture measurements were not significantly impacted by precipitation. • The stock ponds visible from Pierce Point Road were without standing water.	
19-21 October 2021	• Cumulative precipitation for this 3-day period = 1.37 inches.	• Except for paved surfaces, the precipitation infiltrated and did not produce significant runoff. • On the afternoon of 21 Oct, North Kehoe Creek at Pierce Point Road and Abbotts Creek at Pierce Point Road were dry.	
19-24 October 2021	• Cumulative precipitation for this 5-day period = 6.00 inches. • The average recurrence frequency for this precipitation event = ±2 years.	• Soil moisture measurements began rising on 21 Oct and spiked on 24 Oct, indicating runoff likely began late 21 Oct or early 22 Oct, also indicating most of the 24 Oct precipitation produced runoff. • First significant runoff of Water Year 2021-2022 began circa early morning 22 Oct.	• Of the 6.00 inches of precipitation, the initial ±3 inches were sorbed by the surface soil without producing significant runoff.
25-26 October 2021		• On 25 Oct, the flow in North Kehoe Creek at Pierce Point Road = ±3 cfs, and the flow in Abbotts Creek at Pierce Point Road = ±5 cfs. The precipitation catchment areas for North Kehoe Creek and Abbotts Creek are similar; however, the volume of stock pond storage and the area of marsh land (both of which store runoff) is ±3 times greater in the North Kehoe Creek catchment area. • On 25-26 Oct, stock ponds visible from Pierce Point Road had standing water but were not spilling.	• Monitoring Event: mornings of 25-26 Oct.
31 October 2021		• Stock ponds visible from Pierce Point Road had standing water but were not spilling.	
1 November 2021	• Cumulative precipitation for this 1-day period = 0.40 inches. • The average recurrence frequency for this precipitation event <1 year.		
3 November 2021			• Monitoring Event: morning of 3 Nov.

Table 2 (page 2 of 2)

Precipitation and Hydrology

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Date	Precipitation Narrative	Hydrologic Narrative	Comments
8-9 November 2021	• Cumulative precipitation for this 2-day period = 1.51 inches. • The average recurrence frequency for this precipitation event <1 year.	• On 9 Nov, stock ponds visible from Pierce Point Road were spilling.	• Monitoring Event: morning of 9 Nov.
10 November to 11 December 2021	• Cumulative precipitation for this 32-day period = 0.16 inches.		• Monitoring Events: mornings of 17 Nov, 22 Nov, 8 Dec.
12-15 December 2021	• Cumulative precipitation for this 4-day period = 3.16 inches. • The average recurrence frequency for this precipitation event <1 year.	• On 14-15 Dec, stock ponds visible from Pierce Point Road were spilling. On 15 Dec, B-Ranch and C-Ranch stock ponds were spilling.	• Monitoring Event: mornings of 14-15 Dec.
21-29 December 2021	• Cumulative precipitation for this 9-day period = 2.24 inches. • The average recurrence frequency for this precipitation event <1 year.	• On 22 Dec, stock ponds visible from Pierce Point Road had standing water but were not spilling.	• Monitoring Events: mornings of 22 Dec and 29 December.
30 December 2021 to 26 January 2022	• Cumulative precipitation for this 27-day period = 0.38 inches. • The average recurrence frequency for this precipitation event <1 year.		• Monitoring Events: mornings of 5 Jan, 12 Jan, 19 Jan, and 26 Jan.
2-3 January 2022		• King Tides occurred. Ocean water flowed into Kehoe Lagoon as evidenced by observations of kelp fragments in the lagoon and increased salinity and specific conductance (observations and measurements at location PAC3 on 5 January). Lower Abbotts Lagoon normally receives tidal influx of ocean water; however, the King Tides significantly increased the influx, resulting in increased salinity and specific conductance (measurements at location ABB4).	

General Notes

(a) Precipitation and soil moisture measurements from the RCA Meteorological Station https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nvprca

(b) Water Year runs from 1 October through 30 September.

(c) Soil Moisture = volumetric water content.

(d) cfs = cubic feet per second.

(e) Precipitation events with cumulative precipitation greater than 0.20 inches are identified in this table.

(f) Precipitation measurements for January 2021 have been summarized in this table to aid in the interpretation of the January 2021 monitoring results (Lovell 2021).

Table 3 (page 1 of 5)

Field Observations and Field Parameter Measurements

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Field Measure-ment Time	Estimated Flowrate [F] (cfs)	Water Temp (˚C)	pH	Specific Conductance (µS/cm)	Salinity (o/oo) (ppt)	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	SWRCB Salinity Classification	Visual Turbidity	Visual Color	Odor of the Water (observed in the field)	Was Representative Monitoring Performed within a Well-Defined, Well-Mixed Channel?	Comments
PAC1S [1] South Kehoe Creek Downstream of I-Ranch and L-Ranch	27 Jan 21	9:40 am		4	9.9	7.0	650	0.3	230	9.6	22	Freshwater	Translucent	Light brown	None	Yes	
	28 Jan 21	9:00 am		4	9.6	7.4	630	0.3	210	9.4	18	Freshwater	Translucent	Light brown	None	Yes	
	25 Oct 21	11:45 am		3	15.5	6.3	710	0.3	40	7.3	16	Freshwater	Translucent	Light brown	None	Yes	Field calibration check of pH meter: standard = 7.00, measured = 6.96.
	3 Nov 21	10:06 am										Freshwater	Clear	Very light brown	None	Yes	
	9 Nov 21	10:02 am										Freshwater	Translucent	Brown	None	Yes	
	17 Nov 21	9:56 am										Freshwater	Clear	Very light brown	None	Yes	
	22 Nov 21	10:17 am										Freshwater	Clear	Very light brown	None	Yes	
	8 Dec 21	10:27 am										Freshwater	Opaque	Brown	None	Yes	
	14 Dec 21	10:05 am			10.1	7.0	530	0.3	170	8.8	15	Freshwater	Clear	Very light yellow	None	Yes	
	22 Dec 21	8:50 am			8.4	7.7	540	0.3				Freshwater	Clear	Light brown	None	Yes	
	29 Dec 21	9:43 am	10:44 am		9.4	7.3	530	0.3				Freshwater	Clear	Yellow-brown	None	Yes	
	5 Jan 22	9:38 am	10:27 am		12.3	7.2	540					Freshwater	Clear	Light yellow	None	Questionable	The sample was collected from relatively quiescent water and a well-mixed flow channel was not observed.
	12 Jan 22	9:55 am	10:36 am		13.2	6.9	520	0.3	200	10.0	11	Freshwater	Clear	Light brown	None	Questionable	The sample was collected from relatively quiescent water and a well-mixed flow channel was not observed.
PAC1Z South Kehoe Creek Downstream of L-Ranch	29 Dec 21	8:50 am	10:20 am	3	8.9	7.9	920	0.5	220	11.4		Freshwater	Clear	Light yellow	None	Yes	
	5 Jan 22	8:43 am	10:20 am	0.9	12.6	7.4	970					Freshwater	Clear	Light yellow	None	Yes	A manure tanker truck was observed driving from the L-Ranch milking complex, south on L-Ranch Road, then south on Sir Francis Drake Blvd toward Inverness. The tanker truck labored uphill from the L-Ranch milking complex, indicating a full load of manure (±15 tons). The manure likely originated from the L-Ranch Primary Manure Retention Pond.
	12 Jan 22	8:40 am	10:40 am	0.7	12.6	7.3	930	0.5	200	11.4	4.4	Freshwater	Clear	Very light yellow	None	Yes	
	19 Jan 22	8:10 am	8:50 am	1	9.4	7.4	970	0.5				Freshwater	Clear	Light yellow	None	Yes	
	26 Jan 22	8:35 am	9:25 am	0.4	10.2	7.4	990	0.5				Freshwater	Clear	Very light yellow	None	Yes	
PAC2 North Kehoe Creek at Pierce Point Road	21 Oct 21			0													North Kehoe Creek was dry.
	25 Oct 21	11:00 am		2	15.1	6.8	950	0.5	50	8.3	19	Freshwater	Translucent	Light brown	Manure	Yes	Strong manure odor was also observed in the sample container upon return to the office.
	3 Nov 21	9:30 am										Freshwater	Clear	Very light brown	None	Yes	
	9 Nov 21	9:30 am		3	13.8	7.37 [3]						Freshwater	Opaque	Light brown	Strong manure	Yes	Temperature measured with pocket thermometer. Field pH paper measured 7.0 to 7.5. Strong manure odor was observed in the sample container upon return to the office.
	17 Nov 21	9:27 am										Freshwater	Clear	Very light brown	None	Yes	
	22 Nov 21	9:47 am		0.4								Freshwater	Translucent	Light yellow-brown	None	Yes	
	8 Dec 21	9:47 am										Freshwater	Clear	Yellow tint	None	Yes	
	14 Dec 21	9:15 am		2	10.2	7.3	820	0.4	190	9.6	11	Freshwater	Clear	Very light yellow	None	Yes	
	22 Dec 21	8:20 am		2	8.4	7.8	1,030	0.5				Freshwater	Clear	Very light yellow	None	Yes	Sample collected by a different person at a different time.
	22 Dec 21	10:34 am										Freshwater	Clear	Light yellow-brown		Yes	Sample collected by a different person at a different time.
	29 Dec 21	9:09 am	10:48 am		9.7	7.4	730	0.4				Freshwater	Clear	Light yellow-brown	Slight manure	Yes	
	5 Jan 22	9:14 am	10:25 am	<0.3	12.2	7.3	740					Freshwater	Clear	Light yellow	None	Yes	
	12 Jan 22	9:18 am	10:42 am		12.2	7.5	740	0.4	190	10.4	4	Freshwater	Clear	Light yellow	None	Yes	

Table 3 (page 2 of 5)

Field Observations and Field Parameter Measurements

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Field Measure-ment Time	Estimated Flowrate (F) (cfs)	Water Temp (˚C)	pH	Specific Conductance (µS/cm)	Salinity (o/oo) (ppt)	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	SWRCB Salinity Classification	Visual Turbidity	Visual Color	Odor of the Water (observed in the field)	Was Representative Monitoring Performed within a Well-Defined, Well-Mixed Channel?	Comments
PAC3 Kehoe Lagoon	28 Jan 21	9:47 am	10:05 am		10.8	7.5	990	0.5	90	11.8	14	Freshwater	Translucent	Light brown	None	No (2)	
	26 Oct 21	9:10 am	9:50 am		14.2	6.5	1,810	0.6	40	4.2	5	Freshwater	Clear	Light brown	Manure	No (2)	
	3 Nov 21	9:00 am										Freshwater	Clear	Very light brown	None	No (2)	
	9 Nov 21	8:56 am										Freshwater	Clear	Very light brown	Strong manure	No (2)	
	17 Nov 21	8:49 am										Freshwater	Clear	Light yellow-brown	None	No (2)	
	22 Nov 21	8:41 am										Freshwater	Clear	Light yellow-brown	None	No (2)	
	8 Dec 21	9:10 am										Freshwater	Clear	Yellow tint	None	No (2)	
	14 Dec 21	10:48 am										Freshwater	Clear	Very light yellow	None	No (2)	
	22 Dec 21	9:53 am										Freshwater	Clear	Very light yellow	None	No (2)	
	29 Dec 21	10:26 am	10:46 am		9.1	7.3	800	0.4				Freshwater	Clear	Yellow-brown	None	No (2)	Sample collected by the same person at a different time.
	29 Dec 21	10:31 am										Freshwater	Clear	Yellow-brown	None	No (2)	Sample collected by the same person at a different time.
	2-3 Jan 22																“King Tides” caused ocean water to enter Kehoe Lagoon.
	5 Jan 22	8:29 am	10:28 am		12.5	7.0	3,490	1.9				Freshwater	Clear	Yellow-brown	None	No (2)	Kelp fragments in the lagoon.
	12 Jan 22	8:39 am	10:48 am		13.0	7.1	750	0.4	190	8.8	6	Freshwater	Clear	Light yellow	None	No (2)	
	19 Jan 22	8:24 am	9:10 am		9.7	7.1	940	0.5				Freshwater	Clear	Light yellow	None	No (2)	
	26 Jan 22	8:34 am	9:29 am		9.9	7.2	790	0.5				Freshwater	Clear	Light yellow	None	No (2)	
ABB1 East Abbotts Creek at Pierce Point Road	21 Oct 21			0													East Abbotts Creek was dry.
	25 Oct 21	9:30 am		5	15.0	5.9	520	0.3	130	10.2	6	Freshwater	Clear	Very light brown	None	Yes	Field calibration check of pH meter: standard = 7.00, measured = 6.91.
	14 Dec 21	11:15 am										Freshwater	Clear	Very light yellow	None	Yes	Staff gauge = 4.68.
	22 Dec 21	9:50 am		1	8.7	7.6	330	0.2				Freshwater	Clear	Light brown	None	Yes	
	12 Jan 22	10:00 am	10:51 am	0.6	12.2	7.0	300	0.2	160	11.5	3	Freshwater	Clear	None	None	Yes	Staff gauge = 4.30.
ABB2/3 North Abbotts Creek Downstream of I-Ranch	27 Jan 21	10:10 am		3	10.6	7.0	650	0.3	190	10.9	12	Freshwater	Translucent	Light brown	None	Yes	
	28 Jan 21	10:38 am		3	11.3	7.7	610	0.3	50	10.8	10	Freshwater	Translucent	Light brown	None	Yes	
	25 Oct 21	10:30 am		2	15.1	6.5	740	0.3	60	9.8	6	Freshwater	Translucent	Light brown	None	Yes	
	3 Nov 21	10:45 am		1								Freshwater	Clear	Light brown	None	Yes	
	9 Nov 21	9:00 am		1								Freshwater	Translucent	Brown	None	Yes	
	17 Nov 21	7:40 am		0.5								Freshwater	Clear	Very light brown	None	Yes	
	22 Nov 21	7:20 am		0.4								Freshwater	Clear	Very light brown	None	Yes	
	8 Dec 21	10:44 am										Freshwater	Clear	Very light brown	None	Yes	
	14 Dec 21	10:45 am			10.0	7.5	670	0.4	150	10.4	11	Freshwater	Translucent	Light brown	None	Yes	
	22 Dec 21	9:20 am		0.8	8.9	7.7	680	0.3				Freshwater	Clear	Brown	None	Yes	
	29 Dec 21	9:50 am	10:37 am	1	9.5	7.7	660	0.3				Freshwater	Clear	Yellow-brown	None	Yes	
	5 Jan 22	9:51 am	10:23 am	1	12.3	7.4	610	0.3				Freshwater	Clear	Light brown	None	Yes	
	12 Jan 22	9:34 am	10:45 am	0.7	12.9	7.3	570	0.3	180	10.9	14	Freshwater	Translucent	Light yellow-brown	None	Yes	

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Field Observations and Field Parameter Measurements

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Field Measure-ment Time	Estimated Flowrate [F] (cfs)	Water Temp (˚C)	pH	Specific Conductance (µS/cm)	Salinity (o/oo) (ppt)	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	SWRCB Salinity Classification	Visual Turbidity	Visual Color	Odor of the Water (observed in the field)	Was Representative Monitoring Performed within a Well-Defined, Well-Mixed Channel?	Comments
ABB4 [T] Outflow from Middle Abbotts Lagoon	26 Oct 21	9:30 am	10:10 am	2	15.8	7.5	4,890	2.6	120	10.6	3	Saltwater	Clear	Very light brown	None	Yes	
	3 Nov 21	9:00 am										Saltwater	Clear	Very light yellow	None	Yes	
	9 Nov 21	8:50 am										Saltwater	Clear	Very light yellow	None	Yes	
	17 Nov 21	9:00 am										Saltwater	Clear	Very light yellow	None	Yes	
	22 Nov 21	8:58 am		1								Saltwater	Clear	Very light yellow	None	Yes	
	8 Dec 21	9:10 am										Saltwater	Clear	Very light yellow	None	Yes	Many tadpoles in the water.
	14 Dec 21	9:21 am										Saltwater	Clear	Very light yellow	None	Yes	
	22 Dec 21	8:50 am	10:13 am		9.4	8.0	6,780	3.8				Saltwater	Clear	Light yellow	None	Yes	White foam along water edge. Field calibration check of pH meter: standard = 7.00, measured = 6.95.
	29 Dec 21	8:42 am	10:40 am		9.3	7.7	4,340	2.3				Saltwater	Clear	Very light yellow	None	Yes	Vegetation detritus on water surface.
	2-3 Jan 22																“King Tides” caused significant amounts of ocean water to enter Lower Abbotts Lagoon.
	5 Jan 22	8:33 am	10:16 am	6	12.6	7.4	4,220					Saltwater	Clear	Very light yellow	None	Yes	
	12 Jan 22	8:40 am	10:29 am	8	12.5	7.2	5,490	5.7	210	12.0	3	Saltwater	Clear	Very light yellow	None	Yes	
	19 Jan 22	8:40 am	9:25 am	10	10.2	7.8	4,730	2.6				Saltwater	Clear	Very light yellow	None	Yes	
	26 Jan 22	8:30 am	9:28 am		10.6	7.7	4,900	2.7				Saltwater	Clear	Very light yellow	None	Yes	Water velocity = ±1 foot/second.
ABB5 Outflow from Upper Abbotts Lagoon	26 Oct 21	11:00 am	11:55 am	2	16.4	6.2	600	0.3	90	5.2	4	Freshwater	Translucent	Light brown	None	Yes	
	3 Nov 21	10:00 am										Freshwater	Clear	Very light yellow	None	Yes	
	9 Nov 21	9:50 am										Freshwater	Translucent	Light yellow-brown	None	Yes	
	17 Nov 21	10:15 am										Freshwater	Clear	Very light yellow	None	Yes	
	22 Nov 21	9:55 am										Freshwater	Clear	Very light yellow	None	Yes	
	8 Dec 21	10:10 am		0.7								Freshwater	Clear	None	None	Yes	Heavy vegetation in flow channel.
	14 Dec 21	10:08 am										Freshwater	Clear	Light yellow	Slight sulfur	Yes	Heavy vegetation in flow channel.
	22 Dec 21	9:31 am	10:18 am	1	9.1	7.3	450	0.2				Freshwater	Clear	Light yellow	None	Yes	
	29 Dec 21	9:30 am	10:42 am		9.2	7.4	370	0.2				Freshwater	Clear	Very light yellow	None	Yes	Heavy vegetation in flow channel.
	5 Jan 22	9:16 am	10:18 am	±0	11.9	6.6	380					Freshwater	Clear	Very light yellow	None		Heavy vegetation in flow channel.
	12 Jan 22	9:50 am	10:43 am	±0	12.2	7.0	420	0.2	220	8.9	3	Freshwater	Clear	Very light yellow	None		Heavy vegetation in flow channel.
DES2 East Schooner Creek at Sir Francis Drake Blvd	28 Jan 21	11:22 am		4	10.6	7.9	370	0.2	340	11.6	12	Freshwater	Clear	Very light brown	None	Yes	
DES3 Home Ranch Creek Downstream of Ranch Buildings	26 Oct 21	9:25 am	10:50 am	4	15.9	6.9	330	0.1	40	10.5	0.1	Freshwater	Clear	Very light brown	None	Yes	
	3 Nov 21	10:23 am		3								Freshwater	Clear	Very light brown	None	Yes	
	9 Nov 21	10:12 am		4								Freshwater	Translucent	Light brown	None	Yes	
	17 Nov 21	8:50 am										Freshwater	Clear	None	None	Yes	
	22 Nov 21	8:53 am										Freshwater	Clear	None	None	Yes	
	8 Dec 21	9:30 am		2								Freshwater	Clear	None	None	Yes	
	14 Dec 21	9:37 am		5								Freshwater	Translucent	Yellow	None	Yes	
	22 Dec 21	9:10 am	10:27 am	3	9.5	7.4	250	0.2				Freshwater	Clear	Light yellow	None	Yes	
	12 Jan 22	8:55 am	10:57 am	2	13.7	7.3	430	0.2	150	11.0	6	Freshwater	Clear		None	Yes	

Table 3 (page 4 of 5)

Field Observations and Field Parameter Measurements

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Field Measure-ment Time	Estimated Flowrate [F] (cfs)	Water Temp (˚C)	pH	Specific Conductance (µS/cm)	Salinity (o/oo) (ppt)	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	SWRCB Salinity Classification	Visual Turbidity	Visual Color	Odor of the Water (observed in the field)	Was Representative Monitoring Performed within a Well-Defined, Well-Mixed Channel?	Comments
DES6B [T] Schooner Creek at Sir Francis Drake Blvd	28 Jan 21	2:40 pm			12.3	7.1	12,100	14	50	9.6	10	Saltwater	Clear	None	None	Yes	
	25 Oct 21	8:10 am			13.8	6.4	1,520	0.9	250	7.4	24	Saltwater	Clear	Light brown	None	Yes	
	3 Nov 21	8:35 am										Saltwater	Clear	Very light brown	None	Yes	
	9 Nov 21	9:30 am										Saltwater	Clear	Very light brown	None	Yes	
	17 Nov 21	10:08 am										Saltwater	Clear	Light yellow-brown	None	Yes	
	17 Nov 21	10:08 am										Saltwater	Clear	Light yellow-brown	None	Yes	
	22 Nov 21	10:00 am										Saltwater	Clear	None	None	Yes	
	8 Dec 21	8:37 am										Saltwater	Clear	None	None		
	14 Dec 21	10:35 am										Saltwater	Clear		None	Yes	
	22 Dec 21	10:00 am	10:34 am		9.7	7.2	2.940	1.6				Saltwater	Clear	Light yellow	None		
	29 Dec 21	10:18 am	10:56 am		10.6	7.2	6,730	4				Saltwater	Clear	Yellow	None	Yes	Water velocity = ±1 foot/second.
	12 Jan 22	9:45 am	10:55 am		13.3	6.9	17,500	11	150	10.7	8	Saltwater	Clear	Yellow	None		
DES7 [T] Home Ranch Lagoon at Estero Trail Bridge	26 Oct 21	9:39 am	10:40 am		15.6	6.4	17,800	10	50	9.6	3	Saltwater	Clear	Very light brown	None	Yes	
	3 Nov 21	9:24 am										Saltwater	Clear	Very light brown	None	Yes	
	9 Nov 21	9:00 am										Saltwater	Translucent	Light brown	None	Yes	
	17 Nov 21	8:57 am										Saltwater	Clear	None	None	Yes	
	22 Nov 21	9:00 am										Saltwater	Clear	None	None	Yes	
	8 Dec 21	9:10 am										Saltwater	Clear	None	None	Yes	
	14 Dec 21	9:30 am										Saltwater	Clear	Light yellow-brown	None	Yes	
	22 Dec 21	8:30 am	10:40 am		10.1	7.8	29,700	20				Saltwater	Clear	Very light yellow	None		
	29 Dec 21	8:40 am	11:23 am		11.0	7.0	5,320	3				Saltwater	Clear	Light yellow	None	Yes	Vegetation detritus observed in water.
	12 Jan 22	8:45 am	11:00 am		16.3	7.8	43,500	30	140	11.4	4	Saltwater	Clear	None	None	Yes	
DBY1 C Ranch Unnamed Creek	14 Dec 21	10:45 am		0.7								Freshwater	Opaque	Yellow-brown	None	Yes	White foam on water surface. Sample contained dark brown sand-size particles (fecal matter and/or soil).
	15 Dec 21	8:35 am	9:00 am	0.5	9.6	7.7	1,610	0.9	230	10.2	31	Freshwater	Opaque	Yellow-brown	None	Yes	No foam.
	22 Dec 21	9:52 am	11:05 am	1	10.6	8.1	1,460	0.8				Freshwater	Translucent	Yellow	None	Yes	
	29 Dec 21	9:35 am	10:50 am	0.7	10.4	7.8	1,190	0.6				Freshwater	Translucent	Yellow	None	Yes	
	5 Jan 22	9:50 am	11:04 am	1	13.2	7.7	1,190					Freshwater	Translucent	Yellow	None	Yes	
	12 Jan 22	9:34 am	11:03 am	1	15.8	7.5	1,650	0.9	140	11.1	10	Freshwater	Clear	Light Yellow	None	Yes	
DBY2 B-Ranch Unnamed Creek	14 Dec 21	11:00 am		4								Freshwater	Clear	Yellow-brown	None	Yes	White foam on water surface.
	15 Dec 21	10:53 am	11:10 am	2	10.0	7.6	1,580	0.8	160	11.2	12	Freshwater	Translucent	Yellow-brown	None	Yes	White foam on water surface.
	22 Dec 21	9:45 am	10:44 am		10.8	7.5	1,800	0.9				Freshwater	Clear	Yellow-brown	None	Yes	
	29 Dec 21	10:10 am	11:20 am		10.4	7.2	1,170	0.6				Freshwater	Clear	Yellow-brown	Slight ammonia	Yes	White foam covered the entire water surface of the channel below the culvert discharge.
	5 Jan 22	9:15 am	10:31 am		12.8	7.2	1,820	0.9				Freshwater	Clear	Yellow-brown	None	Yes	
	12 Jan 22	9:22 am	11:09 am		14.3	7.2	1,910	1.0	160	10.3	8	Freshwater	Clear	Yellow-brown	None	Yes	
DBY3 A-Ranch Unnamed Creek	14 Dec 21	9:50 am		5								Freshwater	Clear	Very light brown	None	Yes	White foam on water surface.
	15 Dec 21	9:30 am	9:50 am	4	10.1	8.5	1,040	0.5	210	12.0	8	Freshwater	Clear	Very light yellow	None	Yes	No foam.
	22 Dec 21	8:50 am	10:55 am		11.1	8.4	1,210	0.6				Freshwater	Clear	Yellow-brown	None	Yes	White foam on water surface.
	29 Dec 21	8:45 am	10:53 am		11.4	8.1	1,010	0.5				Freshwater	Clear	Yellow	None	Yes	White foam on water surface.
	5 Jan 22	8:50 am	11:02 am		14.9	7.9	1,090	0.5				Freshwater	Clear	Yellow	None	Yes	
	12 Jan 22	8:37 am	11:06 am		15.1	7.9	1,080	0.5	150	11.6	8	Freshwater	Clear	Light yellow	None	Yes	

Table 3 (page 5 of 5)

Field Observations and Field Parameter Measurements

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

General Notes

(a) Monitoring was performed by and/or under the direction of Douglas Lovell, PE (Berkeley CA). All samples were grab samples.

(b) In addition to surface water monitoring conducted October 2021-January 2022, monitoring was conducted in January 2021 (Lovell 2021). The January 2021 results are included herein.

(d) In this table, a blank cell for Flowrate, Water Temperature, pH, Specific Conductance, Salinity, Oxidation-Reduction Potential, Dissolved Oxygen, or Turbidity indicates the observation/measurement was not made.

(e) cfs = cubic feet per second. 0/00 = ppt = parts per thousand. NTU = Nephelometric Turbidity Unit.

(g) Visual turbidity, visual color, and visual particulates were observed in a ±120 mL clear plastic container (the container for bacteria analysis). Visual turbidity was classified as either clear, translucent, or opaque. Visual particulates classified as either "colloidal" (colloidal-size) or "sand" (sand-size).

(h) Estimated Flowrate = volumetric discharge of the entire water flow, rounded to one significant digit. The estimate is approximate, based on visual observations and rudimentary estimates of flow velocity and channel dimensions. The estimate is likely accurate within ±50%. cfs = cubic feet per second.

(i) SWRCB Salinity Classification: Freshwater = "salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time during the CALENDAR YEAR." Saltwater = "salinity is greater than 1 ppth more than 5 percent of the time during the CALENDAR YEAR." (SWRCB 2019a).

(j) Quality Assurance/Quality Control review indicates the following accuracies: Temperature within ±0.1˚ C, pH within ±0.2, Specific Conductance within ±0.5%, Salinity within ±0.1 o/oo, Oxidation/Reduction Potential within ±10%, Dissolved Oxygen within ±0.4 mg/L, Turbidity within ±10%.

(c) Field Measurement Time = time when field parameters were measured. Unless otherwise noted, field measurements were made within 15 minutes of sampling. Where noted, the delay between sampling time and field measurement time was typically due to the time to hike/drive to the monitoring location and back. The delay between sample time and field measurement time significantly affected Water Temperature and may have had a slight impact on pH and Dissolved Oxygen; the other parameters were not significantly affected.

Footnotes

(1) Monitoring was performed in a marshy area with prevalent aquatic vegetation. A well-mixed, reasonably well-defined flow channel existed within the vegetation. Monitoring was performed in this channel.

(2) Monitoring of quiescent water was performed within a lagoon with little to no observable flow. The monitored water was collected approximately 8 feet from shore at a depth of approximately 1 foot (below water surface). The total water depth at the monitoring location was approximately 6 feet.

(3) The pH was analyzed in the laboratory beyond the accepted holding time.

(F) Monitoring was performed on the falling portion of the hydrograph – the flowrate was decreasing at the time of monitoring.

(T) The monitoring location is tidally influenced.

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Laboratory Analytical Results for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Salinity Classification	Total Coliform (mpn/100 mL)	Fecal Coliform (mpn/100 mL)	*E. coli* (mpn/100 mL)	Enterococci (mpn/100 mL)	Comments
PAC1S South Kehoe Creek Downstream of I-Ranch and L-Ranch	27 Jan 21	9:40 am	Freshwater	54,000	22,000	17,000	12,000	
	28 Jan 21	9:00 am	Freshwater	22,000	14,000	11,000	14,000	
	25 Oct 21	11:45 am	Freshwater	11,000	2,100	1,700	1,600	
	3 Nov 21	10:06 am	Freshwater	9,200	700	460	200	
	9 Nov 21	10:02 am	Freshwater	28,000	3,900	2,000	2,000	
	17 Nov 21	9:56 am	Freshwater	9,200	460	230	260	
	22 Nov 21	10:17 am	Freshwater	3,500	460	230	130	
	8 Dec 21	10:27 am	Freshwater	9,200	140	68	220	
	14 Dec 21	10:05 am	Freshwater	5,400	700	330	920	
	22 Dec 21	8:50 am	Freshwater	16,000	700	210	210	
	29 Dec 21	9:43 am	Freshwater	1,600	46	33	60	
	5 Jan 22	9:38 am	Freshwater	9,200	320	170	56	
	12 Jan 22	9:55 am	Freshwater	3,500	170	93	14	
PAC1Z South Kehoe Creek Downstream of L-Ranch	29 Dec 21	8:50 am	Freshwater	3,500	1,100	790	2,000	
	5 Jan 22	8:43 am	Freshwater	5,400	170	45	130	
	12 Jan 22	8:40 am	Freshwater	14,000	680	200	120	
	19 Jan 22	8:10 am	Freshwater	160,000	1,400	400	870	
	26 Jan 22	8:35 am	Freshwater	9,200	700	460	130	
PAC2 North Kehoe Creek at Pierce Point Road	25 Oct 21	11:00 am	Freshwater	22,000	11,000	4,600	>2,419.6	
	3 Nov 21	9:30 am	Freshwater	7,000	4,600	1,400	470	
	9 Nov 21	9:30 am	Freshwater	160,000	11,000	7,900	20,000	
	17 Nov 21	9:27 am	Freshwater	14,000	2,100	920	280	
	22 Nov 21	9:47 am	Freshwater	9,200	700	460	180	
	8 Dec 21	9:47 am	Freshwater	2,800	320	170	140	
	14 Dec 21	9:15 am	Freshwater	22,000	11,000	4,600	3,300	
	22 Dec 21	8:20 am	Freshwater	11,000	4,600	3,300	1,300	Collected by a different person at a different time
	22 Dec 21	10:34 am	Freshwater	14,000	3,300	2,700	1,500	Collected by a different person at a different time
	29 Dec 21	9:09 am	Freshwater	2,200	940	460	650	
	5 Jan 22	9:14 am	Freshwater	5,400	470	330	98	
	12 Jan 22	9:18 am	Freshwater	4,300	700	460	67	

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Laboratory Analytical Results for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Salinity Classification	Total Coliform (mpn/100 mL)	Fecal Coliform (mpn/100 mL)	*E. coli* (mpn/100 mL)	Enterococci (mpn/100 mL)	Comments
PAC3 Kehoe Lagoon	28 Jan 21	9:47 am	Freshwater	17,000	11,000	9,400	17,000	
	26 Oct 21	9:10 am	Freshwater	160,000	35,000	17,000	1,200	
	3 Nov 21	9:00 am	Freshwater	3,500	940	700	1,600	
	9 Nov 21	8:56 am	Freshwater	17,000	3,200	1,700	2,600	
	17 Nov 21	8:49 am	Freshwater	11,000	1,400	920	600	
	22 Nov 21	8:41 am	Freshwater	5,400	1,700	700	1,100	
	8 Dec 21	9:10 am	Freshwater	3,500	700	490	1,200	
	14 Dec 21	10:48 am	Freshwater	17,000	4,600	3,300	3,700	
	22 Dec 21	9:53 am	Freshwater	9,200	700	490	930	
	29 Dec 21	10:26 am	Freshwater	1,500	400	120	390	Collected by the same person at a different time
	29 Dec 21	10:31 am	Freshwater	1,600	280	170	430	Collected by the same person at a different time
	5 Jan 22	8:29 am	Freshwater	3,500	700	220	1,200	
	12 Jan 22	8:39 am	Freshwater	2,200	330	140	250	
	19 Jan 22	8:24 am	Freshwater	4,300	330	220	170	
	26 Jan 22	8:34 am	Freshwater	2,200	470	210	150	
ABB1 East Abbotts Creek at Pierce Point Road	25 Oct 21	9:30 am	Freshwater	9,200	390	210	1,100	
	14 Dec 21	11:15 am	Freshwater	5,400	700	490	370	
	22 Dec 21	9:50 am	Freshwater	1,600	110	70	230	
	5 Jan 22	10:00 am	Freshwater	540	110	79	28	
ABB2/3 North Abbotts Creek Downstream of I-Ranch	27 Jan 21	10:10 am	Freshwater	35,000	17,000	13,000	8,700	
	28 Jan 21	10:38 am	Freshwater	17,000	7,000	920	11,000	
	25 Oct 21	10:30 am	Freshwater	16,000	1,400	700	3,900	
	3 Nov 21	10:45 am	Freshwater	3,500	470	170	10	
	9 Nov 21	9:00 am	Freshwater	92,000	3,900	2,100	2,200	
	17 Nov 21	7:40 am	Freshwater	14,000	680	200	200	
	22 Nov 21	7:20 am	Freshwater	1,700	400	260	170	
	8 Dec 21	10:44 am	Freshwater	4,300	260	130	340	
	14 Dec 21	10:45 am	Freshwater	11,000	1,400	450	820	
	22 Dec 21	9:20 am	Freshwater	22,000	1,100	200	280	
	29 Dec 21	9:50 am	Freshwater	5,400	260	170	200	
	5 Jan 22	9:51 am	Freshwater	9,200	320	68	58	
	12 Jan 22	9:35 am	Freshwater	9,200	170	93	120	

Table 4 (page 3 of 5)

Laboratory Analytical Results for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Salinity Classification	Total Coliform (mpn/100 mL)	Fecal Coliform (mpn/100 mL)	*E. coli* (mpn/100 mL)	Enterococci (mpn/100 mL)	Comments
ABB4 Outflow from Middle Abbotts Lagoon	26 Oct 21	9:30 am	Saltwater	920	140	94	390	
	3 Nov 21	9:00 am	Saltwater	1,600	40	33	<10	
	9 Nov 21	8:50 am	Saltwater	3,500	460	170	52	
	17 Nov 21	9:00 am	Saltwater	2,200	240	140	<10	
	22 Nov 21	8:58 am	Saltwater	1,400	200	68	20	
	8 Dec 21	9:10 am	Saltwater	2,200	170	40	31	
	14 Dec 21	9:21 am	Saltwater	2,200	260	140	120	
	22 Dec 21	8:50 am	Saltwater	1,600	94	70	27	
	29 Dec 21	8:42 am	Saltwater	540	94	70	32	
	5 Jan 22	8:33 am	Saltwater	1,400	40	20	39	
	12 Jan 22	8:40 am	Saltwater	540	32	21	15	
	19 Jan 22	8:40 am	Saltwater	540	20	12	2.0	
	26 Jan 22	8:30 am	Saltwater	920	70	46	5.2	
ABB5 Outflow from Upper Abbotts Lagoon	26 Oct 21	11:00 am	Freshwater	540	46	33	200	
	3 Nov 21	10:00 am	Freshwater	5,400	260	110	75	
	9 Nov 21	9:50 am	Freshwater	5,400	110	68	63	
	17 Nov 21	10:15 am	Freshwater	11,000	400	200	10	
	22 Nov 21	9:55 am	Freshwater	2,200	140	40	7.4	
	8 Dec 21	10:10 am	Freshwater	5,400	110	45	11	
	14 Dec 21	10:08 am	Freshwater	5,400	700	460	650	
	22 Dec 21	9:31 am	Freshwater	3,500	92	68	36	
	29 Dec 21	9:30 am	Freshwater	540	130	79	57	
	5 Jan 22	9:16 am	Freshwater	3,500	140	40	21	
	12 Jan 22	9:50 am	Freshwater	9,200	110	20	6.3	
DES2 East Schooner Creek at Sir Francis Drake Blvd	28 Jan 21	11:22 am	Freshwater	1,600	920	540	550	
DES3 Home Ranch Creek Downstream of Ranch Buildings	26 Oct 21	9:25 am	Freshwater	540	110	79	320	
	3 Nov 21	10:23 am	Freshwater	1,400	200	140	110	
	9 Nov 21	10:12 am	Freshwater	22,000	1,400	680	390	
	17 Nov 21	8:50 am	Freshwater	1,600	110	70	120	
	22 Nov 21	8:53 am	Freshwater	2,800	140	78	82	
	8 Dec 21	9:30 am	Freshwater	2,800	260	170	35	
	14 Dec 21	9:37 am	Freshwater	2,800	490	230	610	
	22 Dec 21	9:10 am	Freshwater	2,200	260	210	220	
	12 Jan 22	8:55 am	Freshwater	1,600	170	79	45	

Table 4 (page 4 of 5)

Laboratory Analytical Results for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Salinity Classification	Total Coliform (mpn/100 mL)	Fecal Coliform (mpn/100 mL)	*E. coli* (mpn/100 mL)	Enterococci (mpn/100 mL)	Comments
DES6B	28 Jan 21	2:40 pm	Saltwater	5,400 (H)	1,700 (H)	1,100 (H)	1,400 (H)	
Schooner Creek at Sir Francis Drake Blvd	25 Oct 21	8:10 am	Saltwater	11,000	4,600	3,300	2,000	
	3 Nov 21	8:35 am	Saltwater	3,500	170	140	52	
	9 Nov 21	9:30 am	Saltwater	22,000	9,400	3,300	2,000	
	17 Nov 21	10:08 am	Saltwater	3,500	170	120	63	
	22 Nov 21	10:00 am	Saltwater	1,700	110	20	37	
	8 Dec 21	8:37 am	Saltwater	5,400	210	92	88	
	14 Dec 21	10:35 am	Saltwater	4,300	940	330	980	
	22 Dec 21	10:00 am	Saltwater	5,400	200	140	86	
	29 Dec 21	10:18 am	Saltwater	2,800	1,100	790	73	
	12 Jan 22	9:45 am	Saltwater	1,700	45	20	11	
DES7	26 Oct 21	9:39 am	Saltwater	350	94	70	150	
Home Ranch Lagoon at Estero Trail Bridge	3 Nov 21	9:24 am	Saltwater	540	46	33	<10	
	9 Nov 21	9:00 am	Saltwater	28,000	2,100	1,700	1,400	
	17 Nov 21	8:57 am	Saltwater	540	220	110	<10	
	22 Nov 21	9:00 am	Saltwater	920	46	21	31	
	8 Dec 21	9:10 am	Saltwater	540	46	26	56	
	14 Dec 21	9:30 am	Saltwater	7,000	920	680	730	
	22 Dec 21	8:30 am	Saltwater	920	70	46	86	
	29 Dec 21	8:40 am	Saltwater	920	170	130	52	
	12 Jan 22	8:45 am	Saltwater	920	70	26	38	
DBY1	14 Dec 21	10:45 am	Freshwater	17,000 (b1)	3,300 (b1)	2,300 (b1)	1,300 (b1)	
C-Ranch Unnamed Creek	22 Dec 21	9:52 am	Freshwater	14,000	2,100	1,300	1,200	
	29 Dec 21	9:35 am	Freshwater	4,300	1,400	940	490	
	5 Jan 22	9:50 am	Freshwater	4,300	330	210	290	
	12 Jan 22	9:34 am	Freshwater	3,500	260	140	180	
DBY2	14 Dec 21	11:00 am	Freshwater	21,000	9,400	7,000	4,400	
B-Ranch Unnamed Creek	22 Dec 21	9:45 am	Freshwater	12,000	2,000	1,400	1,700	
	29 Dec 21	10:10 am	Freshwater	9,200	2,200	1,400	470	
	5 Jan 22	9:15 am	Freshwater	1,100	260	170	250	
	12 Jan 22	9:22 am	Freshwater	9,200	390	270	230	
DBY3	14 Dec 21	9:50 am	Freshwater	22,000	11,000	7,900	3,100	
A-Ranch Unnamed Creek	22 Dec 21	8:50 am	Freshwater	11,000	2,600	1,700	1,400	
	29 Dec 21	8:45 am	Freshwater	9,200	2,800	1,700	2,400	
	5 Jan 22	8:50 am	Freshwater	9,200	320	170	1,100	
	12 Jan 22	8:37 am	Freshwater	9,200	940	460	100	

Table 4 (page 5 of 5)

Laboratory Analytical Results for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

General Notes

(a) Monitoring was performed by and/or under the direction of Douglas Lovell, PE (Berkeley CA). All samples were grab samples. Samples were analyzed by McCampbell Analytical (Pittsburg CA).

(b) In addition to surface water monitoring conducted October 2021-January 2022, monitoring was conducted in January 2021 (Lovell 2021). The January 2021 results are included herein.

(c) ">" denotes measurement above the upper laboratory reporting limit.

(d) "<" denotes measurement below the lower laboratory reporting limit.

(e) mpn = most probable number. cfu = colony forming units. Common practice treats these as equivalent units although they are not equivalent under certain conditions.

(f) Salinity Classification: Freshwater = "salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time during the CALENDAR YEAR." Saltwater = "salinity is greater than 1 ppth more than 5 percent of the time during the CALENDAR YEAR." (SWRCB 2019a).

Footnotes

(b1) The laboratory reported that the sample contained greater than 1% sediment by volume.

(H) The laboratory reported that the sample was prepared/analyzed beyond the accepted holding time. However, the reported concentrations are believed accurate.

Table 5 (page 1 of 2)

Laboratory Analytical Results for Total Suspended Solids, Nitrogen, and Phosphorus

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Total Suspended Solids (mg/L)	Ammonia as Nitrogen (mg N/L)	Un-ionized Ammonia as Nitrogen (calculation) (mg N/L)	Nitrate as Nitrogen (mg N/L)	Nitrite as Nitrogen (mg N/L)	Nitrate + Nitrite as Nitrogen (calculation) (mg N/L)	Total Kjeldahl Nitrogen (mg N/L)	Dissolved Nitrogen (lab filtered) (mg N/L)	Total Nitrogen (mg N/L)	Ortho-phosphate (PO_4) as Phosphorus (mg P/L)	Dissolved Phosphorus (lab filtered) (mg P/L)	Total Phosphorus (mg P/L)	Comments
PAC1S South Kehoe Creek Downstream of I-Ranch and L-Ranch	27 Jan 21	9:40 am		0.18	<0.001	4.1	<0.10	4.1	3.1		7.1 (C)	0.48		0.83	
	28 Jan 21	9:00 am		0.14	0.001	3.3	<0.10	3.3	2.4		5.7 (C)	0.20		0.37	
	25 Oct 21	11:45 am	18.4	<0.20	<0.001	4.0 (H)	<0.10 (H)	4.0 (H)	1.3	4.2	4.8	0.51 (H)	0.52	0.58	
	14 Dec 21	10:05 am	12.0	0.63 (B)	0.001	3.7	0.11	3.8	3.9	4.6	4.6	0.52	0.77	0.71	
PAC1Z South Kehoe Creek Downstream of L-Ranch	29 Dec 21	8:50 am	4.80	2.0	0.032	5.4	0.17	5.57	7.4	7.4	7.7	0.43	0.57	0.64	
	12 Jan 22	9:35 am									4.8				
PAC2 North Kehoe Creek at Pierce Point Road	25 Oct 21	11:00 am	16.0	0.75	0.002	7.7 (H)	0.28 (H)	8.0 (H)	6.9	8.5	9.5	1.4 (H)	1.5	1.6	
	9 Nov 21	9:30 am		6.4	0.045										A manure odor and high turbidity were observed; accordingly, a sample was collected for ammonia analysis.
	14 Dec 21	9:15 am	6.0	0.39 (B)	0.002	3.3	<0.10	3.3	3.0	4.0	3.8	<0.10	0.18	0.85	
	22 Dec 21	8:20 am		0.29	0.004				1.9		4.2			0.46	
PAC3 Kehoe Lagoon	28 Jan 21	9:47 am		0.14	0.001	2.5	<0.10	2.5	3.0		5.5 (C)	0.59		0.87	
	26 Oct 21	9:10 am		<0.10	<0.001						3.6			0.60	
	12 Jan 22	8:39 am									1.6			0.13	
ABB1 East Abbotts Creek at Pierce Point Road	25 Oct 21	9:30 am		<0.20	<0.001	1.8 (H)	<0.10 (H)	1.8 (H)	0.6		2.3	<0.1 (H)		0.11	
	22 Jan 22	10:00 am									<0.70			<0.50	
ABB2/3 North Abbotts Creek Downstream of I-Ranch	27 Jan 21	10:10 am		0.24	<0.001	5.2	<0.10	5.2	3.4		8.6 (C)	0.51		0.83	
	28 Jan 21	10:38 am		0.18	0.002	3.9	<0.10	3.9	2.9		6.8 (C)	0.45		0.70	
	25 Oct 21	10:30 am	11.2	<0.20	<0.001	4.0 (H)	<0.10 (H)	4.0 (H)	3.3	4.8	5.4	0.96 (H)	0.97	1.0	
	14 Dec 21	10:45 am	18.0	0.42 (B)	0.003	3.1	<0.10	3.1	4.2	4.1	4.0	0.60	0.77	0.80	
	12 Jan 22	9:35 am									4.8			0.45	
ABB4 Outflow from Middle Abbotts Lagoon	26 Oct 21	9:30 am		<0.10	<0.001						1.2			0.66	
	12 Jan 22	8:40 am									<0.70			0.26	
ABB5 Outflow from Upper Abbotts Lagoon	26 Oct 21	11:00 am		<0.10	<0.001						2.3			0.59	
	12 Jan 22	9:50 am									0.94			0.18	

Table 5 (page 2 of 2)

Laboratory Analytical Results for Total Suspended Solids, Nitrogen, and Phosphorus

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Location	Date	Sample Time	Total Suspended Solids (mg/L)	Ammonia as Nitrogen (mg N/L)	Un-ionized Ammonia as Nitrogen (calculation) (mg N/L)	Nitrate as Nitrogen (mg N/L)	Nitrite as Nitrogen (mg N/L)	Nitrate + Nitrite as Nitrogen (calculation) (mg N/L)	Total Kjeldahl Nitrogen (mg N/L)	Dissolved Nitrogen (lab filtered) (mg N/L)	Total Nitrogen (mg N/L)	Ortho-phosphate (PO_4) as Phosphorus (mg P/L)	Dissolved Phosphorus (lab filtered) (mg P/L)	Total Phosphorus (mg P/L)	Comments
DES2 East Schooner Creek at Sir Francis Drake Blvd	28 Jan 21	11:22 am		0.12	0.002	1.9	<0.10	1.9	0.76		2.6 (C)	<0.10		0.14	
DES3 Home Ranch Creek Downstream of Ranch Buildings	26 Oct 21	9:25 am		<0.10	<0.001	1.4	<0.10	1.4	<0.40		1.7	<0.1		0.054	
DES6B Schooner Creek at Sir Francis Drake Blvd	28 Jan 21	2:40 pm		<0.10	<0.001	<2.0 (2)	<2.0 (2)	<2.0	0.90		<2.8 (C)	<2.0 (2)		0.20	
	25 Oct 21	8:10 am	10.6	<0.20	<0.001	3.8 (H)	<0.10 (H)	3.8 (H)	1.2	3.6	4.1	0.13 (H)	0.19	0.20	
DES7 Home Ranch Lagoon at Estero Trail Bridge	26 Oct 21	9:39 am		<0.10	<0.001						1.7			0.11	
DBY1 C-Ranch Unnamed Creek	15 Dec 21	8:35 am	50.0	0.24	0.003	4.9	<0.20	4.9	9.1	6.2	6.0	0.68	0.98	1.0	
DBY2 B-Ranch Unnamed Creek	15 Dec 21	10:53 am	9.33	0.63	0.006	2.5	<0.20	2.5	6.1	5.5	5.4	0.53	0.75	0.82	
DBY3 A-Ranch Unnamed Creek	15 Dec 21	9:30 am	<2.50	0.35	0.024	9.3	<0.20	9.3	5.3	9.2	9.0	0.51	0.64	0.89	

General Notes

(a) Monitoring was performed by and/or under the direction of Douglas Lovell, PE (Berkeley CA). All samples were grab samples. Samples were analyzed by McCampbell Analytical (Pittsburg CA).

(b) In addition to surface water monitoring conducted October 2021-January 2022, monitoring was conducted in January 2021 (Lovell 2021). The January 2021 results are included herein.

(c) "<" indicates the result was below the lower laboratory reporting limit.

(d) Un-ionized ammonia was calculated using the Florida Department of Environmental Protection spreadsheet. https://floridadep.gov/waste/district-business-support/documents/un-ionized-ammonia-calculator

Footnotes

(2) For Nitrate, Nitrite, and Orthophosphate analyses, the reporting limit was raised (the sample was diluted) due to the physical nature (salinity) of the sample; consequently, the surrogate recovery was outside accepted limits.

(B) According to the laboratory QA/QC report, this analyte was detected in the associated method blank at a concentration greater than 10% of the reported sample result.

(C) Calculated concentration.

(H) The laboratory reported that the sample was prepared/analyzed beyond the accepted holding time; however, the reported concentrations are believed accurate.

Table 6 (page 1 of 2)

Surface Water Bacteria Objectives for Protection of Human Health

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Water Contact Recreation (REC-1) Beneficial Use in Freshwater (Applicable to Monitoring Locations PAC1S, PAC1Z, PAC2, PAC3, ABB1, ABB2/3, ABB5, DES3)

Citation	Applicability	Geometric Mean *E. coli* (cfu/100 mL)	Statistical Threshold Value (STV) *E. coli* (logarithmic transformed) (cfu/100 mL)	Geometric Mean Enterococci (cfu/100 mL)	Statistical Threshold Value (STV) Enterococci (logarithmic transformed) (cfu/100 mL)	Sampling Requirements	Calculation Interval	Comments
SFBRWQCB Basin Plan. Table 3-1	"Water quality objectives for bacteria in Table 3-1 shall be strictly applied except when otherwise provided for in a TMDL" The objectives are identical to the State Water Resources Control Board's objectives for Inland Surface Waters, Enclosed Bays, and Estuaries (see below).	100	320			"Based on a minimum of five consecutive samples equally spaced over a 30-day period."	42 days for Geometric Mean. 30 days for STV.	
SWRCB Inland Surface Waters. Table 1	"The bacteria water quality objective for all waters where the salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time during the CALENDAR YEAR is: a six-week rolling GEOMETRIC MEAN of *Escherichia coli* (*E. coli*) not to exceed 100 colony forming units (cfu) per 100 milliliters (mL), calculated weekly, and a STATISTICAL THRESHOLD VALUE (STV) of 320 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a CALENDAR MONTH, calculated in a static manner."	100	320			At least 5 consecutive samples over 42 days for the Geometric Mean. Not specified for the STV.	42 days for Geometric Mean. 30 days for STV.	The objectives correspond to an estimated gastrointestinal illness rate of 32 per 1,000 water contact recreators.
USEPA RWQC. Table 1	"The term 'criteria,' as used in §303(c)(2), refers to elements of state water quality standards (WQS), expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use." "EPA recommends using the fecal indicator bacteria (FIB) enterococci and Escherichia coli (E. coli) as indicators of fecal contamination for fresh water and enterococci for marine water." "The sample sizes in the epidemiological data were not large enough to evaluate potential differences for persons over 55 years of age, pregnant women, or other vulnerable individuals. EPA's 2012 RWQC recommendations are based on the general population, which includes children."	100	320	30	110	At least weekly sampling over 30 days.	30 days	The objectives correspond to an estimated gastrointestinal illness rate of 32 per 1,000 water contact recreators.

Water Contact Recreation (REC-1) Beneficial Use in Saltwater (Applicable to Monitoring Locations ABB4, DES6B, DES7)

Citation	Applicability	Geometric Mean Enterococci (cfu/100 mL)	Statistical Threshold Value (STV) Enterococci (logarithmic transformed) (cfu/100 mL)	Sampling Requirements	Calculation Interval	Comments
SFBRWQCB Basin Plan. Table 3-1	"Water quality objectives for bacteria in Table 3-1 shall be strictly applied except when otherwise provided for in a TMDL" The objectives are identical to the State Water Resources Control Board's objectives for Inland Surface Waters, Enclosed Bays, and Estuaries (see below).	30	110	"Based on a minimum of five consecutive samples equally spaced over a 30-day period."	42 days for Geometric Mean. 30 days for STV.	
SWRCB Inland Surface Waters. Table 1	"The bacteria water quality objective for all waters where the salinity is greater than 1 ppth more than 5 percent of the time during the CALENDAR YEAR is: a six-week rolling GEOMETRIC MEAN of enterococci not to exceed 30 cfu/100 mL, calculated weekly, with a STV of 110 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a CALENDAR MONTH, calculated in a static manner."	30	110	At least 5 consecutive samples over 42 days for the Geometric Mean. Not specified for the STV.	42 days for Geometric Mean. 30 days for STV.	The objectives correspond to an estimated gastrointestinal illness rate of 32 per 1,000 water contact recreators.
USEPA RWQC. Table 1	"The term 'criteria,' as used in §303(c)(2), refers to elements of state water quality standards (WQS), expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use." "EPA recommends using the fecal indicator bacteria (FIB) enterococci and Escherichia coli (E. coli) as indicators of fecal contamination for fresh water and enterococci for marine water."	30	110	At least weekly sampling over 30 days.	30 days	The objectives correspond to an estimated gastrointestinal illness rate of 32 per 1,000 water contact recreators.

Table 6 (page 2 of 2)

Surface Water Bacteria Objectives for Protection of Human Health

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Shellfish Harvesting (SHELL) Beneficial Use in Either Freshwater or Saltwater (Applicable to Monitoring Locations DES6B, DES7)

Citation	Applicability	Median Total Coliform (mpn/100 mL)	Statistical Threshold Value (STV) Total Coliform (not logarithmic transformed) (mpn/100 mL)	Median Fecal Coliform (mpn/100 mL)	Statistical Threshold Value (STV) Fecal Coliform (not logarithmic transformed) (mpn/100 mL)	Sampling Requirements	Calculation Interval	Comments
SFBRWQCB Basin Plan. Table 3-1	"Water quality objectives for bacteria in Table 3-1 shall be strictly applied except when otherwise provided for in a TMDL"	70	230	14	43	"Based on a minimum of five consecutive samples equally spaced over a 30-day period."	30 days	The Total Coliform objectives of the San Francisco Bay Regional Water Quality Control Board are identical to the State Water Quality Control Board's Water Quality Control Plan for Ocean Waters of California (SWRCB 2019b). The State Water Quality Control Board's Water Quality Control Plan for Ocean Waters of California (SWRCB 2019b) does not have objectives for Fecal Coliform.

Non-Contact Water Recreation (REC-2) Beneficial Use in Either Freshwater or Saltwater (Applicable to Monitoring Locations PAC1S, PAC1Z, PAC2, PAC3, ABB1, ABB2/3, ABB4, ABB5, DES3, DES6B, DES7, DBY1, DBY2, DBY3)

Citation	Applicability	Mean Fecal Coliform (mpn/100 mL)	Statistical Threshold Value (STV) Fecal Coliform (not logarithmic transformed) (mpn/100 mL)	Sampling Requirements	Calculation Interval
SFBRWQCB Basin Plan. Table 3-1	"Water quality objectives for bacteria in Table 3-1 shall be strictly applied except when otherwise provided for in a TMDL"	2,000	4,000	"Based on a minimum of five consecutive samples equally spaced over a 30-day period."	30 days

General Notes

(a) Objectives in this table include Water Quality Objectives, Water Quality Criteria, and Water Quality Standards as cited in the referenced documents.

(b) Salinity classification based on (SWRCB 2019a). Salinity less than or equal to 1 part per thousand 95% of the time has been classified as Freshwater. Salinity greater than 1 part per thousand more than 5% of the time has been classified as Saltwater.

(c) SFBRWQCB Basin Plan = *San Francisco Bay Basin (Region 2), Water Quality Control Plan (Basin Plan)* (SFBRWQCB 2022).

(d) SWRCB Inland Surface Waters = *Part 3 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California - Bacteria Provisions and a Water Quality Standards Variance Policy* (SWRCB 2019a).

(e) USEPA RWQC = *Recreational Water Quality Criteria* (US Environmental Protection Agency 2012).

(f) Statistical Threshold Value (STV) = Upper 90th Percentile Value.

(g) For *E. coli* and Enterococci bacteria, calculations used logarithmic transformations. For Total Coliform and Fecal Coliform bacteria, no logarithmic transformations were performed.

(h) mpn = most probable number. cfu = colony forming units. Common practice treats these as equivalent units although they are not equivalent under certain conditions.

(i) TMDL = Total Maximum Daily Load. TMDL regulations are not (yet) applicable to the Kehoe, Abbotts, Drakes Estero, and Drakes Bay watersheds.

(j) Mean = arithmetic mean.

(k) Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.
Non-Contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries. Central Coast Regional Board (Region 3).
Beneficial Use definitions are verbatim from https://www.waterboards.ca.gov/about_us/performance_report_1314/plan_assess/docs/bu_definitions_012114.pdf

(l) For REC-1 Beneficial Use in freshwater: (1) the USEPA RWQC (USEPA 2012) document states that objectives for either *E. coli* and Enterococci may be used, whereas (2) the SFBSWRCB Basin Plan (SWRCB 2022) and the SWRCB Inland Surface Waters document (SWRCB 2019a) state that objectives for (only) *E. coli* shall be used. A review of the staff report (SWRCB 2018) supporting the SWRCB Inland Surface Water document did not explain the State Water Resource Control Board's sole use of *E. coli*.

(m) For REC-1 Beneficial Use, the USEPA specifies a 30-day calculation interval for both the Geometric Mean and STV. For REC-1 Beneficial Use, the SFBRWQCB and SWRCB specify a 42-day calculation interval for the Geometric Mean and a 30-day calculation interval for the STV. For SHELL and REC-2 Beneficial uses, the SFBRWQCB and SWRCB specify a 30-day calculation interval for the Mean/Median and STV. A review of the staff report (SWRCB 2018) supporting the SWRCB Inland Surface Water document did not explain the State Water Resource Control Board's selection of a 42-day calculation interval.

Table 7 (page 1 of 5)

Exceedances of Surface Water Objectives for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Water Contact Recreation (REC-1) Beneficial Use in Freshwater

Watershed	Location ID	Location Description	Monitoring Period	Exceedances for Geometric Mean (42-day calculation interval) (*E. coli* objective = 100 cfu/100 mL)	Exceedances for Statistical Threshold Value (STV) (30-day calculation interval) (*E. coli* objective = 320 cfu/100 mL)	Comments
Kehoe	PAC1S	South Kehoe Creek Downstream of I-Ranch and L-Ranch	25 Oct 21 to 12 Jan 22 (79 days)	• ***E. coli* was 1.2 to 4.2 times the objective.** • **The objective was exceeded for all calculation intervals.**	• ***E. coli* was 3.5 to 7.9 times the objective.** • **The objective was exceeded for all calculation intervals.** • **4 of 11 samples exceeded the objective.**	• There are no postings on the National Park Service website or anywhere along South Kehoe Creek warning the public of the health risks of Water Contact Recreation.
	PAC1Z	South Kehoe Creek Downstream of L-Ranch	29 Dec 21 to 26 Jan 22 (28 days)	• Samples were collected over a 28-day period, not the requisite 42-day period. 3 of 5 samples exceeded the objectives.	• ***E. coli* was 2.0 times the objective for the one (only) calculation interval.** • **3 of 5 samples exceeded the objective.**	• There are no postings on the National Park Service website or anywhere along South Kehoe Creek warning the public of the health risks of Water Contact Recreation.
	PAC2	North Kehoe Creek at Pierce Point Road	25 Oct 21 to 12 Jan 22 (79 days)	• ***E. coli* was 13 to 25 times the objective.** • **The objective was exceeded for all calculation intervals.**	• ***E. coli* was 23 to 34 times the objective.** • **The objectives were exceeded for all calculation intervals.** • **10 of 11 samples exceeded the objective, 1 sample equaled the objective.**	• PAC2 is located at the parking area for Kehoe Beach/Kehoe Lagoon. The area receives frequent visitors year-round, including the rainy season. • Based on the exceedances at PAC2, it is likely that North Kehoe Creek, from PAC2 upstream to the J-Ranch milking complex, also exceeded objectives for Water Contact Recreation. • There are no postings on the National Park Service website or anywhere along North Kehoe Creek warning the public of the health risks of Water Contact Recreation.
	PAC3	Kehoe Lagoon	26 Oct 21 to 26 Jan 22 (91 days)	• ***E. coli* was 3.2 to 14 times the objective.** • **The objective was exceeded for all calculation intervals.**	• ***E. coli* was 1.1 to 21 times the objective for calculation intervals from 26 Oct 21 to 5 Jan 22.** The calculation interval from 29 Dec 21 to 26 Jan 22 did not exceed the objective. • **8 of 13 samples exceeded the objective.**	• The Kehoe Beach/Kehoe Lagoon area receives frequent visitors who wade in Kehoe Lagoon and the intermittent outlet stream from Kehoe Lagoon to the ocean. Water contact activities occur year-round, including the rainy season. • **Visitors to the Kehoe Beach/Kehoe Lagoon area have likely contracted gastrointestinal illness from exposure to cattle manure.[(1)]** • There are no postings on the National Park Service website or at/near Kehoe Beach/Kehoe Lagoon warning the public of the health risks of Water Contact Recreation.
Abbotts	ABB1	East Abbotts Creek at Pierce Point Road	25 Oct 21 to 5 Jan 22 (72 days)	• 4 samples were collected, not the requisite 5. 2 of 4 samples exceeded the objective.	• 4 samples were collected, not the requisite 5. 1 of 4 samples exceeded the objective.	• There are no postings on the National Park Service website or at/near ABB1 warning the public of the health risks of Water Contact Recreation.
	ABB2/3	North Abbotts Creek Downstream of I-Ranch	25 Oct 21 to 12 Jan 22 (79 days)	• ***E. coli* was 1.5 to 3.5 times the objective.** • **The objective was exceeded for all calculation intervals.**	• ***E. coli* was 1.0 to 4.2 times the objective.** • **The objective was equaled or exceeded for all calculation intervals.** • **3 of 11 samples exceeded the objective.**	• ABB2/3 is an approximate 5-minute hike from a pullout along Pierce Point Road. • There are no postings on the National Park Service website or at/near ABB2/3 warning the public of the health risks of Water Contact Recreation.
	ABB5	Outflow from Upper Abbotts Lagoon	26 Oct 21 to 12 Jan 22 (78 days)	• *E. coli* was slightly above the objective for the calculation interval from 3 Nov 21 to 14 Dec 21. The remaining calculation intervals did not exceed the objective.	• *E. coli* was slightly above the objective for the calculation interval from 3 Nov 21 to 14 Dec 21. The remaining calculation intervals did not exceed the objective. • 1 of 11 samples exceeded the objective.	• ABB5 is an approximate 5-minute hike from the Abbotts Lagoon Trail. The Abbotts Lagoon Trail receives frequent visitors year-round, including the rainy season. • There are no postings on the National Park Service website, or along the Abbotts Lagoon Trail, or at/near ABB5 warning the public of the health risks of Water Contact Recreation.

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Exceedances of Surface Water Objectives for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Water Contact Recreation (REC-1) Beneficial Use in Freshwater

Watershed	Location ID	Location Description	Monitoring Period	Exceedances for Geometric Mean (42-day calculation interval) (*E. coli* objective = 100 cfu/100 mL)	Exceedances for Statistical Threshold Value (STV) (30-day calculation interval) (*E. coli* objective = 320 cfu/100 mL)	Comments
Drakes Estero	DES3*	Home Ranch Creek Downstream of Ranch Buildings	26 Oct 21 to 12 Jan 22 (78 days)	• ***E. coli* was 1.4 to 1.8 times the objective.** • **The objective was exceeded for all calculation intervals.**	• ***E. coli* was 1.1 to 1.4 times the objective for calculation intervals from 26 Oct 21 to 14 Dec 21.** The remaining two calculation intervals from 17 Nov 21 to 12 Jan 22 did not exceed the objective. • **1 of 9 samples exceeded the objective.**	• DES3 is an approximate 25-minute hike from the Estero Trail parking area. Home Ranch Creek in the immediate vicinity of DES3 receives infrequent visitors. The road crossing Home Ranch Creek ±100 yards upstream of DES3 receives occasional visitors.
Drakes Bay	DBY1*	C-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• Samples were collected over a 29-day period, not the requisite 42-day period. 5 of 5 samples exceeded the objective.	• ***E. coli* was 5.7 times the objective for the one (only) calculation interval.** • **3 of 5 samples exceeded the objective.**	• Visitors frequent Drakes Beach near the mouth of C-Ranch unnamed creek year-round, especially during the rainy season to observe seals. • See note “a” regarding potential ecological impacts to seals. • There are no postings on the National Park Service website, or along C-Ranch Unnamed Creek, or along Drakes Beach, or at/near DBY1 warning the public of the health risks of Water Contact Recreation.
	DBY2*	B-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• Samples were collected over a 29-day period, not the requisite 42-day period. 5 of 5 samples exceeded the objective.	• ***E. coli* was 11.5 times the objective for the one (only) calculation interval.** • **3 of 5 samples exceeded the objective.**	• Visitors frequent Drakes Beach near the mouth of B-Ranch unnamed creek year-round, especially during the rainy season to observe seals. • See note “a” regarding potential ecological impacts to seals. • There are no postings on the National Park Service website, or along B-Ranch Unnamed Creek, or along Drakes Beach, or at/near DBY2 warning the public of the health risks of Water Contact Recreation.
	DBY3	A-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• Samples were collected over a 29-day period, not the requisite 42-day period. 5 of 5 samples exceeded the objective.	• ***E. coli* was 13.4 times the objective for the one (only) calculation interval.** • **4 of 5 samples exceeded the objective.**	• There are no postings on the National Park Service website, or along A-Ranch Unnamed Creek, or along Drakes Beach, or at/near DBY3 warning the public of the health risks of Water Contact Recreation.

Table 7 (page 3 of 5)

Exceedances of Surface Water Objectives for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Water Contact Recreation (REC-1) Beneficial Use in Saltwater

Watershed	Location ID	Location Description	Monitoring Period	Exceedances for Geometric Mean (42-day calculation interval) (Enterococci objective = 30 cfu/100 mL)	Exceedances for Statistical Threshold Value (STV) (30-day calculation interval) (Enterococci objective = 110 cfu/100 mL)	Comments
Abbotts	ABB4	Outflow from Middle Abbotts Lagoon	26 Oct 21 to 26 Jan 22 (92 days)	• None	• **Enterococci was 1.6 times the objective for the single calculation interval from 26 Oct 21 to 22 Nov 21.** The remaining calculation intervals did not exceed the objective. • **2 of 13 samples exceeded the objective.**	• ABB4 is located at the footbridge along the Abbotts Lagoon Trail. The Abbotts Lagoon Trail receives frequent visitors year-round, including the rainy season. • There are no postings on the National Park Service website, or along the Abbotts Lagoon Trail, or at/near ABB4 warning the public of the health risks of Water Contact Recreation.
Drakes Estero	DES6B*	Schooner Creek at Sir Francis Drake Blvd	25 Oct 21 to 12 Jan 22 (79 days)	• **Enterococci was 2.6 to 6.2 times the objective.** • **The objective was exceeded for all calculation intervals.**	• **Enterococci was 3.4 to 18 times the objective.** • **The objective was exceeded for all calculation intervals.** • **3 of 10 samples exceeded the objective.**	• DES6B is located at a parking area and wildlife display that receives frequent visitors. Upper Schooner Bay is a popular destination for canoeing, kayaking, paddleboarding, and wading. Except during the seal protection closure (1 March – 30 June), these activities occur year-round, including the rainy season. • There are no postings on the National Park Service website, or along the upper reaches of Schooner Bay, or along Schooner Creek, or at/near DES6B warning the public of the health risks of Water Contact Recreation.
	DES7*	Home Ranch Lagoon at Estero Trail Bridge	26 Oct 21 to 12 Jan 22 (78 days)	• **Enterococci was 1.5 to 3.2 times the objective.** • **The objective was exceeded for all calculation intervals.**	• **Enterococci was 2.8 to 10 times the objective.** • **The objective was exceeded for all calculation intervals.** • **3 of 10 samples exceeded the objective.**	• DES7 is located at the footbridge along the Estero Trail. The Estero Trail receives frequent visitors. The footbridge contains benches for resting/eating/drinking. DES7 is on the boundary of the Phillip Burton Wilderness. Upper Home Bay is a popular destination for canoeing, kayaking, paddleboarding, and wading. Except during the seal protection closure (1 March – 30 June), these activities occur year-round, including the rainy season. • There are no postings on the National Park Service website, or along the upper reaches of Home Bay, or at/near Home Ranch Lagoon, or at/near DES7 warning the public of the health risks of Water Contact Recreation.

Shellfish Harvesting (SHELL) Beneficial Use

Watershed	Location ID	Location Description	Monitoring Period	Exceedances for Median (30-day calculation interval) (Total Coliform objective = 70 mpn/100 mL) (Fecal Coliform objective = 14 mpn/100 mL)	Exceedances for Statistical Threshold Value (STV) (30-day calculation interval) (Total Coliform objective = 230 mpn/100 mL) (Fecal Coliform objective = 43 mpn/100 mL)	Comments
Drakes Estero	DES6B*	Schooner Creek at Sir Francis Drake Blvd	25 Oct 21 to 12 Jan 22 (79 days)	• **Total Coliform was 50 to 61 times the objective.** • **Fecal Coliform was 12 to 15 times the objective.** • **Both objectives were exceeded for all calculation intervals.**	• **Total Coliform was 23 to 76 times the objective. 10 of 10 samples exceeded the objective.** • **Fecal Coliform was 15 to 174 times the objective. 10 of 10 samples exceeded the objective.** • **Both objectives were exceeded for all calculation intervals.**	• DES6B is located at a parking area and wildlife display that receives frequent visitors. • There are no postings on the National Park Service website, or along the upper reaches of Schooner Bay, or at/near DES6B warning the public of the health risks of Shellfish Harvesting.
	DES7*	Home Ranch Lagoon at Estero Trail Bridge	26 Oct 21 to 12 Jan 22 (78 days)	• **Total Coliform was 8 to 13 times the objective.** • **Fecal Coliform was 5 to 7 times the objective.** • **Both objectives were exceeded for all calculation intervals.**	• **Total Coliform was 20 to 75 times the objective. 10 of 10 samples exceeded the objective.** • **Fecal Coliform was 14 to 31 times the objective. 10 of 10 samples exceeded the objective.** • **Both objectives were exceeded for all calculation intervals.**	• DES7 is located at the footbridge along the Estero Trail. The Estero Trail receives frequent visitors. The footbridge contains benches for resting/eating/drinking. DES7 is on the boundary of the Phillip Burton Wilderness. • There are no postings on the National Park Service website, or along the upper reaches of Home Bay, or at/near Home Ranch Lagoon, or at/near DES7 warning the public of the health risks of Shellfish Harvesting.

Table 7 (page 4 of 5)

Exceedances of Surface Water Objectives for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Non-Contact Water Recreation (REC-2) Beneficial Use

Watershed	Location ID	Location	Monitoring Period	Exceedances for Arithmetic Mean (30-day calculation interval) (Fecal Coliform objective = 2,000 mpn/100 mL)	Exceedances for Statistical Threshold Value (STV) (30-day calculation interval) (Fecal Coliform objective = 4,000 mpn/100 mL)	Comments
Kehoe	PAC2	North Kehoe Creek at Pierce Point Road	25 Oct 21 to 12 Jan 22 (79 days)	• **Fecal Coliform was 1.7 to 2.9 times the objective.** • **The objective was exceeded for all calculation intervals.**	• **Fecal Coliform was 2.0 to 2.8 times the objective.** • **The objective was exceeded for all calculation intervals.** • **6 of 11 samples exceeded the objective.**	• PAC2 is located at the parking area for Kehoe Beach/Kehoe Lagoon. The area receives frequent visitors year-round, including the rainy season. • Based on the exceedances at PAC2, it is likely that North Kehoe Creek, from PAC2 upstream to the J-Ranch milking complex, also exceeded objectives for Non-Contact Water Recreation. • There are no postings on the National Park Service website or anywhere along North Kehoe Creek warning the public of the health risks of Non-Contact Water Recreation.
	PAC3	Kehoe Lagoon	26 Oct 21 to 26 Jan 22 (78 days)	• **Fecal Coliform was 1.2 to 5.2 times the objective for the three calculation intervals from 26 Oct 21 to to 22 Dec 21.** The objective was not exceeded for the remaining calculation intervals.	• **Fecal Coliform was 1.0 to 6.4 times the objective for the three calculation intervals from 26 Oct 21 to 22 Dec 21.** The objective was not exceeded for the remaining calculation intervals. • **4 of 13 samples exceeded the objective.**	• The Kehoe Beach/Kehoe Lagoon area receives frequent visitors year-round, including the rainy season. • There are no postings on the National Park Service website or at/near Kehoe Beach/Kehoe Lagoon warning the public of the health risks of Non-Contact Water Recreation.
Drakes Estero	DES6B*	Schooner Creek at Sir Francis Drake Blvd	25 Oct 21 to 12 Jan 22 (79 days)	• **Fecal Coliform was 1.0 to 1.4 times the objective for the three calculation intervals from 25 Oct 21 to 14 Dec 21.** The objective was not exceeded for the remaining calculation intervals.	• **Fecal Coliform was 1.4 to 1.9 times the objective for the three calculation intervals from 25 Oct 21 to 14 Dec 21.** The objective was not exceeded for the remaining calculation intervals. • **2 of 10 samples exceeded the objective.**	• DES6B is located at a parking area and wildlife display that receives frequent visitors year-round, including the rainy season. • There are no postings on the National Park Service website, or along the upper reaches of Schooner Bay, or along Schooner Creek, or at/near DES6B warning the public of the health risks of Non-Contact Water Recreation.
Drakes Bay	DBY2*	B-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• **Fecal Coliform was 1.4 times the objective for the one (only) calculation interval.**	• **Fecal Coliform was 1.6 times the objective for the one (only) calculation interval.** • **1 of 5 samples exceeded the objective.**	• Visitors frequent Drakes Beach near the mouth of B-Ranch unnamed creek year-round, especially during the rainy season to observe seals. • There are no postings on the National Park Service website, or along B-Ranch Unnamed Creek, or along Drakes Beach, or at/near DBY2 warning the public of the health risks of Non-Contact Water Recreation. • See note “a” regarding potential ecological impacts to seals.
	DBY3	A-Ranch Unnamed Creek	14 Dec 21 to 12 Jan 22 (29 days)	• **Fecal Coliform was 1.8 times the objective for the one (only) calculation interval.**	• **Fecal Coliform was 1.9 times the objective for the one (only) calculation interval.** • **1 of 5 samples exceeded the objective.**	• There are no postings on the National Park Service website, or along A-Ranch Unnamed Creek, or along Drakes Beach, or at/near DBY3 warning the public of the health risks of Non-Contact Water Recreation. • See note “a” regarding potential ecological impacts to seals.

Table 7 (page 5 of 5)

Exceedances of Surface Water Objectives for Fecal Indicator Bacteria

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

General Notes

(a) Where the A-Ranch and B-Ranch drainages empty to Drakes Bay, Elephant Seals and Harbor Seals rest, mate, birth, and nurse and rear their young. Seal pups are frequently observed within the outlet channels of the creeks. While bacteria criteria are not available for seals, the measured concentrations are of particular concern because these areas are seal nurseries.

(b) For the October 2021-January 2022 monitoring, locations PAC1S, PAC1Z, ABB1, ABB2/3, ABB4, ABB5, DES3, DES7, and DBY1 did not exhibit exceedances of REC-2 objectives.

(c) Statistical Threshold Value (STV) = Upper 90th Percentile Value. For *E. coli* and Enterococci bacteria, the calculation used logarithmic transformation. For Total Coliform and Fecal Coliform bacteria, no logarithmic transformation was performed.

(d) mpn = most probable number. cfu = colony forming units. Common practice treats these as equivalent units although they are not equivalent under certain conditions.

(e) * = potential impact from Tule Elk manure.

For the entire Drakes Estero Watershed, the ratio of cattle manure discharge to land/elk manure discharge to land = 24; on a watershed wide basis, approximately 4% of the manure impacts result from elk. For monitoring locations DES3, DES6B, and DES7, elk manure impacts are greater because the Limantour Tule Elk herd grazes upstream of these locations.

For the entire Drakes Bay Watershed, the ratio of cattle manure discharge to land/elk manure discharge to land = 22; on a watershed wide basis, approximately 5% of the manure impacts result from elk. For monitoring locations DBY1 and DBY2, the elk manure impacts are greater because the Drakes Beach herd grazes upstream of these locations.

(f) Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

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

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries. Central Coast Regional Board (Region 3).

Beneficial Use definitions are verbatim from https://www.waterboards.ca.gov/about_us/performance_report_1314/plan_assess/docs/bu_definitions_012114.pdf

Footnote

(1) The water quality objectives for REC-1 are based on a gastrointestinal illness rate of 32 per 1,000 primary contact recreators. The calculated bacteria statistics significantly exceeded the objectives. There is uncertainty regarding (1) the dose-response relationship for gastrointestinal illness, (2) frequency of water contact recreation, and (3) the degree of water contact/incidental water ingestion; however, gastrointestinal illness has likely occurred.

Table 8 (page 1 of 3)

Annual Manure Discharge to Land

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Circa October 2020, prior to liquidation of the I-Ranch milking herd

						Watershed											
						Kehoe			Abbotts			Drakes Estero	Drakes Bay			Pacific Ocean (excluding Drakes Bay)	Tomales	Estero de Limantour
Ranch	Ranch Type	Number of Cattle	Annual Manure Discharge to Land (tons)	Ranch Permitted Area (acres)	Annual Manure Discharge to Land Divided by Permitted Area (tons/acre)	Annual Dairy Manure Discharge to Land (tons)	Annual Beef Manure Discharge to Land (tons)	Annual Total for Watershed (tons)	Annual Dairy Manure Discharge to Land (tons)	Annual Beef Manure Discharge to Land (tons)	Annual Total for Watershed (tons)	Annual Beef Manure Discharge to Land = Annual Total for Watershed (tons)	Annual Dairy Manure Discharge to Land (tons)	Annual Beef Manure Discharge to Land (tons)	Annual Total for Watershed (tons)	Annual Total for Watershed (tons)	Annual Total for Watershed (tons)	Annual Total for Watershed (tons)
A (Nunes)	active dairy	280	6,463	838	7.7								5,093		5,093	1,307		
B (Double M, Mendoza)	active dairy	420	7,561	1,257	6.0								6,078		6,078	1,482		
C (plus that portion of D operated as active dairy) (Spaletta)	active dairy	490	9,107	850	10.7								8,051		8,051	1,056		
I (McClure)	active dairy	570	14,446	1,076	13.4	2,658		2,658	11,788		11,788							
J (plus that portion of K-Ranch operated as active dairy) (Kehoe)	active dairy	870	15,567	1,134	13.7	13,263		13,263								872	1,432	
L (McClelland)	active dairy	230	4,453	1,126	4.0	4,453		4,453								1,307		
Subtotal active dairy		2,860	57,597	6,281	9.2	20,374		20,374	11,788		11,788		19,222		19,222	4,717	1,432	
D (grazing pastures B & C)	beef	62	808	581	1.4							202		606				
ATT	beef	35	460	481	1.0											460		
D Rogers	beef	55	723	382	1.9							723						
E	beef	200	2,628	1,372	1.9							1,840				788		
F	beef	175	2,300	1,510	1.5							2,300						
G	beef	90	1,183	1,151	1.0					710	710	473						
H	beef	285	3,745	1,099	3.4					2,809	2,809	936						
Home Ranch	beef	300	3,942	2,660	1.5							2,365						1,577
K	beef	72	946	566	1.7		946											
M	beef	175	2,300	1,178	2.0					230	230	2,070						
N	beef	90	1,183	924	1.3							1,183						
Subtotal beef		1,539	20,216	11,904	1.7			946		3,749	3,749	12,092		606	606	1,248		
Total cattle		4,399	77,813	18,185	4.3			21,320			15,537	12,092			19,828	5,965	1,432	1,577

Watershed Land Area (acres)	2,350	3,420	9,010	2,760
Cattle Manure Loading to Land in the Kehoe Watershed (tons/acre)	**9.1**			
Cattle Manure Loading to Land in the Abbotts Watershed (tons/acre)		**4.5**		
Cattle Manure Loading to Land in the Drakes Estero Watershed (tons/acre)			**1.3**	
Cattle Manure Loading to Land in the Drakes Bay Watershed (tons/acre)				**7.2**

Table 8 (page 2 of 3)

Annual Manure Discharge to Land

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Circa October 2021, after liquidation of the I-Ranch milking herd

						Watershed											
						Kehoe			Abbotts			Drakes Estero	Drakes Bay			Pacific Ocean (excluding Drakes Bay)	Tomales	Estero de Limantour
Ranch	Ranch Type	Number of Cattle	Annual Manure Discharge to Land (tons)	Ranch Permitted Area (acres)	Annual Manure Discharge to Land Divided by Permitted Area (tons/acre)	Annual Dairy Manure Discharge to Land (tons)	Annual Beef Manure Discharge to Land (tons)	Annual Total for Watershed (tons)	Annual Dairy Manure Discharge to Land (tons)	Annual Beef Manure Discharge to Land (tons)	Annual Total for Watershed (tons)	Annual Beef Manure Discharge to Land = Annual Total for Watershed (tons)	Annual Dairy Manure Discharge to Land (tons)	Annual Beef Manure Discharge to Land (tons)	Annual Total for Watershed (tons)	Annual Total for Watershed (tons)	Annual Total for Watershed (tons)	Annual Total for Watershed (tons)
A (Nunes)	active dairy	330	6,360	838	7.6								5,012		5,012	1,348		
B (Double M, Mendoza)	active dairy	426	7,496	1,257	6.0								6,027		6,027	1,469		
C (plus that portion of D operated as active dairy) (Spaletta)	active dairy	490	9,107	850	10.7								8,051		8,051	1,056		
J (plus that portion of K-Ranch operated as active dairy) (Kehoe)	active dairy	860	15,468	1,134	13.6	13,179		13,179								866	1,432	
L (McClelland)	active dairy	330	5,582	1,126	5.0	5,582		5,582										
Subtotal active dairy		2,436	44,012	6,281	8.5	18,760		18,760					19,089		19,089	4,739	1,432	
D (grazing pastures B & C)	beef	62	808	581	1.4							202		606	606			
ATT	beef	35	460	481	1.0											460		
D Rogers	beef	55	723	382	1.9							723						
E	beef	200	2,628	1,372	1.9							1,840				788		
F	beef	175	2,300	1,510	1.5							2,300						
G	beef	90	1,183	1,151	1.0					710	710	473						
H	beef	285	3,745	1,099	3.4					2,809	2,809	936						1,577
Home Ranch	beef	300	3,942	2,660	1.5							2,365						
I (McClure)	inactive dairy	125	1,239	1,076	1.2		570	570		669	669							
K	beef	72	946	566	1.7		946	946										
M	beef	175	2,300	1,178	2.0					230	230	2,070						
N	beef	90	1,183	924	1.3							1,183						
Subtotal beef and inactive dairy		1,664	21,455	11,904	1.7			1,516		4,418	4,418	12,092		606	606	1,248		
Total cattle		4,100	65,467	18,185	3.6		1,516	20,276				12,092			19,695	5,987	1,432	1,577

Watershed Land Area (acres)		2,350	3,420	9,010	2,760
Cattle Manure Loading to Land in the Kehoe Watershed (tons/acre)		**8.6**			
Cattle Manure Loading to Land in the Abbotts Watershed (tons/acre)			**1.3**		
Cattle Manure Loading to Land in the Drakes Estero Watershed (tons/acre)				**1.3**	
Cattle Manure Loading to Land in the Drakes Bay Watershed (tons/acre)					**7.1**

Table 8 (page 3 of 3)

Annual Manure Discharge to Land

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

			Watershed					
Herd	Number of Elk	Annual Manure Discharge to Grazing Land (tons)	Estero de Limantour (tons)	Pacific Ocean (excluding Drakes Bay) (tons)	Drakes Bay (tons)	Drakes Estero (tons)	Kehoe (tons)	Abbotts (tons)
Tomales Point Herd	221	1,311		1,311			0	0
Drakes Beach Herd	151	909			909		±0	±0
Limantour Herd	113	1,003	501			501	±0	<73
Total Elk	541	3,210	501	1,311	909	501	±0	<73

General Notes

(a) Manure mass = wet weight, as excreted.

(b) Watershed Land Area = total watershed area minus the area of surface water.

(c) Tule Elk census from National Park Service census for 2021.

(d) Refer to Appendix D for the census (number of animals) of cattle and Tule Elk.

(e) The (absolute) mass of manure cited in this table is approximate. Relative comparisons are more accurate (between watersheds, temporal comparisons, dairy cattle versus beef cattle, cattle versus elk, etc.).

Monitoring Location (October 2021-January 2022)

Historical monitoring location

Actively Milking Dairy Ranch

Beef Ranch

Dairy Ranch Not Actively Milking (I-Ranch)

I-Ranch historically operated as an actively milking dairy. Circa June 2021, prior to the October 2021-January 2022 monitoring, I-Ranch liquidated the milking herd. A herd of approximately 125 heifers was maintained during the October 2021-January 2022 monitoring.

0 5,000 10,000

Approximate Scale - Feet

0 1 2

Approximate Scale - Miles

J-Ranch

Kehoe Watershed

PAC2
North Kehoe Creek at Pierce Point Road

North Kehoe Creek

Kehoe Lagoon

PAC3
Kehoe Lagoon

PAC1S
South Kehoe Creek Downstream of I-Ranch and L-Ranch

I-Ranch

South Kehoe Creek

L-Ranch

North Abbotts Creek

ABB2/3
North Abbotts Creek Downstream of I-Ranch

PAC1Z
South Kehoe Creek Downstream of L-Ranch

ABB5
Outflow from Upper Abbotts Lagoon

ABB1
Abbotts Creek at Pierce Point Road

ABB4
Outflow from Middle Abbotts Lagoon

Abbotts Creek

Upper Abbotts Lagoon

Middle Abbotts Lagoon

Abbotts Watershed

North Schooner Creek

Lower Abbotts Lagoon

East Schooner Creek

RCA Meterological Station

DES2
East Schooner Creek at Sir Frances Drake Blvd

DES6B
Schooner Creek at Sir Francis Drake Blvd

Home Ranch Creek

Schooner Bay

DES7
Home Ranch Lagoon at Estero Trail Bridge

DES3
Home Ranch Creek Downstream of Ranch Buildings

Drakes Estero Watershed

Home Ranch Lagoon

Drakes Estero

Home Bay

C-Ranch

DBY1
C-Ranch Unnamed Creek

Estero de Limantour Watershed

Drakes Bay Watershed

B-Ranch

Except for the northern ±1/2 mile of Schooner Bay, the waters of Drakes Estero (including Home Bay) are part of the Phillip Burton Wilderness.

Drakes Bay

DBY2
B-Ranch Unnamed Creek

A-Ranch

DBY3
A-Ranch Unnamed Creek

POINT REYES NATIONAL SEASHORE

POINT REYES NATIONAL SEASHORE

Figure 1

Monitoring Locations (Orthophoto Basemap)

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds Point Reyes National Seashore Marin County CA

Monitoring Location (October 2021-January 2022)

Historical monitoring location

Actively Milking Dairy Ranch

Beef Ranch

Dairy Ranch Not Actively Milking (I-Ranch)

I-Ranch historically operated as an actively milking dairy. Circa June 2021, prior to the October 2021-January 2022 monitoring, I-Ranch liquidated the milking herd. A herd of approximately 125 heifers was maintained during the October 2021-January 2022 monitoring.

0 5,000 10,000

Approximate Scale - Feet

0 1 2

Approximate Scale - Miles

J-Ranch

Kehoe Watershed

PAC2
North Kehoe Creek at Pierce Point Road

North Kehoe Creek

Kehoe Lagoon

PAC3
Kehoe Lagoon

PAC1S
South Kehoe Creek Downstream of I-Ranch and L-Ranch

I-Ranch

South Kehoe Creek

L-Ranch

North Abbotts Creek

ABB2/3
North Abbotts Creek Downstream of I-Ranch

PAC1Z
South Kehoe Creek Downstream of L-Ranch

ABB5
Outflow from Upper Abbotts Lagoon

ABB1
Abbotts Creek at Pierce Point Road

ABB4
Outflow from Middle Abbotts Lagoon

Abbotts Creek

Upper Abbotts Lagoon

Middle Abbotts Lagoon

Abbotts Watershed

North Schooner Creek

Lower Abbotts Lagoon

East Schooner Creek

RCA Meterological Station

DES2
East Schooner Creek at Sir Frances Drake Blvd

DES6B
Schooner Creek at Sir Francis Drake Blvd

Home Ranch Creek

Schooner Bay

DES7
Home Ranch Lagoon at Estero Trail Bridge

DES3
Home Ranch Creek Downstream of Ranch Buildings

Drakes Estero Watershed

Home Ranch Lagoon

Drakes Estero

Home Bay

C-Ranch

DBY1
C-Ranch Unnamed Creek

Estero de Limantour Watershed

Drakes Bay Watershed

B-Ranch

Except for the northern ±1/2 mile of Schooner Bay, the waters of Drakes Estero (including Home Bay) are part of the Phillip Burton Wilderness.

Drakes Bay

DBY2
B-Ranch Unnamed Creek

A-Ranch

DBY3
A-Ranch Unnamed Creek

POINT REYES NATIONAL SEASHORE

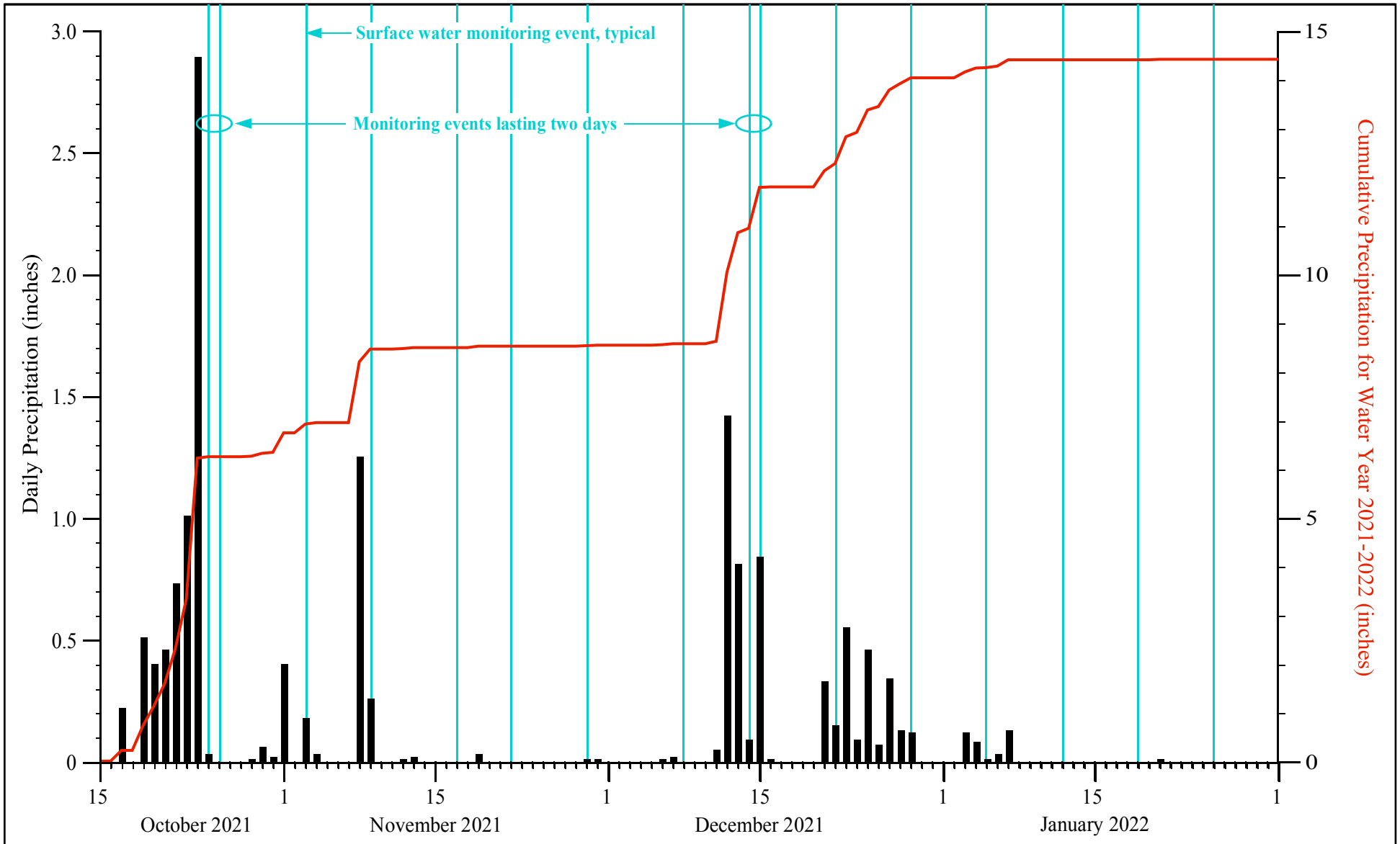
GOLDEN GATE NATIONAL RECREATION AREA

PACIFIC OCEAN

Figure 2

Monitoring Locations (Topographic Basemap)

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds Point Reyes National Seashore Marin County CA



Notes

(a) Precipitation data from the RCA Meterological Station. (https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nvprca)

(b) All monitoring locations were within 7 miles of the RCA Meterological Station.

(c) Water year = 1 October through 30 September.

(d) Cumulative precipitation for Water Year 2020-2021 = 9.6 inches.

Figure 3

Daily and Cumulative Precipitation

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

Monitoring Location (October 2021-January 2022)

Historical monitoring location

Actively Milking Dairy Ranch

Beef Ranch

Dairy Ranch Not Actively Milking (I-Ranch)

I-Ranch historically operated as an actively milking dairy. Circa June 2021, prior to the October 2021-January 2022 monitoring, I-Ranch liquidated the milking herd. A herd of approximately 125 heifers was maintained during the October 2021-January 2022 monitoring.

Notes

(1) Annual Cattle Manure Loading = Total Cattle Manure Discharge to Land/Watershed Land Area.

(2) **The mass of cattle manure cited in this figure corresponds to circa October 2021, after liquidation of the I-Ranch milking herd.**

(3) The mass of Tule Elk manure cited in this figure corresponds to the National Park Service census for 2021.

(4) Manure Mass = wet weight, as excreted.

(5) **The (absolute) mass of manure cited on this figure is approximate. Relative comparisons are more accurate (between watersheds, dairy cattle versus beef cattle, cattle versus elk).**

0 5,000 10,000

Approximate Scale - Feet

0 1 2

Approximate Scale - Miles

J-Ranch

I-Ranch

L-Ranch

C-Ranch

B-Ranch

A-Ranch

Kehoe Watershed

Annual Cattle Manure Loading = 8.6 tons/acre
Watershed Total Area = 2,380 acres
Watershed Land Area = 2,350 acres
Contained Dairy Ranch Leases = 1,030 acres
Contained Beef & Inactive Dairy Ranch Leases = 1,061 acres
Dairy Manure Discharge to Land = 18,760 tons/year
Beef Manure Discharge to Land = 1,516 tons/year
Tule Elk Manure Discharge to Land = ±0 tons/year

Abbotts Watershed

Annual Cattle Manure Loading = 1.3 tons/acre
Watershed Total Area = 3,640 acres
Watershed Land Area = 3,420 acres
Contained Dairy Ranch Leases = 315 acres
Contained Beef & Inactive Dairy Ranch Leases = ±2,214 acres
Dairy Manure Discharge to Land = ±0 tons/year
Beef Manure Discharge to Land = 4,418 tons/year
Tule Elk Manure Discharge to Land <73 tons/year

Drakes Estero Watershed

Annual Cattle Manure Loading = 1.3 tons/acre
Watershed Total Area = 11,100 acres
Watershed Land Area = 9,010 acres
Contained Dairy Ranch Leases = 0 acres
Contained Beef Ranch Leases = ±7,312 acres
Dairy Manure Discharge to Land = 0 tons/year
Beef Manure Discharge to Land = 12,092 tons/year
Tule Elk Manure Discharge to Land = 501 tons/year

Drakes Bay Watershed

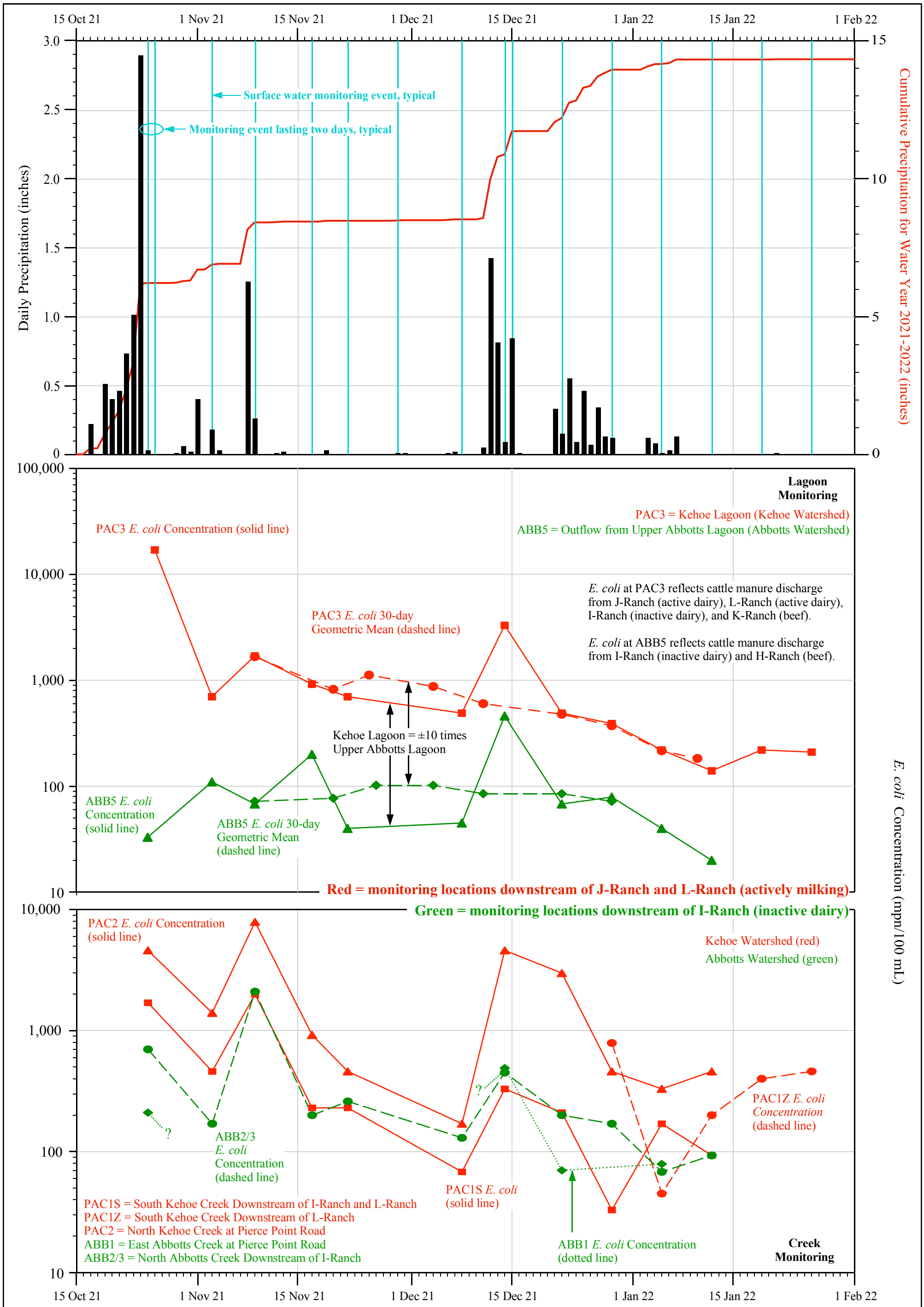
Annual Cattle Manure Loading = 7.1 tons/acre
Watershed Total Area = 2,840 acres
Watershed Land Area = 2,760 acres
Contained Dairy Ranch Leases = 1,638 acres
Contained Beef Ranch Leases = ±436 acres
Dairy Manure Discharge to Land = 19,089 tons/year
Beef Manure Discharge to Land = 606 tons/year
Tule Elk Manure Discharge to Land = 909 tons/year

Estero de Limantour Watershed

Figure 4

Annual Manure Discharge to Land Circa October 2021

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds Point Reyes National Seashore Marin County CA



E. coli at PAC1S reflects cattle manure discharge from I-Ranch (inactive dairy) and L-Ranch (active dairy). *E. coli* at PAC1Z reflects cattle manure discharge from L-Ranch (active dairy). *E. coli* at PAC2 reflects cattle manure discharge from J-Ranch (active dairy). *E. coli* at ABB1 reflects cattle manure discharge from I-Ranch (inactive dairy) and H-Ranch (beef). The portions of L-Ranch upstream of ABB1 are not grazed by cattle. *E. coli* at ABB2/3 reflects cattle manure discharge from I-Ranch (inactive dairy).

30-day Geometric Means have been plotted for illustration purposes because they provide a more precise representation of the temporal trend. 42-day Geometric Means were used to determine exceedances of water quality objectives.

Figure 5

***E coli* Comparisons for the Kehoe and Abbotts Watersheds**

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

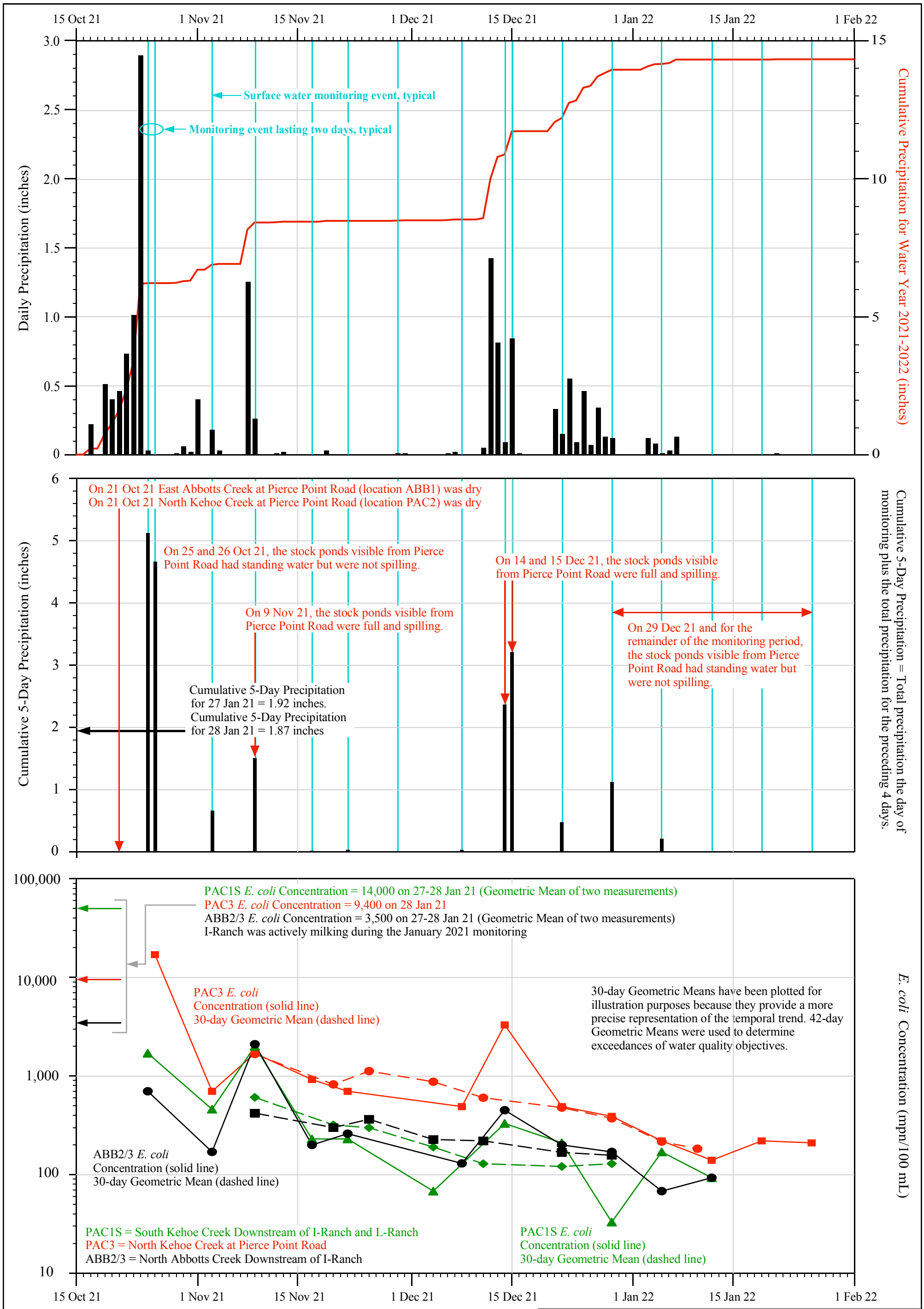


Figure 6

***E coli* Concentrations Measured in January 2021 and October 2021-January 2022**

Kehoe, Abbotts, Drakes Estero, and Drakes Bay Watersheds
Point Reyes National Seashore
Marin County CA

I-Ranch was actively milking during the January 2021 monitoring. I-Ranch liquidated the milking herd circa June 2021 and was not actively milking during the October 2021-January 2022 monitoring.

E. coli at PAC1S reflects cattle manure discharge from L-Ranch (active dairy) and I-Ranch. *E. coli* at PAC3 reflects cattle manure discharge from J-Ranch (active dairy), L-Ranch (active dairy), I-Ranch, and K-Ranch (beef). *E. coli* at ABB1 reflects cattle manure discharge from I-Ranch and H-Ranch (beef). *E. coli* at ABB2/3 reflects cattle manure discharge from I-Ranch.