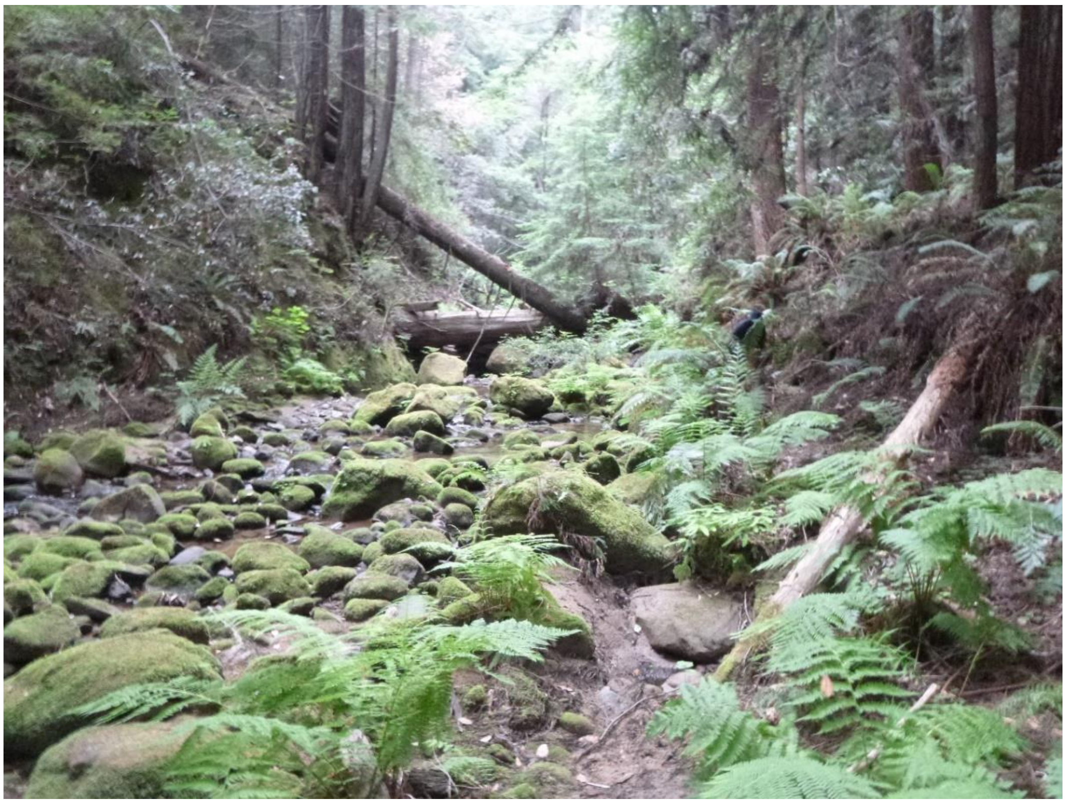
Appendix B
Staff Report and Attachments

Water Quality Improvement Plan to Address the Sediment Impairment on San Gregorio Creek

Draft Staff Report



California Regional Water Quality Control Board
San Francisco Bay Region

by

René Leclerc, P.E.

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San Francisco Bay Regional Water Quality Control Board

1515 Clay Street, Suite 1400

Oakland, CA 94612

Telephone: (510) 622-2300

https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/

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1. San Gregorio Creek Watershed Management Plan
2. Detailed Problem Statement
3. San Gregorio Watershed Rapid Sediment Budget

1.0 INTRODUCTION

This Staff Report provides documentation to support a Water Quality Improvement Plan (Plan) that will be considered by the San Francisco Bay Regional Water Quality Control Board (Water Board) to restore water quality objectives for sediment and habitat conditions in San Gregorio Creek. San Gregorio Creek is located in San Mateo County and drains from the Santa Cruz Mountains to the Pacific Ocean. The Plan's main goal is to help facilitate the recovery of listed populations of coho salmon and steelhead in the San Gregorio Creek watershed. This Staff Report identifies significant sources of sediment within the watershed and identifies implementation actions and mechanisms for implementation to achieve water quality objectives for sediment and habitat conditions in San Gregorio Creek.

1.1 Background

The federal Clean Water Act (CWA) requires California to adopt and enforce water quality standards to protect all water bodies within the State. The Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) delineates these standards for the San Francisco Bay Region.

CWA section 303(d) requires states to identify water bodies that do not meet water quality standards and to take appropriate actions to remedy the impairment(s). San Gregorio Creek was placed on the 303(d) list of impaired water bodies in 1998 because sediment in the creek exceeded levels protective of beneficial uses of the creek, including cold freshwater habitat, fish migration, fish spawning, preservation of rare and endangered species, water recreation, and wildlife habitat uses. Current data indicate that sediment levels in the creek remain high.

Development of a Total Maximum Daily Load (TMDL) is the primary tool for remedying water quality impairments. A TMDL allocates the total load of the pollutant causing an impairment among the pollutant's sources to facilitate source-specific actions to reduce the cumulative load. The CWA requires that TMDLs be developed for 303(d) listed water bodies.

The U.S. Environmental Protection Agency (U.S. EPA) provides guidance that allows states flexibility in addressing water quality impairments and focuses on taking actions to attain water quality standards sooner than through a TMDL, which generally takes longer to prepare (U.S. EPA 2013, 2015). This Plan follows that guidance, entitled U.S. EPA's "Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program." This Plan is an alternative to a TMDL, which if successful will lead to delisting San Gregorio Creek. This Plan is designated as a Category 5-Alt plan by U.S. EPA rather than the traditional Category 5 used to designate a TMDL. The U.S. EPA reviews and accepts Category 5-Alt plans but does not approve them.

We propose this Plan because actions are planned or being taken in the watershed to reduce sediment loads, and thus a Plan will likely achieve water quality objectives more quickly than a TMDL. If the Plan is unsuccessful in achieving water quality standards, then a TMDL may need to be developed. This Plan relies on a collaborative approach with willing and ready stakeholders without implementing new permits, although the Water Board may issue general or individual Waste Discharge Requirements if necessary. The Plan identifies all actions needed to address the sediment impairment, proposes implementation actions, identifies regulatory mechanisms for the actions, and includes water quality monitoring to evaluate effectiveness of the corrective actions and assess attainment of water quality standards.

1.2 Report Organization

The Staff Report is organized as follows:

Chapter 2. Watershed Setting: Describes the physical setting of the watershed, including basin geology, soils, hydrology, land use and property ownership.

Chapter 3. Project Summary: Summarizes the problem statement and provides the basis for the Plan presented in this Staff Report.

Chapter 4. Water Quality Standards: Identifies the water quality objectives for sediment and population ecology and beneficial uses for San Gregorio Creek.

Chapter 5. Historical Land Uses Contributing to Sediment and Habitat Impairments: Identifies historical land use changes affecting basin hydrology, sediment production and channel morphology since the time of the first European settlers.

Chapter 6. Current Sources of Sediment and Habitat Impairments: Identifies available sediment studies and sediment source assessments and summarizes current sources of sediment and habitat impairments.

Chapter 7. Numeric Targets: Identifies numeric targets and desired conditions for the Plan, and summarizes the current watershed status with regard to these targets and conditions.

Chapter 8: Implementation Plan: Identifies implementation actions necessary to attain water quality standards through management of anthropogenic sediment sources and enhancement of stream habitat conditions.

Attachments: Three key documents were developed separately from this Plan and provide information to support the Plan’s conclusions. These documents provide additional detailed information about the San Gregorio watershed; therefore, we consider them part of this Plan. The attachments are as follows:

- Attachment 1 – San Gregorio Creek Watershed Management Plan – a comprehensive report documenting watershed characteristics, basin hydrology, limiting factors for selected species, and management and restoration priorities. This report was prepared by Stillwater Science in 2010 and is posted at: http://www.sanmateorcd.org/reports-and-maps/
- Attachment 2 – Detailed Problem Statement – provides detailed information including references in support of the problem statement summarized in Section 3.2
- Attachment 3 – San Gregorio Creek Rapid Sediment Budget – describes current and historical sediment erosion, transport and deposition processes in the watershed for major land use periods and provides a conceptual sediment budget for each period. This report was prepared by Joan Florsheim in 2015.

2.0 WATERSHED SETTING

The San Gregorio Creek basin drains a 52 square mile area on the west slope of the Santa Cruz Mountains in a rural, unincorporated part of San Mateo County (Figure 2.1). The highest point in the watershed is Borel Hill at 2,572 ft in the southeast part of the basin. Main tributaries to San Gregorio Creek are Clear, El Corte de Madera, Harrington, La Honda, Mindego, and Alpine Creeks (Figure 2.1). San Gregorio Creek begins at the confluence of Mindego and Alpine Creeks and flows west about 11 miles to its terminus at a seasonal lagoon bordering the Pacific Ocean.

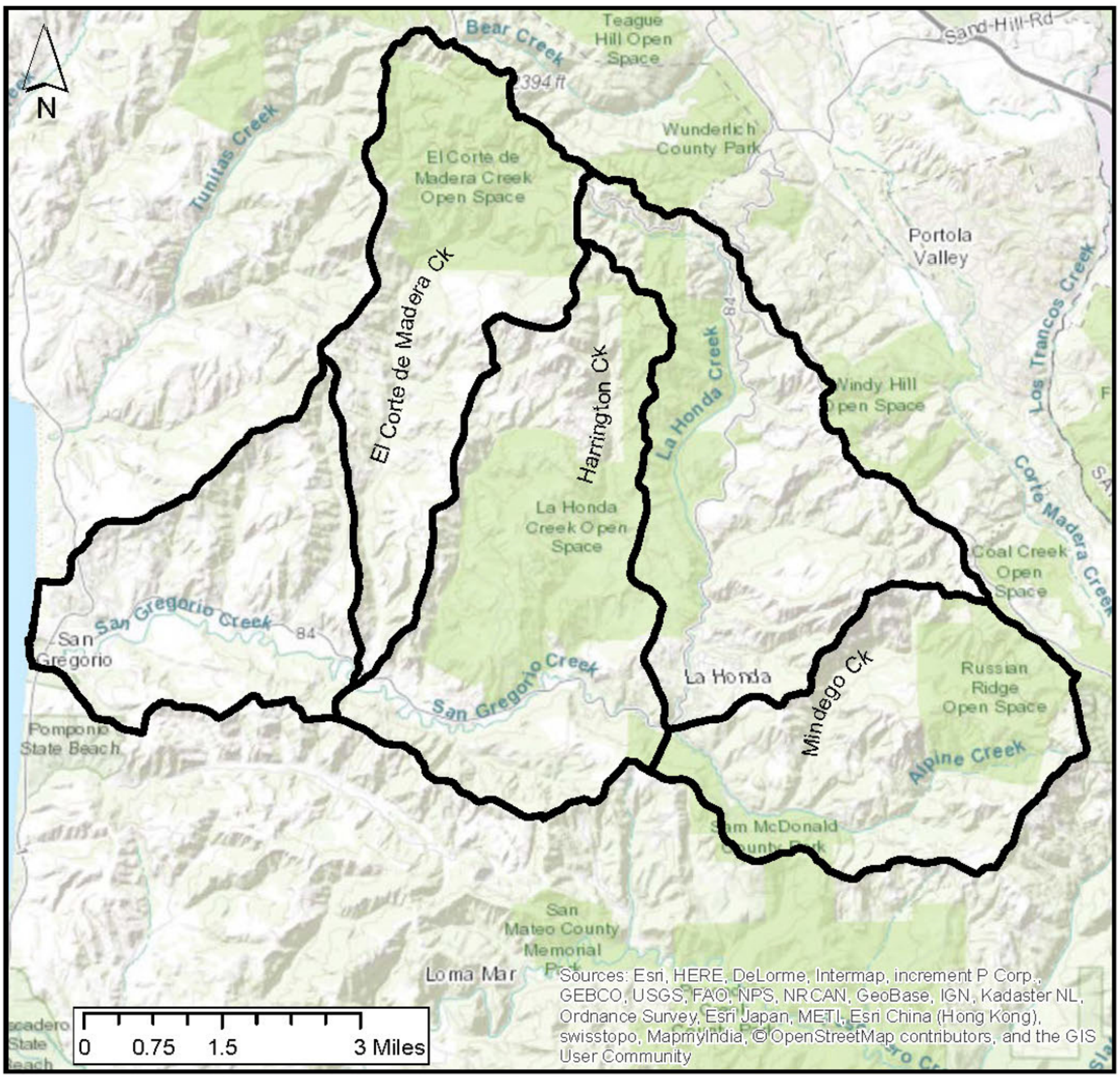

Figure 2.1 San Gregorio Creek Watershed

The watershed setting of San Gregorio Creek is described in Attachment 1, the San Gregorio Watershed Management Plan, which describes regional geology, seismicity, soils, geomorphology, land uses, hydrology, road networks and other physical features of the watershed. This chapter presents an overview of these topics with a focus on information that supports the discussion of current sources of sediment impairment presented in Chapter 6.

2.1 Climate and Hydrology

The region has a Mediterranean climate with dry summers moderated by a cool marine layer that produces frequent coastal fog. Average annual temperature ranges from 40° F in winter to 71° F in late summer. Winter storms produce the vast majority of rainfall in the basin, which sees occasional snow at higher elevations. Average annual rainfall ranges from 18 inches at the coast to 35 inches in the Santa Cruz Mountains. No water supply or flood control reservoirs are located in the watershed. Consequently, basin runoff is unregulated and occurs mostly in winter following storm events. Instream flows during the dry season are significantly affected by surface water diversions and possibly by groundwater pumping in the watershed (Attachment 1, Stillwater Sciences 2014). Surface water diversions were adjudicated by the Superior Court of San Mateo in 1993 (Superior Court of San Mateo, Decree #355792). Among other requirements, the decision mandates that all new surface water diversions meet minimum instream flow requirements; however, pre-existing diversions do not.

A United States Geological Survey (USGS) stream gage is located on San Gregorio Creek at San Gregorio (USGS Gage #11162570). The gage has operated since 1970, with gaps in operation from 1995 to 2001, 2006 and 2007. Table 2.1 shows monthly average daily flows for the period of record. Flow data are reported in cubic feet per second (cfs). Base flows are typically lowest in August and September and can be intermittent, particularly in September.

Table 2.1 Average Monthly Flow (cfs) at San Gregorio Creek Stream Gage

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
85	103	88	39	12	5.9	2.9	1.6	1.2	2.8	17	54

Figure 2.2 shows the annual peak flow for each water year of record, where a water year is defined as the year starting October 1 and ending September 30 the following year. The largest flow of record was 7,910 cfs in January 1982. The next two largest floods occurred in 1995 (6,600 cfs) and 1997 (6,100 cfs). Prior to flow records, large floods on San Gregorio Creek are reported during the winters of 1861-62, 1875-76, and 1939-40 (ESA 2004, FEMA 2015).

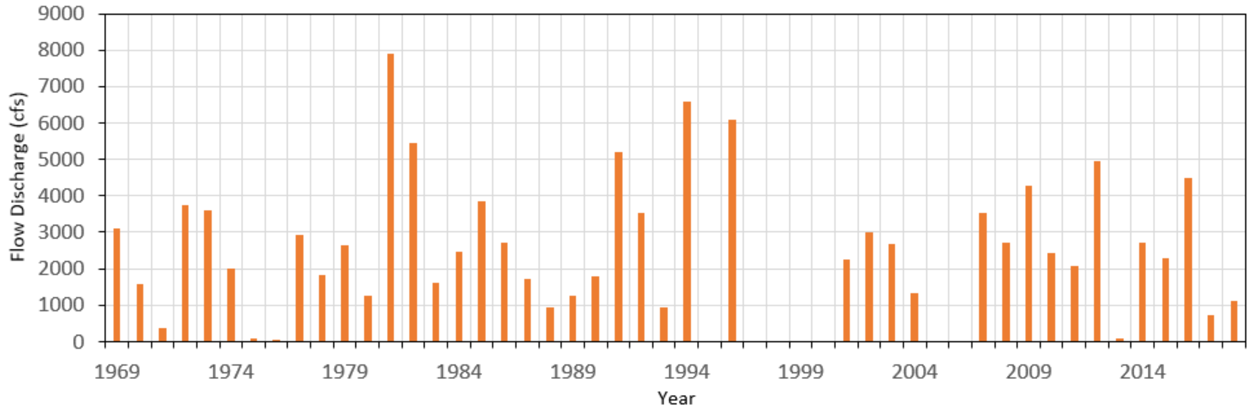

Figure 2.2 Annual peak flows in cubic feet per second at the San Gregorio stream gage (#11162570)

2.2 Geology and Seismicity

Basin geology is controlled by regional faulting along the San Andreas Fault Zone and consists largely of a complex assemblage of sedimentary rocks containing varying amounts of sandstone, siltstone and shale with moderate to very high erodibility (Wentworth et al. 1985, Brabb et al. 2000). Descriptions of geologic rock types and geologic and soils maps are provided in the Watershed Management Plan (Attachment 1).

The watershed is seismically active and crossed by several faults. The San Gregorio Fault Zone and San Andreas Fault Zone are the most likely to produce large earthquakes and bound the watershed to the west and east, respectively. In addition to lateral displacement along fault zones, long-term tectonic uplift is also occurring at between 0.1 millimeter per year (mm/yr) and 1.4 mm/yr (Thornburg 1998, D'Alessio et al. 2005). Tectonic uplift and associated seismicity are identified as important drivers of overall rates of erosion and stream incision in the watershed (Brady et al. 2004, Attachment 1). Detailed information regarding basin seismology and fault history is provided by several authors (Thornburg 1998, Sojourner 2000, Brady et al. 2004).

The San Gregorio Creek watershed has the potential to generate large quantities of sediment due to its underlying geology, steep slopes, periodic heavy rainfall, tectonism, and history of land disturbance. Mass wasting is the predominant sediment producer in the watershed, characterized by landslides, debris flows, debris slides, and stream bank failures associated with mass wasting (Ellen et al. 1997, Pike 1997, Attachment 1). Landslides and debris flows are ubiquitous features in the San Gregorio Creek watershed, particularly on steep slopes bordering larger streams. Many of the basin rock types weather to clay-rich soils prone to erosion and landslides. Consequently, landslide deposits are abundant. Wentworth et al. (1997) identified 60 percent of the watershed area as 'mostly landslides' and the remainder as containing locally scattered small landslides (37 percent) or flat to gently sloping ground incapable of generating landslides (3 percent). Large storms produced hundreds of debris flows in the San Gregorio Creek watershed in 1982-83 (Ellen and Wieczorek 1988, Ellen et al. 1997) and numerous landslides in both 1982-83 and 1997-98 (Godt 1999, Jayko et al. 1999, Wells et al. 2006).

Seismicity also generates mass wasting events as demonstrated following the 1984 Morgan Hill Magnitude 6.2 (M6.2) and 1989 Loma Prieta (M6.9) earthquakes (Wieczorek and Keefer 1987, Keefer 1998).

Other important sources of sediment production include erosion from roads and trails, channel bed and bank erosion, gully erosion, and runoff from residential and agricultural land uses (Becker et al. 2010; Best 2005, 2007a,b, 2012, 2016; Titus et al. 2010; Attachment 3). Legacy effects from historical logging are also important, primarily from former skid trails and logging roads (Balance Hydrologics 2006a, Attachment 1). These anthropogenic sediment sources are discussed in detail in Chapters 5 and 6.

2.3 Geomorphology

The morphology of tributary streams in the San Gregorio Creek watershed ranges from steep headwater channels often influenced by bedrock outcrops, large woody debris (LWD) and historical debris flows to less steeply sloping pool-riffle reaches with well-vegetated riparian corridors (Attachment 3). Tributary streams are bordered by Douglas fir, redwood, and some Monterey pine, particularly in the upper and northern parts of the watershed. The main stem of San Gregorio Creek flows through a narrow valley and is incised through alluvial deposits. San Gregorio Creek has a well-established riparian corridor bordered by Quaternary age stream terraces that increase in age with elevation, reflecting long-term tectonic uplift in the watershed (Sojourner 2000, Attachment 1). Floodplains in the watershed are typically not well developed due to channel entrenchment and hilly topography of the basin; however, exceptions exist, including parts of Harrington Creek and San Gregorio Creek. Active meanders are largely absent, except at the downstream-most 1.5 miles of San Gregorio Creek near the lagoon (Thornburg 1998). There are no engineered levees in the watershed.

Channel bed material varies from a gravel and cobble substrate in upstream tributaries to predominantly sand and gravel in lower San Gregorio Creek approaching the lagoon at Highway 1. Significant variability exists, however, such as where substrate composition is affected by local mass wasting events, bank erosion, channel slope, runoff from adjacent land uses, and variability in contributory basin soils and geology. Substrate embeddedness by fine-grained sediments is reported on all major streams in the watershed (Brady et al. 2004, Balance Hydrologics 2007, Becker and Reining 2008, Attachment 1). Although the percentage of fines was found to be acceptable for fish spawning, Brady et al. (2004) found that substrate embeddedness on La Honda Creek often created a cemented stream bed, which could prevent steelhead from moving the gravel to construct a redd. In addition to instream deposition of fines, in-situ breakdown of friable mudstone bed material can be a major source of embeddedness, as reported on La Honda Creek by Brady et al (2004). In contrast, Mindego Creek contributes a large percentage of durable and semi-durable gravel and cobble substrate found on San Gregorio Creek, derived from Mindego Basalt found in the subwatershed (see Attachment 1).

Stream surveys report a lack of sufficient LWD in most major streams in the watershed (Zatkin 2002, Alford 2013). An exception is La Honda Creek where Brady et al. (2004) reported that existing LWD volume was relatively high with a high annual rate of recruitment compared to rates in northern California redwood forests as a whole (Montgomery et al. 1995, Carroll and Robison 2007, Issel 2015). Investigations by Balance Hydrologics (2020) and discussions with Midpeninsula Regional Open Space District (Midpen) staff (Hébert 2018) indicate that LWD quantities on upper El Corte de Madera Creek are high relative to surrounding watersheds, though both are based on personal observation rather than volumetric measurements. In contrast, Alford (2013) inventoried LWD along the entire mainstem of San Gregorio Creek and found the frequency of LWD to be 0.05 pieces per meter over the 16.7 km survey length, which is low for northern California streams.

2.4 Land Use

The San Gregorio Creek watershed is largely rural. The main communities are La Honda, San Gregorio, Redwood Terrace and Sky Londa. Main roads are Highway 1 which crosses the mouth of San Gregorio Creek and Highway 84 which begins at Highway 1 and parallels San Gregorio Creek before turning north, along La Honda Creek, toward the community of La Honda. About 3,500 people live in the San Gregorio Creek watershed; however, recreational areas such as San Gregorio State Beach are very popular, the latter with an estimated 373,000 visitors in 2013 (Corps 2015). Watershed land cover consists mainly of Douglas fir and Redwood forest (33 percent), grassland (28 percent), coastal scrub (16 percent), and woodlands of Coast live oak and California bay (12 percent). Urban and residential areas occupy 3.5 percent of the total land area and agricultural croplands occupy less than 2 percent (Attachment 1).

Property ownership in the watershed is about half private and half held in the public trust. Midpen, the largest landowner, manages about one-third of the watershed area for recreation, conservation and education. Additional landowners focused on stewardship and environmental protection include the Peninsula Open Space District (POST), San Mateo County Parks, and private lands with conservation easements.

Land uses consist primarily of resource conservation and recreation, residential and commercial development, grazing operations, and agricultural croplands. About one-third of the watershed land area is suitable for grazing (California Department of Conservation 2016). Midpen oversees conservation grazing leases on 2,848 acres, about 8.6 percent of the watershed area (Midpen 2020). The extent of active grazing operations elsewhere in the watershed is not documented in the reports we reviewed. About 350 acres, or 1 percent of total watershed, is farmed; this land is concentrated in the San Gregorio Valley along the creek. Oil drilling, mostly near the Harrington Creek watershed, has been conducted historically. It is not known if drilling continues today, but five wells were reported as active in 2010 (Attachment 1). A review of well status records showed that all wells in the region are either idle or plugged (California Department of Conservation 2021). A small amount of logging occurs on private lands. Since 1997, between 50 and 150 acres have been logged every 10 to 15 years or so, or about 0.2 to 0.5 percent of the total watershed area (CalFire 2021).

There are approximately 140 miles of State or County maintained roads in the watershed and approximately 47 miles of inventoried roads and trails on Midpen lands (Attachment 1). Roads and trails on public trust lands are generally mapped, but private roads and trails are generally not. Many old logging roads on public lands have been repurposed as trails or roads. Florsheim (Attachment 3) documented the length of roads per square kilometer (km^2) in tributary watersheds and found that, for those areas inventoried, road density ranged from 2.9 km/km^2 (7.5 $miles/mile^2$) in the La Honda Open Space Preserve to 5 km/km^2 (13 $miles/mile^2$) in the El Corte de Madera Open Space Preserve.

2.5 Fire History

Striplen (2014) examined fire history in the Santa Cruz mountains and found, based on fire scar information from 95 sample trees, that the frequency of fires had doubled during the logging era (1850 – 1950) when compared with the native and ranching era (1600s – 1850). Fire occurrence had dropped in the most recent era Striplen analyzed (1950 – 2013) but remained higher than it was prior to 1850. Although fires were more frequent, the severity of fire was not determined. Fire history data published by the State of California Department of Forestry and Fire Protection (CalFire 2021) shows only one fire in the San Gregorio Creek watershed since the late 1800s. The fire occurred in 1962 and covered about 400 acres along Skyline Blvd. The recent 2020 CZU Lightning Complex Fire did not affect the San Gregorio Creek watershed and was located just south in the Pescadero and Butano Creek watersheds. Although the CalFire database includes fire information from the late 1800s to present, it notes that earlier records may not have been reliably recorded.

3.0 PROJECT SUMMARY

This chapter presents a summary of the Clean Water Act (CWA) 303(d) listing information, the problem statement, and the basis for the Water Quality Improvement Plan (Plan) presented in this Staff Report.

3.1 CWA 303(d) Listing Information

In 1998, the 11.3-mile-long main stem of San Gregorio Creek was added to the CWA 303(d) list based on the impairment of steelhead trout (*Oncorhynchus mykiss*) habitat due to excessive sedimentation. The watershed has also experienced a decline in populations of sensitive, threatened, or endangered aquatic species that include coho salmon, tidewater goby, red-legged frog, and San Francisco garter snake. In addition to sediment, San Gregorio Creek is also listed as impaired by pathogens. The pathogen impairment is not the subject of this Staff Report and will be addressed separately.

3.2 Problem Statement

A detailed discussion of the literature reviewed to develop this problem statement is provided in Attachment 2. The problem of sediment in San Gregorio Creek is summarized as follows:

- Populations of steelhead and coho salmon in San Gregorio Creek and its tributaries have declined substantially, beginning as early as the 1870s.
- Accelerated erosion and sedimentation is evident in San Gregorio Creek and its tributaries. Accelerated sediment erosion from historical and existing land uses is a significant source of fine sediment[1] in San Gregorio Creek and is causing significant adverse changes to salmon habitat. These adverse changes are documented in a Limiting Factors Analysis prepared as part of the 2010 Watershed Management Plan (Attachment 1). The discharge of sediment is occurring in part due to controllable water quality factors, defined as those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State and that may be reasonably treated.
- The problem of sediment is expressed by high concentrations of fine sediment deposited in the streambed at potential spawning and rearing sites for steelhead. Excess fine sediment in the streambed can cause poor incubation conditions for fish eggs, resulting in high mortality prior to emergence. When large amounts of fine sediment are deposited, the streambed is also more vulnerable to deep scour during storms, which can wash away eggs and thereby further reduce survival during incubation. High concentrations of fine sediment in the streambed also decrease the growth and survival of juvenile salmon and steelhead by reducing the availability of food and refuge and overall quality of rearing habitat.

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[1] When we refer to fine sediment in the streambed, we are referring primarily to sand (< 2mm) and lesser amounts of fine or very fine gravel (2 mm ≤ D ≤ 8 mm). These grain sizes constitute the bed material suspended load in gravel-bedded channel reaches that is transported either as bedload during smaller runoff events (that are greater than the threshold for bed material transport), and/or as suspended load during larger runoff events.

- Floodplain disconnection, declines in large woody debris (LWD), and water diversions have caused or contributed to significant adverse changes to salmon habitat complexity and availability.

Resolution of the sediment impairment in the San Gregorio Creek watershed is one factor that will improve steelhead habitat. Other factors needing resolution to help conserve and enhance the size of the steelhead run are identified or addressed in this Plan as well, including the following:

- Poor access to-and-from potential spawning and rearing habitat resulting from channel incision, human-made structures in channels, and water uses that directly or indirectly block or impede migration by adult and/or juvenile fish
- Habitat simplification resulting from reduction in the amount of large woody debris in the channels and artificial breaching of the lagoon, which eliminates valuable juvenile rearing habitat in years when breaching occurs
- Poor baseflow persistence that appears to significantly reduce the availability of critical habitat for summer and fall rearing of steelhead.

3.3 Basis for a Water Quality Improvement Plan

The Plan approach was selected to address the San Gregorio Creek sediment and habitat impairments based on the following considerations:

- Watershed stakeholders have completed several projects to address sediment and habitat impairments.
- Stakeholders have an ongoing commitment to complete future implementation actions necessary to meet water quality objectives.
- Stakeholders support this approach.
- The San Francisco Bay Regional Water Quality Control Board (Water Board) may use existing regulatory authorities where needed to compel sediment reduction actions.
- This approach provides an efficient and timely path for restoring water quality.
- This approach is based on a technical understanding of anthropogenic sediment sources contributing to the sediment impairment, and implementation actions necessary to meet water quality objectives have been developed.

The stakeholder actions to date are summarized in Section 5.7. Expected future stakeholder implementation actions, stakeholder support, and existing regulatory authorities and Water Board permits are discussed in Chapter 8 (Implementation Plan). The technical understanding of anthropogenic sediment sources and implementation actions needed to meet water quality objectives is provided in the sediment TMDL for the Pescadero Creek and Butano Creek watersheds, located just south of San Gregorio. This TMDL identifies land use sources of excess sediment production and the land management and restoration actions needed to attain desired watershed conditions. Because the land uses and instream habitat conditions in the two watersheds are very similar, the peer-reviewed technical basis of the Pescadero-Butano sediment TMDL can be applied to the San Gregorio Creek watershed for the purpose of developing this Plan.

4.0 WATER QUALITY STANDARDS

Water quality standards applicable to San Gregorio Creek are comprised of the Creek's beneficial uses, the corresponding water quality objectives to protect those beneficial uses, and California's antidegradation policy which requires continued maintenance of existing high-quality waters. San Gregorio Creek beneficial uses are impaired due to nonattainment of sediment and habitat water quality standards, as described below.

The Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) designates the following beneficial uses in the San Gregorio Creek watershed:

- *Cold Freshwater Habitat* (COLD) – 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
- *Fish Migration* (MIGR) – 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 water within the region
- *Fish Spawning* (SPAWN) – Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
- *Preservation of Rare and Endangered Species* (RARE) – 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
- *Water Contact Recreation* (REC1) – 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, whitewater activities, fishing, and uses of natural hot springs
- *Noncontact Water Recreation* (REC2) – Uses of water for recreational activities involving proximity to water, but not normally involving contact with water, where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities
- *Wildlife Habitat* (WILD) – Uses of waters that support wildlife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.

The Basin Plan sets forth narrative water quality objectives for sediment and settleable material. The sediment water quality objective provides that suspended sediment loads and discharge rates shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses. The water quality objective for settleable material states that water shall not contain substances in concentrations that result in the deposition of materials that cause nuisance or adversely affect beneficial uses.

The narrative water quality objectives for sediment and settleable material are not met in the San Gregorio Creek watershed because fine sediment in the streambed substantially exceeds natural background levels. This contributes to the degradation of freshwater channel and floodplain habitat and migratory pathways, and to the decline of watershed salmonid populations listed under the Endangered Species Act. Accordingly, the following beneficial uses are adversely affected: COLD, MIGR, SPAWN, RARE, WILD, REC1 and REC2.

Centuries of human activity in the watershed have degraded habitat (e.g., by removing large woody debris) and decreased habitat connectivity (e.g., by disconnecting floodplains), exacerbating excessive sedimentation that harms salmonids and physically limiting spawning and rearing habitat. This results in non-attainment of the water quality objective for Population and Community Ecology, which states that the health and life history characteristics of aquatic organisms in water affected by controllable (i.e., anthropogenic) water quality factors shall not differ significantly from those for the same waters on areas unaffected by controllable water quality factors. Controllable water quality factors include recruitment and retention of woody debris, channel incision and floodplain disconnection, and water withdrawal during critical low-flow periods.

The antidegradation policy requires that where water quality is better than needed to protect beneficial uses, that such superior water quality be maintained. This Plan is consistent with the antidegradation policy because compliance with the sediment targets it proposes will maintain existing areas of good water quality and decrease sediment discharges in other areas.

5.0 HISTORICAL LAND USES CONTRIBUTING TO SEDIMENT AND HABITAT IMPAIRMENTS

This chapter discusses historical land uses in the San Gregorio Creek watershed, with a focus on land uses contributing to the sediment and habitat impairments. These uses include commercial logging and sawmills, road and trail construction, livestock grazing, agricultural croplands, residential development, instream structures, water diversions, and large woody debris (LWD) removal. These land uses contributed to one or more of the following effects: reach-scale channel aggradation and/or incision; disconnection of the creek from its historical floodplain; reductions in channel and habitat complexity; reduced base flow in summer and fall; and increases in fine sediment supply leading to deposition on the channel bed and filling of deep pools (Brady et al. 2004, Attachment 1, Attachment 3). These changes have led to reductions in overall quality of fish spawning and rearing habitat in San Gregorio Creek and its tributaries.

More detailed information regarding historical land uses and development in the San Gregorio Creek watershed is provided by Brady et al. (2004), the Watershed Management Plan (Attachment 1) and the Rapid Sediment Budget (Attachment 3). Stanger (1967) and Spence et al. (2011) provide information on historical logging operations in the San Gregorio Creek watershed. Foss (1941) documents road construction, and the National Marine Fisheries Service (NMFS 2016) provides a historical perspective of land use in the Santa Cruz mountains.

5.1 Early Americans (pre-1770)

For several thousand years, the Native American Ohlone people of Olpen and Oljon lived in the San Gregorio watershed (Milliken et al. 2009). They managed the landscape by burning the coastal grassland and forests every few years. These were low intensity burns such that only ground fuels like grasses, forbs and shrubs were burned away. This kept thick brush out and encouraged grassland renewal that improved access to food, including edible plants and game. The early American period ended in 1769 with the Spanish Portola Expedition, which extended Spain's empire into Alta California (present-day California).

5.2 The Spanish-Mexican Period (1770 to 1850)

The Spanish established missions at Santa Clara (1770), San Francisco (1776) and San Mateo (1793). They brought European land uses to the region, including farming and grazing. The arrival of cattle and European crops also transformed the landscape through the introduction of non-native plants and grasses. Granted in 1839, the Rancho San Gregorio represents the start of European settlement in the San Gregorio Creek watershed. The Rancho covered about 18,000 acres and included the present-day communities of San Gregorio and La Honda. No information regarding agricultural, land clearing, or grazing activities specific to Rancho San Gregorio was identified in the literature we reviewed, but it is assumed that these activities were conducted on part or all of the land grant (Steele 1883). The first road in the watershed was built during this time and located along what is now Old La Honda Road from La Honda to Skyline Blvd. Following a two-year war between the U.S. and Mexico from 1846 to 1848, California became a U.S. territory in 1848 and the 31st state in 1850.

5.3 Logging the Redwoods (1855 to 1900)

Starting in 1849, the gold rush brought an influx of immigrants to the region and drove up demand for timber and wood products on the San Francisco Peninsula (Stanger 1967). Population expansion on the San Francisco Peninsula during this period cannot be overstated. In 1847, San Francisco had a population of about 500 and by 1870 had grown to a city of about 150,000 residents. Logging of old growth redwood stands on the peninsula grew exponentially to meet demand. The first sawmill in the San Gregorio Creek watershed was constructed in 1855 with an additional 22 to 25 constructed by 1895 (Figure 5.1, Stanger 1967, Attachment 3). Logging and milling operations continued in the watershed into the 1900s.

Figure 5.1 Photo of Hanson's Mill near La Honda (photo taken in 1881; Stanger 1967)

Logging and milling activities caused many adverse impacts to water quality. Construction of skid trails, or temporary roads, and roads for timber harvest increased sediment erosion and delivery to streams, and tree removal increased land surface runoff and consequent erosion. Oxen were used to haul logs, and stream beds were commonly used as 'corduroy roads' where logs were laid perpendicular to the direction of travel to more easily skid logs to their destination, effectively destroying part or all of the channel morphology and substrate (Figure 5.2).

Figure 5.2 Oxen train hauling logs on corduroy road near La Honda (photo taken in 1881; Stanger 1967)

Trees closest to a stream channel were often felled first since they were next to the skid road along the creek bed. Trees further up the stream banks were then felled toward the stream, using gravity to bring them down to the skid road. These logging practices promoted erosion because they left hillslopes and riparian areas largely denuded of vegetation.

In addition to oxen, steam was used for power and transport in the form of narrow gage railroads to move logs, hoists to lift trees upslope, and boilers to run steam-operated sawmills. Waterpower was also used to operate sawmills. Consequently, many sawmills were located on streams and had headworks or a dam constructed for sluicing water to run the mill. In some cases, dams were an obstruction to fish passage (Commissioners of Fisheries 1872). Sawmills also dumped sawdust and blocks (waste wood) into streams, in some cases choking them with mill waste. Sawdust is acidic and the pH of redwood sawdust varies from 4.1 to 5, similar to 7-Up™, cola or acid rain. This resulted in frequent, widespread fish kills on San Gregorio Creek and on other coastal streams where logging was conducted. The situation on San Gregorio Creek in 1872 was described as follows:

> *"All these mills dump their sawdust and blocks into the stream, which so poisons the water that it has become an intolerable nuisance to all the settlers along the stream below, and will soon exterminate the trout."* (Commissioners of Fisheries 1872, p 18)

Similar observations were made just south of San Gregorio on Pescadero Creek, at Anderson's sawmill about 6 miles upstream from the ocean:

> *"Large quantities of sawdust and blocks are deposited in the stream below the dam; fish are found dead, their eyes eaten out by the strong poisonous acids in the water, and their bodies covered beneath the skin with disgusting blisters, like the small pox, whilst the inside is as black as ink. The waters are rendered at times wholly unfit for use."* (Commissioners of Fisheries 1872, p 18)

Due to the severity of the problem, the California State legislature banned the dumping of sawdust into streams and rivers in 1889, following similar legislation passed in Washington (1876) and Oregon (1878).

The period from 1875 to 1905 was a peak period of logging in the Santa Cruz mountains. So much redwood timber was cut that by the late 1800s efforts to preserve the last remaining stands of old growth redwood led to the creation of the first California State Park at Big Basin in 1902. The park protects about 3800 acres of old growth redwood in the Waddell Creek watershed north of Santa Cruz and remains today the largest contiguous stand of old growth redwood south of San Francisco.

5.4 The Rise and Fall of San Gregorio Creek

Thornburg (1998) mapped and dated deposits exposed in a 380 ft (115 m) long, 16 ft (5 m) high vertical stream bank undergoing active erosion by San Gregorio Creek about 2,000 ft upstream of the ocean. Using a combination of historical maps, dating of artifacts exposed in the stream bank and other evidence, Thornburg identified the upper 10 ft to 13 ft (3 m to 4 m) of stream bank deposits as having been deposited between 1854 and 1906. The basal stratigraphic unit consisted of older conglomerate that could not be dated but appeared to be much older than the overlying deposits.

Thornburg identified the historical deposits as a fill terrace resulting from alluviation (aggradation) of the valley floor followed by subsequent incision by the river channel as it re-established its former invert profile following the sedimentation event. Finely bedded sands and clays in the fill terrace indicated that they likely accumulated over several flow events rather than a single large flood. Thornburg mapped numerous fill terraces on both sides of the modern creek alignment from the creek mouth to about a mile upstream. In a later study, Sojourner (2000) expanded the mapping effort another 4 miles upstream and identified additional fill terraces up to 16 ft thick on either side of San Gregorio Creek. Based on historical artifacts found therein, Sojourner also concluded the fill terraces were probably entirely historical in age and from the same period as those identified by Thornburg (1998).

Thornburg and Sojourner concluded that the fill terraces had been deposited during a period of very high sediment loads on San Gregorio Creek resulting from land use impacts including extensive logging in the late 1800s, grazing activity, and large flood events that include the largest flood in California history in 1861-62. Thornburg noted that the widespread aggradation on San Gregorio Creek and its adjacent floodplain appeared similar to that of sediment-choked Sierran rivers during the hydraulic mining era. Both Sojourner and Thornburg speculated that, given similar land use practices in coastal San Mateo and Santa Cruz counties, many other streams likely experienced aggradation as a result of 19th and 20th century land use practices coupled with large runoff events. They provide evidence in support of this notion for Cascade Creek and Pomponio Creek, located just south of the San Gregorio Creek watershed, as well as for Bradley Creek and Butano Creek, both located in the Pescadero Creek watershed.

As logging activity and consequent sediment delivery declined by the early 1900s, San Gregorio Creek re-established its former invert elevation by incising through the aggraded material, resulting in the incised channel appearance and floodplain disconnection seen today. Consequently, the modern-day creek is disconnected from its historical floodplain and exhibits less heterogeneity, complexity, and hydraulic variability than it did before the aggradation event. Floodplain disconnection and habitat simplification also resulted in the elimination of sediment storage areas that existed previously, resulting in more sediment being transported downstream to San Gregorio lagoon. In addition, historical fill terrace deposits continue to be eroded by lateral creek migration, resulting in additional sediment supply for downstream transport (Thornburg 1998).

It is not known when San Gregorio Creek completed its channel incision process following the end of the stream aggradation period. Bridge inspection records for the State Route 84 bridge crossing of San Gregorio Creek near the confluence with El Corte de Madera Creek shows about 2 feet of variation in the channel invert from 1959 to 2007 (Caltrans 2018) with no apparent aggradation or degradation trend over time, indicating relative channel invert stability for this period. Similarly, a specific gage analysis at the USGS stream gage at San Gregorio shows no change in invert elevation since the gage was installed in 1969 (Attachment 3). Consequently, the channel incision process must have completed prior to that time, at least on this part of San Gregorio Creek. Today, San Gregorio Creek at the USGS gage is estimated to be incised by between 10 and 13 ft (Attachment 1), the same as the amount of channel aggradation identified by Thornburg (1998) at her study site which is located about 1.1 miles downstream of the USGS gage.

Limited information exists regarding historical channel aggradation or incision on tributaries to San Gregorio Creek. Brady et al. (2004) reported active channel incision along most of lower La Honda Creek, evidenced by undercutting of structures and areas of armored bank protection. The cause of this incision was unclear. It may reflect overall bed degradation resulting from historical land use changes, such as channel realignment in the 1950s that shortened and steepened La Honda Creek, invert profile adjustment following removal of a small dam constructed in the early 1900s, or other factors. In some locations, local contraction scour caused by structures impinging on the channel cross-section may have contributed to the observed incision. Brady et al. (2004) also identified several bedrock outcrops along the stream bed, indicating bedrock is a likely control on channel incision rate. Caltrans records of the State Route 84 bridge crossing of La Honda Creek just upstream of San Gregorio Creek show about two feet of decline in the channel invert elevation from 1959 to 2000 (Caltrans 2016). It is not known if other tributaries in the watershed are actively incising or aggrading.

5.5 Logging after 1900

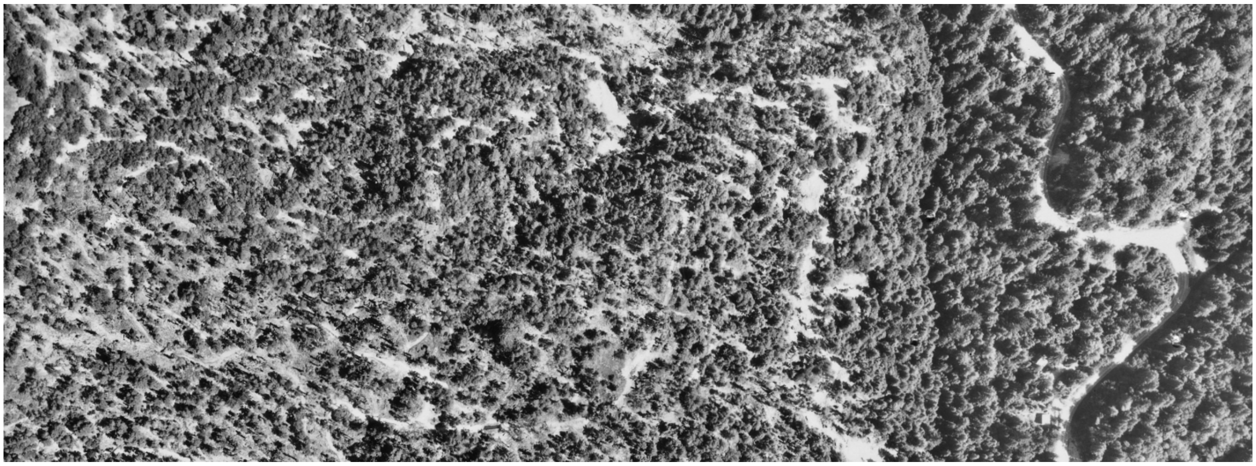
Logging in the San Gregorio Creek watershed continued through the 1900s, mostly as commercial timber harvest operations. In the early part of the century, logging activities were largely unregulated and often resulted in high rates of sediment delivery to streams due to skid trails, unimproved logging roads, water crossings, disturbance of riparian cover and stream banks, and removal of canopy cover through timber felling. The 1946 Forest Practices Act initiated regulation of timber harvest operations on non-federal lands in California. Passage of the 1973 Forest Practice Act marked the beginning of the contemporary period of timber harvest regulation which includes the Forest Practice Rules and a State Board of Forestry that oversees forest activities in the State. Although the Forest Practice Rules have greatly improved water quality conditions since their inception, they continue to be refined and improved over time. It is also not uncommon for additional water quality protections to be imposed on timber harvest activities by the Water Board and other State agencies.

Logging regulations in the 1950s and 1960s, prior to the 1973 Forest Practice Act, permitted 'seed tree' timber harvesting where most desirable trees were felled and a small number of 'seed trees' left to repopulate the forest. This type of logging was common in the watershed and resulted in widespread land disturbance, erosion and sediment production (Hébert 2020). Stream inventories conducted by the California Department of Fish and Game[2] on San Gregorio Creek and its tributaries in the 1960s and early 1970s report ongoing and historical logging activities as sources of stream pollution resulting in turbidity, filling of pools with fine sediment, and embeddedness of gravel and cobble material in the stream channel. Bridge crossings for logging roads also acted as obstructions to fish passage. For example, a 1964 stream survey of El Corte de Madera Creek identified two bridges used for logging operations covering about 2600 acres that were delivering extremely heavy siltation extending several miles downstream (Zatkin 2002). Similarly, a 1962 survey of La Honda Creek stated that logging operations in the upper basin had caused a bad siltation problem in the creek (Becker and Reining 2008). Figure 5.3 shows a 1965 air photo of heavy logging in the La Honda Creek watershed, compared with the same area in 2000. The lighter colored areas between tree canopies result from tree felling, skid trails and roads created by timber harvest activities, whereas the 2000 air photo shows a largely recovered landscape.

Following passage of the 1973 Forest Practice Act in 1974, timber harvest practices in the watershed shifted toward selection logging where many more trees were left following a harvest. This practice generally resulted in less land disturbance and sediment production than the 'seed tree' logging approach taken in the 1950s, 1960s and early 1970s. The MidPeninsula

[2] Name changed in 2013 to California Department of Fish and Wildlife

Regional Open Space District (Midpen) reported that Timber Harvest Plans after 1974 in the area that is now the La Honda Open Space Preserve were all for selection logging (Hébert 2020).



1965 air photo showing effects of logging on land surface cover (lighter areas result from timber harvest activities)

2000 air photo showing recovered forest canopy with no areas of bare surface cover

Figure 5.3 Air photo comparison showing effects of heavy logging in 1965 on surface cover (top) and a recovered forest canopy with no logging in 2000 (bottom).

The extent of logging through the 1970s and 1980s is partly known. Midpen reported that the upper watershed of El Corte de Madera Creek was logged intermittently until about 1988, when the land was purchased to form an open space preserve, and that logging in the La Honda Creek subwatershed occurred throughout the 1970s and 1980s until 1988 (Hébert 2020). Although logging had largely ceased by the 1990s, legacy impacts of old logging roads and skid trails remained (Figure 5.4).

The 1990s were a decade of significant transition to land stewardship, recreation and conservation in the San Gregorio Creek watershed. Since 1997, the earliest year that timber harvest records are available online from CalFire, logging in the watershed has been infrequent and not widespread. Three timber harvest plans have been filed in the San Gregorio Creek watershed since 1997 (CalFire 2021). The largest plan covered 134 acres in the upper Harrington Creek watershed and operated in the mid-2000s. A non-industrial timber management plan is partially located in the upper El Corte de Madera watershed with approximately 50 acres in that drainage, and a 2018 timber harvest plan identifies a logging area of about 30 acres near the confluence of La Honda Creek with San Gregorio Creek. This amounts to about 0.6 percent of the watershed land area having some form of timber harvest in the last 23 years. Although logging is now a minor land use in the watershed, legacy effects from past logging practices remain in the form of old logging roads, skid trails, and other features that contribute sediment to the stream network as well as historic channel incision. Today, the original old growth forests in San Gregorio Creek have been largely replaced by second and third growth stands.

Figure 5.4 Abandoned throughcut logging road with deep rilling in the El Corte de Madera Creek Preserve (photo taken in 1994)

5.6 Other Land Uses Contributing to Sediment and Habitat Complexity Impairments

In addition to historical logging, several other land uses have contributed to the sediment impairment, reduction in aquatic habitat quality, and overall decline in fish populations in San

Gregorio Creek. These include roads, agricultural activities, residential and urban development, removal of LWD, instream structures, water diversions and groundwater withdrawal, and fishing and other recreational uses.

5.6.1 Roads and Residential Development

Early road construction in the watershed paralleled logging activities. Numerous unpaved roads and skid trails were constructed as part of logging operations, and most primary roads were constructed and improved during the logging era from about 1865 to 1910 (Foss 1941, Attachment 3). This included the road from La Honda to San Gregorio (1872), La Honda Road from La Honda to Woodside (1876), and Alpine Road (1878). Each road was improved over time, typically from an unpaved one-lane road to a gravel road then a two-lane paved road. In some cases, a stream was realigned to make room for the road, such as when La Honda Road was widened to a two-lane, paved road in 1919 (Foss 1941, Brady et al. 2004). This encroachment, in addition to streambank hardening by local landowners to protect property, resulted in channel narrowing and deepening on lower La Honda Creek, producing higher rates of stream bank erosion. Other sources of road construction include unpaved roads for agricultural operations, a motorcycle recreation area in the El Corte de Madera Creek watershed in the 1970s, and roads to support oil and gas drilling, which started in the 1920s and expanded in the 1950s and 60s. Over 80 oil wells were drilled in the watershed, mainly in the central part of the watershed. Five wells were reported as still active in 2010 (Attachment 1).

Residential development and population expansion in the region led to additional roads in the communities of La Honda, San Gregorio, Redwood Terrace and Sky Londa (Brady et al. 2004, Attachment 1, Attachment 3). Today, State Routes (Highways) 1 and 84 provide the main transportation corridors. Highway 1 was constructed across the mouth of San Gregorio Creek in 1941. As part of highway construction, the marsh and lagoon were partially filled in and the creek moved south to flow under the Highway 1 bridge. Today, the marsh connects to the creek through a culvert. Consequently, most of the seasonal lagoon volume is located upstream of the bridge (Attachment 1). Highway 84 was constructed during the 1950s and traverses the watershed from Highway 1 to Skyline Boulevard.

5.6.2 Agriculture

The historical extent and intensity of agriculture in the San Gregorio Creek watershed is not well-documented. Ranching after California statehood in 1850 is documented as early as 1855 when the Weeks Ranch was established near La Honda (Stoltz 2002). A description of farming and ranching from the 1950s states that the valley was occupied by vegetable farms, apple orchards, and irrigated pasture along San Gregorio Creek, which supported five commercial dairies at the time (Attachment 1). Further up the watershed, lands were used for dry farming and cattle grazing. A 1961 farm plan of the McDonald Ranch, located in what is now the La Honda Creek Open Space Preserve, shows large scale brush clearing, range seeding of non-native forages, and fertilization for the purpose of sustaining higher stocking rates on the landscape (USDA 1961; Hébert 2019a). Field observations of creeks from the 1960s through the 1980s document cattle grazing as an important sediment producer that, in addition to logging operations, adversely affected salmonid spawning and rearing habitat in the watershed (Zatkin 2002). Specific information regarding the types of erosion from cattle grazing were not identified; however, it is likely that poor grazing practices caused the sediment delivery to creeks. Poor grazing practices typically involve overgrazing and/or grazing in environmentally sensitive areas, such as near streams or gullies. Overgrazing can increase runoff during storm events due to soil compaction and excessive loss of both vegetation cover and root reinforcement. This leads to accelerated erosion and sediment delivery to the stream network.

In contrast, well-managed grazing practices that apply best management approaches can reduce soil erosion through improved vegetation cover and root growth, soil organic matter accumulation, and higher infiltration rates (NRCS 2016). Such best management practices have been increasingly applied in the San Gregorio Creek watershed in recent years, including site evaluations and development of sustainable grazing strategies (George et al. 2020), requirements for maintaining adequate vegetation cover (University of California 2002), and other practices with water quality and environmental benefits (Midpen 2020).

No historical information regarding accelerated erosion from agricultural croplands in the San Gregorio Creek watershed was identified in the literature we reviewed. Discussions with individuals familiar with agricultural croplands in the watershed indicated that hillside farming was more abundant historically than it is today, mainly in hay production, and that rill erosion was sometimes a problem if cover crops did not germinate quickly enough before winter rains (Frahm 2019). Agricultural croplands were identified as an important source of historical sediment production in the Pescadero-Butano watershed, located just south of San Gregorio, where more information on land use practices is available (San Francisco Bay Regional Water Board 2018a). Specifically, from the mid-1800s until the 1970s, hillside croplands contributed to hillslope erosion, such as rilling and gullying. Agricultural conversion, channel straightening and ditching contributed to accelerated erosion on valley floors.

5.6.3 Large Woody Debris (LWD)

Historical declines in instream LWD and LWD recruitment in the San Gregorio Creek watershed are widely discussed in the literature. Causes for the historical declines include historical logging of trees that provided woody material to streams; removal of instream LWD, mainly from the 1960s to the 1990s when it was believed to impede fish passage (Attachment 3); floodplain disconnection resulting from historical channel incision (Alford 2013); and, to a limited extent, the selective removal of LWD by public works agencies to reduce flood risk and erosion hazards and to provide instream structure protection. Field studies of LWD in the watershed and its effects on instream habitat are discussed in Chapter 6.

5.6.4 Water Withdrawal

California Department of Fish and Game stream surveys conducted in the 1970s, 1980s and 1990s (Zatkin 2002) identified stream diversions on San Gregorio Creek as adversely impacting fish rearing habitat, the amount of food available for fish, and fish migration. Stream diversions reduce low flow conditions, particularly in the fall when stream flow is at its annual low, and the use of flashboards, seasonal dams or other instream water diversion structures obstructs fish passage.

The watershed was fully adjudicated in 1993. Water diversions established after the adjudication must maintain a minimum bypass flow of 2 cfs; however, pre-adjudication water diversions do not need to maintain this minimum and can take all available flow. A review of stream gage data for San Gregorio Creek in the community of San Gregorio shows that flows in the creek are below 2 cfs about 50 percent of the time between June and November. This value is below the 4 cfs minimum flow considered necessary for passage of juvenile steelhead in the San Gregorio Creek mainstem (Attachment 1). The State Water Resources Control Board's Division of Water Rights identified that existing approved water demands exceeded 50 percent of the estimated average unimpaired flow on San Gregorio Creek from October 1 to March 1 at the San Gregorio Creek stream gage and this was likely to cause adverse effects on fish habitat in San Gregorio Creek (Becker et al. 2010). Several hundred groundwater wells in the watershed may also affect instream base flows and are currently unregulated (Attachment 1). Water conservation and off-channel storage ponds implemented in recent time have mitigated but not eliminated the effects of water withdrawal on instream habitat quality.

5.6.5 Fishing and Recreation

Land use impacts in San Gregorio Creek and heavy fishing pressure have resulted in significant fish population declines over time. Stream surveys indicate fish restocking as early as the 1930s and as late as 1985 (Becker and Reining 2008, Attachment 1). Fish stocking in San Gregorio Creek is noted prior to the 1930s in the Coast Side Comet, the local newspaper of the day, which identifies a dam in 1917 on San Gregorio Creek about three miles downstream of La Honda that was constructed for a private fish hatchery. The newspaper article states that complaints were made about the dam because it lacked a fish ladder, was an impediment to fish passage and drastically reduced the number of fish near La Honda, much to the upset of hundreds of anglers who fished the stream each year (Coast Side Comet 1917).

Water recreation, mostly at San Gregorio State Beach, has significantly affected the quality of rearing habitat in the San Gregorio lagoon. As stated in Section 2.4, San Gregorio State Beach sees around 400,000 visitors per year. The lagoon, located within the State Park, provides the best conditions for juvenile steelhead in the watershed. Atkinson (2010) found a direct linkage between the size of juvenile steelhead and the time they spent rearing in the lagoon, noting steelhead that reared in the lagoon grew larger than their counterparts that reared in San Gregorio Creek stream reaches. Becker et al. (2010) reported that a substantial portion of smolt production for the watershed occurred in the lagoon and that rearing conditions in the lagoon probably had the largest effect on steelhead production in the watershed. Disturbance of lagoon conditions by beach visitors each year adversely impacts lagoon conditions, primarily when the lagoon is artificially breached by beach goers seeking easier access to the beach from the parking lot. Informational signage discourages this behavior, but it continues due to a lack of alternate access from the parking area to the beach.

Other forms of recreation may have had localized impacts. For example, parts of what is now the El Corte de Madera Creek Preserve were used as a park for off-road motorcycles until the land was purchased by Midpen in 1986.

5.7 Stewardship Era

Over the last three decades, the San Gregorio Creek watershed has seen a trend toward conservation, recreation and education. After numerous land purchases and acquisitions since the 1980s, about half of the watershed area is now owned by public trust organizations focused on stewardship, resource conservation, recreation and education. Midpen is the largest public trust landowner and manages about one-third of the watershed area. Midpen lands are located mainly in middle and upper watersheds of El Corte de Madera Creek, La Honda Creek and Alpine Creek. Other landowners include the Peninsula Open Space District (POST), San Mateo County Parks, California State Parks, and private lands with conservation easements.

As a result of this trend, substantial improvements to water quality made in the watershed over the last two decades include the following:

- Midpen has developed and implemented water quality protections and planning efforts that include sediment source inventories, prescriptions to improve roads and trails, and implementation of conservation and best management practices to improve water quality, restore ecological diversity, address climate change impacts and improve wildfire resiliency.
- Conservation easements purchased by POST require farmers and ranchers to apply setbacks from riparian corridors, implement sediment control plans, and improve water supply and distribution systems for irrigated farmlands.
- San Mateo County Parks has implemented road and trail improvements to address erosion sites in County Parks, prioritized fish passage improvements at all County road crossings of streams, and integrated water quality protections into its public works activities on roads and near streams.
- The San Mateo Resource Conservation District (RCD) has worked on a wide array of projects that include the development of conservation and carbon farm plans, off-channel water supply storage, removal of fish passage impediments, instream LWD installation, and road improvements to reduce fine sediment supply to streams.
- The National Resource Conservation Service (NRCS) works with the RCD, POST and other partners to fund regional conservation partnerships through their Agricultural Conservation Easement Program and Environmental Quality Incentives Program (EQIP), among the many other services they provide.

Many other stakeholders have contributed to resource conservation and environmental protection in the region, such as through implementation of monitoring programs, and education and outreach. More information on these and other efforts to protect and improve water quality is given in Section 6.2. Expected future stakeholder implementation actions are discussed in Chapter 8.

In addition to water quality improvement efforts, the San Gregorio Creek Watershed Management Plan was completed in 2010. It identifies limiting factors to steelhead recovery, provides a comprehensive resource assessment and lists implementation actions needed for watershed restoration (Attachment 1).

6.0 CURRENT SOURCES OF SEDIMENT AND HABITAT IMPAIRMENTS

This chapter summarizes watershed sediment production and large woody debris (LWD) conditions in the San Gregorio Creek watershed. Based on available studies, and on information presented in Chapter 5 and Attachment 2, current sources of sediment and habitat impairments are identified.

6.1 Conceptual Sediment Budget

San Gregorio Creek watershed sediment production is a function of multiple natural and anthropogenic sources. Important natural drivers of watershed sediment production include basin geology and soils, climate, and land surface cover. Anthropogenic sediment sources result from human activities, namely current and historical land uses, and can be characterized within the context of an overall conceptual sediment budget (Figure 6.1). The relationships between the physical environment (top), erosion processes (middle), and sediment transport and deposition (bottom) are shown by the arrows in Figure 6.1. Erosion sources resulting from historical and current land use activities, discussed in Sections 6.2 and 6.3, fall within both the land surface erosion and instream erosion categories in Figure 6.1 and supplement naturally occurring sediment erosion sources.

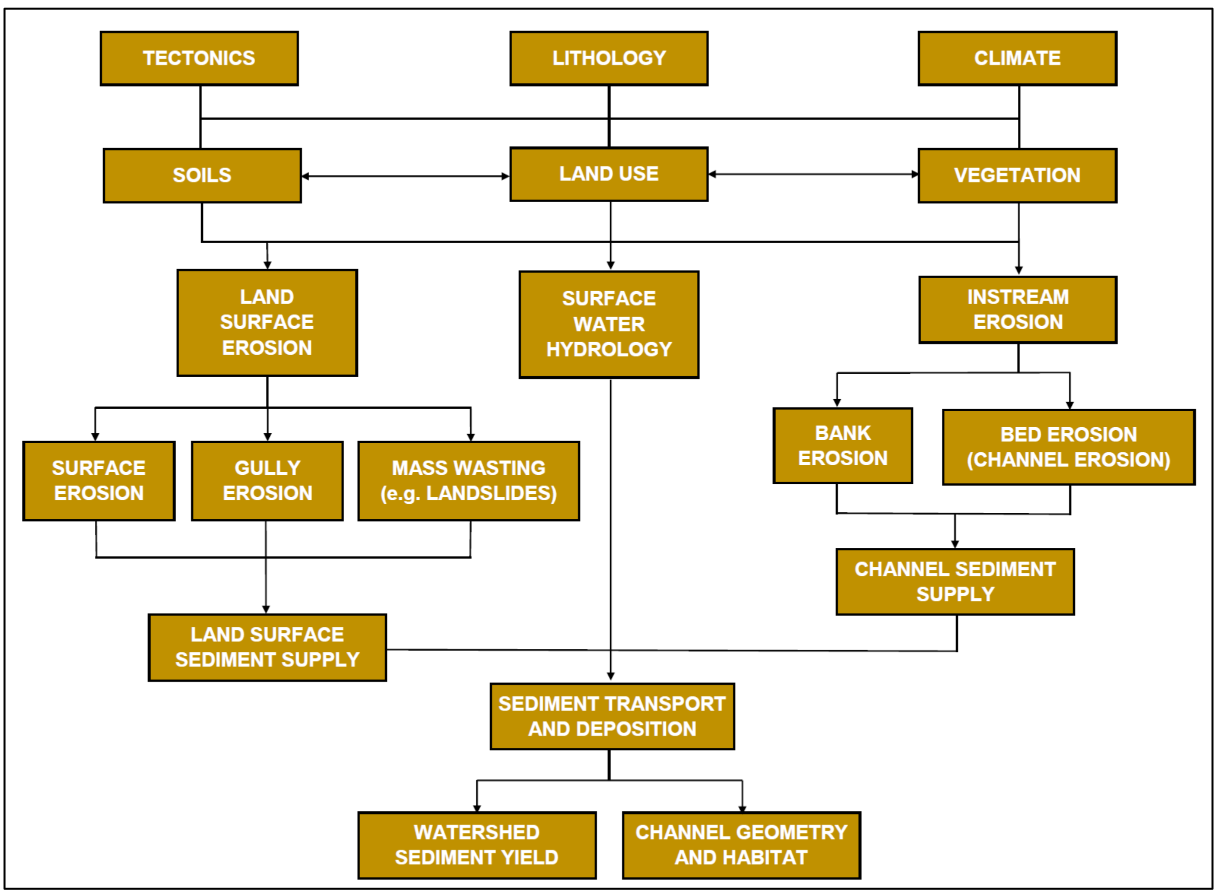


Figure 6.1 San Gregorio Creek watershed conceptual sediment budget

Watershed sediment production plays a vital role in maintaining healthy streams, including productive aquatic habitat conditions, channel stability, and habitat complexity and connectivity over time. The sediment impairment addressed by this Water Quality Improvement Plan (Plan) refers only to fine sediment introduced by current and historical land use practices that contribute to degraded flow and habitat conditions for steelhead and coho salmon (Attachment 2). Other sediment sources, such as those that provide spawning gravels and substrate for rearing habitat and food supply, are vital to overall stream health, channel stability, and the success of restoration efforts.

6.2 Previous Studies

This section summarizes available studies of watershed sediment production and LWD conditions in the San Gregorio Creek watershed.

<u>6.2.1 Watershed Sediment Production</u>

Through a contract with the San Francisco Bay Regional Water Quality Control Board (Water Board), Florsheim (Attachment 3) prepared a comprehensive review of information relevant to watershed sediment production, including a description of the geologic setting, sediment erosion processes, and current and historical land uses. Florsheim reported that historical land use disturbances likely increased watershed sediment production. However, impacts from historical land use disturbances could not be quantified because they largely occurred in the late 1800s and early 1900s, and few records are available. Florsheim identified land use activities, such as road construction, logging, residential development, oil and gas production, ranching and other agricultural activities as likely sources of the increases. Using sediment sampling data collected from 1985 to 1993 at the San Gregorio Creek USGS stream gage in the community of San Gregorio, Florsheim developed a sediment rating curve that identified sediment transport rates for a range of flow discharges. Florsheim found that sediment transport was highly variable year to year and varied by as much as three orders of magnitude when comparing dry versus wet years. Sediment transport rates were driven primarily by the timing, intensity, and duration of rainfall events. Although uncertainty is high, Florsheim reported that most effects of historical land use activities on watershed sediment budget may have already occurred because rates of basin sediment yield, computed from sediment load measurements at the USGS stream gage, were similar to pre-disturbance erosion rates estimated from cosmogenic radionuclides over the last 1,500 to 1,600 years.

The San Gregorio Creek Watershed Management Plan (Attachment 1) identifies the watershed as having the potential for very high fine sediment yields, due largely to its geologic and hydrologic characteristics (see Chapter 2). Landslides, debris flows and associated stream bank erosion are identified as major sediment producers. Roads, trails, streambanks, and runoff from residential and agricultural lands are mentioned as sources of sediment, with further information provided only for roads. No quantitative analyses of sediment production or yield were performed as part of the Watershed Management Plan. Much of the information presented is from local observations made during stream surveys or from previous sediment studies that examine specific areas of the watershed and focus mostly on roads.

Brady et al. (2004) examined sediment production on lower La Honda Creek and found that landslides and hillslope erosion transport the most sediment to La Honda Creek and that these sediment sources greatly exceed any sediment derived from existing land uses, including roads. The study did not identify, however, to what extent landslide and hillslope erosion was caused or augmented by current or historical human activities. Brady et al. (2004) also identified gullying in the La Honda Creek subwatershed as a major problem and one that reflects deforestation and changes in land use due to grazing and residential development. Lastly, channel incision and bank erosion are also identified as contributing fine sediment to La Honda Creek, due partly to past channel realignment, encroachment and LWD removal, but also due to sediment inputs and channel instability resulting from landslides. Brady et al. (2004) identified human activities, such as home construction, roads and driveways, poorly designed drainage, agricultural tilling and irrigation runoff as potential anthropogenic fine sediment sources. However, an assessment of these off-channel sediment sources was outside the project scope and they were not investigated further.

In an analysis of historical gully erosion, Florsheim (Attachment 3) compared gullies and channel heads in 1941 and 2007 air photos in the Coyote and Harrington Creek tributaries and found no significant change in gully or channel head formation over time. This was based, however, on coarse measurements because only low-resolution air photos were available from 1941. The San Mateo Resource Conservation District (RCD 2017) conducted an in-depth study of gully formation in the adjacent Pescadero-Butano watershed and found that gully formation had peaked sometime between 1982 and 2005, with few new gullies having formed by 2016. Between 20 percent and 25 percent of all gullies identified in the watershed were road-related, meaning they formed as a result of a road or road drainage feature. Geology and exposure to ocean salts (aspect and proximity to the shoreline) were the primary drivers of gully development, the latter due to higher erosivity caused by changes in soil chemistry from exposure to ocean salts. It is likely that this trend also occurs in the San Gregorio Creek watershed.

The MidPeninsula Regional Open Space District (Midpen) has conducted several sediment studies on its open space lands as part of road and trail inventories, sediment source evaluations, and post-project water quality monitoring (Best 2002, 2005, 2007a, b, 2012, 2016; Balance Hydrologics 2006a, b, 2007, 2008, 2009, 2020). Much of this work focused on the El Corte de Madera Creek Open Space Preserve (ECDM Preserve), for which a Watershed Protection Plan was developed and implemented over the last two decades. Sediment source studies focused on inner gorge areas bordering the stream network found that 20 percent of sediment delivery to streams came from actively used roads or trails and 80 percent came from landslides, bank failures and debris flows (Balance Hydrologics 2006a). About two-thirds of the landslides were associated with roads; however, the study did not identify whether roads caused the landslides. The study did not map smaller landslides, but observations during a prior road inventory identified many shallow landslides along roads in the ECDM Preserve as caused by fill placement on steep slopes or by concentration of road runoff (Best 2002).

Similar to findings by Florsheim (Attachment 3) on San Gregorio Creek, Balance Hydrologics (2009) also found interannual sediment production rates in the ECDM Preserve to vary by as much as three orders of magnitude between wet and dry years, ranging from 12 tons/mi^2/yr in 2007 (a dry year) to 1200 tons/mi^2/yr in 2006 (a very wet year). This degree of interannual variability in basin sediment yield is typical of watersheds throughout the bay region (Lewicki and McKee 2009). A subsequent study in the ECDM Preserve, following the completion of most erosion control elements of the Watershed Protection Plan, demonstrated the program's success by quantifying significant declines in sediment sources, sediment transport in streams, and sedimentation in pools (Balance Hydrologics 2020).

The studies identified above constitute all the work completed to characterize and quantify anthropogenic sediment production in the San Gregorio Creek watershed. They identify sediment sources and characterize variability in sediment yield over time, but do not provide sufficient information to develop a watershed sediment budget. However, a detailed sediment budget documenting historical changes in sediment yield over time has been prepared for the adjacent Pescadero-Butano watershed as part of a sediment Total Maximum Daily Load (TMDL) (San Francisco Bay Regional Water Board 2018a). The findings of the Pescadero-Butano sediment TMDL are important because the Pescadero-Butano watershed and San Gregorio Creek watershed share similar physical, environmental, and land use characteristics. The Pescadero-Butano Sediment TMDL found that anthropogenic sediment sources accounted for about half of the current average annual sediment yield from the Pescadero-Butano watershed. Overall, road-related erosion is the most significant anthropogenic sediment source in the Pescadero-Butano watershed (San Francisco Bay Regional Water Board 2018a). Gullying, landslides, and channel incision are the most common forms of erosion resulting from human activities. Natural background sediment sources are also high in the Pescadero-Butano watershed for reasons similar to those described for San Gregorio Creek (see Chapter 2).

6.2.2 Large Woody Debris (LWD)

Studies of LWD loadings in the watershed have been conducted in the San Gregorio Creek main stem and in lower La Honda Creek. Alford (2013) measured LWD in the main stem and found 0.05 pieces/meter, where a piece of LWD was defined as at least 0.3 meters in diameter and at least 2 meters long. This frequency is relatively low when compared to the range of 0.03 to 0.1 pieces/meter described by Montgomery et al. (1995) for low gradient streams (slope < 0.3) in forested areas. Pristine streams in old growth forests exhibit the highest levels of instream LWD ranging from 0.24 pieces/meter in northern California to 0.4 pieces/meter in the Pacific Northwest (Montgomery et al. 1995, Carroll and Robison 2007). In contrast, Brady et al. (2004) reported that both instream LWD and LWD recruitment were high on the lower 5 km of La Honda Creek. They measured LWD as any wood equal to or larger than 0.2 meters in diameter and 1.8 meters in length. LWD ranged from 0.12 to 0.45 pieces/meter in the sample reaches they studied. The average for the 5 km long study reach was 0.25 pieces/meter with most LWD recruitment from bank erosion and landslides adjacent to the creek.

Studies by Issel (2015) on San Gregorio Creek and Brady et al. (2004) on lower La Honda Creek document the linkage between LWD and deep pool formation on watershed streams. Both studies found that LWD forms pools with greater depth, cover and complexity, and the lack of LWD resulted in shallower pool depths with low shelter value and little instream cover. Pool spacing was also affected by LWD, with more pools per channel width in streams when high levels of LWD were present.

Field measurements of LWD were not available for other streams in the San Gregorio Creek watershed although qualitative information is available. Balance Hydrologics (2020) characterized El Corte de Madera Creek within the ECDM Preserve as having higher LWD loads than most other watersheds in the region. The Watershed Management Plan (Attachment 1, p. 99) cites multiple California Department of Fish and Game stream surveys performed in the 1990s as characterizing an overall lack of LWD for optimal fish spawning and rearing conditions within the San Gregorio Creek watershed.

6.2.3 Summary of Previous Studies

In summary, we conclude the following from available studies of watershed sediment production and LWD:

- Elevated erosion rates resulting from historical land uses in the late 1800s and early 1900s have fallen to a point where they are no longer a major contributor to the sediment impairment.
- Limited data suggest that erosion rates in the San Gregorio Creek watershed are similar to long-term erosion rates (Attachment 3). Based on these data, and on investigations of sediment delivery from similar land use conditions in the Pescadero-Butano watershed, we estimate that current San Gregorio Creek watershed sediment yields are between one- and two-times background (pre-historic) levels.
- Important delivery mechanisms of anthropogenic sediment sources to San Gregorio Creek are landslides, debris flows, gullies, stream bed and bank erosion and to a smaller extent land surface erosion, especially on hillslopes.
- Road-related erosion is the primary anthropogenic source of fine sediment loading contributing to the San Gregorio Creek sediment impairment. Historical and ongoing channel incision and associated bank erosion are also important contributors. Additional but less important sources of fine sediment loading in the San Gregorio Creek watershed include agricultural operations where best management practices have not been implemented. Lastly, urban and residential development are a minor contributor of fine sediment to the watershed overall but may have significant local effects where sediment is discharged into streams.
- San Gregorio Creek lacks LWD for optimal fish spawning and rearing conditions, but measurements and anecdotal information on some tributary streams indicate higher LWD loadings than on the main stem.

7.0 NUMERIC TARGETS

Water Quality Improvement Plans include goals for meeting water quality standards (U.S. EPA 2008). Such goals are analogous to Total Maximum Daily Load (TMDL) numeric targets. Both describe the desired condition of the water body to protect beneficial uses and are expressed as indicators and associated target(s) necessary to meet water quality standards. Further, both provide a quantitative means to demonstrate attainment of narrative water quality objectives. Here we use the term "numeric target" to provide consistency for parties who will implement both the San Gregorio Water Quality Improvement Plan (Plan) and the Pescadero-Butano Sediment TMDL.

The numeric targets for the San Gregorio Watershed are established to achieve narrative water quality objectives for sediment, settleable material, and population and community ecology; these objectives are described in Chapter 4. The numeric targets are based on those established for the Pescadero-Butano Sediment TMDL, with slight variation for residual pool volume (V*) as discussed below (San Francisco Bay Regional Water Board 2018a). The targets include three parameters that are responsive to and/or influence sediment supply and transport and are related to the ecological requirements of coho salmon, steelhead, and other native species. These parameters are: 1) residual pool volume, 2) substrate composition – percent fines; and 3) large woody debris loading. Each parameter is discussed in the following sections and summarized in Table 7.1.

Table 7.1 Numeric Targets for San Gregorio Creek and its Tributaries

Target Condition	Parameter	Numeric Target
Sediment Condition	Residual Pool Volume (V*), a unitless measure of the fraction of a pool's volume that is filled by fine sediment	Decreasing trend in the volume of fine sediment deposited in pools[a] AND Maximum value ≤0.45
Sediment Condition	Substrate Composition – Percent Fines	Percent of fine sediment less than 0.85 mm in diameter is ≤ to 14 percent of the total bulk core sample (≤14 percent fines <0.85 mm) AND Percent of fine sediment less than 6.40 mm in diameter is ≤ 30 percent of the total bulk core sample (≤30 percent fines <6.40 mm)
Habitat Condition	Large Woody Debris loading in Redwood[b] Channels	≥300 cubic meters per hectare of bankfull channel area (m^3/ha)
Habitat Condition	Large Woody Debris loading in Hardwood Channels	≥100 m^3/ha

[a] Major disturbance events, such as floods and fires, may significantly increase V* for one or more years after the event, and shall be taken into account when evaluating V* trends.

[b] Redwood channels are defined as those where the adjacent valley floor and/or hillslopes are vegetated primarily by coast redwood forest. Hardwood channels are defined as those where the adjacent valley flat is vegetated by a hardwood forest (typically some combination of willow species, white alder,

California bay laurel, bigleaf maple, tan oak, and/or Oregon ash). The LWD loading targets apply to channel reaches that provide actual or potential spawning habitat for anadromous salmonids.

7.1 Residual Pool Volume (V*)

V*, pronounced 'V-Star', measures the fraction of a pool's volume that is filled by fine sediment (Lisle and Hilton 1992). Streams with high V* values have higher fine sediment levels in pools. Reductions in V* over time can indicate that actions taken to improve water quality are reducing fine sediment loading in streams. Thus, V* provides a way to quantify the effects of increased or decreased fine sediment loading on channel morphology and aquatic habitat. As described in the Detailed Problem Statement (Attachment 2), increases in fine sediment supply can adversely affect salmonid rearing habitat due to filling of pools, embedment of stream gravels, and increased turbidity.

V* values in northern California stream channels vary widely and are influenced by several factors including basin geology, soils, hydrology, slope, historical and current land disturbance conditions, channel morphology, and flood history (Lisle and Hilton 1992, 1999). Regional studies of V* by the North Coast Regional Water Quality Control Board (North Coast Regional Water Board 1993) and Lisle and Hilton (1999) show average V* values in natural channels ranging from about 0.05 to 0.50. Streams assessed in the North Coast Regional Water Board study were in coastal northern California watersheds with no human disturbance for at least the last 40 years, whereas Lisle and Hilton do not discuss land use disturbance history in their study other than to identify study locations as being in natural channels in northern California and southern Oregon. Because no local V* data were available, the Pescadero-Butano Sediment TMDL selected a numeric target for V* of 0.21, or the average of streams surveyed in the North Coast Regional Water Board (1993) and Lisle and Hilton (1999) studies. The TMDL recognized that this numeric target is an estimate that may be refined later as watershed-specific data become available (San Francisco Bay Regional Water Board 2018a).

The following V* data are available for the San Gregorio Creek watershed:

- The Water Board (San Francisco Bay Regional Water Board 2018b) collected V* samples in 11 stream reaches throughout the watershed and computed a mean V* value from at least five pools within each stream reach. Mean V* values of stream reaches ranged from 0.16 to 0.47 with an average watershed V* of 0.26.
- Balance Hydrologics (2020) measured V* on streams in the El Corte de Madera Open Space Preserve and found substantial pool-to-pool variability in V* values, which ranged from 0.13 to 0.67 in their most recent 2019 survey.
- Balance Hydrologics (2020) established V* monitoring locations in 2004 and repeated V* sampling at each site in 2005, 2006, 2018 and 2019. Results showed that average V* values declined about 15 percent from the 2004 – 2006 period to the 2018 – 2019 period, due in part to the implementation of best management practices (BMPs) for roads and trails designed to reduce fine sediment delivery to streams. Balance Hydrologics also noted that V* conditions were significantly affected by the timing and magnitude of winter storms as well as by the longer-term effects of large, infrequent

flood events on available sediment supply. This was evidenced by similar declines in V* over the same period in the upper La Honda Creek watershed where no restoration actions had been taken.

Based on this evidence, we propose a numeric target of a decreasing trend through time in the mean volume of fine sediment deposited in pools in channel reaches where the slope of the streambed is less than or equal to five percent. This numeric target deviates from the fixed target for V* in the Pescadero-Butano Sediment TMDL. However, this approach is consistent with observations of V* in the San Gregorio Creek watershed and reflects the finding that "(t)here is substantial pool-to-pool variability [in V*], thus year-to-year comparisons are more important than a numeric value for an individual pool or creek reach" (Balance Hydrologics 2020). This approach measures temporal and spatial change relative to location(s) in a stream system over time to determine how sediment transport and storage are behaving in response to changes in sediment inputs. Implementation of erosion control BMPs can result in lower V* values over time; however, disturbance events such as major floods, fires or landslides can significantly raise V* for one or many years. Consequently, interpretation of V* measurements must take these factors into account when evaluating the success of erosion control BMPs and other implementation actions outlined in this Plan.

The authors of the V* method (Lisle and Hilton 1999) recognized the importance of temporal variations in V* in determining stream health, stating: "One cannot use V* to adequately interpret channel conditions with respect to sediment supply without referring to time trends in sediment inputs and/or the range of values of V* associated with the particular type of parent material" (Lisle and Hilton 1999). Consequently, numeric targets for V* in San Gregorio Creek seek a reduction in V* values over time until an equilibrium condition specific to the stream system or specific pool location becomes known. We also propose a maximum V* of ≤0.45, consistent with that adopted in the Pescadero-Butano Sediment TMDL.

7.2 Substrate Composition – Percent Fines

Proposed targets for percent fines in channel substrate are: 1) percent fines less than 0.85 mm (coarse sand) in diameter is less than or equal to 14 percent of the total sample, and 2) percent fines less than 6.40 mm (fine pebbles) in diameter is less than or equal to 30 percent of the total sample. These targets are identical to those adopted in the Pescadero-Butano Sediment TMDL, and are appropriate here because of the similarity in watershed characteristics and land uses. These targets apply to potential spawning sites for anadromous salmonids in wadable streams with a gradient less than 3 percent, where wadable is defined as a stream that an average person can safely cross on foot during low flow conditions while wearing chest waders. These numeric targets are based on research establishing substrate conditions deleterious to salmonid survival to emergence in freshwater habitat (North Coast Regional Water Board 2006). These targets complement the proposed residual pool volume targets because together they provide a measurable indicator of sediment supply, spawning gravel availability and overall rearing habitat quality.

The Water Board (San Francisco Bay Regional Water Board 2018c) measured substrate composition at 11 sites in San Gregorio Creek and its tributaries. All the sites met the numeric target for substrate composition. Sediment samples on San Gregorio Creek were found to be composed, on average, of bed material with 15 percent fine pebbles or smaller material and four percent coarse sand or smaller material, well within the numeric targets proposed here for substrate composition.

7.3 Large Woody Debris (LWD) Habitat Targets

LWD plays an important role in improving aquatic habitat quality for salmonids. It adds structure, provides refugia, traps sediment, increases channel stability in some cases, creates deep pools and habitat variability, improves food supply, and provides an effective mechanism in metering and sorting of instream sediment (Collins et al 2012). Key pieces of LWD, those large enough to resist transport even during large floods, are the primary agent for LWD benefits in streams.

Numeric targets for LWD in the San Gregorio Creek watershed are proposed for streams in both redwood and hardwood forest and are identical to those adopted in the Pescadero-Butano Sediment TMDL given the similarity of the two watersheds. The watershed-wide average numeric target for LWD loading in redwood channels is ≥300 m^3/ha. Redwood channels are defined as those where the adjacent valley floor and/or hillslopes are vegetated primarily by coast redwood forest. The watershed-wide average numeric target for LWD loading in hardwood channels is ≥ 100 m^3/ha, where hardwood channels are defined as those where adjacent lands are vegetated by a hardwood forest. These numeric targets apply only where both of the following criteria are met in a channel reach:

1) the channel reach provides actual or potential spawning or rearing habitat for anadromous salmonids
2) the channel reach is located on public property or open space lands where projects and actions would not threaten public safety or damage property.

8.0 IMPLEMENTATION PLAN

This chapter outlines implementation actions for restoring water quality in the San Gregorio Creek watershed. The intent of this Implementation Plan is to restore and protect beneficial uses of San Gregorio Creek and its tributaries by reducing fine sediment loading from anthropogenic sources and by restoring salmonid habitat. The Implementation Plan builds on a proven track record of stakeholder actions to restore water quality, and it relies on existing regulatory programs and the State Water Board's and San Francisco Bay Regional Water Board's authorities under the California Water Code.

The Pescadero Creek and Butano Creek watersheds (Pescadero-Butano watershed) lie just south of the San Gregorio Creek watershed and share several land uses found to contribute excess fine sediment supply to streams. In addition, several of the implementing parties are the same for both watersheds. Consequently, this Implementation Plan is modeled after the Pescadero-Butano Sediment TMDL Implementation Plan. The strategies identified in the Pescadero-Butano TMDL Implementation Plan are expected to reduce fine sediment and enhance habitat necessary to meet numeric targets in the San Gregorio Creek watershed. As in the Pescadero-Butano Sediment TMDL, we anticipate achievement of water quality objectives within 20 years of the date this Water Quality Improvement Plan (Plan) is accepted through Resolution.

Based on information presented in Chapters 5 and 6, implementation actions for the San Gregorio Creek watershed focus on roads, livestock grazing, agricultural croplands, channel incision and erosion, and habitat enhancement projects such as large woody debris (LWD) installation and floodplain restoration. Unlike the Pescadero-Butano Implementation Plan, this Implementation Plan includes actions for San Gregorio Lagoon, seeks opportunities to improve summer and fall base flow conditions, and excludes actions for commercial timber harvest operations because they are rare in the San Gregorio Creek watershed. The implementation actions are intended to restore properly functioning conditions with regard to sediment delivery to channels and improve sediment transport and storage in freshwater channel reaches. They are also needed to conserve and restore ecological function in San Gregorio Creek, its tributaries, and San Gregorio Lagoon.

The implementation actions identified here form a subset of a broader, multi-benefit set of implementation actions for ecosystem restoration in the San Gregorio Creek watershed identified in the Watershed Management Plan (Attachment 1) and by the Central California Coastal Recovery Plans for coho salmon and steelhead (NMFS 2012, 2016). Although more broad in focus, both Recovery Plans identify recovery actions consistent with the habitat enhancement actions recommended in this Plan. The San Francisco Bay Regional Water Quality Control Board (Water Board) recognizes that actions identified in this Implementation Plan will be performed within the broader context of overall watershed planning efforts for multi-benefit goals identified by stakeholders. These multi-benefit goals are wide-ranging and include ecosystem function, conservation agriculture and grazing, water management, wildfire protection, economic resiliency, public uses, health and safety.

8.1 Legal Authorities

The Water Board has responsibility and authority for regional water quality control of point[3] and nonpoint sources of pollution. The Water Board regulates point sources with National Pollutant Discharge Elimination System (NPDES) permits, which regulate pollutant discharges into waters of the United States; state-only waste discharge requirements under Water Code 13263, for discharges to waters of the state; or Clean Water Act section 401 certifications for discharges of dredge or fill material to waters of the United States. The Water Board's approach to nonpoint source regulation is guided by the State Water Resources Control Board's Policy for Implementation and Enforcement of the Nonpoint Source Program (State Water Board 2004), which allows flexibility in regulation of nonpoint source discharges. Tools to regulate nonpoint source discharges include Waste Discharge Requirements (WDRs), conditional waivers of WDRs, and direct enforcement of the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) discharge prohibitions. Here, a combination of these regulatory tools will assist in meeting sediment targets and reversing impairments of water quality objectives.

8.2 Regulatory Tools

This plan relies largely on local stakeholders and property owners to implement necessary actions to protect water quality and reduce sediment discharges. If necessary actions are not being taken to accomplish the Plan goals, then the Water Board may use one or more of the following regulatory tools, as needed, to achieve water quality objectives:

- Municipal Regional Stormwater NPDES Permit (Order No. R2-2015-0049; NPDES Permit No. CAS612008)
- Basin Plan Discharge Prohibition No. 9, which states: "it shall be prohibited to discharge silt, sand, clay, or other earthen materials from any activity in quantities sufficient to cause deleterious bottom deposits, turbidity or discoloration in surface waters or to unreasonably affect or threaten to affect beneficial uses"
- 401 certifications or WDRs for projects that propose to fill or otherwise physically alter creeks, wetlands or other waters, facilitated by guidance in the San Gregorio Creek Watershed Management Plan (Attachment 1)
- California Water Code section 13267, which authorizes the Regional Water Board to require technical or monitoring program reports from dischargers
- California Water Code section 13263 and 13383, which authorize the Regional Water Board to issue individual WDRs to regulate discharges of waste
- California Water Code section 13304, which authorizes the Water Board to require cleanup of unauthorized discharges to waters of the state

[3] A point source is any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel, conduit, discrete fissure, or container. By law, agricultural stormwater discharges and return flows from irrigated agriculture are not "point sources".

- California Water Code section 13261, which allows the Water Board to issue waivers of WDRs
- San Mateo County Routine Maintenance Program (Order No. R2-2021-005)
- Development of a Total Maximum Daily Load (TMDL) for sediment and population and community ecology for the San Gregorio Creek watershed.

8.3 Implementing Parties and Timeline

Responsibility for achieving water quality objectives will fall on several parties, including road and trail system owners, agricultural operators, the County of San Mateo and other public and private landowners. The responsibility for achieving the sediment and population and community ecology water quality objectives shall be shared among all the implementing parties. Cooperation is necessary not only to attain water quality objectives but also to avoid duplicative actions, such as monitoring and reporting. Responsible entities are encouraged to select a lead entity to manage the shared responsibilities.

The primary implementing parties include:

- San Mateo County
- Midpeninsula Regional Open Space District (Midpen)
- Private agricultural landowners or operators
- Peninsula Open Space Trust (POST)
- California Department of Transportation (Caltrans)

In addition, we recognize the San Mateo County Resource Conservation District (RCD) for its role in assisting private landowners reach a variety of environmental goals, including improving water quality. The RCD itself does not bear responsibility for achieving the sediment and population and community ecology water quality objectives. However, the RCD's role in helping private landowners is important to the success of this Plan.

The Water Board and other federal, state and local agencies play a critical role in facilitating implementation actions through their regulatory authorities. Cooperation between regulators and implementing parties in reaching the Plan's goals will be an important ingredient in Plan success. Throughout the Plan outreach process, stakeholders have encouraged the Water Board to be open to creative approaches that streamline their efforts while meeting regulatory requirements. The Water Board is committed to working with all stakeholders to identify solutions and implement the Plan.

The timeline for implementing parties to collectively meet the performance standards in this Plan is 20 years from the date this Plan is accepted through Resolution by the Water Board.

8.4 Implementation Action Overview

This Plan builds on management measures required by existing local, regional and statewide regulations to reduce or eliminate waste discharges from anthropogenic sediment sources. The subsections below describe the implementation actions needed to meet water quality objectives for sediment, settleable material, and population and community ecology. Most of the implementation actions are the same or similar to those of the Pescadero-Butano Sediment TMDL and are aimed at achieving the following goals:

- Conserve and augment steelhead trout populations
- Restore an annual spawning run of coho salmon
- Protect and enhance habitat for native aquatic species
- Protect and enhance the aesthetic and recreational values of the creek and its tributaries.

To achieve these goals, stakeholders in the watershed must work to:

- Reduce anthropogenic sediment loads, and fine sediment in particular, to San Gregorio Creek and its tributaries
- Attain and maintain suitable gravel substrate quality and adequate pool depth in freshwater reaches of San Gregorio Creek and its tributaries
- Enhance stream-riparian habitat complexity and connectivity by restoring floodplains where doing so is technically feasible and compatible with adjacent land uses, installing LWD jams, enhancing natural wood loading, and identifying and implementing opportunities to improve fish passage and habitat conditions during low flow periods
- Identify and implement opportunities to improve fish rearing conditions in San Gregorio lagoon and adjacent marsh, including upstream of Highway 1.

The best solutions to sediment supply and habitat quality issues in this watershed are those "owned" by stakeholders. Therefore, we support collaborative stewardship efforts that select and implement the most effective and appropriate best management practices (BMPs) described later in this section. Implementation measures and efforts should build upon existing programs, such as those led by the RCD, San Mateo County, National Resource Conservation Service, and many other federal, state and non-governmental organizations.

Specific implementation actions necessary to meet the numeric targets for water quality objectives are discussed next. These include actions for roads and trails, livestock grazing, agricultural croplands, and habitat enhancement.

8.5 Implementation on Roads and Trails

Combined, the State and County maintain about 140 miles of roads in the watershed and private roads on Midpen lands contain approximately 47 miles of inventoried roads and trails (Attachment 1). The mileage of private roads in the watershed is not known, but given the rural landscape, these roads are thought to be largely unpaved and unimproved. This Implementation Plan calls for inventories and proper maintenance and repair of roads and trails in the San Gregorio watershed.

Poorly designed or maintained roads and trails are typically a major source of anthropogenic sediment production and delivery to streams in rural and forested watersheds (Weaver et al. 2015). Inadequate drainage can result in erosion of road or trail surfaces, roadside ditches and adjacent fill slopes. Poor road or trail drainage can also result in increased erosion through rilling and gullying, such as from a culvert or cross drain that outlets onto an erodible hillslope. In addition, roads built on steep or unstable slopes can trigger landslides or other forms of mass wasting that increase sediment loads to stream channels. Inadequate inspection and maintenance also play a critical role in sediment production from roads. For example, inadequate culvert inspection and cleanout can lead to plugged culverts that force flows up and over the road surface or downslope along the road or trail alignment, resulting in potentially significant erosion.

The effects of poorly designed or maintained roads and trails are most acute where they are hydrologically connected to streams. A hydrologically connected road is any road or road segment that has a continuous surface flow path to a natural stream channel during a storm runoff event (Weaver et al. 2015). A suitable design runoff event for most purposes is a 1-year 6-hour storm, with antecedent moisture conditions corresponding to the wettest month of the year. Connectivity usually occurs through road ditches, road surfaces, gullies, or other drainage structures or disturbed surfaces.

Like the Pescadero-Butano Implementation Plan, this Implementation Plan includes the goal to limit the length of unpaved roads that are hydrologically connected to 25 percent of the total length of unpaved roads in the watershed. Paved road surfaces are not included in this requirement for hydrologic disconnection.

Specific implementation actions needed to reduce sediment production from roads and trails in each jurisdiction are discussed below. Implementing parties for these actions are San Mateo County, Caltrans, Midpen and POST, and private agricultural landowners or operators.

The goal of these implementation actions is to hydrologically disconnect and stormproof roads to the extent feasible. Characteristics of storm-proofed roads are described as follows:

<u>Storm-proofed stream crossings</u>

- All stream crossings have a drainage structure designed for the 100-year flood flow (including woody debris and sediment).
- Stream crossings have no diversion potential (functional critical dips are in place).
- Culvert inlets have low plug potential (trash barriers or deflectors are installed where needed).
- Culverts are installed at the base of the fill and in line with the natural channel.
- Any existing culverts or new emergency overflow culverts that emerge higher in the fill have full round, anchored downspouts that extend to the natural channel.
- Stream crossing culvert outlets are protected from erosion (extend culverts at least 6 feet beyond the base of the fill and use energy dissipation where needed).
- Culvert inlet, outlet and bottom are open and in sound condition.
- Deep fills (deeper than a backhoe can reach from the roadbed) with undersized culverts or culverts with high plugging potential are fitted with an emergency overflow culvert.

- Bridges have stable, non-eroding abutments and do not significantly restrict 100-year flood flow.
- Stream crossing fills are stable (unstable fills are removed or stabilized).
- Approaching road surfaces and ditches are "disconnected" from streams and stream crossing culverts to the maximum extent feasible using road shaping and road drainage structures.
- Class I (fish-bearing) crossings meet California Department of Fish and Wildlife and National Marine Fisheries Service fish passage criteria.
- Abandoned or decommissioned stream crossings are excavated to exhume the original, stable, stream bed and channel sideslopes, and then stabilized with mulch and vegetation.

Storm-proofed road and landing fills

- Unstable and potentially unstable road and landing fills that could deliver sediment to a stream are excavated (removed) or structurally stabilized.
- Excavated spoil is placed in locations where eroded material will not enter a stream.
- Excavated spoil is placed where it will not cause a slope failure or landslide.

Storm-proofed road surface drainage

- Road surfaces and ditches are hydrologically "disconnected" from streams and stream crossing culverts. Road surface runoff is dispersed, rather than collected and concentrated.
- Ditches are drained frequently by functional ditch relief culverts, rolling dips or cross-road-drains.
- Outflow from ditch relief culverts does not discharge to streams.
- Ditch relief culverts with gullies that deliver to a stream are removed or dewatered.
- Ditch and road surface drainage does not discharge (through culverts, rolling dips or other cross drains) onto active or potential landslides. It is recognized that most hillslopes in the San Gregorio Creek watershed are active or potential landslides and therefore may be unavoidable.
- Decommissioned roads have permanent drainage and do not rely on ditches.
- Fine sediment contributions from roads, cutbanks and ditches are minimized by utilizing seasonal closures and installing a variety of surface drainage techniques including berm removal, road surface shaping (outsloping, insloping or crowning), rolling dips, ditch relief culverts, waterbars and other measures to disperse road surface runoff and reduce or eliminate sediment delivery to the stream.

8.5.1 Performance Standards for Roads and Trails

The performance standards and implementation actions for paved and unpaved roads in the San Gregorio Creek watershed are the same as those in the Pescadero-Butano Sediment TMDL. The performance standards are:

Roads: Design, construct, and maintain roads to

1) Reduce road-related sediment delivery to channels to ≤ 500 cubic yards per mile per 20-year period, **or** limit the length of roads that are hydrologically connected to 25 percent of total road length;

2) Result in culvert inlets with low plug potential; and
3) Install critical dips at culverted crossings that have a diversion potential.

Gullies and/or shallow landslides: Promote natural recovery and minimize human caused increases in sediment delivery from unstable areas. Manage existing roads and other infrastructure to prevent additional erosion of legacy sediment delivery sites and/or delivery from potentially unstable areas.

8.5.2 San Mateo County Roads

San Mateo County is expected to achieve the Performance Standards for Roads and Trails through compliance with the Municipal Regional Stormwater Permit (MRP), in which San Mateo County is a permittee. Because the MRP is in the process of being reissued, we describe both the current and anticipated future permit requirements applicable to rural roads in the watershed. The current MRP, NPDES Permit No. CAS612008, Order No. R2-2015-0049 (as amended), contains provisions for rural public works construction and maintenance. These provisions require the County to adopt and implement road maintenance guidelines to protect aquatic habitat, water quality, and fisheries; conduct training for road maintenance staff; and report annually on the implementation of BMPs and the compliance status for rural roads construction and maintenance. Proposed revisions to be included in the reissued MRP, which are scheduled to be considered for adoption in 2022, would require San Mateo County to prepare a road erosion inventory and a prioritized list and schedule of actions for County roads in the San Gregorio Creek watershed by September 30, 2025. In future reissuances of the MRP, Water Board staff will propose requirements to implement the schedule of actions such that twenty percent of the actions would be completed by June 30, 2029, fifty percent by 2032, and the remaining fifty percent by 2035.

Further, the San Mateo County Routine Maintenance Program (County RMP), approved by the Water Board in 2021 (Order No. 2021-0005), authorizes the County to perform routine stream maintenance activities including road maintenance, such as work to address roadside ditches, ditch relief culverts, culvert maintenance or replacement and other minor maintenance. Both this order and the MRP require the County to report on its actions. These reports will allow Water Board staff to determine if appropriate actions are taken and progress is made toward achieving the Performance Standards for Roads and Trails.

8.5.3 California Department of Transportation (Caltrans)

Caltrans is responsible for runoff from State highways and associated construction activities. Discharges from State highways are regulated through a Statewide stormwater permit issued to Caltrans, NPDES Permit No. CAS000003. The permit requires Caltrans to maintain an inventory of road segments that are prone to erosion and sediment discharge to creeks, prioritize unstable or eroding surfaces or slopes for repair and stabilization, and report actions taken to address erosion sites as part of its annual report to the Water Board. Caltrans' responsibility in the San Gregorio Creek watershed consists of Highway 1, which crosses San Gregorio Creek near the State beach; Highway 35, also named Skyline Blvd. and located along the crest of the upper watershed; and Highway 84, which traverses the watershed from San Gregorio to Skyline Blvd. north of La Honda.

Stakeholders in the watershed have identified culvert placement at some locations on Highway 84 as causing accelerated sediment delivery to La Honda Creek. Water Board staff expect Caltrans to include the roads listed above in its inspection and inventory of road segments prone to erosion and sediment discharge to creeks. Water Board staff will review Caltrans' inventory and prioritization plan annually. If Highway 84 through the San Gregorio Creek watershed is not inspected and prioritized for any needed repairs within three years of the acceptance of this Plan through Resolution, the Water Board would use Water Code 13267 or 13383 authorities to compel these actions. Caltrans is expected to complete BMP implementation and/or project construction at erosion sites in the San Gregorio Creek watershed by September 30, 2032 when Caltrans' Report of Waste Discharge for permit reissuance is due.

8.5.4 Open Space Roads

Midpen and POST manage or oversee a significant portion of the roads in San Gregorio Creek watershed. This Plan acknowledges and builds upon the actions Midpen and POST have taken to date to minimize sediment production on high and medium priority road erosion sites (Hébert 2019b). Going forward, Midpen and POST are expected to achieve the Performance Standards for Roads and Trails by completing the following actions:

Planning and Prioritization:

Midpen and POST are expected to take the following planning and prioritization actions:

1) Adopt and implement best management practices for maintenance of unpaved (dirt/gravel) roads
2) Conduct a survey of stream crossings associated with unpaved public roadways
3) Develop a prioritized implementation plan and schedule for repair and/or replacement of high priority crossings/culverts to reduce road-related erosion and protect stream-riparian habitat conditions.

The Planning and Prioritization actions are expected to be completed by February 1, 2027.

Implementation and Reporting:

Midpen and POST are expected to achieve road repairs and replacements per their prioritized implementation plan. By February 1, 2032, Midpen and POST are expected to submit a report to the Water Board that provides, at a minimum, the following:

1) Description of the road network and/or segments repaired or replaced
2) Identification of erosion and sediment control measures taken to achieve performance standard(s) specified in Section 8.5.1
3) A schedule for implementation of additional control measures to be taken.

For paved roads, focusing erosion and sediment control actions primarily on road crossings, should be sufficient to meet the performance standard.

Midpen is expected to address most of the remaining low priority road erosion sites through Midpen's Open Space Maintenance and Restoration Program (Hébert 2021). The program is similar to the San Mateo County Routine Maintenance Program (Order No. 2021-0005) described in Section 8.5.2 and is expected to be submitted to the Water Board for approval under the 401 Certification program for stream maintenance. This order includes annual reporting requirements which will allow Water Board staff to determine if appropriate actions are taken and progress is made toward achieving the Performance Standards for Roads and Trails.

If a report documenting the implementation plan is not submitted by February 1, 2032, the Water Board will consider a regulatory action, such as issuance of WDRs or a waiver of WDRs, to control sediment discharges from paved and unpaved roads. The regulatory action would be similar to what is being developed for County roads in the MRP and would rely on a road inventory, conditions assessment, prioritization to retrofit or replace, and time schedule to implement identified sediment control measures.

8.5.5 Private Roads

This Implementation Plan does not specify actions for owners of private roads. Instead, we rely on the ongoing efforts of the San Mateo RCD to implement water quality protections on private roads. Specifically, the San Mateo RCD has expressed its intent to implement a sediment inventory and assessment protocol for grazing and non-grazing agricultural lands. The protocol was developed for road and non-road erosion sites in the Pescadero-Butano watershed. The inventory and assessment include site description, site map, prioritized actions for BMP implementation by the landowner, potential costs, partnerships and coordination, permitting requirements, and an implementation schedule when such information is available. The San Mateo RCD supports expansion of this protocol to the San Gregorio Creek watershed and anticipates funding to be made available through National Resource Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) grants funding (Polger 2020).

8.6 Implementation on Livestock Grazing Lands

The Watershed Management Plan (Attachment 1) identifies 9,142 acres or 27.5 percent of the San Gregorio Creek watershed as grassland. We assume this vegetation type represents most or all the land suitable for grazing. Of this, 2,848 acres (8.6 percent of the watershed area) is Midpen land with active grazing leases (Hébert 2019b). We were unable to determine the acreage of active grazing operations outside Midpen lands.

Grazing operations can cause excess sediment erosion via poor grazing practices, such as overgrazing, poorly designed or maintained roads, or a lack of fencing to protect erosion-prone areas like gullies or stream banks. Overgrazing can lead to insufficient land surface cover – often measured as residual dry matter (RDM) on the ground at the beginning of a new growing season (University of California 2002) – and result in land surface erosion, rill and gully formation or shallow landslides. Effective erosion control measures include implementation of grazing strategies that eliminate overgrazing, installation of exclusion fencing to keep livestock away from eroding stream banks or active gullies, restoring native woody vegetation along stream corridors, and diversion or dispersion of concentrated runoff from roads. The NRCS Field Office Technical Guide (NRCS 2021) provides guidance on selection and implementation of these management practices.

Like the Pescadero-Butano Implementation Plan, this Implementation Plan calls for grazing operations of 50 acres or more to ensure their practices minimize land surface erosion and protect streams and riparian corridors. We identify grazing lands as all lands grazed by livestock including ranchlands, riparian areas, and pasturelands. Implementing parties for these actions are Midpen and other private agricultural landowners or operators with grazing operations of 50 acres or more.

8.6.1 Performance Standards for Grazing Operations

The performance standards and implementation actions for grazing operations in the San Gregorio Creek watershed are the same as those in the Pescadero-Butano Sediment TMDL. The performance standards are:

Surface erosion associated with livestock grazing: Attain or exceed minimal residual dry matter (RDM) values consistent with University of California Division of Agriculture and Natural Resources Guidelines (2002).

Stream corridors: Protect streambanks, wetlands, and riparian areas from degradation through grazing management, livestock access controls, and vegetated buffers.

Roads: Design, construct, and maintain roads to

1) Reduce road-related sediment delivery to channels to ≤ 500 cubic yards per mile per 20-year period; **or** limit the length of roads that are hydrologically connected to 25 percent of total road length;
2) Result in culvert inlets with low plug potential; and
3) Install critical dips at culverted crossings that have a diversion potential.

Gullies and/or shallow landslides: Manage grazing practices to allow for natural recovery of gullies and/or landslides, prevent human-caused increases in sediment delivery from unstable areas, and decrease connectivity of gullies to stream channels.

8.6.2 Implementation Plan for Grazing Operations of 50 Acres or More

Unless an alternative plan is submitted to and accepted by Water Board staff (discussed below), grazing operations of 50 acres or more are expected to plan, prioritize and implement sediment management actions. Grazing operations less than 50 acres in size are not expected to take action. This Implementation Plan calls for owners or operators of grazing operations of 50 acres or more to prepare (or update) Ranch Management Plans to include the following actions:

Planning and Prioritization:

Grazing operations are expected to take the following planning and prioritization actions:

1) Complete a comprehensive inventory and assessment of natural resources, rangelands, and management practices. This includes documenting all sediment sources that may deliver sediment to streams; evaluating streams, water bodies and riparian corridors for evidence of grazing-related erosion; and evaluating opportunities for improving habitat along streams and riparian corridors
2) Inventory and assess the effectiveness of all BMPs being implemented to control erosion, including animal fencing, water availability for livestock, maintaining adequate amounts of residual dry matter (RDM), winterization practices, and measures to reduce gully erosion
3) Identify where changes to management practices are necessary to control erosion, or where new or additional BMPs are needed
4) Complete a road inventory and evaluate management and maintenance methods to control excess road-related erosion
5) Develop an implementation schedule for actions identified in 1-4 above.

Planning and Prioritization actions are expected to be completed By February 1, 2027.

Implementation and Reporting:

Grazing operations are expected to take the actions identified in their prioritized implementation plan. By February 1, 2032, grazing operators are expected to submit a report to the Water Board that provides, at a minimum, the following:

1) A description of the property/ranch and road network that indicates where actions have been taken to reduce sediment erosion
2) Identification of site-specific erosion control measures that have been implemented to achieve performance standards stated in section 8.6.1
3) A schedule for implementation of additional control measures to be taken.

The requirement to complete a Ranch Management Plan may be addressed by an alternative plan that is acceptable to Water Board staff. For example, the San Mateo RCD has worked with the Water Board to develop a sediment management strategy for grazing and non-grazing agricultural lands that addresses the requirements of the Pescadero-Butano Implementation Plan, which are the same requirements as in this Implementation Plan. Consequently, the RCD's approach is expected to meet the performance standards above. The approach consists of a sediment source inventory and assessment and actions to address each sediment erosion site. The approach focuses on high-risk areas, namely roads and areas with hydrologic connectivity to watercourses. It follows guidance provided by the University of California Division of Agriculture and Natural Resources Publication 8014: Sediment Delivery Inventory and Monitoring (University of California 2000). Thus, ranch owners or operators on private lands are expected to work with local conservation agency staff to develop and implement a program that achieves the sediment control actions described above. Water Board staff expect to meet with the San Mateo RCD at least annually to receive information on the extent of implementation of sediment control actions on private lands.

We recognize that some owners and operators of grazing lands in the San Gregorio Creek watershed are implementing BMPs that protect creeks and riparian areas, in addition to other conservation practices beyond the scope of this Implementation Plan, such as endangered species protection, improving wildfire resiliency, controlling non-native invasive species, and replacing historical herbivory to maintain native grasslands. The Water Board supports these practices and recognizes that the sediment reduction goals of this Implementation Plan must be considered within the context of multi-benefit resource planning and conservation objectives, such as those identified in the Midpen 2014 Vision Plan Conservation Atlas (Midpen 2014) and the Watershed Management Plan (Attachment 1).

While not part of this Implementation Plan, we also recognize that other practices, such as carbon and conservation farming, can improve water quality over time. Such practices can improve soil health and restore degraded soils such that they develop greater vegetation cover, root reinforcement, and infiltration capacity, all of which reduce land surface erosion and the potential for gully formation. Soil degradation resulting from past agricultural and rangeland management practices is a problem in some parts of the San Gregorio Creek watershed (Howard 2021). Consequently, although not expected by this Implementation Plan, we encourage efforts to restore soil health on grazing lands in the watershed. These and other conservation practice standards for prescribed grazing and soil carbon are described by the NRCS (2017, 2020).

If locally administered grazing-related programs are not adequate to address the sediment impairment, control of discharges would be addressed through WDRs or waivers of WDRs. Permit details, including the compliance schedule and appropriate management practices, would be determined during the permit development process, which would include stakeholder participation. The goal of such a permit would be to build off existing local efforts to control sediment delivery from the grazed area and supporting unpaved road network.

8.7 Implementation on Non-Grazing Agricultural Lands

This Implementation Plan calls for areas of agricultural croplands of five acres or greater to plan, prioritize, and implement sediment management actions. Implementing parties for these actions are private agricultural landowners or operators with agricultural croplands of five acres or more. Farmlands of less than five acres are not expected to take action.

The Watershed Management Plan (Attachment 1) identifies 332 acres or one percent of the San Gregorio Creek watershed as agricultural croplands, located mainly in the San Gregorio Valley. Due to the limited extent of agricultural croplands and their location predominantly on the valley floor where slopes are gradual (< 5%), sediment management actions on agricultural croplands focus only on high-risk sediment sources, namely roads and areas that are hydrologically connected to the drainage network. Farmers are not expected to implement management actions to reduce erosion from cultivated fields. Exceptions may exist however, such as where lands are delivering a significant amount sediment from land surface erosion to stream channels (e.g., due to poor agricultural practices on hillslopes).

8.7.1 Performance Standards for Non-Grazing Agricultural Operations

The performance standards and implementation actions for Non-grazing Agricultural operations in the San Gregorio Creek watershed are the same as those in the Pescadero-Butano Sediment TMDL. The performance standards include all of the following:

Roads: Design, construct, and maintain roads to

1) Reduce road-related sediment delivery to channels to ≤ 500 cubic yards per mile per 20-year period; **or** limit the length of roads that are hydrologically connected to 25 percent of total road length;
2) Result in culvert inlets with low plug potential; and
3) Install critical dips at culverted crossings that have a diversion potential.

Stream corridors: Protect streambanks, wetlands, and riparian areas from degradation through vegetated buffers.

Gullies and/or shallow landslides: Manage non-grazing agricultural practices to allow for natural recovery of gullies and/or landslides, prevent human-caused increases in sediment delivery from unstable areas, and decrease connectivity of gullies to stream channels.

Effectively attenuate significant increases in storm runoff, so that the runoff from non-grazing agricultural lands shall not cause or contribute to downstream increases in rates of bank or bed erosion.

8.7.2 Implementation Plan for Non-Grazing Agricultural Operations of Five Acres or More

Unless an alternative plan is submitted to and accepted by Water Board staff (discussed below), Non-grazing Agricultural operations of five acres or more are expected to plan, prioritize and implement sediment management actions. This Implementation Plan calls for owners or operators of Non-grazing Agricultural operations of five acres or more to prepare (or update) Farm Management Plans to include the following actions:

Planning and Prioritization:

Non-grazing Agricultural owners or operators on private lands are expected to take the following planning and prioritization actions:

1) Inventory and assess natural resources, agricultural lands, and management practices. This includes documenting all sediment sources that are considered high-risk, namely sediment sources that are road-related or hydrologically connected to the drainage network and may deliver sediment to streams; evaluating streams, water bodies and riparian corridors for evidence of agriculture-related erosion; and, evaluating opportunities to improve habitat along streams and riparian corridors
2) Inventory and assess the effectiveness of all BMPs being implemented to control erosion
3) Inspect the points of surface water discharge from the farm for signs of erosion of the bed and bank of the receiving channel

4) Identify where changes to management practices and/or additional BMPs are needed to control surface erosion from the farm and at points of surface water discharge that exhibit signs of receiving water erosion
5) Complete an assessment of unpaved road conditions on the property and evaluate current management and maintenance methods to control excessive road-related erosion
6) Develop an implementation schedule for actions and improvements identified during steps 1-5 above.

Non-grazing Agricultural owners or operators on private lands are expected to work with local conservation agency staff to develop and implement a program that achieves the sediment control actions described above. Planning and Prioritization actions are expected to be completed By February 1, 2027.

Implementation and Reporting:
Non-grazing Agricultural owners or operators on private lands are expected to take the actions identified in their prioritized implementation plan. By February 1, 2032, Non-grazing Agricultural operators are expected to submit a report to the Water Board that provides, at a minimum, the following:

1) A description of the land including the road network that indicates where actions have been taken to reduce sediment erosion
2) Identification of site-specific erosion control measures that have been implemented to achieve performance standards stated in section 8.7.1
3) A schedule for implementation of additional control measures to be taken.

Non-grazing Agricultural operations of five acres or more are expected to work with RCD staff to develop and implement a program that achieves the sediment control actions described above. Owners and operators of agricultural lands who are already implementing sediment control BMPs that protect creeks and riparian areas would continue their good stewardship and document these efforts to demonstrate compliance.

Water Board staff expect to meet with the San Mateo RCD at least annually to receive information on the extent of implementation of sediment control actions on Non-grazing Agricultural operations. If existing policies and local efforts are not sufficient to address farm-related erosion, control of discharges would be addressed through WDRs or waivers of WDRs. Permit details, including the compliance schedule and appropriate management practices, would be determined during the permit development process, which would include stakeholder participation. The goal of such a permit would be to build off existing local efforts to control sediment delivery from the farmed area and supporting unpaved road network.

Like the Implementation Plan for Livestock Grazing (Section 8.6), an alternative plan may be developed and, if accepted by Water Board staff, used in lieu of the sediment management actions listed above to achieve sediment reduction performance standards for Non-grazing

Agricultural lands. Such a plan has been developed by the San Mateo RCD for the Pescadero-Butano Implementation Plan and is expected to be applied to the San Gregorio Creek watershed (see Section 8.6).

8.8 Implementation for Habitat Enhancement
Because of similarities in the two watersheds, we recommend that habitat enhancement actions similar to those adopted in the Pescadero-Butano Implementation Plan be taken in the San Gregorio Creek watershed. Habitat enhancement actions would focus on improving aquatic habitat for steelhead and coho salmon spawning and rearing in the San Gregorio Creek watershed and lagoon.

These actions can take a myriad of forms but are expected to fall into one or more of the following categories:

1) Identifying and implementing opportunities to restore floodplain connectivity, primarily along the San Gregorio Creek main stem
2) Improving instream physical habitat structure by adding LWD
3) Preventing or reducing future channel incision
4) Increasing base flow in San Gregorio Creek, particularly during low flow summer and fall time periods
5) Protecting or restoring steelhead and coho rearing habitat in San Gregorio Lagoon.

Recommended habitat enhancement actions are summarized below, as are important elements of habitat enhancement projects. Implementing parties for these actions have not yet been determined but, similar to the Pescadero-Butano Implementation Plan, are expected to consist of state and local government agencies, landowners and/or designated agents, and reach-based stewardships. Unless otherwise stated, the expected target date for completing the actions identified in this habitat enhancement plan is February 15, 2037. We recognize, however, that some of these efforts may extend beyond the target date.

<u>8.8.1 Floodplain Reconnection and Large Woody Debris (LWD)</u>
Floodplains and LWD jams provide essential high-quality rearing habitats and enhance food production for coho salmon and steelhead. These features also help store sediment, diversify habitat types, and can be incorporated as part of stream bed or bank stabilization efforts. Because LWD surveys exist only for the San Gregorio Creek main stem and lower La Honda Creek, we recommend that surveys be conducted on other watershed tributaries to determine where LWD installation would help meet numeric targets (see Chapter 7). Similarly, a planning effort to identify opportunities, constraints, and potential benefits of floodplain reconnection is needed. We assume that such opportunities exist primarily on the San Gregorio Creek main stem, but other opportunities may exist on tributary stream segments where disconnected floodplains exist.

To re-establish suitably diverse, complex and connected stream-riparian habitat, we recommend stakeholders and property owners collaborate on channel, riparian and floodplain habitat enhancement projects. Habitat enhancement projects typically involve multi-benefit goals. Successful projects must consider instream habitat enhancement goals and changes in channel stability or flow conditions, and they must address existing erosion problems and property owner concerns, to name a few. Consequently, we anticipate implementing parties to include multiple stakeholders including state and local government agencies, landowners and/or designated agents, local conservation agency staff, and technical experts. An example of such a project was implemented on San Gregorio Creek, where LWD was added just upstream of the Event Center property and downstream of Harrington Creek (Stillwater Sciences 2015).

8.8.2 Enhance Summer Base Flows

We recommend that habitat enhancement actions for San Gregorio Creek include a framework for enhancing summer base flows. Low flow periods on San Gregorio Creek in late summer and fall have been identified as a limiting factor for steelhead and coho salmon (Attachments 1 and 2, NMFS 2016). Lower creek flows reduce access to food and refuge for rearing juvenile steelhead and coho and can also limit fish passage between stream reaches. Completed actions to improve base flow conditions include the recent construction of off-channel water storage ponds for agricultural operations at Repetto Farm and Blue House Farm on San Gregorio Creek. These ponds are filled when stream flows are plentiful and available as an alternative to surface water withdrawal from the creek during low flow conditions.

Although new opportunities to construct off-channel water storage ponds in the San Gregorio Creek watershed may not be available (Frahm 2019), we recommend that the implementing parties investigate other opportunities. These activities may include additional water conservation efforts, public outreach, and other ecosystem restoration efforts that positively impact stream base flows. For example, sustained improvements to soil health over an extended period (years or decades) can positively affect the runoff hydrograph via reduced runoff and increased soil infiltration rates. This has multiple beneficial effects including less runoff during storm events, less erosion and sediment delivery to streams, as well as lower peak flows in streams that reduce instream erosion rates and the potential for local flooding. In addition, higher soil infiltration rates allow more water to enter the groundwater aquifer, resulting in a higher groundwater table and therefore higher stream base flows during dry periods.

Watershed stakeholders have reported that funding for the USGS stream gage at San Gregorio is uncertain. We strongly support continued funding to maintain operation of the USGS stream gage on San Gregorio Creek. Stream flow monitoring provides critical data for the steelhead and coho salmon restoration effort. These data will provide the flow and suspended sediment measurements necessary to interpret and evaluate progress toward achieving numeric targets during the 20-year period of Plan implementation.

8.8.3 Fish Passage Barriers

Fish passage barriers in the San Gregorio Creek watershed are documented in Appendix F of the Watershed Management Plan (Attachment 1). Some of these have since been removed, such as the barrier on Alpine Creek at Pescadero Road; however, many still remain. These barriers impede adult steelhead spawning migration into the tributaries and/or the migration of juvenile steelhead out of the tributaries as smolt. Artificial barriers include structures, such as small dams, weirs or other constructed features used for water diversion or impoundments, as well as culverts and bridges at road crossings (Ross Taylor and Associates 2004, Attachment 1). Consequently, we recommend that remaining artificial barriers to fish passage be prioritized for removal or remediation where feasible to improve fish passage and migration for steelhead and coho salmon.

8.8.4 San Gregorio Lagoon and Marsh

As discussed in Section 5.6.5, artificial breaching of the sandbar at the mouth of San Gregorio lagoon has significantly degraded the quality of fish rearing habitat in the lagoon. California State Parks has added informational signage to discourage this behavior, but it continues, in part because the only path from the parking lot to the beach is partially submerged when the lagoon is full. We recommend that opportunities to mitigate or resolve this problem continue to be explored by the California State Department of Parks and Recreation (California State Parks). Actions that may help reduce the frequency of artificial breaching events include placement of additional temporary signage on the sandbar, development of alternative access from the parking lot to San Gregorio Beach, beach patrols to ensure the sandbar is not breached, or other means to discourage artificial breaching of the lagoon. Discussions with California State Parks indicated that installation and maintenance of a lagoon camera to monitor breaching may also aid in finding a solution to the artificial breachings (Hyland 2021).

Completed in 1941, Highway 1 bisects the San Gregorio lagoon and its adjacent marsh lands. We recommend that opportunities to reconnect marsh lands upstream of Highway 1 to the lagoon be explored by California State Parks and adjacent private landowners. Currently, a culvert connects part of the marsh to the lagoon on the north side of San Gregorio Creek just upstream of Highway 1 (Hyland 2021). Tidewater goby, an endangered species, is known to access this area through the culvert when lagoon levels are high and the culvert is partially submerged. We encourage the examination of opportunities to expand forage and refuge for rearing steelhead and coho in this and other marsh lands near the lagoon.

Lastly, we encourage stakeholders to combine marsh land connection efforts upstream of Highway 1 with other opportunities where practicable and ecologically sound. One such project may include harvesting eucalyptus trees, an invasive species, growing on California State Park lands for use in LWD projects on San Gregorio Creek (Robins 2021). Concerns over potential toxicity from oils and alleopathic chemicals in the wood would need to be addressed, as well as the suitability and longevity of eucalyptus wood in LWD applications.

8.9 Water Quality Monitoring

Four types of monitoring are recommended to assess baseline conditions and progress toward achievement of water quality objectives for sediment and population and community ecology:

1) Baseline monitoring to characterize existing conditions and provide a basis for future comparison

2) Implementation monitoring to document actions taken to reduce fine sediment discharge and enhance habitat complexity and connectivity
3) Effectiveness monitoring to evaluate effectiveness of sediment control actions in reducing rates of sediment delivery to channels
4) Effectiveness monitoring of pool filling, substrate composition and LWD loading to evaluate channel response to sediment control and habitat enhancement efforts.

Baseline monitoring data for V* and substrate composition were collected by the Water Board in 2018. No surveys for LWD loading are currently planned but are needed in stream reaches where no data are available.

Where permits are not in place, implementation monitoring is expected to be conducted by landowners or designated agents to document that sediment control actions identified in this Plan have been implemented. Where permits are in place, implementation monitoring shall be conducted per the compliance monitoring and reporting provisions of applicable waivers of WDRs, WDRs, NPDES permits, and 401 Certifications.

Water Board staff anticipates working in partnership with other government agencies to conduct upslope effectiveness monitoring to evaluate sediment delivery to channels from land use activities and natural processes. The first sediment source analysis update would occur no more than ten years after this Plan is accepted through Resolution. A subsequent update may occur, assuming the water quality targets for sediment are not already achieved, 20 years after this Plan is accepted through Resolution.

In-channel effectiveness monitoring should be conducted by entities with expertise in monitoring and the ability to work effectively with private property owners. In-channel effectiveness monitoring is expected to be conducted to evaluate (1) progress toward achieving water quality targets, and (2) channel response to management measures and natural processes. Parameters are expected to include pool filling, percent fines composition of the substrate, and LWD concentrations (see Table 7.1). The number of sites to be monitored is expected to be selected based on availability/presence of the applicable habitat feature (e.g., spawning gravels and pools), as well as the number of samples needed to have a high degree of confidence in estimated values.

Optimally, monitoring should be done on five-year intervals for pool filling and percent fines composition and on ten-year intervals for LWD concentrations. The longer period for LWD concentrations is to account for the infrequent transport of LWD within the stream system that is associated with larger, infrequent flood events, in addition to LWD introduction as part of habitat enhancement projects. As part of adaptive management, alternative water quality parameters and/or numeric target values may be established at a future date, should information become available that one or more alternative parameters or target values provide a superior basis for determining attainment of water quality objectives for sediment, and the protection of fisheries-related beneficial uses.

We also recommend that habitat complexity-related water quality indicators be monitored with the following target conditions:

1) An increasing trend in bankfull channel width-to-depth ratio - ideally toward 12:1
2) A decreasing trend in the average spacing between alluvial and/or forced gravel bars within the active channel, with the ideal being ≤7 times the width of the bankfull channel
3) An increasing trend through time in the mean area and frequency of riffles and gravel bars within the mainstem channel.

These indicators offer a means to quantify trends in channel complexity and interconnectivity beneficial for fish and wildlife species in the San Gregorio Creek watershed.

8.10 Plan Evaluation and Adaptive Management

We will use the data collected by the above monitoring programs to assess progress towards attaining water quality standards and to determine if the implementation actions are on track to achieve water quality objectives. At approximately five-year intervals, Water Board staff will evaluate the implementation actions and monitoring data to determine if additional actions are needed to achieve water quality objectives.

Key questions that will be considered as part of the adaptive management process include:

- Status of steelhead and coho salmon populations in the watershed:
  - What is the population of steelhead and coho salmon in the watershed?
  - Is there an increase in the number or percentage of steelhead that survive past the juvenile rearing life stage as sediment reduction and habitat enhancement measures are implemented?
- Progress toward achieving numeric targets and habitat enhancement goals:
  - Are San Gregorio Creek and its tributaries progressing toward the Plan's numeric targets? If there has not been adequate progress, how might implementation actions, targets or allocations be modified?
  - What are expected benefits of various actions to enhance habitat for steelhead? Which actions, and in which locations, would have the most benefit and be the most cost-effective?
  - Are the specified sediment reduction measures and recommended habitat enhancement measures resulting in an improving trend in channel stability?
  - What effect will climate change have on hydrology, sediment transport, and habitat for the watershed's aquatic species?
  - How will climate change affect the outcome of implementation measures and how should these measures be adjusted in response?
  - Are there new data or information available such that revision of water quality targets or implementation strategy is warranted?
- What feedback are stakeholders providing on what is working, what is not working, what the challenges are, what new information exists that can help guide the adaptive

management process, and updates on the prioritization of next steps to achieve the Plan performance standards?

Adaptive implementation entails modifying actions, as needed, as new information becomes available. The Water Board may propose alternative water quality parameters and/or numeric target values at a future date as part of the adaptive implementation process, should information become available that an alternative parameter or target value provides a superior basis for determining attainment of water quality objectives for sediment and habitat.

If the implementation actions in this Plan do not resolve the impairments to sediment and population and community ecology within 20 years from the date this Plan is accepted through Resolution by the Water Board, then development of a TMDL will be considered.

9.0 LIST OF REFERENCES

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