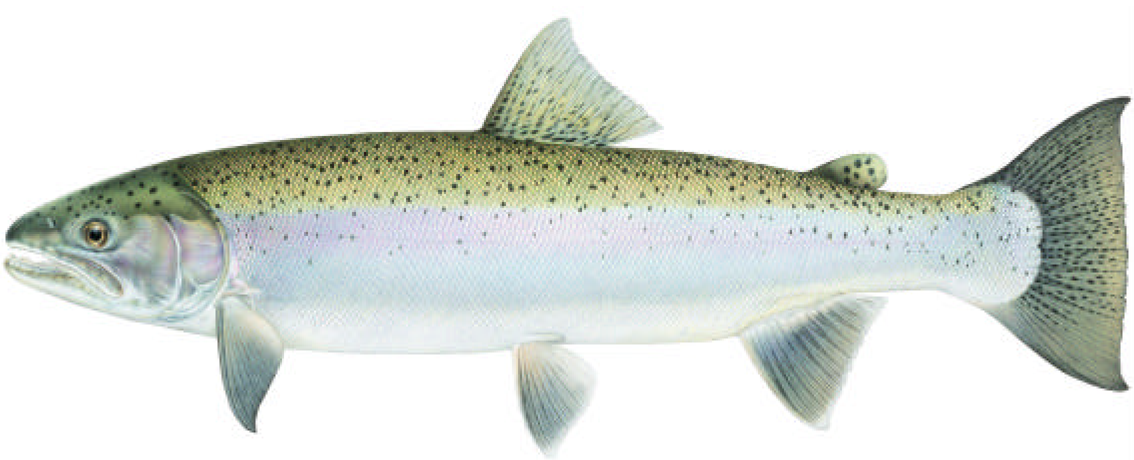
Steelhead Assessment and Recovery Opportunities in Southern Santa Barbara County, California



BY

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and

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Cover Illustration Courtesy of Joe Tomelleri©

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A final word of thanks to the cougar and bear whose paths I crossed, and presence I felt, while exploring their streams and canyons that whisper with the story of the Chumash. To the aromatic bay and twisted sycamore dropping yellow leaves that fly with the kingfisher, heron, and wren. All this above the constant song of the flowing stream and occasional dance of the steelhead.

This report is dedicated to all who use these pages to help open the door to steelhead recovery in southern Santa Barbara County streams and elsewhere. This report is also dedicated to Valerio, the Chumash spirit that inhabits the canyons of upper Mission and Rattlesnake Creeks. And to my family for introducing me to the amazing mystery of streams, which continues to teach me valuable life lessons and always recharge the soul.

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Matt Stoecker, Santa Barbara June 2002 <”))))))><

Executive Summary

Steelhead are migratory rainbow trout (*Oncorhynchus mykiss*) that exhibit an anadromous life history; being born in freshwater streams and spending a portion of their lives in the ocean before returning to freshwater to spawn. During the early 1900's steelhead were abundant in the smaller coastal streams of southern Santa Barbara County. Over the past century, human modification of riverine habitat has devastated steelhead populations in southern California. The National Marine Fisheries Service (NMFS) listed the unique southern steelhead as a federally endangered species in 1997. The NMFS estimates the southern steelhead population to be less than 1% of its historic population size. The southern steelhead population has experienced the most dramatic decline throughout California and likely North America. The loss of freshwater habitat due to the construction of migration barriers such as road crossings, dams, and flood control structures presents the single greatest limiting factor for steelhead in southern Santa Barbara County streams.

The objectives of this study are to identify site-specific restoration actions for wild, southern steelhead in those watersheds from Jalama Creek to Rincon Creek and to prepare a report prioritizing site-specific restoration actions. The primary focus of the study is to identify, prioritize, and formulate recommended actions for migration barriers within the study area.

Due to the large number of unique watersheds within the study area, focal watersheds were identified following a preliminary watershed investigation. Field surveying of focal watersheds was conducted to collect information about salmonid habitat conditions, current salmonid population status, and the location and severity of migration barriers. An extensive data collection and interviewing effort was conducted to develop a comprehensive table of historical and contemporary salmonid sightings for study area watersheds. A Geographic Information System (GIS) database was developed specifically for this project to compile collected data, assess salmonid habitat conditions, analyze migration barrier impacts to steelhead, and prioritize watershed recovery opportunities. Multiple barrier ranking methods were developed specifically for this project to prioritize over 500 identified migration barriers for steelhead passage improvement benefits. These biologically based barrier ranking methods allow prioritization at a watershed and regional level and immediate and long-term scope.

Of 168 stream miles analyzed in this report, 125 stream miles are currently upstream of migration barriers that are impassable or severely impede upstream steelhead migration. The 43 stream miles that are currently available to steelhead generally occur in the lowest reaches of the watersheds where salmonid habitat conditions and stream flows are often inadequate for successful steelhead production. Impassable barriers have completely blocked access to several watersheds and eliminated the steelhead population. Removing or modifying barriers to allow steelhead access to spawning and rearing habitat that is currently blocked was determined to be the highest regional priority and essential first step for steelhead recovery in the study area.

Restoring steelhead access to upstream habitat requires a bottom to top approach. Keystone barriers that are the most downstream barrier blocking or significantly impeding upstream adult steelhead passage were identified in focal watersheds. Steelhead restoration priorities should focus on these keystone barriers prior to steelhead passage projects upstream in their respective watershed. Providing effective upstream steelhead passage at keystone barriers is an essential step to steelhead recovery within each watershed and the region.

The following keystone barriers were identified as the top seven immediate barrier priorities for implementing a project that provides upstream steelhead passage. These barriers are all known to directly impede upstream access to a currently (2000-2002) documented adult steelhead population. Upstream passage at these locations would directly benefit southern steelhead populations. These barriers are listed in descending order of their upstream habitat score (habitat quality multiplied by habitat quantity) that would be immediately available to steelhead with passage provided at that barrier.

1) Gaviota Creek- Northern-most Highway 101 Culvert (CALTRANS)
2) Arroyo Hondo- Highway 101 Culvert (CALTRANS)
3) San Jose Creek- Concrete Channel (S.B. County Flood Control District)
4) Carpinteria Creek- Private Road Crossing (Bliss)
5) Maria Ygnacio Creek- Old San Marcos Road Crossing (S.B. Co. Public Works)
6) Mission Creek- Flood Control Channels (2) (CALTRANS)
7) Las Canovas Creek (Gaviota Creek)- Highway 101 Culvert (CALTRANS)

The following six keystone barriers are also high regional priorities for implementing upstream steelhead passage projects. These barriers occur in watersheds that have existing or historic salmonid documentation and may currently impede upstream steelhead migration. These barriers are also listed in descending order of their available upstream habitat score.

1) El Capitan Creek- Highway 101 Culvert (CALTRANS)
2) Corral Creek- Highway 101 Culvert (CALTRANS)
3) Montecito Creek- Flood Control Channel (Casa Dorina)
4) San Ysidro Creek- Pipeline (Montecito Water) and Debris Basin Dam (S.B. Co.)
5) Dos Pueblos Creek- Flood Control Channel (Shulte)
6) Rincon Creek- Highway 101 Culvert (CALTRANS)

Site-specific recommended actions for steelhead passage at individual barriers is detailed in this report along with specific barrier analysis and photographs. The steelhead passage projects pursued for barriers should be the most effective, long-term, self-sustainable, alternative that consistently allows upstream passage without dependence on human maintenance, while helping to restore other important aquatic functions. While many other factors will help improve riverine habitat conditions and long-term steelhead sustainability, steelhead recovery cannot occur without providing access to habitat currently blocked by migration barriers. Implementing recommended actions outlined in this report would help to lay the foundation for southern steelhead recovery in southern Santa Barbara County.

Steelhead recovery is dependant on cooperating with all interested parties, promoting the positives, understanding the perspective of others, and being respectful of the role each of us play in the challenging job of welcoming the elusive steelhead home.

Chapter 1: Introduction and Background

1.0 Introduction

Prior to European arrival, native Chumash tribes maintained a high quality of life while inhabiting the biologically diverse coastline adjacent to the Santa Barbara Channel and around Point Conception. Uniquely adapted steelhead trout (*Oncorhynchus mykiss*), an integral component of this biologically diverse area, inhabited the streams in Chumash territory. Each year, tens of thousands of steelhead left the hunting grounds of the Pacific Ocean to ascend the productive streams where life began. "Freshwater fishing…was of very little importance (to the Chumash), except for the exploitation of annual steelhead trout runs during the rainy season…" (Landberg, 1965). These annual runs of large adult steelhead brought with them a huge amount of nutrients obtained while feeding in the Pacific Ocean. This connection between land and sea, and the immense transfer of oceanic nutrients inland, was accomplished in the form of steelhead. No other creature within the region so effectively brought the rich bounty of the ocean onshore to be spread throughout the region's watersheds. This annual pulse of nutrients inland revived the biotic community of the watershed, and benefited many life forms throughout the region.

With the arrival of Europeans came the extensive modification of the region's riverine ecosystems. The construction of migration barriers, water extraction, and alteration of riparian and aquatic habitats led to the elimination of steelhead in most southern Santa Barbara County streams. This broken link between land and sea has had a devastating impact on the natural environment and quality of life in southern California. Due to the uniqueness of the southern steelhead and their near extinction, the National Marine Fisheries Service listed the southern California steelhead Evolutionarily Significant Unit (ESU) as endangered in 1997. The southern steelhead is currently the most endangered steelhead ESU in all of California and likely North America. It is estimated that the current steelhead population size in southern California is less than 1% of its historical size. The construction of migration barriers that prevent steelhead from accessing freshwater streams that provide essential spawning and rearing habitat is the primary reason for this dramatic decline in steelhead.

Steelhead recovery planning and restoration actions have focused primarily on the larger river systems in southern California. The smaller coastal streams of southern Santa Barbara County have been largely overlooked for their steelhead recovery potential. Not only do these streams offer tremendous steelhead potential, but effective restoration of self-sustainable, wild steelhead populations to these streams is usually less complex than on the larger rivers, where major dams and water projects exist. Many of the smaller streams discussed in this report offer relatively straight forward steelhead recovery opportunities that can help kick start regional steelhead recovery and provide a source of steelhead for future recolonization of other watersheds throughout southern California.

The objectives of this project are to:

- Identify site-specific restoration actions for wild, southern steelhead in those watersheds from Jalama Creek to Rincon Creek.
- Prepare a report prioritizing site-specific restoration actions.

This report is set up so that topics such as salmonid habitat conditions, migration barriers, and salmonid documentation are each grouped in their own section. Each section describes methods used to analyze information about the particular topic and presents the results of the analysis. For example, the methods used to identify, assess, and rank migration barriers are discussed in the barrier section. Also discussed in this section are the actual findings and recommendations. This format allows readers to more easily understand how specific findings were obtained within that particular section without referring to various sections throughout the report that each compiles the various methods, findings, and results of the project. Recommended actions for specific steelhead migration barriers are discussed within each individual watershed section. Users that are only interested in one watershed can easily obtain all the recommendations compiled for that watershed. The subsequent sections of this report outline background information about steelhead, methods used, study findings, and prioritized, and site-specific recommended actions that will benefit southern steelhead. This introductory section also provides important information about the ecology and life history of steelhead. Section 2.0 provides information on methods used to identify focal watersheds within the study area and outlines the results of those finding. Section 3.0 describes the methods used for developing a unique GIS database for this project and presents summary tables and maps resulting from this effort. Section 4.0 describes the field surveying techniques utilized in the study and coordination of access public and private land. Section 5.0 describes the methods used to inventory and assess salmonid habitat conditions and presents the results of that effort. Section 6.0 describes the methods used to collect salmonid population information within the study area and presents the results of this effort. Section 7.0 describes the methods used to identify, assess, and prioritize steelhead migration barriers and presents prioritized, site-specific recommendations for barriers within each focal watershed. Section 8.0 describes the methods developed to prioritize keystone barriers within the study area and presents the results of this prioritization. Section 9.0 summarizes habitat conditions for each focal watershed and describes the method used to prioritize these watersheds based on their steelhead recovery potential. Section 10.0 lists references utilized during the project.

1.1 Steelhead Ecology and Life History

1.1.1 Historic Distribution and Population Size

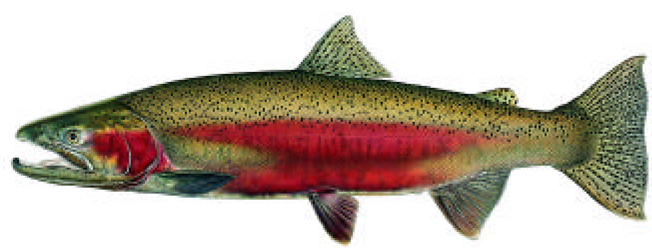

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Figure 1.1
Male steelhead in spawning coloration
Courtesy of Joe Tomelleri

In recent history, steelhead ascended streams from northwestern Mexico up to the Kuskokwim River, Alaska and across the Bering Sea to the Kamchatka Peninsula and Okhostk Sea drainage's of the Western Pacific (Barnhart, 1986). The current southern limit of steelhead and coastal rainbow trout distribution occurs somewhere in northern Mexico. Populations of southern steelhead existed in almost all of the significant watersheds within Santa Barbara and Ventura Counties, with the largest runs of adult steelhead occurring in the Santa Ynez, Santa Clara, Santa Maria and Ventura Rivers. Of these rivers, the Santa Ynez is thought to have had the largest population of steelhead in all of southern California with estimates of 13,000 to 25,000 adults returning in the 1943-1944 run (Titus, 1994). Moore (1980) estimated the historical steelhead run up the Santa Clara River at around 9,000 adults. Estimates for the 1946 run up the Ventura River are between 4,000 and 5,000 adults (Clanton and Jarvis, 1946). Steelhead are known to have historically inhabited many of the smaller coastal watersheds in southern Santa Barbara County draining into the ocean between the Santa Ynez River and the Ventura River. While historic estimates of adult steelhead run size do not exist for these smaller streams, their combined annual run size was likely in the thousands due to the comparison of the combined quantity of these many streams and the quantity of stream miles in the larger rivers of the region. Since the beginning of the century it is estimated that steelhead populations have been reduced to less than one percent of their former population size in southern California.

Figure 1.1.1
Historic steelhead distribution in North America
Courtesy of worldwaters.com

1.1.2 Geographic Variability

Environmental conditions are dramatically different throughout the steelhead's range in North America. In Alaska and British Columbia, steelhead rivers may be glacial fed, are very cold, usually perennial, and often hundreds of miles long. Southern California steelhead streams, on the other hand, may be spring fed, much warmer, intermittent in reaches, and only a few miles long. Similarly, the ecological requirements and life histories of the steelhead utilizing these environments also differ. Virtually all studies of steelhead ecology have been conducted on northern populations and little has been published about the ecological requirements of southern steelhead. Despite the minimal amount of technical data, it has been widely observed that southern steelhead do indeed exhibit unique ecological requirements and behaviors, such as temperature requirements, duration of different life stages, environmental flexibility, and displaying polymorphic life history behavior. Many aspects of steelhead ecology are similar throughout their range and are well documented. Additionally, rainbow trout that do not become steelhead share many of the same ecological requirements with their anadromous relatives and appear to play a vital role in the sustainability of the anadromous steelhead population. The important relationship between non-anadromous rainbow trout and anadromous steelhead is well described by McEwan (2001) and should be referenced for additional information about the polymorphic life history behavior of rainbow trout/steelhead that is critical for resource managers to understand for successful long-term recovery planning.

1.1.3 Genetic Uniqueness and Importance

Steelhead have excellent homing abilities, so unique stocks or races have developed in specific drainages and in some cases tributaries of that drainage (Moyle, 1976). A 1994 study by Jennifer Nielsen found that the southern steelhead are genetically unique from northern stocks and actually have greater genetic diversity. This greater level of genetic diversity indicates that southern steelhead have evolved over a longer period of time and are a more ancestral population than northern steelhead. Recognizing the uniqueness and importance of the devastated southern steelhead population, the National Marine Fisheries Service listed the southern steelhead as an endangered species, under the federal Endangered Species Act, in August of 1997.

1.2 Steelhead Life History

1.2.1 Spawning

Steelhead spawn in cool, clear, well-oxygenated streams with suitable depth, current velocity, and gravel size (Reiser and Bjornn, 1979). This habitat type is usually associated with the upper reaches of streams and their tributaries. The optimal water depth for steelhead spawning is approximately 14 inches and ranges from about 6 to 36 inches (Bovee 1978). When a pair of adult steelhead reaches adequate habitat conditions during the spawning run, the female will clear out a depression (redd) in the small to medium sized gravel substrate, where her eggs are laid. The male defends the redd from intruders and fertilizes the eggs as the female extrudes them (Shapovalov and Taft, 1954). The female then covers the eggs with a shallow layer of gravel to protect and stabilize them in their embryonic state.

Figure1.2.1
Pair of steelhead spawning in Mission Creek
Note the cleared out redd
Courtesy of C. Fusaro

1.2.2 Egg and Larval Development

The duration and success of egg incubation is highly variable and dependent on a number of factors including water temperature, dissolved oxygen concentration, and suspended sediment deposition. Eggs hatch into a larval stage (alevin) where they remain in the redd and feed on their attached yolk sack. Alevins are approximately 14.0 millimeters long when they are hatched and grow to 28.0 millimeters before becoming juveniles, at which point they have already absorbed the yolk sac and leave the protection of the redd (Wang, 1986). The egg and larval stages of steelhead development are highly susceptible to environmental factors, and most natural mortality occurs at this time (Shapovalov and Taft, 1954).

Figure 1.2.2
Incubating eggs and alevins emerging from gravel

1.2.3 Juvenile Development

Young juvenile steelhead (fry) often school together in shallow, protected areas along the stream banks. Fry are carnivorous and feed primarily on aquatic and terrestrial insects. As they grow, fry become territorial and soon the school breaks up and many of the fry move into riffles that they will inhabit and defend. Fry tend to move into deeper water as they grow in size, inhabiting runs and pools (Barnhart, 1986). Juvenile steelhead are highly variable in length (2.8 cm.- 40.6 cm.) and usually stay in fresh water for one year or more (Scott and Crossman, 1973). The length of juvenile residence is determined by environmental and genetic factors. Southern steelhead tend to exhibit a high amount of flexibility in residence time due to the extreme and highly variable environmental conditions which exist throughout its range. Juvenile steelhead may remain in freshwater as coastal rainbow trout, mature, and spawn without ever migrating to sea. Similarly, rainbow trout offspring may produce young that migrate to the ocean to become steelhead. See McEwan (2001) for more about the polymorphic life history of rainbow trout/steelhead.

Figure 1.2.3
Santa Ynez River Fry
Courtesy of S. Englblom

1.2.4 Smoltification

Juvenile steelhead lose their dark oval parr marks along their sides and acquire a silver coloration when they undergo a drastic physiological change called smoltification, which allows them to migrate from freshwater to the saline ocean. Smolting steelhead often display a dark tailing edge on their caudal, or tail, fin and have flaky silver scales. On the Santa Ynez River, Scott Engblom's research has found that outmigrating smolts measure between 150-200 mm in total length and are predominantly in the 160-170 mm range. Engblom found that most of the smolting fish are 1 year olds, but some are 2 years old (pers. comm. Engblom).

Figure 1.2.4
Santa Ynez River Smolt
Cour*tesy of S. Englom*

When favorable conditions exist, smolts leave their former stream habitat and may spend a period of time in an estuarine or freshwater lagoon environment before entering the ocean. Outmigration of smolts on the Santa Ynez River typically occurs between mid-March and early May (pers. comm. Engblom). Due to the highly variable climatic conditions and flow regimes that exist in southern California, smolts may spend a considerable amount of time in the lagoon or slough habitat found at the stream mouth. It is here where smolts, acclimate themselves to salt water and often times wait for adequate flow conditions to open the mouth of the stream allowing migration to the ocean.

1.2.5 The Ocean Odyssey and Adulthood

Smolts gradually attain the steel-blue back coloration of sub-adults while feeding on the bounty of the northern Pacific Ocean. Some steelhead migrate extensively while feeding at sea and fish born in North American streams have been caught off the coast of Japan. Steelhead are also know to have short oceanic or only estuarine migrations. By utilizing abundant oceanic food sources such as juvenile greenling, squid, and amphipods, the majority of steelhead growth occurs in the ocean (LeBrasseur 1996; Manzer 1968). While at sea, southern steelhead can attain large sizes. Reports from the early 1900's related the popularity of fishing the lower Santa Ynez River for steelhead as large as 9 kg (20 lbs.). The range in size of returning steelhead is highly variable and dependant on many factors such as the duration of time spent in the ocean, abundance of prey, and individual hunting skill. Steelhead returning to freshwater for a second time or more are typically the largest returning fish. On the Santa Ynez River, Engblom has recorded adult steelhead from 14 to 28 inches in length (pers. comm. Engblom). Documentation collected and reported in this study shows similar variability in the smaller coastal streams with documented steelhead up to 30 inches in length. Sexual maturity is obtained while southern steelhead are at sea and with this comes adulthood and the eventual urge to return to freshwater streams and spawn. Steelhead have excellent homing abilities and can effectively locate their stream of origin from thousands of miles away by methods not yet fully understood to science. It is believed that celestial navigation, the magnetic pull of the earth, and the ability to smell out individual river chemistry all contribute to guiding adult steelhead back to their natal streams.

1.2.6 The Spawning Run

Due to drought and/or human-related activities, southern steelhead are often impaired or blocked from accessing their natal streams due to low flow conditions. It appears that when faced with this prospect southern steelhead adapt, and either delay their upstream spawning migration until adequate flows exist or enter and ascend another suitable stream nearby. This action of straying from their stream of birth appears to be an important survival technique for a species whose freshwater habitat is dependant on extremely variable climatic conditions and human competition for resources, which may effectively eliminate upstream migration for a number of years. Straying also provides the mechanism for steelhead to recolonize watersheds where steelhead have been extirpated due to natural or human factors.

When favorable flow conditions exist, adult steelhead enter the lagoon, slough, or stream mouth to begin their upstream migration. Steelhead can enter the stream any time flows permit, but in southern California this generally occurs following sizable rainfall events during late fall, winter, and early spring and is dependant on the stream flow discharge of that particular season. During years with higher stream flows, steelhead have a larger window of opportunity to migrate upstream.

Once again acclimated to the fresh water, steelhead begin their upstream migration toward the headwaters of the watershed where the higher quality spawning and rearing habitat is usually located. During this journey upstream, steelhead utilize many aspects of the riverine habitat, both terrestrial and aquatic. Trees and bank side vegetation are used for shade and protective cover. To minimize energy outputs steelhead follow the path of least resistance upstream. They accomplish this by utilizing submerged structures for protection from the current and by effectively reading the variable stream velocities provided by their riverine environment.

Figure 1.2.6
Adult southern steelhead preparing to spawn
Courtesy of S. Englblom

After a short while in fresh water, the silvery adult steelhead begin to take on the appearance of large rainbow trout and exhibit other morphological changes such as jaw configuration; which become more pronounced in the males. Spawning males usually have an elongated jaw and snout that are turned inward toward the mouth. The hooked lower jaw is called a kype. Adult males usually become more colorful than the females in freshwater. As spawning nears, the males often display bright pink gill covers and a lateral stripe of similar color. Steelhead spawning characteristics, and the degree to which they change, are variable throughout their range. Southern steelhead usually spawn shortly after ascending the stream to suitable spawning habitat. Unlike Pacific salmon, steelhead may not die after spawning and can return to the ocean, regain lost body weight, and enter the stream again as a larger repeat spawner during the following season(s). Steelhead may repeat this cycle several times in their life.

1.3 Environmental Factors Affecting Steelhead

Environmental factors such as barriers to migration, in-stream sediment, water temperature, water depth, dissolved oxygen, and water movement have profound influences on steelhead survival. These environmental factors vary among watersheds over time and are influenced by natural environmental conditions and human practices. The ecological requirements steelhead have for these factors vary with respect to origin (hatchery or wild), geographic varieties (i.e. southern vs. Alaskan), and among individuals within a population. The harsh environmental conditions that occur in southern California streams have led to adaptations and ecological requirements that are unique among steelhead populations found elsewhere in northern Pacific watersheds.

1.3.1 Barriers to Migration

While in fresh water steelhead are highly mobile, utilizing optimal aquatic habitats within a stream as conditions change over time. Steelhead occupy a variety of stream habitats from the headwaters to the mouth, as both migratory corridors and habitat for rearing and spawning. Barriers to migration between these habitats have proved disastrous to steelhead populations throughout their range. Types of barriers include dams, culverts, diversions, flood control channels, flow dynamics, water quality, and natural features such as waterfalls. Barriers lead directly to the fragmentation of steelhead habitat and may completely eliminate anadromous steelhead from accessing a stream to spawn.

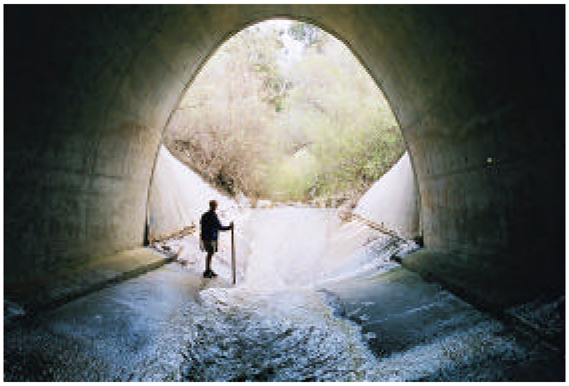

Figure 1.3.1
Rincon Creek Highway 101 Culvert

Fragmentation of habitat has drastic effects on steelhead populations by reducing available habitat and increase genetic isolation. Reducing available habitat correlates directly to the reduction in population size of the species using that habitat (Netti, 1997). The upstream habitat blocked by barriers is usually the most optimal and critical for steelhead survival. Steelhead utilize the lower mainstem of most streams as migration corridors to access the spawning and rearing habitat in the headwaters, and to get back to the ocean. The vast majority of the steelhead's freshwater life is typically spent in the upper reaches of a stream or tributary where suitable habitat exists for spawning and rearing. Genetic isolation encourages inbreeding within a population and can reduce the genetic diversity of a population and species. Ecological studies have shown that high genetic diversity within a species or population correlates to the ability of the population to adapt to slow changes in environmental conditions and to survive environmental catastrophes common to southern California (i.e. fires, floods, and droughts). The reduction in genetic diversity through inbreeding also reduces the ability of steelhead populations to recover from disease.

It has been reported that 7 inches is the minimum depth required for successful migration of adult steelhead (Thompson 1972, as cited in McEwan 2001), although the distance fish must travel through shallow water areas is also critical. Water depth can be a significant barrier or impedance in streams that have been altered for flood control purposes (McEwan 2001). The CDFG Habitat Restoration Manual reports that an adult steelhead can maintain a maximum swim speed of 6.0 ft/sec. for 30 minutes until exhaustion and a maximum burst speed of 10.0 ft/sec. for 5 seconds until exhaustion. The maximum leap, or jump, speed is listed as 12 ft/sec. Jumping upstream of a structure becomes difficult or impossible when the jump pool depth becomes less than 1.25 times the jump height of the structure from the pool surface. For example, a barrier than has a vertical height of 4 feet above the surface of the downstream pool, which has a jump pool depth of 5 feet, will be near the maximum jumping capability of an adult steelhead. Should the pool become shallower, the jump depth would decrease and the jump height would increase, likely resulting in an impassable structure.

1.3.2 In-stream Sediments

The fresh water environment of steelhead is adversely affected by suspended and deposited sediment. Sigler (1984) observed that chronic turbidity in streams during emergence and rearing of steelhead negatively affects the number and quality of fish produced. Suspended sediments can cause physiological damage to steelhead at concentrations of 3,000 parts per million or greater; these include: adhesion of silt particles to the chorion of salmonid ova (Cordone and Kelley, 1961), abrasion, thickening, and fusion of gill filaments (Herbert and Merkens, 1961).

Figure 1.3.2
Excessive sediment from Casitas Creek entering Rincon Creek

As suspended sediments settle out of the water column they become bedload sediments. These deposited sediments have a number of adverse impacts on steelhead and can drastically reduce the salmonid carrying capacity of a stream. Cordone and Kelley (1961) observed that when sediments settle out of suspension they frequently cover essential spawning sites, cover eggs, prevent emergence of recently hatched young, and decrease the amount of shelter available to fry that were able to hatch. Deposited sediment also reduces the production of aquatic insects that are essential prey to steelhead survival.

Excessive sedimentation alters the entire hydrology of a watershed leading to channel widening, loss of the pool-riffle sequence, reduced pool depth, and decreased stability of substrate and banks (Barnhart, 1986). This degradation of aquatic habitats drastically lowers the capacity of a stream to rear juvenile steelhead to smolts.

1.3.3 Water Temperature

Water temperature affects steelhead during all life stages. Water temperature affects all metabolic and reproductive activities including: incubation time of eggs, development, growth, swimming, and ability to capture and assimilate food (Tebo, 1974). Bovee (1978) gives the temperature range for the incubation of eggs between 0 and 24 degrees Celsius. The time it takes for eggs to develop is dramatically reduced with a decrease in water temperature. Observations of egg development have shown that at 15 degrees Celsius eggs hatch in 19 days and at 5 degrees Celsius eggs hatch in 80 days (Barnhart, 1986).

Elevated summer and fall temperatures seem to be a significant factor in southern steelhead survival. Climatic conditions combined with human impacts such as the removal of shade sources and reduced stream flows can elevate temperatures to lethal levels. Optimal temperature requirements may vary, depending on the season and life stage, and while much is known about the effects of water temperature on northern populations with different climates and environments it appears little research has been conducted specifically on southern steelhead water temperature limits. It is known that southern steelhead populations exhibit a high amount of flexibility and tolerance to higher temperatures. Rainbow trout/juvenile steelhead presence has been observed in Santa Barbara County streams with water temperatures greater than 81 F (pers. observ. Stoecker).

The effects of water temperature on dissolved oxygen, disease, and water pollutants have also been observed. Hooper (1973) noted that steelhead have difficulty extracting oxygen from water with temperatures greater than 21 degrees Celsius, regardless of the amount of oxygen present. Elevated water temperature also appears to increase the virulence of many fish diseases and the toxicity of most chemicals (Lantz, 1971).

1.3.4 Stream Depth

Stream depth provides steelhead with shelter from extreme water temperatures, excessive water velocities, and predation. Southern California streams are often subjected to low flow conditions due to drought, water extractions, and the annual summer-fall dry season. Survival during dry season stream conditions is believed to be a major limitation to steelhead and adequate depth is essential for survival (Douglas, 1995). Pools provide depth and habitat that is critical to steelhead survival during the dry season. An abundance of large pools has been shown to be an important characteristic in healthy aquatic ecosystems. In a small coastal California stream, Cross (1975) found that 67%-96% of young-of-the-year steelhead resided in pools. Loss of pools due to excessive sediment input and filling can greatly reduce a streams capacity to rear steelhead to smolt size (Barnhart, 1986).

Figure 1.3.4
Excellent pool habitat on upper San Ysidro Creek

1.3.5 Dissolved Oxygen

Adequate amounts of dissolved oxygen are required by steelhead during all stages of their life. While in fresh water, steelhead require high amounts of dissolved oxygen in the water column and intragravel waters. Resner and Bjorn (1979) observed that dissolved oxygen be, at least, 80% of saturation for successful spawning to occur. Embryonic and alevin survival is highly dependent on intragravel dissolved oxygen and concentrations of less than 7.2 mg/L can cause total mortality (Reiser and Bjornn, 1979).

1.3.6 Water Movement

Water movement affects spawning, egg and fry development, migration and habitat preference. Reiser and Bjornn (1979) observed that steelhead spawn in moving water between 15 and 110 cm/sec. Productive spawning grounds are associated with highly permeable substrate that keeps eggs well oxygenated during incubation. Increased intragravel velocities within the spawning gravels improve the survival of steelhead eggs and fry before emergence and also the condition of the fry that emerge (Shumway 1960; Silver 1960; Coble 1961). Habitats with increased current speeds and turbulence usually contain higher dissolved oxygen and food levels and when steelhead have access they preferred such habitat, particularly under conditions of oxygen stress at higher temperatures (White 1991; Hill and Grossman, 1993). Reiser and Bjorn (1979) observed that water velocities of 3-4 meters per second begin to greatly hinder the swimming ability of steelhead and may retard migration.

1.4 Study Area

The study area of this project is a watershed-defined region extending from the Rincon Creek watershed, west to the Jalama Creek watershed. The entire study area occurs in southern Santa Barbara County except for the eastern half of the Rincon Creek watershed. The boundary line between Santa Barbara and Ventura County occurs along the centerline of Rincon Creek. With the exception of Jalama Creek, all the streams in the study area drain south off of the Santa Ynez Mountain Range and into the Santa Barbara Channel. Jalama Creek drains in a westerly direction north of Point Conception and the western end of the Santa Ynez Mountain Range.

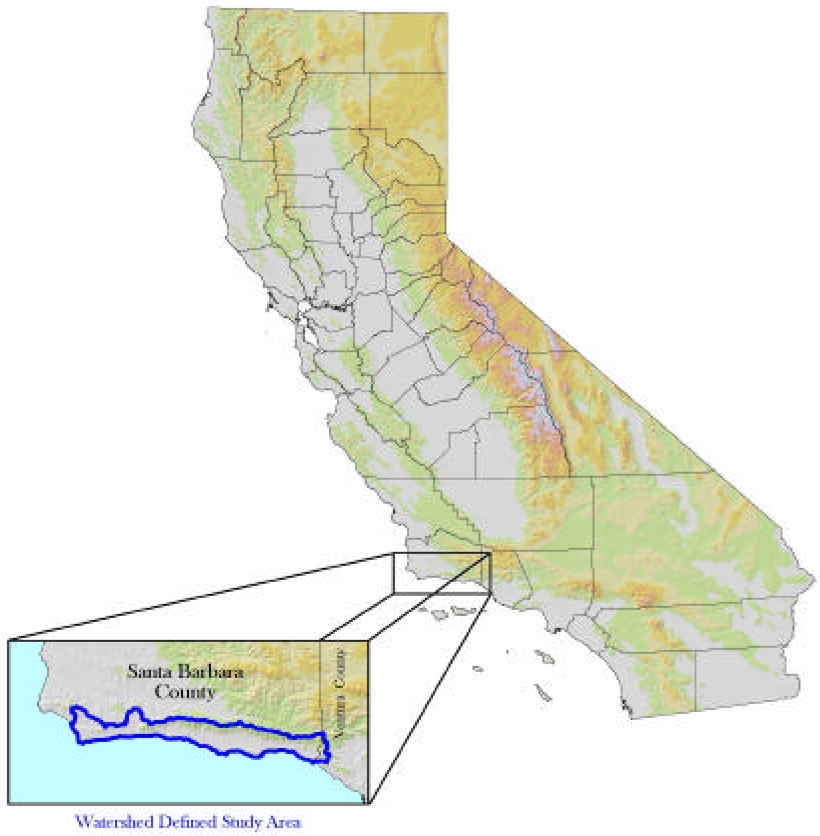

Figure 1.4

The varied geologic, topographic, and climatic features of the region contribute to a rich distribution of biodiversity throughout a wide range of plant and animal communities. Point Conception and the crest of the Santa Ynez Mountains are often characterized as the biological dividing line between northern and southern California due to the climatic and oceanographic changes that occur there. An intermingling of northern and southern plant and animal species occurs in this unique transitional area. About 1400 species are native to this region and of these, more than 140 species are endemic. California is unique among the nation's states due to its wide variety of ecosystems. As noted above, the southern steelhead that inhabit the region are also unique within the state.

1.5 Project Objectives

Identify site-specific restoration actions for wild, southern steelhead in those watersheds from Jalama Creek to Rincon Creek. Prepare a report prioritizing site-specific restoration actions.

1.6 Project Team

Matt Stoecker – Ecological Consultant and Steelhead Project Manager
Ethan Inlander – CCP Science Program Manager
Cory Gallipeau – CCP GIS Technician
James Studarus – CCP Operations Manager
Shaw Allen – Research Assistant
Nikolai Ferrell – Research Assistant

Chapter 2: Watershed Evaluation and Focal Watershed Identification

2.0 Preliminary Watershed Evaluation and Identification of Focal Watershed

Due to the high number of unique watersheds occurring within the study area, focal watersheds were identified at the beginning of the study in order to direct project efforts toward the watersheds that appeared to have the highest potential for steelhead production and recovery, assuming adequate migratory access to the watershed was eventually provided. The focal watershed ranking method was developed, and information collected, during a preliminary watershed inventory.

2.1 Preliminary Watershed Evaluation

A preliminary watershed inventory was carried out with the study area to collect existing information on the watersheds, identify current steelhead restoration projects or stakeholder interest, compile historical and contemporary documentation of salmonids in the study area, and estimate the steelhead recovery potential of the watersheds. Knowledgeable individuals with various backgrounds, groups, and agencies were interviewed to determine what data and previous assessment work existed. A course field overview was also conducted along public transportation routes, on public land, and also by air thanks to several days worth of donated airplane use and piloting time. The GIS Database was also being developed during this time and preliminary information regarding watershed size and public ownership was developed.

2.2 Identification of Focal Watersheds

Following the preliminary watershed evaluation, many of the small, ephemeral drainages that would offer minimal, or no, salmonid habitat were eliminated from further investigation. Several of these drainages did not actually have streams, but rather small gullies that do not sustain surface flow except during heavy rainfall events. Out of all the many unique watersheds within the study area, a first round cut of 44 watersheds and sub-watersheds that were believed to have adequate habitat to sustain salmonids were ranked using a focal watershed ranking method. Some of the watersheds excluded in the first cut may have a limited amount of potential for salmonids during wet years, but production would likely be very limited due to the apparent lack of perennial habitat, and/or minimal stream length. The Goleta Slough Watershed was broken up into three sub-watersheds in order to analyze these distinct sub-watersheds within the larger Goleta Slough Watershed individually. Watershed attributes that were collected in the field or developed using the GIS were then compiled and the 44 watersheds were ranked using the focal watershed ranking method described below.

2.2.1 Focal Watershed Ranking Method (Stoecker)

The focal watershed score was obtained by adding a salmonid documentation score to a watershed/steelhead recovery potential score. The diagram outlining the focal watershed ranking method and components that make up the focal watershed score are described below.

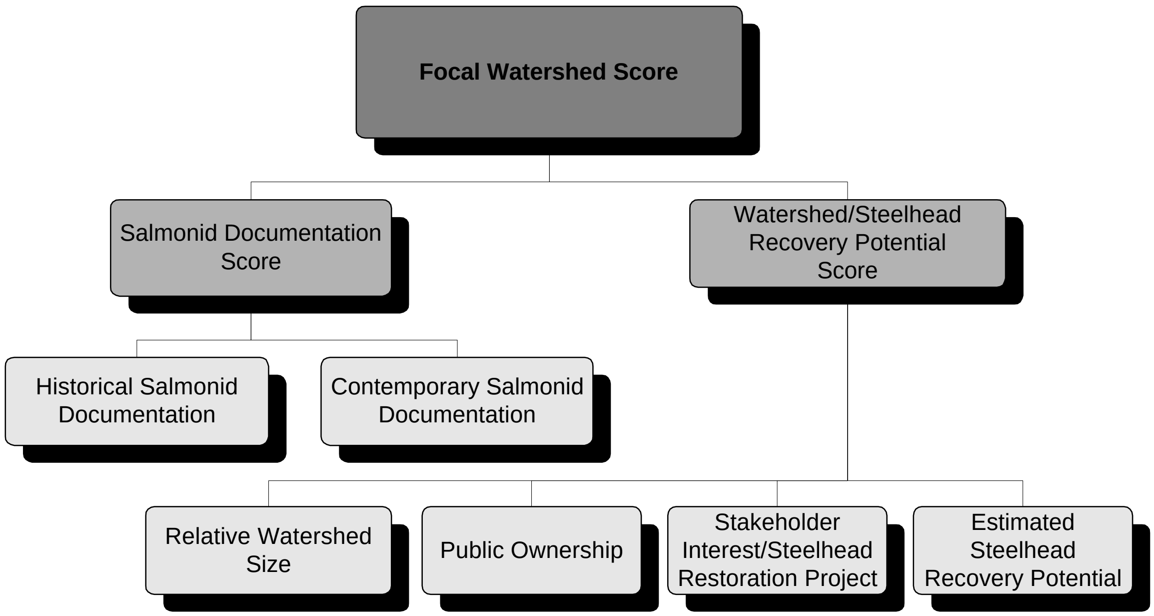

Figure 2.2.1

2.2.1.1 Preliminary Salmonid Documentation Subtotal

Watersheds with historical and contemporary salmonid documentation, collected in the preliminary watershed evaluation, received a higher score than those with only historical documentation or no salmonid documentation. With the exception of a few Pacific salmon documentations, all salmonid sightings in the study area are believed to be coastal rainbow trout/steelhead (*Oncorhynchus mykiss*). The term salmonid is used to describe all life stages of *O. mykiss* and other Pacific salmon species documentation, which in some cases may have been misidentified adult steelhead. Additional points were given to watersheds with contemporary salmonid documentation because the recent presence of salmonids indicates that the watershed is capable of providing adequate habitat conditions for native rainbow trout and steelhead. An arbitrary, but commonly applied, total length of 16 inches was used to separate sightings of presumed anadromous steelhead (greater than 16 inches) in order to give additional value to watersheds where their presence has been documented. A maximum salmonid documentation score of 5 points was possible for a watershed and determined by adding points for the following type of documentation collected during the preliminary watershed evaluation:

1.0- Historical (pre-1980) documentation of salmonid(s) <16 inches.
1.0- Historical (pre-1980) documentation of salmonid(s) ≥16 inches.
1.0- Contemporary (post-1980) documentation of salmonid(s) <16 inches.
2.0- Contemporary (post-1980) documentation of salmonid(s) ≥16 inches.

2.2.1.2 Watershed/Steelhead Recovery Potential Subtotal

The watershed/steelhead recovery potential score was obtained by adding the watershed scores applied for relative watershed size, public ownership, presence of stakeholder interest/steelhead project, and estimated steelhead recovery potential. These components are described below.

2.2.1.3 Relative Watershed Size

One basic principle of ecology is the positive correlation between the population size of a species and the size of adequate habitat available. For this reason, a larger watershed, presumably with a greater quantity of aquatic habitat for steelhead, received a higher score than a smaller watershed. In the absence of direct field surveying to determine habitat quality, this method was determined to be a suitable way to estimate habitat size during this preliminary assessment phase of the project. The relative size of each watershed was determined using the GIS to calculate the acreage of each watershed and then divide the size of each watershed by the largest watershed in the study area (Jalama Creek). Relative watershed size scores ranged from 0.06 to 1.00 (Jalama Creek). The combined sub-watersheds of the Goleta Slough Watershed comprise the largest true watershed in the study area.

2.2.1.4 Public Ownership

Watersheds with a higher percentage of public ownership received a higher score than watersheds with a smaller percentage of public ownership. Private ownership is not necessarily viewed as a negative in terms of steelhead recovery in a watershed, but with limited preliminary knowledge of private landowner interest in steelhead recovery, a higher amount of public ownership was thought to be a positive for implementation of potential steelhead recovery efforts. In some situations, steelhead recovery efforts on private lands may be more readily implemented than on public property. The percentage of public ownership for each watershed was determined using the GIS. Public ownership scores ranged from 0-0.82 (Arroyo Quemado). See the final Publicly Owned Lands Summary Table for updated public ownership percentages (section 3.0).

2.2.1.5 Stakeholder Interest/Steelhead Project

Future steelhead restoration efforts may be more readily implemented in watersheds with stakeholder support for steelhead recovery. For example, the strong desire of citizens in the City of Santa Barbara to reestablish a run of steelhead in Mission Creek may help to move naturalization of the lower creek’s concrete channels forward, despite the enormous cost of such a project. Watersheds where stakeholder interest in steelhead recovery was noted or a steelhead recovery project was identified, in the preliminary watershed evaluation, received a score of 1.0.

2.2.1.6 Estimated Steelhead Recovery Potential

After the preliminary watershed evaluation was completed and information was compiled and reviewed, the project manager and project expert researcher applied an estimated steelhead recovery potential score to each watershed based on collective knowledge of each stream and estimations of the watershed’s ability to support steelhead in its current state, should migratory access be provided or improved. A maximum estimated steelhead recovery potential score of 2.0 was possible and based on one of the following designations:

0.0- Watershed estimated to have very low steelhead recovery potential.
0.5- Watershed estimated to have low steelhead recovery potential.
1.0- Watershed estimated to have fair steelhead recovery potential.
1.5- Watershed estimated to have good steelhead recovery potential.
2.0- Watershed estimated to have excellent steelhead recovery potential.

2.3 Focal Watershed Results

A maximum focal watershed score of 10 points was possible. Watersheds that scored 5.0 or greater were identified as primary focal watersheds and received the highest project focus within the study area. Watersheds that scored between 2.0-4.99 were identified as secondary focal watersheds that would receive a high project focus, depending on time restraints and access limitations. Watersheds that received a score of less that 1.99 were identified as non-focal watersheds and were not included in additional study efforts, except compilation of regional salmonid documentation and limited migration barrier identification. The following table shows the results of the preliminary focal watershed ranking.

Focal Watershed Identification Table
Initial methodology used to identify watersheds for detailed study

WATERSHED NAME	STREAM CODE	Historical Documentation of Salmonid(s) < 16"	Historical Documentation of Salmonid(s) ≥ 16"	Contemporary Documentation of Salmonid(s) < 16"	Contemporary Documentation of Salmonid(s) ≥ 16"	Salmonid Documentation Subtotal (A)	Relative Watershed Size (Maximum = 1.0)	Public Ownership (% 0-1.0)	Stakeholder Interest / Steelhead Project (1)	Estimated Steelhead Recovery Potential (0 - 2)	Watershed / Salmonid Recovery Potential Subtotal (B)	Focal Watershed Score (A+B)	Focal Watershed Category (1=Primary, 2=Secondary, 0=Non-Focal)
Rincon	RN	1	0	1	0	**2**	0.60	0.59	1	1.5	**3.69**	**5.7**	**1**
Carpinteria	CA	1	0	1	2	**4**	0.62	0.58	1	2.0	**4.20**	**8.2**	**1**
Franklin	FN	0	0	0	0	**0**	0.18	0.03	0	0.0	**0.21**	**0.2**	**0**
Santa Monica	SM	0	0	0	0	**0**	0.15	0.05	0	1.0	**1.20**	**1.2**	**0**
Arroyo Paredon	AP	0	0	1	0	**1**	0.19	0.17	1	1.0	**2.36**	**3.4**	**2**
Toro	TR	0	0	0	0	**0**	0.15	0.18	0	0.0	**0.33**	**0.3**	**0**
Romero	RO	0	0	0	0	**0**	0.24	0.37	0	1.0	**1.61**	**1.6**	**0**
San Ysidro	SY	0	0	1	0	**1**	0.16	0.49	0	1.0	**1.65**	**2.7**	**2**
Montecito	MO	1	0	1	0	**2**	0.28	0.48	1	1.5	**3.26**	**5.3**	**1**
Sycamore	SC	0	0	0	0	**0**	0.16	0.13	0	0.5	**0.79**	**0.8**	**0**
Mission	MN	1	1	1	2	**5**	0.47	0.35	1	1.5	**3.32**	**8.3**	**1**
Arroyo Burro	AB	0	0	0	0	**0**	0.40	0.16	1	1.0	**2.56**	**2.6**	**2**
Atascadero*	AO	1	1	1	2	**5**	0.81	0.27	1	1.5	**3.58**	**8.6**	**1**
San Jose*	SJ	1	1	1	2	**5**	0.64	0.24	1	1.5	**3.38**	**8.4**	**1**
Tecolotito*	TO	1	0	0	0	**1**	0.49	0.29	0	1.0	**1.78**	**2.8**	**2**
Devereaux	DX	0	0	0	0	**0**	0.15	0.07	0	0.0	**0.22**	**0.2**	**0**
Bell	BL	0	0	0	0	**0**	0.25	0.33	0	0.5	**1.08**	**1.1**	**0**
Tecolote	TE	1	1	0	0	**2**	0.23	0.57	0	1.0	**1.80**	**3.8**	**2**
Eagle	EE	0	0	0	0	**0**	0.19	0.31	0	0.0	**0.50**	**0.5**	**0**
Dos Pueblos	DP	1	0	1	0	**2**	0.34	0.54	0	1.0	**1.88**	**3.9**	**2**
Las Varas	LV	0	0	0	0	**0**	0.12	0.05	0	0.0	**0.17**	**0.2**	**0**
Gato	GO	1	0	0	0	**1**	0.14	0.62	0	1.0	**1.76**	**2.3**	**2**
Las Llagas	LL	0	0	0	0	**0**	0.11	0.10	0	0.0	**0.12**	**0.1**	**0**
El Capitan	EC	0	0	0	0	**0**	0.25	0.63	1	1.0	**2.88**	**2.9**	**2**
Corral	CL	1	0	0	0	**1**	0.26	0.52	0	1.0	**1.78**	**2.8**	**2**
Refugio	RE	1	1	1	0	**3**	0.34	0.27	1	1.5	**3.11**	**6.1**	**1**
Tajiguas	TS	1	0	0	0	**1**	0.25	0.01	0	1.0	**1.26**	**2.3**	**2**
Arroyo Quemado	AQ	1	0	0	0	**1**	0.12	0.82	0	1.0	**1.94**	**2.9**	**2**
Arroyo Hondo	AH	1	1	1	0	**3**	0.18	0.69	1	2.0	**3.87**	**6.9**	**1**
Molino	ML	0	0	0	0	**0**	0.06	0.48	0	0.5	**1.04**	**1.0**	**0**
San Onofre	SO	1	0	1	0	**2**	0.08	0.43	0	1.0	**1.51**	**3.5**	**2**
Gaviota	GA	1	1	1	0	**3**	0.82	0.27	1	2.0	**4.09**	**7.1**	**1**
Agua Caliente	AC	0	0	0	0	**0**	0.10	0.18	0	0.5	**0.78**	**0.8**	**0**
Alegria	AA	0	0	0	0	**0**	0.14	0.00	1	1.0	**2.14**	**2.1**	**2**
Cuarta	CU	0	0	0	0	**0**	0.06	0.00	0	0.5	**0.56**	**0.6**	**0**
Sacate	SE	1	0	0	0	**1**	0.06	0.00	1	0.5	**1.56**	**2.6**	**2**
Santa Anita	SA	1	0	1	0	**2**	0.13	0.00	1	1.5	**2.63**	**4.6**	**2**
Arroyo El Bulito	AE	0	0	0	0	**0**	0.10	0.00	1	1.0	**2.10**	**2.1**	**2**
Arroyo San Augustin	AS	0	0	0	0	**0**	0.07	0.00	1	1.0	**2.07**	**2.1**	**2**
Barranca Honda	BH	0	0	0	0	**0**	0.10	0.00	0	0.5	**0.60**	**0.6**	**0**
Cojo	CO	1	0	0	0	**1**	0.13	0.00	1	1.5	**2.63**	**3.6**	**2**
Wood	WD	0	0	0	0	**0**	0.16	0.00	0	0.0	**0.16**	**0.2**	**0**
Black	BK	0	0	0	0	**0**	0.06	0.00	0	0.0	**0.06**	**0.1**	**0**
Jalama	JA	1	1	1	2	**5**	1.00	0.03	0	2.0	**3.03**	**8.0**	**1**

*Sub-watersheds of the Goleta Slough Watershed

WATERSHED CATEGORY	TOTAL
Focal-Primary (5.0-10.0)	10
Focal-Secondary (2.0-4.99)	18
Non-Focal (0-1.99)	16

Table 2.3

2.4 Focal Watershed Discussion and Limitations-

This Focal Watershed Ranking Method was based on information collected during the preliminary watershed evaluation conducted in late 2000 and early 2001. Some numbers reflected in this preliminary ranking have changed as additional salmonid documentation information was obtained, stakeholder interests changed, more detailed information about habitat conditions became available, and the GIS Database was finalized. For example, while no salmonid documentation for Romero Creek was identified during the preliminary watershed evaluation, one *Oncorhynchus mykiss* was observed in lower Romero Creek towards the end of this project after field surveys were completed. Romero Creek would have made the focal watershed list had this sighting occurred prior to the focal watershed ranking. Several watersheds that were designated "non-focal" may have significant steelhead recovery potential and should be studied in the future to determine watershed conditions, limitations, and opportunities for steelhead recovery. In particular, Santa Monica, Romero, Sycamore, Bell, Eagle, and others creeks west of Gaviota that appear to offer some potential for steelhead recovery should be surveyed for migration barriers, potential salmonid populations, and habitat conditions in the future. While field survey work for non-focal watersheds was not conducted, valuable GIS-derived information about non-focal watersheds was developed and is summarized in tables and maps provided in this report.

Chapter 3: GIS Database Development

3.0 Methods

3.0.1 Watershed Boundaries and Size

A watersheds layer was generated specifically for this project that incorporated multiple data sources, various processing steps, and data exchanges that occurred through a data sharing agreement. The initial watersheds data set was created by Conception Coast Project (CCP) for the "Draft Guidebook for Reference-Based Assessment of the Functions of Riverine Waters/Wetland Ecosystems in the South Coast Region of Santa Barbara County, California" (HGM), which CCP performed as a subcontractor for Lyndon Lee and Associates for the Santa Barbara County Water Agency. The watershed boundaries were derived by CCP from a USGS 30m DEM for the rural areas in the western part of the study area from the Jalama Creek Watershed to the Eagle Creek Watershed. This data layer was then merged with existing watershed boundaries in the urbanized areas from the Santa Barbara County Flood Control District. The merged data set was requested from CCP by the Santa Barbara County Department of Public Health Environmental Health Services (EHS) and provided to them with the stipulation that the data would be returned to CCP after it was edited and value added.

The data set was converted from a polygon theme to a line theme for subsequent editing. The jagged pixel boundaries that were created from the DEM in the rural areas were smoothed by digitizing, visual examinations were performed and necessary edits were made using USGS 7.5 minute quadrangle Digital Raster Graphics (DRGs), digital aerial photography from May 2000, and the Calwater 2.2 data set from California Department of Forestry and Fire Protection (CDF). The data layer was returned back to CCP for more advanced processing, once again with the agreement that it would be returned to EHS after it was value added. CCP subdivided the Goleta Slough Watershed into 3 sub-watersheds to maintain distinctions regarding the uniqueness of each system so that management and assessment concerns, as well as comparisons among various watersheds, were more balanced. CCP also field checked portions of the watershed boundaries of Toro Creek, Garrapata Creek, Romero Creek, and San Ysidro Creek to verify their accuracy and boundary locations. The resulting data set was cleaned, polygon topology was built, and watersheds were attributed by name. Total watershed size in acres was calculated from this data layer.

3.0.2 Streams Layer

A 1:24,000 scale vector streams layer was generated specifically for this project. The streams layer utilized several data sources. The primary data source was a digitized 1:24,000 scale streams layer from the County of Santa Barbara Department of Public Health Environmental Health Services (EHS). This data set was acquired by CCP through a GIS data sharing agreement between EHS and CCP. The EHS streams layer covered streams on several of the USGS 7.5 minute quadrangles, including Pitas Point, White Ledge Peak, Carpinteria, Santa Barbara, Goleta, Dos Pueblos Canyon, Santa Ynez, and Solvang. This comprised about 534 miles of stream. CCP digitized the remaining stream arcs in the study area. Streams were digitized on-screen using USGS 7.5 minute quadrangle Digital Raster Graphics (DRG) in the background. The view scale for digitizing was generally about 1:6000. The digitized streams were added to the EHS streams layer to comprise the final streams layer. The final streams layer was edited to remove pseudo-nodes, recalculate lengths, and to attribute named streams. The final layer included about 750 miles of stream.

3.0.3 Elevation

Maximum, minimum, and mean elevation values in feet were summarized for each watershed using data from a USGS 30m Digital Elevation Model.

3.0.4 Precipitation

Maximum, minimum, and mean average rainfall amounts in inches were summarized for each watershed using data from the PRISM Climate Mapping Project through the Spatial Climate Analysis Service at Oregon State University.

3.0.5 Wetlands

Acreage values for each respective wetland type and the total number of wetlands per watershed were counted and summarized using National Wetlands Inventory (NWI) data from the US Fish and Wildlife Service.

3.0.6 Ownership

Acreage values per ownership class were calculated for each watershed. Assessor parcel data from the Santa Barbara County Department of the Clerk-Assessor-Recorder-Elections were purchased by CCP. Parcel data covered all of the study area except for the east half of the Rincon Creek watershed, which occurs in Ventura County. Assessor parcel data were not available for Ventura County so the numbers for ownership in the Rincon watershed only apply for Santa Barbara County. The associated property table was joined to the vector parcel data, and the resulting dataset was queried by the "owner" field in the table. All parcels in Santa Barbara County owned by the US Federal Government were represented in the property table by the name "USA". This class was not descriptive enough of the federal agency or department that has jurisdictional authority so these ownership values were reclassified. This was done using ancillary data from the California Gap Analysis Project (GAP) and Los Padres National Forest (LPNF) ownership boundaries.

3.0.7 Land Use

Landsat 7 ETM satellite imagery collected on 9/11/99 was used to differentiate and map types of land cover and land use. Classes were differentiated using an unsupervised cluster analysis technique that involves the computer extracting digital information from the raw image with no instructions from the operator. The computer groups pixels in the raw image data that possess similar reflectance values and spectral signatures. However, the initial groups, or clusters, are rarely the final classifications, as they often times are large and/or contain diverse classes of spectral data that need to be subdivided and/or grouped. In consultation with ancillary data such as aerial photography and consulting local experts, ten classes were initially described. Four of the vegetation classes were the least differentiable and required additional processing. These classes were removed from the initial classification and replaced with classes from a Normalized Difference Vegetation Index (NDVI). NDVI is a technique by which multiple bands of image data are reduced to a single number per pixel that represents a measure of vegetative characteristics such as biomass or leaf area. The results of this process further combined these four classes into three and when combined with the six classes initially defined, made nine total classes. The nine category land use classification was stratified further resulting in a final classification of eight classes: ocean/open water, urban/impervious, irrigated agriculture/golf courses/lawns, scrub/shrub, woodland/chaparral, forested/riparian/chaparral, grassland, and disturbed soils/heavily grazed/bedrock. The data set used in this calculation contained the watershed boundary from the County of Santa Barbara Water Agency HGM assessment. Therefore, the boundary of the land use data set is slightly different than that of the other data layers used in the watershed characteristic calculations, resulting in acreage values that may be different than those that would otherwise be produced using the appropriate project boundary. Acreage values per land use class were tabulated for each watershed.

- Class 1- Ocean & Open Water
  ETM class 1 represents the ocean and other open water bodies such as lakes, ponds, and reservoirs.

- Class 2- Urban (Residential/Commercial) & Impervious Surfaces
  ETM class 2 represents urbanized areas (high & low density residential and commercial) and other impervious surfaces such as roads and highways. In addition, beach sand shares a similar spectral signature to urban/impervious areas due to its smooth texture and high reflectivity in the visible wavelengths.

- Class 3- Irrigated Agriculture, Golf Courses, and Residential Lawns
  ETM class 3 represents irrigated areas (e.g. commercial agriculture, irrigated golf courses). Avocado groves and citrus orchards are the most prevalent type of irrigated agriculture while golf courses and lawns (larger than a 30m square pixel in the Landsat 7 image) comprise most of the other features associated with this ETM land use class.

- Class 4- Shrub/Scrub and Coastal Chaparral
  ETM class 4 consists of a vegetation mosaic dominated by shrub/scrub and coastal chaparral characteristic to the south coast of Santa Barbara County. These vegetation communities often contain an interspersion of exotic grasses and forbs as well. The distribution of the shrub/scrub and coastal chaparral species is discontinuous to scattered due to anthropogenic disturbance (land clearing, light to moderate grazing, etc.)

- Class 5- Native Chaparral and/or Woodlands (open canopy)
  ETM class 5 consists predominantly of a homogeneous cover of 1) native chaparral communities and 2) native/non-native woodlands. The distinction between ETM classes 5 and 6 is the result of 2 factors: 1) shadows in the imagery due to steep topography, which result in differing spectral signatures and thus separation into 2 ETM classes, and 2) variation in hillslope aspect that affect the structure/physiology of the vegetation cover.

- Class 6- Native Chaparral & Riparian Forest (closed canopy)
  ETM class 6 consists of 1) homogeneous native chaparral communities and 2) native/non native riparian forest (closed canopy). Once again, the distinction between ETM classes 5 and 6 is the result of 2 factors: 1) shadows in the imagery due to steep topography, which result in differing spectral signatures and thus separation into 2 ETM classes, and 2) variation in hillslope aspect that affect the structure/physiology of the vegetation cover.

- Class 7- Grasslands

  ETM class 7 represents grassland communities dominated by non-native species. This land use class results from anthropogenic disturbance typically in the form of land clearing activities, or from light to moderate grazing of domestic livestock (i.e. cattle). Ground cover of grasses and forbs is continuous with little or no exposed soils. As the level of disturbance increases (e.g., moderate to heavy grazing, removal of the grass/forb cover due to mowing/grading, etc.), a transition to ETM class 8 occurs (see below).

- Class 8- Heavily Grazed Grasslands, Exposed/Graded Soils, Bedrock

  ETM class 8 represents several land use classes such as un-vegetated bedrock outcroppings on the Santa Ynez Mountain front, heavily grazed grasslands where the vegetative cover has been reduced and/or eliminated sufficiently to expose the underlying soils, areas where grasslands are being actively mowed, or soils that are graded/exposed.

3.0.8 Roads

Road length was summarized for each watershed using USGS road data at a scale of 1:100,000 that was processed by the Teale Data Center through the State of California. Trails were queried out of the data set before the calculations were made.

3.1 GIS Database Development Results

Summary tables and maps of watersheds characteristics were developed using the finalized data complied and assessed in the GIS Database. These tables summarize information developed for watershed, topographical, climatic, land use, and public land ownership characteristics for focal watersheds. The associated series of maps display this information for all watersheds in the study area. Additional summary tables are proved in the appendix for non-focal watersheds. In addition to providing critical information for watershed assessment in this study, this compilation of information is provided to give an overview of existing watershed conditions and to aid future watershed related studies and steelhead recovery planning.

Topographic Characteristics for Focal Watersheds

Watershed Name	Size (acres)	Watershed rank Size	Max elevation (feet)	Watershed rank Max elevation	Mean elevation (feet)	Watershed rank Mean elevation	Stream length (miles)	Watershed rank Stream length	Intermittent Length	%Streams intermittent	Perennial Length	%Streams perennial	Min precipitation (inches)	Max precipitation (inches)	Watershed rank Max precipitation	Mean precipitation (inches)	Watershed rank Mean precipitation	Number wetland types per watershed
Rincon Creek	9362	6	4782	1	1518	6	33.62	6	27.78	83%	5.84	17%	15	29	1	22	2	6
Carpinteria Creek	9770.6	5	4638	2	1657	4	35.07	5	20.01	57%	15.06	43%	15	29	1	23	1	6
Arroyo Paredon	3004.6	17	3870	8	1299	13	10.76	17	6.94	65%	3.82	35%	17	27	2	22	2	0
San Ysidro Creek	2606.9	19	3565	12	1695	1	9.40	19	6.68	71%	2.72	29%	15	23	4	21	3	1
Montecito Creek	4241.7	12	3759	9	1616	5	13.53	16	9.29	69%	4.24	31%	15	25	3	21	3	2
Mission Creek	6942.4	8	3959	6	1319	12	20.69	11	16.10	78%	4.58	22%	15	27	2	20	4	5
Arroyo Burro	6542.2	9	3956	7	916	21	25.17	9	23.01	91%	2.16	9%	17	27	2	20	4	3
Atascadero Creek*	12833.1	3	3729	10	971	16	49.12	2	48.80	99%	0.32	1%	17	27	2	20	4	11
San Jose Creek*	10064	4	3044	16	943	17	42.39	4	41.43	98%	0.00	0%	17	25	3	20	4	7
Tecolotito Creek*	7685.8	7	3054	15	576	27	29.66	7	26.16	88%	3.49	12%	17	25	3	19	5	15
Tecolote Creek	3620.8	16	3159	14	1361	9	15.96	15	6.24	39%	9.72	61%	17	23	4	20	4	3
Dos Pueblos Creek	5387	10	3989	5	1435	7	26.82	8	16.55	62%	10.17	38%	17	23	4	20	4	8
Gato Creek	2249.2	21	4254	4	1692	2	9.90	18	7.62	77%	2.29	23%	17	23	4	20	4	1
El Capitan Creek	3965.7	15	4257	3	1669	3	18.12	12	12.84	71%	5.28	29%	15	25	3	20	4	2
Corral Creek	4198.9	13	3703	11	1324	11	17.27	13	9.91	57%	7.35	43%	17	25	3	20	4	1
Refugio Creek	5200.7	11	3228	13	1103	14	20.88	10	12.87	62%	8.01	38%	15	25	3	19	5	6
Tajiguas Creek	3982.9	14	2595	20	922	20	17.02	14	11.87	70%	5.15	30%	15	21	5	18	6	4
Arroyo Quemado	1922.1	24	2529	21	980	15	7.22	22	4.58	63%	2.64	37%	17	19	6	18	6	2
Arroyo Hondo	2797.8	18	2788	18	1418	8	9.16	21	4.24	46%	4.92	54%	17	21	5	19	5	1
San Onofre Creek	1327.1	26	2598	19	1347	10	3.92	28	1.40	36%	2.52	64%	17	21	5	20	4	1
Gaviota Creek	12877.7	2	2801	17	938	18	44.40	3	22.55	51%	21.85	49%	17	21	5	18	6	11
Alegria Creek	2285	20	1492	26	640	24	9.36	20	7.80	83%	1.56	17%	15	17	7	17	7	5
Sacate Creek	892.3	28	1368	28	619	25	4.07	27	1.54	38%	2.53	62%	15	19	6	17	7	0
Santa Anita Creek	2046.8	22	1456	27	744	23	6.17	24	2.61	42%	3.56	58%	15	19	6	18	6	1
Arroyo El Bulito	1579.9	25	1712	23	768	22	5.22	26	2.03	39%	3.19	61%	15	19	6	18	6	2
Arroyo San Augustin	1141.6	27	1689	24	560	28	5.78	25	5.78	100%	0.00	0%	15	19	6	17	7	2
Cojo Creek	2034.3	23	1624	25	594	26	6.44	23	3.26	51%	3.18	49%	15	19	6	16	8	4
Jalama Creek	15779.5	1	2096	22	934	19	53.56	1	38.82	72%	14.74	28%	15	21	5	19	5	6

* Sub-watersheds of the Goleta Slough Watershed

Refer to Table Folder for:
Land Use Summary Table - Focal Watersheds
Table 3.1.2

Refer to Table Folder for
Land Use Summary Table - *Focal Watersheds*
Table 3.1.2

Public Ownership Characteristics for Focal Watersheds Watershed Name	City owned acres (SBCO only)	County owned acres (SBCO only)	LPNF owned acres (SBCO & VCO counties)	LTSBC owned acres	State owned acres (SBCO only)	UC Regents owned acres (SBCO only)	Other federally owned acres (SBCO only)	VAFB owned acres	Public ownership (acres)	Watershed rank Public Ownership (acres)	%wshed city owned (SBCO only)	%wshed county owned (SBCO only)	%wshed LPNF owned (SBCO & VCO counties)	%wshed LTSBC owned	%wshed state owned (SBCO only)	%wshed UC Regent owned (SBCO only)	%wshed other federally owned (SBCO only)	%wshed VAFB owned	% Watershed public ownership	Watershed rank % Watershed public ownership
Rincon Creek*		3.0	5502.2				1.2		**5506.4**	**2**		0.0%	58.8%				0.0%		**58.8%**	**5**
Carpinteria Creek	9.6	10.4	5607.2		33.4		9.6		**5670.2**	**1**	0.1%	0.1%	57.4%		0.3%		0.1%		**58.0%**	**6**
Arroyo Paredon		92.6	407.4				0.0		**500.0**	**21**		3.1%	13.6%				0.0%		**16.6%**	**20**
San Ysidro Creek		4.4	1252.7		0.2				**1257.3**	**17**		0.2%	48.1%		0.0%				**48.2%**	**11**
Montecito Creek	1396.0	15.6	670.3						**2081.9**	**12**	32.9%	0.4%	15.8%						**49.1%**	**10**
Mission Creek	1397.2	40.8	1129.8		2.9	133.6	6.8		**2711.1**	**6**	20.1%	0.6%	16.3%		0.0%	1.9%	0.1%		**39.1%**	**13**
Arroyo Burro	327.7	98.6	542.5		34.6		100.4		**1103.6**	**18**	5.0%	1.5%	8.3%		0.5%		1.5%		**16.9%**	**19**
Atascadero Creek**	3.6	555.5	2983.2		18.3		5.5		**3566.2**	**3**	0.0%	4.3%	23.2%		0.1%		0.0%		**27.8%**	**15**
San Jose Creek**	67.2	157.1	2214.9		3.2		2.5		**2444.8**	**10**	0.7%	1.6%	22.0%		0.0%		0.0%		**24.3%**	**18**
Tecolotito Creek**	854.4	128.2	1215.3		36.6	321.1	19.5		**2575.0**	**8**	11.1%	1.7%	15.8%		0.5%	4.2%	0.3%		**33.5%**	**14**
Tecolote Creek			2066.0						**2066.0**	**13**			57.1%						**57.1%**	**7**
Dos Pueblos Creek			2968.2						**2968.2**	**5**			55.1%						**55.1%**	**8**
Gato Creek			1386.6						**1386.6**	**15**			61.6%						**61.6%**	**4**
El Capitan Creek			2461.0		37.8				**2498.9**	**9**			62.1%		1.0%				**63.0%**	**3**
Corral Creek			2211.3		15.8				**2227.1**	**11**			52.7%		0.4%				**53.0%**	**9**
Refugio Creek			1327.6		16.6				**1344.2**	**16**			25.5%		0.3%				**25.8%**	**17**
Tajiguas Creek		23.0			0.1				**23.1**	**22**		0.6%			0.0%				**0.6%**	**22**
Arroyo Quemado		1104.3	470.4	7.5					**1582.3**	**14**		57.5%	24.5%	0.4%					**82.3%**	**2**
Arroyo Hondo		0.8	1923.0	736.8					**2660.6**	**7**		0.0%	68.7%	26.3%					**95.1%**	**1**
San Onofre Creek			570.7		6.0				**576.7**	**19**			43.0%		0.5%				**43.5%**	**12**
Gaviota Creek			1554.3		1888.5				**3442.8**	**4**			12.1%		14.7%				**26.7%**	**16**
Alegria Creek																				
Sacate Creek																				
Santa Anita Creek																				
Arroyo El Bulito																				
Arroyo San Augustin																				
Cojo Creek																				
Jalama Creek		5.3					0.6	523.3	**529.2**	**20**		0.0%					0.0%	3.3%	**3.4%**	**21**

* Parcel data was used for land in Santa Barbara Co but was not available for Ventura Co. Ownership data from Los Padres NF was used to estimate LPNF ownership in Ventura C

** Sub-watersheds of the Goleta Slough Watershed

Refer to Map Folder for:
Watersheds and Topography Map Series
Map 3.2.1

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Watersheds and Topography Map Series
Map 3.2.1

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Land Use Map Series
Map 3.2.2

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Refer to Map Folder for:
Publicly Owned Lands Map Series
Map 3.2.3

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Publicly Owned Lands Map Series
Map 3.2.3

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Publicly Owned Lands Map Series
Map 3.2.3

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Map 3.2.3

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Publicly Owned Lands Map Series
Map 3.2.3

Chapter 4: Field Survey Access and Effort

4.0 Coordination with Public Agencies and Land Managers

Access to survey a significant amount of stream within the study area was obtained through collaboration with public landowners and managers including; Santa Barbara County Water Agency, CALTRANS, California State Parks, Los Padres National Forest, and Santa Barbara County and City owned and managed lands. Field Surveys were conducted in coordination with the Santa Barbara County Creek Walkers Program and with individuals affiliated with several public agencies.

4.1 Parcel Ownership

In order to conduct field surveys, it was necessary to gain permission from landowners to access several streamside properties. The Santa Barbara County Assessor's Parcel database was used to identify landowners who would need to be contacted. The parcels database was overlaid with the streams layer to identify parcels that were adjacent to, or that contained, stream reaches of interest. The contact information for these parcels was extracted from the database, and landowners were contacted.

4.2 Obtaining Permission to Survey Private Property

Once focal watersheds and stream reaches that occurred on private land were determined, landowners were contacted by phone and written permission to conduct field surveys was obtained directly or using the Postal Service.

4.3 Aerial Surveying

Several stream reaches, where access to conduct field surveys was restricted, were surveyed from the air using donated piloting time and plane use, as well as one day in a helicopter. This surveying technique focused on identification and severity assessment of migration barriers and salmonid habitat conditions and attributes.

4.4 Field Surveying Effort and Date

The degree to which access was obtained to conduct field surveys determined the possible effort given to surveying a given stream reach. The field survey effort for each stream reach assessed is identified on the Habitat Reach Summary Table, in order to provide the level of survey effort conducted. The date of the main survey effort is provided. Additional site-specific surveying of habitat, barriers, or salmonid sampling may have occurred on additional dates. The more detailed field surveying dates took precedent or other surveying effort dates.

1= Ground surveyed.
2= Partial ground survey of accessible stream reaches and from publicly owned roads and land, in addition to aerial surveying.
3= Partial ground survey of accessible stream reaches and from publicly owned roads and land.
4= No ground survey due to access restrictions. Remote surveying techniques utilized from publicly accessible locations, in addition to aerial surveying.
5= No ground surveying due to access restrictions.

Chapter 5: SALMONID HABITAT INVENTORY AND ASSESSMENT

5.0 Field Surveying of Salmonid Habitat Conditions

A relatively quick and straightforward salmonid habitat field surveying technique was developed by Stoecker, which incorporates the identification of key habitat characteristics that directly or indirectly affect salmonid productivity or correlate with productive salmonid habitat. Distinct habitat reaches were identified in the field when noticeable changes in stream and/or riparian habitat conditions were observed. Upstream and downstream reach locations were collected using GPS or by identifying the physical location. In some cases, habitat conditions changed rapidly, while in other cases the change was very gradual. The following habitat attributes were assessed while conducting field surveys.

Relative values assigned for some of the habitat quality attributes are based upon comparison to aquatic habitat conditions found within the study area streams. The relative values are determined by comparison to the most ideal salmonid habitat conditions observed in stream reaches such as upper Arroyo Hondo, upper San Ysidro Creek, upper San Jose Creek, Gobernador Creek, and other stream reaches within the study area that have extremely high quality salmonid habitat and high densities of naturally reproducing *O. mykiss*. The identification of ideal salmonid habitat conditions and relative values in other reaches was carried out by the survey team, consisting of Stoecker and Ferrell or Allen, all of whom have extensive training and experience conducting salmonid sampling and stream habitat surveys in Southern California streams while working with the California Department of Fish and Game, U.S. Forest Service, UCSB Biology Department, and/or working as a private fisheries consultant. The following habitat attributes were assessed while conducting field surveys.

5.0.1 Abundance of Spawning Substrate

The relative abundance of adequately sized spawning substrate (small to medium sized gravel) within a given stream reach was identified or estimated. During field surveys, particular attention was paid to spawning substrate abundance in ideal locations, such as the tail-out between a significant pool and the downstream run or riffle, where ideal water depth and velocity occur. See the steelhead ecology section for more on steelhead spawning and habitat relationships.

5.0.2 Substrate Embeddedness

During field surveys the average percentage of substrate embeddedness occurring with a habitat reach was determined by sampling the embeddedness of adequately sized spawning substrate in fine, deposited sediment such as silt and sand. See the steelhead ecology section for more on steelhead spawning and habitat relationships.

5.0.3 Surface Flow

The seasonal duration of surface water flows can be highly variable in stream reaches from year to year due to fluctuations in annual precipitation, water extractions, and other factors. Stream reaches that sustain some surface water throughout the year are critical for salmonids because they reside in fresh water for at least the first year of their lives. It is difficult to assign accurate surface flow duration values to particular stream reaches after only a couple limited site visits or based upon existing information, which is often conflicting due to the constantly changing conditions within the watershed. Groundwater basins, shifting faults, water extractions, and precipitation events all impact flow durations and are poorly understood in the region. For purposes of this report a very rough estimate of surface flow duration for habitat reaches was assigned based on field observations, information collected, and personal communication with knowledgeable individuals familiar with surface flow duration along a given stream reach.

5.0.4 Pool Abundance

The relative abundance of pools (greater than 2 feet in depth) was estimated during field surveys, from aerial surveys, from existing documentation, interviews with knowledgeable individuals, and/or estimated from pool abundance trends observed in accessible adjacent stream reaches.

5.0.5 In-stream Cover

The relative amount of in-stream cover provided by large substrate, bedrock ledges, large woody debris, roots, undercut banks, and other features providing protected areas of cover was estimated.

5.0.6 Riparian Canopy Cover

See the riparian canopy cover section in the following GIS Habitat Analysis section (5.3) for information on the identification of riparian canopy cover, which utilized both field surveying techniques and GIS analysis.

5.1 GIS Habitat Analysis

In addition to field surveying of habitat conditions, the GIS was used to analyze several habitat components used to obtain the habitat quality score and total habitat score. The following attributes were collected or developed using the GIS.

5.1.1 Habitat Reaches

Habitat reaches were represented in the GIS as specific stream segments from the developed streams layer. The upstream and downstream nodes of individual habitat reaches were determined in several ways. Many nodes were identified using non-differential GPS during field surveys of the habitat reaches. In these cases, the GPS points were downloaded and processed in the GIS to indicate the boundaries of the habitat reaches. Of a total of 231 habitat reaches mapped, 118 were located in the GIS using GPS locations. For habitat reach limits that could not be mapped using the GPS, descriptions of the positions of reach nodes were made by field technicians, and translated into positions in the GIS. These descriptions generally utilized features in the USGS DRGs that intersected the stream, such as road crossings or topographic contours. Once the end nodes of a habitat reach were identified, the stream reach was split at these nodes. If the resulting habitat reach was comprised of more than one arc, the arcs were un-split. Each habitat reach was attributed with a unique GIS Habitat ID number. The length of each habitat reach was also calculated.

5.1.2 Stream Gradient

Stream gradient indirectly effects salmonid habitat conditions and has been shown to have a positive correlation with salmonid habitat conditions and distribution. Higher gradient stream reaches typically have higher dissolved oxygen levels, better water circulation through spawning gravels, longer surface flow duration, better pool to riffle development, cooler water temperatures, less spawning gravel embeddedness, and higher water quality. This generalization does not always hold true, but was observed in most study area watersheds. See section one for more on steelhead ecology and habitat associations.

Estimated stream gradient values were assigned to habitat reaches in order to factor this component into the reach habitat quality score. Stream gradient values were calculated in the GIS because of the difficulty of measuring stream gradient for all reaches in the field. For each habitat reach, the elevation of the upstream and downstream node was extracted from the USGS 30-meter Digital Elevation Model (DEM). Though the source DEM recorded elevation in meters, these values were recalculated to feet. For each habitat reach, the total elevation rise of the reach was calculated by subtracting the elevation of the downstream node from the elevation of the upstream node. For each habitat reach, the calculated rise was divided by the length of the reach. The resulting "rise over run" value was multiplied by 100 to calculate stream gradient in units of percent.

The resulting stream gradient characterization worked well generally. In a few cases, it appeared that the assigned stream gradient did not accurately characterize the stream gradients observed in the field. This is likely due to the 30-meter spatial resolution of the DEM. Some stream reaches were adjacent to features such as hills or cliffs, which had higher elevations than the stream nodes. The coarse resolution of the DEM sometimes allowed stream nodes to be assigned the elevation of the nearby features. These cases were rare. Several dozen stream gradient measurements were tested in the field and compared to the GIS-derived gradients with good comparison results. The methodology was determined to be the most useful approach in the GIS given the available GIS data and inability to field-measure stream gradient on all habitat reaches of the study area.

5.1.3 Riparian Canopy Cover

Estimated riparian canopy cover (RCC) values were assigned to habitat reaches in order to factor this component into the habitat quality score for each habitat reach. The estimated RCC values were calculated in the GIS for all stream reaches. The RCC values were derived from a Landsat 7 ETM+ satellite image acquired on September 11, 1999. The normalized difference vegetation index (NDVI) is a ratio image that utilizes Band 4 (near infrared) and Band 3 (red). The equation to generate an NDVI image is:

$$\mathbf{NDVI = ((Band\ 4 - Band\ 3) / (Band\ 4 + Band\ 3)).}$$

Band 3 measures the portion of the electromagnetic spectrum that is absorbed by chlorophyll in plants. Band 4 measures the portion of the electromagnetic spectrum that is reflected by mesophyll leaf structure. NDVI exploits the contrast in these two bands and reveals the range and vigor of plant material in the image (Tucker 1979, Jackson et al.1983, Tucker et al. 1991). The initial NDVI image for the study area had values ranging from 0.5 to 0.7. These values were rescaled to a range from 0 to 255.

Twenty-nine field sites were used to validate the use of NDVI as a surrogate for determining riparian canopy cover. At these field sites, the riparian cover was described as one of four classes. Class 1 had a canopy cover of 0-25%. Class 2 had a canopy cover of 25-50%. Class 3 had a canopy cover of 50-75%, and Class 4 had a canopy cover of 75-100%. These field canopy cover classes were compared to NDVI values at the sites within the GIS. These values matched well, having a correlation with an R^2 of 0.38. Field-measured canopy cover classes generally correlated well with the determined NDVI values. The equation of a linear fit of the two sets of values was used to describe the predicted error in terms of canopy cover classes. These sites had a predicted average absolute error of 0.70 canopy cover classes. Several sites were identified as outliers for various reasons. Some of these sites were identified in the field as having significant reduced riparian canopy cover due to cultivated agricultural production or streambed modification within the riparian zone, and were characterized as having lower riparian canopy values. Because the NDVI did not discriminate between agricultural/exotic and native riparian vegetation, several sites had higher NDVI values than test sites determined in the field. Seven outlier sites were removed from the analysis. When removed, the correlation of the remaining 22 sites had an R^2 of 0.80 with a predicted average absolute error of 0.34 canopy cover classes. With a strong correlation and an average absolute error smaller than one half of one cover class, the NDVI was determined to be a suitable surrogate measure for riparian canopy cover.

The habitat quality scoring methods required that the RCC values for a habitat reach have a range from 0 to 1, which correlates to 0 to 100% RCC values. For example, a habitat reach that received a score of 0.75 should have a riparian canopy cover of approximately 75%. The NDVI image was reclassified into 10 classes, using an equal area classification. This means that each of the 10 classes had approximately the same area throughout the study area. For each habitat reach, the average class value was calculated for the 30-meter pixels that intersected the habitat reach. This yielded values ranging from 0 to 10. For each habitat reach, this value was divided by 10 to yield a value ranging from 0 to 1. These resulting values were used as input for calculating the habitat quality for each habitat reach.

5.2 Habitat Scoring Method (Stoecker)

Developing reach habitat scores for focal watersheds within the study area was essential for analyzing and prioritizing steelhead migration barriers for fish passage projects and determining watershed priorities based on habitat value. Selected habitat reaches were assigned a habitat quality score based on the addition of selected watershed attribute scores discussed below. The reaches total habitat score was determined by multiplying a given stream reaches habitat quantity by a habitat quality multiplier (see diagram below). This method of multiplying habitat quantity by habitat quality to obtain a habitat score is consistent with the habitat scoring method being developed by Ross Taylor for the California Department of Fish and Game's "Priority Ranking of Culverts for Treatment". Several habitat attributes have been added to the CDFG method in order to estimate habitat quality values and habitat reach scores with greater detail utilizing field assessment. Habitat quantity scores were also determined with a higher precision than the CDFG method to more accurately assess the length of stream being considered.

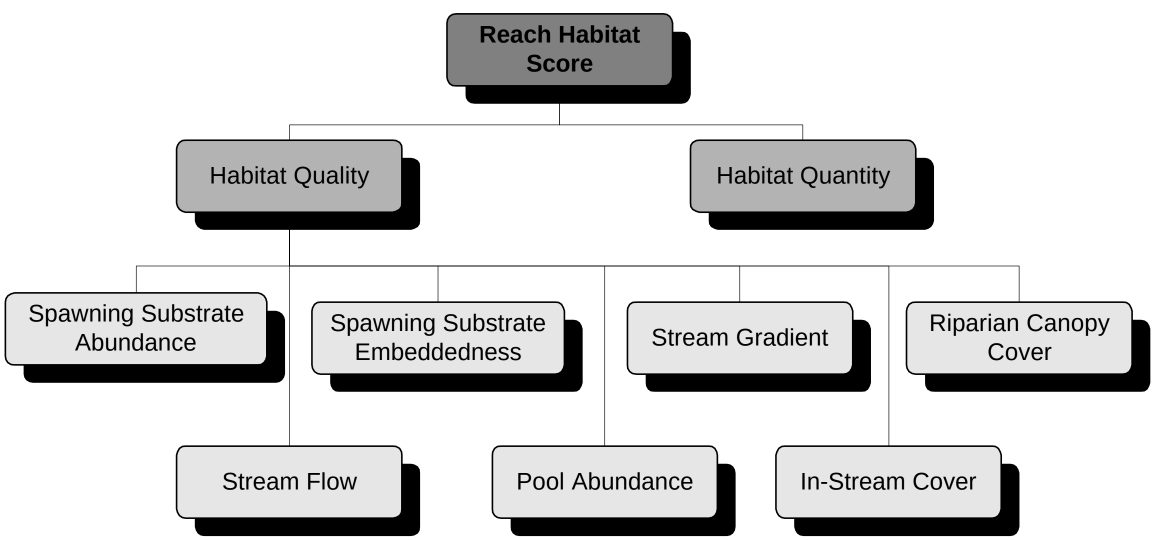

Figure 5.2

5.2.1 Habitat Quantity Criteria

For each identified habitat reach, or desired portion of a habitat reach, the linear quantity of stream was determined to the hundredth of a mile using the GIS.

5.2.2 Habitat Quality Criteria

For each habitat reach identified in the habitat assessment, a habitat quality multiplier was determined by adding the scores of several important watershed characteristics that directly influence, or positively correlate with, the quality of steelhead habitat. The maximum possible habitat quality score is 10. Once this habitat quality score was determined, the number was divided by 10 to convert the determined score into the final habitat quality score and multiplier, which have a value between 0-1. The habitat quality score was then assigned to the entire habitat reach so that segments of that reach could be analyzed for barrier ranking without recalculating the habitat quality. With over 500 migration barriers to analyze using reach habitat scores, this was an important feature. The following habitat attribute scores make of the habitat quality score.

5.2.2.1 Abundance of Spawning Substrate

0= Adequately sized spawning substrate scarce or absent.
0.5= Low abundance of adequately sized spawning substrate present.
1.0= Moderate abundance of adequately sized spawning substrate present.
1.5= High abundance of adequately sized spawning substrate present.

5.2.2.2 Substrate Embeddedness

0= Greater than 75% substrate embeddedness
0.5= 75%-50% substrate embeddedness
1.0= 50%-25% substrate embeddedness
1.5= Less than 25% substrate embeddedness

5.2.2.3 Stream Gradient

0= Less than 1% Stream Slope, and culverts and channelized reaches.
0.25= 1%-2% Stream Slope
0.50= 2%-4% Stream Slope
0.75= 4%-6% Stream Slope
1.0= Over 6% Stream Slope

5.2.2.4 Surface Flow

0.0= Dry
Prolonged dry streambed conditions generally occur in this reach during drier months of a typical rainfall year or throughout the year, during years with low rainfall. Some reaches that are dry for extended periods may provide limited spawning and rearing habitat when flows are present and will receive points elsewhere for other characteristics such as substrate embeddedness and abundance.

0.1= Variable
Seasonally variable surface flow conditions are believed to occur in this reach. Areas of dry streambed may occur, along with isolated pools, and/or low surface flows during

drier periods of a year. The availability of summer and fall surface flows in this reach is dependent on constantly changing climatic, geologic, and human-influenced factors. During wetter years, this reach may retain perennial surface flow conditions throughout and during droughts the entire reach may dry up.

0.2= Perennial
Surface flows are believed to exist continuously throughout the year in this reach, although factors mentioned above may alter the perennial designation of the stream reach or sections of it.

5.2.2.5 Pool Abundance

0= Pools scarce or absent.
0.5= Relatively low abundance of pools present.
1.0= Relatively moderate abundance of pools present.
1.5= Relatively high abundance of pools present.
2.0= Relatively high abundance of pools present with multiple “refuge pools” (greater than 5 feet deep) present.

5.2.2.6 In-stream Cover

0= Scarce or Absent
0.25= Low
0.5= Moderate
0.75= Moderate to High
1.0= High

5.2.2.7 Riparian Canopy Cover

Riparian canopy cover values identified using the GIS were field tested for accuracy then applied to all stream reaches. See the GIS Habitat Analysis Section (5.3) for more detailed information about this process. The riparian canopy cover densities were then given respective values over a range from 0-1.0 with 0 representing no riparian canopy cover and 1.0 theoretically corresponding to a 100% riparian canopy cover. This method allowed for greater detail in determining the average riparian canopy cover value for the entire habitat reach.

5.3 Habitat Quality Scoring Limitations and Discussion

Values for habitat quality attributes, on stream reaches that were not ground surveyed due to access restrictions, were estimated based on adjacent stream reaches surveyed, collected documents describing habitat conditions, observations of collected photographs of the reach, personal communication with knowledgeable individuals, aerial photography, and aerial surveying. The survey date and survey effort for habitat reaches are listed on the Habitat Reach Summary Table (Section 5.5).

Habitat quality values and habitat reach scores were not applied to lagoon and slough habitats for several reasons. The habitat ranking criteria is designed for flowing stream reach habitat and does not work for the very unique habitat conditions encountered in lagoons and sloughs. The quality of lagoon and slough habitat is highly variable from season to season and dependent on a variety of factors, which take extensive multi-year studies to begin to understand and determine the value to salmonids (pers. comm. Dr. J. Smith). The assessment of lagoons and sloughs was beyond the scope of this project and was not essential to determining priorities for upstream migration barriers, which all occurred upstream of these habitats. The importance of lagoon and slough habitat to salmonids cannot be understated as they can play a critical role in the steelhead productivity of a watershed. Important lagoon and slough functions can include: productive rearing habitat, important salt and freshwater acclimation habitat for steelhead migrating between these water types, and providing an abundance of prey available for rapid salmonid growth. A multi-year study on the role of lagoons and sloughs on steelhead productivity, historical extent, habitat reductions, limiting factors, and restoration opportunities are needed for southern Santa Barbara County streams.

The habitat quality value applies to the quality of that reach for salmonids only and should not be interpreted as the ecological condition of that reach or the quality of that reach to other fish species. Water quality was not sampled or analyzed in this study due to time and budget limitations and the site-specific restoration objectives of this study.

5.4 Habitat Scoring Results

See following Habitat Reach Table for scoring results.

Refer to Table Folder for:
Habitat Reach Table
Table 5.4

Refer to Table Folder for:
Habitat Reach Table
Table 5.4

Refer to Table Folder for:
Habitat Reach Table
Table 5.4

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Habitat Reach Table
Table 5.4

Refer to Table Folder for:
Habitat Reach Table
Table 5.4

Chapter 6: SALMONID STATUS

6.0 Status

Determining the status of salmonids within study area watersheds is an important factor in protecting known salmonid populations, ranking fish passage improvement projects and watershed priorities for steelhead recovery planning. In order to fully understand the status of salmonids in a particular watershed it is important to identify existing populations in the field as well as compile historical documentation through data collection and interviewing knowledgeable individuals. All the salmonid documentation collected during this study was compiled in chronological order for each watershed in order to document known historical salmonid presence, current population presence, and in many cases identify population trends and salmonid extirpation from a watershed.

6.1 Salmonid Sampling Techniques

Non-capture salmonid sampling techniques were employed while conducting field surveys in order to provide a general assessment of current salmonid presence, distribution, and population status within study watersheds. Electroshocking and trapping methods that cause unnecessary stress, and occasional mortality, to salmonids were not utilized. Observations were made from the stream bank and underwater. Stream bank observation techniques included surveying streams in an upstream manner, moving slowly, staying low, utilizing features to hide, wearing polarized glasses, using binoculars, and thoroughly observing likely pools and runs where salmonids are most readily observed. Underwater snorkeling methods were also employed to identify salmonids with greater accuracy in deeper runs and pools. This technique is an effective way to identify the size and quantity of salmonids present. Only positively identified *O. mykiss* observations are reported by Stoecker, Ferrell, and Allen within the Salmonid Documentation Table.

6.2 Data Collection and Interviews

An intensive document search was conducted to collect recorded observations of salmonids in all study area watersheds. Data was colleted from numerous local libraries, historical societies, museums, agency files, universities, archives, existing salmonid documentation data sources, and individuals. Dozens of individuals were interviewed throughout the course of the study, providing historical and contemporary salmonid sighting information. These sources of information are listed with each salmonid observations identified in the Salmonid Documentation Table.

6.3 Salmonid Documentation Results

Refer to Table Folder on CD for Table 6.3 - Salmonid Documentation Table.

6.4 Steelhead Photography Gallery

The following photographs show adult steelhead captured or observed from study area watersheds, sloughs, or coastal waters near stream mouths. Sighting descriptions for each of these photographs can be found in the Salmonid Documentation Table in the previous section.

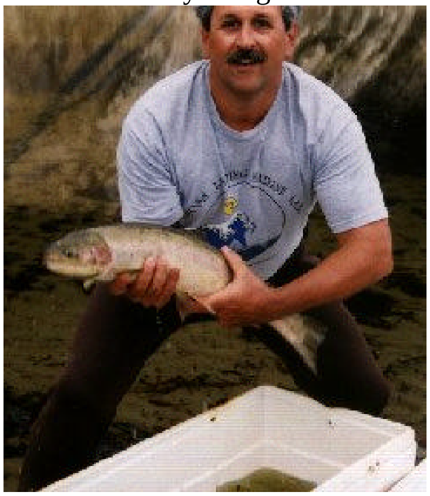
1) Carpinteria Creek 1942- Courtesy George Bliss

2) Carpinteria Creek 2000- Courtesy Santa Barbara News Press

3) Carpinteria Slough 1988- Courtesy Peter Robinson

4) Mission Creek 2000- Courtesy Craig Fusaro

5) Maria Ygnacio 2000- Courtesy Craig Fusaro



6) Arroyo Hondo 1969- Courtesy J.J. Hollister

7) Arroyo Hondo 2001- Courtesy Dan Dugan

8) Gaviota Creek 2001- Matt Stoecker

9) Jalama Creek 1980's- Courtesy Jalama Store

6.5 Salmonid Status Scoring Method (Stoecker)

This method was developed to assign study area watersheds a score in order to factor this component into barrier and watershed ranking methods described later in the report. The salmonid status score for a watershed is based on salmonid documentation summarized in the Salmonid Documentation Table above. Watersheds with current (2000-2002) salmonid documentation and adult steelhead documentation since 2000 received the highest salmonid status score. Historic documentation of a "trout", "rainbow trout", or "steelhead" greater than 16 inches in total length and found within an anadromous reach of stream was considered an "adult steelhead" for purposes of salmonid status scoring. This adult steelhead designation gives additional weight to presumed anadromous steelhead presence in a watershed. *Oncorhynchus mykiss* of greater or lesser total length than 16 inches may exhibit anadromous, or entirely freshwater, life history behavior. The following scores were applied to each watershed based on the Salmonid Documentation Table.

0.20- No salmonid documentation was discovered for this watershed.
0.30- Historical, non-specific salmonid references or documentation exists for this watershed.
0.40- Historical (pre-1980) salmonid documentation exists for this watershed.
0.50- Historical (pre-1980) salmonid documentation exists for this watershed and adult steelhead have been documented.
0.60- Contemporary (1980-1999) salmonid documentation exists for this watershed.
0.70- Contemporary (1980-1999) salmonid documentation exists for this watershed and adult steelhead have been documented.
0.80- Current (2000-2002) salmonid documentation exists for the watershed.
0.90- Current (2000-2002) salmonid documentation exists for the watershed and adult steelhead have been documentation prior to 2000.
1.0- Current (2000-2002) salmonid documentation exists for the watershed and adult steelhead have been documentation since 2000.

6.6 Salmonid Status Scoring Limitations

The assigned salmonid status should not be considered a definite salmonid status designation for a watershed as permission to survey all stream reaches in the study area for salmonid presence was not obtained. For example, no current (2000-2002) documentation of *O. mykiss* occurs for Jalama Creek, but a comprehensive survey of the watershed has not occurred during that time, due to access restrictions. Juvenile *O. mykiss* were sampled in Jalama Creek in 1989 and CDFG personnel electroshocked an adult steelhead in 1994 (see Salmonid Documentation Table). While it is likely that Jalama Creek supports a current salmonid population, including an active steelhead run, restricted access has limited recent documentation opportunities and the watershed received a score of 0.7.

Chapter 7: BARRIER IDENTIFICATION, ASSESSMENT, AND RECOMMENDATIONS

7.0 Barrier Identification and Location

One principle objective of this project was to identify structures that impede or prevent upstream steelhead migration in order to prioritize fish passage improvement projects. The term “barrier” in this report shall refer to any structure in the stream channel that impedes with varying degrees of difficulty, or completely blocks upstream adult steelhead migration. Field surveys were conducted in an upstream manner and all barriers where given a unique Barrier ID. This unique Barrier ID described, in code, the stream location of the barrier and order in which it is encountered moving upstream on the mainstem from the ocean or tributary confluence if located on a tributary to the mainstem. For example, BR_CA_GR_6 identifies a barrier (BR) in the Carpinteria Creek (CA) watershed that occurs on the Gobernador Creek (GR) tributary and is the 6th barrier on Gobernador Creek, upstream from the Carpinteria Creek confluence. BR_CA_1 is the first barrier identified on Carpinteria Creek upstream from the ocean. Watershed stream codes for the focal watersheds are provided on the focal watershed identification table in section 2.0.

A total of 513 natural and anthropogenic migration barriers were mapped for this project. The locations for about 200 of these barriers were recorded in the field using a Global Positioning System (GPS). In these cases, the GPS points were downloaded and processed in the GIS to indicate the locations of barriers. At several barrier locations, a GPS signal could not be acquired due to signal interference with dense riparian canopy cover, confined canyon walls, or overcast conditions. Where private land was not accessible, barriers were identified through document research, interviews, aerial photographs, and aerial surveying techniques. Upstream natural limits were also estimated on restricted stream reaches, where a 10% sustained stream slope was determined using CDFG barrier estimation methods and based on stream slope identification on USGS topographical maps. For barriers that were not mapped with the GPS, descriptions of their positions were made by field technicians, and translated into positions in the GIS. These descriptions generally utilized features in the USGS DRGs that intersected the stream, such as road crossings or topographic contours. In other cases, barrier locations were described in relation to barriers that had GPS locations. For example: “Barrier B is located 500 feet upstream of barrier A”. Fifty of the 513 barriers were represented in the GIS as linear features, while the remaining barriers were represented as points. The linear barrier features were comprised of portions of the stream layer. Once all 513 barriers were digitized in the GIS, their positions were validated on screen or on plotted maps by the field technicians. This was necessary because in some cases, the GPS coordinates for a barrier did not accurately display the position of a barrier on the stream reach. Actual GPS coordinates can be obtained from the Conception Coast Project.

7.1 Barrier Ownership/Interest

In many cases, multiple owners and interests are associated with identified barriers and adjacent land or easements and maintenance agreements exist with different entities. Determining the exact “owner” of some structures is difficult. For example, the Army Corps of Engineers may have built a concrete channel that is currently maintained by the Santa Barbara County Flood Control District for CALTRANS, which is all on top of private property. For this report, any entity that has been identified as having an interest in a certain barrier was identified in the Ownership/Interest column of the migration barrier table for each watershed. This information was determined through parcel data, interviews with knowledgeable individuals, and research conducted at various agency locations, such as the CALTRANS office complex in San Luis Obispo and the Santa Barbara County Administration Building.

7.2 Barrier Type

The following types of steelhead migration barriers were identified in southern Santa Barbara County streams and are identified in the migration barrier table for each watershed.

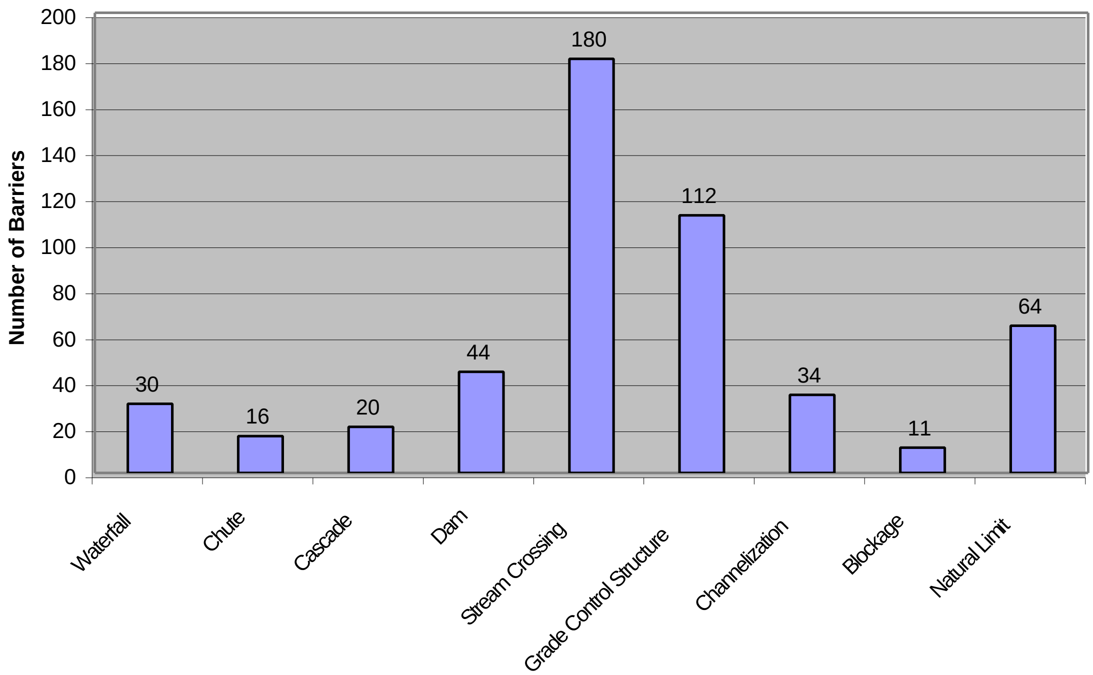
Barrier Categories and Types

Barrier Categories	Definition	Barrier Types Encountered
Natural Features		
Waterfall	Free-falling stream flow from a vertical, or close to vertical, feature.	Bedrock Waterfall, Boulder Waterfall
Chute	Steep stream reach with high water velocities over exposed bedrock.	Bedrock Chute, Bedrock and Boulder Chute
Cascade	Steep stream reach comprised of small waterfalls separated by shallow pools and/or short sections of turbulent flow.	Boulder Cascade, Steep Stream Reach
Anthropogenic Structures		
Dam	Structure designed to impede, retain, regulate, and/or divert the flow of water or movement of sediment and stream-born debris.	Debris Basin, Diversion, Water-Storage, Stone, Seasonal Diversion
Stream Crossing	Structure that facilitates the passage of vehicular, equipment, railroad, pedestrian, or other traffic across the stream.	Bridge, Culvert (Concrete, Metal, Box, Double Box, Open-bottom Arch, Stone), Apron, In-stream
Grade Control Structure	Structure intended to provide streambed, utility, or bank protection and/or influence the movement of streambed substrate, stream flow, or debris.	Riprap, Berm, Curb, Boulder, Pipe Crossing, Gaging Weir
Channelization	Stream reach that has been modified with extensive bank and streambed protection measures and/or altered from the "natural" alignment.	Channelization (Concrete, Riprap), Stream Realignment, Concrete-lined Bottom, Confined Stream Channel, Bank Revetment
Blockage	Structure or accumulation of discarded material that impedes the movement of water and/or substrate.	Metal Pipe, Aerial Pipe, Quarry Tailing, Failed Culvert, Collapsed Bank Revetment
Estimated Natural Upstream Limit to Steelhead Migration		
Estimated Natural Limit	Estimated location where the stream sustains a slope exceeding 10%. Method based on CDFG estimated upstream limit to salmonid migration, where direct surveying is not possible.	Sustained Slope Exceeding 10%

The barrier "Definitions" are based on local structural observations and defined by Stoecker for this project and are not intended to be an established or accepted definition.
Some structures may fit into multiple barrier categories (i.e. a Bridge and Grade Control Structure)

Table 7.2

The following graph summarizes the quantity of different types of barriers identified in this project.



Barrier Types and Numbers
Figure 7.2

7.3 Barrier Severity

In order to determine the impact of a barrier to steelhead, the severity of the structure to steelhead migration needed to be assessed. For steelhead recovery planning purposes, improving upstream, adult steelhead migration is most critical. Providing adult steelhead upstream passage at existing barriers allows the range of the steelhead population to expand along with resulting juvenile steelhead and coastal rainbow trout populations that can recolinize the habitat opened up to returning adult steelhead. Upstream passage requirements for adult steelhead are far different than for smaller, upstream migrating rainbow trout or juvenile steelhead. The smaller, juvenile steelhead and rainbow trout do not have the jumping and swimming capabilities that adult steelhead have and are prevented from upstream passage more readily than adult steelhead. Many barriers identified in this report are impassable for juvenile steelhead and rainbow trout during all flow conditions, but allow adult steelhead to migrate upstream during migration flows. In order to focus recovery efforts on the barriers that will have the greatest benefit for adult steelhead, which in turn will expand the range of juvenile steelhead and rainbow trout, severity ranking scores where applied for upstream adult steelhead migration. See the steelhead ecology discussion in section 1.0 for more information on steelhead migration capabilities and impacts from barriers.

7.3.1 Barrier Severity Ranking (Stoecker)

The barrier severity value was based on the degree of difficulty that a structure or natural feature would impose on the upstream migration of a healthy, adult steelhead during ideal migration flow conditions, assuming adequate upstream migration to the structure. The severity value was determined by measuring essential characteristics of the structure and adjacent stream configuration essential to evaluating steelhead migration capabilities along potential upstream migration routes past the structure. Determining barrier severity is a very site-specific process as each structure offers a unique set of circumstances that do not always conform to an established set of assessment protocol. Barrier configuration and severity are both subject to change as streambed and structural conditions alter over time. Barriers were assigned one of the following severity values based on the degree of difficulty imposed by the structure or feature. See the individual barrier descriptions and diagnosis provided for site-specific barrier severity assessment and ideal migration flow conditions.

- 0.0- Unknown
- 0.1- Negligible
- 0.2- Minimal
- 0.3- Minimal to Low
- 0.4- Low
- 0.5- Low to Moderate
- 0.6- Moderate
- 0.7- Moderate to High
- 0.8- High
- 0.9- Extremely High to Impassable- During most flow conditions this structure is impassable but, depending on the configuration of the structure and surrounding substrate, may provide an extremely high degree of difficulty for upstream passage during rare flow events. This value was also applied to natural features that were identified as impassable, but were composed of seasonally mobile material that may alter the configuration of the feature and allow limited upstream passage in the future.
- 1.0- Impassable -Upstream passage at this site was determined to be impossible for adult steelhead in the current configuration during all flow conditions. Estimated natural upstream limits, where the sustained stream slope exceeded 10%, were given estimated impassable ratings that are not specific to a given feature. These estimated natural upstream limits were applied to stream reaches where access was restricted or time was limited, as recommended by the CDFG Habitat Restoration Manual.

7.3.2 GIS Analysis of Barriers

Once barriers were digitized and their positions validated, the barriers were attributed with their Barrier ID and severity. Barriers that represented estimated upstream natural limits were also attributed. In order to analyze barriers for restoration prioritization, several calculations had to be made.

- For each barrier, the distance to the ocean was calculated using Arc View Network Analyst. The mouth of each stream was treated as an “event”, and the barrier was treated as a “facility”. Network Analyst measured the distance from the event to the facility. For linear barriers, this calculation was made from the downstream end of the barrier. The upstream end of linear barriers was also mapped and total linear length determined.

- For each barrier, the total stream length upstream to the estimated natural limits was calculated using Network Analyst and manual calculations.
- For each barrier the total stream length to the next upstream impassable barrier (severity 1.0) was also calculated. For this analysis, impassable barriers included estimated natural limits.
- For each barrier, the total habitat score upstream to the estimated natural limits was calculated. The habitat score is calculated as the length of the habitat reach multiplied by the habitat quality.
- For keystone barriers (the most downstream barrier in a watershed with a severity of 0.9 or 1.0), the total habitat score to the next severity 0.9 or 1.0 barrier was calculated.

7.4 Migration Barrier Priority Ranking

7.4.1 Migration Barrier Priority Ranking Discussion

Ranking methods can be highly useful to sort steelhead migration barriers into a rough estimate of priorities, but should be considered adaptable. There are many ways to rank migration barriers, and establishing the criteria for doing this can be tailored to the needs of the individual or group conducting the ranking. For example, an agency responsible for public roads may want to include maintenance schedules, cost of fish passage improvements, and a stream crossing's 100-year flow capacity in the criteria. Similarly, a resource manager in charge of steelhead recovery may be primarily interested in the biological benefits of improved fish passage at barriers for ranking purposes. Information provided in this report about migration barriers, watershed attributes, and salmonid status can be utilized by many different interests and modified to include desired ranking criteria components. Ross Taylor, who is designing the California Department of Fish and Game's "Priority Ranking of Culverts for Treatment", noted that a barrier ranking method is used mainly to sort the barriers into a rough-cut of high, medium, and low priority sites. Additional factors and professional judgment should be considered for scheduling remediation projects, but are not conducive to assigning a number value to (pers. comm. Taylor). Depending on the components included in the criteria and how they are applied in the ranking methodology, each method will likely come up with different priority rankings for barriers.

In order to effectively rank and prioritize the hundreds of steelhead migration barriers identified in this study, three ranking methods were developed specifically for this project to prioritize the biological benefit of implementing effective steelhead passage projects at barriers on both the watershed and regional level. The Migration Barrier Priority Ranking for Individual Watersheds method allows ranking of identified migration barriers within a watershed. Two Keystone Barrier Priority Ranking methods allow ranking of the "keystone" barriers occurring in the study areas focal watersheds for their immediate and long-term fish passage project priority. The keystone barriers within the region are identified as the most downstream structure(s) in each watershed with a barrier severity of "Extremely High Degree of Difficulty-Impassable" or "Impassable". These keystone structures are directly blocking or significantly impeding upstream adult steelhead passage within the watershed.

These ranking methods were developed primarily for the benefit of individuals and agencies involved with recovering the endangered southern steelhead and are designed to prioritize fish passage projects at barriers that will provide the greatest biological benefit to steelhead at a watershed and regional scale without including other factors beyond the scope of this project. Complex factors such as structural limitations, geomorphic challenges, ownership, transportation limitations, storm flow sizing, and fish passage project cost estimates, were not included in these ranking methods and will require additional evaluation with project preplanning efforts. The criteria for running the ranking methods developed will be described following the descriptions and scoring values for the components of these ranking methods

7.4.2 Migration Barrier Priority Ranking for Individual Watersheds

The objective of this ranking method is to arrange the migration barriers within a watershed in order from high to low biological priority for improving or providing upstream adult steelhead passage. The highest priority barriers are those with the highest barrier severity and greatest total habitat score upstream of the barrier to the determined, or estimated, natural upstream limit(s). This method ensures that the most severe migration barriers in a watershed receive the highest priority and are arranged in ranking from the furthest downstream structure directly impacting anadromous steelhead to structures upstream that may impact steelhead in the future with adequate downstream access. This method allows migration barriers within the accessible “anadromous reach” of a watershed and the inaccessible “non-anadromous reach” to be ranked and prioritized assuming restoration efforts allow upstream access to the barrier.

Criteria

1) All watershed barriers that received a barrier severity of 1.0 (Impassable) and 0.9 (Extremely High Degree of Difficulty - Impassable) were first ranked simultaneously in descending habitat scores upstream of the barrier to the identified, or estimated, natural limit(s) to migration.
2) Barriers with a severity of 0.8 (High Degree of Difficulty) were group together and ranked next in the same manner and following the previous grouping of 0.9 and 1.0 severity barriers.
3) Each successive barrier severity grouping from 0.7 to 0 was ranked in the same manner and following where the previous ranking number left off.
4) Where major tributaries were encountered, barrier ranking continues in the same grouping manner for both tributaries at the same time, giving the higher ranking to the barrier(s) that have the highest habitat score. In the Carpinteria Creek watershed, for example, barriers on Gobernador Creek received a higher ranking than those on upper Carpinteria Creek upstream of the confluence due to the larger upstream habitat scores associated with barriers on that tributary.

7.4.3 Customizing the Barrier Ranking Method

This method is designed to give priority to the barriers with the highest barrier severity and the largest total habitat score to natural upstream limits. It is logical that the ranking of barrier with similar severities should move upstream from the ocean where returning adult steelhead would be attempting to migrate from. This method focuses on giving the highest ranking to barriers that block or severely impede upstream passage, in order to reestablish migratory connectivity and promote steelhead recolonization of unpopulated reaches. With this ranking method, a 0.8 severity barrier may receive a lower rank than an impassable 1.0 severity barrier upstream, despite the importance of improving upstream migration at the “high” severity structure in the future. This ranking method can easily be run differently using the provided information on the migration barrier table for each watershed and modifying the ranking method. For example, the barrier ranking could be made more conservative by including 0.8 severity barriers in the first grouping (#1) of the ranking criteria. This modification would elevate the ranking of barriers that are potentially passable during ideal flows conditions, but have a high degree of difficulty.

7.5 Recommended Actions for Barriers

Site-specific characteristics of identified barriers were taken into consideration in formulating recommended actions, which are described in the individual barrier write-ups. Recommended actions for fish passage improvement projects at migration barriers were formulated on a site-specific basis using "Preferred Treatment Options for Unimpeded Fish Passage" identified in the California Department of Fish and Game's *California Salmonid Stream Habitat Restoration Manual,* the National Marine Fisheries Service *Guidelines for Salmonid Passage at Stream Crossings,* personal communications with CDFG and NMFS Fish Passage Experts, field assessment, and based on previous fish passage project experience. While both of these guidelines focus on road crossings, the preference for eliminating "encroachment into the 100-year flood plain" can be applied to other structures within the stream channel that are impeding steelhead migration. The following top two recommendations for fish passage improvements at stream crossings are from the NMFS guidelines (Final Draft: March 22, 2000) and are listed in order of preference.

1) Bridge- with no encroachment into the channels 100-year flood plain.
2) Streambed alteration strategies- bottomless arch culvert, embedded culvert, or ford.

The California Department of Fish and Game guidelines also note that:

1) Entry jumps (into a culvert or onto a structure) should never exceed 1.0 foot for upstream adult steelhead passage.

Recommended actions for fish passage improvement projects were formulated based on the most effective action to ensure effective passage over a wide range of flows and sustainable over the long term. In many cases, the complexity of the migration barrier, uncertain purpose, unknown owner, adjacent structures dependant on the barrier, or other factors may require that additional studies be undertaken to identify alternatives for improving fish passage. According to new NMFS and CDFG guidelines, upstream juvenile steelhead and rainbow trout passage must be included with fish passage improvement projects.

7.6 Barrier Analysis, Priority Ranking Results, and Recommended Actions

The following section is broken up into focal watersheds and provides information about migration barriers, barrier impacts on steelhead accessibility, and habitat impeded by the presence of barriers. The results of the Migration Barrier Priority Ranking for Individual Watersheds are included on the migration barrier table for each watershed. Write ups for individual barriers are provided with descriptions, fish passage diagnosis, and recommended actions for improving steelhead passage. Actions were also recommended along with fish passage projects would that improved habitat conditions for steelhead. This section was set up this way so that individuals and agencies interested in one watershed could easily pull that watershed smaller section from the report for planning purposes. Due to time and budget limitations, several barriers do not have detailed write-ups or recommended actions. Photographs are provided for many of the structures that do not have barrier write-up. Many of these barriers are similar to other structures described in the report and similar recommended actions can be determined by comparison. All accompanying photographs should be credited to Matt Stoecker unless otherwise noted in the write up.

7.7 Watershed Barrier Descriptions

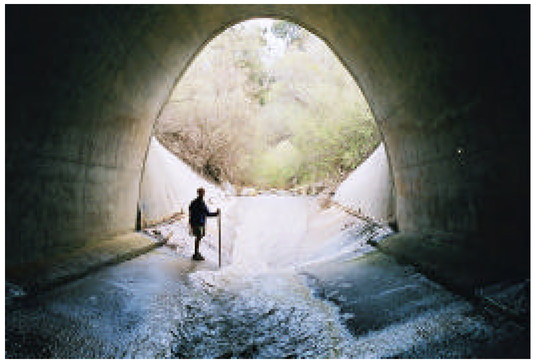
Refer to Map Folder for:
Rincon Creek Map
Map 7.7.1.1

Refer to Map Folder for:
Rincon Creek Map
Map 7.7.1.1

Refer to Table Folder for:
Rincon Creek Barrier Table
Table 7.7.1.2

Refer to Table Folder for:
Rincon Creek Barrier Table
Table 7.7.1.2

Barrier ID: BR_RN_1
Stream: Rincon
Barrier Type: Culvert and Apron
Location: Highway 101 Crossing
Ownership/Interest: CALTRANS



Description: This concrete arch culvert has a shallow U-shaped bottom and mild slope for over 800 feet to the base of a steep inlet apron. Three small 8-12 inch tall concrete drops occur along the length of the culvert. The inlet apron measures 41 feet in length with a vertical height of 6 feet 5 inches from the downstream culvert bottom to the upstream apron lip. The slope of the inlet apron measured greater than 15%. A detailed analysis of this culvert, along with fish passage analysis and alternatives, is discussed in a report titled, Preliminary Plan Formulation Report for the Rincon Creek Aquatic Ecosystem Restoration Project Santa Barbara/Ventura County, California prepared by MEC Analytical Systems, Inc. for the U.S. Army Corps of Engineers, Los Angeles District 2002.

Diagnosis: During migration flows, steelhead can easily swim into the outlet of the culvert, which is at streambed level or slightly submerged, depending on stream flow and lagoon influence from downstream. The mild slope of the culvert and three, small concrete drops would allow moderately difficult upstream passage of adult steelhead for over 800 feet through the culvert to the base of the inlet apron. The steep slope of this inlet apron, length, and smooth concrete characteristics produce excessive water velocities during all migration flows, in addition to shallow conditions during lower stream flows, that preclude all upstream steelhead passage. The culvert is currently not sized to carry a 100-year flow event (pers. comm. Capelli).

Recommended Action: Of the three alternatives recommended in the above-mentioned report, the alternative to replace the culvert with a bridge would provide the most effective upstream migration for steelhead as well as meet the 100-year flood conveyance capacity. In addition, this alternative would restore approximately 850 feet of aquatic and riparian habitat that is currently buried, including the upstream portion of the lagoon. The high amount of suspended sediment in lower Rincon Creek also plays a role in fish passage project effectiveness. Steelhead migration in lower Rincon Creek is impaired by the high suspended sediment loads coming from Casitas Creek and fish passage at the Highway 101 culvert needs to be highly effective over a wide range of flows, especially lower flows when water turbidity is not as great.
See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_RN_2
Stream: Rincon
Barrier Type: Bridge and Grade Control Structure
Location: #1 Highway 150 Bridge
Ownership/Interest: CALTRANS

Description: Downstream from this Highway 150 bridge, a concrete curb of varying thickness spans 42 feet across the entire stream channel. Sediment has accumulated behind this curb to within one foot of the top. Water is mainly concentrated over the middle and river-left portion of the curb at lower flows. A riprap apron composed of concrete slabs extends 7 to 9 feet downstream from between 6 inches to 2 feet below the lip of the curb. The apron has a moderate downward slope. Flows drop vertically from the downstream end of the apron 2 to 3 feet into the pool downstream. The maximum depth of the downstream pool measured 2 feet 2 inches. The overall height of the structure from pool surface to the lip of the concrete curb measured 5 feet.

Condition: This structure is in fair condition with several feet of undercutting on the downstream side of the apron. The alignment of the bridge and Highway 150 seem to be contributing to significant bank erosion upstream of the bridge.

Diagnosis: The downstream pool is sufficiently deep to provide a moderately difficult jump at migration flows onto the riprap apron. Due to the lack of resting spots on the 7-9 foot long sloping apron, turbulent water flow, highly turbid water from erosion inputs on Casitas Creek, and the presence of the 6 inch to 2 foot tall concrete curb at the upstream end of the apron, adult steelhead passage at this structure has an extremely high degree of difficult under ideal flow conditions. Adult steelhead may be able to clear the entire structure on the river-right side where the horizontal jump is only 7 feet, but during these higher flow events the high-suspended sediment load caused by Casitas Creek inputs may prevent navigation of the structure. Juvenile salmonids are likely precluded from upstream migration during all flows.

Recommended Action: CALTRANS is currently planning the replacement of this bridge and realigning a section of Highway 150 away from the creek bank. A natural unimpeded streambed would pass under the proposed new bridge (pers. comm. Cesena). Implementing this proposed CALTRANS bridge replacement and road realignment project that provides unimpeded upstream migration of salmonids is recommend.

Barrier ID: BR_RN_3
Stream: Rincon
Barrier Type: Bridge and Grade Control Structure
Location: #2 Highway 150 Bridge
Ownership/Interest: CALTRANS

Description: Under the #2 Highway 150 Bridge the streambed is covered with smooth relatively flat concrete that extends 25 feet from the upstream end to a small, concrete and boulder riprap curb that measured 46 feet across the stream channel. The curb measured 6 inches to 2 feet in height from the downstream pool surface with a moderate downstream slope.

Condition: The structure has some undercutting on the downstream side and is in fair condition.

Diagnosis: The small size of the curb and short, relatively flat concrete channel bottom represent a minimal degree of difficult to upstream migrating adult and juvenile salmonids during most flow conditions.

Recommended Action: CALTRANS is currently planning the replacement of this bridge and realigning this section of Highway 150 away from the creek bank. A natural unimpeded streambed would pass under the proposed new bridge (pers. comm. Cesena). Implementing this proposed CALTRANS bridge replacement and road realignment project in conjunction with the downstream #1 Highway 150 Bridge (BR_RN_2) is recommended.

Barrier ID: BR_RN_4
Stream: Rincon
Barrier Type: Stone Dam
Location: Approximately 500 feet upstream from #3 Highway 150 Bridge
Ownership/Interest: Private landowner on left side of creek

Description: This dam was built with large boulders, stones, and concrete by the previous landowner to make a recreational pool upstream, but quickly filled in with sediment (pers. comm. current landowner). The dam has a shallow U-shape in the center that concentrates flows over, and around, a large boulder ledge that extends out from the dam with a moderate downward slope. The horizontal length from the upstream lip of the dam to the downstream lip of the large boulder ledge measured 8 feet. Water also flows on either side of the boulder ledge down steep concrete chutes. The maximum jump depth of the pool downstream measured 5 feet 10 inches and the jump height from the pool surface to the top of the dam measured 3 feet 6 inches.

Condition: Downstream scour has caused significant undermining of the dam and adjacent revetment that is compromising the integrity of the structure. This dam is in poor condition.

Diagnosis: The lack of resting areas, shallow depth, and high velocities encountered in the two concrete chutes would require upstream migrating fish to jump to the top of the dam and across the shallow depth and/or high water velocities encountered at the top. The downstream pool has sufficient depth to allow a moderately difficult jump at migration flows. Upstream juvenile passage would be extremely difficult or impassable, depending on how much the pool backfills at higher flows.

Recommended Action: Work with the owner to determine the desirability of retaining this structure. If the structure is not desired it should be removed completely or significantly lowered to maintain the high-quality rearing habitat in the downstream pool. Lowering the dam by removing the large boulder at center would improve adult and juvenile salmonid passage while maintaining the downstream pool. While surveying this structure the current landowner noted that he regularly observes rainbow trout in the downstream pool up to 9 inches in length. This landowner seemed very positive about the salmonid population in Rincon Creek and may consider structural modifications to the dam that would benefit upstream fish passage.

Barrier ID: BR_RN_5
Stream: Rincon
Barrier Type: Private Culvert Stream Crossing
Location: #1 Crossing upstream from #3 Highway 150 Bridge
Ownership/Interest:

Description: This 12-foot wide concrete and steel road crossing spans the creek with water flowing underneath in three one-foot diameter culvert pipes. All culverts are blocked with cobbles at the upstream end, but still convey the flows encountered. Water is also flowing under the structure outside of these culverts. The downstream lip of the road crossing drops 1 foot 7 inches vertically to the irregular, concrete and boulder riprap apron that extends 20 feet downstream at a moderate to high slope. Flows are concentrated down the river-left side of the apron, which transitions into the small pool downstream. On the river-right side, the apron drops one-foot onto substrate.

Condition: The structure appears to be in poor condition with significant undermining of the crossing adjacent to the clogged culverts and minor undercutting downstream of the apron and on both adjacent banks.

Diagnosis: Minimal resting areas, shallow water depths, and high velocities associated with the rip-rap apron along with small, impassable culvert pipes and sediment blockage on the upstream side of the crossing produce extremely difficult or impassable upstream migration conditions for all salmonids at all flows. Upstream passage would require negotiating the apron at high stream flows, jumping onto the road crossing from no pool depth, and swimming across the road crossing with high water velocities. The jump required from the apron onto the road crossing is likely impossible under all flow situations.

Recommended Action: Work with owner(s) to assess the feasibility of removing this crossing and the next crossing upstream (BR_RN_6) and replacing these with one shared bridge that has a natural streambed underneath. This option would eliminate safety and access concerns for the landowners on the other side of the creek during high flows and removes two structures blocking or impeding salmonid migration. Other alternatives such as a bottomless arch culvert crossing may also provide an effective solution.

Barrier ID: BR_RN_6
Stream: Rincon
Barrier Type: Private Culvert Stream Crossing
Location: #2 Crossing upstream from #3 Highway 150 Bridge
Ownership/Interest:

Description: This concrete and steel road crossing is similar in construction to the previous, downstream crossing (BR_RN_5) although lacks the downstream apron and contains only two visible corrugated plastic culverts with one-foot diameters. Both culverts pass under the crossing on the river-right side and convey all visible water under the crossing into the downstream pool. Both culverts were clear of substrate at the upstream end and running at full capacity. No jump exists from the downstream pool into the culverts. The maximum jump depth of the downstream pool measured 2 feet 2 inches. The height from the downstream pool's surface onto the crossing measured 1 foot 4 inches.

Condition: This crossing appears to be in fair condition with moderate bank erosion on both downstream sides.

Diagnosis: Passage through the plastic culvert has a moderate to high degree of difficulty due to the high velocities inside and small diameter culverts. These culverts likely clog with sediment and/or debris during significant flow events limiting upstream passage. During migration flows, sufficient depth exists in the downstream pool to provide an easy jump onto the crossing itself, but high stream velocities and no resting areas during higher flows would produce a moderate to high degree of difficulty for passage.

Recommended Action: See recommendation for BR_RN_5.

Barrier ID: BR_RN_7
Stream: Rincon
Barrier Type: Culvert Stream Crossing
Location: #3 Crossing upstream from #3 Highway 150 Bridge (#1 Stanley Park Road crossing)
Ownership/Interest:

Description: This concrete riprap crossing spans the creek at a width of 25 to 30 feet from the upstream surface edge to the downstream surface edge. This crossing has been repaired and added onto several times and contains four visible metal culverts of varying size and condition. The two smooth metal culverts on the river-left side measured one-foot in diameter and were conveying water under the crossing. At the center of the crossing two corrugated metal culverts with 2-foot diameters sit side-by-side. The river-right culvert was not conveying any water while the other culvert was. All culverts, except the 2-foot diameter culvert conveying water, were completely blocked with sediment on the upstream side of the crossing. The 2-foot diameter culvert conveying water measured approximately 25-30 feet in length with a moderate slope. The jump height into this culvert measured 10 inches and the jump depth measured 2 feet 2 inches.

Condition: The culverts are in fair to poor condition and the structure has moderate undercutting adjacent to the culverts and downstream bank edges.

Diagnosis: The one culvert that was visible from the upstream end of the crossing was running at 90% capacity during the flows encountered (~6 c.f.s). The moderate slope of this culvert produces a highly difficult passage scenario under ideal conditions and during most migration flows this culvert is likely conveying excessive water velocities or is clogged with sediment and flows are passing over the crossing. The culvert inlet appeared to be cleared recently to convey water and was surrounded by deposited substrate with a steep slope of cobbles upstream of the culvert. Passage over the top of the crossing at high flows would be extremely difficult due to the high water velocities over the smooth concrete road, lack of resting areas, and moderately difficult jump onto the crossing.

Recommended Action: Work with the owner to assess the feasibility of removing this crossing and replacing it with a bridge that does not impact the streambed or impede fish passage. Because of the low stream banks adjacent to the existing crossing it may be ideal to place a new bridge approximately 150 feet upstream near an existing pedestrian bridge where the stream banks are higher and more ideally suited for a bridge. A bridge would reduce the safety and access concerns for upstream resident that are occasionally trapped during high stream flows (pers. comm. local landowners).

Barrier ID: BR_RN_8
Stream: Rincon
Barrier Type: Culvert Stream Crossing
Location: #4 Crossing upstream from #3 Highway 150 Bridge (#2 Stanley Park Road crossing)
Ownership/Interest:

Description: This concrete and boulder riprap crossing has two 31-foot long corrugated metal culverts with 2-foot diameters conveying water through it. Both culverts are running at approximately 25% of capacity and have moderately steep slopes. Downstream of the paired culverts, water drops one-foot onto a steep boulder riprap cascade that continues to drop 6 vertical feet over 14 horizontal feet with no resting or jump pools. The downstream pool had a maximum jump depth measuring 2 feet 9 inches. The overall height of the structure from the pool surface measured 7 feet 6 inches to the downstream lip of the concrete crossing.

Condition: The structure is undercut several feet on the downstream river-left side and is in fair condition overall.

Diagnosis: Due to the long, steep boulder cascade downstream of the culverts, the lack of resting areas and jump pools within the cascade, the one-foot vertical drop below the culverts, the moderately steep culverts, and steep inlet at the upstream end of the culverts, this structure is likely impassable to all fish at all flows.

Recommended Action: Work with the owner(s) to assess the feasibility of removing this structure and replacing it with a bridge that does not impact the streambed or impede fish passage. A bridge would also reduce the safety and access concerns for upstream residents that are occasionally trapped during high flows.

Barrier ID: BR_RN_9
Stream: Rincon
Barrier Type: Stream Crossing
Location: #5 Crossing upstream from #3 Highway 150 Bridge
Ownership/Interest:

Description: This boulder and concrete structure appears to serve as equipment crossing due to the presence of tractor tracks crossing the creek just upstream. Stream flow is primarily concentrated across the center of the crossing and down a three-step cascade that flows adjacent to a large boulder. The overall vertical height of the structure from the downstream pool surface to the top of the crossing measured 8 feet 9 inches. A pool measuring 3 feet wide by 3 feet long and having a depth of 3 feet occurs on the upstream side of the large boulder. This "resting pool" is 4 feet 11 inches from the downstream pool, which has a jump depth of 4 feet 2 inches. Upstream of the above-mentioned resting pool is a 3-foot vertical jump to a shallow and turbulent second resting pool. The second resting pool measured 4 feet 6 inches across by 2 feet 6 inches long with a depth of 1 foot 5 inches. From this second resting pool, the upper-most jump rises 10 inches over 3 horizontal feet to a 2-foot deep pool on the upstream side of the structure.

Condition: Scour has eroded the downstream banks on both sides of the structure and is undermining adjacent alder trees and the crossing itself. The structure is in poor condition and may not serve a vital purpose.

Diagnosis: The following diagnosis breaks the structure up into three separate jumps starting from the downstream pool. 1) The downstream pool provides sufficient jump depth to allow a moderately difficult jump to the first resting pool on the upstream side of the large boulder during moderate migration flows. During high flows, this small resting pool will likely have excessive velocities and turbulence to provide a resting spot. 2) During low and moderate flows, the 3-foot deep resting pool upstream of the boulder will limit the ability of adult steelhead to make the 3-foot vertical jump to the shallow and turbulent second resting pool. 3) During low flows, this last jump would be relatively easy with a short one-foot jump to the upstream pool. At best, this structure has an extremely high degree of difficulty and during most flow conditions is impassable. Because this structure was not surveyed during high flow conditions it is unknown if the downstream pool backwaters sufficiently to create improved passage opportunities.

Recommended Action: Work with owner to determine the desirability of this structure. Assess the feasibility of removing the crossing to allow unimpeded fish passage and if necessary provide alternative equipment passage. It seems likely that tractors could cross the stream during low flows without this structure. One difficulty with removing this structure appears to be the fact that it currently acts as a grade control for the private road (Stanley Park Road) running adjacent to the upstream river-right bank. Removing the structure may cause head cutting upstream that could compromise the integrity of this road. A more detailed assessment of this structure, removal impacts, and optimizing of the adjacent residential road system is recommended.

Barrier ID: BR_RN_10
Stream: Rincon
Barrier Type: Culvert Stream Crossing
Location: #6 Crossing upstream from #3 Highway 150 Bridge
Ownership/Interest:

Description: This 12-foot wide concrete and steel beam road crossing contains three one-foot diameter smooth metal culverts. All three culverts conveyed water at 50% capacity during the survey. A small amount of water flowed over the surface of the crossing. Downstream of the crossing's surface, an irregular and damaged concrete and boulder riprap apron slopes downstream over 12 horizontal feet and terminates 2-3 feet above the downstream pool. The overall height of the structure from the downstream pool surface to the surface of the crossing measured 7 feet 10 inches.

Condition: Scour on the downstream side of the structure has undercut the structure 4 feet on the river-right side. The adjacent stream banks have been eroded significantly.

Diagnosis: The downstream pool provides a sufficient jump depth of 5 feet to allow a moderately difficult vertical jump (4 feet 5 inches) and horizontal jump (6 feet) to a small resting pool broken through the concrete apron. This resting pool measured 4 feet by 2 feet with a depth of 16 inches. From this resting pool, steelhead would attempt to migrate through the culverts at low and moderate flows. Passage through the culverts is not possible due to the constricted size and smooth characteristic of these pipes, presence of obstructive concrete and boulders at the culvert outlets, moderate slope, and deposited sediment at the upstream inlet. With higher stream flows it may be possible, although extremely difficult, for steelhead to jump and swim onto the crossing and migrate upstream. During all stream flows, this structure would likely be impassable to upstream steelhead migration or, at best, presents an extremely high degree of difficulty.

Recommended Action: Work with owner to assess the feasibility of removing this structure and replacing it with a bridge or natural streambed alternative such as a large bottomless arch culvert.

Barrier ID: BR_RN_11
Stream: Rincon
Barrier Type: Stream Crossing
Location: #7 Crossing upstream from #3 Highway 150 Bridge
Ownership/Interest:

Description: This relatively flat, concrete and steel crossing appears to convey all stream flow over the surface of the road. The crossing is elevated 10 inches above the streambed with a small 11-inch deep pool downstream.

Condition: The crossing appears to be in fair condition with minor cracking and minimal undercutting.

Diagnosis: Due to the minimal jump required and relatively flat slope of the crossing, this structure represents a low degree of difficulty to upstream adult steelhead migration and likely does not impede juvenile salmonid passage under most flow conditions.

Recommended Action: Fish passage improvements should be implemented if the upstream resident wants to replace this crossing with a different alternative for safety reasons, but the benefit of modifying this structure for salmonid passage is minimal. This crossing should be monitored to ensure that scour does not increase the jump height of the crossing in the future.

Barrier ID: BR_RN_12
Stream: Rincon
Barrier Type: Bedrock and Boulder Waterfall
Location: Approximate elevation 520 feet
Ownership/Interest:

Description: This waterfall is created by two large boulders that have wedged against the adjacent bedrock wall on the river-left side of the stream. Stream flow is confined between the bedrock wall and upstream boulder. Water flows in a curved path around the side of the large boulder and along the bedrock wall before falling vertically at the base of the large boulder into a small pool that measured 2 feet 6 inch deep. The total jump height from the downstream pool surface to the top of the falls measured 6 feet 10 inches.

Condition: The structure appeared to be fairly stable, but subject to change over time as the wedged boulders break up and/or mobilize downstream.

Diagnosis: Due to smaller boulders at the base of the waterfall, the pool depth downstream is not sufficient to allow a jump over the falls during low to moderate flows. During high flows, the downstream pool will likely backwater sufficiently to allow a difficult jump to the top of the waterfall.

Recommended Action: No action is currently recommended, as this waterfall appears to be a natural impediment.

Barrier ID: BR_RN_13
Stream: Rincon
Barrier Type: Quarry Tailing Blockage
Location: Approximate elevation between 520-660 feet
Ownership/Interest:

BR_RN_13: Rock Quarry Looking Upstream

Description: This barrier description includes a significant reach of Rincon Creek that has been extremely modified from a past rock quarry operation. This section of stream has been dramatically confined and partially buried with large boulder debris that was blasted from the adjacent canyon walls. Debris tailing mounds below the blasting sites (especially on the river-left side of the stream) have created excessive stream gradients associated with boulder cascades, waterfalls, and bedrock chutes. Specific features of this modified stream reach are discussed below as they relate to potential upstream steelhead passage.

Condition: This is an extremely altered stream reach with major channel realignment and riparian degradation.

Diagnosis: Four impassable features within this quarry reach are discussed below starting with the most downstream feature at the lower end of the quarry section and proceeding upstream.

1) Steep Boulder Gradient- Large boulder debris from the quarry has created a 77-foot long section of steep boulder cascades near the lower end of the quarry with a measured slope of 18%. This section is impassable to all salmonids during all flow conditions.

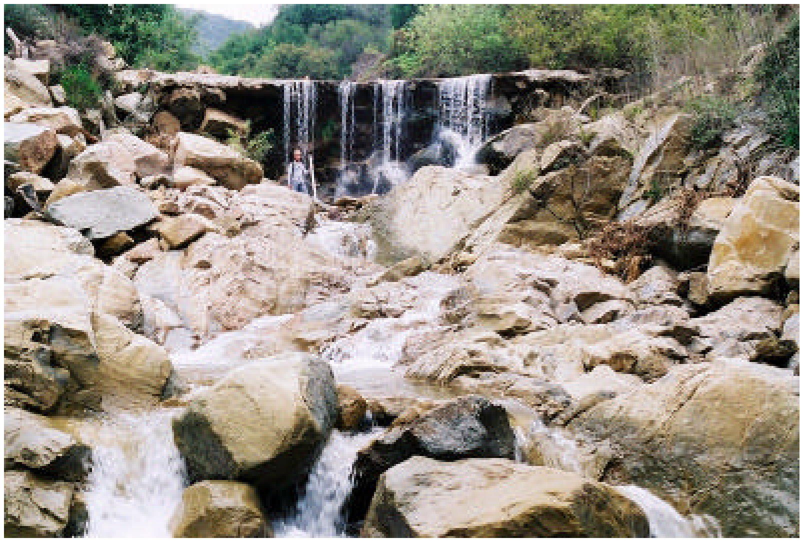
2) Boulder Waterfall/Cascade- Upstream of the steep boulder gradient a large boulder jam has produced a long section of boulder cascades and a waterfall that measure 29 feet in total height. This section is impassable to all salmonids at all flows.

BR_RN_13: Boulder Waterfall/Cascade

3) Bedrock Chute- A steep bedrock chute exists upstream of the boulder waterfall/cascade that has a total height of 15 feet and slope in excess of 30%. This feature does not appear to be part of the original streambed and is likely a result of the debris-tailing mound on the river-left side of the stream confining the stream against this bedrock on the river-right side.

BR_RN_13: Bedrock Chute

4) Failed Road Crossing- Near the upstream end of the quarry operation, downstream from the Rincon Creek Trail crossing, a failed road crossing spans most of the stream channel and has a height of 15 feet. The far river-right side of the crossing has blown out and no longer connects to that stream bank. This structure appears to be eroding rapidly but currently would be impassable for upstream steelhead migration.



BR_RN_13: Failed Road Crossing

Historical Note- Anglers familiar with this stream prior to the quarry operation (1958) believe that steelhead were able to migrate upstream of this site and regularly caught salmonids upstream of the quarry (pers. comm. Sjovold, Henke). According to Mr. Sjovold, the quarry ruined approximately 0.75 mile of some of the best trout habitat in Rincon Creek. Sjovold noted that trout were caught throughout the quarry reach the two years prior to the quarry operation and rainbow trout up to 13-14 inches were caught up to 3.5 miles upstream from the quarry site. It is my impression after surveying this reach and interviewing knowledgeable individuals that steelhead were likely capable of migrating upstream of the quarry site, but the original streambed has been completely buried with quarry debris in many areas and/or realigned against bedrock walls and is now completely impassable to all fish at all flows. Calculations made using a USGS topographical map that was field checked in 1952, prior to quarry operations, indicate that the stream slope through this pre-quarry section reached a maximum slope of around 8%. Steelhead are known to migrate up to, and sometimes past, stream reaches with a 10% slope (CDFG Habitat Restoration Manual).

Recommended Action: According to Mr. Sjovold, the quarry was a major petroleum related operation that extracted rock to build the Richfield Island, southeast of Rincon Point. It is believed that a conditional use permit was obtained from both Santa Barbara and Ventura Counties and a lease was obtained from the Los Padres National Forest to extract rock from the quarry. Under this conditional use permit, Sjovold recalls that the quarry operator was required to restore the creek after the quarry operation ended and this never happened. Sjovold believed that Atkinson Construction filed the mining claim and was under contract to Richfield (now ARCO-Atlantic Richfield Company) to build the Richfield Island. Recommendations for this section of Rincon Creek include:

1) Locating the original permits, leases, and information regarding the quarry operation as well as the construction of roads to access the quarry, which may include downstream barrier crossings.
2) Determining the owner/operator of the quarry at the time of construction and current owner of the quarry's products (i.e. Richfield Island) and others.
3) Work with appropriate owners and stakeholders to address restoring this section of Rincon Creek and potentially mitigate the damage that has occurred due to the quarry and potential road crossings.
4) Assess the feasibility of providing unimpeded steelhead migration through this stream reach to the upper watershed.

Refer to Map folder for:
Carpinteria Creek Map
Map 7.7.2.1

Refer to Map folder for:
Carpinteria Creek Map
Map 7.7.2.1

Refer to Table Folder for:
Carpinteria Creek Barrier Table
Table 7.7.2.2

Refer to Table Folder for:
Carpinteria Creek Barrier Table
Table 7.7.2.2

Barrier ID: BR_CA_1
Stream: Carpinteria
Barrier Type: Pedestrian Culvert Crossing
Location: 50 feet upstream from Highway 101 Bridge
Ownership/Interest: City of Carpinteria

Description: This pedestrian crossing has three small concrete box culverts at the center of the structure that convey low stream flows under the crossing. Each of the three adjacent box culverts measured 60 inches wide with a height of 20 inches. The bottom of each the culvert was partially embedded with streambed substrate and the middle culvert was completely clogged with debris and aquatic vegetation. The relatively flat slope within the culverts is consistent with that of the streambed. The top of the crossing is smooth concrete and relatively flat.

Condition/Sizing: This structure is in fair condition with minor damage to the concrete from bedload sediment abrasion during high stream flows. The crossing is designed to carry low stream flows through the culverts and higher stream flow over the top. The culverts are highly susceptible to clogging.

Diagnosis: The short length, minimal culvert slope, and at-streambed level of the culverts present a low to moderate degree of difficulty to upstream adult steelhead migration. Should the culverts all become clogged during high stream flows and water is conveyed over the structure, adult steelhead would still be able to migrate upstream with a moderately difficult jump onto the crossing and short burst across the top. Migration over the top of the crossing could delay upstream migration due to the need for adequate water depth on top of the crossing in conjunction with tolerable water velocities.

Recommended Action: The City of Carpinteria and Carpinteria Creek Committee are currently discussing fish passage improvements at this pedestrian crossing. Because this structure is the lowest significant impediment to upstream steelhead migration in the watershed, discussions of removing the crossing are encouraged to eliminate blockage hazards and delays to upstream migration. A pedestrian bridge or existing alternative crossing site that does not impact the streambed is recommended.

Barrier ID: BR_CA_2
Stream: Carpinteria
Barrier Type: Private Stream Crossing
Location: Driveway at 6217 and 6199 Casitas Pass Road
Ownership/Interest: Bliss

Description: This crossing consists of a concrete road that spans the entire stream channel in a mild U-shape between the bank tops. The crossing is 28 feet wide with an overall length across the creek of approximately 100 feet, depending on where measurements are taken. The overall length of the crossing from bank to bank is difficult to determine because there has been significant modification of the banks to create the gradual U-shape crossing. Downstream of the crossing, large boulders have been placed to reduce scour and undercutting of the concrete crossing. These large boulders extend downstream from the crossing 20 feet producing an irregular and moderately steep cascade. Concrete and boulder riprap extends downstream from the crossing on both banks.

Condition: The structure is in poor condition with many breaks in the concrete, exposed metal bars, significant undercutting of the downstream side of the crossing, and moderate bank erosion.

Diagnosis: The overall height of the crossing, from the bottom of the downstream pool to the downstream lip of the crossing, measured 8 feet. During moderate flows, the 2-foot deep pool at the downstream end of the boulder cascade would provide sufficient depth to provide a steelhead with a moderately difficult jump approximately half way up the boulder cascade to a small, 1-foot deep resting pool 6 feet downstream from lip of the crossing. From this resting pool, a steelhead would need to jump vertically 4 feet and horizontally 6 feet in order to land on the top of the crossing. Executing this jump from the shallow resting area would likely be impossible due to the lack of pool necessary to gain enough jumping acceleration. The shallow, sheeting flows over the crossing during low flows and fast velocities encountered during high flows make this jump, landing, and migration across this crossing extremely difficult or impossible, depending on the configuration of the downstream boulder cascade and stream flows.

Recommended Action: Due to the extremely high severity of this structure to upstream migration and location downstream of virtually all productive spawning and rearing habitat in the watershed, this structure must be removed or modified to ensure effective upstream passage of steelhead. The Carpinteria Creek Committee and Department of Fish and Game are currently working on addressing improved steelhead passage at this site. Removing this structure and replacing it with a bridge that does not impact the channel is recommended and would provide the most effective, long-term solution to the fish passage situation and possibly for the landowner. The relatively narrow stream channel provides an adequate situation for a bridge at, or near, this site. Because of the significant amount of sediment trapped behind this crossing and the change in streambed elevation downstream, additional studies are needed to determine what possible impacts would be associated with removing this structure. Carl Stucky, who is a contact with the owner of the crossing, reported that a bridge would need to be able to carry 40,000 pounds of weight and ideally a gate restricting access from the public at the Highway 192 entrance would accompany a new crossing.

Barrier ID: BR_CA_3
Stream: Carpinteria
Barrier Type: Metal Pipe Blockage
Location: Approximately 200 feet downstream from Highway 192 Bridge
Ownership/Interest:

Description: A small pipe crosses the creek and traps a small amount of stream substrate upstream. The pipe has a height of 20 inches from the downstream streambed. The purpose and history of this small pipe obstruction is not known.

Condition: The pipe had experienced considerable wear and is in poor condition.

Diagnosis: During migration flows, all life stages of salmonids could migrate upstream past this structure with a minimal to low degree of difficulty.

Recommended Action: Determine the purpose and desirability of the pipe and if feasible remove the metal pipe to prevent additional blockage or future safety hazards associated with a failure. Removal of this pipe would take minimal effort with a power saw.

Barrier ID: BR_CA_4
Stream: Carpinteria
Barrier Type: Gaging Weir
Location: Approximately 140 feet upstream from Highway 192 Bridge
Ownership/Interest: USGS

Description: This gauging station consists of a concrete curb that extends across the stream channel and is keyed into a sloping concrete wall on the river-right bank. The curb ranges in height from 12 inches to 26 inches from the downstream streambed.

Condition: The structure is in fair condition with moderate damage to the concrete curb.

Diagnosis: At migration flows this structure would be submerged or produce a minimal jump for upstream steelhead passage with a low degree of difficulty.

Recommended Action: Improved fish passage is not critical, but any future modifications of this structure should ensure easy upstream passage. Continue to monitor this site to ensure that scour does not produce more difficult passage conditions. Any modifications would need to be coordinated with USGS.

Barrier ID: BR_CA_5
Stream: Carpinteria
Barrier Type: Private Stream Crossing
Location: Approximate elevation 180 feet; Upstream boundary of Cate School property.
Ownership/Interest: Cate School Corporation

Description: This concrete crossing spans 76 feet across the stream channel and into loose silt, sand, and cobble-dominated banks. A 2-foot diameter metal pipe extends from under the structure. The crossing has a shallow concave in order to concentrate stream flows across the center of the smooth concrete surface. The centerline of this concave has three distinct slope changes along the 33 feet from the downstream lip to the upstream lip. Starting from the downstream edge, the first 9 feet had the steepest slope measured at 15.7%. The next 15 feet had a slope measured at 6.1%. The most upstream 9 feet, where vehicles would cross the structure, has the mildest slope of 3.7%. The surface of the structure rises 2 feet 8 inches over 33 feet for an average slope of 8.1%. 100 feet downstream from the crossing, the slope of the natural streambed was measured at 2.6%. The concrete measured between 2 and 2.5 feet thick from the exposed footing to the surface lip on the downstream side of the crossing. Downstream scour has produced a 4-foot vertical drop from the downstream edge of the structure to the deepest part of the streambed where a jump pool for steelhead would form during migration flows.

Condition: The concrete is in fairly good condition but the structure has been severely undercut and side cut by stream flows that have caused major downstream scour under the entire structure and on both stream banks. A large hole on the upstream side of the crossing has undercut the middle of the structure and washed away streambed material that the concrete crossing was original poured onto producing a 15-foot wide by 17-foot long void under the crossing that is over 2-feet deep. This crossing is on the verge of complete failure and presents a hazard both to vehicular passage over the crossing and to private property during flood flows.

Diagnosis: The undersized metal pipe under the crossing is non-functional with the intake buried under the sediment backed up behind the structure. No fish passage could occur through this pipe. At the time of the survey there was no visible route under the crossing. Assessment of watermarks, substrate scour, and the downstream tail-water control indicates that a pool of at least 2 feet deep will develop downstream of the crossing during migration flows. During these conditions, a moderately difficult jump of 2 feet would allow steelhead to jump onto the downstream portion of the crossing. The smooth concrete and slope of over 15% would have shallow, high velocity flows making upstream migration extremely difficult or impassable for adult steelhead. In addition, the flows passing under the crossing into the jump pool would interfere with hydraulic conditions needed for jumping onto the structure.

Recommended Action: Work with landowner to determine if this structure is necessary or if alternative crossings in the area could provide access across the stream. If the crossing is not necessary or access can be obtained elsewhere, it is recommended that the structure be removed and the banks stabilized and planted with a small buffer of native riparian vegetation. The extent of sediment trapped upstream of the structure will need to be assessed prior to removal. If access at this site is necessary, a bridge with no encroachment in the stream channel is recommended.

Barrier ID: BR_CA_6
Stream: Carpinteria
Barrier Type: Private Bridge and Channelization
Location: Approximate elevation 215 feet
Ownership: Arnesen

Description: A concrete channel with four separate steps separated by three reaches of concrete channel extends 93 feet 6 inches downstream from the downstream side of a private bridge. Natural streambed occurs underneath the bridge. At the downstream end, the channel is 22 feet wide with stone and concrete walls rising almost vertically on each side. The river-right wall measured 12 feet tall and the river-left wall measures 8 feet tall. At the upstream end of the structure, under the private bridge, the channel size measures 16 feet wide and 8 feet 8 inches tall to the bottom of the metal I-beams on the bridge.

Condition: This channelized reach is in poor condition with major side cutting and the complete failure of portions of the stone and concrete wall revetment, which connect to the channel bottom. A downstream scour has caused loss of property on both banks and is compromising the integrity of the structure. The landowner noted that his bridge overtopped during the 1999 El Nino storm and had to be rebuilt: although it is still not sized for another flow event of that size (pers. comm. Arnesen).

Diagnosis: The following discussion is broken up into the four jumps and three concrete reaches of the channel that steelhead would attempt to migrate past, starting from the downstream end and working upstream.
<u>Jump #1</u>**-** Downstream of the channel, a small pool with a depth of 1 feet 6 inches provides adequate depth to allow an easy jump 1 foot 6 inches onto the first reach of the channel. During high flows a jump may not be necessary to swim into the channel.
<u>Channel reach #1</u>- This reach measured 60 feet in length with a slope of 1.1%. Shallow sheeting flows across the reach during low flows, high stream velocities encountered at higher flows, and limited resting areas across this smooth concrete reach present steelhead with a moderate to high

degree of difficulty upstream passage. The stone wall on river-right provides some roughness in the channel, which may facilitate limited migration along this reach.
Jump #2- This step rises 3 feet 1 inch vertically from the concrete reach downstream where no pool formation is possible. The absence of adequate jump depth makes upstream migration of this step extremely difficult to impassable.
Channel reach #2- This reach measured 19 feet 6 inches in length with a relatively flat slope. Upstream migration across this reach would present a moderate to high degree of difficulty due to reasons mentioned in channel reach #1.
Jump #3- This step rises 1 feet 7 inches vertically from the concrete reach downstream where no pool formation is possible. The absence of adequate jump depth presents a high degree of difficulty to upstream migration of this step.
Channel reach #3- This reach measures 11 feet 6 inches in length with an overall slope of 3.3% that gradually increases toward the upstream end. Upstream migration across this reach would present a high degree of difficulty due to reasons mentioned in channel reach #1.
Jump #4- This step rises a total of 1 foot 8 inches from the concrete reach downstream where not pool formation is possible. The absence of adequate jump depth presents a high degree of difficulty to upstream migration of this step. Upstream of this last step, natural sand and silt substrate is present with 3 inches of water depth.

Due to the combined difficulty of migrating across this complex structure, upstream steelhead migration is likely completely blocked.

Recommended Action: Work with landowner to assess the feasibility and impacts of removing the entire concrete channel and existing bridge and installing a wider span bridge with restoration of a natural streambed that does not impede fish passage. Bioengineering techniques should be investigated to stabilize the banks should such a project move forward. It is critical to provide effective, unimpeded passage at this private crossing because Carpinteria Creek regularly dries up downstream of this structure and all the perennial rearing habitat in upper Carpinteria Creek exists upstream of this structure. This structure is undersized and highly damaged and modifying the existing concrete channel for fish passage is not recommended. The landowner expressed an interest in improving steelhead passage at this site should financial incentives become available (pers. comm. Arnesen). A detailed assessment of this structure, channel removal, bridge installation, and potential bank stabilization techniques are recommended. Note: Two juvenile O. mykiss were observed in the small pool downstream of this structure on 12/17/01 (pers. observation Stoecker).

Barrier ID: BR_CA_7
Stream: Carpinteria
Barrier Type: Bridge and Apron
Location: Approximate elevation 235 feet (Crossing on USGS map)
Ownership: Pinkham

Description: Access to survey this structure was not obtained but the following information was obtained through personal communication with the owner. Under the bridge crossing, an irregular concrete and boulder apron extends downstream at a moderate slope. Because of the roughness of the boulders embedded in the apron, upstream salmonid passage is reportedly regularly achieved even by smaller rainbow trout (pers. observation Pinkham).

Diagnosis: Upstream migration of salmonids has reportedly been observed many times over the past several decades at this site. Based on communication with the landowner it was estimated that this structure presents a moderate to high degree of difficulty for upstream migration of salmonids.

Recommended Action: Appropriate members of the Carpinteria Creek Committee should contact the landowner and discuss the possibility of assessing fish passage at this site, the availability of financial incentives, and potential improvements that could be made, if deemed desirable.

Barrier ID: BR_ CA_8
Stream: Carpinteria
Barrier Type: Debris Basin Dam
Location: Approximate Elevation 340 feet
Ownership/Interest: Santa Barbara County Flood Control District

Description: This debris dam is composed of boulder and concrete riprap and is of similar construction to the Gobernador Creek debris dam (BR_CA_GR_6). A small pool downstream of riprap apron had a jump depth measuring 1 foot 6 inches. A jump height onto the riprap apron measured 4 feet 6 inches. The apron extends 35 feet from the downstream lip upstream to the outlet of the culvert with an overall slope of 4.8%. This apron has several slope changes and an irregular boulder embedded surface. The length and slope of the culvert could not be accurately determined because the culvert inlet was clogged with sediment and debris. It is assumed that the length is similar to the Gobernador Creek culvert, which measured 97 feet.

Condition: This obsolete debris basin has not been maintained for several years and accumulated sediment and debris behind the dam has clogged the culvert at the inlet and filled most of the basin. Surface flows are still able to permeate through the upstream debris and pass through the culvert. Currently, the SBCFCD has no access road to the debris basin and dam and reportedly drove heavy equipment up the stream channel to access the dam in the recent past (pers. comm. Pinkham, Vedder). Moderate undercutting is occurring on the downstream river-right side of the dam.

Diagnosis: During migration flows, the downstream pool depth will increase and a jump onto the apron and passage among the large embedded boulder apron would be possible with a high degree of difficulty for an adult steelhead. The long, smooth culvert through the debris dam is impassable to upstream migrating steelhead due to the shallow water depth during low flows and the excessive water velocities during moderate and high flows. Debris has also completely clogged the entire inlet to the culvert.

Recommended Action: Due to the abundant high quality habitat found upstream of this debris dam, steelhead passage at this location is a high priority for restoring steelhead to the Carpinteria Creek watershed. Due to the obsolete status of this debris dam, it is recommended that the SBCFCD remove the structure completely. See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_CA_9
Stream: Carpinteria
Barrier Type: Seasonal Diversion Dam
Location: Approximate elevation 390 feet
Ownership/Interest: Cate School Corporation/Vedder

Description: A 2-foot tall temporary diversion dam composed of sand, cobble, boulder, and plastic tarps backs up a small pool where a 5-inch diameter PVC pipe is diverting water. The diversion appeared to be in operation as leaves were sucked onto the pipe inlet.

Condition: The dam will blow out with a sizable flow event.

Diagnosis: The dam is impassable during low flows, but will likely blow out with migration flows to allow upstream salmonid passage. The diversion intake is well screened to prevent salmonid mortality.

Recommended Action: Include this diversion source in a water budget assessment for the watershed. Work with landowner to ensure adequate passage during migration flows and continued proper screening of the diversion intake.

Barrier ID: BR_CA_10
Stream: Carpinteria
Barrier Type: Bedrock and Boulder Waterfall
Location: Approximate elevation 450 feet
Ownership: Cate School Corporation/Vedder

Description: Several massive boulders have wedged against the adjacent bedrock walls in this narrow gorge-like reach to create a waterfall that measured 7 feet 5 inch tall from the downstream pool surface. The maximum pool depth measured 3 feet 8 inches.

Condition: Fairly stable, but mobile over time and subject to seasonal change.

Diagnosis: During low and moderate flows, the jump height of this waterfall is likely to tall to allow upstream passage. Large boulders downstream of the falls may backwater the pool several feet during high flow conditions, reducing the jump height and producing an adequate jump depth to allow a highly difficult jump over the waterfall.

Recommended Action: No action recommended for this natural feature.

Barrier ID: BR_CA_11
Stream: Carpinteria
Barrier Type: Bedrock Waterfall
Location: Approximate elevation 520 feet
Ownership/Interest: Cate School Corporation/Vedder

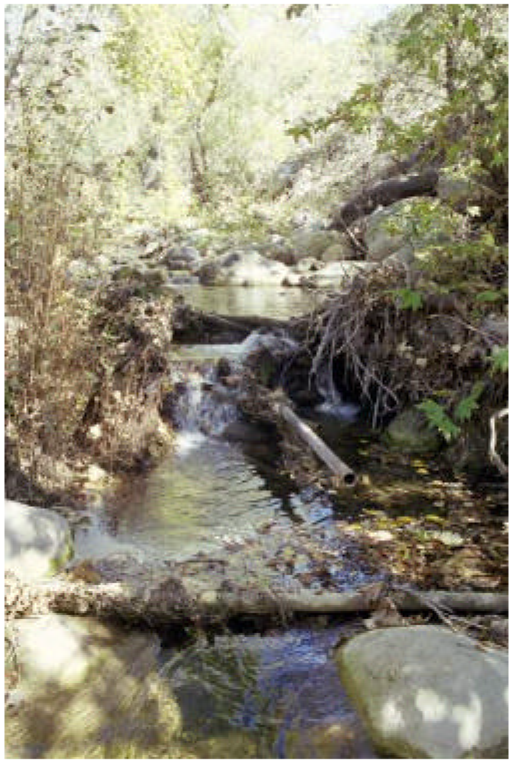
Description: At low flows this steep sloping waterfall has a vertical height of 12 feet 10 inches from the surface of the downstream pool to the lowest point at the top of the waterfall. Flows are evenly divided during low flows between the steep slope on the river-right side of the bedrock structure and a sloping chute on the river-left side. The maximum depth of the downstream pool measured 9 feet 10 inches during the low flow encountered.

Condition: This bedrock structure is very stable.

Diagnosis: During low and moderate flows this structure is likely impassable due to the excessive jump height, although the ideal jumping pool downstream is deep enough to test the limits of how high a healthy adult steelhead can jump. Adult steelhead have been observed jumping over a 10-foot tall waterfall in a British Columbia stream with a deep downstream pool such as this one (pers. observation Stoecker). During high flow conditions, the downstream pool will likely increase in depth several feet to reduce the jump height and increase the jump depth to produce a short window of extremely difficult upstream adult steelhead passage. Smaller adult steelhead may not be able to make the jump while large, healthy adults may be able to make the jump under ideal conditions.

Recommended Action: No action recommended for this natural feature.

Barrier ID: BR_CA_GR_1
Stream: Gobernador
Barrier Type: Metal Pipe Blockage
Location: Approximate elevation 260 feet
Ownership/Interest:



Description: Several abandoned metal pipes have become wedged and entangled to produce a drop of 3 feet over to small step.

Diagnosis: During low flows, upstream migrating salmonids need to execute an easy 2-foot jump into a small resting pool produced by the metal pipes and then jump 1-foot over the top of the last pipe. Upstream migration past this site has a minimal to low degree of difficulty.

Recommended Action: These metal pipes should be removed to avoid additional blockage and to eliminate this unnecessary hazard. Salmonids may benefit from this easy removal job by providing unimpeded passage, reduced risk of injury from getting cut by the old metal pipes, and eliminating additional blockage at this site or downstream in the future.

Barrier ID: BR_CA_GR_2
Stream: Gobernador
Barrier Type: Stream Crossing
Location: Approximate elevation 280 feet
Ownership/Interest:

Description: This concrete low-flow crossing is at streambed grade and passes all water over the top of the structure. The relatively flat crossing spans the entire stream channel and is approximately 9 feet wide, although partially buried.

Condition: The crossing is in good condition with no significant damage or associated erosion. This crossing does not appear to be used often with vegetation growing over the driveway approaches.

Diagnosis: Due to the flat slope of this crossing and easy access past the streambed level concrete, upstream passage for all salmonid life stages has a minimal to low degree of difficulty. At extremely high flows, upstream migration may be somewhat more difficult than natural conditions due to the lack of resting areas over the crossing.

Recommended Action: Minimal benefit to salmonids would result from modifying or removing this structure. Continue to monitor the crossing and contact landowner to determine if it is desirable. If easy migration conditions change or the landowner is interested in eliminating the crossing, it could be removed with relative ease and likely minimal disturbance to the surrounding area.

Barrier ID: BR_ CA_GR_3
Stream: Gobernador
Barrier Type: Box Culvert Stream Crossing
Location: Approximate elevation 290 feet
Ownership/Interest:

Description: This concrete crossing spans the stream channel in a gradual U-shape from bank top to bank top. A concrete box culvert measuring 60 inches wide and 26 inches tall at the downstream end extends 136 inches under the center of the crossing. A debris grate composed of 2-inch diameter metal bars surrounds the inlet of the culvert where flows drop 23 inches from the upstream substrate down into the culvert bottom. The pool below the crossing extends into the culvert and created a depth of 8 inches throughout.

Condition: The concrete structure and debris grate are in fair conditions with moderate damage from bedload sediment passing over and through the crossing at high flows.

Diagnosis: During most migration flows upstream salmonid migration into the backfilled culvert is easy. The jump from inside the culvert, through the metal grate, and out the top of the inlet would be highly difficult or impossible during all flow conditions. It is likely that this grate becomes blocked with debris during high flows that correspond to upstream migration times. Steelhead might be able to make a highly difficult jump on top of the crossing and burst across it during ideal moderate to high flow conditions. Overall, this structure presents a high degree of difficulty to upstream migrating steelhead.

Recommended Action: Work with landowners on the west side of Gobernador Creek in this area to determine if one new crossing can be jointly used to facilitate access across the creek. Investigate the possibility of removing this and the next upstream crossing (BR_CA_GR_4) and installing a bridge that does not impact the streambed and provides landowners with access during all flows. The downstream crossing (BR_CA_GR_2), which is easily passable for steelhead, could still be utilized as a secondary crossing. If removing the two crossings and combining access with one bridge is not possible, then each of these crossings should be considered for removal and replacement with a bridge or other streambed simulation strategy that does not impeded upstream migration.

Barrier ID: BR_ CA_GR_4
Stream: Gobernador
Barrier Type: Box Culvert Stream Crossing
Location: Approximate elevation 300 feet
Ownership/Interest:

Description: This concrete stream crossing is very similar to the next downstream crossing (BR_CA_GR_3) and was likely built around the same time and possibly by the same individual(s). The crossing spans the entire stream channel in a gradual U-shape from bank top to bank top. A concrete box culvert measuring 60 inches wide and 28 inches tall at the downstream end extends 146 inches under the center of the crossing. A debris grate composed of 3-inch diameter metal bars covers the inlet with a flat, parallel configuration and 6-inch spacing between the bars. Flows pass through the grate and down a steep slope at the inlet of the culvert and drop 40 inches to the culvert bottom. Unlike the crossing downstream, the culvert bottom extends downstream of the culvert 34 inches and forms a small ledge. At low flows, water drops 3 inches off this ledge into a pool downstream with a maximum depth of 3 feet.

Condition/Sizing: This structure is in extremely poor conditions due to major undercutting of the road on both downstream sides (up to 7 feet deep) and scour on adjacent downstream banks. The integrity of this crossing is compromised due to scour influenced by the crossing.

Diagnosis: During migration flows, steelhead would have easy access into the culvert as the downstream pool partially submerged the culvert, or with an easy jump onto the concrete ledge. Upstream migration through the culvert would be extremely difficult or impossible during all flows due to the absence of any pool depth inside the culvert, high velocities or shallow flows within the culvert, lack of resting areas, the excessively steep slope at the inlet, and the presence of the metal grate. In addition, during high flow events the grate is likely susceptible to clogging and may be completely blocked. When water is flowing over the top of the crossing, adult steelhead may be able to execute an extremely difficult jump onto the culvert and burst across surface. Steelhead that could make the jump would also have to avoid being sucked back into the culvert if it was not clogged.

Recommended Action: See recommendation for BR_CA_GR_3.

Barrier ID: BR_ CA_GR_5
Stream: Gobernador
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 345 feet
Ownership/Interest:

Description: This private crossing is composed of boulder and concrete riprap and spans the stream channel in a shallow U-shape. The overall height of the structure, from the crossing's surface to the bottom of the downstream pool, measures 15 feet. The maximum pool depth measured 5 feet giving the structure a height of 10 feet tall from the pool surface. During low flows, water is conveyed under the crossing in three irregularly placed metal pipes with equal diameters of 10 inches. Water flowing out of the culverts cascades 7 feet down a steep riprap section onto a moderately sloped step measuring 70 inches in length and then falls almost vertically 3 feet 6 inches into the downstream pool. The overall horizontal distance from the pool to the downstream lip of the crossing measured 15 feet. Sediment is backed up to the top of the upstream side of the structure.

Condition/Sizing: The crossing is in poor condition with moderate concrete wear, significant undercutting of the structure, and erosion of adjacent downstream banks.

Diagnosis: The downstream pool has sufficient depth for a steelhead to execute a vertical jump of at least six feet and likely more during high flows as the pool becomes deeper. During migration flows, the 10-foot vertical jump and 15-foot horizontal jump to the crossing make this structure impassable to upstream migrating steelhead. The small, smooth metal culverts provide no opportunity for fish passage.

Recommended Action: Work with landowner to identify options and structural requirements for this access and assess the feasibility of removing the crossing and replace it with a bridge or other streambed simulation strategy that does not impede upstream passage. This assessment will need to look at the issue of sediment trapped upstream of the crossing and potential impacts to the Debris Dam upstream. The fairly narrow stream channel in this reach is ideal for placement of a smaller bridge spanning the creek from the bank tops.

Barrier ID: BR_CA_GR_6
Stream: Gobernador
Barrier Type: Debris Basin Dam
Location: Approximate elevation 390 feet
Ownership/Interest: Santa Barbara County Flood Control District

Description: This debris dam is composed of boulder and concrete riprap and conveys low to moderate stream flows through the dam in a 4-foot diameter smooth concrete culvert that measures 97 feet in length. Water discharges from the culvert onto a 25-foot long apron composed of boulder and concrete riprap with a varying slope of approximately 4%. On the downstream side of this apron, water falls vertically 30 inches off the apron into a pool with a maximum depth of 2 feet.

Condition: This dam is regularly maintained and cleared of debris by the SBCFCD and is in fair condition with minor concrete damage and wear inside the culvert associated with bedload sediment scour during high stream flows. Low and moderate flows pass through the culvert when it is conveying water. Storm flows pass over the top of the structure when the debris basin has been filled and the culvert is blocked.

Diagnosis: During migration flows, the jump onto the apron and passage among the large embedded boulders would be moderately difficult for adult steelhead. The long, smooth culvert through the debris dam is impassable to upstream migrating steelhead due to the shallow water depth during low flows and the excessive water velocities during moderate and high flows.

Recommended Action: Due to the abundant high quality habitat found upstream of this debris dam, steelhead passage at this location is a high priority for restoring steelhead to Gobernador Creek and the Carpinteria Creek watershed. See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_CA_GR_7
Stream: Gobernador
Barrier Type: Bedrock and Boulder Waterfalls
Location: Approximate elevation 750 feet
Ownership/Interest: Cate School Corporation/Vedder

BR_CA_GR_7

BR_CA_GR_7_B

Description: Two waterfalls occur within 100 feet of each other in a confined gorge section discussed here as W1 and W2.
W1- The downstream waterfall occurs in the most confined part of the gorge at the upstream side of a large pool that measures 60 feet long and ranges from 15 to 24 feet wide. The maximum pool depth exceeded 6 feet and may be greater under some of the undercut bedrock walls. At least 65 *O. mykiss* ranging from 3 to 13 inches in length were observed in this pool during a snorkeling survey. The waterfall measured 14 feet 10 inches tall from the downstream pool surface to the top of the waterfall. At the top, flows wrap around a 4-foot diameter boulder and drop 11 feet down boulders and bedrock that make up the falls. A small pool measuring 6 feet long, 3 feet wide, and 1 foot 8 inches deep occurs at the bottom of the 11-foot drop. The flows from this small pool spill over a bedrock lip and down 3 feet 9 inches to the downstream pool.
W2- This waterfall occurs 100 feet upstream of W1, and is composed of several large boulders wedged against the bedrock walls of the gorge downstream. The pool downstream of the waterfall had a maximum depth measuring 3 feet 6 inches and the waterfall measured 11 feet in height from the pool's surface to the top of the waterfall.

Condition/Sizing: While both waterfalls are composed of large boulders that appear fairly stable, it is likely that the configurations of these waterfalls are subject to seasonal changes as the boulders break up and mobilize.

Diagnosis: Both of these waterfalls represent significant barriers to upstream steelhead migration and are likely impassable in their current configuration due to the excessive jump height and limited downstream pool depth. In a confined area like this, these natural features experience intense flow velocities, substrate movement, pool scour, debris jams, and boulder break ups during storm flows. Neither feature was observed during high stream flows when water depth will increase substantially. It is possible that these waterfalls will become passable with moderate changes to the waterfalls and/or the downstream pool configuration. *O. mykiss* have been present upstream of these structures for many decades (see sighting table).

Recommended Action: No recommended action for these natural features.

Refer to Map Folder for:
Arroyo Paredon, San Ysidro, Montecito Creek Map
Map 7.7.3.1

Refer to Map Folder for:
Arroyo Paredon, San Ysidro, Montecito Creek Map
Map 7.7.3.1

Refer to Table Folder for:
Arroyo Paredon, San Ysidro, Montecito Creek Barrier Table
Table 7.7.3.2

Refer to Table Folder for:
Arroyo Paredon, San Ysidro, Montecito Creek Barrier Table
Table 7.7.3.2

Barrier ID: BR_AP_1
Stream: Arroyo Paredon
Barrier Type: Bridge and Concrete-lined Bottom
Location: Highway 192 Crossing
Ownership/Interest: CALTRANS

Description: The bridge is constructed of cut stone and concrete. The concrete-lined bottom extends 71 feet in length from the upstream side of the bridge to a small pool downstream. The upper 21 feet of the concrete-lined bottom drops 2 feet 11 inches at a slope measuring 13.9% to a small pool under the bridge where the concrete has been completely eroded through. This damaged concrete pool measured 9 feet long, 3 feet wide, and 1 foot 9 inches deep. The lower 50 feet of concrete bottom has a mild slope measuring 4.5% to the downstream lip of the concrete where stream flows dropped 2 feet vertically into a pool with a jump depth of 1 foot 2 inches.

Condition: The concrete-lined bottom is in poor condition with several areas completely eroded through to streambed and extensive cracking throughout. Concrete at the upstream and downstream end is undermined with exposed metal re-bar at the inlet.

Diagnosis: During migration flows, the downstream pool should have sufficient depth to allow a moderately difficult jump onto the concrete bottom and swim to the small pool under the bridge. This pool may not provide much of a resting area during high stream flows. The upstream 21 feet of steep concrete will have high stream velocities during migration flows and impose extremely difficult passage conditions for upstream steelhead migration. Passage may be possible during moderate migration flows. The extensive agricultural operations in the headwaters of Arroyo Paredon may add to the difficulty of navigating upstream of this site due to the high amounts of suspended sediment carried with the migration flows.

Recommended Action: CALTRANS is reportedly removing this bridge and concrete bottom and replacing it with a newer bridge that has a natural bottom and will not impede upstream steelhead passage (pers. comm. Cesena). This action is encouraged.

Barrier ID: BR_SY_1
Stream: San Ysidro
Barrier Type: Grade Control Structure
Location: Under private bridge upstream from lagoon
Ownership/Interest: Santa Barbara County Flood Control District

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Description: This small, partially buried concrete curb has a jump height of 10 inches above a 1-foot deep pool on the river-right side under a private bridge.

Diagnosis: The small height of this structure presents a minimal degree of difficulty for upstream passage. Sharp exposed metal re-bar on the curb presents a hazard to upstream steelhead migration.

Condition: The curb is in poor condition with a high amount of wear, cracking, and damaged re-bar.

Recommended Action: Eliminate the exposed metal re-bar on the curb. Continue to monitor.

Barrier ID: BR_ SY_2
Stream: San Ysidro
Barrier Type: Bridges and Channelization
Location: UPRR and Santa Barbara County road crossing
Ownership/Interest: UPRR and Santa Barbara County Public Works- Roads Division

Description: A rough concrete-lined channel extends from 10 feet upstream of the UPRR crossing 72 feet downstream to the start of major concrete channel failure underneath the S.B. County road crossing. The concrete channel drops 2 feet 11 inches into the failed section onto the streambed bottom. From this point, the remnants of the concrete channel and an 8-foot wide slot of natural streambed extend downstream 93 feet until the entire concrete bottom has disappeared.

Condition/Sizing: The concrete channel is in extremely poor condition with several feet of undercutting occurring under the county road crossing and downstream 93 feet under the failing former channel. The remaining intact channel upstream of the county road is also in poor condition with significant concrete wear and cracking. The channel width varies from 27 feet 5 inches under the county road crossing to 18 feet 11 inches under the UPRR crossing.

Diagnosis: During migration flows, steelhead must make a difficult jump from the streambed onto the remaining channel followed by a 72-foot swim across rough and damaged concrete with a maximum slope measured at 1.6%. Overall this structure presents a high degree of difficulty for upstream passage due to the jump, moderate concrete slope above the jump, and the length of the concrete where migration flows will have high velocities and/or shallow depth.

Recommended Action: Investigate the feasibility of removing the concrete from the streambed and reinforcing the adjacent wall revetments and supports from the UPRR crossing downstream. Additional engineering and sizing studies are needed to better understand the potential options for fish passage at this extensive structure. It is likely that this study will need to also assess potential impacts to downstream revetments along private property.

Barrier ID: BR_SY_3
Stream: San Ysidro
Barrier Type: Boulder Grade Control Structure
Location: Upstream from Highway 101 crossing
Ownership/Interest: Santa Barbara County Flood Control District

Description: This grade control is composed of 5 large boulders lined up across the stream channel. The jump height through the spaces between the boulders measured 11 inches from the surface of the downstream pool. The pool had a maximum jump depth of 1 foot 9 inches.

Condition: The boulders appear to be in good condition.

Diagnosis: This is a good example of a grade control structure that allows upstream fish passage with a minimal to low degree of difficulty. The spaces between the boulders allow upstream migrating steelhead to avoid jumping the total height of the boulders**.**

Recommended Action: No action recommended. Continue to monitor.

Barrier ID: BR_SY_4-7
Stream: San Ysidro
Barrier Type: Grade Control Structures
Location: Downstream from Highway 192 Bridge
Ownership/Interest:

Grade Control #4

Grade Control #5

Grade Control #6

Grade Control #7

Description and Diagnosis: These four grade control structures occur downstream of the Highway 192 Bridge over several hundred feet.

#4- This grade control had a jump height measuring 1 feet 7 inches, a jump pool depth measuring 2 feet 5 inches, a thickness of 1 feet 4 inches, and length of 30 feet from bank to bank. During migration flows, upstream passage for all salmonid life stages has a low degree of difficulty due to the minimal jump height.
#5- This moderate sloping grade control measured 2 feet 7 inches tall from the shallow downstream pool with a thickness of 2 feet 10 inches. During migration flows, the large boulders associated with this structure would provide velocity breaks for moderately difficult passage up the sloping 'cascade'. Exposed metal re-bar at the upstream end presents a hazard to fish passage.
#6- This grade control had a jump height measuring 2 feet, a jump pool depth measuring 1 feet 9 inches, and a thickness of 2 feet 7 inches. During migration flows, this structure presents only a low to moderate degree of difficulty for upstream migration of all salmonid life stages.

#7- This grade control had a jump height measuring 1 feet 10 inches, a jump pool depth measuring 10 inches, and a thickness of 1 foot. This structure presents only a minimal to low degree of difficulty for upstream migration of all salmonid life stages during most flows.

Condition: All structures are in poor condition with moderate wear and exposed metal re-bar on #5-#7.

Recommended Action:
#4- No action recommended. Continue to monitor.
#5- Assess the feasibility of cutting a rough notch approximately 5 feet wide by 10 inches deep at center to lower the height of the structure and reduce the upper-most slope of the grade control. Eliminate the exposed metal re-bar at the upstream end.
#6- Eliminate the exposed metal re-bar at the upstream end. Continue to monitor.
#7- Eliminate the exposed metal re-bar at the upstream end. Continue to monitor.

Barrier ID: BR_SY_8
Stream: San Ysidro
Barrier Type: Boulder Cascades
Location: 1.88 miles from mouth
Ownership/Interest:

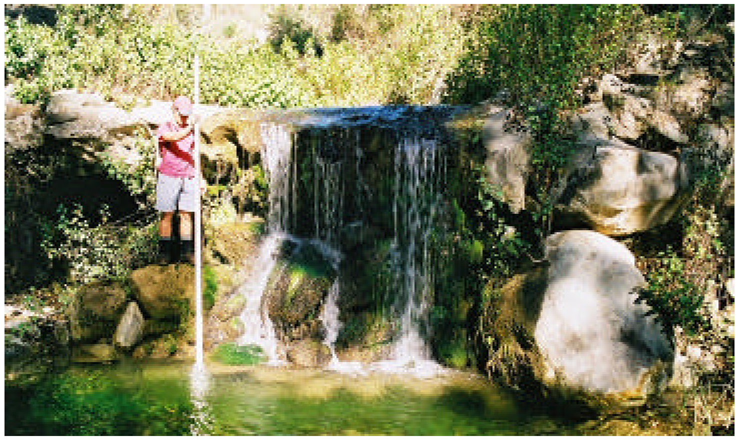
Description: This boulder cascade measured 4 feet 10 inches tall and had a downstream pool depth of 1-foot.

Condition: This natural feature is seasonally mobile.

Diagnosis: This feature is impassable during low flows due to the limited downstream pool depth and presence of boulders where the flows fall over the cascade. During moderate and high stream flows, the downstream pool depth should increase to allow upstream passage with a high degree of difficulty. At least three high flow routes over the cascade were observed.

Recommended Action: No action recommended for this natural and seasonally mobile feature.

Barrier ID: BR_ SY_9
Stream: San Ysidro
Barrier Type: Pipe crossing and grade control structure
Location: Approximately 100 feet downstream from Santa Barbara County Flood Control District Debris Basin Dam
Ownership/Interest: Montecito Co. Water Agency



Description: A pipeline crosses the stream with a concrete and boulder grade control structure covering the top that spans 33 feet across the channel and averages 8 feet wide. Extensive downstream scour has occurred and has severely undercut the structure. A small amount of stream flow is currently passing under the concrete. The scour has produced a 9-foot vertical drop from the top of the grade control to the surface of the downstream pool. This pool measured approximately 17 feet in diameter and had a maximum depth of 3 feet 11 inches. Two *O. mykiss* (5"-7") were observed rising to terrestrial insects off the surface of this pool.

Condition/Sizing: This structure is in extremely poor condition due to major undermining from scour and is at risk of failing.

Diagnosis: The excessive jump height and limited pool depth downstream make passage at this structure extremely difficult or impossible depending on the extent to which the downstream pool may backfill during high stream flows. The structure is impassable during low and moderate flow conditions.

Recommended Action: This structure is likely the first impassable barrier to upstream migrating steelhead and is at a high risk of failure. The grade control is influencing the sediment transport in this reach and any modification or removal and rerouting of the pipe would likely impact the dam upstream due to head cutting. Should fish passage be provided at this site, additional access upstream would be limited because of the Debris Dam immediately upstream. This structure needs to be further assessed for fish passage along with the Debris Basin Dam upstream and in conjunction with SBCFCD, Montecito Co. Water Agency, and other stakeholders. Removal of the grade control, rerouting of the pipe (possibly overhead), and restoration of a natural streambed will provide the most effective long-term solution for steelhead passage.

Barrier ID: BR_ SY_10
Stream: San Ysidro
Barrier Type: Debris Basin Dam
Location: Approximate Elevation 490 Feet
Ownership/Interest: Santa Barbara County Flood Control District

Description: This debris dam is composed of boulder and concrete riprap and conveys low to moderate stream flows through the dam in a 4-foot diameter smooth concrete culvert that measures 64 feet 6 inches in length. The slope of the culvert measured 4.8%. Water discharged from the culvert and dropped 5 feet onto an apron composed of boulder and concrete riprap that extends downstream 14 feet 3 inches over a mild slope among embedded boulders and two shallow pools (8 and 10 inches deep). On the downstream side of this apron, water dropped vertically 20 inches off the structure into a pool with a maximum depth of 15 inches.

Condition: This dam is regularly maintained and cleared of debris by the SBCFCD and is in fair condition with minor concrete damage and wear inside the culvert associated with bedload sediment scour during high stream flows. Low and moderate flows pass through the culvert and storm flows pass over the top of the structure when the debris basin has been filled and culvert is blocked.

Diagnosis: During migration flows, the jump onto the apron and passage among the large embedded boulders would be easy for adult and juvenile salmonids. The 5-foot jump into the culvert presents an extremely high degree of difficulty due to the absence of any jump depth and pool formation during low and moderate flows. The long, smooth culvert running through the debris dam is impassable to upstream migrating steelhead due to the shallow water depth during low flows and the excessive water velocities produced by the 4.8% slope.

Recommended Action: Due to the presence of salmonids in this watershed and the abundance of high quality habitat found upstream of the dam, fish passage at this location and the pipeline crossing (BR_SY_9) immediately downstream are the highest priority for restoring steelhead to the San Ysidro Creek watershed. Along with the pipe crossing grade control structure downstream these two structures are the only impassable anthropogenic barriers to upstream steelhead migration on San Ysidro Creek. Local stakeholders and the SBCFCD should investigate the feasibility of removing this dam and identify alternative means of achieving safe water conveyance and flood control for this stream. Due to the presence of the pipeline crossing approximately 100 feet downstream, these two structures should be considered together providing fish passage. See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_ MO_1
Stream: Montecito
Barrier Type: Concrete Channelization
Location: Extends from mouth upstream to UPRR Crossing
Ownership/Interest: Santa Barbara County Flood Control District (maintained)

Description: This concrete channel extends from the beach sand at the mouth of Montecito Creek upstream over 800 feet to approximately 25 feet downstream of the UPRR crossing. The measured length of this channel was 810 feet, but it is likely longer as beach sand covered part of the downstream end and streambed substrate covered the upstream end. What remains of the Montecito Creek lagoon is entirely within this channel and the "lagoon" water was backed up the channel 332 feet from the outflow on the beach. The exposed portion of the channel measured 478 feet in length from the upstream end of the lagoon water to the top of the channel. The walls of the channel are slightly less than vertical and measured 6 feet 5 inches tall upstream from the pedestrian bridge near the downstream end. At this same location the channel has a shallow V-shape bottom measuring 33 feet 9 inches across at the base of the concrete walls. Low stream flows are concentrated in a small, 2-foot wide U-shaped low-flow channel that runs most of the channel length at center. The low-flow channel becomes less confined in the upstream-most 200 feet and eventually disappears at the upper end of the channel with spread out shallow flows. The slope of the channel was measured at 1.4% upstream of the pedestrian crossing and appeared fairly uniform. Karl Treiberg (SBCFCD) noted that this channel was built by the Army Corp of Engineers, is privately owned, and SBCFCD maintained.

Condition: At least two locations exist along the channel where the concrete has been completely eroded through and natural substrate is exposed. Under the private road crossing upstream of the pedestrian bridge, a hole 7 feet 6 inches long by 3 feet 4 inches wide extends 1 foot 7 inches deep to natural substrate below the channel. This damaged hole undercuts the channel up to 2 feet. The next hole thought he concrete is located 75 feet upstream of the first hole and measures 4 feet long by 2 feet 6 inches wide and extends 14 inches deep to the natural bottom. Significant undercutting is also occurring at this site. Steel reinforcement bars are also exposed in the channel along with significant concrete cracking and wear. Overall the channel is in fair to poor condition.

Diagnosis: Observations at this site during high stream flows were not made to determine weather or not there is any significant undercutting or drop that occurs off the downstream end of the channel onto the beach. This diagnosis will assume that adequate access to the "lagoon" is consistently achieved during migration flows, although this should be monitored in the field. Due to the length of the channel, minimal presence of resting areas, accelerated velocities encountered during migration flows, and shallow sheeting flows during low and moderate flows at the upstream end, this structure presents a high degree of difficulty to upstream passage. This channel may be impassable during years of low rainfall and minimal stream flow such as the 2001-2002 winter season.

Recommended Action: In conjunction with the fish passage efforts undertaken by the SBCFCD at upstream structures, improving upstream steelhead passage at this channel is recommended. Due to the complexity of flood control issues, close proximity of adjacent property and homes, and extensive length of this structure, an assessment of fish passage alternatives should be conducted. In addition to other possible alternatives, naturalizing this 800-foot reach of buried stream and ecologically important lagoon habitat should be assessed. The alternatives study should include assessing the feasibility of removing the concrete channel bottom, reinforcing concrete walls or protected banks, and re-forming the channel with natural streambed substrate. Natural substrate conditions along this reach will provide the most effective steelhead passage and greatest biological benefit to overall aquatic habitat conditions. The damaged holes in the concrete may provide valuable resting spots to migrating steelhead and should not be eliminated until a project to improve overall passage has begun. A fish passage and stream naturalization effort at this site will require collaboration between SBCFCD, Army Corps, NMFS, CDFG, and private landowners adjacent to the channel.

Barrier ID: BR_MO_2,3,4
Stream: Montecito
Barrier Type: Grade Control Structures
Location: 30, 150, and 275 feet upstream from Highway 101 Crossing
Ownership/Interest: MO_2 = CALTRANS

Description and Diagnosis:

MO_2- This small, concrete curb is keyed into sloping concrete walls at the upstream end of the Highway 101 crossing bank revetments. This curb measured 21 feet across the channel with a thickness of 1 foot 6 inches. The jump height of the curb measured 1 foot 3 inches from the surface of the downstream pool, which had a jump depth of 2 feet 5 inches. Damaged re-bar on top of the curb was facing downstream. Low flows where concentrated at center. Upstream steelhead passage at this site is easily obtained with a minimal degree of difficulty.

MO_3- This concrete curb measured 23 feet across the channel with a thickness of 2 feet. The height of the curb measured 3 feet 5 inches from the surface of the downstream pool, which had a jump depth of 1 foot 4 inches. Lower flows are currently directed against the far river-right side of the curb where an eroded notch exists 2 feet 8 inches above the downstream pool surface. Severe undercutting of the downstream river-right bank revetment is occurring. During migration flows steelhead could make a moderately difficult jump over this curb as the downstream pool fills and stream flows spill over the center of the curb. The concentrated stream flows against the river-right revetment may impede upstream passage during lower flows.

MO_4- This concrete curb measured 30 feet across the channel with a thickness of 2 feet. The height of the curb measured 2 feet 9 inches from the surface of the downstream pool, which had a jump depth of 4 feet 4 inches. During migration flows steelhead could make a moderately difficult jump over this curb. Concentrated low flows against the river-right revetment may impede upstream passage during lower flows.

Recommended Action:
MO_2- The damaged metal re-bar should be eliminated to prevent injuring to upstream migrating steelhead.

MO_3- Cutting a notch approximately 3 feet wide and 6 inches deep at center would improve fish passage by concentrating lower flows toward the center of the pool, promoting jump pool development away from the river-right bank revetment, and reducing the jump height. The eroded notch existing on the river-right side may need to be patched to concentrate flows to a new center notch.

MO_4- A notch of similar dimensions as recommended for MO_3 would provide a similar benefit.

Barrier ID: BR_MO_5
Stream: Montecito
Barrier Type: Grade Control Structure
Location: 400 feet upstream from Highway 101 Crossing
Ownership/Interest: Santa Barbara County Flood Control District

BR_MO_5 Before Modification

BR_MO_5_MOD After Modification

Description: This grade control structure measured 25 feet between sloping concrete wall revetments on adjacent stream banks. The flat concrete bottom measured 50 feet in length from the inlet to the downstream lip. The slope measured 6.66% with a rise of 3 feet 4 inches over 50 feet. The SBCFCD added wooden baffles to this structure early in 2002 after the first survey was conducted on 6/6/01. Significant erosion prevention measures were also constructed on both downstream banks where massive erosion had previously occurred. Large boulders were also placed immediately downstream of the structure, apparently to prevent downstream scour. Ten downstream facing V-shaped baffles were installed on the concrete bottom. The baffles have been spaced 5 feet apart and consist of two 11-foot 6 inch long pieces of 3.5 by 3.5 inch wood that is bolted into the concrete. These baffles concentrate water toward the center of the downstream V-shape. Water passed under some of the baffles where space exists between the concrete surface. A boulder weir was built 26 feet downstream of the grade control to backfill the downstream pool during migration flows. During low flows encountered following the construction, the jump height from the top of the first baffle to the downstream pool surface measured 1 foot 6 inches. Downstream from the placed boulders, the pool depth measured 2 feet 6 inches.

Condition: The recently completed project appears to have improved bank erosion problems and reduced downstream structural undercutting. The concrete structure itself is in fair condition with minimal wear. Natural substrate is backed up to the top of the upstream side of the grade control.

Diagnosis: During the initial survey of this structure in 2001 the steep slope and length of the concrete surface was impassable to upstream migrating steelhead due to excessive water velocities and/or shallow depth. The wood baffles appear to have made upstream migration possible under ideal flow conditions by providing a series of resting pools upstream of the V-shaped baffles. Upstream migration from the downstream pool into the first baffle pool will have a low degree of difficulty during migration flows with adequate downstream jump depth. Migration over the lower baffles appears to have a low to moderate degree of difficulty with the baffle pools backing up to the bases of the next baffle. The upper baffles occur on a steep slope and have up to 12 inches of exposed concrete downstream of the next baffle that does not have water backed up over it. These reaches have minimal jump depth and present a moderate to high degree of difficulty during migration flows. The baffles should reduce velocities enough to enable steelhead to migrate upstream during higher flows with a high degree of difficulty overall.

Recommended Action: While this baffle and weir project has improved upstream fish passage conditions; the wood baffles will be highly susceptible to failure during storm flow events when large substrate moves across the structure. The effectiveness and maintenance of these baffles should be monitored to determine if adequate upstream passage conditions occur at the beginning of each migration season and following significant stream flows. An elaborate fishway design for this structure was developed by SBCFCD in 2000, but was never implemented (pers. comm. Treiberg). The baffles and boulder weir should be monitored during migration flows to determine their effectiveness of providing adequate upstream passage conditions. This structure will likely continue to present a significant impediment to upstream migrating steelhead during certain flow conditions and following baffle failure during high stream flow events. A project that provides unimpeded upstream passage during a wide range of flows and is not dependant on continual human maintenance should be assessed for this site. Removal of the structure and bank stabilization techniques should be considered. A natural stream bottom would provide the most effective and dependable upstream passage situation. Removal of the structure would dramatically affect the surrounding stream banks and additional studies are needed to determine the feasibility of this action and potential bank reinforcement techniques.

Barrier ID: BR_MO_13
Stream: Montecito
Barrier Type: Debris Basin Dam
Location: 1.0 mile upstream from mouth. Adjacent to Olive Mill Road, near the Hot Springs Road intersection.
Ownership/Interest: Santa Barbara County Flood Control District

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Description: The Montecito Creek Debris Basin Dam was under construction while surveying this stream reach. The project has a complex fishway that was designed in conjunction with the National Marine Fisheries Service, U.S. Army Corps of Engineers, and California Department of Fish and Game.

Diagnosis: The completed project was not surveyed.

Recommended Action: Additional assessment of the completed project during migration flows should occur to determine the effectiveness of the fishway at providing adequate upstream and downstream migration conditions. The impassable concrete channel (BR_MO_14) immediately upstream of the new debris dam and fishway currently limits the effectiveness of providing passage at the debris dam and fish passage should be provided there in order for this fishway to provide any benefit. See recommended action for BR_MO_14. See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_ MO_14
Stream: Montecito
Barrier Type: Concrete Channelization
Location: Extends upstream from new Montecito Debris Basin Dam (BR_MO_13)
Ownership/Interest: Santa Barbara County Flood Control District

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Description: This survey was conducted on 6/8/01 during construction of the Montecito Debris Basin Dam. The length of the concrete channel may change with the completion of the new Debris Dam. The survey of the channel began near the downstream end, where a temporary dam and water intake were set up to convey flows around the project area. This concrete channel extends upstream from this water intake 669 feet. The profile of the channel as well as the slope varies slightly throughout its length. Under the downstream private road crossing for the Casa Dorina retirement community, the channel is 25 feet wide at the base of the channel walls. The walls of the channel are slightly less than vertical and averaged 6 feet tall. At this same location the channel has a shallow, U-shaped low-flow channel at center that measured 2 feet 3 inches wide and 5 inches deep. The low-flow channel becomes less confined at the upstream end of the channel and eventually disappears with unconfined and shallow flows near the inlet. The slope of the channel was measured to be 3.1% at the downstream crossing. The upstream-most 75 feet of the channel had a slope measuring 3.5%.

Condition: Several locations exist along the channel where the concrete has been completely eroded through and the natural substrate is exposed. These damaged areas are discussed here working upstream from the downstream intake and temporary dam:

1) 40 feet upstream from the intake- this hole through the concrete bottom measured 8 feet long by 4 feet wide and had significant undercutting of the concrete.
2) 75 feet upstream from the downstream Casa Dorina crossing- the channel is highly damaged with exposed re-bar bent or broken and facing downstream every 20 inches.
3) 297 feet upstream from the intake- a large, damaged hole measuring 22 feet long, 4 feet wide, and 3 feet deep has major undercutting 4 to 5 feet under the concrete channel. Exposed re-bar surrounds the hole. One unidentified 3-inch fish spooked under the channel in this pool.
4) 390 feet upstream from the intake- another large damaged hole similar in size to the previous one exists here.
5) 500 feet upstream from the intake- Damaged and exposed re-bar is present.

6) 596 feet upstream from the intake- A large, damaged hole measuring 8 feet long, 3 feet 6 inches wide, and 13 inches deep has major undercutting taking place under the concrete channel. Exposed re-bar surrounds the hole.

Diagnosis: Due to the length of the channel, sustained moderately-high slope, accelerated stream velocities during migration flows, and unconfined sheeting flows near the inlet, this structure presents an extremely high degree of difficulty to upstream steelhead passage and is likely impassable during most/all flows. The damaged holes in the concrete may provide resting spots to migrating steelhead and should not be eliminated until a project to improve overall passage has begun. The large amount of sharp downstream facing metal re-bar present a gauntlet of hazards to upstream migrating steelhead and would likely inflict serious injury, puncture eyes, and possibly cause mortality.

Recommended Action: Any fish passage project at this channel will be complex and require significant coordination among stakeholders and detailed studies to assess alternatives for fish passage while maintaining adequate flood protection. A fish passage feasibility study to determine alternatives and associated impacts should be conducted. Within this study, the option to naturalize this channel reach and reinforce adjacent stream banks should be evaluated. Natural substrate conditions will provide the most effective upstream steelhead migration and overall aquatic benefit. Until a fish passage improvement project has begun, the holes in the channel should not be eliminated as they may offer the only chance for steelhead to migrate upstream of this channel. All exposed re-bar should be quickly eliminated and cut ends made dull.

Barrier ID: BR_MO_18
Stream: Montecito
Barrier Type: Bridge and Grade Control Structure
Location: Highway 192 Crossing
Ownership/Interest: CALTRANS

Description: The stream is confined between the vertical concrete bridge supports that measured 18 feet 7 inches apart. Concrete bank revetment with associated with adjacent homes extends downstream on the river-right side, and is keyed into the bridge. A grade control structure just downstream from the bridge measured 4 feet 1 inch in height from the surface of the downstream pool, which had a jump depth measured at 2 feet 6 inches. The grade control is actually 2 feet tall, but major downstream scour has dropped the substrate elevation and exposed the footing material the grade control sits on. Stream flows conveyed over this 1 to 2-foot thick grade control drop onto downstream boulders exposed from scour. A second 8-foot long concrete grade control extending 18 feet across the channel between the bridge supports occurs 20 feet upstream from the above mentioned grade control structure.

Condition: The grade control structures under the bridge are in poor condition with significant wear and undercutting. The bridge supports and downstream bank revetment are also extremely undercut and damaged. The structural integrity of the downstream bank revetments appears to be severely weakened.

Diagnosis: The presence of boulders below the grade control drop, limited pool depth, and jump height produce moderate to highly difficult passage conditions for adult steelhead during migration flows. Passage during lower flows may not be achievable for these same reasons.

Recommended Action: It is likely that the revetment downstream of the bridge will need to be significantly improved in the near future. This revetment is currently dependant on the presence of the bridge and any significant modifications to the bridge crossing will need to be coordinated with adjacent landowners. The extensive damage and poor condition of the grade controls and adjacent revetment present a complex situation that should be further evaluated to assess alternatives for improving fish passage and providing bank protection. Alternatives should assess options that maintain natural streambed conditions and reduce the confinement of the creek channel. One option to consider is the removal of the bridge deck and river-left support and associated grade control structures, slight channel realignment toward the river-left side, installation of a wider-span bridge, and reinforcement of the existing bank revetment and bridge support on the river-right side.

Barrier ID: BR_ MO_CS_2
Stream: Cold Springs
Barrier Type: Debris Basin Dam
Location: Approximate Elevation 550 Feet
Ownership/Interest: Santa Barbara County Flood Control District

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Description: This debris dam is composed of boulder and concrete riprap and conveys low to moderate stream flows through the dam in a 4-foot diameter smooth concrete culvert that measures 73 feet 6 inches in length. The slope of the culvert measured 5.33%. Water discharged from the culvert drops 13 feet 11 inches in height down the steep sloping face of the dam.

Condition: This dam is regularly maintained and cleared of debris by the SBCFCD and is in fair condition with minor concrete damage and wear inside the culvert associated with bedload sediment scour during high stream flows. Low and moderate flows pass through the culvert and storm flows pass over the top of the structure when the debris basin has been filled and culvert is blocked.

Diagnosis: During all migration flows, the height from the downstream pool to the culvert outlet is far too great to allow any upstream jump to the culvert. This structure is completely impassable during all stream flows.

Recommended Action: Due to the presence of salmonids in this watershed and the abundance of high quality habitat found upstream of the dam, fish passage at this location is a high priority for eventually restoring steelhead to the Montecito Creek watershed. See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Refer to Map Folder for:
Mission Creek Map
Map 7.7.4.1

Refer to Map Folder for:
Mission Creek Map
Map 7.7.4.1

Refer to Table Folder for:
Mission Creek Barrier Table
Table 7.7.4.2

Refer to Table Folder for:
Mission Creek Barrier Table
Table 7.7.4.2

Barrier ID: BR_MN_1,2,5
Stream: Mission
Barrier Type: Concrete Channels
Location: MN_1= Chapala Street Crossing to UPRR Crossing, MN_2=Castillo Bridge to upstream of Arrellaga Bridge, MN_5= Downstream of Mission Street Bridge to Los Olivos Street.
Ownership/Interest: MN_1=SBCFCD, MN_2 and MN_5=CALTRANS

Description and Diagnosis: The combined length of these three channelized reaches totals approximately 1.15 miles along the downstream 2.49 stream miles of Mission Creek. This lower reach of Mission Creek is a patchwork of various bank revetment project that likely span over a century and consist of everything from stacked tires and trash to the massive concrete trapezoidal channels built by CALTRANS. Nearly the entire stream channel is tightly confined by adjacent residential and commercial development. A brief description and diagnosis of the three channelized reaches are discussed below.

MN_1- The total length of this SBCFCD channel measured 0.17 mile, using GPS. The relatively flat channel gradient and presence of eroded holes and vegetation growing along the river-left side, allows upstream steelhead passage with a moderate to high degree of difficulty during moderate stream flows. Upstream passage is not possible during low flows, when shallow water depth occurs throughout the channel length. During extremely high stream flows, excessive water velocities likely prevent upstream passage.

MN_2- This CALTRANS channel measured 0.74 mile, using GPS. The trapezoidal concrete channel measured 25 feet 9 inches wide along the bottom. The angle of the sloping concrete walls is approximately 45 degrees. The slope of the downstream 200 feet of the channel measured less than 1% (0.83). Near the Anapamu pedestrian bridge crossing, Highway 101 actually crosses over a portion of the concrete channel that enters a large box culvert. During low flows, upstream steelhead migration is not possible due to the unconfined, shallow water depth throughout the channel. When adequate water depth occurs in the channel, accelerated stream velocities are sustained throughout the long channel with no velocity breaks. Upstream steelhead passage is prevented due to exhaustion attempting to migrate the long channel.

MN_5- This CALTRANS channel measured 0.27 mile, using GPS. The channel is almost identical in configuration to the downstream channel (MN_2). During low flows, a short 2-foot vertical drop occurred at the downstream end of the channel to the surface of the downstream pool, which measured 2 feet 7 inches deep. Sufficient water depth exists to allow a jump onto the concrete channel with a low degree of difficulty. Once on the channel, steelhead will encounter similar limitation as described above for MN_2. While this channel is shorter than the downstream channel, the slope increased and was measured at 1.2% at the upstream end.

Condition: The lowest channel (MN_1) is in poor condition with significant wear and damage through the concrete bottom in several places. The CALTRANS channels (MN_2 and MN_5) are in fair condition with moderate concrete wear on the channel bottom and minimal cracking.

Recommended Action: Due to the structural and political complexity of providing flood control and landowner safety, stream restoration and steelhead passage in lower Mission Creek needs to be addressed in a much larger planning process that seems to be moving forward in Santa Barbara. In order to make the most informed decision about the future of lower Mission Creek, a watershed-focused stakeholder planning process should be initiated that assesses long-term alternatives from the ocean to at least the Santa Barbara Natural History Museum. An entire watershed-wide plan would be ideal to formulate, but may not be essential to addressing critical components of accomplishing stream restoration, adequate flood control, landowner safety, steelhead passage, and other components for lower Mission Creek.

The planning process should include an alternatives analysis of the various options that could be pursued in lower Mission Creek. One of the alternatives that should be assessed is the complete removal of the concrete channels, naturalization of the streambed, and extensive bank stabilization using biotechnical methods. Such an alternative would provide the greatest biological benefit to the Mission Creek ecosystem and likely public health and recreational opportunities. This option may require significant streambed realignment, property acquisition, and enormous costs and multi-jurisdictional cooperation. See David Pritchett's "Mission Possible" document in the appendix for additional discussion on lower Mission Creek restoration planning. Site-specific recommendations for lower Mission Creek concrete channels are far beyond the scope of this study.

Providing adequate upstream steelhead passage on lower Mission Creek is essential for the recovery of the species to the watershed. Currently, 88.1% of the historically accessible steelhead habitat in the Mission Creek watershed occurs upstream of the downstream CALTRANS channel (BR_MN_2). Developing a long-term, effective Lower Mission Creek Naturalization Plan that incorporates unimpeded upstream steelhead passage is recommended.

Barrier ID: BR_MN_3,4
Stream: Mission
Barrier Type: Grade Control Structures
Location: Under Pedregosa Street Bridge
Ownership/Interest: CALTRANS

Description and Condition: Two grade control structures exist at the Pedregosa Street Bridge.

#3- This 1-foot thick concrete curb, on the downstream side of the bridge, measured 41 feet across the channel between adjacent concrete walls. The curb height measured 3 feet above the surface of a concrete apron that extends downstream from the bottom of the curb in a perpendicular manner to the downstream pool surface. Low flows are concentrated off-center toward the river-left side of the curb. The apron is damaged downstream from where low flows drop onto it and this broken-out notch begins 2 feet from the base of the curb. The jump depth of the downstream pool measured 14 inches just below where the flows are concentrated. The pool depth immediately upstream of the curb measured 15 inches. The downstream side of the structure was undercut up to 2 feet 6 inches and adjacent wall revetments are also substantially undercut.

#4- Under the bridge, a small concrete grade control structure measuring 4 feet 6 inches wide extends 34 feet across the channel. This structure is partial buried with substrate, but had a maximum height of 7 inches above the surface of the downstream pool, which measured 1 feet 7 inches deep. The concrete appears to be in poor condition with moderate wear and undercutting on the downstream side.

Diagnosis:
#3- Due to the moderate jump height and apron interfering with the jump location and extending the horizontal jump requirement, this structure may impede passage during moderate and low flows when the downstream pool depth is not sufficient. During higher migration flows, the downstream pool will provide sufficient depth to allow a moderately difficult jump over this structure. Future steelhead migrating up Mission Creek need to get upstream as quickly as possible before low flow conditions limit upstream movement and this structure may reduce the

window of opportunity for upstream passage and potential leave fish stranded as the stream flows subside.

#4- During most flow situations, upstream passage over this structure would have a minimal degree of difficulty. Scour during higher stream flows may alter the configuration and severity of this structure.

Recommended Action:
#3- Due the moderate severity of this structure and presence low in the Mission Creek watershed, the curb should be modified or removed to provide unimpeded future steelhead passage. A notch approximately 3 feet wide and 5 inches deep should be cut near the center of the curb and a wide U-shape notch in the apron immediately downstream of this curb notch should also be cut to. This action would focus attraction flows, reduce the horizontal and vertical jump required, and may help to create a deeper jump pool downstream. A scour/jump box could also be installed downstream of the notch to provide adequate jump depth and help to prevent additional undermining of the structure.
#4- Continue to monitor this structure. If modifications to the curb downstream occur, consider cutting a notch with similar dimensions at the center to concentrate low flows over the structure.

Barrier ID: BR_MN_6
Stream: Mission
Barrier Type: Bridge and Grade Control Structures
Location: Tallant Road Bridge
Ownership/Interest: City of Santa Barbara

Description: This bridge crossing and complex series of downstream grade control features appear to have undergone several additions and modifications following the initial construction of the crossing. The total distance of the concrete altered bottom measured 126 feet from the upstream side of the concrete channel under the bridge to the downstream end of the riprap grade control structure. The overall height of the crossing measured 12 feet 1 inch from the downstream substrate bottom to the top of the concrete channel under the bridge. The height from the downstream end of the grade control to the upstream end measured 7 feet 11 inches. The downstream grade control structure measured 4 feet 2 inches in height and flows dropped at an angle of approximately 45 degrees to a relatively flat 10-foot long apron that flows into the downstream pool, which is often dry for much of the year. Upstream of the grade control, a mild sloping concrete bottom extends 42 feet upstream with a 16-inch deep pool occurring along most of its length. From the top of this pool, a concrete apron with a slope measured at 8% extends 22 feet upstream to the base of a 13-17 inch tall curb at the downstream end of the concrete channelized reach under the bridge. This channelized reach extends under the bridge for 41 feet with a measured slope of 2.6% to natural substrate upstream.

Condition: The structure is in fair condition overall, but has significant undercutting on the downstream end and adjacent banks due to scour. Significant wear and cracking of the concrete has occurred in several places.

Diagnosis: Upstream steelhead migration at this crossing would likely be impossible under all flow conditions due to the extremely difficult passage of the grade control structure and the concrete curb at the downstream end of the bridge. Due to the presence of concrete reaches downstream of these spots, there is minimal jumping depth for steelhead to gain momentum to jump upstream. The sloping concrete leading up to the curb below the bridge is particular problematic with accelerated migration flows, no resting areas, no jump depth, and smooth concrete upstream that will also have high stream velocities and minimal resting areas.

Recommended Action: The series of ‘protective’ streambed and bank modifications downstream of the bridge appear to be the results of chasing the inevitable effects of downstream scour resulting from constructing hard-scape structures in the natural streambed. It has been observed at other locations that this continual downstream construction mind-set in response to scour is a losing proposition. Ideally this trend can be reversed at the Tallant Road crossing by working with the City of Santa Barbara to remove the concrete from the channel, replace the seemingly undersized bridge with a wider span bridge that offers a larger stream flow capacity, provide a natural streambed with unimpeded steelhead migration, and stabilize banks adjacent to the site. Due to the presence of residential homes immediately upstream of the bridge and directly adjacent to the stream channel, additional studies are recommended to determine the feasibility of removing the structure and naturalizing this stream reach without jeopardizing property upstream. Innovative bioengineering techniques should be investigated to reinforce/stabilize the stream banks and provide the maximum biological and aesthetic results. Modifying the existing structure for fish passage may not prove effective for upstream passage, will not address flood flow capacities at the bridge, may not address continual downstream scour, and will require continual maintenance and future retrofitting to ensure fish passage and structural integrity. Providing upstream salmonid passage at this site in the future is essential to the recovery of Mission Creek steelhead as most productive spawning and rearing habitat in the watershed in found upstream of this site.

Barrier ID: BR_MN_7
Stream: Mission
Barrier Type: Grade Control Structure
Location: Adjacent to Santa Barbara Museum of Natural History
Ownership/Interest:

Description: This concrete and boulder grade control structure is keyed into a stone revetment wall on the river-right stream bank and measured 24 feet across the channel. The downstream pool depth measured 2 feet 2 inches and is limited by a concrete-lined pool bottom. The jump height from the pool surface to the top of the structure measured 3 feet 2 inches. The top of the structure slants downstream over 6 feet and then drops to the downstream pool.

Condition: The structure appears to be in fair condition with moderate concrete wear.

Diagnosis: This structure presents a moderate degree of difficulty for upstream steelhead migration during moderate and low stream flows due the limited depth of the concrete-lined pool downstream, moderate jump height, and significant horizontal jump required. As the downstream pool depth increase during higher stream flows, the jump over this structure will become easier as the jump height decreases.

Recommended Action: Upstream passage conditions could be improved, especially for juvenile salmonids and future adult steelhead migration during lower flows, by cutting a relatively level notch approximately 3 feet wide and 8 inches deep slightly off-center toward the river-left side where the maximum pool depth downstream is located. This action would reduce the jump height, length and steepness of the top of the structure, and concentrate flows toward the deepest part of the downstream pool for an increased jump depth.

Barrier ID: BR_MN_8
Stream: Mission
Barrier Type: Bridge and Apron
Location: Downstream-most (#1) Mission Canyon Road Bridge
Ownership/Interest:

Description: This stone arch bridge has been reinforced with a concrete bottom and sloping apron that are significantly damaged. The concrete bottom measured 58 feet in length from the upstream end of the concrete bottom to the downstream end of the apron. The apron ends 10 inches above the downstream pool. The smooth concrete apron measured 6 feet 11 inches in length with a slope of 31%. The jump height from the downstream pool surface to the top of the apron measured 2 feet 9 inches. Five feet downstream from the apron the jump depth measured 3 feet 4 inches. The maximum depth of the pool measured 8 feet 6 inches. A small 7-inch deep pool in broken concrete exists at the upstream end of the sloping apron and extends upstream 16 feet. The upper 35 feet of concrete–lined bottom has a slope of less than 2%.

Condition: The concrete bottom is in poor condition with significant damage throughout its length.

Diagnosis: During moderate migration flows the downstream pool has sufficient depth to allow a moderately difficult jump upstream to the shallow pool and concrete channel. During high stream flows migration will become more difficult as stream velocities are accelerated along the concrete-lined bottom and down the sloping apron, pushing the jump location further back in the downstream pool.

Recommended Action: It is likely that a significant amount of maintenance is scheduled to occur at this crossing in the near future. Improved fish passage should be incorporated into future maintenance projects and the desirability of maintaining the concrete-lined bottom should be assessed with streambed naturalization and bridge reinforcement options considered. If removing the concrete-lined bottom is not feasible, then a notch 10 inches deep and 2 feet wide at the upstream end of the apron should be cut where flows are concentrated. Immediately upstream of this notch, the shallow concrete pool should be dug out to a depth of approximately 24 inches to provide an adequate resting/landing spot for upstream migration salmonids of all life stages. This action would significantly improve passage for juveniles and eventual adult steelhead passage during lower stream flows.

Barrier ID: BR_MN_9
Stream: Mission
Barrier Type: Bridge and Apron
Location: Downstream from Highway 192 Bridge
Ownership/Interest: CALTRANS

Description: Natural streambed conditions exist under the Highway 192 Bridge. Immediately downstream of the bridge a long concrete and boulder riprap apron extends 34 feet downstream with a slope measured at 11%. The total height of the apron, from the downstream pool surface to the top of the apron measured 5 feet 3 inches. Flows dropped vertically 9 inches off the apron into the downstream pool, which had a jump depth of 4 feet 5 inches. Exposed, damaged re-bar at the downstream end of the apron presents and significant hazard to upstream migrating salmonids.

Condition: The apron is in poor condition with significant wear and undercutting on the downstream side. The apron is also causing major scour and bank erosion that appears to be influencing the substantial loss of property on both downstream banks and undermining the road fill.

Diagnosis: The downstream pool has sufficient depth to allow an easy jump onto the apron, but at that point migrating salmonids have no resting areas, accelerated water velocities and/or shallow water depth, and a long apron with an excessive slope that precludes upstream passage. There is a small chance that the downstream pool would increase 4-5 feet in depth during high stream flows to allow an extremely difficult jump far up the apron followed by an extremely difficult bursting swim to the top. Passage is extremely unlikely even during this situation due to the extremely high velocities and turbulence encountered. No such flow opportunities were observed during several observations throughout two winter seasons (2000-2002).

Recommended Action: CALTRANS should assess the feasibility of eliminating this apron and either stabilize the bridge supports and adjacent stream banks or replace this bridge with a bridge that does not influence the streambed. Adjacent stream bank stabilization should use a bio-technical approach. This situation is similar to the Arroyo Paredon Highway 192 Bridge replacement project CALTRANS is currently planning. Attempts to battle the continual expansion of downstream scour by extending the apron are not recommended. Effective passage at this site is essential to providing upstream access to both tributaries of upper Mission and Rattlesnake Creeks.

Barrier ID: BR_MN_10
Stream: Mission
Barrier Type: Boulder Cascade
Location: 25 feet upstream from Rattlesnake Creek confluence
Ownership/Interest:

Description: This boulder cascade occurs just upstream from Rattlesnake Creek and appears to be a backup of boulders behind a very large boulder approximately 8 feet in diameter. The low flows encountered dropped 4 feet 1 inch from the river-left side of the large boulder to a small pool with a maximum depth of 2 feet 4 inches.

Condition: The large boulder holding this cascade together appears to be fairly stable but smaller boulder are likely seasonally mobile.

Diagnosis: Rainbow trout have consistently been observed in contemporary times throughout the Rattlesnake Creek tributary and the main stem of Mission Creek downstream of Rattlesnake Creek. This cascade feature appears to be preventing colonization of upper Mission Creek as no rainbow trout were observed upstream during extensive surveys, including snorkeling over two dozens high quality pools upstream of this cascade to the Tunnel Road Crossing (BR_MN_21). The only rainbow trout observation in Mission Creek upstream of Rattlesnake Creek occurred in the small pool downstream of this structure. While smaller salmonids appear to be unable to migrate upstream of this structure due to jump height limitations, adult steelhead would be able to migrate upstream of this structure with a high degree of difficulty during moderate to high stream flows. With adequate upstream access at barriers mentioned downstream, adult steelhead will be able to recolonize upper Mission Creek, which will add considerably to the size of the overall salmonid population in the Mission Creek watershed and likely increase steelhead production.

Recommended Action: No recommended action for this natural feature. Address downstream barriers and steelhead will migrate upstream of this feature and recolonize upper Mission Creek. Natural sea-run recolonization of this upper section of Mission is recommended to encourage the anadromous tendencies of the re-established salmonid population as opposed to reseeding this reach with rainbow trout from Rattlesnake Creek, which may currently have more residential tendencies.

Barrier ID: BR_MN_11
Stream: Mission
Barrier Type: Bridge and Apron
Location: Upstream-most (#2) Mission Canyon Road Bridge
Ownership/Interest: Santa Barbara County Roads Division

Description: This bridge has a concrete and cut-stone bottom that measured 66 feet 6 inches from the downstream to upstream end with an overall slope measuring 5%. The lower end of the concrete bottom is extremely damaged with a large, irregular-shaped hole completely through the concrete and a confined chute eroded down the last 12 feet to a 15-inch vertical drop into the downstream pool, which had a jump depth of 7 feet. Several holes through the concrete exist under the bridge along the channel bottom. At the upstream end of the bridge, the concrete bottom measured 16 feet 7 inches between the stone walls and 11 feet tall to the underside of the bridge.

Condition: The concrete bottom is in poor condition with significant wear and damage through the concrete bottom. The downstream end of the structure and adjacent bank revetments are significantly undercut and damaged.

Diagnosis: During migration flows the downstream pool has sufficient depth to allow a moderately difficult jump upstream onto the concrete channel or into the eroded chute. Migration up the chute and the jump onto the channel presents a high degree of difficulty due to the limited jump depth from the damaged pool, high turbulence during migration flows, and confined high velocities in the chute. Accelerated velocities will also be encountered along the channel upstream.

Recommended Action: It is likely that a significant amount of maintenance will occur at this crossing in the near future. Any modification plans to this bridge should include fish passage improvements. The feasibility of naturalizing the streambed under the bridge and reinforcing the bridge supports should be studied. This option would likely have the greatest benefit for fish passage and may help to increase the flow capacity and reduce/eliminate downstream erosion of the structure and adjacent private property.

Barrier ID: BR_MN_12
Stream: Mission
Barrier Type: Pipe Crossing Grade Control Structure
Location: Downstream from Santa Barbara Botanic Garden
Ownership/Interest: Southern California Gas Co./City of Santa Barbara

Description: This concrete and boulder structure spans the entire stream channel and apparently was built to protect a subsurface pipeline, which was not observed. Surface flows spill over the structure at three different points and are most concentrated near the river-left side in an eroded, U-shape chute in the concrete. The jump depth of the pool downstream was measured at 2 feet 5 inches. The jump height of the structure measured 3 feet 7 inches from the pool surface to the downstream edge of the eroded chute. The chute is 11 feet 2 inches long with a moderate slope along the top of the structure.

Condition: The structure is extremely undercut on the downstream side and at risk of failure.

Diagnosis: During migration flows the downstream pool would fill sufficiently to increase the jump depth and reduce the jump height to allow a moderate to highly difficult jump for upstream migrating adult steelhead during ideal flow conditions. This structure would present a significant impediment to juvenile salmonid migration during all flows and adult migration during low and moderate flows.

Recommended Action: Determine weather or not the owners of this pipeline is in operation and if the grade control can be removed to allow natural streambed connectivity. If still in use, the pipeline could be run deeper under the streambed or possibly overhead as is accomplished elsewhere in the watershed. Work with the owners to determine possible options.

Barrier ID: BR_MN_13
Stream: Mission
Barrier Type: Old Mission Dam
Location: Santa Barbara Botanic Garden
Ownership/Interest: Santa Barbara Botanic Garden

Description: Native Chumash that were enslaved by Franciscan Padres built this dam in 1807. The dam historically diverted stream flows into an aqueduct that carried the water to a storage reservoir near the Mission. According to signage next to the dam, this waterworks system apparently remained in good repair into the 1840's. Use of the Mission waterworks was discontinued after the floods of 1913-14. The Santa Barbara Botanic Garden acquired the property and dam in 1940. The dam measured 17 feet tall from the downstream pool surface to the bottom of the notch in the dam where flashboards were placed to create the upstream reservoir. The flashboard notch measured 7 feet 7 inches tall to the top of the dam surface. The total height of the dam from the downstream substrate to the top of the structure measured 27 feet 9 inches. Observations of a photograph on the signage next to the dam shows the height of the dam from the downstream substrate to the bottom of the notch at approximately 12 feet, indicating that downstream scour has significantly eroded the downstream side of this dam approximately 8 feet or more. The maximum depth of the downstream pool measured 3 feet 2 inches.

Condition: The dam is in poor condition with significant wear, downstream scour, and bank erosion.

Diagnosis: Upstream passage of all salmonid life stages during all stream flows is completely blocked due to the excessive height and limited jump depth at the dam.

Recommended Action: This historic structure has different meanings for people in the region and its continued existence as an attraction is likely desirable by some despite its obsolete function, poor condition, continual maintenance costs, and impact on the connectivity of the creek. Some argue that the dam should be removed to reestablish the aquatic connectivity of Mission Creek, open upper Mission Creek for eventual steelhead runs, restore surface flows upstream of the dam that often go subsurface into the sediment backed up behind the dam, and out of respect for the native Chumash that were enslaved to build the dam for the Franciscan Padres. The Botanic Garden should be approached to determine what their long-term objectives (50-plus years) are for the dam and outlook of eventual steelhead passage at the site. If continual maintenance of the dam is desirable, several options to allow fish passage exist and should be assessed in detail. Due to the low flows encountered in Mission Creek for much of the year, any fish passage option should be effective under a wide range of flows. A series of approximately three to five large step pools built on to the downstream side of the dam, in addition to possibly cutting the existing notch deeper, may provide the most effective passage. A fish ladder is not encouraged due to their susceptibility to clogging and limited effectiveness under low flow conditions. The subsurface flow conditions that exist upstream of the dam for much of the year, under the backed up sediment, presents a significant problem for any fish passage project that leaves the dam in place. A feasibility should be completed that looks at all passage options including dam removal to make the most informed decision about restoring steelhead upstream of this site for the first time in close to 200 years.

Barrier ID: MN_14
Stream: Mission
Barrier Type: Debris Basin Dam
Location: Upstream from the Santa Barbara Botanic Garden, approximately 5.91 miles from the ocean.
Ownership/Interest: Santa Barbara County Flood Control District

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Description: This concrete and boulder debris dam conveys flows through a smooth concrete culvert with a measured length of 68 feet 8 inches and slope of 6.1%. Downstream of the culvert outlet, stream flows dropped 7 inches onto a small concrete apron that extends 3 feet downstream with a moderate slope that ends abruptly 2 feet 9 inches above the surface of the downstream pool, which has a jump depth of 3 feet 1 inch.

Condition: The culvert appears to be in good condition with minimal wear. The dam appears to be in fair condition with 1-2 feet of undercutting on the downstream side of the dam.

Diagnosis: During migration flows, adult steelhead would be able to make a moderately difficult jump from the downstream pool into the culvert. The length of the culvert, smooth surface, and relatively steep slope would produce excessive water velocities with no resting areas that would prevent upstream passage. During low flows, the water depth in the culvert is to shallow to allow upstream passage and during moderate and high flows the water velocities inside the culvert will be to great for steelhead passage.

Recommended Action: See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_MN_15,17-21
Stream: Mission
Barrier Type: #15= Bedrock Chute, #17= Bedrock Waterfall, #18 and #19 =Bedrock and Boulder Waterfall, #20= Bedrock and Boulder Cascade, #21= Bedrock Waterfall
Location: Miles from the ocean: #15= 5.98, #17= 6.06, #18= 6.37, #19= 6.49, #20= 6.70. #21= Under Tunnel Road Bridge
Ownership/Interest: #18, #20, #21= City of Santa Barbara

Description and Diagnosis: These six natural features each constitute a significant obstacle to potential future upstream steelhead migration. Each of these structures may prevent upstream passage during certain years depending on stream flows, development of the downstream pool, and configuration of the feature. A brief description of each feature and diagnosis are provided below with pictures.

#15- This bedrock chute measured 6 feet 6 inches tall from the downstream pool to the top of the main chute at the center. The slope of the chute was approximately 45%. Two potential high flow routes exist on the far river-right and river-left side of the chute. At the tail-out of the downstream pool, exposed bedrock with a narrow outlet would allow the shallow downstream pool to back fill approximately 3 feet during high stream flows. This situation would create a pool depth of approximately 4 feet 6 inches and a jump to the top of the chute approximately 3 feet 6 inches high. These high flow conditions may allow a jump upstream with a high degree of difficulty.

#17- This bedrock waterfall measured 8 feet 7 inches tall from the downstream pool surface to the top of the waterfall. The downstream pool depth measured 6 feet. During high stream flows the downstream pool may backfill approximately 2 feet producing a pool depth of 8 feet and a jump height of 6 feet 7 inches. A jump during this high flow situation may provide an extremely difficult upstream jump over the waterfall, but during these flows the downstream pool will be extremely turbulent.

#18- This bedrock and boulder waterfall measured 7 feet in height from the surface of the downstream pool, which had a jump depth of 8 feet 5 inches. While the downstream pool has sufficient depth to allow a difficult jump to the top of the waterfall during migration flows, a large boulder at the top of the waterfall may block attempts to land upstream. This boulder may blow out in the next significant flow event reducing the severity and extremely difficult upstream passage may be possible even with it in place.

#19- This bedrock and boulder waterfall measured 10 feet 2 inches in height from the surface of the downstream pool, which had a maximum depth of 4 feet 3 inches. Large boulders downstream of the waterfall limit the extent and depth of the pool, which will be inundated with turbulent falling water during high stream flows essential for an attempt at jumping this tall waterfall. Passage at this waterfall is not possible in its current configuration, but the waterfall is composed of many boulders that may be seasonally mobile and extremely difficult passage may be obtained if the configuration changes favorably during future high flow events. Passage is highly dependant on the development of the downstream pool depth each year.

#20- This two-part bedrock and boulder waterfall measured 5 feet 5 inches tall from the downstream pool surface to a small resting pool 1 feet deep midway up the waterfall. From this small pool, a second jump of 3 feet occurs to the top of the feature. The total height of the waterfall measured 8 feet 5 inches from the downstream pool surface to the top. The downstream pool measured 4 feet 4 inches deep and would provide sufficient depth for a steelhead to jump to the small pool in the waterfall. From the small pool upstream passage is likely impossible due to the limited depth, excessive jump height, and overhanging boulder blocking the jump. During high stream flows, the downstream pool may back fill approximately 2 feet to produce a pool depth of 6 feet 4 inches and a jump of 6 feet 5 inches to the top of the waterfall. This situation may allow an extremely difficult upstream jump. Passage at this structure is highly dependant on seasonal changes in the configuration of the waterfall and downstream pool development.

#21- This bedrock waterfall under the Tunnel Road Bridge measured 16 feet in height from the surface of the downstream pool, which had a depth of 4 feet 6 inches. This feature is completely impassable to all salmonids under all flow conditions.

Recommended Action: No recommended action for these natural and seasonally changing features.

Barrier ID: BR_MN_16
Stream: Mission
Barrier Type: Stone Dam
Location: Approximately 0.38 mile upstream from Old Mission Dam
Ownership/Interest:

Description: This stone dam measured 16 feet 6 inches across the stream channel with a height of 4 feet 2 inches above the downstream pool, which had a jump depth of 4 feet 11 inches. Flows are currently concentrated over the center in a small notch.

Condition: The structure is extremely undercut on the downstream side up to 3 feet.

Diagnosis: The downstream pool has sufficient depth to allow a moderately difficult jump over the dam during ideal migration flow conditions. Passage for juveniles and adult steelhead during low stream flows will be difficult or impossible depending on the flows and depth of the downstream pool.

Recommended Action: This old dam does not appear to serve any purpose and no adjacent development would be impacted by its removal. This dam can be broken apart with relative ease, minimal cost, and provide significant benefit to future salmonid passage during lower flow conditions.

Barrier ID: BR_MN_RE_1
Stream: Rattlesnake Creek
Barrier Type: Pipe Crossing Grade Control Structure
Location: Approximately 150 feet upstream from Mission Creek confluence
Ownership/Interest:

Description: A 20-inch diameter pipe crosses the creek with some damaged concrete 'protection' across the top. The height from the surface of the downstream pool to the top of the pipe and concrete measured 3 feet. The downstream jump depth measured 5 feet 6 inches.

Condition: This pipe crossing has experienced major undercutting and stream flow is now passing under the pipe in several places. The concrete poured on top of the pipe is in extremely poor condition with major damage and complete failure in places. Scour has eroded most of the sediment away from under the pipe.

Diagnosis: The downstream pool has sufficient depth to allow a moderately difficult jump over this structure during most flows.

Recommended Action: Determine if this pipe is still in operation and if/when the owner plans to maintain the structure. If the pipe is no longer functioning, it should be removed to improve upstream access for juvenile salmonids and eventually adult steelhead with downstream passage. If the structure is still in use, running the pipe across the creek overhead should be considered.

Barrier ID: BR_MN_RE_2
Stream: Rattlesnake
Barrier Type: Riprap Channelization
Location: Approximately 0.31 mile upstream from Mission Creek confluence
Ownership/Interest:

Description: The following measurements and photograph are from Kuyper 1998. This channelized reach of Rattlesnake Creek measured 30 feet in length and consists of riprap, concrete filled sacks, and low-lying concrete. The creek is confined to 10 feet in width for sections of this channelized reach. A large boulder keyed into the bank revetments on both sides produces a two-step drop approximately 6 feet in height above the downstream pool surface. The depth of the downstream pool appears to be at least 2 feet deep. This structure was likely built to protect the adjacent residences, which Kuyper notes are precariously close to the stream channel on the adjacent banks.

Condition: The reach is a mesh of different revetment projects that were likely not coordinated together. This patchwork of projects has been built into the channel of the creek, reducing the flow capacity and width.

Diagnosis: During migration flows, jumping the entire structure would be extremely difficult or impossible depending on the downstream pool development and depth. High water velocities and turbulence will be encountered during migration flows through this confined stream reach that would likely prevent upstream passage.

Recommended Action: Work with landowners to collectively assess this stream reach for improving fish passage while maintaining bank protection. Full or partial removal of the large boulder creating the drop should be investigated in coordination with maintaining bank protection. Providing fish passage at this reach requires significant landowner coordination and a detailed study outlining restraints and alternatives for the entire reach.

Barrier ID: BR_MN_RE_3
Stream: Rattlesnake
Barrier Type: Bridge and Apron
Location: Approximately 0.53 mile upstream from Mission Creek confluence
Ownership/Interest:

Description: The following measurement numbers and photograph are from Kuyper 1998. A concrete apron extends 40 feet under a private driveway and drops a total of 4 feet to the downstream pool. Flows drop off the apron and onto a short relatively flat concrete step before falling to the pool.

Condition: The structure appears to be in fair condition with significant downstream undercutting from scour and adjacent bank erosion.

Diagnosis: The downstream pool appears to provide sufficient depth during migration flows to allow a moderately difficult jump onto the apron. During low flows, the spread out and shallow water conveyed across the smooth concrete would prevent upstream passage. During high stream flows, accelerated water velocities across the concrete and the lack of resting areas will produce extremely difficult upstream passage condition. Moderate flows may provide the best option for upstream passage when adequate depth exists across the apron and velocities are not to great. Even during ideal flow conditions upstream passage would be extremely difficult.

Recommended Action: Contact the owner(s) of the bridge and discuss the feasibility of removing the concrete apron and either stabilizing the existing bridge supports or replacing the current bridge with a wider span bridge that does not impact the stream channel and has a lesser chance of experiencing damage and erosion.

Barrier ID: BR_MN_RE_4
Stream: Rattlesnake
Barrier Type: Obsolete Diversion Dam
Location: Approximately 0.85 mile upstream from Mission Creek confluence
Ownership/Interest:

Description: This old concrete diversion dam and 7-inch diameter pipe are no longer functioning. The pipe intake is buried by sediment upstream. The height of the dam above the surface of the downstream pool measured 1 foot 6 inches. The downstream pool measured 4 feet 1 inch deep.

Condition: The structure is in poor condition with major undercutting on the downstream side due to scour and moderate concrete wear throughout.

Diagnosis: The downstream pool provides sufficient depth to allow upstream salmonid passage with a minimal to low degree of difficulty.

Recommended Action: This obsolete structure should be broken up and the metal pipe removed to, prevent potential downstream pipe blockage with a structural failure, avoid a change in configuration that increases the passage severity, and to improve upstream passage during all flows.

Barrier ID: BR_MN_RE_5
Stream: Rattlesnake
Barrier Type: Aerial Pipe Blockage
Location: Approximately 0.08 mile downstream from Las Canoas Road Bridge
Ownership/Interest:

Description: This aerial pipe crossing has two separate structural supports in the stream channel that have backed up large boulders and debris creating several waterfalls and steep cascades over 6 feet in height with minimal jump pool depths.

Condition: The pipe crossing supports are close to completely failed, with the concrete bases completely broken and separated from the streambed.

Diagnosis: The boulders and debris backed up behind the failing pipe supports have excessive jump heights and steep sloping cascades that produce extremely difficult or impassable situation for upstream migrating salmonids depending on the seasonal configuration.

Recommended Action: The owner of this structure needs to remove these failed pipe supports quickly as they may pull the overhead pipe down with high stream flows. The aerial pipeline should be redesigned to eliminate structures within in the streambed that impede upstream fish migration and present blockage hazards.

Barrier ID: BR_MN_RE_6
Stream: Rattlesnake
Barrier Type: Bridge and Apron
Location: Las Canoas Road Bridge
Ownership/Interest: City of Santa Barbara

Description: A cut-stone and concrete bottom extends 37 feet 3 inches under this stone arch bridge with a slope of approximately 2%. At the upstream end of the bridge the bottom width between the bridge supports measured 27 feet 10 inches wide and the height of the arch bridge from the center of the bottom measured 11 feet 6 inches. Downstream of this relatively flat section under the bridge, a concrete apron measuring 14 feet 8 inches in length drops with a slope measured at 26.4%. The downstream end of the apron dropped vertically 2 feet 9 inches to the pool downstream. The overall height of the apron from the downstream pool surface measured 6 feet 8 inches. The downstream pool had a maximum depth of 3 feet 3 inches and a jump depth near the apron of 2 feet 3 inches.

Condition: The apron appears to have been built to prevent scour from undermining the bridge. Scour is now undermined the apron and adjacent banks downstream. The river-left bank is experiencing massive erosion caused by this structure, which is compromising the integrity of Las Canoas Road.

Diagnosis: The downstream pool has sufficient depth to allow a moderately difficult jump onto the lower reach of the concrete apron, but excessive velocities and/or shallow depth on the steep apron prevent any upstream salmonid migration at this site.

Recommended Action: A detailed study of fish passage alternatives is needed and should consider:
1) Removing the entire structure and replacing it with a wider span bridge that does not impact the stream channel, impeded fish migration, limit vehicular traffic like the current one-lane bridge, or further promote scour and bank erosion. This action would have the greatest results for fish passage and likely other road related objectives.
2) Cutting a rough channel down the center of the stone and concrete bottom that focuses flows into a series of two to three large step pools that are cut into the apron. This alternative would allow fish to jump into the lowest step pool, from the downstream pool, and make the series of jumps up to the channel under the bridge. The rough channel under the bridge would need resting pools cut into it or some other type of velocity break concept. This action may only be effective at passing fish during ideal flows and would require constant maintenance.

Barrier ID: MN_RE_7
Stream: Rattlesnake
Barrier Type: Debris Basin Dam
Location: 0.17 mile upstream from the Las Canoas Road Bridge
Ownership/Interest: Santa Barbara County Flood Control District

Description: This concrete and boulder debris dam conveys low flows through a smooth concrete culvert with a measured length of 65 feet and slope of 5.4%. Downstream of the culvert outlet, a smooth concrete apron with an overall slope measured at 11.4% extends downstream 13 feet 10 inches. The apron ends abruptly and stream flow falls vertically 5 feet 7 inches to the substrate below. There is no developed jump pool downstream and flows fall directly onto woody debris and gravel with a water depth of 3 inches.

Condition: The dam appears to be in fair condition with significant downstream scour and only moderate concrete damage.

Diagnosis: Upstream passage of salmonids at this site is not possible during all stream flows due to the lack of a downstream pool, excessive jump height, steep apron, and high velocities and/or shallow water depth throughout the long, relatively steep culvert. No resting areas or velocity breaks occur along the 78 feet 10 inches of the culvert and apron.

Recommended Action: See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_MN_RE_8,10,11,12,13,14
Stream: Rattlesnake
Barrier Type: Bedrock and/or Boulder Cascades and Chutes
Location: Between 0.30 & 1.16 miles upstream from Las Canoas Road Bridge
Ownership/Interest: City of Santa Barbara

Description and Diagnosis: These six natural features impose significant limitations to upstream salmonid migration. Several other natural features occur between #10 and #11 that would also present difficult passage situations, depending on the seasonal configuration and development of the downstream pool. Rainbow trout were observed throughout Rattlesnake Creek upstream to just below #14. No trout were observed surveying 750 feet upstream of #14.

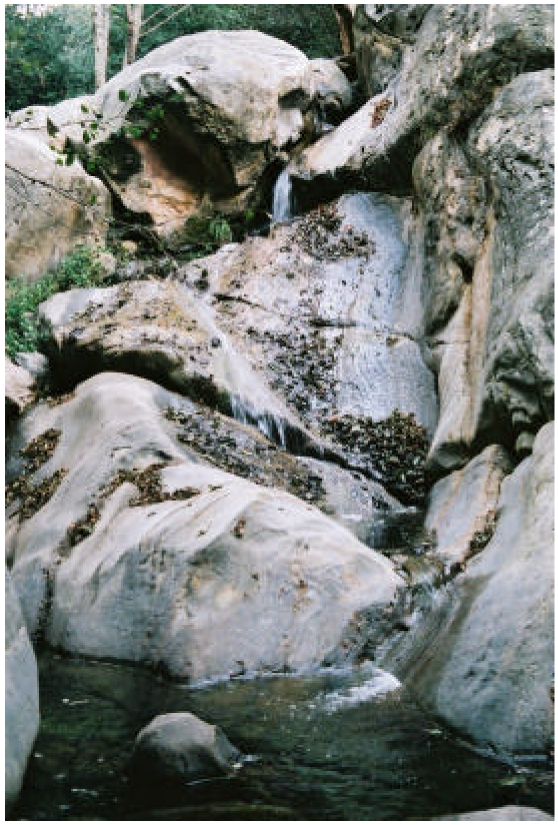
#8- This bedrock waterfall and boulder cascade occur where exposed bedrock confines the stream channel. A steep 250-foot long boulder gradient occurs upstream of the waterfall upstream. The waterfall measured 6 feet 4 inches in height from the surface of the downstream pool, which had a jump depth of 5 feet 6 inches. At the top of the waterfall, flows cut through a narrow bedrock chute measuring 3 feet wide at the top, 11 inches wide at the bottom, and 4 feet deep. The chute measured 12 feet long and had a water depth of 1 foot 9 inches. A small waterfall of 2 feet 9 inches occurs at the inlet of the chute. During moderate to high migration flows the downstream pool depth has been observed to increase over 16 inches producing sufficient depth for a steelhead to jump the waterfall and swim up the chute with a high degree of difficulty. The passage severity of the mobile boulder cascades upstream will be highly dependent on the configuration of the reach each season.

#10- This bedrock chute occurs 200 feet upstream of the old Rattlesnake Mission Dam and had a measured length of 9 feet between upstream and downstream pools with a slope of approximately 30%. The downstream pool measured 2 feet 2 inches deep. A highly difficult swim up this short bedrock chute is possible during moderate stream flows due to the presence of several velocity breaks.

#11- This boulder cascade measured 6 feet 8 inches from the top of the drop to the surface of the downstream pool, which had a jump depth of 1 feet 7 inches. Upstream migration during moderate to high stream flows would have a high degree of difficulty, but would be possible if the downstream pool depth increased approximately 2 feet, adding to the jump depth and lowering the jump height.

#12- This steep bedrock and boulder cascade measured 18 feet in total height with a series of 7 short waterfalls between 1 and 3 feet in height dropping down the cascade with small 6 to 14 inch deep pools associate with them. The overall slope of the cascade was estimated at 35%. Upstream passage at this site is highly unlikely in its current configuration due to the lack of adequate jump pool depths associated with the series of small falls and highly turbulent conditions encountered during elevated stream flows. The small boulders in this cascade do appear to be seasonally mobile and adequate passage conditions may occasionally occur.

#13- This two-part boulder cascade measured 23 feet tall on the downstream section to a 60-foot long, moderately-sloped reach that proceeded upstream to the base of the second steep reach measuring 20 feet tall. A massive boulder that produces a 10-foot drop onto boulders holds the downstream 23-foot cascade together. This reach is currently impassable due to the excessive heights of both sections and lack of sufficient downstream jump depths. Some boulders within this reach are seasonally mobile and the cascade likely changes configuration often, potentially allowing limited passage in the future.



#14- This bedrock chute measured a total of 25 feet tall and consists of a massive bedrock wall on the river-left side and large boulders at the top and down the river-right side. No significant jump pools exist and all slopes encountered exceed 40%. This excessively tall chute is completely impassable and is very stabile. Downstream natural features may limit steelhead passage up to this site during most or all years, but this site is an absolutely impassable location that will not dramatically change in severity anytime soon.

Recommended Action: No recommended actions for these natural features.

Barrier ID: BR_MN_RE_9
Stream: Rattlesnake
Barrier Type: Old Mission Dam
Location: 0.40 mile upstream from Las Canoas Road Bridge
Ownership/Interest: City of Santa Barbara

Description: Chumash natives that were enslaved by Franciscan Padres built the "Rattlesnake Dam" in 1808 to supply water to the Mission water system. Water was diverted from this site down an aqueduct to the Mission. The dam is composed of cut stones, cobbles, and likely lime mortar. The dam no longer functions and is naturally being washed away. The dam measured 35 feet across the channel and is keyed into bedrock walls on both sides. The total height of the dam from the downstream substrate to the top of the dam measured 21 feet 10 inches. A major portion of the dam has blown out and stream flows now fall 11 feet 6 inches from the damaged notch to the surface of the downstream pool, which measured 4 feet 10 inches deep.

Condition: The dam is in extremely poor condition with massive structural failure and significant undercutting on the downstream side. Sediment is backed up to the top of the failed notch.

Diagnosis: The excessive height of the dam would likely prevent upstream migration during most/all flows unless the downstream pool fills approximately 3-4 feet during high stream flows. Passage at such flows would be extremely difficult due to turbulent water conditions in the downstream pool and very high water velocities confined through the failed notch in the dam.

Recommended Action: Continue to allow the dam to naturally erode. The dam will likely blow out on its own, but if recovery efforts downstream allow steelhead to migrate upstream to this site and passage is still significantly impeded, the rest of the dam should be broken apart.

Refer to Map Folder for:
Arroyo Burro Creek Map
Map 7.7.5.1

Refer to Map Folder for:
Arroyo Burro Creek Map
Map 7.7.5.1

Refer to Table Folder for:
Arroyo Burro Creek Barrier Table
Table 7.7.5.2

Refer to Table Folder for:
Arroyo Burro Creek Barrier Table
Table 7.7.5.2

Barrier ID: BR_AB_1
Stream: Arroyo Burro
Barrier Type: Bridge and Grade Control Structure
Location: Downstream from Cliff Drive Bridge
Ownership/Interest: City of Santa Barbara

Description: This grade control structure occurs downstream from the Cliff Drive Bridge and a large culvert outlet on the river-left stream bank. The upstream extent of the Arroyo Burro lagoon occurs at this structure. The uppermost portion of the grade control structure consists of a concrete curb spanning the length of the stream channel with a thickness of 2 feet 6 inches. The curb has a shallow flat-bottom notch cut into it with a bottom length of 8 feet 6 inches. This notch concentrates lower flows that drop 1-foot onto the concrete and boulder riprap apron below that conveys stream flows 18 feet to the lagoon downstream. The overall slope of the riprap apron, from the curb lip to the lagoon surface downstream, measured 23%. The jump depth of the downstream lagoon was measured at 4 feet 2 inches.

Condition: The structure appeared to be in fair condition with moderate concrete wear and cracking. It appears that the bridge may be undersized for a 100-year flood.

Diagnosis: While surveying this structure, adequate jump depth in the downstream lagoon would allow a relatively easy jump or swim onto the apron during migration flows. During moderate to high stream flows, upstream steelhead passage can likely be obtained with a high degree of difficulty due to the many velocity breaks and small resting/jumping pools provided by the large boulders on the apron. Adequate migration onto the apron is dependant on the jump depth of the downstream lagoon, which may change seasonally with fluctuations in lagoon water levels and sandbar formation at the beach. Upstream passage may be complicated by high flow discharges from the culvert on the river-left bank, which conveys water perpendicularly to the flow of Arroyo Burro across the apron. This culvert outfall may confuse steelhead attempting to navigate up the structure by creating difficult hydraulic conditions and/or contribute poor water quality that might deter upstream migration. At the upstream end of the apron, the 1-foot tall curb presents the most significant structural challenge to upstream migration due to the minimal jump depth downstream during low and moderate flows.

Recommended Action: Steelhead passage plans at this site should be assessed in conjunction with long-term Arroyo Burro lagoon restoration objectives. While steelhead passage conditions can be improved in the short term by cutting the existing notch down 1 additional foot and creating a series of two or three resting/jumping pool on the apron, this action would not address several important issues listed below.

1) The structure would continue to limit the size of the Arroyo Burro lagoon by preventing upstream lagoon expansion.
2) Native stickleback and other fish species currently found in the lagoon may not be able to migrate upstream of a steelhead passage modification at this site due to their limited upstream migration capabilities (sticklebacks were observed downstream of the structure, but not upstream).
3) The culvert on the river-left bank would continue to convey water of questionable quality into the lagoon at a critical migration site.
4) The 100-year flood capacity of the bridge would not be improved.

Long-term objectives for Arroyo Burro lagoon restoration and steelhead passage at Cliff Drive should include assessing the feasibility of:

1) Reducing the size of the main parking lot at the Brown Pelican and Watershed Resource Center and establishing a native vegetation buffer along the lower lagoon. This action would help to reduce the direct drainage of automotive pollution and parking lot runoff into the lagoon. Currently the buffer between parking lot and lagoon is very limited.
2) Eliminating the overflow parking lot to the north along the upper lagoon and allow for lagoon expansion and a native vegetation buffer along the lagoon. Adequate parking lot space should be located nearby, but none on top of critical wetland habitat.
3) Eliminating the Cliff Drive Bridge and entire downstream grade control structure to allow lagoon expansion, unimpeded upstream steelhead migration, and native lagoon species distribution expansion. Replace the bridge crossing with a wider span bridge that does not impact the stream channel and provides a larger storm flow conveyance capacity.
4) Prevent the culvert at the grade control structure, and other culverts along the lower lagoon, from conveying polluted water directly into the lagoon.

Barrier ID: BR_AB_2
Stream: Arroyo Burro
Barrier Type: Grade Control Structure
Location: 0.33 mile upstream from Cliff Drive Bridge
Ownership/Interest:

Description: This concrete and boulder grade control structure measured 6 feet 2 inches tall from the top of the structure to the surface of the downstream pool, which measured 2 feet 3 inches depth. The downstream side of the structure can be broken up into two distinct slopes. The milder downstream slope rises 2 feet 2 inches over 10 feet with a slope of 21.7%. The upper-most slope rises 4 feet over 12 feet with a slope of 30%.

Condition: The structure appears to be in fair conditions with moderate wear and adjacent bank erosion. The grade control is completely filled with sediment on the upstream side.

Diagnosis: During migration flows, adult steelhead would be able to swim or jump onto the lower end of this structure with relative ease. Once on the structure, steelhead would encounter high water velocities and minimal areas to rest or gain momentum to jump. Due to the excessive slope of the uppermost portion of this structure, upstream steelhead passage is likely not possible during all stream flows.

Recommended Action: Due to the impassability of this structure near the downstream end of the Arroyo Burro watershed, an effective fish passage project must be implemented at this site to begin steelhead recovery in this system. With an estimated 91.1% of the watershed (Main stem Arroyo Burro and San Roque Creek) found upstream of this structure, and limited downstream spawning habitat, steelhead production in the Arroyo Burro watershed is likely not possible without providing additional access. The most effective, self-sustainable solution for allowing steelhead passage at this site is to remove the structure and reinforce adjacent stream banks. Additional assessment of this structure and potential implications of removal need to be conducted with the safety of adjacent homes considered. Several homes adjacent to the stream channel upstream would likely be impacted by removal and would require sufficient bank protection measures. Bioengineering techniques to stabilize stream banks following removal should be assessed.

Refer to Map Folder for:
Atascadero, Maria Ygnacio Creek Map
Map 7.7.6.1

Refer to Map Folder for:
Atascadero, Maria Ygnacio Creek Map
Map 7.7.6.1

Refer to Table Folder for:
Atascadero, Maria Ygnacio Creek Barrier Table
Table 7.7.6.2

Refer to Table Folder for:
Atascadero, Maria Ygnacio Creek Barrier Table
Table 7.7.6.2

Barrier ID: BR_AO_1
Stream: Atascadero
Barrier Type: Grade Control Structure
Location: Upstream end of Goleta Slough tidal influence
Ownership/Interest: The Gas Company/Santa Barbara County Flood Control District

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Description: This grade control structure spans 84 feet across the stream channel at the upstream end of the Goleta Slough, separating the tidal water downstream from the fresh water of Atascadero Creek upstream. Ward Drive dead-ends approximately 100 feet downstream from this site. Apparently, The Gas Co. has a pipeline running under this structure for protection and the SBCFCD maintains the structure (pers. comm. Treiberg). The structure is constructed of rough concrete and boulder riprap and consists of a 2-foot 11 inch tall berm at the upstream end that drops at an approximately 45-degree angle, at center, to a relatively flat apron downstream. Shallow stream flows were spread out across the concrete berm at center and toward the river-left side. The apron measured between 34 and 29 feet in length downstream from the berm to the Goleta Slough water. Slough water was backed up onto the apron with depths of 7 inches to 2 feet measured along the irregular, boulder-embedded apron. Approximately 90% of the apron was submerged by slough water. Downstream of the apron a submerged vertical drop of 2 feet 11 inches occurred to the downstream substrate.

Condition: The structure is in poor condition with several holes through the apron, cracked concrete, and significant undercutting of the apron from downstream scour.

Diagnosis: The severity of this structure to upstream steelhead migration appears to be dependant on the tidally influenced Goleta Slough and the extent to which the apron is submerged or potentially elevated above the downstream pool. The structure limits upstream steelhead passage during low flows due to the limited jump depth on the apron downstream of the berm and the steep angle of the berm and shallow flows encountered. Smaller native fish species found within the Goleta Slough are likely blocked from migration upstream during most or all flows. With moderate and high stream flows there would be sufficient water depth across the apron, velocity breaks provided by the embedded boulders, and reduced jump height over the berm to allow upstream steelhead migration with, at greatest, a high degree of difficulty. Kuyper 1998 observed this structure completely submerged after a major precipitation event sometime in 1997 or 1998. A likely route over the berm during moderate flows occurs on the far river-right side where the slope is more gradual to the top of the berm. Tidal action that increases the depth of water over the apron would reduce the difficulty of upstream passage. Adult steelhead have migrated upstream of this structure as recently as 2000 (See Salmonid Documentation Table).

While steelhead migration is likely impaired during lower flows, the impacts of this structure are more severe to the migration and distribution of other native species found in the Goleta Slough. Conversely, this structure may impede upstream migration of exotic species present in the slough. The impact of any migration impediment at the downstream end of a stream is always significant due to the limited window of opportunity steelhead have in these flashy creeks to quickly get upstream to spawn. In this case, steelhead bound for Maria Ygnacio, San Antonio, or upper Atascadero Creek must deal with several difficult upstream barriers whose severity is highly dependant on stream flows. Delayed passage at his site may leave steelhead stranded at upstream barriers that are only passable during short periods of higher stream flow.

Recommended Action: The impact of this structure on the overall tidal dynamics and ecological health of the Goleta Slough should be assessed. The functionality and desirability of this structure should be determined with the owner and the SBCFCD along with larger Goleta Slough Management studies currently being discussed by several local groups. Elimination of the structure and rerouting the pipeline over, or further under, the creek would provide the most effective upstream fish passage and may expand the size of the Goleta Slough and have other potential benefits. Upstream sediment trapped behind the structure needs to be evaluated in conjunction with alternatives assessed. A short-term action that would improve passage immediately can be achieved by, cutting a notch approximately 5 feet wide and 10 inches deep at the center of the berm. This action would concentrate low flows across the berm, increase water depth, and reduce the height of the berm.

Barrier ID: BR_AO_2 and BR_AO_MY_1
Stream: Atascadero and Maria Ygnacio
Barrier Type: Bridge and Grade Control Structure
Location: Under the Paterson Avenue Bridge across the Maria Ygnacio and Atascadero Creek confluence
Ownership/Interest: Santa Barbara County Public Works- Roads Division

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BR_AO_2

BR_AO_MY_1

Description: This bridge and grade control structure occurs exactly where Maria Ygnacio Creek and Atascadero Creek flow together to form lower Atascadero Creek. This is the only structure in this report that has two different Barrier ID's due to its presence on two different stream reaches. A concrete bridge support divides the two creeks during lower flows, which then flow together downstream and drop off a concrete curb to the pool downstream. The 1-foot thick concrete curb measured 116 feet across the stream channel in a shallow V-shape that concentrates flows at center downstream of the bridge support. Flows dropped 4 feet 6 inches vertically to the surface of the downstream pool, which had a jump depth measured at 7 feet 8 inches. A small landing pool 4 feet in diameter and 16 inches deep occurs immediately upstream of the curb. Upstream of the concrete curb, a boulder and concrete riprap apron extends approximately 79 feet up the likely upstream migration route on the Maria Ygnacio Creek side at a slope of 4.11%. A small berm exists at the upstream end of the apron with a height of approximately 14 inches. A similar apron configuration exists on the Atascadero Creek side. A USGS stream gage occurs on the downstream side of the concrete bridge support. The Patterson Avenue Bridge and associated apron and bridge support was constructed in 1967.

Condition: The structure is in fair condition overall, but is causing severe undercutting and bank erosion on the downstream river-left side. High flow marks, and a date of 1-10-95 painted next to them, occurs 9 feet high on the bridge support and 4 feet from the bottom of the bridge.

Diagnosis: Migrating across the rough, boulder-embedded apron has a low degree of difficulty due to the presence of velocity breaks and moderate slope. The downstream pool provided adequate depth to allow a moderately difficult jump upstream of the apron. Salmonid habitat conditions in the Maria Ygnacio sub-watershed are far better that in upper Atascadero Creek and the location of this structure complicates upstream navigation to the correct upstream tributary, especially during high stream flows when a fish may jump the curb from the river-left side of the downstream pool and be forced to migrate up Atascadero Creek. The passage severity of this structure is highly depend on the formation of the downstream pool and tailwater control, which likely experiences major seasonal change and is subject to blowing out during higher flows. The reduction of the downstream pool depth would increase the jump height and reduce the jump depth leading to a higher severity and potentially an impassable structure. The severity of this structure likely changes from season to season. The overall upstream steelhead passage difficulty of the structure was rated as “high” due to the physical configuration and the likelihood of disorientation caused by the location at the confluence.

Recommended Action: The complicated hydraulic conditions encountered at this site and the importance of all components of the structure to the integrity of the bridge requires additional analysis to determine potential fish passage improvement recommendations. Cutting a notch at center of the curb may compromise the integrity of the bridge support with uncertain benefits. The most effective option for improving upstream steelhead passage would be to eliminate the apron and drop under the bridge. It appears that one possibility may be to remove the concrete apron and curb under this wide bridge, reinforce the adjacent stream banks, and rebuild a central bridge support that penetrates deep into a natural substrate bottom. This action would also likely result in a greater flow capacity under the bridge.

Barrier ID: BR_AO_MY_2
Stream: Maria Ygnacio
Barrier Type: Grade Control Structure
Location: 0.16 mile upstream from the Atascadero Creek confluence
Ownership/Interest:

Description: This concrete grade control may be associated with underground utilities (pers. comm. Treiberg). During low stream flows encountered, the height of the structure measured 12 inches above the surface of the downstream pool, which had a depth measured at 1 foot 7 inches. A smooth, moderately sloping section of concrete conveys low flows for 6 feet across the structure.

Condition: The grade control is in extremely poor condition with severe undercutting and concrete damage.

Diagnosis: During moderate and high stream flows the structure is submerged and imposes a minimal to low degree of difficulty to upstream migration. During low flows the structure may limit upstream migration due to the shallow water depth across the structure.

Recommended Action: Identify the owner of the structure and determine its functionality and desirability. If feasible, remove or break up the concrete to improve low flow migration and prevent potential changes in the configuration and severity of the structure caused by scour and erosion.

Barrier ID: BR_AO_MY_3
Stream: Maria Ygnacio
Barrier Type: Concrete Channelization/Box Culvert Crossing
Location: Hollister Avenue Bridge and Pedestrian Path Crossing
Ownership/Interest: Santa Barbara County Public Works- Roads Division

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Description: The Hollister Avenue Bridge was constructed in 1963 by the SBCPWRD and the Army Corps of Engineers riprapped the channel below the bridge in 1968 (Kuyper 1998, citing C. Elbert). A concrete pedestrian path crosses the creek underneath the bridge through a small box culvert. The stream flows are confined to a small concrete and boulder riprap channel that winds under the bridge in an S-shape. At the downstream end, the 3-foot deep U-shaped channel measured 4 feet 6 inches wide at the bottom and 10 feet 6 inches wide at the top. Large boulders have been placed at the downstream end of the structure, apparently to prevent downstream scour. The lowest 10 feet of the channel is fairly smooth concrete with a stepper slope. The channel extends a total of 147 feet from the downstream end to the upstream end. The downstream end of the pedestrian path box culvert occurs 70 feet upstream from the downstream end of the channel. The smooth-bottom concrete box culvert measured 31 feet long, 4 feet wide, and 3 feet 6 inches tall with a slope of 4.3%. A damaged metal grate occurs on the upstream end of the culvert.

Condition: The structure appears to be in fair condition overall with moderate concrete wear and cracking and a highly damaged metal grate.

Diagnosis: Entry into the channel from downstream is achievable with a moderate degree of difficulty during migration flows when water depth is adequate. Passage through the box culvert imposes a high degree of difficulty due to the moderately sloped smooth concrete bottom, accelerated stream velocities, absence of resting spots, shallow water depth during low flows, and likely seasonal debris blockage at the culvert inlet and metal grate. Signs of clearing debris from the metal grate are present. During moderate flows and unblocked conditions, upstream passage can occur with a high degree of difficulty. This structure is impassable during low flows and may be impassable for extended periods of time with debris blockage at the culvert.

Recommended Action: Improved steelhead passage at this site is necessary to ensure consistent access upstream from year to year. The feasibility of providing natural substrate conditions under the bridge should be assessed to provide the most effective, unimpeded upstream steelhead passage. This action could consist of removing all of the riprap bottom and significantly reinforcing the adjacent bridge wall supports or leaving some of the riprap adjacent to the bridge walls in place and reestablishing a majority of the natural streambed under the bridge. The pedestrian path could hug one of the bridge support walls under the full length of the bridge and either cross the creek upstream or downstream over an elevated bridge out of the stream channel and storm flows. At a minimum, the box culvert should be removed and converted to a rough riprap channel similar to the adjacent upstream and downstream configuration and a small bridge or arch culvert installed over this channel. Removal of the grate and potential blockage point would accompany this action. The box culvert is the major impediment and potential blockage point throughout this structure. The moderately steep, smooth 10-foot section of concrete at the downstream end of the channel should be roughened to reduce the water velocities encountered.

Barrier ID: BR_AO_MY_4
Stream: Maria Ygnacio
Barrier Type: Channelization
Location: Under the UPRR Crossing and Highway 101 Bridges
Ownership/Interest: UPRR and CALTRANS

Description: Under the UPRR crossing, 104 feet of stone-lined bottom and adjacent vertical stone walls line the creek channel. A bike path occurs on the far river-left side of the channel confining the stone-lined bottom to a width of 33 feet 4 inches across. Significant scour on the downstream end of the UPRR channel has produced a drop measured at 7 feet from the lip of the channel to the substrate of the downstream pool. The pool depth ranged widely over several observations throughout 2000-2001 and is seasonally variable with modifications to the downstream substrate configuration and fluctuations in stream flow. During a survey on 5/22/2001 with a stream flow of approximately 0.5 c.f.s., the jump depth of the downstream pool measured 4 feet and a jump height was measured at 4 feet 6 inches.
The stone-lined UPRR channel reach is relatively flat and connects with the upstream sloping concrete walls that line the banks of Maria Ygnacio Creek and extend underneath and upstream of the Highway 101 Bridge Crossings. Upstream of the UPRR stone-lined channel, the stream bottom becomes natural between the sloping concrete walls and consists of fine silts, sand, and cobbles. The concrete walls extend under the Highway 101 Bridges to provide protection to the concrete bridge supports along the banks and bike path. The concrete walls extend upstream of Highway 101 and into the lower reaches of San Antonio Creek and Maria Ygnacio Creek upstream from the confluence. Small pools and an irregular stream bottom were present in this reach. The same type of sloping concrete wall extends downstream of the UPRR channel drop on the river-left side adjacent to the bike path.

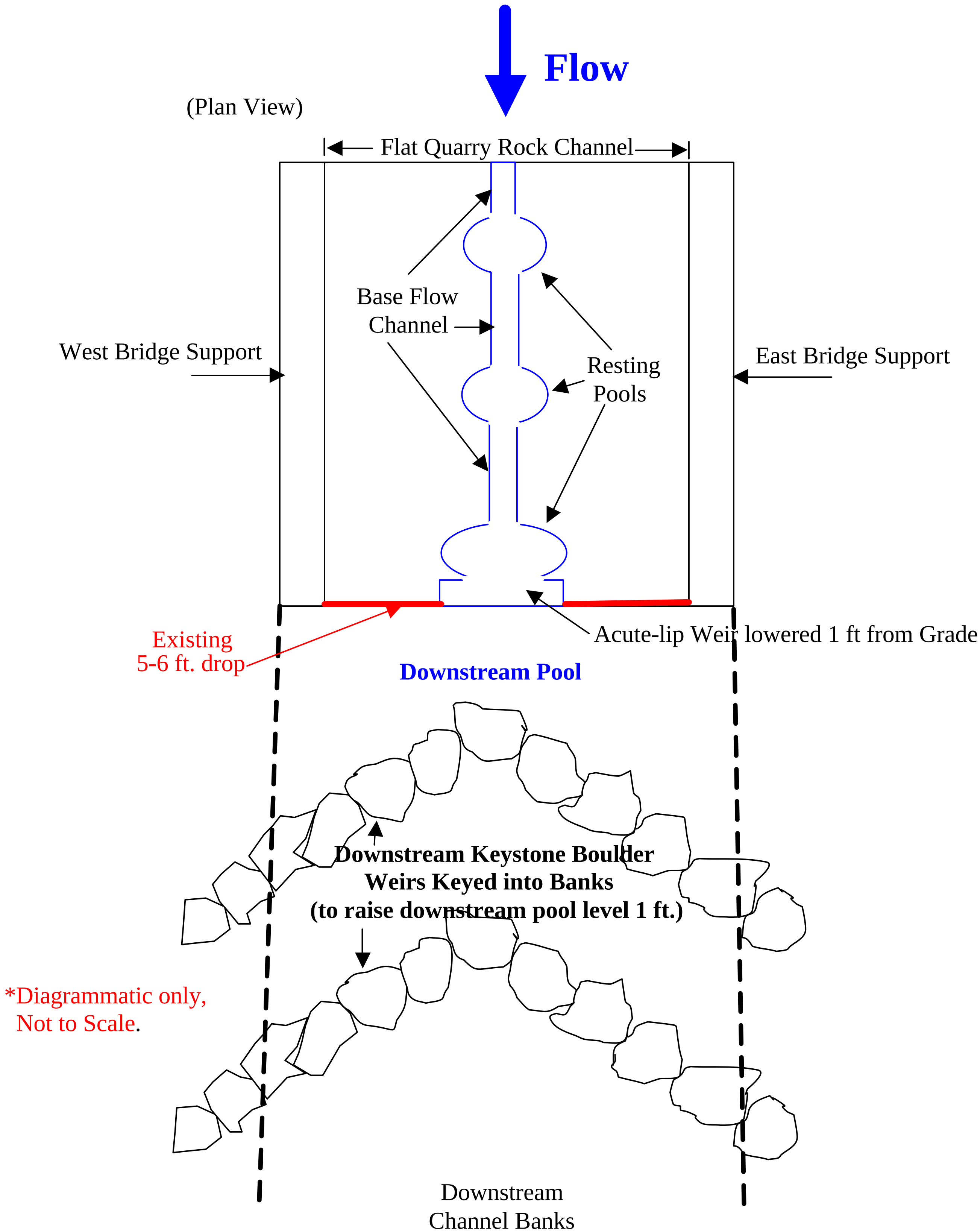
Condition: The UPRR stone-lined bottom is in poor condition with moderate wear occurring throughout the channel and significant downstream scour and extensive adjacent bank erosion. The concrete walls of the bike path downstream of the UPRR channel are significantly undercut in several places and are at risk of failure.

Diagnosis: The severity of upstream passage at this site is highly dependant on the configuration of the jump pool downstream of the UPRR channel. With moderate to high stream flows and a pool depth at least equal to the jump height onto the channel, an upstream jump onto the channel is possible for adult steelhead with a moderate to high degree of difficulty. Slightly accelerated stream velocities across the stone-lined bottom during higher stream flows or shallow water depth during lower flows, add to the difficulty of migrating past this 104 feet of channelization. Overall, this structure is passable for adult steelhead with a high degree of difficulty during ideal flow conditions with adequate downstream pool formation and depth. The window of opportunity for adult steelhead to migrate upstream of this location is significantly reduced due to the presence of this structure and may be blocked for extended periods of time, or seasonally depending on jump pool depth and stream flows. High stream flows in Maria Ygnacio Creek were observed to carry high amounts of suspended sediment and navigation over this structure may be limited during these flows. Upstream steelhead migration past the CALTRANS concrete wall section upstream of the UPRR channel presents no significant challenge with the natural substrate conditions and velocity breaks associated with the irregular bottom. A 27-inch long steelhead was rescued from the drying pool downstream of the UPRR channel on 6/16/2000 by C. Fusaro (California Trout), N. Lohmus (CDFG), and M. Cardenas (CDFG) and transferred downstream to the Goleta Slough. It is unknown whether or not this adult steelhead made it upstream of the UPRR channel earlier in the season or was prevented from upstream migration due to low flow condition.

Recommended Action: Upstream migration conditions for steelhead should be improved at this site to allow adult steelhead easy access to upstream habitat in Maria Ygnacio and San Antonio Creeks. Efforts to improve upstream passage at this site have been initiated by Craig Fusaro (California Trout) and David Pritchett (FishTap) with advice from Jon Mann (NMFS). Fusaro designed the diagram below of the proposed project. The proposed action would cut a low-flow channel across the UPRR channel with resting pools and install downstream boulder weirs. This action would likely provide improved passage by increasing the water depth across the channel within the low-flow channel, providing resting spots along the channel, assisting in adequate downstream pool formation, and slightly reducing the jump height. The downstream weirs may be susceptible to damage or failure over the long-term and the effectiveness of such a project would likely not be known until after it was completed and monitored for several seasons. A grant proposal for this project with additional information can be obtained from David Pritchett. In addition to the proposed project discussed above a long-term goal of providing unimpeded access at this site should be coordinated with UPRR and CALTRANS. A feasibility study should determine the possibility of removing the entire UPRR structure, replacing it with a wide-span bridge that does not impact the stream channel (such as the Montecito Creek UPRR crossing), reinforcing upstream concrete walls and CALTRANS bridge supports, and reestablishing a natural stream bottom through this reach.

Diagram by Craig Fusaro, California Trout, Inc.

CONCEPTUAL DIAGRAM* OF FISH PASSAGE MODIFICATIONS SUGGESTED BY JOHN MANN, NATIONAL MARINE FISHERIES SERVICE FISH PASSAGE SPECIALIST



Barrier ID: BR_AO_MY_5
Stream: Maria Ygnacio
Barrier Type: Grade Control Structure
Location: 40 feet downstream from the University Drive Bridge
Ownership/Interest: Santa Barbara County Public Works- Roads Division

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Description: This concrete and boulder grade control structure spans 50 feet across the stream channel and measured 18 feet 6 inches from the downstream lip of the riprap apron to the top of a concrete curb on the upstream end. No stream flow was present while surveying this structure. The riprap apron extends from the base of the concrete curb to the downstream substrate with an overall slope measured at 2 %. The concrete curb has a steep slope of approximately 45 degrees to the downstream apron and measured 2 feet in height above the apron, at center. On the far sides of the structure, the apron transitions gradually to within 12 inches of the top of the concrete curb. Upstream of the structure, fine silt and sand was backed up to the top of the concrete curb. The grade control is likely intended to provide protection to the upstream bridge and bank protection.

Condition: The structure is in fair condition with moderate wear and downstream scour.

Diagnosis: During migration flows, steelhead can swim directly onto the apron where adequate velocity breaks occur along the moderate slope, allow upstream passage with a moderate degree of difficulty. Shallow, unconfined flows across the structure during lower flow periods may block upstream passage due to shallow water depth and lack of sufficient jump depth on the apron to burst, or jump, over the concrete curb at the upstream end. Additional downstream scour during migration flows, or in the future, may increase the severity of this structure by producing a jump onto the apron.

Recommended Action: It appears that upstream bridge protection measures are designed around the presence of the grade control structure and backed up sediment upstream. The grade control may also serve to provide improved flow measurement consistency for the USGS gaging station just upstream. The bridge appears to be built wide enough to allow a continuous natural stream bottom through this reach with moderate reinforcement of the bank protection measures and removal of the grade control. This option would provide unimpeded access for steelhead, but needs to be further studied to determine the technical feasibility and is not immediately critical. When major modifications are to occur at this site this option should be considered. In the short-term, cutting a notch approximately 4 feet wide and 6 inched depth at the center of the concrete curb would improve upstream passage during moderate and low flow condition by increasing water depth across the structure and reducing the jump height of the concrete curb.

Barrier ID: BR_AO_MY_6
Stream: Maria Ygnacio
Barrier Type: Grade Control Structure
Location: 0.17 mile downstream from the Cathedral Oaks Road Crossing
Ownership/Interest: Santa Barbara County Flood Control/Santa Barbara County Public Works-Roads Division

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Description: This sloping concrete grade control structure measured 14 feet in length from the upstream end to the surface of the downstream pool, which had a jump depth of 2 feet 1 inch. The vertical height of the structure from the downstream pool surface to the top of the structure measured 3 feet 1 inch. The overall slope of the structure measures 22%.

Condition: The structure is in fair condition with significant downstream scour and undermining of the concrete and adjacent pipe and wire revetment.

Diagnosis: During migration flows the downstream pool depth will increase, reducing the height of the structure and length of the sloping concrete face. Adult steelhead should be able to migrate upstream with a moderate degree of difficulty during ideal flow conditions, either by jumping over the entire structure or bursting directly up the sloping face when velocities are not to great and the distance has been considerably reduced. During lower flows the structure is impassable due to shallow water depth over the steep concrete slope. Five *O. mykiss* ranging from 2.5 to 4 inches in total length were observed in the downstream pool on 6/2/2001.

Recommended Action: A Goleta Sanitary District pipeline crosses overhead near this structure with concrete support structures on the creek banks. The grade control is likely intended to protect this pipe crossing. The feasibility of removing this grade control structure and reinforcing the existing pipe supports or setting them back further out of the stream channel should be assessed. Elimination of the grade control and alternative pipe crossing bank protection would provide the most effective steelhead passage alternative at this site and is recommended for effective and reliable fish passage at this site.

Barrier ID: BR_AO_MY_7
Stream: Maria Ygnacio
Barrier Type: Grade Control Structure
Location: 0.14 mile downstream from the Cathedral Oaks Road Crossing
Ownership/Interest: Santa Barbara County Flood Control/Santa Barbara County Public Works-Roads Division

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Description: This sloping concrete grade control structure is similar to the downstream one (BR_AO_MY_6) and measured 13 feet in length from the upstream end to the surface of the downstream pool, which had a jump depth of 2 feet 6 inch. The vertical height of the structure, from the downstream pool surface to the top of the structure, measured 3 feet 1 inch. The overall slope of the structure measured 23.7%.

Condition: The structure is in poor condition with significant downstream scour, undermining of the concrete, and adjacent pipe and wire revetment damage on the downstream river-right side.

Diagnosis: During migration flows the downstream pool depth will increase, reducing the height of the structure and length of the sloping concrete face. Steelhead should be able to migrate upstream with a moderate degree of difficulty during ideal flow conditions, either by jumping over the structure or bursting directly up the sloping face when length has been reduced and velocities are not to great. During lower flows the structure is impassable due to shallow water depth over the steep concrete slope. A corrugated metal pipe was discharging polluted water with a high amount of suds into the creek just downstream of this grade control structure. The structure may have been constructed to provide protection to this pipe. Two *O. mykiss* measuring 3-4 inches in total length were observed in the downstream pool on 6/2/2001.

Recommended Action: The feasibility of removing this grade control structure and reinforcing the adjacent banks, that currently have pipe and wire revetment, should be assessed. Elimination of the grade control would provide the most effective and reliable upstream steelhead passage alternative at this site. Polluted discharging from the metal pipe should be prevented.

Barrier ID: BR_AO_MY_8
Stream: Maria Ygnacio
Barrier Type: Double Box Culvert
Location: Cathedral Oaks Road Crossing
Ownership/Interest: Santa Barbara County Public Works-Roads Division/ CALTRANS

Description: Each box culvert measured 12 feet tall by 12 feet wide with a 12-inch thick central divider. Downstream of the culvert outlets, a 25-foot wide smooth concrete apron extends 20 feet and drops vertically 2 feet 4 inches to the surface of the downstream pool. The downstream pool had a measured jump depth of 3 feet 6 inches. Upstream of the apron, the culvert runs straight under the road for 122 feet with a mild slope measured at 0.5%. At the culvert inlet, curved wing walls and a concrete bottom become confined as they extend upstream 45 feet to the natural substrate upstream. The inlet to the structure is confined to only 3 feet 9 inches wide at the base of the sloping wingwalls. The overall length of the concrete bottom from the downstream lip of the apron to the natural substrate upstream measured 187 feet. This bridge was constructed in 1961 pursuant to a contract administered by the County of Santa Barbara (Kuyper 1998 citing Elbert). Due to the alternating patchwork of ownership and maintenance between CALTRANS and Santa Barbara County along Cathedral Oaks Road/Highway 192 there may be overlap in ownership, maintenance, and/or easements for this structure (pers. comm. Marrs).

Condition: The concrete appears to be in good condition with minimal damage. The confined inlet design seems counter intuitive in the confined construction has apparently resulted in significant erosion due to the encroachment into the channel. Boulders have been placed around the inlet to prevent additional bank erosion and undercutting.

Diagnosis: Sufficient jump depth in the downstream pool will allow steelhead to make a moderately difficult jump onto the concrete apron during migration flows. During low flows the apron is too shallow to allow upstream migration. Upstream passage during high stream flows will be difficult due to accelerated stream flows inside the confined culvert with no velocity breaks. The confined inlet configuration will also produce increased water velocities during elevated stream flows. Overall the structure presents a high degree of difficult for upstream migration steelhead under ideal moderate stream flows. These moderate flow conditions may only persist for a limited amount of time each year. This structure has a narrow window of opportunity for steelhead to migrate upstream and significantly limits upstream access on Maria Ygnacio Creek, especially during low stream flow years such as the 2001-2002 winter.

Recommended Action: For long-term steelhead passage effectiveness, reliability, stream health, increased storm flow capacity, wildlife connectivity, and aesthetic value, this entire crossing should be replaced in the future with a wide-span bridge(s) and reestablished natural stream channel. This action may be most appropriate or feasible in the future when outside grant money becomes available and/or the structure has been significantly damaged, is in need of major modifications, or is not providing adequate storm flow capacity. In the short-term, cutting a low flow channel with two or three resting pools across the downstream apron and into one of the box culverts would improve upstream passage into the culvert (see the channel design in the BR_AO_MY_4 diagram). This action would concentrate lower flows to increase water depth across the apron into one of the box culverts equipped with alternating “Washington baffles”. A 12-inch tall concrete curb would need to be installed across the upstream end of the box culvert without the baffles to concentrate lower flows into the baffled box culvert. The baffles would increase lower stream flow depth and provide velocity breaks during higher stream discharges to improve upstream passage over a wider range of flows. One or more upstream facing V-shaped boulder weirs installed downstream of the crossing would help to provide adequate downstream pool depth for jumping onto the apron. Baffles require frequent maintenance during migration flows and both baffles and boulder weirs are susceptible to failure. Baffles would also reduce the flow capacity of the culvert and increase the likelihood of debris blockage. Debris blockages and/or baffle failure could produce completely impassable conditions at the crossing.

Barrier ID: BR_AO_MY_12
Stream: Maria Ygnacio
Barrier Type: Pipe Crossing/Concrete Channelization
Location: 0.07 mile downstream from Old San Marcos Road Bridge
Ownership/Interest: Cachuma Operations Maintenance Board (COMB)

Description: The specific measurements and the accompanying photograph are from Kuyper 1998. This U-shaped section of concrete channel was constructed to protect a COMB pipeline that crosses the creek underneath (pers. comm. Treiberg). The structure measured 55 feet long from the upstream to downstream end with a downstream drop of 1 foot 6 inches to the surface of the downstream pool. The downstream pool measured 7 feet deep downstream of the concrete channel. Low stream flows are concentrated down the center of the channel. Pipe and wire revetment occurs along the sides of the channel and directly downstream.

Condition: The concrete appears to be in poor condition with significant wear and downstream undercutting cause by scour.

Diagnosis: During low stream flows, upstream steelhead passage is not possible due to the lack of sufficient water depth. The adequate downstream pool depth would allow an adult steelhead to jump onto the concrete channel during most flows, unless the pool configuration changes. The damaged pipe structure downstream of the structure may interfere with an upstream jump. During high stream flows, upstream passage is not possible due to the excessive velocities encountered across the moderately sloped, smooth concrete channel and lack of velocity breaks. When adequate water depth and tolerable water velocities occur across the channel, during moderate stream flows, upstream adult steelhead passage may be possible with a high degree of difficulty. The window of opportunity for upstream migration may be very short, depending on stream flow duration.

Recommended Action: Work with the COMB to assess the feasibility of removing this structure and either rerouting the pipeline high overhead and away from the stream banks or deeper under the creek with a natural streambed at this site. This action would provide the most effective and dependable upstream passage for steelhead under the widest range of stream flows.

Barrier ID: BR_AO_MY_13
Stream: Maria Ygnacio
Barrier Type: Bridge and Apron
Location: Old San Marcos Road Bridge crossing
Ownership/Interest: Santa Barbara County Public Works-Roads Division

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Description: Downstream of the San Marcos Road Bridge, a sloping concrete apron extended 29 feet with a slope of 17.8% to a relative flat reach of concrete that extended 14 feet to the downstream pool. The overall height of the structure, from the downstream edge of the concrete to the top of the apron, measured 5 feet 9 inches. The downstream pool measured 2 feet 8 inches deep downstream of the apron and submerged the flat concrete 5 inches near the downstream end. This structure was constructed to protect the bridge supports by reducing bank erosion and scour. According to Kuyper 1998, the Army Corps of Engineers built the current concrete apron in 1968. The Santa Barbara County Public Works-Roads Division repaired the structure in 1997 (Kuyper 1998, citing C. Elbert).

Condition: The apron appears to be in fair condition with a low amount of concrete damage and associated erosion and scour.

Diagnosis: The steep slope of the apron and lack of velocity breaks, produces excessive stream velocities during moderate and high stream flows that would prevent upstream steelhead passage. During low stream flows, shallow water depth would also prevent upstream passage. There is a small chance that during years with extremely high stream flow, a very narrow window of opportunity may allow limited, extremely difficult upstream adult steelhead passage. For passage to occur, high stream flows would need to raise the stream depth around four feet on the downstream side of the apron to allow potential upstream passage along one of the adjacent banks where reduced velocities would occur. During these high stream flow conditions, excessive amounts of suspended sediment in the creek would likely prevent upstream navigation and passage.

Recommended Action: Work with the SBCPWRD to assess road crossing alternatives, limitations, and long-term objectives at this site. Modification of the downstream apron may significantly impact the integrity of the bridge supports. The feasibility of removing the concrete apron, bridge supports, and reinforcing the bridge strength without placing supports in the stream channel should be assessed. The bridge appears to have a wide enough span to allow unconfined natural stream channel conditions to occur underneath. In addition to strengthening bridge span to allow the removal of the supports from the channel, the adjacent stream banks under the bridge may need to be further reinforced with bioengineering techniques. If such a project is not feasible for structural of financial reasons, replacement of the entire structure with a wide-span bridge that does not impact the stream channel should be assessed.

Barrier ID: BR_AO_MY_14
Stream: Maria Ygnacio
Barrier Type: Stream Crossing
Location: 0.25 mile upstream from Old San Marcos Road Bridge
Ownership/Interest:

Description: The measurements and accompanying photograph are from Kuyper 1998. Stoecker provides additional evaluation and recommended action. This concrete crossing was poured directly on the streambed substrate with a 6-inch diameter metal pipe running underneath. The surface of the crossing measured 12 feet from the downstream to upstream end with a mild slope. A drop of approximately 1 foot 6 inches occurred on the downstream side to a shallow pool.

Condition: The crossing is in poor condition with significant concrete damage and moderate undercutting on the downstream side.

Diagnosis: Accelerated water velocities through the small, confined culvert would provide extremely difficult or impassable conditions, depending on the substrate configuration at the culvert inlet. During moderate to high migration flows, adult steelhead can jump or swim onto and across the surface of the crossing with a moderate degree of difficulty. Upstream passage may be limited during low flows when stream flow is being conveyed through the confined culvert.

Recommended Action: Assess the feasibility of improving upstream steelhead passage with the owners and determine road-crossing requirements for this site. A bridge that does not impact the stream channel and natural streambed would provide the most effective long-term solution for steelhead passage at this site and may be desirable for upstream residents that have limited access during high stream flows.

Barrier ID: BR_AO_MY_15
Stream: Maria Ygnacio
Barrier Type: Stream Crossing
Location: 0.62 mile upstream from Old San Marcos Road Bridge
Ownership/Interest:

Description: The measurements and accompanying photograph are from Kuyper 1998. Stoecker provides additional evaluation and recommended action. Access to this site was restricted. This U-shaped concrete crossing measured 15 feet from the downstream to upstream end. Kuyper noted the exposed height of the crossing was 5 feet. Concrete slabs exist on the downstream side of the crossing, presumably to prevent downstream scour or from past road failure. Low stream flows are concentrate within the shallow U-shaped surface of the crossing. No jump depth or pool information was provided.

Diagnosis: The shallow water depth across the concrete crossing, and likely excessive jump height, would prevent upstream passage during low flows. Depending on downstream pool formation and depth, upstream steelhead passage can likely be obtained during moderate to high stream flows with a high degree of difficulty. Excessive stream velocities may impair passage across the smooth concrete crossing during higher flows. The window of opportunity for upstream migration may be very limited due to these factors, especially during exceptionally dry years and low stream flow.

Recommended Action: Work with owner to determine the structural requirements necessary for a bridge at this site and assess the feasibility of installing one. Complete removal of the structure and replacement with a wide span bridge that does not impact the stream channel will provide the most effective long-term solution at this site. A bridge may be highly desirable to upstream resident for access across the creek during moderate and high stream flows.

Barrier ID: BR_AO_MY_16
Stream: Maria Ygnacio
Barrier Type: Stream Crossing
Location: 1.04 miles upstream from Old San Marcos Road Bridge
Ownership/Interest:

Description: The measurements and accompanying photograph are from Kuyper 1998. Stoecker provides additional evaluation and recommended action. This U-shaped concrete crossing occurs just downstream from the SBCFCD Debris Dam and measured 15 feet from the downstream to upstream end. Kuyper noted the exposed height of the crossing was 6 feet. Boulders have been placed on the downstream side of the crossing, presumably to prevent downstream scour. Low stream flows are concentrate within the shallow U-shaped surface of the crossing and onto the cascade of boulders on the downstream side. No significant jump depth occurred downstream from the boulders.

Diagnosis: The shallow water depth across the concrete crossing and limited jump depths occurring along the boulder cascade would block upstream steelhead passage during low flows. During moderate to high migration flows, the boulder cascade may have sufficient water depth and jumping/resting areas to allow upstream steelhead passage onto the concrete crossing with a high degree of difficulty. Excessive stream velocities may impair passage across the smooth concrete crossing during high flows and have a high degree of difficulty during moderate flows. The window of opportunity for upstream migration may be very limited due to these factors, especially during exceptionally dry years and low stream flow. The overall, the structure has a high degree of difficulty for upstream adult steelhead passage during ideal moderate to high stream flows.

Recommended Action: Work with owner to determine the structural and access requirements for this stream access. It appears that the crossing mainly serves the purpose of allowing the SBCFCD access to conduct maintenance activities at their Debris Dam and grade control upstream. If this access does not serve any residential purpose and is only used for the Debris Dam, steelhead passage improvements should be planned in conjunction with the Debris Dam (BR_AO_MY_17). If the crossing is desirable for other reasons, the feasibility of both removing the structure and having an in-stream crossing on substrate or installing wide-span bridge that does not impact the stream channel should be assessed. Complete removal of the structure will provide the most effective long-term solution at this site.

Barrier ID: BR_AO_MY_17,18
Stream: Maria Ygnacio
Barrier Type: Debris Dam and Grade Control Structure
Location: Approximate Elevation 260 feet and 285 feet
Ownership/Interest: Santa Barbara County Flood Control District

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BR_AO_MY_17

BR_AO_MY_18

Description: Access to survey this reach of stream was not obtained. The following measurements and accompanying photograph are from Kuyper 1998. Stoecker conducted additional assessment. This debris dam is composed of boulder and concrete riprap and conveys low to moderate stream flows through the dam in a 54-inch diameter smooth concrete culvert. Water discharges from the culvert onto a pool with 6 feet deep. Kuyper notes that the United States Department of Agriculture's Soil Conservation Service (SCS) and the SBCFCD, in response to the Painted Cave Fire, built the dam and grade control in 1990. The grade control structure occurs approximately 500 feet upstream of the debris dam. The structure measured 15 feet tall and is composed of grouted riprap. The purpose of the structure is to function as an inlet to the debris basin. The downstream face of the structure has an angle of approximately 45 degrees for a length of 38 feet.

Condition: This dam is regularly maintained and cleared of debris by the SBCFCD (pers. comm. Treiberg). Low and moderate flows pass through the culvert when it is conveying water and storm flows pass over the top of the structure when the debris basin has been filled and the culvert is blocked.

Diagnosis: During migration flows, the jump into the culvert appears to be relatively easy for steelhead. The long, smooth culvert through the debris dam is most likely impassable to upstream migrating steelhead due to the shallow water depth during low flows and the excessive water velocities during moderate and high flows. The height of the grade control and steepness appear to prevent all upstream migration of steelhead. Kuyper gave this debris dam and grade control structure “definite” steelhead impedance ratings. SBCFCD reportedly installed metal baffles in this culvert at one time in an attempt to improve steelhead passage, but they blew out with higher flows and no longer remain (pers. comm. Treiberg). Salmonids are currently not known to occur upstream of the dam.

Recommended Action: Due to the high quality salmonid habitat upstream of these structures, and the presence of salmonids downstream, fish passage should be provided at these sites. See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_AO_MY_19
Stream: Maria Ygnacio
Barrier Type: Stone Dam
Location: 0.21 mile upstream from Santa Barbara County Flood Control District Debris Basin Dam (BR_AO_MY_17) Approximate elevation 300 feet
Ownership/Interest: Ygnacio Valley Group Inc.

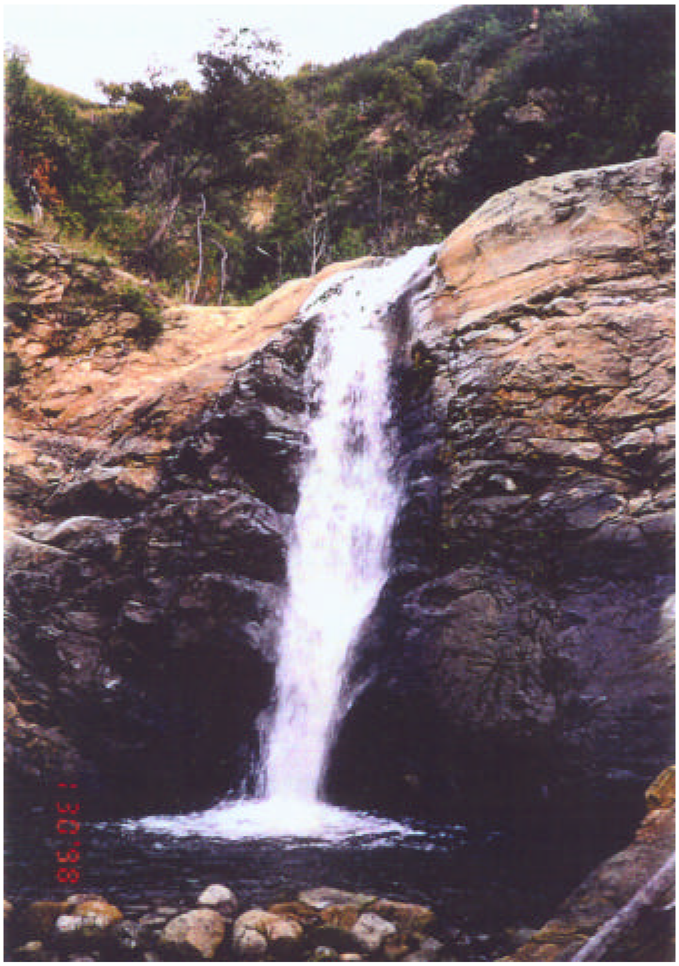
Description: The measurements and accompanying photograph are from Kuyper 1998. Access to this site was restricted. This eroded dam is composed of concrete and natural streambed stone. Where flows spill over the dam, Kuyper measured the height of the dam face at 3 feet, from the top to the surface of the downstream pool that had a depth of 6 feet. The dam measured 5 feet thick across the top.

Condition: The dam is highly eroded and appears to have been blown out in the past as an additional 2 feet of dam height exists on the river-left side. The dam is filled with a small amount of sediment on the upstream side. No apparent water diversion operations appear to be functioning at this structure, which appears to be obsolete.

Diagnosis: Sufficient jump depth occurs in the downstream pool to allow upstream steelhead passage with a low to moderate degree of difficulty during most flow conditions. The passage severity of this structure is dependant on the configuration of the downstream pool.

Recommended Action: Upstream passage for juvenile salmonids, and adults during low flows or with reduced downstream pool height, can be improved by removing this structure or cutting a notch 4 feet wide by 6 inches deep at center to concentrate low flows, improve attraction flows, and reduce the jump height.

Barrier ID: BR_AO_MY_20
Stream: Maria Ygnacio
Barrier Type: Bedrock Waterfall
Location: Approximate elevation 480 feet
Ownership/Interest: Ygnacio Valley Group Inc.



Description: The measurements and accompanying photograph are from Kuyper 1998. Access to this site was restricted. This bedrock waterfall measured 25 feet tall from the downstream pool to the top of the waterfall.

Diagnosis: The excessive height of the waterfall prevents upstream migration of all salmonid during all flow conditions. This bedrock feature is very stable and represents the upstream limit to the historic steelhead range in Maria Ygnacio Creek and will not likely permit passage anytime in the near future.

Recommended Action: No recommended action for this natural feature.

Barrier ID: BR_AO_MY_SA_1
Stream: San Antonio
Barrier Type: Bridge and Riprap Apron
Location: San Marcos Road Bridge Crossing
Ownership/Interest: Santa Barbara County Public Works-Roads Division

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Description: Downstream of the San Marcos Road Bridge, a sloping concrete and boulder riprap apron extends 23 feet 3 inches with an overall slope of 17.6% to the downstream pool. The overall height of the structure from the downstream edge of the apron to the top of the apron measured 4 feet 1 inch. At the upstream end of the boulder embedded apron, a 1-foot 8-inch tall concrete curb with a 55.3% slope and 8-inch vertical lip occurs. Above the concrete curb, a relatively flat and smooth concrete channel extends under the bridge 45 feet to the upstream end. The downstream pool measured 11 inches deep below the apron. The concrete-lined bottom and apron were constructed to protect the bridge supports that occur in the stream channel, by reducing bank erosion and scour.

Condition: The concrete appears to be in good condition with minimal damage and minimal downstream undercutting of the apron. Significant bank erosion occurs downstream despite pipe and wire bank revetment efforts.

Diagnosis: The presence of large embedded boulders in the downstream apron reduces stream flow velocities across the apron and increases water depth between the boulders to provide adequate passage conditions during moderate to high stream flows to the base of the concrete curb. The concrete curb and small vertical lip impose a significant impediment due to the accelerated stream velocities falling from the upstream concrete channel, lack of velocity breaks, and minimal downstream water depth on the apron for obtaining adequate acceleration for jumping the curb. Upstream passage during higher migration flows along the river-right side of the apron, where the concrete curb has no vertical lip, may be obtained with a moderate to high degree of difficulty. The concrete-lined bottom under the bridge would have accelerated stream velocities during migration flows that would add to the difficulty of migrating upstream of the entire structure. Overall, upstream adult steelhead passage may be possible with a high degree of difficulty and during a limited window of ideal migration flow.

Recommended Action: Work with the SBCPWRD to assess alternatives for improving upstream steelhead passage at this site. For the most effective long-term steelhead passage improvement, the feasibility of removing the entire crossing and replacing it with a wider span bridge that does not impact the stream channel should be assessed. In the short-term, a migration channel should be cut across the concrete bottom under the bridge with associated resting pools/velocity breaks to concentrate lower flows and reduce velocities across the concrete during high stream flows. This channel would also reduce the height of the concrete curb at the upstream end of the apron allowing easier access from the apron into the migration channel.

Barrier ID: BR_AO_MY_SA_4
Stream: San Antonio
Barrier Type: Culvert Stream Crossing
Location: San Antonio County Park
Ownership/Interest: Santa Barbara County Parks Department

Description: This newer-looking concrete crossing extends 45 feet across the stream channel and has two 3-foot diameter concrete culverts conveying stream flows through the structure. The concrete culverts measured 65 feet 6 inches in length with slopes of 3.4%. Outflow from the culverts dropped 2 feet to the surface of the downstream pool, which had a jump depth of 2 feet 4 inches.

Condition: The concrete crossing itself appeared to be in good condition with minimal wear or cracking. Significant downstream scour has undercut the structure up to 3 feet. High stream flows that are conveyed over the top of the crossing have caused major bank erosion on the opposite side of the river-right riprap bank revetment.

Diagnosis: During higher migration flows, the conveyance capacity of the two culverts is quickly surpassed, and/or blocked with debris. These high stream flows are conveyed across the surface of the crossing and down the steep downstream. When the culverts are blocked with debris, upstream steelhead migration is not possible due to the excessive water velocities across the steep downstream face of the road crossing. With lower flow conditions and unobstructed culverts, shallow water depth in the culverts prevents upstream passage. When adequate water depth occurs in the smooth culverts, stream velocities are likely to great to allow upstream migration due to the moderately steep culvert slope and smooth concrete surface. The structure is likely impassable during all flow condition.

Recommended Action: This structure should be removed and replaced with a bridge to provide the most effective upstream steelhead passage, reduce bank erosion, eliminate sediment clearing of the culvert, prevent further downstream scour, improve aquatic connectivity for other native species, provide road access during high stream flows, eliminate crossing hazards during high stream flows, and to improve the aesthetic value of the adjacent public parks. This recently built public road crossing is directly blocking steelhead access to the protected upstream habitat in San Antonio County Park. This structure may have been built within steelhead habitat after the species was listed as endangered. Alternative access to the parking lot on the east side of the creek may be obtained from Highway 192, instead of the Tuckers Grove Park access currently being used, and eliminate the need to install a bridge across the creek at this site.

Barrier ID: BR_AO_MY_SA_5
Stream: San Antonio
Barrier Type: Debris Basin Dam
Location: Approximate Elevation 370 feet
Ownership/Interest: Santa Barbara County Flood Control District

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Description: This debris dam is composed of concrete and conveys low to moderate stream flows through the dam in a 3-foot diameter corrugated metal culvert that measures 77 feet 6 inches in length. The slope of the culvert was measured at 4.3%. The inside of the culvert has been lined with concrete. Water discharges from the culvert into a pool with a maximum depth of 2 feet 4 inches.

Condition: This dam is regularly maintained and cleared of debris by the SBCFCD and is in fair condition with minor concrete damage and significant wear inside the culvert associated with bedload sediment scour during high stream flows. Low and moderate flows pass through the culvert when it is conveying water and storm flows pass over the top of the structure when the debris basin has been filled and the culvert is blocked.

Diagnosis: During most stream flows, the jump into the culvert would be easy for steelhead. The long culvert through the debris dam is impassable to upstream migrating steelhead due to the shallow water depth encountered during low flows and the excessive water velocities during moderate and high flows.

Recommended Action: See section 7.9 for additional discussion and recommended action for this SBCFCD Debris Dam.

Barrier ID: BR_AO_MY_SA_EF_1
Stream: East Fork San Antonio
Barrier Type: Stone Dam
Location: Approximately 1.25 miles upstream from Highway 154 Bridge
Ownership/Interest: Rancho Vista del Mundo

Description: This stone and concrete dam measured 8 feet tall from the downstream substrate to the top of the dam and is keyed into boulders on the banks and within the streambed. Downstream bank erosion has seriously undermined a concrete patio on the river-left bank next to a small house. Sediment is filled to the top of the dam, which apparently does not serve a purpose anymore (pers. comm. Landowner). Surface stream flows were absent during the survey.

Condition: The dam is in poor condition with significant adjacent bank erosion.

Diagnosis: A slight notch at the center of the dam concentrates low flows. The downstream pool would need to fill approximately 4-feet to allow a difficult upstream jump over the dam. Upstream steelhead passage would likely be prevented during all stream flows at this dam, depending on downstream pool formation from season to season.

Recommended Action: The landowner indicated that this dam is no longer used and the possibility of removing the dam may be desirable for the landowner due to the major bank erosion near the small house caused by downstream scour. Work with the landowner to remove this small dam. Removing this dam would likely be relatively easy and the native stones that make up the dam could likely be broken up and left on sight.

Refer to Map Folder for:
San Jose Creek Map
Map 7.7.7.1

Refer to Map Folder for:
San Jose Creek Map
Map 7.7.7.1

Refer to Table Folder for:
San Jose Creek Barrier Table
Table 7.7.7.2

Refer to Table Folder for:
San Jose Creek Barrier Table
Table 7.7.7.2

Barrier ID: BR_AO_SJ_1
Stream: San Jose
Barrier Type: Concrete Channelization
Location: From the Goleta Slough upstream approximately 0.78 mile to the upstream side of the Hollister Avenue Bridge
Ownership/Interest: Santa Barbara County Flood Control District

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Description: This entire reach of San Jose Creek was created by realigning the stream from its former channel to the west into this trapezoidal concrete channel, which was built by the Army Corps or Engineers (pers. comm. Treiberg). Portions of the original natural stream channel continue to exist to the west, but the upstream end of this channel has been covered around Hollister Avenue and confined by development. The total length of the concrete lined channel measured 0.78 mile, using GPS. Stream flows are unconfined and spread out over the bottom of the lower channel and then become more confined in the middle and upper reaches as the slope increases. The lowest reach of the channel is relatively flat, but the slope gradually increasing to 1-2% at the upstream end. Under the Hollister Avenue Bridge the concrete channel measured 20 feet wide on the bottom and 9 feet tall to the bridge bottom. The channelized reach is currently maintained by the SBCFCD (pers. comm. Treiberg).

Condition: The channel is in poor to fair condition with significant concrete wear and several holes completely eroded through the bottom. A total of five significant holes through the concrete were observed. The channel walls are cracked in many places with vegetation growing through the concrete in several locations.

Diagnosis: The downstream end of the channel transitions into natural silt substrate and no jump exist for steelhead attempting to migrate into the channel. Prior to 1984, Beguhl noted that he observed adult steelhead ascend the concrete channel to within a couple hundred feet of the upstream end, but they could never successfully negotiate the upper reach (pers. comm. Beguhl). Sjovold also observed adult steelhead trying unsuccessfully to swim upstream in the concrete channel (See the Salmonid Documentation Table in Section 6.0 for more information about these sightings). The steepest slope in the channel occurs along the upper reach, where excessive water velocities and/or shallow water depth prevent upstream steelhead migration. The excessive length of the channel, with no significant resting areas, accelerated stream velocities, and/or shallow water conditions, prevents upstream steelhead migration.

Stream flows are extremely exposed in this reach due to the lack of riparian cover and water temperatures are elevated with the direct sunlight. The channel is a prime poaching and predation spot where upstream and downstream migrating salmonids are readily captured by human and other predatory animals. The channel also eliminates the biofiltration functions provided in a natural stream channel, which allows pollutants to more readily enter the Goleta Slough and Ocean.

Recommended Action:

Background-

Observations of the U.S. Coast Survey maps, depicting the Goleta Slough in 1870, show the slough system and lower San Jose Creek prior to significant alterations by humans. When comparing this map to existing conditions it is easy to recognize the naturally shifting nature of these streams as they historically entered the Goleta Slough. The map shows the confined channel of “Arroyo de San Jose” eventually tapering out as the stream flows apparently spread out into the expanses of the “La Goleta” slough. Adjacent to the creeks entering the slough, this historic map shows isolated reaches of former stream channels that were no longer connected to the active stream channel. These isolated stream channel reaches attest to the seasonal shifting nature of these creeks as they emerged from the foothills and carved through the lowland alluvial deposits around the Goleta Slough. Like other creeks entering the Goleta Slough, San Jose Creek historically jumped it’s banks and changed courses often during years of high stream flow.

Santa Barbara County is currently working on developing a watershed planning process for San Jose Creek that will address watershed restoration, steelhead passage, flood control, and other watershed issues. The Army Corps of Engineers is studying potential improvements to the existing concrete channel from Hollister Avenue to the Goleta Slough. Significant funding from the Corps will likely be available for an actual project. The plan is looking into increasing the flow capacity of the currently undersized channel by possibly replacing it with a larger capacity box channel configuration. Fish passage measures within the new channel have been proposed. The modification of the existing channel or construction of a new concrete channel will provided minimal, or no, benefit to the ecological health of San Jose Creek, Goleta Slough, and near shore ocean environment and may not effectively provide upstream steelhead passage due to the dependence on fish passage measures subject to damage, debris blockage, and flows limitations that are also dependant on continual human maintenance.

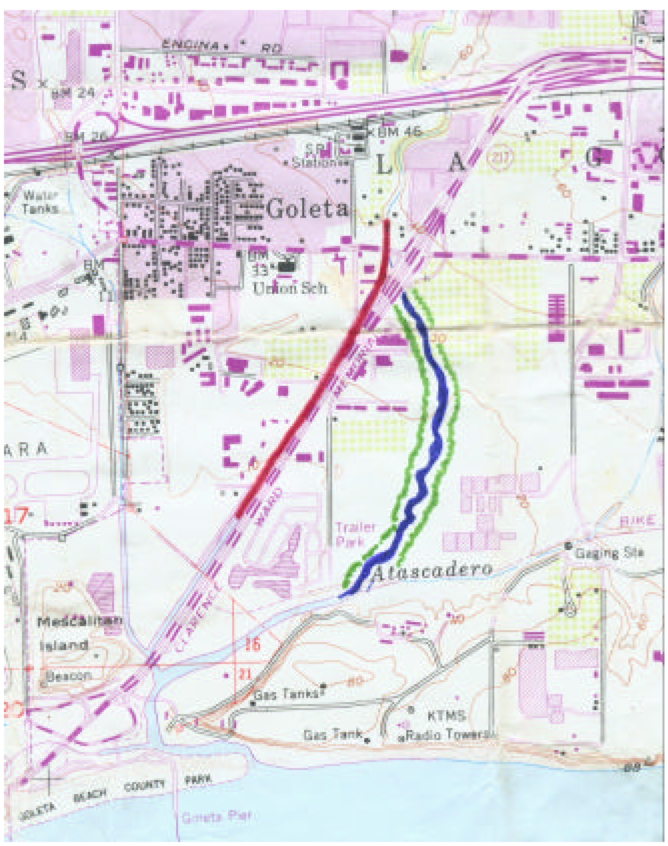
Lower San Jose Creek Restoration Feasibility Study-

The ecological health of the entire San Jose Creek watershed and the Goleta Slough system, as well as benefits to water quality and recreational opportunities, are tied into future projects on the lower creek. Due to the historically shifting nature of the creeks passing through the Goleta Slough and the fact that the existing stream location was realigned into the constructed flood control channel, the focus of future planning on lower San Jose Creek should not be bound to the existing location of the concrete channel. In fact, the most ideal alternative for meeting all stakeholder objectives may involve looking beyond the existing channel location, which most view as undesirable and functionally undersized. Naturalizing the existing channel reach is likely not feasible due to the confined nature of the channel between development along Kellogg Street and Highway 217, but should be assessed. One alternative that offers an amazing opportunity for many stakeholder objectives involves creating a new lower San Jose Creek.

Creating a New Lower San Jose Creek-

An alternatives analysis that looks into options for modifying the existing channel, reestablishing the former channel, and creating a new stream channel should be conducted. The third option of creating a new stream channel is described below and may offer a solution that meets most stakeholder objectives and is not currently being considered. A coordinated effort with watershed stakeholders should assess the feasibility of abandoning the existing concrete channel and realigning the creek from near the upstream end of the channel at Hollister Avenue under Highway 217 to the open agricultural land to the east. Should the landowner(s) be interested in selling a portion of this agricultural land, a buffered riparian and stream corridor approximately 200-300 feet wide could be established through this area and into lower Atascadero Creek, near the grade control structure (BR_AO_1) at the Goleta Slough. Lower Atascadero Creek is not confined by adjacent development and appears to have a channel large enough to convey the increased flows. Historically, the streams draining into Goleta Slough jumped their banks and shifted in such a manner reconnecting to other adjacent streams near the slough. This action would have many potential benefits, including those described below.

1) Revival of a naturalized lower San Jose Creek and native riparian corridor (0.78 miles of which are currently lost with the existing concrete channel).
2) Development of public trails and bike paths along this creek parkway that are consistent with Santa Barbara County objectives of developing a park in this area and providing public linkages from Goleta to the ocean and the existing bike path along Atascadero Creek.
3) Increased flood control with an adequately sized, unconfined, natural stream channel, using biotechnical bank stabilization techniques, and a native riparian buffer zone.
4) Unimpeded migration of aquatic species, including steelhead.
5) Improved water quality into the slough and ocean would be accomplished by providing riparian shade and restoring the biofiltration functions of a natural stream channel.



The above maps shows a rough conceptual drawing of the newly created lower San Jose Creek in blue with surrounding riparian buffer in green. This area is currently being used for agriculture. The existing, confined concrete channel is shown in red. The natural stream channel of San Jose Creek can be seen extending form the upper end of the concrete channel to Highway 101. Connecting the natural creek upstream of Hollister Avenue across Highway 217 may require the construction of a bridge(s), but may work well with Highway 217 modifications being discussed.

It is likely that many of the items identified in the “Issue Areas” list produced by the San Jose Creek Watershed group as well as developing stakeholder goals for San Jose Creek would be addressed and accomplished with the implementation of the above-mentioned project. This project has many unanswered questions and needs to be studied in detail to determine the feasibility of such an action. Because of the considerable costs associated with such a project and need to buy agricultural lands to accomplish this plan, the material removed to create the new stream channel could be used to fill the existing channel. This ‘new’ land on top of the existing concrete channel site and surrounded by commercial development could potentially be sold or traded to commercial or agricultural interests to offset project costs.

Barrier ID: BR_AO_SJ_2, 3, 6
Stream: San Jose
Barrier Type: Grade Control Structures
Location: #2= 90 feet downstream from USGS Gaging Station, #3= Approximate elevation 100 feet (USGS Gaging Station), #6= Approximate elevation 240 feet
Ownership/Interest: #3=Santa Barbara County Flood Control District, #6=Rancho Dos Arroyos

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Description and Condition: Three similar grade control structures exist on San Jose Creek. Each structure is composed of concrete and varying amounts of cobble and/or small boulders.

#2= This grade control structure is highly damaged and broken into at least three separate pieces. The height from the downstream pool to the top of the concrete structure measured 12 inches. The maximum pool depth downstream at the jump location measured 1 foot 2 inches.

#3= This grade control/gaging weir measured 37 feet across the channel and 12 inches in height from the surface of the downstream pool, which had a jump depth measured at 2 feet 9 inches. This structure is maintained by SBCFCD (pers. comm. Treiberg).

#6= This structure was surveyed in 1998 by Kuyper and measured 1 feet 6 inches in height above a shallow downstream pool 6 inches deep (Kuyper, 1998). The structure appears to have significant wear and concrete damage.

Diagnosis: All of these grade control structures will have minimal jump heights, or be completely submerged, during migration flows and impose a minimal to low degree of difficulty for upstream passage of salmonids. Juvenile salmonids can migrate upstream of these structures during moderate flow conditions.

Recommended Action: Improvements for fish passage at these sites would provide a minimal to low benefit to steelhead, but downstream scour might alter their configuration and severity in the future. While #3 serves a function as a gaging station, both #2 and #6 are in extremely poor condition, do not appear to be essential or maintained, and could be broken up and/or removed to eliminate the possibility of the structures increasing in severity in the future. Continue to monitor these structures if left in place.

Barrier ID: BR_AO_SJ_4
Stream: San Jose
Barrier Type: Diversion Dam
Location: Approximate elevation 145 feet
Ownership/Interest:

Description: Access to survey this structure was not obtained. The following survey measurements and accompanying photograph of the dam are from Kuyper 1998. Kuyper reported that: The overall height of this structure measured approximately 11 feet from the downstream pool surface to the top of the dam. A concrete spillway measuring approximately 65 feet in length extends downstream from the 4-foot tall dam and flows drops nearly 7 vertical feet off the end into a pool with a maximum depth of 5 feet. Low stream flows along the structure were less than 2 inches deep and moderately accelerated. Photo observations suggest that this is a flashboard dam with a narrow slot in the dam designed to accept flashboard insert, which would allow the storage of water upstream (pers. observ. Stoecker).

Condition: This structure is reportedly no longer used for the purpose of providing a water supply for surrounding agricultural applications or any other apparent function (Kuyper, 1998). Photo observations indicate that this structure is in extremely poor condition with major downstream undercutting and concrete spillway failure.

Diagnosis: Kuyper noted that this structure would “definitely” impede steelhead migration during low stream flows due to insufficient water depths and its height above the downstream channel bottom. High discharge conditions may yield sufficient stream depth along this structure, but stream flows may reach excessive velocities as they are forced out of the small weir and travel along the spillway. An upstream migration severity of extremely high to impassable was applied to this structure.

Recommended Action: Work with the owner to assess the feasibility of removing this structure due to its reported obsolete status, extremely high severity or impassibility, deteriorating condition, and presence of up to 2.25 miles of high-quality salmonid habitat upstream.

Barrier ID: BR_AO_SJ_5
Stream: San Jose
Barrier Type: Stream Crossing
Location: Approximate elevation 175 feet
Ownership/Interest:

Description: Access to survey this structure was not obtained. The following survey measurements and accompanying photograph of the stream crossing are from Kuyper 1998. Kuyper reported that the overall height of this 25-foot wide concrete stream crossing measured approximately 8 feet from the downstream pool surface to the top of the crossing. The downstream pool depth measured 5 feet. All stream flow is conveyed over the top of the crossing and then falls steeply down a concrete apron and vertically off the apron 2 feet above the downstream pool.

Condition: Photo observations indicate that this structure is experiencing major downstream undercutting and adjacent bank erosion.

Diagnosis: During migration flows the high water velocities associated with the steep apron and excessive jump height likely present impassable conditions for all upstream steelhead migration, but extremely difficult passage may be possible depending on how much the downstream pool backfills during very high stream flow conditions.

Recommended Action: Work with the owner to assess the feasibility of removing this structure and replacing it will a bridge or other streambed simulation strategy that allows unimpeded fish passage and improved landowner access and safety at this crossing. Additional assessment of the sediment accumulation upstream of the crossing and impacts of removing the structure are needed.

Barrier ID: BR_AO_SJ_7,8,9
Stream: San Jose
Barrier Type: Bedrock (#7=Cascade, #8=Chute, #9=Waterfall)
Location: Approximate elevations (#7= 300', #8= 360', #9=950')
Ownership/Interest: #7&8=Rancho Dos Arroyos, #9=San Marcos Trout Club

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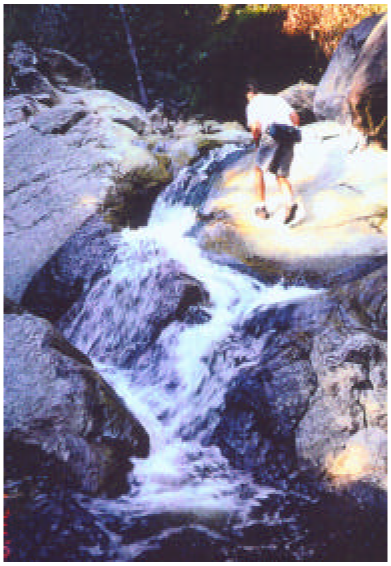
Description: Observations, descriptions, and photographs of these natural features are from Kuyper 1998.

#7= This two-part bedrock cascade measured 16 feet in height over two separate 8–foot tall sections.



#8= This bedrock chute measured 20 feet in height.

#9= This bedrock waterfall measured 30 feet in height.

Condition: All three bedrock features appear stable and likely will not change configuration much in the near future.

Diagnosis: Kuyper noted that both #7 and #8 have the potential to prevent upstream steelhead migration. The steep slopes and height associated with these two features may produce excessive velocities and/or jump heights for upstream steelhead migration during most or all stream flows. Both #7 and #8 were given severities of extremely difficult or impassable. The excessive height of the bedrock waterfall (#9) is impassable to steelhead during all flow conditions.

Recommended Action: No recommended actions for these natural features.

Barrier ID: BR_AO_SJ_SP_1
Stream: San Pedro
Barrier Type: Grade Control Structure
Location: Downstream from UPRR Crossing
Ownership/Interest: UPRR

Description: A concrete-lined bottom with a slope less than 1% extends 70 feet from the upstream end of the UPRR crossing to the top of a two-step grade control structure drop downstream of the railroad crossing. The upstream step drops 2 feet 5 inches onto a fine silt bottom with no pool. This fine silt bottom extends 16 feet downstream to the next 1-foot thick grade control that drops 2 feet 3 inches to the substrate downstream with no developed pool. The grade control steps measured 35 feet 6 inches long between vertical wall revetments downstream of the UPRR crossing. The silt-laden bottom between the grade control steps may have concrete underneath at some depth, but none could be detected 6 inches below the silt. Low flows are spread out across the structure and very shallow.

Condition: All the concrete appears to be in good condition.

Diagnosis: No developed pools exist downstream of either grade control step. Adequate jump depth would occur only during high stream flows when water velocities across the 70 feet of concrete-lined bottom would be impassable or impose an extremely high degree of difficulty to upstream migration.

Recommended Action: Discuss options to improve fish passage at this site with UPRR. It appears that the low-lying railroad bridge may not be adequately sized for a 100-year flow event and improving the flow capacity of this crossing may be a desirable action for UPRR. A bridge upgrade or other issue may also make replacement of this crossing desirable. When improvements to this crossing are planned, removing the entire structure and replacing it with a larger capacity crossing with a natural streambed that does not impede steelhead should be considered. Montecito Creek has a good example of a UPRR crossing that does not significantly impact the stream. If the structure needs to stay in place for now in its current configuration, passage can be improved be cutting a notch in each grade control step approximately 3-4 feet wide and 6 inches deep. These notches should be in-line with each other. A migration channel should be cut in the 70-foot long concrete-lined bottom that connects the upper notch to the upstream end of the concrete. This migration channel should have several velocity break features and resting pools in it and a landing/resting pool immediately upstream of the upper notch. This action would improve passage conditions over the two grade control steps by lowering the jump height, creating downstream pool depth, and allowing migration during lower flows by increasing the depth of water across the structure. The upstream migration channel would increase low flow depth and reduce higher flow velocities across the concrete reach to the upstream side of the structure.

Barrier ID: BR_AO_SJ_SP_2
Stream: San Pedro
Barrier Type: Double Box Culvert Crossing
Location: Highway 101 Crossing
Ownership/Interest: CALTRANS

Description: According to the engraved date on the crossing, this 195-foot long double box culvert was built in 1945. Each culvert measured 16 feet wide and 4 feet tall. The bottom of the relatively flat culverts was covered with 5 inches of fine sediment.

Condition: The culverts appeared to be in good condition, but may be undersized with the short culvert height.

Diagnosis: During migration flows the silt deposits in this culvert will be swept away leaving a smooth concrete bottom that will have accelerated stream flows and/or limited water depth making upstream passage moderately to highly difficult. The flows entering the culvert will already be accelerated due to the long concrete channel immediately upstream of the culvert.

Recommended Action: Any fish passage improvement action at this site should be completed in coordination with the long upstream flood control channel that is impassable. See recommended action for BR_AO_SJ_SP_3.

Barrier ID: BR_AO_SJ_SP_3
Stream: San Pedro
Barrier Type: Concrete Channelization
Location: Extends from Highway 101 Culvert upstream 0.29 mile
Ownership/Interest: Santa Barbara County Flood Control District

Description: This trapezoidal concrete channel connects to the downstream Highway 101 double box culvert (BR_AO_SJ_SP_2) and extends 0.29 mile upstream. The measured slope of the channel increased from 1.2% near the bottom to 1.8% at the upstream end. The channel measured 10 feet 6 inches wide on the bottom with sidewalls angled at approximately 45 degrees and 7-8 feet tall. The channel makes several gradual turns along its length. Residential homes and property are immediately adjacent to this channel.

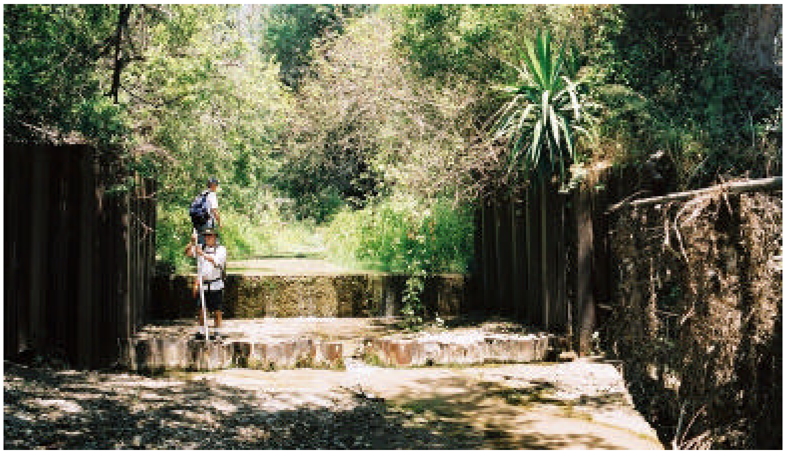
Condition: The channel is in fair condition with a moderate amount of wear and cracking repairs. A small amount of vegetation is growing in several cracks.

Diagnosis: The smooth concrete bottom is void of any velocity breaks and would have accelerated velocities during migration flows and shallow water depth during lower flows. These limitations and excessive length of the channel would prevent upstream migration of salmonids.

Recommended Action: In addition to providing passage at the UPRR crossing structure (BR_AO_SJ_SP_1), steelhead recovery to San Pedro Creek would require effective passage upstream of this concrete channel. Salmonid habitat is limited downstream and virtually all the essential spawning and rearing habitat in the system occurs well upstream of this channelized reach. Removal of this concrete channel, stream naturalization, and extensive bank stabilization would provide the most effective fish passage and ecological benefit by adding 0.29 mile of aquatic and riparian habitat back to the system. While this action is likely technically feasible, it is also a complex and costly proposition that would likely have tremendous adjacent landowner opposition. Installing baffles along the bottom of the channel to improve passage would likely have limited effectiveness, continually experience damage, and would reduce the flow capacity of the channel. Any significant action to provide passage at this site will likely require a major planning effort and alternatives study with community involvement.

Barrier ID: BR_AO_SJ_SP_4,5,6,7
Stream: San Pedro
Barrier Type: Grade Control Structures
Location: #4= 0.48 mile upstream from Highway 101, #5= 25 feet downstream from Stow Canyon Road Crossing, #6= 300 feet upstream from Stow Canyon Road Crossing, #7= 100 feet upstream from Cathedral Oaks Bridge
Ownership/Interest: Santa Barbara County Flood Control District

Description and Diagnosis:



#4= This unique concrete curb grade control has adjacent corrugated metal walls and a small metal grade control downstream with a space at center. The height of the concrete curb above the downstream substrate measured 2 feet 11 inches. The curb measured 19 feet across and 2 feet thick. The small space in the downstream metal grade control would allow upstream passage to the base of the concrete curb. No pool depth was present at the base of the curb during low flows, but during migration flows adequate depth would allow an upstream jump with a moderate to high degree of difficulty.

#5= This 1-foot thick concrete curb measured 2 feet 3 inches in height from the downstream substrate. No pool downstream was present and flows were spread out across the curb. Sediment was filled to the top of the upstream side of the structure. The low height of this structure would present a low to moderate degree of difficulty for an upstream jump during migration flows.

#6= This concrete and boulder riprap grade control structure measured 2 feet 9 inches tall from the downstream substrate and slanted 8 feet upstream at a slope of 34%. No downstream pool was present. During migration flows upstream passage of adult steelhead at this site would have a moderate to high degree of difficulty due to the accelerated velocities over the steeply sloped structure.

#7= This 1-foot thick curb measured 1 feet 3 inches tall from the surface of the downstream pool, which measured 13 inches deep. Upstream passage at this short structure has a minimal degree of difficulty during migration flows.

Recommended Action:

All of these structures are passable during migration flows, but upstream migration could be improved during lower flows by concentrating the spread out flows to increase the water depth across and downstream of the structure. The following recommended actions would improve upstream passage should steelhead be restored access to this reach of San Pedro Creek.

#4= Cut a notch 4 feet wide by 6 inches deep at the center of the concrete curb.
#5= Cut a notch 4 feet wide by 6 inches deep at the center of the concrete curb.
#6= Cut a notch 4 feet wide by 10 inches deep at center to reduce the jump height, focus lower flows, and shorten the sloping face of the structure for easier access upstream.
#7= Cut a notch 4 feet wide by 3 inches deep at the center.

Refer to Map Folder for:
Tecolotito, Glen Annie Creek Map
Map 7.7.8.1

Refer to Map Folder for:
Tecolotito, Glen Annie Creek Map
Map 7.7.8.1

Refer to Table Folder for:
Tecolotito, Glen Annie Creek Barrier Table
Table 7.7.8.2

Refer to Table Folder for:
Tecolotito, Glen Annie Creek Barrier Table
Table 7.7.8.2

Barrier ID: BR_TO_GA_5
Stream: Glen Annie
Barrier Type: Double Box Culvert
Location: Approximately 50 feet downstream from UPRR Crossing
Ownership/Interest:

Description: The owner and purpose of this structure could not be determined, but it may have been built by UPRR for protection and/or maintenance access to the railroad upstream or by the property owner on the river-right side of the creek (pers. comm. Treiberg). This gradually turning double box culvert measured 105 feet in length along the center support in the culvert. Each box culvert measured 12 feet wide by 8 feet tall. Downstream of the culvert, flows drop 2 feet 3 inches onto concrete slabs and into the small pool below, which had a maximum depth of 2 feet 5 inches. The bottom of the culvert is smooth concrete with a mild slope. At the upstream end of both culverts, a steep, concrete apron rises 2 feet 3 inches over a distance of 8 feet with a slope of 28% to a pool upstream.

Condition: The structure appears to be in fair condition with minimal wear and moderate downstream scour and bank erosion.

Diagnosis: During moderate flows, steelhead can jump into the culvert with a moderate degree of difficulty. The lack of velocity breaks and excessive length of the culverts would be impassable during low flows due to the unconfined, shallow water depth and during high flows due to the accelerated water velocities. During moderate flows, when adequate water depth and velocities are encountered inside the culverts, highly difficult passage to the upstream end of the culvert may be possible. During all flows, the steep apron at the upstream end of the culvert is impassable due to the lack of jump depth inside the culvert and accelerated velocities.

Recommended Action: The purpose and desirability of this structure should to be determined and alternatives for fish passage evaluated with UPRR, CALTRANS and SBCPWRD, all of whom have upstream structures in the creek that may affected if structure is to be modified. The removal of this structure with adequate bank protection and streambed naturalization would provide the most effective long-term solution for steelhead recovery. A steelhead passage plan should be developed with the above-mentioned agencies and stakeholders to address the complicated and extensive array of barriers from this culvert to the upstream side of the culvert passing under Glen Annie Road.

Refer to Map Folder for:
Tecolote, Dos Pueblos, Gato Creek Map
Map 7.7.9.1

Refer to Map Folder for:
Tecolote, Dos Pueblos, Gato Creek Map
Map 7.7.9.1

Refer to Table Folder for:
Tecolote, Dos Pueblos, Gato Creek Barrier Table
Table 7.7.9.2

Refer to Table Folder for:
Tecolote, Dos Pueblos, Gato Creek Barrier Table
Table 7.7.9.2

Barrier ID: BR_TE_1
Stream: Tecolote
Barrier Type: Culvert
Location: UPRR, Highway 101, S.B. County road crossings
Ownership/Interest: UPRR, CALTRANS, Santa Barbara County Public Works-Roads Division

Description: This extremely long culvert was not completely surveyed due to high amounts of automotive exhaust fumes encountered inside the culvert during two survey attempts. The outlet and inlet conditions are described here. The outlet of the culvert is the UPRR railroad section, which is composed of cut stone blocks. The height of the flat bottom arch culvert measured 10 feet 6 inches at center and 9 feet 6 inches wide at the bottom. Water was backed up into the culvert at a depth of 1 foot 10 inches. The inlet of the culvert is part of the CALTRANS section, which is composed of smooth concrete and has a shallow U-shaped bottom and arch top measuring 13 feet 6 inches in height and 14 feet wide. A concrete apron extends upstream 75 feet from the culvert inlet at a slope measured at 3.8% to a metal debris grate. The slope inside the culvert appeared to be slightly less than the apron. Based on observations of this crossing from outside, the total length of the culvert is estimated to exceed 500 feet in length.

Condition: The culvert appeared to be in fair condition with minimal wear and no significant damage observed. The condition inside the culvert was not determined.

Diagnosis: Upstream steelhead passage into the culvert is easily attained due to the downstream pool extending into the culvert. The potential for upstream steelhead passage through the length of the culvert was not determined due to the high concentrations of automotive fumes encountered in the culvert. Upstream migration through this culvert was determined to be extremely difficult at best, and likely impossible, due to the excessive culvert length, moderate culvert slope near the inlet, apparent lack of resting areas within the culvert, absence of light, shallow water conditions during low flows, and accelerated velocities encountered during high flows.

Recommended Action: Additional survey of the inside of the culvert should be conducted with a mask on hand for the exhaust fumes. See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_TE_2-17,20
Stream: Tecolote
Barrier Type: Grade Control Structures
Location: Between 0.37 & 0.98 mile upstream from mouth
Ownership/Interest: Santa Barbara County Flood Control District

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Description: A total of sixteen grade control structures of similar size and severity exist between the Highway 101 Culvert and the Vereda Leyenda Bridge crossing and are described here. Most of these structures (except #2 and #4) are composed of a 1-foot thick concrete curb measuring just over 2 feet in height with a relatively flat concrete apron extending between 10 feet and 10 feet 6 inches downstream. The length of these structures across the stream channel varies, but on average they are approximately 35 feet in length. One additional small grade control structure (#20) occurs upstream of the Vereda Leyenda Bridge and has a downstream-facing slope with a length of 8 feet and slope of 9.4%. See the accompanying table for additional information.

Tecolote Creek Grade Control Structures (SBCFCD)

Barrier ID	Miles from Ocean	Curb Height	Pool Depth	Apron Length	Condition	Notes	Severity
BR_TE_2	0.37	2'3"	1'10"	No apron	Fair	Moderate erosion on downstream river-right bank.	0.2
BR_TE_3	0.44	2'2" *	6" *	9'9"	Fair	Apron elevated 2 inches above downstream pool. Moderate wear/erosion.	0.6
BR_TE_4	0.45	2'2"	1'	No apron	Fair	Screened water pump in downstream pool river-right side. Moderate wear.	0.4
BR_TE_5	0.47	2'5" *	11" *	10'	Fair	Apron submerged between 5"-11". Moderate wear.	0.5
BR_TE_6	0.5	2'4" *	10" *	10'6"	Fair	Apron submerged up to 10". Moderate wear.	0.5
BR_TE_7	0.53	2'2" *	4" *	10'6"	Fair	Shallow apron. Moderate wear and erosion dwonstream	0.6
BR_TE_8	0.57	2'2" *	5" *	10'6"	Fair	Apron elevates 2 inches above dwonstream pool. Moderate bank erosion.	0.6
BR_TE_9	0.6	2'2" *	4" *	10'6"	Fair	Apron submerged. Moderate bank erosion.	0.6
BR_TE_10	0.61	2'2" *	3'10"	10'6"	Extremely Poor	Curb and apron extremely damaged and undercut over 5 feet. Deep scour poo	0.5
BR_TE_11	0.63	2'4" *	7" *	10'6"	Poor	Undercut 2 feet on upstream side. Moderate wear on curb.	0.5
BR_TE_12	0.65	2'3" *	3" *	10'6"	Fair	Apron elevated 2 inches above downstream pool. Moderate wear/erosion.	0.6
BR_TE_13	0.66	2'6" *	5" *	10'6"	Fair	Apron elevated 2 inches above downstream pool. Moderate wear/erosion.	0.6
BR_TE_14	0.68	2'3" *	4" *	10'	Fair	Apron elevated 2 inches above downstream pool. Moderate wear/erosion.	0.5
BR_TE_15	0.7	2'3" *	5" *	10'6"	Fair	Apron elevated 3 inches above downstream pool. Moderate wear/erosion.	0.6
BR_TE_16	0.72	2'3" *	4" *	10'6"	Fair	Moderate wear.	0.6
BR_TE_17	0.75	2'4" *	7" *	10'6"	Fair	Moderate wear. Water pipe/pump in downstream pool with fine mesh screen	0.5
BR_TE_20	0.98	1'5"	6"	No apron	Fair	9.4% slope concrete face. Structure buried on river-right side.	0.4

Measurements made during an estimated stream flow of 2.5 c.f.s on 2001-05-30
* Curb height measured from the downstream apron. Pool depth measured on the apron downstream where steelhead would attempt to jump from

Condition: All of these structures have sediment backed up behind them. Most structures are in fair condition with moderate concrete wear, although a couple are significantly damaged and undercut (see table). Many of the structures have significant scour pools on the downstream side and erosion occurring on adjacent stream banks.

Diagnosis: The structures with aprons on the downstream side would require upstream migrating steelhead to swim onto the apron during migration flows when water velocities will be accelerated and jump pool depth will be limited. The low jump height of these grade controls will allow steelhead to make a low to moderately difficult jump over each of these structures during higher migration flows when sufficient depth exists on the aprons or downstream pool. During low and moderate flow conditions when minimal jump depth exists on the aprons, upstream passage will be extremely difficult or impossible.

Recommended Action: It is likely that the presence of these grade control structures so close together has significantly altered the character of lower Tecolote Creek by increasing slower run and pool habitat and promoting the accumulation of fine sediments. While each structure described here has a relatively moderate severity to upstream passage, collectively these 17 grade controls would have a significant impact on upstream steelhead migration, especially during seasons with low stream flows and short windows of opportunity to get upstream quickly to adequate spawning habitat not found in this lower reach. The effectiveness and desirability of these structures could not be determined. If maintaining these structures is desirable, fish passage could be dramatically improved by cutting a notch approximately 3 feet wide by 5 inches deep at the center of the curbs and providing a small concrete jump box or dug out depression in the concrete apron to increase the jump depth where flows are focused.

BR_TE_3

BR_TE_4

BR_TE_5

BR_TE_7

BR_TE_8

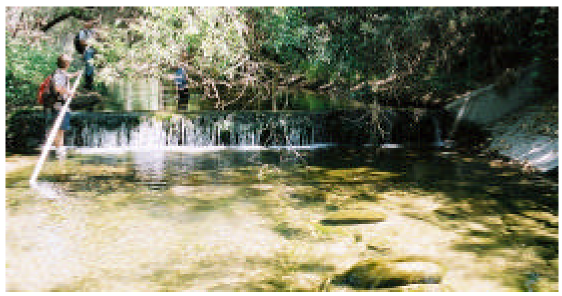
BR_TE_9

BR_TE_10

BR_TE_11

BR_TE_12


BR_TE_13


BR_TE_14


BR_TE_20

Barrier ID: BR_TE_18
Stream: Tecolote
Barrier Type: Temporary Dam
Location: 0.07 mile downstream from Vereda Leyenda Bridge
Ownership/Interest:

Description: This strange, temporary dam structure consisted of metal stakes pounded into the streambed with sheets of corrugated metal attached to back up or focus stream flows. A small space between the sheets at center allowed water to flow through. Water may be pumped out of the pool formed upstream although no signs of water extraction were observed. One 9-inch rainbow trout was observed 15 feet upstream of this structure holding in the center of the stream. This robust individual appeared to be in good condition, with a rosy lateral coloration and was actively feeding.

Condition: This dam appears to be a temporary structure that likely will blow out with a significant amount of stream flow. The metal stakes and sheeting may present a safety hazard at this location or, if blown out, downstream.

Diagnosis: No jump is needed to migrate past the structure and the opening in the center will allow easy migration upstream. During migration flows, debris may block the opening and produce a small jump or swim over the structure with a low severity. The sharp metal may present a hazard to fish while migrating past.

Recommended Action: Investigate the purpose of the structure and remove if found to be appropriate.

Barrier ID: BR_TE_19
Stream: Tecolote
Barrier Type: Grade Control Structure and Bridge
Location: Vereda Leyenda Bridge
Ownership/Interest: Santa Barbara County Public Works- Roads Division

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Description: Downstream from the bridge crossing a concrete and boulder riprap apron extends 52 feet at a slope measured at 13.3 %. This apron may also function as a grade control structure. Large boulders are placed downstream of the structure, apparently to limit scour. An old corrugated plastic culvert found at the center of the apron near the bottom no longer functions.

Condition: The structure appears to be in fair condition with some wear and recent concrete additions. On the upstream side, sediment has backed up to the top of the structure.

Diagnosis: During migration flows, adult steelhead would be able to swim onto the apron, where accelerated water velocities would be encountered. The presence of large embedded boulders on the apron would provide some velocity breaks but resting areas that steelhead could utilize are minimal. Limited, extremely difficult upstream passage at this structure may be possible when flows are ideal.

Recommended Action: Due to the high severity of this structure and its location relatively low in the watershed, a long-term fish passage improvement project is recommended. The most effective, self-sustainable solution for steelhead migration at this site would be to remove the entire apron and reinforce or modify it. Additional studies are needed to assess the role of this structure to sediment transportation within the system and identify options for providing fish passage. If the apron needs to stay in place, a series of large step pools traveling up the apron may provide an effective solution.

Barrier ID: BR_TE_21,22
Stream: Tecolote
Barrier Type: Grade Control Structures
Location: 1.12 & 1.30 miles from ocean
Ownership/Interest: Santa Barbara County Flood Control District

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Description: These two grade control structures are fairly similar in their concrete and boulder riprap construction.

#21- This structure measured 45 feet from the top to the downstream pool surface with a slope of 10.9%. The overall height of the structure measured 6 feet 9 inches from the downstream pool surface to the top. The maximum pool depth measured 3 feet.

#22- This structure measured 34 feet from the top to the downstream pool surface with a slope of 20.8%. The overall height of the structure measured 7 feet 1 inch from the downstream pool surface to the top. The maximum pool depth downstream measured 3 feet 6 inches.

Condition: Both structures appear to be in fair conditions with moderate wear and adjacent bank erosion.

Diagnosis: During migration flows, adult steelhead would be able to swim or jump onto both of these structures. Once on the structures, salmonids would encounter high water velocities and minimal areas to rest or gain momentum to jump. The presence of large embedded boulders on the apron would provide some velocity breaks and extremely difficult upstream passage may be possible for adult steelhead when flow conditions are ideal. Both structures are major impediments to upstream passage and would severely limit or block upstream movement of steelhead during migration flows.

Recommended Action: Due to the high severity of these structures and their location relatively low in the watershed, an effective fish passage project needs to be implemented at these sites. While the most effective, self-sustainable solution for passing steelhead at this site would be to remove the structures and reinforce adjacent stream banks, this option may not be feasibly depending on the effectiveness of these structures for flood control. Work with the SBCFCD to assess the effectiveness and desirability of these structures for flood control within the system and alternatives for fish passage at these sites. If the structures must remain in place, providing adequate step pools up the structures is recommended.

Barrier ID: BR_TE_23,24
Stream: Tecolote
Barrier Type: Stream Crossing and Dam
Location: #23=Approximate elevation 140 feet, #24=Approximate elevation 450 feet
Ownership/Interest: Wallover Inc.

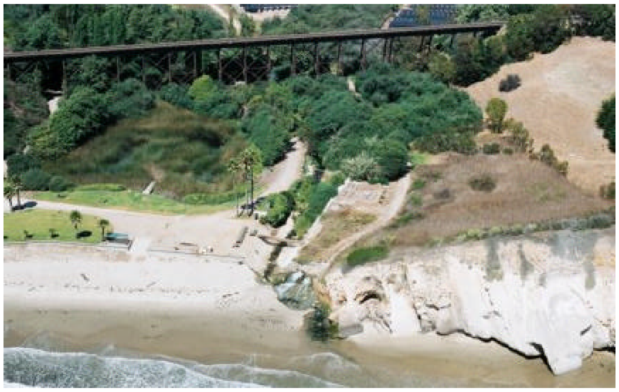
Description: Field surveys did not extend upstream of BR_TE_22 due to access restrictions. The following two structures were observed briefly from the air. Additional structures may also be present upstream of BR_TE_22, which could not be observed.

Diagnosis:
#23- This crossing was identified briefly and the construction type and impact it may have on upstream steelhead migration could not be determined.

#24- This dam was observed near the downstream end of a confined gorge and appeared to be impassable to upstream migration because of the excessive height and absence of any fish passage structures. The dam did not appear to be functioning, but may serve a purpose that was not determined.

Recommended Action: Additional surveying of Tecolote Creek from BR_TE_22 to the upstream natural migration barrier(s), including assessment of the stream crossing and dam mentioned here is recommended.

Barrier ID: BR_DP_1
Stream: Dos Pueblos
Barrier Type: Concrete Channelization
Location: Extends from mouth of creek upstream for approximately 0.2 mile
Ownership/Interest: Dos Pueblos Ranch



Description: Access to ground survey this structure was not obtained and information about this structure was limited to aerial surveying and personal communication with knowledgeable individuals. This trapezoidal concrete channel extends from the mouth of Dos Pueblos Creek upstream approximately 0.2 mile, to near the first upstream road crossing. At the downstream end of the channel a concrete apron approximately 15 feet long extends out over the sand beach where flows drop approximately 2 feet into a small, sand-bottom pool that is influenced by the waves and tides. The channel appears to have a bottom width of approximately 20 feet and slanted walls rising approximately 7 feet. The channel confines stream flows under one road crossing, the UPRR trestle, and past what remains of the former lagoon, which continues to exist on the west side of the channel, but is now disconnected from the creek and sea. Page reported that chemicals are sprayed into the isolated lagoon at the mouth of Dos Pueblos Creek for mosquito abatement. The history of this structure could not be determined and the may have been built by UPRR and/or the Dos Pueblos Ranch. Dos Pueblos Ranch owns the surrounding land.

Condition/Sizing: The channel appears to be in poor condition with significant damage along, and completely through, the channel at several locations. During biological monitoring surveys for Level 3 Communications in 2001, Carl Page reported that the road adjacent to the highly damaged concrete channel is being severely undermined (pers. comm. Page). Vegetation is also present growing within and through the channel.

Diagnosis: Locating and jumping into this channel from the ocean presents at least a moderate to high degree of difficultly to sea-run steelhead. The narrow length of beach and tidal action downstream of the channel prevents an adequate sand bar from forming and maintaining a significant lagoon. Depending on the configuration of the sand downstream, upstream migrating adult steelhead may not have adequate pool depth to jump onto the channel during most, or all, flows. Virtually no acclimation zone between fresh and salt water exists for potential upstream and downstream migrating salmonids.

In addition to the physical difficulties encountered by steelhead trying to jump into the channel, at least two metal pipes discharge water onto the concrete apron adjacent to the channel outlet. During two aerial surveys, the amount of discharged water exceeded the amount of stream flow exiting the channel. This water is apparently coming from the aquaculture operation approximately 0.15 mile upstream on the east side of the creek (pers. comm. Page). The discharged water may significantly deter or completely eliminate upstream passage of steelhead onto the channel depending on the chemical and temperature characteristics of this water, which may be intolerable to steelhead. The different water chemistry being discharged may also prevent steelhead from even attempting to enter Dos Pueblos from the ocean due to the altered water chemistry characteristics flowing into the ocean, which steelhead hone in on to locate their natal stream or other suitable creek during their spawning run.

If upstream migration into the channel is achieved, steelhead passage to the top of the channel appears to be relatively easy during migration flows due to the mild slope and many velocity breaks provided along the channel’s damaged, substrate-lined, and vegetated bottom. Several areas of the upper channel where not observed from the air due to the thick riparian conditions near the upstream end. Page noted that steelhead migration along the channel is achievable, but expressed concern about steelhead entry into the channel from the ocean and potentially negative effects

Recommended Action:
The water discharged from the aquaculture operation may be severely limiting or preventing steelhead from attempting to enter Dos Pueblos Creek and should not occur at the present site. The discharge pipe should be relocated far away from the mouth of the creek and potentially piped out to sea.

Work with the landowner, and UPRR, to discuss the possibility of a Lower Dos Pueblos Creek Restoration Feasibility Study and Implementation Plan. Such a project may prove to be desirable for the landowner with financial incentives and/or as a potential mitigation effort associated with future development projects proposed on Dos Pueblos Ranch. The study and plan should consider assessing the following components:

1) Naturalizing Dos Pueblos Creek along the current channelized reach, while providing adequate protection to adjacent facilities and the UPRR trestle.
2) Reconnecting and rehabilitating the former lagoon habitat.
3) Redesigning the existing facilities and roads near the mouth away from the creek and lagoon.
4) Relocate the aquaculture discharge far away from the creek mouth.
5) Exotic plant removal and native revegetation

Improvements to the existing channel that would reduce or eliminate the resting holes in the concrete that assist in potential upstream migration, should not occur without adequate improvements to upstream passage.

Barrier ID: BR_DP_2
Stream: Dos Pueblos
Barrier Type: Grade Control Structure
Location: Downstream from southern Highway 101 Bridge
Ownership/Interest: CALTRANS

Description: This grade control structure was only observed from the public road access under Highway 101 due to access restrictions within the stream channel. A concrete-lined bottom extends under much of the Highway 101 Bridges and ends with a significant drop onto natural substrate or developed pool. Various bank revetments made of boulders, concrete filled sacks, and concrete slabs have been constructed adjacent to the grade control structure. The stream is very confined in this reach with access roads immediately adjacent to the grade control structure on both banks.

Condition: The structure appears to be in fair condition with moderate bank erosion and undercutting.

Diagnosis: During moderate to high stream flows observed on 2001-03-08 (picture above) this grade control produced highly aerated pool conditions downstream with 4-foot vertical jump to the top of the structure. The downstream pool appeared to be sufficiently deep to allow a jump with a high degree of difficulty to upstream migrating steelhead.

Recommended Action: Upstream passage is likely limited to short periods during moderate to high stream flows. With the location of this structure far downstream in the watershed, it is important that steelhead are not held up here waiting for adequate flows to migrate upstream. Work with CALTRANS to assess limitations and options for improving fish passage. Removal of the concrete bottom and reinforcement of the adjacent stream banks using bioengineering methods should be evaluated for optimum, long-term fish passage effectiveness. Installation of one or more downstream weirs could increase the jump depth and improve upstream passage, but may be susceptible to washing out and/or causing downstream scour at the weir site.

Barrier ID: BR_DP_3
Stream: Dos Pueblos
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 275 feet
Ownership/Interest: Dos Pueblos Ranch

Description: Observations of this structure were limited to the air due to access restrictions. Carl Page, a biological monitor working on the Level 3 Communications project on Dos Pueblos Creek, provided the accompanying photograph. This dirt-fill road crossing has two smooth plastic culverts approximately 2 feet in diameter and 25 feet in length. The culverts sit just above the streambed level on the downstream side.

Condition: This crossing appears to have been recently constructed or modified. Dirt-fill crossings with undersized culverts are highly susceptible to blowing out during moderate to high stream flows.

Diagnosis: Due to the relatively small diameter of the culverts, length, and smooth interior configuration, migration flows through the culvert would be confined and accelerated with no velocity breaks for upstream migrating salmonid. Depending on the condition of the culvert, slope, and configuration on the upstream end of the culvert, this crossing presents a significant impediment or complete barrier to upstream steelhead migration.

Recommended Action: Work with the landowner to replace this structure with a bridge, large embedded culvert, or bottomless arch culvert that will not impeded steelhead passage and will provide effective and safe vehicle passage. Providing steelhead access upstream of this structure is critical because the creek often dries up downstream of this site and the most productive spawning and rearing habitat in the watershed occurs upstream.

Barrier ID: BR_DP_4
Stream: Dos Pueblos
Barrier Type: Failed Dam
Location: Approximate elevation 350 feet
Ownership/Interest: Dos Pueblos Ranch

Description: Information about this structure and the accompanying picture was obtained from Carl Page, a biological monitor working at Dos Pueblos Creek for Level 3 Communications. Remains of this old concrete weir still exist on the stream banks and some concrete slabs are present in the channel. The weir no longer functions and does not span the width of the channel. A natural bottom extends between the old weir abutments.

Condition: This weir is almost completely washed away.

Diagnosis: The remaining weir abutments confine the stream slightly and trap a small amount of substrate upstream. During migration flows, water velocities may increase slightly past the remaining parts of the weir into a moderately sized pool. Upstream passage for all life stages of salmonids is possible with a low degree of difficulty.

Recommended Action: The remaining concrete and metal should be removed to eliminate potential blockage at this site, or further downstream, and improve the ease of upstream migration.

Barrier ID: BR_DP_5
Stream: Dos Pueblos
Barrier Type: Grade Control Structure
Location: Approximately 250 feet upstream from BR_DP_4
Ownership/Interest: Dos Pueblos Ranch

Description: Information about this structure and the accompanying picture were obtained from Carl Page, a biological monitor working at Dos Pueblos Creek for Level 3 Communications. This grade control structure consists of an upstream V-shaped concrete curb and apron that extends upstream. The curb is approximately 1-foot thick and extends 1-2 feet in height above the downstream pool during subsurface flows. The upstream apron has a moderately steep slope.

Condition: The structure appears to be in poor condition with moderate cracking and damage occurring on the curb and apron.

Diagnosis: The downstream pool appears to provide adequate depth for upstream migrating steelhead to jump over the curb and onto the apron with a low degree of difficulty. The moderate slope of the apron will produce increased water velocities during migration flows and the apron appears to have limited resting areas for steelhead to utilize while attempting to swim upstream. This structure likely imposes a moderate to high degree of difficulty to upstream migrating steelhead.

Recommended Action: Assess the desirability of this structure with the landowner and determine if it is necessary. If the grade control is not needed, it should be removed to allow unimpeded upstream passage for salmonids.

Barrier ID: BR_DP_6
Stream: Dos Pueblos
Barrier Type: Concrete Channelization with Water Diversion
Location: Approximate elevation at the downstream end of the channel is 460 feet
Ownership/Interest: Dos Pueblos Ranch

Description: Due to access restrictions, information about this structure was obtained from the air. The riparian canopy obstructed visual observation of much of this structure making it difficult to determine exactly what type of construction and operation is occurring. Two off-stream reservoirs occurs downstream of the concrete channel on the west side of the creek and apparently store surface flows diverted from the stream at the channel. One weir reportedly does divert water into these collection reservoirs and is the main source of water extraction for the Dos Pueblos Ranch (pers. comm. H. Schulte 2001-08-04). From the air it appears that the concrete channel extends approximately 300 feet in length. The channel was being worked on with tractors. The channel appeared to contain all the surface flow. At the downstream end of the channel it appears that cobble and boulder levees/weirs have been made to confine stream flows into several pools downstream. Several significant drops occur downstream of the concrete channel that appear to have some concrete and boulder construction associated with them.

Condition: It is difficult to determine how this diversion functions and what condition it is in without on-the-ground assessment. The observable sections of the concrete channel appeared to be in poor condition.

Diagnosis: The downstream pools appear to have small vertical drops associated with them and a section of moderate to steep riprap between them that would significantly limit or block upstream steelhead migration due to the jump heights and increased water velocities over the riprap section. Depending on the condition and slope of the concrete channel, this section may also impede upstream migration due to accelerated stream velocities during migration flows or other factors.

The actual source of diversion was not observed, but may also limit migration and potentially suck salmonids out of the creek and into the collection reservoirs. Based on these limited observations, it appears that upstream migration of steelhead past this entire structure would be extremely difficult or impassable.

Recommended Action: A detailed assessment of this structure should occur on the ground and fish passage further evaluated in coordination with the landowner. Discuss the operation of this structure with the landowner and determine possible fish passage improvements if necessary. The highest quality habitat, and optimal summer rearing habitat, in Dos Pueblos Creek exists upstream of this site and access to the upper watershed should be a high priority for ensuring a self-sustainable steelhead population. Safe downstream migration of juvenile steelhead and adults should also be ensured past any diversion sources.

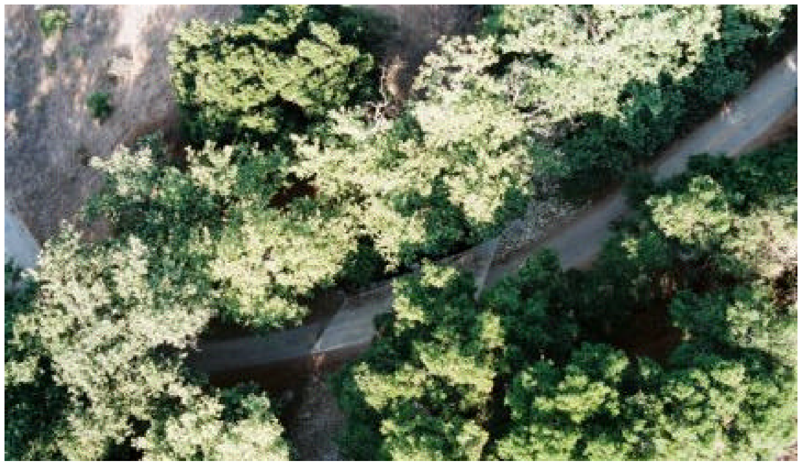
Barrier ID: BR_GO_1
Stream: Gato
Barrier Type: Stone Culvert
Location: 0.22 mile upstream from mouth
Ownership/Interest: UPRR

Description: Access to survey Gato Creek was not obtained. Information was obtained from *Gato Creek Faunal Survey* (Hunt 1995), personal communication with Hunt, and aerial photography. This UPRR crossing passes over Gato Creek approximately 0.22 mile upstream from the mouth of the creek at the ocean. The narrow earth fill across the single railroad track appears to have a relatively short width across the stream channel. The UPRR culvert is likely 70-100 feet long with a similar vintage and stone construction as described for the UPRR crossing of Cojo Creek (BR_CO_1).

Diagnosis: Hunt observed this culvert and did not think it would present an impassable barrier to upstream steelhead migration. Many of the UPRR culverts are set at grade level and have worn, irregular bottoms that would facilitate upstream steelhead passage. See the BR_CO_1 description. During high stream flows, the concentration and acceleration of water through the narrow culvert may limit upstream passage.

Recommended Action: Work with Las Varas Ranch and UPRR to assess the culvert for fish passage.

Barrier ID: BR_GO_2
Stream: Gato
Barrier Type: Stream Crossing
Location: Approximately 0.2 mile upstream from UPRR crossing
Ownership/Interest: Las Varas Ranch



Description: Access to survey Gato Creek was not obtained. Information was obtained from *Gato Creek Faunal Survey* (Hunt 1995), personal communication with Hunt (2001), and aerial photography. Hunt observed this road crossing in 1995 and reported that downstream of the paved crossing had experienced a high amount of scour and the road surface was elevated at least 8 feet above the downstream substrate. Stream flows were conveyed across the top of the crossing with sediment backed up to the top of the upstream side of the road, which completely blocked a culvert passing under the road (pers. comm. Hunt 2001).

Condition: The crossing appears to be in extremely poor condition with major erosion and undercutting from scour.

Diagnosis: Hunt described this crossing as a "major barrier' that he believed would block upstream steelhead passage. Aerial photo-observation from 2001 revealed that a significant drop still occurred downstream of this crossing and that upstream steelhead passage is likely still blocked at this structure.

Recommended Action: Work with the Las Varas Ranch to assess the feasibility of replacing this crossing with a bridge that does not impact the stream channel, provides unimpeded upstream steelhead access, and improved vehicular access during higher stream flows.

Barrier ID: BR_GO_3
Stream: Gato
Barrier Type: Culvert
Location: Highway 101 Crossing
Ownership/Interest: CALTRANS

Description: Access to survey Gato Creek was not obtained. Information about this culvert was obtained from *Gato Creek Faunal Survey* (Hunt 1995), personal communication with Hunt, aerial photography, and surveying from Highway 101. The culvert appears to exceed 400 feet in length. The measurements and configuration of the culvert were not determined, but are assumed to be similar to other CALTRANS Highway 101 culverts.

Diagnosis: Hunt observed this structure and recalls that the culvert was a significant impediment to upstream migration, although not as severe as BR_GO_2. Assuming this culvert is similar to other long concrete CALTRANS culverts built over Highway 101, upstream steelhead migration is likely impossible due to the excessive culvert length, lack of resting areas within the culvert, shallow water conditions during low flows, and accelerated velocities encountered during high flows.

Recommended Action: See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_GO_4,5,6,7
Stream: Gato
Barrier Type: Stream Crossings
Location: Approximate elevations (320', 790', 910', 1060')
Ownership/Interest: Las Varas Ranch (and Los Padres National Forest for BR_GO_7)

Description and Diagnosis: Access to survey Gato Creek was not obtained. Information was obtained from *Gato Creek Faunal Survey* (Hunt 1995), personal communication with Hunt (2001), and aerial photography.

GO_4 and **GO_5-** Hunt observed these crossing to be within the streambed and believed they would likely not significantly impede upstream steelhead migration.

GO_6- Hunt observed this structure and reported that this "Arizona crossing" would be a major impediment/barrier to upstream steelhead migration and likely was impassable (pers. comm. Hunt).

GO_7- Hunt was unsure about the configuration of this concrete bridge and potential severity it may impose on upstream steelhead migration.

Recommended Action: Work with the Las Varas Ranch to further assess these stream crossings for future salmonid passage.

Barrier ID: BR_GO_8
Stream: Gato
Barrier Type: Diversion Dam
Location: Approximately 3.7 miles from ocean at the 1120-foot elevation
Ownership/Interest: Las Varas Ranch and Los Padres National Forest

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Description: Access to survey Gato Creek was not obtained. Information about this dam was obtained from the Gato *Creek Faunal Survey* (Hunt 1995), personal communication with Hunt (2001), and photo-observations were made from pictures provided in Hunt 1995 (attached). See the Santa Barbara County *Gato Creek Water Diversion. Final Environmental Impact Report. 83-EIR-19; 82-MP-4* and Hunt 1995 for more detailed information regarding the diversion dam operations and associated off-stream reservoir. The downstream face of the dam appears to be between 4-5 feet in height above the downstream bedrock, where no observable pool exists. It appears that this dam occurs on Los Padres National Forest land.

Diagnosis: Upstream steelhead migration does not appear to be possible due to the lack of an observable downstream pool to provide acceleration needed for the jump over the concrete dam. During high stream flows, adequate downstream depth may develop that could allow limited upstream steelhead passage. Additional surveying of the structure is needed to assess fish passage in more detail.

Recommended Action: Work with the Las Varas Ranch to further assess fish passage at this structure. Aside from the physical migration limitations imposed by the diversion dam, the extraction of surface flows from Gato Creek appears to have significantly impacted the availability of aquatic habitat downstream of the diversion and migration of aquatic species within the watershed. Along with improving or providing fish passage at the dam site, improving the availability of surface flows in the lower creek should also be assessed. Due to the location of the diversion dam high in the watershed, near the historic limits of available steelhead distribution, the creek’s potential to sustain a steelhead population relies on adequate releases of water to maintain some level of year-round surface flow downstream of the dam. Currently, most of the creek appears to dry up downstream of the dam for long periods of time. See Hunt 1995 for more information about surface flow duration. The introduction of exotic fish species from the off-stream reservoir into Gato Creek has also been identified, with observations of green sunfish near the UPRR crossing. This non-native species directly preys on, and competes with salmonids and other native wildlife and its presence in the watershed should be eliminated.

Barrier ID: BR_GO_9
Stream: Gato
Barrier Type: Bedrock Waterfall
Location: Approximately 0.1 mile upstream from Diversion Dam (BR_GO_8)
Ownership/Interest: Los Padres National Forest

Description: Access to survey Gato Creek was not obtained. Information about this waterfall was obtained from the Gato *Creek Faunal Survey* (Hunt 1995), personal communication with Hunt (2001), and photo-observations were made from a picture provided in Hunt 1995 (attached). The waterfall is said to occur approximately 500 feet upstream of the diversion dam (Hunt 1995). The bedrock waterfall appears to be between 7-9 feet tall with a small pool downstream.

Diagnosis: The limited size of the downstream pool and excessive height of the waterfall, suggest that upstream steelhead migration would likely not be possible and that this feature may signify the natural upstream limit to steelhead migration in the watershed.

Recommended Action: No recommended action for this natural feature.

Refer to Map Folder for:
El Capitan, Corral Creek Map
Map 7.7.10.1

Refer to Map Folder for:
El Capitan, Corral Creek Map
Map 7.7.10.1

Refer to Table Folder for:
El Capitan, Corral Creek Barrier Table
Table 7.7.10.2

Refer to Table Folder for:
El Capitan, Corral Creek Barrier Table
Table 7.7.10.2

Barrier ID: BR_EC_1
Stream: El Capitan
Barrier Type: Culvert Stream Crossing
Location: State Park Road Crossing
Ownership/Interest: California State Parks

Description: This 41-foot long corrugated metal culvert has a shallow U-shaped bottom and half circle top that is encased in concrete. A concrete apron with a minimal slope extends 4 feet 10 inches from the downstream end of the culvert to a pool downstream, which is only 3 inches below the concrete lip during low flows. An apron of the same length occurs between concrete wing walls on the upstream end of the structure and is at streambed level. The culvert had a measured height of 9 feet 10 inches at center and a maximum width of 16 feet 6 inches. The metal corrugations within he culvert measured 2 inches in depth. The downstream pool measured 11 inches deep just downstream from the apron.

Condition: The bottom of the culvert is extremely rust-damaged with several holes through the culvert and exposed substrate below. Large woody debris was stuck sideways at the inlet of the culvert presenting a moderate risk of future blockage.

Diagnosis: Due to the minimal or non-existent jump needed to enter the culvert, minimal slope, and roughness of the corrugations, this culvert presents a low to moderate degree of difficulty upstream salmonid passage. During extremely high flows, water velocities within the culvert may exceed the capabilities of upstream migrating steelhead for a limited time. During low flows, the shallow water depth on the downstream apron and small lip transition into the culvert would be moderately difficult for steelhead to pass.

Recommended Action: Work with the State Parks to determine the long-term desirability of this structure and future plans for the road crossing. Due to the extremely poor condition of the culvert, the location of this structure being the most downstream in the watershed, the State Parks ownership, and existing metal hazards, any maintenance or improvement to this structure should include fish passage improvements. Ideally, this crossing could be replaced with a bridge and natural bottom.

Barrier ID: BR_EC_2
Stream: El Capitan
Barrier Type: Culvert
Location: Highway 101 Culvert
Ownership/Interest: CALTRANS

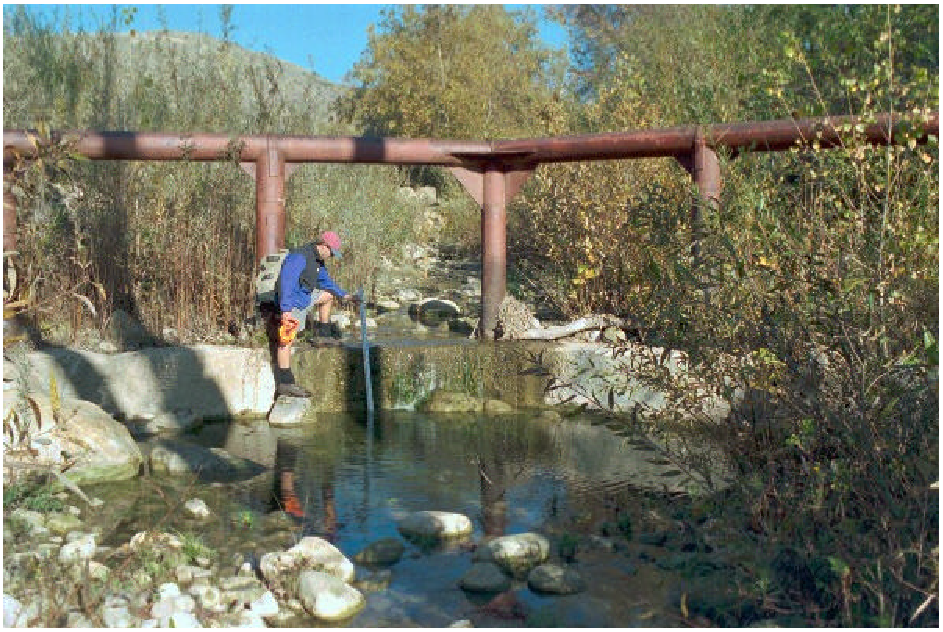
Description: This concrete culvert measured approximately 450 feet in total length with several changes in slope. A concrete apron measuring 25 feet long extends from the downstream end of the culvert between two wing walls and into a pool downstream, which had a maximum depth of 4 feet. The downstream pool backwatered the entire apron to the downstream end of the culvert. At the downstream end of the culvert, the height measured 11 feet 9 inches at center and the width measured 10 feet near the bottom. The bottom of the culvert has a shallow U-shape that measures 8 inches deep from center to the sidewalls of the culvert. The original culvert has been added onto and now consists of two separate reaches that connect 240 feet upstream from the outlet of the culvert. The downstream 240-foot reach of culvert has a slope of approximately 2%. The upstream 210-foot reach has a steep transition at the downstream end and a measured slope of 6.5 % over the upstream-most 95 feet.

Condition: The upstream 210-foot reach of culvert is extremely damaged with several large holes completely through the bottom, major undercutting, flows reemerging into the culvert through cracks, and exposed metal reinforcement bars. These damaged holes have produced large pools with several feet of depth. In its current state this structure has a high risk of failure.

Diagnosis: It appears that no jump is required for steelhead to access the culvert unless this pool depth diminishes as downstream sediment moves during high flows. During migration flows, the high velocities within the culvert and lack of resting spots would make upstream migration past the downstream 240-foot reach extremely difficult or impossible. Ironically, the major damage and pool development in the steeper upstream 210-foot reach of culvert may provide the only resting areas in the culvert and allow migration (assuming fish could negotiate the lower reach) up these pools to within 63 feet of the culvert inlet. The excessive slope of the final 63 feet of culvert is completely impassable to any steelhead during any flow conditions due to excessive stream velocities. CALTRANS personnel visited this culvert in 2001 and looked at the damage within the culvert (pers. comm. Steinman).

Recommended Action: The successful restoration of a steelhead population in the El Capitan Creek watershed is dependant on adequate migration upstream of Highway 101. No impassable anthropogenic barriers exist upstream of this culvert on the mainstem of El Capitan Creek and steelhead would have immediate access to the entire length of the mainstem and most of the West Fork of El Capitan Creek. High quality salmonid habitat exists in upper El Capitan Creek. See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_EC_3
Stream: El Capitan Creek
Barrier Type: Grade Control Structure
Location: Approximately 100 feet upstream from Highway 101 culvert
Ownership/Interest: CALTRANS



Description: This "trash rack" is designed to catch large, downstream migrating debris that may clog the Highway 101 culvert downstream. The structure has an upstream-facing V-shape with a concrete curb base and large metal pipes forming a grate. The 2-foot thick concrete curb spans the entire channel measuring 28 feet to the river-right side and 33 feet to the river-left side form the center of the V. During low flows, the height from the downstream pool to the downstream lip of the curb measured 2 feet 2 inches. The maximum depth of the downstream pool measured 2 feet 10 inches. The metal pipes have a 12-inch diameter and are spaced 7 feet 2 inches apart. The horizontal pipe across the top measured 6 feet 1 inch tall. Sediment is filled to the top of the upstream side of the curb.

Condition: The concrete and metal have moderate amounts of wear and are in fair condition.

Diagnosis: During migration flows, the jump height over this structure is minimal and would present a low to moderate degree of difficulty for upstream migrating steelhead. During low flow conditions, stream flow is spread out over several feet of the curb and onto several boulders on the downstream side.

Recommended Action: This structure should be considered by CALTRANS along with the Highway 101 culvert downstream. A notch near center measuring approximately 2 feet 6 inches wide and four inches deep would help focus attraction flows and increase the downstream jump pool depth. Should the Highway 101 culvert be removed and replaced with a bridge, this structure would likely not longer serve any purpose and should be removed also.

Barrier ID: BR_EC_4
Stream: El Capitan Creek
Barrier Type: Culvert Stream Crossing
Location: Approximately 150 feet upstream from Highway 101 culvert
Ownership/Interest: CALTRANS

Description: This concrete crossing has a broad U-shape that extends 86 feet across the stream channel. A relatively flat section measuring 16 feet long occurs at the center and a 2-foot diameter corrugated metal pipe conveys low stream flows underneath. The width of the crossing is 10 feet and has a downstream slope of less than 1%. The culvert measured 12 feet 2 inches long and the downstream lip measured 11 inches above the pool surface downstream. The upstream end of the culvert was 85% filled with sediment. The height of the crossing from the downstream lip to the downstream pool surface measured 3 feet 5 inches.

Condition: The culvert is in poor shape with significant damage from rust, debris, and heavy equipment clearing the culvert out when it becomes clogged.

Diagnosis: During migration flows, the culvert is likely impassable due to sediment clogging the inlet. This crossing was also observed several times during high stream flows conveying all or most of the stream flow over the crossing. During high stream flows the jump onto the crossing and swim across the concrete surface presents a moderate to high degree of difficulty due to the high water velocities encountered across the crossing.

Recommended Action: The property owners have expressed an interest in restoring a steelhead run to El Capitan Creek and are willing to explore options for improving fish passage at this crossing with a bridge or other effective solution, but wait to see a commitment from CALTRANS to provide upstream passage at Highway 101 prior to investing the effort at this crossing. When steelhead passage at Highway 101 becomes a reality the landowners at El Capitan should be contacted about improving passage at this crossing.

Barrier ID: BR_EC_5,6,7
Stream: El Capitan Creek
Barrier Type: #5-Bedrock Chutes, #6-Bedrock Waterfall, #7- Bedrock Chutes
Location: Los Padres National Forest
Ownership/Interest: Los Padres National Forest

Description: Several significant natural features that would impede or block upstream steelhead passage occur in upper El Capitan Creek and are described below.

#5- This series of bedrock chutes measured 19 feet long and 5 feet 6 inches tall from the surface of the downstream pool to the top of the chute. A small, 1-foot deep pool exists half way up the chute. The downstream pool measured 4 feet 2 inches deep.

#6- This bedrock waterfall measured 8 feet tall from the downstream pool surface to the top of the waterfall. The maximum pool depth downstream measured 6 feet 1 inch. The upper 6 feet of the waterfall conveys water down a very steep bedrock chute that drops vertically 2 feet above the downstream pool.

#7- This series of four bedrock chutes measures over 25 feet in height with the upstream-most chute measuring over 12 feet in height. No significant pool exists immediately downstream of the upper chute.

Condition: All bedrock features appear very stable.

Diagnosis:
#5- This steep series of bedrock chutes produces high water velocities and contains only one small resting pool that would require a steelhead to jump 2 feet 4 inches to reach followed by a second jump of 3 feet 4 inches from the 1-foot pool depth to clear the structure. Due to the high water velocities, limited resting pool depth, and long horizontal jump to the top of the chute this structure produces extremely difficult or impossible upstream passage conditions for steelhead. During high flows, limited upstream passage may be accomplished by utilizing velocity breaks adjacent to the roots, boulders, and debris on the river-left bank.

#6- The jump height and confined upper section of this waterfall make upstream migration extremely difficult for steelhead, but the deep downstream pool may provide limited passage when higher flows increase the depth and reduce the jump height.

#7- The absence of a well-developed pool associated with the upper chute and excessive height would completely block upstream steelhead passage.

Recommended Action: No recommended actions for these natural features.

Barrier ID: BR_EC_WF_1
Stream: El Capitan Creek
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 880 feet
Ownership/Interest: El Capitan Ranch

Description: This dirt-fill crossing contains a 6-foot diameter corrugated metal culvert that measured 61 feet 2 inches in length. The middle of the culvert was moderately squashed with a diameter of 5 feet 3 inches at the center. The height from the downstream lip of the culvert to the streambed downstream measured 8 feet 7 inches.

Condition: The culvert is in fair shape with minimal damage from rust, but significant compaction in the center. Significant undercutting of the structure downstream and associated bank erosion is occurring. Four washed-out culverts are scattered downstream from this site that apparently failed at this crossing in the past.

Diagnosis: During migration flows, the culvert is impassable due to the excessive jump height, presence of boulders downstream where steelhead would try to jump, and absence of a well-developed jump pool.

Recommended Action: This is the only anthropogenic barrier on the West Fork of El Capitan Creek. The structure is highly susceptible to failure during high flows due to the dirt-fill construction. The dirt road associated with this crossing is also prone to washing out in areas and contributed a significant amount of erosion into the creek during winter rains in 2000 and 2001. Work with the landowners to assess the possibility of decommissioning this dirt road for vehicular use, removing this crossing, and if desired retain a pedestrian trail with a natural streambed crossing at the creek. Currently, this former oil exploration road does not appear to service any structures in upper El Capitan Canyon. The washed-out culverts downstream of the crossing should also be removed to avoid a future blockage downstream.

Barrier ID: BR_EC_WF_2
Stream: El Capitan Creek
Barrier Type: Boulder Cascade
Location: Approximate elevation 1126 feet
Ownership/Interest: Los Padres National Forest

Description: This boulder cascade measured 7 feet 5 inches in height. A steep boulder gradient with a 15% slope extended from this cascade 50 feet upstream.

Condition: This feature is mobile during high stream flows and likely changes configuration dramatically over time.

Diagnosis: Currently, this section of the West Fork is impassable due to the excessive slope and several steep drops with minimal or absent jump pool depth. The configuration of this cascade may change to allow adequate upstream migration conditions for steelhead in the future.

Recommended Action: No action recommended for this natural feature.

Barrier ID: BR_CL_1
Stream: Corral
Barrier Type: Culvert
Location: UPRR and Highway 101 Culvert
Ownership/Interest: UPRR and CALTRANS

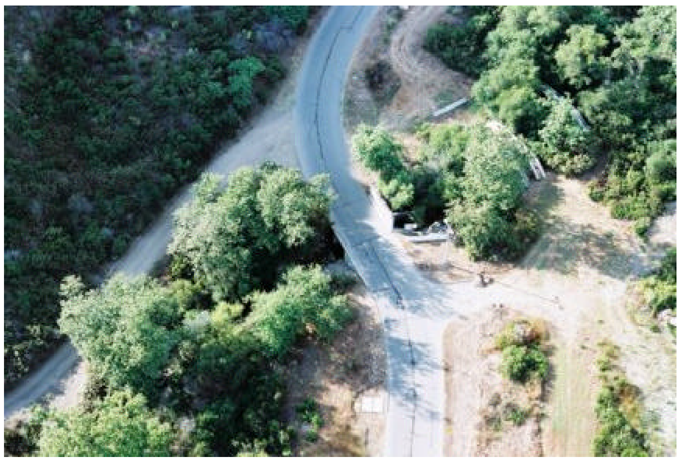
Description: Access to survey Corral Creek was not obtained. Surveys were conducted from the beach and Highway 101 to obtain general information about this culvert. The culvert appears to exceed 400 feet in length. No jump height occurred at the outlet of the UPRR arch culvert, which measured 14 feet tall by 10 feet 10 inches wide. A well-defined channel is worn into the bottom of the UPRR culvert that measured 2 feet deep and 8 inches wide. The measurements and configuration of the CALTRANS culvert were not determined, but are assumed to be similar to other CALTRANS Highway 101 culverts.

Diagnosis: Observations from the beach indicate that the CALTRANS culvert is similar to other long concrete CALTRANS culverts built over Highway 101 and upstream steelhead migration is impossible due to the excessive culvert length, lack of resting areas within the culvert, shallow water conditions during low flows, and accelerated velocities encountered during high flows. There exists historic documentation of adult steelhead in Corral Creek and rainbow trout presence until some time in the early 1990’s. See the Salmonid Documentation Table in section 6.0 for more information. High quality salmonid habitat is present in the upper reaches of Corral Creek.

Recommended Action: See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

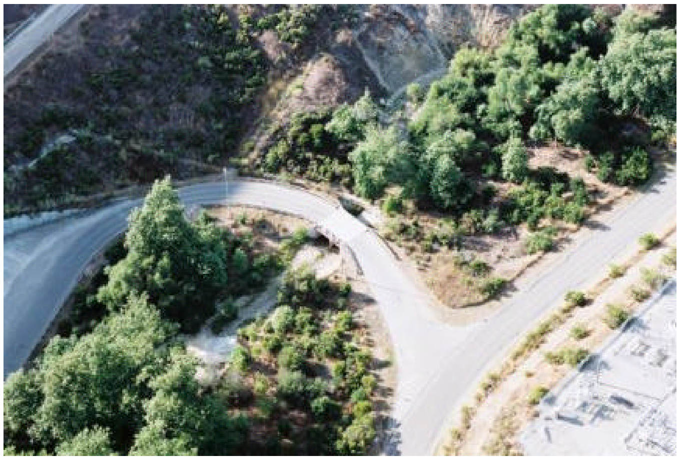
Barriers: BR_CL_2,3,4,5,6,7
Stream: Corral
Barrier Types: Stream Crossings
Locations: Respective mileage from the ocean: (0.58, 0.96, 1.00, 1.01, 1.29, 1.64)
Ownership/Interest: ExxonMobil

Description: Five active ExxonMobil road crossings and one apparently obsolete crossing occur on Corral Creek. Observations of Corral Creek upstream of Highway 101 were made from the air and with existing photo-observation due to restricted access onto ExxonMobil property. The structures are described below:

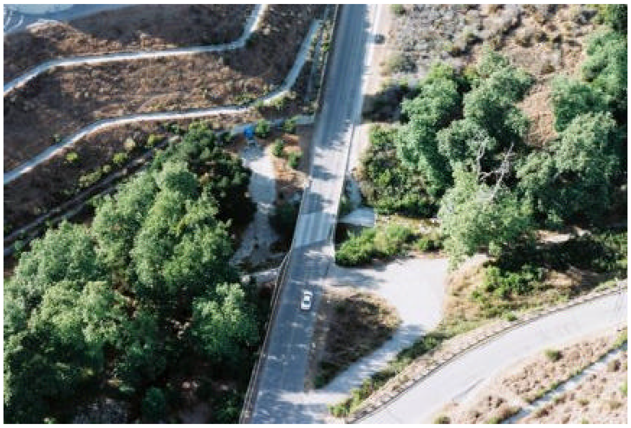


BR_CL_2

BR_CL_3



BR_CL_4,5



BR_CL_7

#2,3,5,7- These crossings are similar in construction and were likely built around the same time with the development of the Las Flores Plant road system. The observed two-lane road crossings convey stream flows through concrete double-box culverts. Wing-walls extend from the upstream and downstream sides of the culverts and some appear to have concrete bottoms and sloping inlet and/or outlet aprons associated with them.

#4- This structure is located approximately 100 feet downstream from #5. The concrete structure appears to be an obsolete concrete road crossing that is no longer used due to the double-box culvert crossings just upstream and downstream. This old crossing has a metal culvert extending from the downstream side that appears to be filled with sediment on the upstream side. An estimated vertical drop of 3 to 4 feet occurs on the downstream side. The concrete is significantly undercut on the downstream side and the culvert appears to be highly rusted.

BR_CL_6

#6- This road crossing occurs just downstream from the confluence of Las Flores Creek and was covered from view by riparian vegetation adjacent to the crossing. The configuration of the crossing could not be determined.

Diagnosis:
#2,3,6- The severity of these crossings to upstream steelhead migration could not be estimated from the air.
#4- This structure would present a moderate to high degree of difficulty for upstream steelhead migration due to the vertical jump required to land on top of the concrete and the accelerated water velocities conveyed across the structure during migration flows.
#5- This box culvert appeared to be at streambed level with natural substrate extending through the culvert. Upstream migration appears to have a low to moderate degree of difficulty due to the mild slope and velocity breaks provided by the natural streambed.
#7- A relatively steep, smooth, concrete apron occurs on the upstream end of the crossing and a concrete riprap apron appears to extends downstream of the crossing with a possible drop on the downstream side. The overall length of the concrete bottom, from the top of the inlet apron to the bottom of the outlet apron, appears to be around 70 feet. Shallow water flows across the concrete bottom during lower flows and excessive water velocities during higher flows would likely present extremely difficult or impossible conditions for upstream migration. Additional information about the slope and configuration of the crossing are needed to accurately determine the severity.

Recommended Action:
Background- The April 1984 *Revised Draft Environmental Impact Statement/Report. Technical Appendix 7 TERRESTRIAL BIOLOGY for Santa Ynez Unit/Las Flores Canyon Development and Production Plan* recommends for the proposed project to "Design culverts so that fish movements will not be restricted during low and high flows (i.e., bottom of culvert should be at or slightly below stream bed elevation and should not constrict flow which would increase velocities). This would allow free upstream of downstream movement by resident or anadromous trout." It is apparent through photo-observations and aerial surveying that this recommended action was not followed at all culvert crossings built for the Las Flores Plant. Salmonid documentation research (as summarized in the Salmonid Documentation Table) shows that Corral Creek's rainbow trout/steelhead population was prolific until the mid 1980's and was last reported in 1993, when apparently the population became extirpated from the watershed upstream of Highway 101. Yearly biological surveys have not documented rainbow trout presence since

1993. The isolation of the salmonid population, with the construction of the Highway 101 culvert, likely began the decline of the salmonid population upstream, which may have been further impacted with the construction of the Las Flores Plant and road culverts.

Recommendation- In conjunction with providing essential fish passage at the UPRR and CALTRANS Highway 101 culvert crossing (BR_CL_1), ExxonMobil should remedy all road crossings to “allow free upstream or downstream movement by resident or anadromous trout” as recommended in the April 1984 document described above. The following actions are recommended.

> 1) Obtain access to the ExxonMobil property to conduct a detailed ground assessment of fish passage at all structures within the stream channel that may have impacted, or could potential impact, salmonid migration.
> 2) Minimize the number of road crossings. It appears that the BR_CL_3 and BR_CL_5 crossings connect the Las Flores Plant road system at a similar location and could be consolidated into just one crossing.
> 2) Eliminate the old crossing (BR_CL_4) if it is no longer serving any purpose.
> 3) Replace the existing box culverts that would significantly impede salmonid migration with bridges that span the entire stream channel, have natural streambed conditions underneath, and allow unimpeded migration for salmonids and other native species migrating along Corral Creek. This action is consistent with recommendations made in the April 1984 document.

Barrier ID: BR_CL_LF_1
Stream: Corral
Barrier Type: Stream Realignment/Culvert
Location: Approximately 150 feet upstream from the Corral Creek confluence.
Ownership/Interest: Exxon/Mobil

Description: The Las Flores Plant was constructed on top of Las Flores Creek upstream from its confluence with Corral Creek. This lower reach of Las Flores Creek is buried in a culvert for approximately 0.5 mile. The configuration of the existing conveyance system under the facilities could not be determined, but the outlet appears to be a circular culvert (pers. observ. Las Flores Biological Monitoring Photographs). The Las Flores Biological Monitoring Photograph of this culvert outlet shows a short, steep concrete apron extending from the culvert and dropping at least 6 feet over a steep section of boulders and onto the streambed downstream.

Diagnosis: The excessive jump required to enter the culvert, apparent lack of a jump pool, and the excessive length of the culvert would completely block any upstream passage to upper Las Flores Creek.

Recommended Action: Modifying the existing culvert for fish passage with baffles or other option is likely not feasible due to the significant cost, increased likelihood of debris blockage, reduced flow capacity, and likely limited effectiveness for steelhead passage. Any future abandonment plan, major facilities reconfiguration plan, or major re-permitting process at Las Flores Plant should include the unearthing and restoration of Las Flores Creek.

Refer to Map Table for:
Refugio, Tajiguas Creek Map
Map 7.7.11.1

Refer to Map Table for:
Refugio, Tajiguas Creek Map
Map 7.7.11.1

Refer to Table Folder for:
Refugio, Tajiguas Creek Barrier Table
Table 7.7.11.2

Refer to Table Folder for:
Refugio, Tajiguas Creek Barrier Table
Table 7.7.11.2

Barrier ID: BR_RE_1
Stream: Refugio
Barrier Type: Double Box Culvert
Location: State Park crossing at upstream end of lagoon
Ownership/Interest: California State Parks

Description: This concrete culvert passes underneath the UPRR Bridge and has a road on top that provides vehicle access to Refugio State Park. The double box culvert structure consists of two equal sized culverts measuring 8 feet 2 inches tall and 14 feet wide. A 1-foot thick concrete dividing wall, separates the culverts. The river-right culvert was clear of sediment while the river-left culvert had 6 inches of sediment deposited in the lower half. The culvert measured 240 feet in length with a rise of 2 feet 6 inches and an estimated slope of approximately 1%. Concrete wing-walls focus upstream flows from the CALTRANS riprap channelization (BR_RE_2) into the culvert. No jump height existed on the downstream side of the culvert and the river-left culvert had water backed up 70 feet inside with a depth of 6 inches at downstream end. According to CALTRANS as-built plans, this culvert was constructed in 1974.

Condition/Sizing: The culverts are in good condition with minimal damage inside. Woody debris and sediments had collected on the upstream side of the central concrete support at the inlet.

Diagnosis: Steelhead have easy access into the culverts during most flow conditions due to the absence of any jump and mild slope. The long length of the culvert and smooth concrete bottom make upstream migration during low flows difficult or impassable due to the spread out and shallow water depth. During moderate flows, when adequate water depth exists and velocities are tolerable, passage through the culverts would be moderately difficult. During high stream flows, the combination of excessive water velocities confined through the culvert and lack of resting areas would present a high degree of difficulty for upstream migration. The structure is passable, but limits upstream migration to periods with adequate flow.

Recommended Action: In addition to limiting upstream migration, this structure has buried a significant amount of lower Refugio Creek in a biologically important area for salmonids, where fresh water flows into what remains of the confined lagoon downstream. This is an important mixing zone for the native species living in the lagoon as well as for adult and juvenile steelhead acclimating between saline and fresh water. With any future projects at this site, CALTRANS should consider removing this structure or modifying it so that a natural streambed exists under the crossing for unimpeded upstream passage and a restored streambed. Options to evaluate should include:

1) Replacing the entire structure with a large bottomless arch culvert.
2) Removing the concrete bottom and reinforcing the existing structure and walls.

Barrier ID: BR_RE_2
Stream: Refugio
Barrier Type: Riprap Channelization
Location: Under Highway 101 Bridges
Ownership/Interest: CALTRANS

Description: This concrete and boulder riprap channel extends from the inlet of the double box culvert downstream (BR_RE_1) approximately 0.16 miles upstream. Under the Highway 101 Bridges, the trapezoidal channel measured 20 feet wide at the bottom, 54 feet wide at the top, and 13 feet 9 inches tall from the channel bottom to the top of the channel walls. Near the downstream end of the channel, the slope was measured at 1.9%. The concrete channel was apparently constructed to protect the Highway 101 Bridge supports and to focus flows into the downstream culvert. Large riparian vegetation was apparently removed from the adjacent stream banks with the construction of this channel, or at some point in the past. Vegetation, especially willow, is growing in the channel.

Condition/Sizing: Several significant holes in the concrete channel have produced pools up to 2 feet 7 inches deep. Areas where flows resurface through the concrete indicate that the channel is undercut and damaged in several locations.

Diagnosis: The embedded boulders, rough channel bottom, mild slope, and sufficient resting areas in the channel allow steelhead upstream passage with a low to moderate degree of difficulty during migration flows. This reach of stream and associated riparian vegetation has been significantly degraded and modified with the construction of this channel.

Recommended Action: Due to the presence of these bridges over Highway 101, Refugio Creek has great potential for steelhead recovery without the complexity associated with providing passage at an impassable Highway 101 culvert, such as those present on other Gaviota Coast streams. While upstream passage is possible along this reach of Refugio Creek, aquatic and riparian habitat conditions and improved fish migration can be achieved.

When future work on this channel and or the box culvert downstream (BR_RE_1) is scheduled, CALTRANS should assess the feasibility of naturalizing the stream reach throughout this lower section of Refugio Creek to improve fish passage and overall stream health. This feasibility study and project might include:

1) Naturalizing the streambed throughout this reach.
2) Reinforcing the stream banks and bridge supports using a biotechnical approach.
3) Reestablishing native riparian vegetation along this stream reach.

Barrier ID: BR_RE_3
Stream: Refugio
Barrier Type: Stream Crossing
Location: 0.4 mile from mouth
Ownership/Interest: Freeman

Description: This concrete low-flow crossing measured 48 feet across the stream channel and 17 feet wide. The surface of the crossing had a downstream facing slope measured at 2.9%. The pool downstream measured 3 feet deep and backed up to within 11 inches of the surface of the crossing. The downstream end of the crossing slants 8 feet into the downstream pool.

Condition: The crossing appears to be in good condition with minimal concrete damage.

Diagnosis: Sufficient pool depth and a low jump height allow easy upstream migration onto the surface of the crossing for all salmonids and apparently even the many Arroyo chub present upstream. The wide, mild sloping surface of the crossing produces shallow water depth that would limit upstream migration of large steelhead during low flows.

Recommended Action: Continue to monitor the condition of this crossing and work with landowner to improve fish passage with any future modifications.

Barrier ID: BR_RE_4
Stream: Refugio
Barrier Type: Culvert Stream Crossing
Location: #2 Refugio Road crossing
Ownership/Interest: Santa Barbara County Public Works-Road Division

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Description: This concrete crossing has four slightly squashed corrugated metal culverts passing underneath it that measured approximately 3 feet tall, 4 feet 8 inches wide, and 40 feet long. The culverts are close to streambed level at their outlets, which are cut flush with the downstream slanting side of the crossing. The surface of the crossing is smooth concrete and measured 23 feet 3 inches wide with a minimal downstream slope.

Condition/Sizing: The structure is in poor condition with significant culvert damage on the downstream side caused by heavy equipment clearing sediment deposits away from the structure. The downstream river-left side of the crossing is undercut with significant bank erosion. The upstream side of the crossing and all four culverts were filled with sediment for most/all of the 2000-2001 migration season, with stream flows passing over the crossing top. This structure is not sized for a significant stream flow event and remains a safety hazard to vehicle access on Refugio Creek.

Diagnosis: This structure acts similar to a small debris dam during heavy rainfall years and effectively traps sediment behind the crossing and blocks all four culverts. As was observed in 2001, this crossing may remain filled with sediment for extended periods of time and remain impassable to all salmonids. With sediment cleared from the upstream side and culverts, steelhead can pass through the culverts with a moderate degree of difficulty during low and moderate flows. The severity this structure imposes on upstream migrating steelhead is highly dependant on the accumulation of substrate and debris upstream, the extent of culvert blockage, and the timing and effectiveness of clearing activities.

Recommended Action: This crossing imposes a significant safety hazard for Refugio Canyon residents and liability to SBCPWRD and should be replaced for these reasons alone. In addition, this structure severely limits or blocks steelhead migration during years of high stream flow with the blockage of the culverts. During the 2000-2001 migration season, subsequent clearing of the culverts occurred after ideal migration flows had subsided. Due to the relatively unconfined nature of the stream channel and low bank tops at this site, replacement of this structure with a bridge may not be practical or safe. A study is needed to determine an effective solution for both vehicular and steelhead passage that will accommodate high stream flows. Unimpeded steelhead passage at this site is essential for steelhead recovery in Refugio Creek due to the presence of almost all adequate spawning and rearing habitat upstream from this site. A large, bottomless arch culvert may provide an effective solution. Moderate road realignment on the north side of crossing away from the stream channel may be necessary to facilitate an effective solution.

Barrier ID: BR_RE_6
Stream: Refugio
Barrier Type: Culvert Stream Crossing
Location: #3 Refugio Road crossing
Ownership/Interest: Santa Barbara County Public Works-Road Division

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Description: This concrete crossing spans 83 feet across the stream channel and measured 24 feet wide. The structure has four 3-foot diameter corrugated metal culverts passing underneath road. A concrete apron that transitions from an extremely steep slope to a mild slope extends 42 feet downstream of the culvert outlets. The overall height of the crossing from the downstream pool surface to the downstream lip of the crossings surface measured 12 feet 6 inches.

Condition/Sizing: The culverts appear to direct flows toward the river-right stream bank and have cause significant erosion, despite the presence of a small concrete wall intended to keep flows from eroding the bank. The concrete apron is extremely undercut and damaged. Significant bank erosion has also occurred on the river-left side downstream of the crossing. During high stream flows, this crossing is effective at trapping sediment, clogging the culverts, and forcing stream flows over the top of the road surface.

Diagnosis: The combined height, length, and steepness of the concrete apron produces excessive stream velocities and slope that prevent upstream migration during all flow conditions. Unimpeded steelhead passage at this site is essential for steelhead recovery in Refugio Creek due to the limited amount of adequate spawning and rearing habitat downstream from this site and the presence of perennial rearing habitat and high quality spawning substrate found upstream. Several Refugio Canyon residents observed two adult steelhead, approximately 24 inches in length, in the pool downstream of this crossing in 1969 (pers. comm. Alegria, Hancock, Brown).

Recommended Action: Apparently, at least one person has been swept off the crossing in their car and killed trying to cross this structure during high stream flows (pers. comm. Hancock). This crossing remains a significant safety hazard for Refugio Canyon residents and liability to SBCPWRD and should be replaced due to these reasons alone. The stream channel is narrow enough and stream banks high enough at this site to facilitate a bridge across the creek. Complete removal of this structure and replacement with a bridge and natural streambed that does not present a hazard to vehicle access or impede upstream steelhead migration is recommended.

Barrier ID: BR_RE_7
Stream: Refugio
Barrier Type: Box Culvert Stream Crossing
Location: Private crossing approximately 0.5 mile upstream from #3 Refugio Road Crossing
Ownership/Interest: Alegria

Description: This 12-foot wide private crossing extends 52 feet across the stream channel from bank top to bank top. The overall height of the crossing, from the downstream pool surface to the top of the crossing measured 9 feet 6 inches. A concrete box culvert passes low flows through the crossing. The box culvert outlet occurs 5 feet 8 inches above the downstream pool surface. This 17-foot long box culvert measured 2 feet 7 inches tall and 2 feet 8 inches wide at the outlet. The slope of the box culvert measured 4.9%. A steep concrete and boulder apron drops 2 feet into a small 10-inch deep pool. The apron then drops steeply 3 feet 9 inches into the downstream pool. Sediment is backed up to the culvert on the upstream side and likely clogs the culvert during high stream flows.

Condition/Sizing: Massive undercutting has occurred on the downstream side of the crossing and the overall structural condition is poor with significant concrete cracking and damage. The roof of the box culvert is also very damaged.

Diagnosis: During low flows no upstream steelhead passage would be possible due to the excessive jump height and limited pool depth. This crossing would likely block upstream steelhead passage during migration flows, but may allow an extremely difficult passage situation during ideal flows, should they occur. The possibility of upstream passage is highly dependant on how much the downstream pool backfills during high flows and whether or not the culvert is clogged.

Recommended Action: Work with landowner to assess the feasibility of removing this crossing and replacing it with a bridge and natural streambed. The stream banks are narrow enough and may be high enough in this area to facilitate a bridge across the creek that can also pass peak stream flows. The bridge may need to be slightly elevated at this site to provide adequate sizing for the 100-year flow and stream banks would need to be reinforced for bank protection.

Barrier ID: BR_RE_8,9,10,11
Stream: Refugio
Barrier Type: Culvert Stream Crossings
Location: #4, #5, #6, #7 Refugio Road crossings
Ownership/Interest: Santa Barbara County Public Works-Road Division

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Description: These concrete and corrugated metal culvert crossings are constructed in a similar manner. The crossings are identified as the #4 to # 7 Refugio Road crossings over Refugio Creek heading upstream from Highway 101. The #6 Refugio Road crossing (BR_RE_10) occurs just down the road from the Circle Bar B Ranch parking area. The crossings are described below with their respective barrier ID number (#8= BR_RE_8).

#8-The concrete section of this 21-foot wide road crossing measured 34 feet across the stream between the connecting asphalt road and the entire road measured 54 feet across the stream channel. The crossing consists of 3 corrugated metal culverts with 3-foot diameters. The overall height of the crossing from the downstream pool surface to the road surface on the downstream side measured 3 feet 10 inches. The jump height from the downstream pool surface to the bottom of the culverts measured 3 feet 10 inches. The jump depth in the downstream pool measured 3 feet 2 inches. A 10-foot long concrete chute on the river-left side of the crossing drops toward the downstream pool with a 19% slope that ends to 2 feet above the downstream pool. Deposited sediment was still backed up to the top of the upstream side of this crossing during survey work conducted on 6-1-2001 and for the 2000-2001 winter season. All three culverts were completely obstructed with substrate and flows were conveyed over the road surface.

#9- The concrete section of this crossing measured 18 feet 6 inches wide and 65 feet across the stream between the connecting asphalt road. The crossing consists of 3 corrugated metal culverts with 3-foot diameters. The overall height of the crossing from the downstream pool surface to the road surface on the downstream side measured 4 feet 1 inch. The outlets of two culverts were at streambed level and the river-left culvert measured 6 inches above the substrate. The downstream pool backed up into the river-right culverts. Deposited sediment was backed up to the top of this crossing during survey work conducted on 6-1-2001 and for the 2000-2001 winter season. All three culverts were completely obstructed with substrate on the upstream side and most stream flow was conveyed over the road surface, which had a slope measured at 4.5%.

#10- This concrete section of this crossing measured 29 feet wide and 27 feet across the stream between the connecting asphalt road. The crossing consists of 3 corrugated metal culverts with 3-foot diameters. The overall height of the crossing from the downstream pool surface to the road surface on the downstream side measured 5 feet. The jump height from the downstream pool surface to the culvert outlets measured 16 inches. Deposited sediment was backed up to the top of this crossing during the 2000-2001 migration flow season and was cleared by 9-10-2001. The middle culvert measured 39 feet 6 inches long with a slope of 6.5%.

#11- This concrete section of this crossing measured 22 feet 6 inches wide and 29 feet across the stream between the connecting asphalt road. The crossing consists of 2 corrugated metal culverts with 4-foot diameters. The overall height of the crossing from the downstream pool surface to the road surface on the downstream side measured 7 feet. The jump height from the downstream pool surface to the culvert outlets measured 3 feet 4 inches. The culvert measured 29 feet 6 inches long with a slope of 2.5%. At the outlet of the culverts, stream flows dropped onto a slightly downstream sloping concrete apron 18-21 inches in length. Concrete and boulder riprap occur on the downstream banks. The culvert inlets were 50-75% blocked with substrate and large woody debris.

Condition/Sizing: All the crossings are undersized to convey higher stream flows under the road crossing and highly susceptible to substrate and woody debris blockage as observed during the

2000-2001 winter. Downstream scour has significantly undermined these crossings and adjacent stream banks to varying degrees. The concrete and metal culverts are in fair shape with moderate concrete wear, minimal to moderate rusting in the culverts, and some culvert damage on the exposed upstream and downstream sides where clearing activities have occurred.

Diagnosis: During higher migration flows these structures function similarly to small debris dams and effectively trap sediment that blocks the small diameter culverts. As was observed in 2001, these crossing may remain filled with sediment for extended periods of time and remain impassable to all salmonids. Even with sediment cleared from behind the culverts, upstream steelhead passage would still be impossible or extremely difficult with the lower flow conditions encountered after such a clearing operation would likely occur following the upstream steelhead migration season when stream flows have subsided. Upstream migration over the top of the crossings during migration flows would be extremely difficult or impossible due to the substantial jump heights required to land on the crossing and accelerated velocities across the smooth concrete road surface. The migratory severity of these crossings is highly dependant on the accumulation of upstream sediment, configuration of the downstream substrate, pool formation, and inlet conditions, all of which are highly susceptible to seasonal change. With the culverts clear of substrate and adequate jump depth downstream for steelhead to access the culverts, steelhead would encounter high water velocities in the moderately sloping culverts and likely sloping substrate conditions immediately upstream of the culvert inlets. Following substrate clearing there are often excessively steep substrate conditions at the inlet where flows are accelerated and confined down the steep substrate, which forms a funnel-shaped drain into the culvert (pers. observation 2000-2001 Stoecker).

Recommended Action: Refugio Canyon residents acknowledged that these crossings often conveying stream flows over the top of the road surface and limit vehicle access during higher stream flows. The crossings impose a significant safety hazard for Refugio Canyon residents and a liability to SBCPWRD and should be replaced for those reasons alone. Complete removal of these structures and replacement with bridges or large bottomless arch culverts that do not present a hazard to vehicle access or impede upstream steelhead migration is recommended. It is likely that the most cost effective way to address the Santa Barbara County road crossings on Refugio Creek will be to determine structural requirements at each site and develop a road crossing improvement plan for all crossings in the canyon. Implementation of projects may need to be staggered in order to allow residential vehicle access. A temporary loaner bridge could be obtained to allow vehicle passage at these sites while a permanent bridge is installed. Continual maintenance, modification, and/or clearing of the crossings is discouraged due the ineffectiveness of fish passage, on-going safety hazard, and significant water degradation that occurs downstream of clearing efforts that dislodge massive amounts of substrate and dramatically increase the suspended sediment load in the stream. This elevated suspended sediment load during the lower stream flows encountered with clearing efforts may suffocate salmonids and other native aquatic species downstream. Additional studies are needed assess the impacts of removing these crossings, bank stabilization alternatives, and structural requirements for bridge installation.

#8- The road is very confined on the west side of this crossing between a steep canyon wall and a sharp turn in the creek and presents a challenging situation for installing a bridge. It is likely that the canyon wall would need to be cut into further, road slightly elevated, and stream bank strongly reinforced on this river-right side to facilitate a bridge at least 50 feet long.
#9- Due to the relatively wide stream channel at this site, a bridge approximately 80 feet long would likely stay out of the stream channel and 100-year flow event.
#10/#11- Both of these sites have relatively narrow stream channel widths, ideal for the installation of bridges with lengths of approximately 50 feet.

Barrier ID: BR_RE_13, WF_2, WF_WNF_1, EF_1
Streams: Refugio, West Fork, West North Fork, East Fork
Barrier Type: Bedrock Chute, Boulder Cascade, Waterfall, Bedrock Waterfall
Location: RE_13= Approximately 0.41 mile upstream from the West Fork. WF_2 and WNF_1= Approximate elevations 880 feet. EF_1= Approximate elevation 830 feet.
Ownership/Interest: RE_13=Circle Bar B (Brown), WF_2 and WNF_1= Saralegui, EF_1= Los Padres National Forest

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Description and Diagnosis: These four natural features signify the presumed natural upstream limitations to salmonid migration in the Refugio Creek watershed and are described below. Access to ground survey these features was not obtained and limited information and the accompanying photographs are from Kuyper 1998.

RE_13- Photo-observation of this bedrock chute indicates that this steep section has accelerated stream velocities and turbulent flows with minimal resting areas. Kuyper reported that this structure "halts steelhead migration".

WF_2- Photo-observation of this long boulder cascade indicates that excessive and sustained stream gradient would prevent upstream steelhead passage, as reported by Kuyper.

WNF_1- Photo-observation of this waterfall indicates that the excessive jump height and limited downstream pool formation would prevent further upstream steelhead migration, as reported by Kuyper.

EF_1- Kuyper reported that this impassable bedrock waterfall has a height “in excess of 50 feet”.

Recommended Action: No recommended actions for these natural features.

Barrier ID: BR_RE_WF_1
Stream: West Fork Refugio
Barrier Type: Culvert Stream Crossing
Location: Approximately 250 feet upstream from Refugio Creek.
Ownership/Interest: Saralegui

Description: Access to ground survey this crossing was not obtained. The following measurements and accompanying photograph are from Kuyper 1998. Additional photo-analysis and recommendations are provided below. This concrete road crossing conveys all stream flow over the road surface, as no culvert is present. Kuyper reports a crossing height of 4 feet above the downstream pool surface. Flows drop from the crossing onto some exposed substrate and into a pool with an unknown depth.

Diagnosis: Kuyper noted that the "height of this structure, the lack of adequate streamflow along its length, and insufficient water depth downstream from the structure qualify this road crossing as a "definite" steelhead migration barrier". Photo-observations indicates that during ideal migration flow extremely difficult upstream passage may be obtained with adequate downstream pool formation, but most flows would prevent upstream migration due to factors mentioned by Kuyper.

Recommended Action: Contact the landowner to discuss the feasibility of providing adequate steelhead passage conditions at this site when access to this portion of the watershed is provided with downstream barrier passage. Assess the possibility of replacing this structure with a bridge or large embedded culvert.

Barrier ID: BR_TS_1
Stream: Tajiguas
Barrier Type: Culvert
Location: UPRR and Highway 101 Culvert
Ownership/Interest: UPRR and CALTRANS

Description: Access to survey Tajiguas Creek was not obtained. Surveys were conducted from the beach and Highway 101 to obtain general information about this culvert. The culvert appears to exceed 400 feet in length. The measurements and configuration of the culvert were not determined, but are assumed to be similar to other CALTRANS Highway 101 and UPRR culverts.

Diagnosis: Assuming this culvert is similar to other long concrete CALTRANS culverts built over Highway 101, upstream steelhead migration is impossible due to the excessive culvert length, lack of resting areas within the culvert, shallow water conditions during low flows, and accelerated velocities encountered during high flows. A rainbow trout/steelhead was observed in the pool below this culvert in 2001 and historic documentation of adult steelhead exists for this watershed. See the Salmonid Documentation Table in section 6.0 for more information.

Recommended Action: See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_TS_2
Stream: Tajiguas
Barrier Type: Old Dam
Location: 0.67 mile upstream from Highway 101 Culvert
Ownership/Interest: MAZ Properties Inc.

Description: Observations of this dam were limited to the air because of access restrictions. The dam appears to extend from a large concrete abutment on the east side of the creek across the stream channel and into a steep wall with exposed bedrock. Surface flow was observed passing under the dam, which was empty of sediment and water. The total height of the dam was estimated at 15 feet.

Condition: The dam does not appear to be in operation and may have significant damage underneath.

Diagnosis: Limited observations from the air prevented accurate assessment of this dam and the severity of this structure could not be determined. A significant drop was observed from the base of the dam to the downstream pool and migration under the dam would likely be extremely difficult or impossible with confined flows passing under the dam.

Recommended Action: Work with owner to assess fish passage, the condition of the dam, desirability, and feasibility of removing the structure if it is not functioning any purpose. Depending on the condition of the dam, this structure may present a significant hazard to the UPRR/Highway 101 culvert and public safety if portions of it were to wash downstream during high stream flows and block the culvert inlet.

Barrier ID: BR_TS_3,4,5,6,7,8,9,10,12,13 and BR_TS_WF_WNF_1
Stream: Tajiguas
Barrier Type: Stream Crossings
Location: See Barrier Table
Ownership/Interest: MAZ Properties Inc.

Description: At least eleven stream crossings (or similar looking structures) were observed from the air and others may be present that were concealed from view due to the thick riparian canopy in the upper watershed. Only limited information could be obtained from the air due to access restrictions. The crossings are described below:

BR_TS_3

#3- This crossing occurs near several residences and a large barn. Only the dirt-fill road crossing was observed, but it is likely that a culvert passes stream flows underneath.

BR_TS_4

BR_TS_5

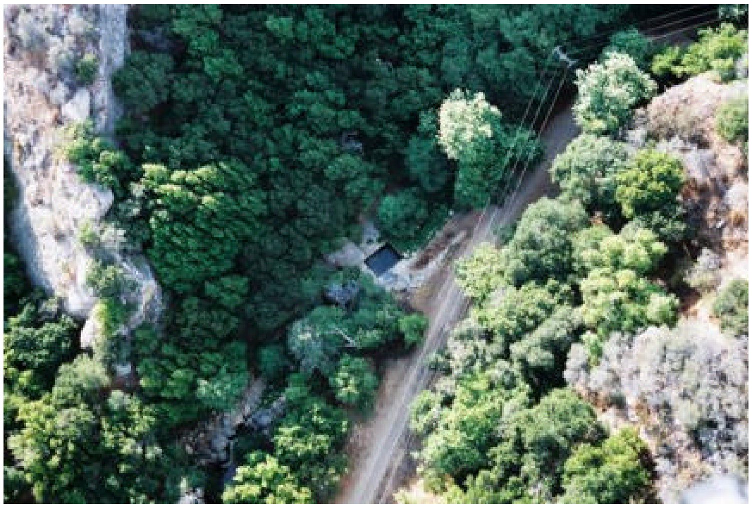
BR_TS_6

#4,5,6- These crossings were the only structures that could be observed well enough to determine the general construction and estimate their severity to potential salmonid migration. These three crossings are all fairly similar in construction and impact on salmonid migration. All three concrete crossings appear to be trapping large amounts of sediment upstream. Steep concrete aprons slope toward the downstream side. The crossings appear to range from 8-15 feet in height above the downstream substrate. Crossing #6 has a small culvert just under the road surface, but all crossings appear to convey moderate and high stream flows over the crossing surface and down the apron. Crossings #4 and #5 appeared to be in poor condition with significant scour occurring on the downstream side and adjacent banks. Crossing #6 appeared to be in fair condition with moderate undercutting on the downstream side.
#7,8,9,10,12,13,WNF_1- The configurations and condition of these structures could not be determined from the air due to the thick riparian canopy, but their presence and approximate location was observed.

Diagnosis: Only the severity of crossings #4,5, and 6 could be roughly estimated based on aerial observations. All other crossings would likely represent significant impediments or complete barriers to upstream salmonid migration due to their presence across the stream channel.
#4,5,6- The height of each crossing and steep concrete apron will likely produce excessive jump heights and stream velocities during migration flows that would present extremely difficult or impossible upstream passage conditions for adult steelhead.

Recommended Action: An on-the-ground fish passage assessment of these crossings should be conducted and other possible in-stream structures identified. Work with the landowner to develop a plan that removes or modifies barriers to fish migration, minimizes the number of stream crossings, and consolidates the crossing points along the stream to bridges, bottomless arch culverts, embedded culverts, and/or natural streambed crossings that will not impede upstream salmonid migration.

Barrier ID: BR_TS_11
Stream: Tajiguas
Barrier Type: Dam
Location: Approximate elevation 350 feet
Ownership/Interest: MAZ Properties Inc.



Description: Observations of this dam were limited to the air because of access restrictions. The dam occurs in a confined section of Tajiguas Creek just upstream from exposed bedrock on the west side of the creek and adjacent to a dirt road. Surface flows appear to spill into a large square-shaped holding area consisting of concrete and boulders. Water could not be seen flowing out of this structure, but a significant vertical drop occurs on the downstream side of the dam, the height of which could not be determined due to the riparian canopy.

Condition: The condition of this structure could not be determined.

Diagnosis: Due to the significant drop on the downstream side of the structure it is likely that upstream migration would not be possible. Depending on the downstream pool depth and vertical height of the structure, upstream passage may be possible although highly unlikely.

Recommended Action: Work with the landowner to further assess fish passage, the condition of the dam, desirability, and feasibility of removing the structure if it is not functioning any purpose. If water diversions are still occurring at this site, assess the feasibility of modifying this structure or designing a different structure that allows water extraction along with salmonid passage.

Refer to Map Folder for:
Arroyo Quemado, Arroyo Hondo, Molino, San Onofre Creek Map
Map 7.7.12.1

Refer to Map Folder for:
Arroyo Quemado, Arroyo Hondo, Molino, San Onofre Creek Map
Map 7.7.12.1

Refer to Table Folder for:
Arroyo Quemado, Arroyo Hondo, Molino, San Onofre Creek Barrier Table
Table 7.7.12.2

Refer to Table Folder for:
Arroyo Quemado, Arroyo Hondo, Molino, San Onofre Creek Barrier Table
Table 7.7.12.2

Barrier ID: BR_AQ_1
Stream: Arroyo Quemado
Barrier Type: Stream Crossing
Location: Immediately downstream of the UPRR/Highway 101 Culvert
Ownership/Interest:

Description: This private road crossing was not ground surveyed due to access restrictions. Photo observation of the crossing, provided by Carl Page, shows that the in-stream crossing appears to be constructed of concrete and is at streambed level with surface flow observed crossing over the top.

Diagnosis: The relatively flat slope and streambed level of this short crossing present a minimal to low degree of difficulty to upstream salmonid migration.

Recommended Action: No action is recommended at this crossing, but continued monitoring should occur to prevent future adverse fish passage situations. Modifications to the structure or downstream scour could alter the configuration of the crossing and change the severity to salmonid migration.

Barrier ID: BR_AQ_2
Stream: Arroyo Quemado
Barrier Type: Culvert
Location: UPRR/Highway 101 Culvert
Ownership/Interest: UPRR and CALTRANS

Description: This long, two-part culvert consists of a short UPRR culvert at the outlet end and long CALTRANS culvert that conveys stream flows underneath the northbound dirt-fill highway crossing and under the southbound bridge. The culvert measures approximately 450 to 500 feet in length, depending on the exact length of the UPRR section, which was not accessed. The UPRR section appears to be less than 75 feet long and is relatively flat with a worn stone bottom and several shallow pools. The CALTRANS section connects to the UPRR culvert and proceeds upstream with a shallow U-shaped bottom, moderately steep slope, and arch top measuring 13 feet 6 inches tall and 13 feet at the widest point.

Condition: Several holes through the concrete bottom of the CALTRANS section exist and the worn bottom is in poor condition overall. High-water marks were observed 7 feet up on the culvert wall indicate that storm flows have exceeded 60% of the culverts capacity.

Diagnosis: Due to the streambed level of the flat UPRR section, steelhead can easily enter into the culvert during migration flows. Steelhead can also migrate onto the downstream end of the CALTRANS culvert, but the approximately 400 feet of moderately steep culvert upstream from this point has shallow water during low flows and excessive velocities during moderate and high flows that would prevent steelhead from being able to migrate upstream of the culvert.

Recommended Action: Apparently CALTRANS is currently planning a significant highway improvement project at their Arroyo Quemado Highway 101 crossing (pers. comm. Cesena). Proposed planning should include providing steelhead access upstream of Highway 101 to formally occupied steelhead habitat. See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_AQ_3
Stream: Arroyo Quemado
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 100 feet
Ownership/Interest: Santa Barbara County

BR_AQ_3_DS

BR_AQ_3_US

Description: This irregular culvert crossing consists of three corrugated plastic culverts, rock and boulder fill, concrete slabs, and metal pipes. The culverts each have different diameters measuring (from river-right to river-left) 2 feet 6 inches, 2 feet, and 3 feet. The culverts are approximately 23 feet in length and each is at, or near, streambed level.

Condition: The culverts are in extremely poor condition with several being smashed at the upstream end with holes completely through. The crossing is poorly constructed and at a high risk of failure. The metal bars used in the construction of this crossing present a significant risk to blocking the Highway 101 culvert downstream if/when this crossing fails during future high stream flows.

Diagnosis: During migration flows, salmonids could easily swim into the downstream end of these culverts, but the damaged condition at the upstream ends would present a highly degree of difficulty to swim or jump past. It is likely that during migration flows these culverts clog with debris and are impassable.

Recommended Action: The crossing should be replaced in the near future for safety considerations and this replacement should facilitate potential future steelhead passage. The 43-foot length across the channel at this spot is adequate to install a relatively cheap railroad car bridge that does not impact the streambed or impede upstream fish migration.

Barrier ID: BR_AQ_4
Stream: Arroyo Quemado
Barrier Type: In-stream Crossing
Location: Approximate elevation 145 feet
Ownership/Interest: Santa Barbara County

Description: This crossing is composed of natural streambed gravels and cobbles. The crossing is at streambed level with moderate disturbance of substrate due to vehicles crossing the stream.

Diagnosis: This crossing likely flushes out during moderate to high stream flows and would present a low degree of difficulty to upstream fish passage.

Recommended Action: No recommended action to improve potential fish passage. Continued monitoring of the site should occur to prevent future adverse fish passage situations.

Barrier ID: BR_AQ_6
Stream: Arroyo Quemado
Barrier Type: Boulder Cascade
Location: Approximate elevation 320 feet
Ownership/Interest: Santa Barbara County

Description: This steep boulder cascade extended for several hundred feet with a measured sloped of 10.9%. Small pools and resting areas would be present throughout this reach with sufficient stream flow.

Diagnosis: The steepness of this reach would likely produce highly difficult passage conditions for upstream migrating steelhead during moderate and high stream flows and may be impassable depending on the boulder and pool configuration during each season.

Recommended Action: No recommended action for this natural feature.

Barrier ID: BR_AQ_7
Stream: Arroyo Quemado
Barrier Type: Stream Crossing
Location: Approximate elevation 480 feet
Ownership/Interest: Santa Barbara County

Description: Dark light conditions limited observations of this dirt-fill crossing. Two culverts passed under the crossing at or near streambed level.

Condition: The structure appeared to be in fair condition. Dirt-fill crossings are highly susceptible to blowing out during high stream flows.

Diagnosis: It appeared that the crossing would present a moderate to high degree of difficulty to upstream steelhead passage.

Recommended Action: Reassess this crossing during the daytime to better determine possible severity for potential upstream fish passage.

Barrier ID: BR_AH_1
Stream: Arroyo Hondo
Barrier Type: Culvert
Location: Highway 101 Culvert
Ownership/Interest: CALTRANS

Description: This concrete arch culvert measured 15 feet 5 inches tall at center and 16 feet wide at the bottom of the walls. The shallow U-shaped bottom extended 334 feet under Highway 101 with a slope of approximately 1%. Downstream of the culvert, a concrete channel measuring 15 feet 9 inches wide and 167 feet long extends to the confined lagoon, which had a maximum depth of 4 feet 5 inches. The lagoon pool backwatered the concrete channel 18 inches near the downstream end and extends upstream 98 feet upstream into the concrete channel. The concrete channel was built to convey culvert flows past the UPRR railroad trestle supports that are adjacent to the channel.

Condition: The concrete appears to be in fair condition with moderate wear.

Diagnosis: While adult steelhead are consistently observed in the small lagoon pool downstream of the culvert, only one adult steelhead has been documented upstream of the culvert since the Highway was built (pers. comm. Hollister). See the Salmonid Documentation Table in section 6.0 for more information about salmonid sightings and two pictures of adult steelhead observed both downstream and upstream of the culvert. It appears that upstream steelhead passage is possible during moderate to high flow conditions when there is adequate water depth inside the mild sloping culvert and moderate water velocities are encountered. However, the window of opportunity for steelhead to pass upstream is very short and may not occur often, or at all, during a migration season with low stream flows. Excellent salmonid habitat conditions exist in Arroyo Hondo Creek upstream of the highway. This is the only anthropogenic barrier in on the creek and improving access at this culvert ensures access to all accessible habitat in the watershed.

Recommended Action: Shell oil reportedly has some money set aside for a fish passage project at this culvert (pers. comm. Lohmus). A short-term baffle project is being discussed for improving upstream passage at this culvert. Baffles will not ensure effective upstream passage and do not address the loss of most of the Arroyo Hondo lagoon. See section 7.8 for additional discussion and long-term recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_SO_2
Stream: San Onofre
Barrier Type: Culvert
Location: UPRR and Highway 101 Culvert
Ownership/Interest: UPRR and CALTRANS

Description: The outlet of the UPRR arch culvert measured 11 feet 6 inches tall by 9 feet 10 inches wide. A stone bottom apron extended downstream 23 feet from the culvert outlet and flows dropped 3 feet 7 inches to the surface of the downstream pool, which measured 3 feet 11 inches. The UPRR culvert extends upstream approximately 100 feet with a mild slope. The CALTRANS box culvert extends over 300 feet upstream from the UPRR culvert with a moderate to steep slope and flat smooth concrete bottom.

Diagnosis: Adequate jump depth in the pool would allow a moderate to highly difficult jump onto the UPRR apron and swim into the culvert during moderate stream flows. Once inside the UPRR culvert upstream steelhead migration is impossible due to the excessive culvert length, lack of resting areas within the culvert, shallow water conditions during low flows, and accelerated velocities encountered in the CALTRANS culvert during high flows. Historic documentation of rainbow trout presence in San Onofre Creek exists. See the Salmonid Documentation Table in section 6.0 for more information. High quality salmonid habitat is present in the upper reaches of Corral Creek.

Recommended Action: See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Refer to Map Folder for:
Gaviota Creek Map
Map 7.7.13.1

Refer to Map Folder for:
Gaviota Creek Map
Map 7.7.13.1

Refer to Table Folder for:
Gaviota Creek Barrier Table
Table 7.7.13.2

Refer to Table Folder for:
Gaviota Creek Barrier Table
Table 7.7.13.2

Barrier ID: BR_GA_1
Stream: Gaviota
Barrier Type: Undersized Bridge
Location: Gaviota State Beach Road Crossing
Ownership/Interest: Santa Barbara County Public Works-Roads Division

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Description: The slightly elevated Gaviota State Beach Road, which crosses the lower Gaviota Creek flood plain from Highway 101 to the bridge, acts similar to a long, low-lying dam that focuses stream flows towards this undersized bridge. The steel beam and concrete covered bridge measured 80 feet long and 36 feet wide. The bridge is located on lower Gaviota Creek just upstream from the lagoon and approximately 0.35 mile upstream from the ocean. Moderate to high stream flows exceed the minimal flow capacity of the undersized bridge, which is highly susceptible to debris blockage, and pass over the road.

Condition: This bridge is extremely undersized and highly susceptible to debris and sediment blockage during elevated stream flow events. After only 4 years of use, the bridge is already experiencing significant wear and metal damage from bedload sediment and debris during high flows, and from heavy equipment trying to unclog the bridge and allow flows to pass underneath.

Diagnosis: In January 2001, sediment and woody debris was backed up to the top of the upstream side of the bridge, or higher, with only a small opening for stream flow to pass underneath. Flows immediately dropped 1-foot 6 inches vertically under the bridge onto tangled woody debris and sediment. Upstream migration for steelhead was completely blocked during this time due to the tangle of woody debris under the bridge and confined drop with no clearance for steelhead to jump. Subsequent observations of the bridge in 2001 and 2002 have revealed that upstream passage is possible when the structure has been cleared, but during the seasonal timing of upstream steelhead migration and elevated stream flows, steelhead passage at this bridge is not guaranteed and is highly dependant on the extent to which the bridge traps debris and sediment.

Recommended Action: Eliminating this bridge and rerouting the current Gaviota State Beach Road access is recommended for the following reasons:

1) This structure significantly impedes or completely blocks steelhead access to over 99% of the spawning and rearing habitat found in Gaviota Creek, depending on the blockage extent during migration season. There are many impediments upstream of this bridge that are extremely flow sensitive in terms of their barrier severity to steelhead. It is essential that steelhead are not held up at this bridge for parts of the migration season as this limits their window of opportunity to migrate past these upstream structures.
2) This crossing remains a significant safety hazard during high flows for Hollister Ranch residents, State Park users, and others using this road access. As reported in the March 8, 2001 Santa Barbara News Press, the inundation of this crossing and debris accumulation blocked vehicular passage for three days and limited medical help to a 911 emergency on Hollister Ranch.
3) The bridge and road are focusing stream flows toward the Gaviota State Park parking lot and causing major erosion and stream bank failure.

Recommended Study:

The current road crossing location is not an ideal site for a bridge due to the unconfined stream channel of lower Gaviota Creek and the shifting nature of the stream across this area. Future inundation of this bridge and road are inevitable if left in the current configuration. It is recommended that Santa Barbara County Public Works-Road Division assess alternatives for rerouting this road, bridge, and access. This assessment should consider decommissioning and removing Gaviota State Beach Road from near Highway 101 to the west side of the existing bridge and rerouting the road out of the streambed and flood plain to minimize safety concerns, provide year-round vehicular access, limit the need for emergency maintenance, prevent the road crossing from focusing flows that are undermining the State Park parking lot, provide the most effective and consistent steelhead passage, and eliminate the negative biological impacts of the road on the lower reach of Gaviota Creek.

This action could be accomplished with an alternative road crossing upstream where elevated channel banks and a more confined section of stream facilitate the use of a bridge that passes a 100-year flow event. One option to consider includes crossing the creek approximately 0.5 mile upstream from the current site, near the recently completed pipeline crossing, where the elevated creek banks and narrow channel would be ideal for a bridge crossing. A road currently exists on the west side of the creek from this location all the way to the Gaviota State Park kiosk and Hollister Ranch Road. This existing road could be improved and widened to allow access that does not impact the stream channel. Highway 101 access to this new crossing could be obtained through the existing southbound rest stop turn-off ramps. Other possible crossing locations should be evaluated. Coordination with CALTRANS will be necessary to coordinate access to and from Highway 101.

Another component of this study should include reducing the size of the Gaviota State Park parking lot and limiting the impact on the adjacent creek and lagoon. The parking lot was built on top of what was once a unique, and now rare, wetland habitat around the lower creek and lagoon. As the agency responsible for properly managing our public lands, California State Parks should develop a plan to reduce the size of the concrete parking lot and prevent constriction of this biologically unique meeting place of fresh and saltwater, land and ocean.

Barrier ID: BR_GA_2,3,5,6,9,10,11,12,13
Stream: Gaviota
Barrier Type: Grade Control Structures
Location: Between 1.39 & 2.27 miles upstream from ocean
Ownership/Interest: CALTRANS

Description: A total of nine grade control structures with similar severities to upstream steelhead migration occur adjacent to Highway 101 along this stream reach. An additional grade control structure (BR_GA_4) received a higher severity to upstream migration and is described separately. These concrete structures span the width of the stream channel with varying configurations and associated downstream pool depths, summarized in the table below. These grade control structures were built to provide protection to the adjacent Highway 101 (pers. comm. Cesena). All of the structures are constructed of concrete and are keyed into adjacent stream banks and/or bank revetment protection. Several of the structures are also keyed into large streambed boulders and sections of exposed bedrock. Important measurements for assessing passage severity are described in the table below.

Gaviota Creek (CALTRANS) Grade Control Structure Description Table-

ID	Miles to Ocean	Height	Pool Depth	Channel Length	Surface Width	Condition	Comments
BR_GA_2	1.38	2' 9"	6' 4"	26'	9"4"	Fair	9-foot max. depth of downstream pool.
BR_GA_3	1.41	2' 8"	2' 8"	27'	5'	Poor	Considerable undercutting of the structure downstream. Unconcentrated flows.
BR_GA_5	1.6	3' 2"	2' 7"	17'	5'	Fair	Moderate wear and downstream undercutting.
BR_GA_6	1.62	2' 2"	1' 10"	27' 6"	5'	Extremely Poor	Opposite of the southbound end of Highway 101 tunnel. Undermined 3' 6".
BR_GA_9	1.9	3' 9"	1' 6"	58'	2'	Extremely Poor	At a 45 degree angle across stream. Extremely undercut on downstream side.
BR_GA_10	2.16	3' 7"	2' 4"	34'	5'	Extremely Poor	Keyed into large boulder at center. Worn on top and undercut on downstream side.
BR_GA_11	2.21	1' 9"	2' 1"	23' 6"	9'	Poor	Eroded chute concentrates flows at center. Significant downstream undercutting.
BR_GA_12	2.23	1' 6"	3'	14'	6'	Extremely Poor	Major concrete damage and downstream undercutting.
BR_GA_13	2.27	4' 4"	5'	18'	11'	Poor	Major concrete damage and downstream undercutting.

Measurements along this reach made during stream flow ranging from of 4-6 c.f.s on 2001-01-09

Jump Height- Vertical height of the grade control structure measured from the surface of the downstream pool to the top of the grade control structure.

Pool Depth- Maximum pool depth at "jump location" approximately 5 feet downstream from where flows are concentrated over the structure.

Surface Width- Length of the structures surface, from the upstream to downstream lip.

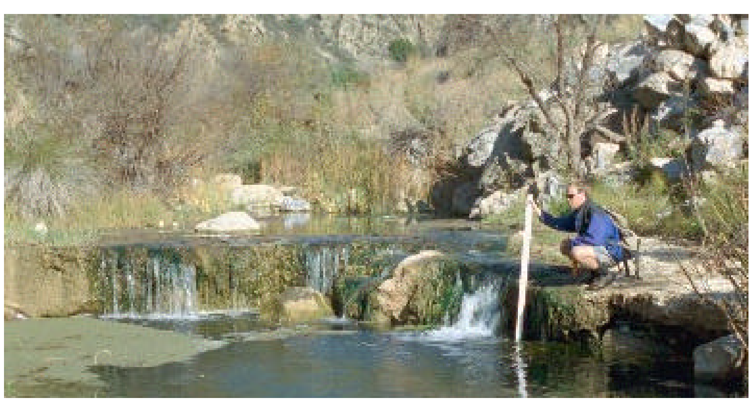
Condition: Most structures are in fair condition with moderate concrete wear, although a couple are significantly damaged and undercut (see table). Many of the structures have significant scour pools on the downstream side, undercutting of the concrete, and adjacent stream bank erosion. All of these structures have effectively trapped a moderate amount of substrate on the upstream side.

Diagnosis: During ideal migration flows, and with adequate downstream pool development, healthy adult steelhead can migrate upstream of these barriers with a high degree of difficulty overall. However, the cumulative impact of these structures on upstream steelhead migration is significant, especially during seasons with short durations of low stream flow. During these low-flow years, upstream steelhead passage may not be possible at some of these barriers due to inadequate jump depth, excessive jump height, and shallow water depth over the top of the structures. Even during ideal migration flows, steelhead must spend a considerable amount of time and effort to migrate past these structures. Negotiating all of these structures will slow upstream migration and possibly limit spawning success and out-migration. This is a critical factor to consider with the short, flashy flows encountered in southern California streams. Each grade control is also susceptible to seasonal changes in the configuration of the structure and adjacent substrate. Boulders that accumulate on the downstream side of a structure may restrict upstream passage by reducing the jump depth downstream or blocking the ideal jump location. Additional diagnosis of individual barriers is provided with recommendations below.

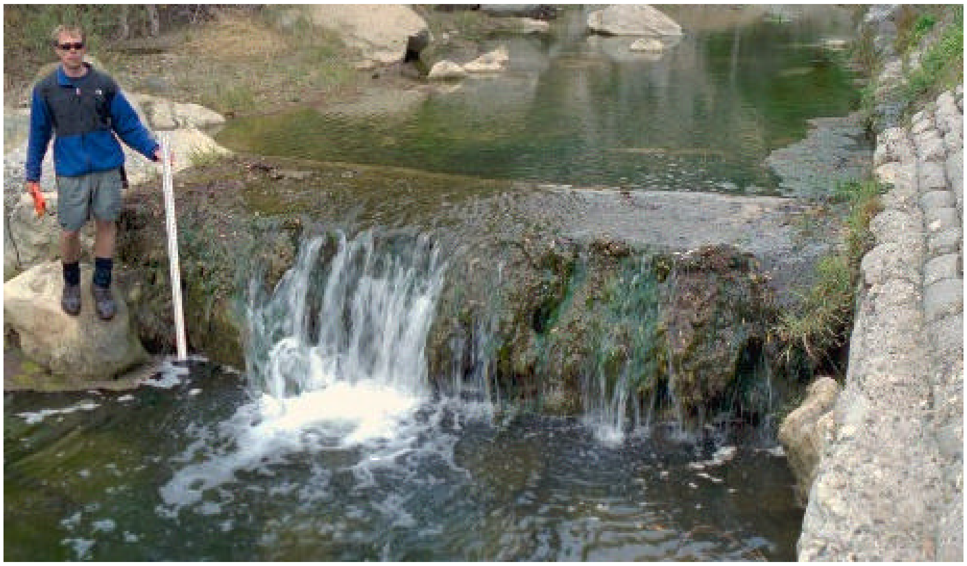
Recommended Action: Improved steelhead passage at all of the CALTRANS barriers identified in this report that are impacting migration on Gaviota Creek should be a part of a larger Gaviota Watershed Restoration and Management Plan formulated by CALTRANS, California State Parks, Los Padres National Forest, and private watershed interests. The following recommended actions should be viewed as short-term actions to immediately improve conditions at the described grade control structures, while long-term solutions are being formulated in the above mentioned watershed plan. Recommendations should be further evaluated with CALTRANS to assess the feasibility of implementing these actions without compromising the structural integrity of the Highway 101 infrastructure.

Immediate Short-term Recommended Actions-

GA_2- Reduce the long, upstream-downstream surface length of the grade control by cutting a large U-shape section out of the upstream end of the structure at center. This action will allow steelhead to jump from the downstream pool over the structure to the upstream natural streambed without having to negotiate the swim across the shallow water depth and/or accelerated water velocities encountered on the concrete surface. This action will reduce the barrier severity for upstream passage during low flows.



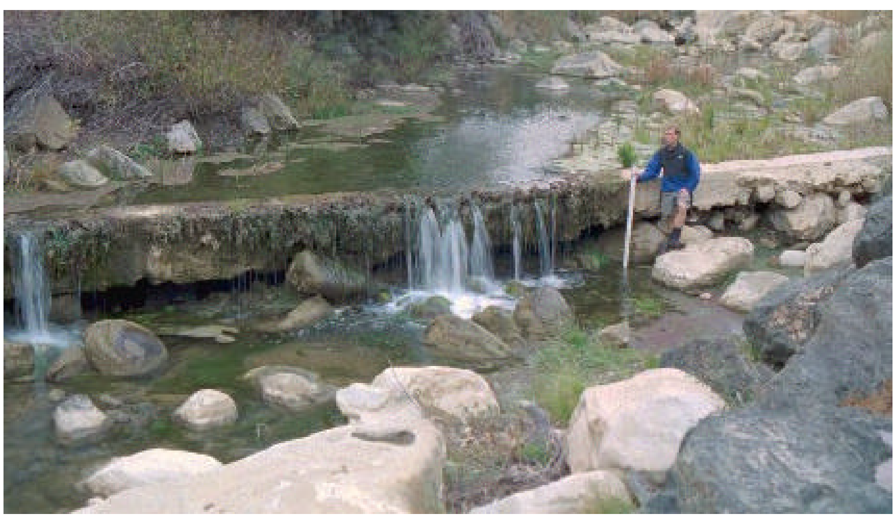
GA_3- If removal is not feasible, concentrate stream flows across the structure to the deepest part of the downstream pool by cutting a notch approximately 4-feet wide by 5 inches deep slightly off-center toward the river-right side of the structure (just to the west of a large boulder downstream of the structure). This action will concentrate flows to help steelhead locate the optimal jumping site, ensure adequate jump depth, slightly lower the required jump height, and improve passage during lower stream flows by providing water depth across the concrete.



BR_GA_5,6

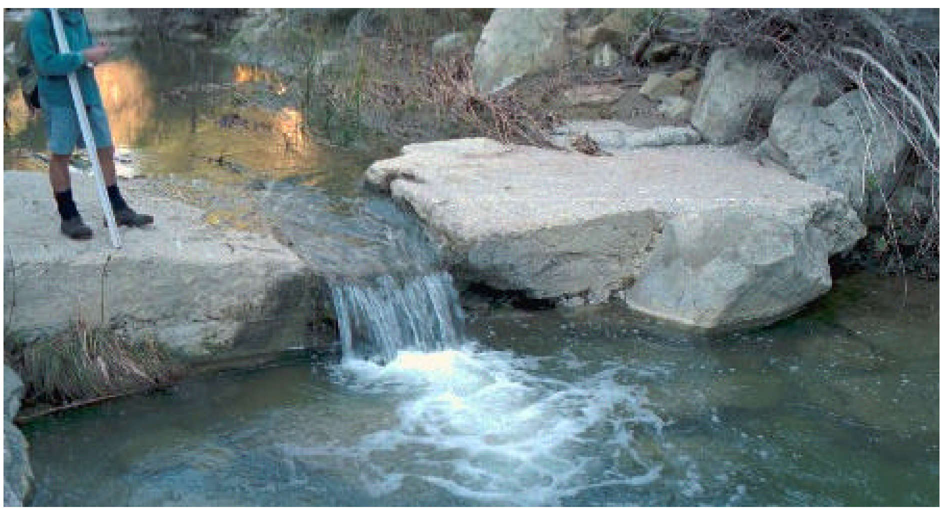
GA_5- If removal is not feasible, cut a notch approximately 3 feet wide and 5 inches deep at center. This action will provide passage benefits described above for GA_3.

GA_6- A large pool measuring 6 feet 6 inches deep occurs on the upstream side of this grade control and the concrete structure is undermined 3 feet toward the downstream end. Failure of this grade control due to complete undermining is likely to occur in the near future. If removal is not feasible, notching the structure as described in GA_5 is recommended.

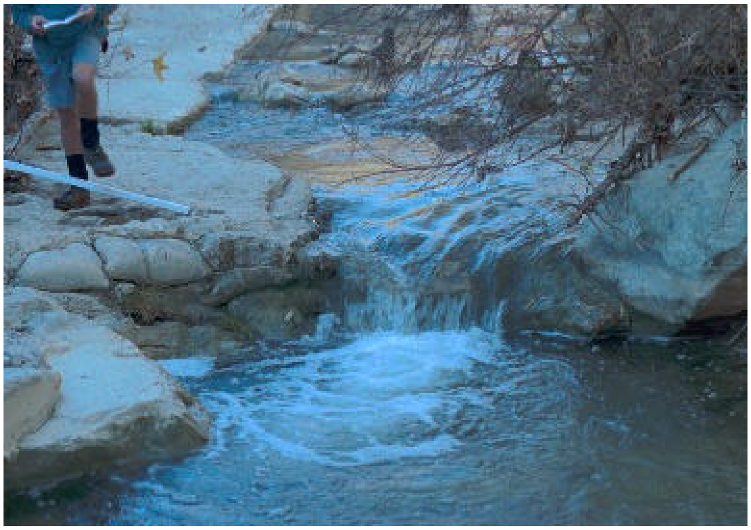


GA_9- This grade control is extremely undermined and at risk of failure. This is one of the most difficult grade controls for upstream steelhead migration due to stream flows landing on downstream boulders and the lack of a developed jump pool. If removal is not feasible, a notch approximately 4 feet wide and 7 inches deep should be cut at center and boulders downstream of this cut moved to allow pool development. Note: This type of action may further compromise the integrity of this already fragile structure.

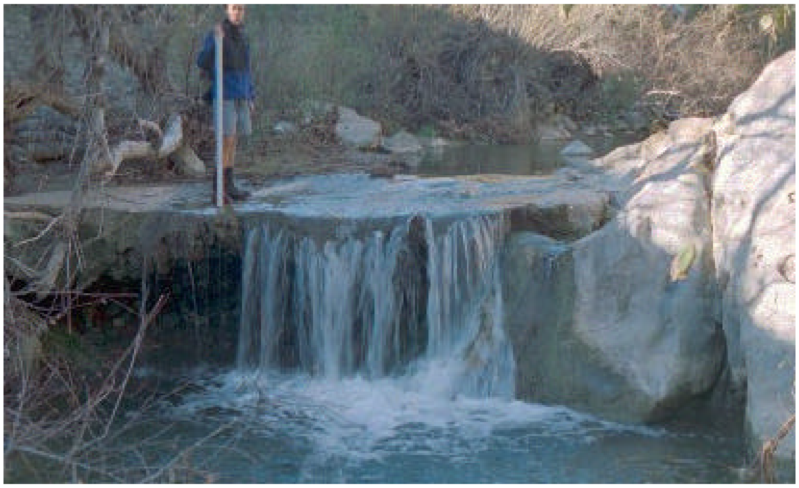
GA_10- A large boulder occurs at center of this grade control with adjacent damage and downstream erosion through the concrete. If removal is not feasible, the existing eroded chute to the river-left side of the boulder should be enhanced as a passage route by widening the chute and cutting a notch 2-3 feet wide and 8 inches deep at the top to concentrate flows down that route. Several medium sized boulders just downstream should be moved to enhance the jump pool downstream of the chute.



GA_11- Lower stream flows are concentrated across an eroded chute at the center of this grade control structure allowing sufficient downstream jump pool development and adequate water depth across the concrete surface. This situation is a good example of how other structures mentioned here could be “notched” to improve fish passage conditions. Continue to monitor this structure to ensure an adequate upstream passage configuration, especially the downstream pool depth.



GA_12- This structure has sufficient downstream pool depth and flows are concentrated across the surface to allow upstream passage with a minimal to low degree of difficulty. Ensure that future changes in configuration of this structure do not increase the passage severity.



GA_13- Due to the significant jump height required at this site, upstream steelhead passage is dependant on the depth of the downstream pool. Flows are spread out over the surface of this structure and should be concentrated to direct attraction flows toward the deepest part of the pool and away from the exposed bedrock on the river-left side. Cutting a notch cut across the structure would accomplish this and provide needed depth across the surface of the concrete, but is likely not practical due to the thinness of the concrete. Scour from this structure has seriously undermined the adjacent river-right bank revetment and CALTRANS should assess removing this structure and stabilizing the bank revetment.

Long-term Recommended Actions-

Gaviota Creek is one of the most biologically unique and important watersheds in the region. This is the only watershed in the study area that cuts through the Santa Ynez Mountain Range and its course provides a valuable wildlife migration corridor between the coastal environment and the

Santa Ynez Valley. Highway 101 was also constructed through this route due to the relative ease of passage through the Santa Ynez Mountains. Highway 101 and Highway 1 follow the main stem and tributaries of the watershed and have had a significant impact on the aquatic and riparian health of the watershed. As part of a larger watershed plan, alternatives for minimizing the effects of Highway 101 and Highway 1 on the Gaviota Creek watershed should be determined. This long-term plan should investigate options to reroute portions of the highways away from the stream channel.

One long-term Highway 101 alternative to assess for the lower Gaviota Creek reach discussed in this section, is to by-pass the confined 'gorge' reach where the highway confines the creek and all the above-mentioned grade control structures are built to stabilize the highway. To accomplish this, a wide-span bridge near the southbound rest stop on Highway 101 could be constructed to focus traffic through a tunnel that would emerge near the current southbound bridge upstream of the gorge. This tunnel would provide a straight line of access for traffic and would allow the complete removal of all the barriers from BR_GA_2 to BR_GA_13, as well as reaches of highway through the gorge reach. This long-term action would provide unimpeded upstream steelhead access on lower Gaviota Creek, improving conditions along one of the region's most important wildlife corridors, and improving recreational opportunities to one of the most unique and spectacular bedrock gorges in Santa Barbara County.

Barrier ID: BR_GA_4
Stream: Gaviota
Barrier Type: Grade Control Structure
Location: 1.54 miles upstream from the ocean
Ownership/Interest: CALTRANS

Description: This concrete grade control structure spans 26 feet across the creek and is anchored into a large boulder on the river-right side and CALTRANS bank revetment on the river-left side adjacent to Highway 101. The surface of the grade control measured 9 feet from upstream to downstream lip. The total height of the structure measured 6 feet 10 inches from the top of the structure to the surface of the downstream pool, which had a measured jump depth of 3 feet 7 inches.

Condition: The structure is in poor condition with significant concrete wear and downstream scour and bank erosion.

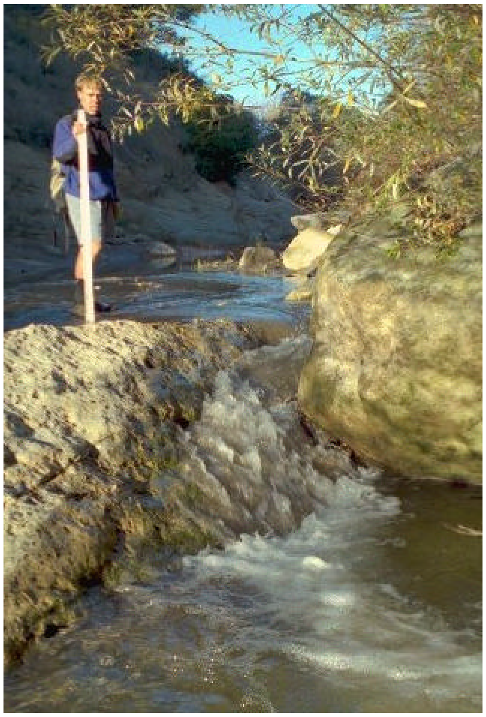
Diagnosis: This is the tallest grade control structure on Gaviota Creek and a significant impediment to upstream steelhead migration. The downstream pool depth is not sufficient to allow upstream migration during low flows. With moderate to high stream flow, the downstream pool will backfill sufficiently to reduce the jump height and increase the jump depth allowing an upstream steelhead jump with a high degree of difficulty. Accelerated stream velocities across the concrete surface where steelhead will land make upstream migration even more difficult. When stream flows provide adequate water depth to migrate upstream of this structure, there is a high amount of suspended sediment in Gaviota Creek that will add to the difficulty of navigate past this structure. The window of opportunity for steelhead to migrate upstream of this grade control is very short and may not occur during a migration seasons with low stream flow, such as 2001-2002. Even during ideal migration flows, steelhead must spend a considerable amount of time and effort to migrate past this structure. This grade control is also susceptible to seasonal changes in the configuration of the structure and adjacent substrate. Boulders that accumulate on the downstream side of a structure may restrict upstream passage by reducing the jump depth downstream or blocking the ideal jump location.

Recommended Action: This structure was modified in the mid 1990’s with two downstream boulder weirs and creation of a slight depression and lip on the surface of the grade control. The boulder weirs failed and no longer provide the desired backfilling effect for the downstream pool. Providing effective passage upstream of this site to productive spawning and rearing habitat in upper Gaviota Creek is critical for the persisting steelhead population. For a long-term management recommendations, as well as a long-term alternative to consider, see the recommended action for the BR_GA_2,3,5,6,9,10,11,12,13 write-up.

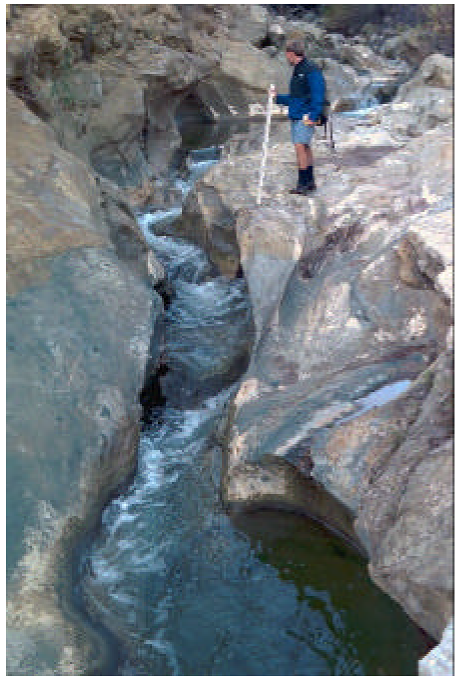
In the short term, a notch 3 feet wide by 12 inches deep should be cut at center across the grade control structure with a wider and deeper landing/resting pool cut near the downstream end of this notch for steelhead to land in. This action will concentrate flows to help steelhead locate the optimal jumping site, slightly lower the required jump height, provide a place to land on top of the structure, and improve passage by providing water depth and velocity breaks across the concrete surface.

Barrier ID: BR_GA_14,15
Stream: Gaviota
Barrier Type: Bedrock Chutes
Location: 2.79 & 2.82 miles from ocean
Ownership/Interest: California State Parks

Description and Diagnosis:



GA_14- This bedrock chute occurs where the adjacent river-right bedrock wall and a large boulder confine the stream flow, which drops down a 45 degree sloping bedrock chute to the downstream pool. The jump height from the downstream pool surface to the top of the chute measured 2 feet 6 inches. The jump depth of the downstream pool measured 2 feet. Sufficient jump depth will develop at this site during moderate and high migration flows to allow a moderately difficult jump over the chute.



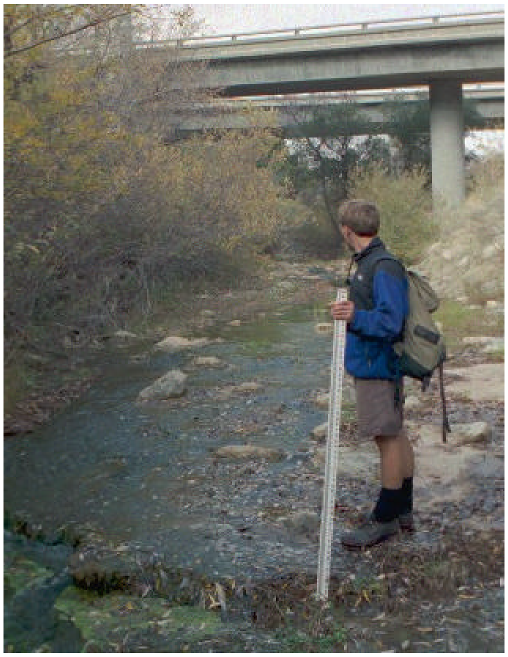
GA_15- This unique bedrock chute cuts a series of small drops and pools through 31 feet of bedrock with an overall slope measured at 10.7%. Sufficient water depth and adequate resting areas occur throughout this chute allowing moderately difficult upstream migration for adult steelhead.

Condition: The configuration of GA_14 may change with the mobility of the large boulder. GA_15 is stabile.

Recommended Action: No actions recommended for these natural features.

Barrier ID: BR_GA_16,17
Stream: Gaviota
Barrier Type: Bank Revetment at Bridge and Channelization
Location: Bridge at end of San Julian Road upstream to under Highway 1 Bridges
Ownership/Interest: CALTRANS

BR_GA_16



BR_GA_17

Description: A long, concrete bank revetment built by CALTRANS on the river-left side of the creek ends under a bridge that provides access from San Julian Road. The revetment confines the stream and produces a sloping drop under the bridge that is 2 feet in height and conveys stream flows into a large pool with a jump depth measured at 4 feet. The concrete bank revetment proceeds upstream past the West Fork Gaviota Creek confluence. This entire stream reach was historically the lower end of Las Cruces Creek, prior to the realignment of Gaviota Creek into Las

Cruces Creek in the late 1960’s. See the BR_GA_18,19 write-up for more on the Highway 101/Highway 1 interchange and stream realignment. A mild-sloping concrete and boulder riprap channel starts downstream of the Highway 1 Bridges and proceeds 0.10 mile to the upstream end of the bridge crossings.

Condition: The concrete revetment is extremely damaged under the bridge and undermined at the downstream end. Scour had caused major erosion on the downstream river-left stream bank. The rest of the revetment and upstream riprap channel are in fair conditions with moderate wear and cracking.

Diagnosis: Sufficient jump depth occurs downstream of the bridge to allow upstream passage of steelhead with a low to moderate degree of difficulty during most/all migration flows. Upstream migration throughout the upstream revetment reach and riprap channel has a low degree of difficulty due to the presence of adequate resting areas and mild stream slope encountered on the predominantly natural substrate bottom and rough, boulder embedded riprap channel.

Recommended Action: Continue to monitor and ensure that future damage or maintenance repairs do not increase the severity of upstream passage through this stream reach.

Barrier ID: BR_GA_18,19
Stream: Gaviota
Barrier Type: Double Box Culvert Crossing and Stream Realignment
Location: Immediately upstream from Las Cruces Creek
Ownership/Interest: CALTRANS

BR_GA_18

BR_GA_19

Description: Historically, Gaviota Creek flowed underneath the current site of the Highway 101 and Highway 1 Interchange along the existing southbound lanes of Highway 101 and into the main stem of Gaviota Creek near the West Fork Gaviota Creek confluence. In the late 1960's, the interchange project realigned Gaviota Creek to the west through the southern end of the low ridge separating Las Cruces and Gaviota Creek, just north of their former confluence and the current intersection. The stream was realigned through this low ridge and into Las Cruces Creek just upstream from the existing Highway 1 Bridges.

A double box culvert was constructed at the lowest end of the realigned reach of Gaviota Creek immediately upstream from the Las Cruces Creek confluence to allow access to private land in upper Las Cruces Creek. Direct surveying of the double box culvert was not conducted due to access restrictions. Kuyper 1998 notes that the as-built plans for the culvert measured 10 feet wide, 8 feet tall, and 97 feet long. However, observations by Kuyper indicated that the exposed height of the culvert was only 6 feet tall and that approximately 2 feet of sediment had been deposited along the bottom of the culvert. The realigned reach of Gaviota Creek, upstream from the Las Cruces Creek confluence, has minimal riparian vegetation and significant erosion occurring on the banks. A small concrete grade control structure occurs at the upstream end of the realigned stream reach.

Condition: While the double box culvert appears to be in fair condition with minimal wear and downstream bank erosion, the realigned stream channel reach upstream has experience significant bank erosion and scour near the concrete grade control at the upstream end.

Diagnosis: The double box culvert appears to be at, or below, streambed level with natural substrate settled out along the bottom. When adequate flows exist along this realigned reach of Gaviota Creek, upstream migration is feasible with a low to moderate degree of difficulty. During high stream flows the culvert bottom may become exposed producing accelerated water velocities along the 97 feet of concrete. This situation would increase the severity of upstream migration at this site.

This highway realignment project has had a significant negative impact on steelhead habitat and migration conditions in Gaviota Creek for the following reasons:

1) Riparian Connectivity- The realigned reach does not have any significant riparian vegetation on the banks to provide shade and has riparian connectivity between the well-developed riparian habitat upstream and Las Cruces Creek has been eliminated. The absence of shade along this reach is likely elevating stream temperatures and increasing the duration of subsurface flows along this reach.

2) Subsurface Flows- Probably the most significant impact of the realignment on steelhead and other aquatic species is the prolonged absence of surface flows in this reach. Numerous observations over the past 9 years have shown that stream flows readily go subsurface near the upstream end of the realigned reach, where the natural creek channel continues to occur. It is likely that ground water recharge of surface flows is not occurring across the realigned reach. This may be due to the underlying material being highly porous. The result of this “dry reach” on salmonid migration is a reduction, and potential elimination, of stream flow connectivity between lower and upper Gaviota Creek. The window of opportunity for steelhead to move upstream is reduced and the ability for spawned-out adults or smolts to out-migrate is even more problematic. Adult steelhead that do make is upstream of this reach during years with adequate flow, as well as out-migrating smolts, are susceptible to becoming trapped in the watershed or stranded in this reach. During years with low rainfall such as 2001-2002, this reach may remain dry and impassable throughout the year. Surface flows were not observed in this realigned reach during the 2001-2002 winter migration season and one adult steelhead was observed upstream of this reach during June of 2001. It is likely that this adult steelhead made it upstream with sufficient flows during the 2000-2001 migration season and became trapped. While this individual may have successfully over-summered, it is unlikely that a large adult could survive two years of being trapped upstream of this realigned reach.

3) Erosion- The stream banks associated with the realigned reach are unstable and contribute a significant amount of erosion into the creek.

Recommended Action: This entire highway interchange needs to be addressed in a larger Gaviota Creek Watershed Restoration and Management Plan. The feasibility of reestablishing the natural Gaviota Creek channel in the future and realigning the highways away from, and off of, the natural stream channel should be assessed. The original, natural stream channel will likely have the most prolific groundwater recharge that will maintain surface flows for the greatest duration, producing the most effective migration conditions for upstream and downstream migrating steelhead. Such a project should assess realigning the road infrastructure away for the natural stream channels and riparian habitat instead of realigning the streams away from the "ideal" highway locations on top of the natural stream channel. Additional easements may need to be purchased by CALTRANS in order to achieve such a plan. Historically, this area was a very unique meeting place of the three main tributaries of Gaviota Creek and migration intersection for both humans and native wildlife traveling between the ocean to the south, the Santa Ynez Valley to the north, the El Jaro basin to the west, and the Santa Ynez Mountains to the east.

Barrier ID: BR_GA_20
Stream: Gaviota
Barrier Type: Box Culvert
Location: Highway 101 Crossing north of Highway 1 Interchange
Ownership/Interest: CALTRANS

Description: This box culvert measured 197 feet 10 inches from the upstream to downstream end. The downstream end of the culvert dropped 2 feet 11 inches to the pool bottom downstream. The culvert measured 9 feet 10 inches wide and 10 feet 1 inch tall. A jump height of 7 inches was measured from the downstream pool surface to the culvert lip. Concrete wingwalls occur at the upstream and downstream end. The downstream 113 feet of the culvert had a measured slope of 11.3%. Upstream of this straight section, the culvert runs an additional 34 feet in a straight alignment and then makes a moderate left turn and runs an additional 50 feet to the culvert inlet. The combined upper two reaches had a measured slope of 3.6 %.

Condition: The culvert itself is in fair condition with significant damage occurring on the culvert bottom and walls in the lower 10 feet.

Diagnosis: The excessive length, smooth bottom, and steep slope of this culvert produce shallow flow conditions and/or excessive water velocities that prevent all upstream migration of salmonids during all flow conditions. This culvert was observed to be directly blocking upstream access to an adult steelhead while conducting a survey of this structure (see salmonid documentation table in section 6.0). The culvert prevents access to high quality habitat conditions in upper Gaviota Creek. Of all the 379 anthropogenic barriers identified in this report, this Highway 101 crossing was determined to provide the greatest accessible upstream habitat score (quality X quantity), with passage provided, of all barriers known to be directly blocking a current (2000-2002) steelhead population. This structure received the highest immediate priority ranking in the entire study area using the Immediate Keystone Barrier Priority Ranking method (See ranking method and table in section 8.0).

Recommended Action: Reliable, effective upstream steelhead passage at this site was determined to have the greatest immediate benefit to southern steelhead recovery in the study area and should be accomplished with the removal of the entire structure and bridge installation that does not impact the stream channel or impede steelhead passage. See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Barrier ID: BR_GA_CA_1
Stream: Las Canovas
Barrier Type: Box Culvert
Location: Highway 101 Crossing
Ownership/Interest: CALTRANS

Description: This 10-foot by 10-foot box culvert measured 321 feet from the upstream to downstream end. Four distinct slope changes occur within the culvert. The downstream end of the culvert conveys water directly into Gaviota Creek (as shown in the picture). Alder and willow are growing on the lower end of the culvert and have backed up boulders and debris within the culvert. The deposited boulders created a pool that extended 67 feet into the culvert with a depth of 1 foot 3 inches. Salmonids were observed in this pool (see Salmonid Documentation Table in section 6.0). The downstream 150 feet of the culvert had a measured slope of less than 2%. The culvert then turns to the right and rises steeply with a 10% slope over 44 feet. The third section extends 64 feet at a slope of 6.3%. The upstream section measured 63 feet in length with a slope of 1.8%. Wingwalls occur at the culvert inlet.

Condition: The culvert itself is in fair condition with significant concrete wear occurring.

Diagnosis: The excessive length, smooth bottom, and steep slope of this culvert produce shallow flow conditions and/or excessive water velocities that prevent all upstream migration of salmonids during all flow conditions. Gaviota Creek has an active steelhead population with adult steelhead known to be migrating to the mouth of Las Canovas Creek, but no salmonid were observed upstream of this culvert. Excellent spawning gravels and cool, year-round flows occur in Las Canovas Creek, which is blocked by this culvert.

Recommended Action: Reliable, effective upstream steelhead passage at this site will directly benefit southern steelhead recovery should be accomplished with the removal of the entire structure and bridge installation that does not impact the stream channel or impede steelhead passage. See section 7.8 for additional discussion and recommended action for this CALTRANS Highway 101 culvert.

Refer to Map Folder for:
Agua Caliente, Alegria, Sacate, Santa Anita Creek Map
Map 7.7.14.1

Refer to Map Folder for:
Agua Caliente, Alegria, Sacate, Santa Anita Creek Map
Map 7.7.14.1

Refer to Table Folder for:
Agua Caliente, Alegria, Sacate, Santa Anita Creek Barrier Table
Table 7.7.14.2

Refer to Table Folder for:
Agua Caliente, Alegria, Sacate, Santa Anita Creek Barrier Table
Table 7.7.14.2

Barrier ID: BR_SA_1
Stream: Santa Anita
Barrier Type: Stone Culvert
Location: UPRR Crossing
Ownership/Interest: UPRR

Description: Detailed information about this structure could not be obtained due to restricted access. Observations made from the air were limited. The culvert appears to be the standard UPRR construction found along the Gaviota Coast, consisting of cut stone blocks. See the Cojo Creek UPRR Culvert (BR_CO_1) description for additional information on a similar UPRR culvert. This culvert is relatively short because it only passes the train tracks on top of the narrow earth fill. The slope inside the culvert may be relatively flat due to its location just upstream of the Santa Anita Creek lagoon were the stream slope is mild.

Diagnosis: A fish passage assessment is needed to determine the severity of this structure to upstream migrating steelhead. Many UPRR culverts have mild slopes associated with them, worn stone bottoms that provide resting areas and velocity breaks, and by themselves allow upstream steelhead migration.

Recommended Action: Conduct a fish passage assessment of this culvert in coordination with UPRR and the Hollister Ranch. If the culvert is a significant impediment to steelhead, a fish passage project should occur to allow access to this watershed, which currently supports a population of rainbow trout/steelhead. Effective passage at this downstream-most site is critical for steelhead success in the Santa Anita watershed.

Barrier ID: BR_SA_2
Stream: Santa Anita
Barrier Type: Arch Culvert Stream Crossing
Location: Rancho Real Crossing
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Detailed information about this structure could not be obtained due to restricted access. Observations made from the air were limited. Only the downstream end of this structure was observed due to thick vegetation on the inlet side. The road crossing appears to consist of a metal arch culvert with a trapezoidal concrete channel conveying stream flows underneath it. The channel appears to have a smooth surface with flows spread out across its width. A vertical drop of approximately 1 foot exists from the downstream lip of the perched channel to the pool downstream.

Diagnosis: The jump into the culvert appears to be relatively easy during most flow conditions and migration into the culvert appears to be possible with a low to moderate degree of difficulty. The inlet configuration of the structure is unknown and the overall severity cannot be accurately determined.

Recommended Action: Conduct a fish passage assessment of this structure to determine the severity of the crossing for upstream migrating steelhead. If the structure is found to significantly impede blocked steelhead, work with the Hollister Ranch Homeowners Association to assess improved fish passage alternatives. A bridge or other structure with a natural stream bottom (i.e. bottomless arch culvert) would provide the most effective long-term fish passage solution. Naturalizing the bottom of this existing arch culvert and reinforcing it should also be investigated. Providing unimpeded passage at this crossing is critical for steelhead in Santa Anita Creek with almost the entire watershed upstream.

Barrier ID: BR_SA_3
Stream: Santa Anita
Barrier Type: Dam
Location: Approximate elevation 45 feet
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Detailed information about this structure could not be obtained due to restricted access. Observations made from the air were limited. The former reservoir behind this concrete and earth-fill dam is completely filled with sediment. The collected sediment deposits extend several hundred feet upstream of the dam. A concrete spillway occurs on the west side of the dam and concentrates flows down a series of steps, which were reported to be a fishway built for upstream steelhead migration (pers. comm. Benech 2001). The overall height of the spillway was estimated at 25 feet from the downstream pool. The fishway does not appear to be maintained with vegetation and deposited sediments occurring throughout its length.

Condition/Sizing: This dam and reservoir are obsolete and do not appear to serve any of their original purposes. The fishway is not in functional condition. The structural integrity of the dam is not known.

Diagnosis: It is difficult to know weather or not the fishway was ever effective at passing steelhead in the past. Currently, the fishway does not appear to be maintained for fish passage and it is doubtful that steelhead can migrate upstream of the dam.

Recommended Action: Work with the Hollister Ranch to assess the feasibility of removing this obsolete dam to provide unimpeded steelhead passage to the upper watershed. Gradual lowering of the dam’s earthen center over several years in conjunction with selective sediment releases may be a cost effective way to eliminate this structure without severely disrupting the downstream and adjacent environment. Sediment behind the dam could also be removed and used for local projects requiring fill. Additional studies should be conducted to determine dam removal feasibility, alternatives, and the potential impacts of various options. Special care should be taken to prevent property damage and loss of habitat at the ecologically important lagoon. Modifying the existing structure for fish passage, including rehabilitating the existing fishway or building a different fishway, is not recommended due to the limited effectiveness of these structures in the low flowing streams of this area, susceptibility to clogging with debris, the dependence on maintenance, and ongoing costs.

Barrier ID: BR_SA_4
Stream: Santa Anita
Barrier Type: Stream Crossing
Location: Approximate elevation 105 feet
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Detailed information about this structure could not be obtained due to restricted access. Observations made from the air were limited. This road crossing has sediment backed up to top of the upstream side and carries stream flow over the top of the road. On the downstream side of the road, stream flows fall off a sloping apron onto the streambed below.

Condition/Sizing: Significant bank erosion is occurring downstream where the crossing concentrates flows. The crossing appears to convey all flows over the road or a culvert is buried with sediment.

Diagnosis: The height of this structure could not be determined, but the significant jump needed to reach the apron, lack of resting areas across the structure, and high water velocities encountered over this structure during migration flows combine to make upstream steelhead passage at this site extremely difficult or impossible.

Recommended Action: Work with Hollister Ranch Homeowners Association to improve fish passage at his crossing in conjunction with structures downstream. Assess the feasibility of installing a bridge or bottomless arch culvert at this site to provide unimpeded steelhead migration and improved vehicle access and safety.

Barrier ID: BR_SA_5
Stream: Santa Anita
Barrier Type: Stream Crossing
Location: Approximate elevation 160 feet
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Detailed information about this structure could not be obtained due to restricted access. Observations made from the air were limited due to the extensive riparian vegetation around the crossing. Only the road surface of the crossing spanning the creek was observed at this location.

Diagnosis: Stream flows were not observed on the road and suggest that water pass underneath this crossing, likely in a culvert. The severity this structure would impose on steelhead migration could not be determined.

Recommended Action: Work with Hollister Ranch Homeowners Association to assess fish passage at his crossing in conjunction with structures downstream. If fish passage is significantly impeded or blocked at this crossing, a bridge or bottomless arch culvert should be considered to provide unimpeded steelhead migration and improved access and safety.

Barrier ID: BR_SA_6
Stream: Santa Anita
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 200 feet
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Detailed information about this structure could not be obtained due to restricted access. Observations made from the air were limited. A small concrete channel upstream of the crossing carries low stream flows into a small culvert that conveys water under the concrete road crossing. Downstream of the culvert outlet, a steep apron extends approximately 4 feet into a large and fairly deep pool. Rainbow trout were observed in this pool in 2001 (see sighting table).

Condition/Sizing: The culvert is not sized for a 100-year flow. The crossing is constructed to carry high flows over the top. The downstream apron appears to be undercut.

Diagnosis: The jump from the downstream pool into the culvert appears to be moderately difficult during migration flows, but passage through the culvert and approximately 20 feet of concrete channel on the upstream side would likely be extremely difficult or impossible depending on the slope of the culvert and channel.

Recommended Action: Investigate options with the Hollister Ranch Homeowners Association to replace this crossing and upstream channel with a bridge.

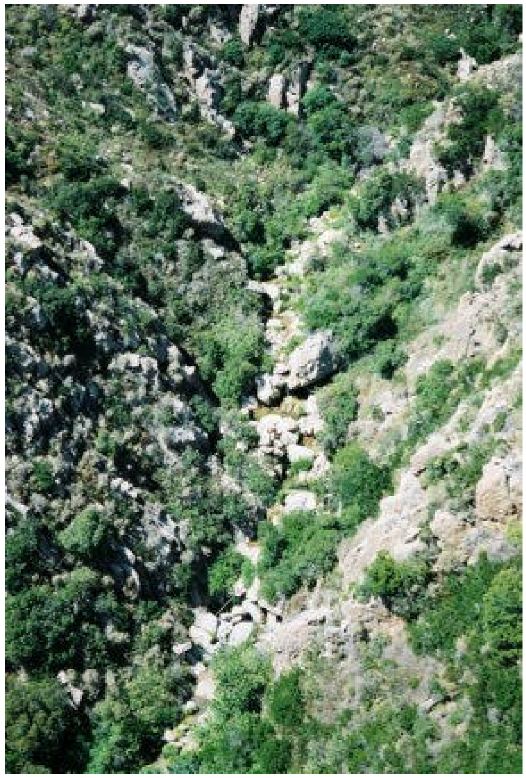
Barrier ID: BR_SA_7
Stream: Santa Anita
Barrier Type: Stream Crossing
Location: Approximate elevation 240 feet
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Observations made from the air were limited due to the extensive riparian canopy covering the crossing. It appears that this crossing is a private driveway that heads west from the main Santa Anita Creek road.

Diagnosis: The impact of this crossing to potential upstream steelhead migration could not be determined.

Recommended Action: Work with the Hollister Ranch Homeowners Association to assess fish passage at this crossing in conjunction with structures downstream. If fish passage is significantly impeded or blocked at this crossing, assess options to replace the structure with a bridge.

Barrier ID: BR_ SA_8
Stream: Santa Anita
Barrier Type: Bedrock and Boulder Waterfalls
Location: Approximate elevation 400 feet
Ownership/Interest: Hollister Ranch Homeowners Association



Description: Santa Anita Creek flows through a confined bedrock gorge as it passes through the Santa Ynez Mountain Range. The steep gorge contains massive boulders and exposed bedrock, which produce at least four significant waterfalls that exceed 8 feet in height. Two of the waterfalls in this reach appear to be 10 and 15 feet in height.

Diagnosis: This reach appears to be impassable due to the excessive height and complexity of these waterfalls. Several of the waterfalls do not have well-developed pools for jumping downstream. Large pools and excellent habitat conditions were observed within this reach though, and some of this habitat below the waterfalls was likely accessible to steelhead historically

Recommended Action: No recommended action for this natural feature.

Refer to Map Folder for:
El Bulito, San Augustin, Cojo Creek Map
Map 7.7.15.1

Refer to Map Folder for:
El Bulito, San Augustin, Cojo Creek Map
Map 7.7.15.1

Refer to Table Folder for:
El Bulito, San Augustin, Cojo Creek Barrier Table
Table 7.7.15.2

Refer to Table Folder for:
El Bulito, San Augustin, Cojo Creek Barrier Table
Table 7.7.15.2

Barrier ID: BR_CO_1
Stream: Cojo
Barrier Type: Stone Culvert
Location: UPRR crossing
Ownership/Interest: UPRR

Description: Detailed information about this structure could not be obtained due to restricted access. Limited observations were made from the air and from the legal limits of the beach. The railroad culvert is constructed of cut stone blocks with an inverted U-shape arch top and flat bottom. The stone bottom extends to the small lagoon downstream and appeared to be only 2 inches above the surface of the lagoon. The lagoon had an estimated 4-foot depth just downstream of the culvert. The overall length of the culvert was estimated between 100 and 125 feet and the relatively flat slope was 1% or less.

Condition/Sizing: The culvert itself is in fair condition with moderate wear of the stone blocks. Undercutting of the structure on the downstream side is likely, but was submerge from view by the lagoon.

Diagnosis: The stone blocks on the bottom of the culvert appeared to be worn with many grooves and pockets of water to provide velocity break for upstream migrating steelhead. The jump height into the culvert and pool depth/lagoon development is highly dependant on the seasonal sandbar formation. During the brief beach survey on 2001-08-12, conditions were suitable to allow low to moderately difficult upstream passage of adult and juvenile salmonids through the shallow water in the culvert.

Recommended Action: Along with other culverts that empty onto the sand beach, this culvert should be assessed during high stream flows to see if the sandbar continues to allow lagoon development for adequate jump pool depth and tolerable jump height into the culvert. If upstream passage is obstructed during high stream flows because of the lagoon configuration, this structure should be further assessed for potential fish passage improvements that are acceptable to UPRR requirements. Passage at this site is critical for Cojo steelhead potential with all spawning habitat, and all rearing habitat except for the lagoon, located upstream. While upstream migration may not be severely impeded, the culvert has likely reduced the extent of the original lagoon and may have limited its productivity for salmonid rearing and acclimation.

Barrier ID: BR_ CO_2
Stream: Cojo
Barrier Type: Culvert Stream Crossing
Location: Approximately 100 feet upstream from UPRR Culvert (BR_CO_1)
Ownership/Interest: Bixby Ranch or Western Gate Ranch, or both

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Description: Observations of this structure were made from the air, as access was restricted to this stream reach. A corrugated metal culvert and dirt-fill road crossing occur just downstream from a former concrete road, which apparently blew out at the former culvert location. The existing culvert appears to be 3 feet in diameter, approximately 25 feet in length, slightly elevated above the streambed at the outlet, and likely has a low to moderate slope at this low stream gradient reach near the creek mouth.

Condition/Sizing: The crossing is in poor condition with highly eroded banks and is covered with soil that is susceptible to washing out during moderate to high stream flows. The structure is not sized for a 100-year flow and likely is rebuilt after washing out following high stream flows. This culvert imposes a significant threat to blocking, and potentially leading to the failure of, the UPRR crossing 100 feet downstream.

Diagnosis: While detailed information about this structure was not attainable from the air survey, it appears that the approximately 25-foot length of the narrow culvert would produce high stream velocities during migration flows that may only allow limited, extremely difficult upstream steelhead migration. Debris blockage at the inlet and other unidentified factors may completely block upstream passage.

Recommended Action: With almost the entire Cojo Creek watershed upstream of this culvert, it is critical to work with the landowner to remove this structure and provide alternative means of access across the creek at this site or elsewhere. Assess the feasibility of installing a bridge across the existing road site for unimpeded steelhead migration and improved sizing and safety.

Barrier ID: BR_ CO_3,4,5,6
Stream: Cojo
Barrier Type: Stream Crossings
Location: Approximate elevations for barriers #3= 290’, #4= 300’, #5=320’, #6= 360’
Ownership/Interest: Hollister Ranch Homeowners Association

Description: Identification of these structures was made from the air, as access was restricted to this stream reach. Detailed information about these crossings was not obtained due to the thick riparian canopy limiting observations. Other crossings and structures may exist that were not observable. These four private crossings appear to vary in construction and consist of combinations of concrete surfaces, dirt fill, concrete culverts, wood decking, and corrugated metal pipe culverts.

Condition/Sizing: Determining the condition and sizing of these crossings was not possible from the air, but it appeared that most are constructed to carry high stream flows over the top of the crossings.

Diagnosis: Migration flows appear to be confined through or over the top of all these crossings. All crossings appeared to significantly impeded or block upstream steelhead migration due to the significant size of the in-stream construction and vertical rise above the downstream substrate.

Recommended Action: This upper reach of Cojo Creek should be ground-surveyed to accurately determine all potential structures impeding steelhead migration and fish passage should be assessed at each structure encountered. The removal of crossings that severely impede or block upstream steelhead migration and replacement with bridges or large, embedded culverts should be assessed. Evaluate reducing the number of stream crossings in this reach by consolidating these crossings into a couple bridges that do not impact the stream or impede upstream steelhead migration and may provide improved access/safety for landowners.

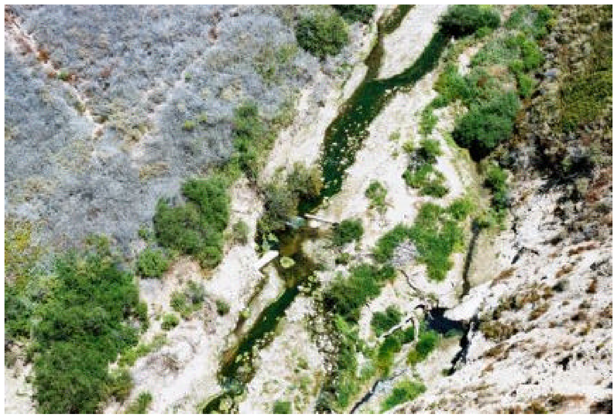
Refer to Map Folder for:
Jalama Creek Map
Map 7.7.16.1

Refer to Map Folder for:
Jalama Creek Map
Map 7.7.16.1

Refer to Table Folder for:
Jalama Creek Barrier Table
Table 7.7.16.2

Refer to Table Folder for:
Jalama Creek Barrier Table
Table 7.7.16.2

Barrier ID: BR_ JA_1
Stream: Jalama
Barrier Type: Dam
Location: 0.58 mile upstream from mouth
Ownership/Interest: Vandenberg Air Force Base (VAFB)



Description: The exact purpose of this structure was not determined by aerial survey or personal communication with Camm Swift, who surveyed lower Jalama Creek on VAFB property. This structure may have served as an old diversion dam, road crossing abutment, utility crossing protection, or other purpose. The structure is highly damaged and apparently not maintained to function any specific purpose at this time. A concrete curb approximately 25 feet in length and 1 to 2 feet thick spans one-third of the stream channel and is keyed into the river-right bank. A large portion of concrete, presumably once part of the structure, lays in the streambed approximately 15 feet downstream. According to Camm Swift, the total height of the structure is not greater than 2 feet 6 inches from the surface off the downstream pool, during lower flow conditions encountered. A concrete apron drops steeply from the curb and becomes less steep toward the downstream pool, which Camm estimated had a maximum depth of approximately 3 feet.

Condition: This obsolete structure appears to be significantly impacting downstream sediment and water movement causing high flows to cut around the concrete on the river-left side forming a side-channel and small island. This side-channel appears to be accelerating the significant bank erosion adjacent to the channel during high flows. The structure is in extremely poor condition.

Diagnosis: It appears that adequate pool depth exists downstream of the structure to allow a moderately difficult jump for adult steelhead to the upstream side during migration flows. In years with prolonged low stream flow, this structure may significantly block or impede upstream passage of adult steelhead. CDFG personnel observed an adult steelhead upstream of this structure in August 1994 (see sighting table).

Recommended Action: Because this structure is located downstream of all Jalama Creek tributaries and most of the main stem, has no apparent purpose, and is in extremely poor condition, it should be removed to improve upstream passage for adult and juvenile steelhead (and other native fish species) and to minimize further bank erosion on the adjacent river-left bank. It is likely that VAFB personnel could easily remove this structure in one day, or a matter of seconds.

Barrier ID: BR_ JA_2
Stream: Jalama
Barrier Type: Bridge and Apron
Location: Downstream-most Jalama Road Bridge
Ownership/Interest: Santa Barbara County Public Works-Road Division

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Description: Due to access restrictions, general observations of this structure were made from the Jalama Road bridge. A mild sloping concrete apron extends approximately 9 feet downstream from under the downstream side of the bridge. Flows fall vertically off the downstream end of the apron approximately 1 foot 6 inches into the pool downstream, which had a maximum depth of between 2 to 3 feet. The overall height of the apron is less than 3 feet from the pool surface.

Condition/Sizing: The apron is in poor condition with significant wear, concrete cracking, and undercutting on the downstream side.

Diagnosis: Due to the sufficient depth of the downstream pool, mild slope of the apron, and low overall height, this structure presents a moderate degree of difficulty. During low flow conditions the shallow depth of the apron may impede passage.

Recommended Action: Upstream passage for juveniles and improved ease of access for adults could be obtained with the removal or modification of this apron. Work with SBCPWRD to obtain more detailed information about the apron and assess fish passage options with the road district. Assess the desirability of the structure with SBCPWRD and possibility of lowering the structure, shortening the apron length, or removing the apron and stabilizing the adjacent banks.

Barrier ID: BR_ JA_3,4,5
Stream: Jalama
Barrier Type: Culvert Stream Crossings
Location: Approximate elevations: #3=455', #4=500', #5=615'
Ownership/Interest: Bixby Ranch

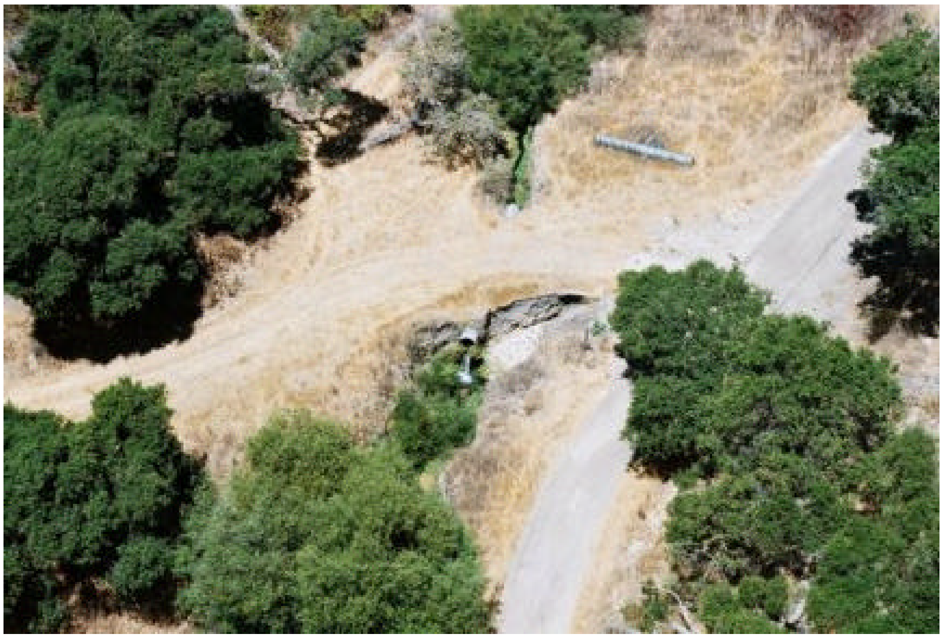
Description: Detailed information about these three structures was not attainable from the air survey. These crossings are almost identical in construction with corrugated metal culverts passing under the dirt-fill road.

Condition/Sizing: The structures do not appear to be sized for a 100-year flow and are likely rebuilt following large storm flows.

Diagnosis: Knowledge about the slope of the culverts is needed to accurately determine the severity of these crossings. All three culverts appear to be at, or near, streambed level with no significant jump required to enter the downstream end. It is likely that these culverts clog easily with their small diameter, estimated at 3 feet. During migration flows, water velocities in these culverts may significantly impede upstream migration depending on their respective slopes and other characteristics that could not be determined from the air.

Recommended Action: Work with the landowner to assess the severity of these structures and investigate alternative means of access across the creek at these sites or elsewhere if passage is significantly impeded. A larger diameter culvert that is embedded in the substrate could provide a quick, easy, and inexpensive fix for fish passage.

Barrier ID: BR_ JA_EA_1
Stream: Espada
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 115 feet
Ownership/Interest: Bixby Ranch



Description: Observations of this structure were limited from the air. A corrugated metal culvert passes through the dirt-fill crossing.

Condition/Sizing: The crossing appears to be in poor condition with significant erosion on the downstream side. The structure does not appear to be sized for a 100-year flow.

Diagnosis: While detailed information about this structure was not attainable it appears that the approximately 3 to 4-foot jump into the perched culvert and approximately 25-foot length of the confined culvert would completely block upstream migration of adult steelhead. Knowledge about the slope of the culvert and downstream pool depth are needed to accurately determine if this crossing is impassable. In a best case scenario the crossing may provide limited, extremely difficult passage for steelhead with optimal flow conditions.

Recommended Action: Because this crossing blocks most of the Espada Creek tributary, it is important to work with the landowner to remove this structure and provide alternative means of access across the creek at this site or elsewhere. A large diameter culvert, at least the width of the active stream channel and slightly embedded in the streambed substrate, could provide a quick, easy, and inexpensive fix for fish passage. Coordinate with the landowner to determine the feasibility of removing the next structure just upstream (BR_JA_EA_2) and only replacing one of these crossings with a structure that does not impede fish passage and allows adequate vehicle access.

Barrier ID: BR_ JA_EA_2
Stream: Espada
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 170 feet
Ownership/Interest: Bixby Ranch

Description: Culvert and dirt-fill crossing. Detailed information about this structure was not attainable from the air survey.

Condition/Sizing: The crossing appears to be recently built or modified with significant damage to adjacent riparian vegetation. The structure is probably not sized for a 100-year flow and likely is rebuilt following a wash out associated with high stream flows.

Diagnosis: Knowledge about the size and slope of the culvert are needed to accurately determine the potential severity of this crossing to fish passage. Due to the high amounts of cut riparian vegetation upstream it is likely that this culvert will clog easily and would produce an extremely difficult to impassable upstream passage situation for adult steelhead.

Recommended Action: See recommended action for BR_JA_EA_1.

Barrier ID: BR_ JA_EO_1
Stream: Escondido
Barrier Type: Culvert Stream Crossing
Location: Jalama Road Crossing
Ownership/Interest: Santa Barbara County Public Works-Roads Division

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Description: Detailed information about this structure was not attainable due to restricted access around the crossing and was only assessed from the public road. It appears that Escondido Creek passes under Jalama Road in a round, corrugated metal culvert with a diameter of approximately 3 feet. The slope of the culvert appears to be relatively mild. A concrete and boulder riprap apron extends downstream of the culvert into thick brush on private property where the downstream end could not be observed. The sound of water falling downstream may indicate a drop at the downstream end of the apron associated with downstream scour.

Condition: The crossing appears to be in fair condition from the road surface. The sizing of the structure was not determined.

Diagnosis: A more detailed assessment of the size and slope of the culvert and downstream end of the riprap apron is needed. Due to the mild slope of the culvert and roughness of the downstream apron, it is possible that this crossing may provide passage to upstream migrating steelhead with a moderate to high degree of difficulty.

Recommended Action: Assess conditions of this crossing and fish passage with Santa Barbara County personnel and with any necessary permission from the landowner. In particular, survey the downstream end of the apron to determine the current configuration for upstream access onto the apron. If passage is blocked or significantly impeded, the feasibility of removing the structure and replacing the crossing with a bridge and unimpeded natural bottom or streambed simulation strategy is recommended.

Barrier ID: BR_ JA_EO_1_a
Stream: Escondido
Barrier Type: Weir
Location: Just upstream of Jalama Road Crossing
Ownership/Interest: Bixby Ranch

Description: This structure was not observed from Jalama Road or from the air and is only described in this report here, due to discovering its existence after datasets were finalized near the completion of this project. The following description is from the Bixby Ranch Specific Plan Environmental Assessment Volume III, October 24, 1990 page C-7.

"A weir has been constructed on Escondido Creek, just upstream of its confluence with Jalama Road, with gaging stations placed at the weir and upstream of it. The other two creeks proposed for weirs also have one gaging station each to monitor and record flows. Rick Hoffman, Consulting Hydrologist, set up these devices. The weir on Escondido Creek has been in place for approximately three years (Hoffman, pers. comm., 1990)."

Diagnosis: Rick Hoffman was contacted to obtain additional information about this structure, but was not at liberty to discuss his work on the Bixby Ranch. Little else is known about this structure, including potential impacts to fish migration.

Recommended Action: Work with landowner to assess this structure for fish passage and discuss way to improve or provide passage if necessary. The statement about the "other two creeks proposed for weirs also have one gaging station each to monitor and record flows" indicates possible weir building on Espada and Gasper Creeks as these both have gaging station on them. The proposed building of weirs on those tributaries should be investigated to determine if this was completed or just planned.

Barrier ID: BR_ JA_EO_2
Stream: Escondido
Barrier Type: Culvert Stream Crossing
Location: Approximate elevation 395 feet
Ownership/Interest: Bixby Ranch

Description: Detailed information about this structure was not attainable from the air survey. The crossing has a corrugated metal culvert passing under a dirt-fill road.

Condition/Sizing: Major bank erosion occurs on the upstream banks and water is backed up behind this crossing. The structure does not appear to be sized for a 100-year flow.

Diagnosis: The downstream end of the culvert appears to be at streambed level. Knowledge about the slope of the culvert and conditions at the upstream end of the culvert are needed to accurately determine if this crossing is impassable. In a best case scenario the crossing would significantly impede upstream passage of adult steelhead.

Recommended Action: Work with the landowner to further assess fish passage at this crossing. If passage significantly impeded, work with the landowner to assess alternative means of access across the creek at this site or elsewhere.

7.8 CALTRANS Highway 101 Culvert Recommended Action

Background-

Recovery of steelhead to several watersheds within the study area requires adequate upstream steelhead passage at the Highway 101 CALTRANS culvert near the creek mouth. These culverts completely prevent steelhead from accessing several focal watersheds and directly block over 46% of historically accessible steelhead habitat within the study area that is currently blocked by migration barriers. See the keystone barrier priority ranking table in section 8.0 for specific CALTRANS barriers that are blocking upstream steelhead passage in each watershed and the amount of stream habitat occurring upstream of these barriers. In addition, CALTRANS culverts and concrete channels associated with highways have lined over 4 miles of streambed within the study area in concrete, or 2.5% of identified, historically accessible steelhead habitat. This amount is equivalent to burying or concrete-lining the combined stream lengths of the Arroyo Hondo and Arroyo Quemado watersheds that were historically accessible to steelhead. The construction of CALTRANS culverts and concrete-lined channels has lead to the complete extirpation of anadromous steelhead in several watersheds within the study area. Providing effective and reliable steelhead passage upstream of these CALTRANS Highway 101 culverts must be an essential component of steelhead recovery in southern Santa Barbara County. No steelhead production opportunities exist in several watersheds until fish can effectively migrate upstream of the Highway 101 culvert or concrete channel site. In many cases, the CALTRANS Highway 101 culverts were built onto existing UPRR railroad culverts.

UPRR Railroad Culverts-

In the early 1900’s, the railroad transportation route that is know owned by UPRR was established along the coastline of Santa Barbara County and across the many creeks, near the stream mouth. By themselves, many of these UPRR culverts allowed upstream steelhead passage due to their short length, relatively mild slope, and irregular stone bottoms that provide velocity breaks through the culvert. See the Cojo Creek UPRR culvert crossing (BR_CO_1) for additional information about the design and impacts of these individual UPRR culverts. Several creeks in the study area such as Carpinteria, Arroyo Paredon, San Ysidro, Montecito, Mission, San Jose, Dos Pueblos, El Capitan, Refugio, Arroyo Hondo, Gaviota, Agua Caliente, Alegria, and others do not have UPRR culverts and the railroad passes over the stream channel on the original steel trestle or on a bridge. The UPRR railroad crossing does not prevent upstream steelhead passage on any of the creek with trestles or bridges.

CALTRANS Highway 101 Culverts-

During the 1960’s and 1970’s, CALTRANS began to add concrete culverts onto the upstream side of many of the UPRR culverts in order to build Highway 101. When no UPRR culvert occurred on a creek, or the highway alignment needed to be in a different place, CALTRANS built Highway 101 culverts or bridges separately. On streams where UPRR trestles occurred, such as El Capitan Creek and Arroyo Hondo, Highway 101 culverts were extended downstream to convey culvert flows under the trestle supports. The CALTRANS culverts often consist of several sections that have also been added onto the original culvert over the years as the highway became wider. The sections of these concrete box culverts are usually long, steeply sloped, smooth-bottomed, and usually impassable. See individual barrier write-ups for description and passage severity ranking.

Other Owners and Interests-

In several cases, the complex Highway 101 culvert crossings are also owned, maintained, or partially leased by other agencies, private parties, or adjacent landowners. The large amount of dirt fill over the culverts often contains additional roads, utility crossings, and/or private access. Several of the Highway 101 culverts have Santa Barbara County roads crossing them.

Figure 7.8a
Highway 101 and UPRR culvert crossing at Corral Creek

The above air photograph shows the UPRR/Highway 101 culvert crossing at the mouth of Corral Creek. The UPRR culvert empties onto the beach. The CALTRANS culvert extends several hundred feet on the upstream end and prevents all upstream steelhead migration. No adult steelhead have been observed upstream of the highway since completion of the culvert and the rainbow trout population that became isolated upstream appears to have been extirpated from the watershed as recently as the early 1990's.

Recommended Action:

Long-term, effective, steelhead passage and regional watershed restoration of lower stream and lagoon reaches impacted by these crossings should be a top regional objective for steelhead, watershed, and wetland recovery. Achieving this objective will require CALTRANS, UPRR, and other stakeholder interests to collaborate and develop a long-term management plan that outlines a long-term vision for the southern Santa Barbara County coastline that improves watershed health, steelhead passage, and the existing transportation infrastructures. The removal of several Highway 101 culvert crossings and replacement with having a natural streambed underneath will be an essential component of accomplishing this objective.

This alternative meets all CDFG and NMFS objectives for fish passage and would allow unimpeded steelhead migration during the widest range of stream flows. There are many advantages to removing the culverts and replacing them with a bridge(s) including:

- Unimpeded migration for steelhead and other wildlife
- Several hundred feet of stream and/or lagoon habitat restored with riparian connectivity
- Optimal sizing for peak streams flows improves safety and structural integrity
- Bridges last longer and require less maintenance
- Cost effective over time
- Aesthetic and recreational opportunities

This recommended action can be accomplished by removing the entire culvert and excavating a large V-shape into the existing highway crossing dirt fill, stabilizing the streams banks using biotechnical techniques, naturalizing the streambed underneath, and installing a wide-span bridge that does not aversely impact the stream channel. Refugio Carpinteria, Maria Ygnacio, San Jose, and Dos Pueblos Creeks are all examples of CALTRANS Highway 101 bridges that allow upstream steelhead migration. The picture below of the Highway 101 and UPRR crossing of Refugio Creek shows what removal of the culvert and bridge installation would look like.

Figure 7.8b
Highway 101 Bridge allowing upstream steelhead passage on Refugio Creek

Implementation of individual projects can be timed to coincide with culvert crossings that have significantly deteriorated and are in need of major retrofitting or highway modifications. For example, the CALTRANS culvert at El Capitan Creek is in need of a major retrofitting due extensive culvert damage and would be a prime location to replace with a bridge. Each culvert replacement with bridges would have different costs associated with it but may range from approximately 5 to 8 million dollars (pers. comm. Chuck Cesena, CALTRANS and Mark Capelli, NMFS).

The following Highway 101 culverts are directly impeding a documented, current (2000-2002) adult steelhead run and deserve the highest immediate priority for removal and installation of bridges. The removal of these culverts will immediately benefit known southern steelhead populations and CALTRANS should formulate a 10 year plan to remove these crossings and replace them with bridges that do not impact the stream channel or steelhead migration.

- Gaviota Creek (BR_GA_20)
- Las Canovas Creek (BR_GA_CA_1)
- Arroyo Hondo (BR_AH_1)

The following Highway 101 culverts are directly impeding a documented, current (2000-2002) salmonid population or potential steelhead access and deserve a high priority for removal and installation of bridges: The removal of these culverts will immediately benefit known salmonid populations or allow natural recolonization of the watershed by expansion into the expanded habitat range for southern steelhead. CALTRANS should formulate a 25-year plan to remove these crossings and replace them with bridges that do not impact the stream channel or steelhead migration.

- Rincon Creek (BR_RN_1)
- El Capitan Creek (BR_EC_2)
- Tecolote Creek (BR_TE_1)
- Corral Creek (BR_CL_1)
- Tajiguas Creek (BR_TS_1)
- Arroyo Quemado (BR_AQ_1)
- San Onofre Creek (BR_SO_2)

The following Highway 101 culverts occur in historically accessible steelhead habitat where salmonids are not currently documented and steelhead do not likely have direct access due to downstream barriers. The removal of these culverts and installation of bridges does not have an immediate priority, but is essential for long-term steelhead recovery for that individual watershed or tributary.

- Gato Creek (BR_GO_3)
- Arroyo Burro (BR_AB_10)
- Glen Annie Creek (BR_AO_TO_GA_7)
- West Fork Gaviota (BR_GA_WF_5) – Highway 1 Culvert

The Big Sur Coast: An Example of the Effectiveness of Highway Bridges-

Along the Big Sur coast, from San Luis Obispo to Monterey, smaller coastal streams descend quickly to the ocean from the Coast Range. CALTRANS has built spectacular bridges over every major river and stream along this coastline for Highway 1. Despite the threatened listing of steelhead along the Big Sur coast, these short coastal streams have intact, wild, self-sustainable steelhead populations. All of these steelhead populations have adequate steelhead passage under the Highway 1 bridges that cause little impact to the sensitive lower creek and lagoon areas. In fact, these low impact bridges offer benefits to bird life while having minimal impact on the streams, flood conveyance, and the riparian corridor. If impassable culverts were present instead of the existing bridges on the Big Sur coast, the steelhead populations would be devastated and in many cases extirpated, as is the case in southern Santa Barbara County. If Highway 101 bridges are installed on streams in southern Santa Barbara County, similar to those on the Big Sur coast, the regions steelhead populations could begin the recover process to a sustainable state.

Modifying the Existing Highway 101 Culvert for Fish Passage-

Modification of the existing culvert with baffles, fishways, or other “band-aid” approaches that attempt to improve fish passage is highly discouraged for the following reasons:

- Safety and Structural Integrity-
  Baffles, or other internal culvert modification, can reduce the flow capacity of the culvert and increase the likelihood of debris blockage that could cause complete failure of the highway. Installing baffles or other fish passage measures inside a culvert causes damage to the culvert and can lead to increased maintenance, reduced culvert life, and safety hazards.

- Limited Biological Effectiveness-
  The effectiveness of baffles for fish passage is extremely limited under a narrow window of tolerable stream flows and is highly dependant on continual human maintenance and clearing of debris to be functional. With the flashy stream flows encountered in southern California streams, steelhead have a limited window of opportunity to migrate upstream to adequate spawning and rearing habitat. Streams within this study area do not have the consistent flows needed to provide adequate fish passage over a long duration of time, such as large river systems to the north with adequate sustained year-round flow. Even the most ideal baffle design, in perfect operating condition, will impose a significant degree of difficulty to upstream passage. The dark, excessive length, and steep slope of the culverts adds to the difficulty and unpredictability of baffles for providing effective upstream steelhead passage. The stronger, sharp metal baffles can directly injure upstream and downstream migrating steelhead and cause cuts and infections. Modifying the culvert for fish passage also ensures that that section of stream will not be restored to a natural state and will provide limited biological benefit for the all watershed functions and dependant species, as it remains buried.

- Ongoing Maintenance and Cost-
  Baffles or other internal culvert modification are highly prone to blowing out of the culvert during high stream flows, preventing upstream steelhead passage during the migration season and causing structural damage to the culvert. Baffles are usually replaced after the steelhead migration season has ended, when flows have subsided and maintenance crews can reinstall them. In order to be effective, baffles require continual monitoring during the migration season, structural maintenance, replacement costs, and continual culvert maintenance costs.

7.9 Santa Barbara County Flood Control District Debris Dam Recommended Action

Background-

The Santa Barbara County Flood Control District (SBCFCD) currently maintains several debris dams and basins on southern Santa Barbara County streams. The debris dams were constructed from the 1960’s until the 1990’s by SBCFCD and other agencies described in the individual barrier write-ups. Many of these dam where built in response to fires occurring in the Santa Ynez Mountains and designed to trap the anticipated high levels of sediment and debris conveyed down the creek during successive high rainfall events (pers. comm. Treiberg).

Ecological Impact on Salmonids-

The culverts that convey stream flows through the debris dams are impassable for steelhead and/or rainbow trout populations due to the excessive length, moderate to steep slope, smooth bottom, accelerated stream velocities, shallow depth, and/or excessive jump height at the outlet. The effectiveness of the recently complete fishway at the new Montecito Debris Dam has not yet been assessed. These debris dams reduce the connectivity of a salmonid population within their respective watersheds and prevent salmonids from accessing habitat upstream. In most cases, the highest quality salmonid habitat for spawning and rearing is encountered upstream of the debris dams, where perennial flows are generally sustained. The construction and maintenance of the debris basins upstream of the dam has a significant impact on the aquatic and riparian habitat of the stream. The basins are highly exposed to the sunlight due to the absence of large trees that form the natural riparian canopy. Fast growing willows are common in the basins until sediment is trapped and cleared. Exotic plant species are also quick to become established in the disturbed debris basin and can readily spread upstream and downstream from these locations.

Debris Dam Maintenance and Flood Control Benefit-

The debris dams that are maintained and periodically cleared are effective in trapping large amounts of sediment and debris during periods of high stream flow. During years with lower peak stream flow, the debris dams do not usually fill with sediment and generally require minimal maintenance. Following extremely high stream flow years, the debris basin and culvert often fill completely with sediment causing stream flows to be conveyed over the dam. Following such high flow events, the SBCFCD clears the debris basins of sediment and unplugs the culvert so stream flows can pass through the culvert and the basin is cleared for future sediment trapping. The debris dam on Carpinteria Creek is not currently maintained, and the culvert and basin are significantly filled with sediment, debris, and riparian growth. The SBCFCD has recently completed two projects designed to improve steelhead passage conditions at a grade control structure and newly built debris dam on Montecito Creek.

Study of the Impacts of Debris Dams on Watershed Functions-

The significant impacts that the debris dams have on the hydrology, geomorphology, biology, socioeconomic, and flood control within local watersheds are poorly understood. Due to the significant biological impacts of debris dams on southern Santa Barbara County watersheds, there is local interest to better understand the impacts of debris dams and identify opportunities to improve stream conditions for native wildlife and natural stream functions. A master's project that would conduct an environmental analysis of south coast debris basins has been proposed by the Santa Barbara County Task Force of the Southern California Wetlands Recovery Project, in coordination with the Bren School of Environmental Science and Management at the University of California Santa Barbara.

Recommended Action-

Providing upstream salmonid passage at SBCFCD debris dam sites is a high priority for long-term watershed and regional southern steelhead recovery in several focal watersheds. Due to the complex issues surrounding debris dams and limited knowledge of their effectiveness for providing flood control, a coordinated study of the impacts of debris dams on watershed dynamics is recommended in order for the SBCFCD to maintain flood control objectives while ensuring healthy stream functions and upstream passage for the endangered southern steelhead. A collaborative management plan should be developed in coordination with the SBCFCD, NMFS, CDFG, watershed stakeholders and potentially other interested parties.

One component of this study should investigate the feasibility of removing some of the debris dams and implementing alternative actions for achieving flood control objectives. In order to more fully understand the potential impacts of removing debris dams, a detailed analysis of successfully completed debris dam removals should be conducted. In addition to assessment of successfully removed debris dams, a unique opportunity exists to conduct a case study of debris dam removal at the obsolete Carpinteria Creek Debris Dam (BR_CA_8).

The following debris dams are known to be currently preventing upstream steelhead/rainbow trout passage and should be high priorities for allowing effective fish passage at the site.

- Carpinteria Creek (BR_CA_8)
- Gobernador Creek (BR_CA_GR_6)
- San Ysidro Creek (BR_SY_10)
- Cold Springs Creek (BR_MO_CS_2)
- Rattlesnake Creek (BR_MN_RE_7)
- Maria Ygnacio Creek (BR_AO_MY_17,18)

The following debris dams occur on stream reaches where the status of salmonids is not currently known. Providing effective fish passage at these dam sites should be pursued along with downstream projects that allow steelhead access to the dam in the future.

- Mission Creek (BR_MN_14)
- San Antonio Creek (BR_AO_MY_SA_5)

The newly completed debris dam on Montecito Creek (BR_MO_13) should be monitored to determine the effectiveness of the installed fishway.

Outfitting the existing debris dam culverts with baffles or constructing fishways around the dams is not recommended due to the poor effectiveness of these actions. See section 7.8 for additional discussion of the disadvantages of baffles and fishways. Baffles that were installed inside the Maria Ygnacio Debris Dam culvert to provide upstream fish passage regularly blew out (pers. comm. Treiberg), and they no longer exist. Salmonids are currently known to exist downstream of this dam, but not upstream.

Chapter 8: Keystone Barrier Priority Ranking

8.0 Keystone Barrier Identification

A keystone barrier is the most downstream barrier in a watershed that is determined to be impassable or impose an extremely high degree of difficulty to upstream, adult steelhead passage during ideal migration flows. These barriers have received barrier severity scores of 0.9 (Extremely High Degree of Difficulty-Impassable) or 1.0 (Impassable). The Highway 101 CALTRANS Culvert (BR_AH_1) on Arroyo Hondo, which received a severity score of 0.8 (High Degree of Difficulty), was included as a keystone barrier due it being the only anthropogenic barrier in the watershed and it's relatively high severity. Barriers on private land that were not directly assessed for severity, but are believed to block upstream migration, were also included. Steelhead passage improvement priorities should focus on these barriers prior to steelhead passage projects upstream in their respective watershed, unless unique opportunities arise upstream that should be capitalized on. Keystone barriers should be thought of as essential steps to steelhead recovery within each watershed.

8.1 Priority Ranking Methods for Keystone Barriers within the Study Area

Two methods were developed to rank the most critical "keystone" barrier(s) for each focal watershed within the study area. These two ranking methods allow resource managers to assess which regional fish passage improvement projects will provide 1) the greatest immediate benefit to existing salmonid populations and 2) the greatest long-term benefit to regional steelhead recovery. The same keystone barriers identified in each watershed are ranked using both methods. The objective of both Keystone Barrier Priority Ranking for Multiple Watersheds methods is to arrange the furthest downstream barriers in focal watersheds that are directly, or potentially blocking, or severely impeding upstream steelhead passage in order from high to low priority for improving or providing upstream steelhead passage.

8.1.1 Immediate Keystone Barrier Priority Ranking (Stoecker)

This ranking method was designed to give the highest priority to fish passage improvement projects at keystone barriers that would provide the greatest immediate habitat gain to currently (2000-2002) documented adult steelhead populations. The method determines the habitat gain that would result from adequate fish passage at the barrier site to the next impassable or extremely high severity barrier that likely blocks upstream passage during most or all flow conditions. This ranking method factors the salmonid population status of each watershed into the ranking score for each keystone barrier so that barriers known to be directly impacting recently identified upstream migrating adult steelhead receive a higher score than barriers that exist in a watershed where salmonids have not been identified recently.

Criteria

1) Determine the habitat score upstream of each keystone barrier to the next identified barrier (or barriers for multiple tributaries) with a barrier severity of 0.9 (Extremely High Degree of Difficulty-Impassable) or 1.0 (Impassable). See section 5.0 for habitat scoring methods.
2) Sort the barriers into three separate groupings based on the salmonid status for the watershed that the keystone barrier occurs in. The highest-ranking group of barriers has the highest salmonid status score of 1.0, which means that salmonids are present (2000-2002) in the watershed and current (2000-2002) adult steelhead documentation exists. The next grouping of barriers has salmonid status scores of 0.9 and 0.8. The

third and final grouping of barriers have salmonid status scores less than 0.8. See section 6.0 for the salmonid status scoring method and definitions.

3) Within each of the three salmonid status groupings, rank the keystone barriers by the determined total habitat score upstream to the next 0.9 or 1.0 severity barrier(s) in a descending manner from the greatest habitat score.

8.1.2 Long-term Keystone Barrier Priority Ranking (Stoecker 2002)

This ranking method is designed to prioritize the keystone barriers based strictly on the determined habitat score upstream of the barrier to the identified or estimated natural upstream limit(s). This ranking is intentionally not influenced by the watershed's salmonid status in order to identify long-term steelhead recovery potential regardless of weather or not salmonids continue to exist in the drainage and without considering upstream migration barriers. All upstream tributaries with habitat quality scores are included in this scoring. In most watersheds, multiple impassable barriers exist upstream of the keystone barrier and require a significant long-term effort to allow access to the maximum amount of historically available habitat. See individual watershed barrier tables for more information about upstream barriers. This ranking should help resource managers determine where the greatest amount of habitat gain will potentially occur above keystone barriers with long-term planning and improved upstream steelhead passage.

Criteria

1) Combine all the reach habitat scores upstream of each keystone barrier to the natural upstream limits.
2) Sort the keystone barriers by descending total habitat score to the natural upstream limits.

Refer to Table Folder for:
Keystone Barrier Priority Ranking Results
Table 8.1.3

Refer to Table Folder for:
Keystone Barrier Priority Ranking Results
Table 8.1.3

Chapter 9: Habitat Summary and Recovery Ranking of Watersheds

9.0 Habitat Introduction

In order to assist local resource managers focus steelhead restoration efforts on the watersheds in the study area that have a high steelhead recovery potential, key habitat conditions are summarized in this section along with a ranking method that was developed to provide a rough estimate of watershed priorities.

9.1 Watershed Habitat Summary

The following table summarizes the determined habitat scores and regional rankings for focal watersheds. The total habitat score is the result of multiplying the determined total habitat quantity by the habitat quality for each stream reach and adding all the habitat reach scores for each watershed. Each watershed is also ranked against other focal watersheds for each of the habitat scoring boxes in order to allow comparison within each of the habitat columns. The numbers obtained for habitat quantity and quality are derived from identified habitat reaches described in section 5.0 and displayed on individual watershed maps in section 7.0.

9.1.1 Watershed Habitat Summary Table

Watershed Habitat Summary Statistics

Total Habitat Quantity		
Watershed	Miles	Rank
Gaviota	23.05	1
Jalama	21.18	2
Atascadero*	16.36	3
Carpinteria	16.07	4
SanJose*	11.14	5
Mission	9.26	6
Rincon	7.42	7
Arroyo Burro	7.21	8
Corral	6.94	9
Tecolotito*	6.76	10
Refugio	5.72	11
El Capitan	5.62	12
Tajiguas	5.28	13
Dos Pueblos	4.81	14
Montecito	4.17	15
Arroyo Paredon	4.14	16
Tecolote	4.08	17
Gato	3.80	18
Cojo	3.72	19
San Ysidro	3.25	20
Santa Anita	2.58	21
Arroyo Quemado	2.28	22
Arroyo Hondo	1.89	23
San Onofre	0.82	24

Average Habitat Quality		
Watershed	Quality	Rank
Arroyo Hondo	0.885	1
Carpinteria	0.793	2
Corral	0.748	3
Rincon	0.740	4
Montecito	0.735	5
El Capitan	0.733	6
San Ysidro	0.710	7
Tecolote	0.668	8
Dos Pueblos	0.649	9
San Onofre	0.637	10
Mission	0.633	11
Santa Anita	0.632	12
Arroyo Paredon	0.612	13
Tajiguas	0.577	14
Refugio	0.575	15
Jalama	0.571	16
Arroyo Burro	0.538	17
Cojo	0.525	18
San Jose*	0.515	19
Arroyo Quemado	0.504	20
Gato	0.494	21
Atascadero*	0.455	22
Gaviota	0.434	23
Tecolotito*	0.398	24

Total Habitat Score		
Watershed	Score	Rank
Carpinteria	12.58	1
Jalama	11.99	2
Gaviota	9.89	3
Atascadero*	6.97	4
Mission	5.67	5
Rincon	5.37	6
Corral	5.15	7
El Capitan	4.12	8
San Jose*	3.74	9
Arroyo Burro	3.72	10
Refugio	3.22	11
Dos Pueblos	3.12	12
Tajiguas	3.04	13
Montecito	3.02	14
Tecolote	2.55	15
Arroyo Paredon	2.48	16
San Ysidro	2.28	17
Tecolotito*	1.93	18
Cojo	1.93	18
Gato	1.87	20
Arroyo Hondo	1.65	21
Santa Anita	1.51	22
Arroyo Quemado	1.09	23
San Onofre	0.52	24

*** Sub-watersheds of the Goleta Slough Watershed**
Goleta Slough watershed has a Total Habitat Score of 12.46, an Average Habitat Quality of 0.466 and a Total Habitat Quantity of 34.27 miles

Table 9.1.1

9.2 Steelhead Recovery Ranking of Watersheds (Stoecker)

The Steelhead Recovery Ranking of Watersheds method was designed to rank the focal watersheds identified in this study based on the total habitat score and the salmonid status values for each watershed. This ranking is intended to give a rough estimate of the steelhead recovery "potential" for focal watersheds, assuming that adequate migratory access is provided at migration barrier sites identified in this report. This ranking method is weighted to give watersheds with a higher total habitat score a higher priority, but also factors the salmonid status score into the ranking and places watersheds with currently documented (2000-2002) anadromous adult steelhead occurrence at the top of the ranking.

Criteria-

1) Add all reach habitat scores within each focal watershed to get a total habitat score for the watershed. See section 5.0 for habitat scoring method.
2) Multiply this total habitat score for each watershed by the salmonid status score to get the steelhead recovery score for the watershed. See section 6.0 for salmonid status scoring methods.
3) Sort the watershed in a descending order based on the steelhead recovery score.
4) In order to give watersheds with a current (2000-2002) adult steelhead presence a higher priority ranking, the Arroyo Hondo watershed and San Jose Creek sub-watershed were elevated in rank to just below the top five watersheds that also have current adult steelhead documentation, but higher total habitat scores. The San Jose Creek sub-watershed received a salmonid status score of 1.0 in this ranking, despite not having current adult steelhead documentation, due to the "current" adult steelhead documentation in Maria Ygnacio Creek, which shares the same watershed with San Jose Creek (Goleta Slough).

9.3 Steelhead Recovery Ranking of Watersheds Results

Steelhead Recovery Ranking of Watersheds

Watershed	Total Habitat Quantity (miles)	Total Habitat Quantity Rank	Average Habitat Quality	Average Habitat Quality Rank	Total Habitat Score (A)	Total Habitat Score Rank	Salmonid Status (B)	Steelhead Recovery Score (AxB)	Steelhead Recovery Priority
Carpinteria	16.07	4	0.793	2	12.58	1	1.0	12.58	**1**
Gaviota	23.05	1	0.434	23	9.89	3	1.0	9.89	**2**
Jalama	21.18	2	0.571	16	11.99	2	0.7	8.39	**3**
Atascadero*	16.36	3	0.455	22	6.97	4	1.0	6.97	**4**
Mission	9.26	6	0.633	11	5.67	5	1.0	5.67	**5**
San Jose*	11.14	5	0.515	19	3.74	9	1.0	3.74	**6**
Arroyo Hondo	1.89	23	0.885	1	1.65	21	1.0	1.65	**7**
Rincon	7.42	7	0.740	4	5.37	6	0.9	4.83	**8**
Corral	6.94	9	0.748	3	5.15	7	0.7	3.61	**9**
Dos Pueblos	4.81	14	0.649	9	3.12	12	0.9	2.81	**10**
Tajiguas	5.28	13	0.577	14	3.04	13	0.9	2.74	**11**
Montecito	4.17	15	0.735	5	3.02	14	0.9	2.72	**12**
Tecolote	4.08	17	0.668	8	2.55	15	0.9	2.30	**13**
Refugio	5.72	11	0.575	15	3.22	11	0.7	2.25	**14**
El Capitan	5.62	12	0.733	6	4.12	8	0.5	2.06	**15**
San Ysidro	3.25	20	0.710	7	2.28	17	0.9	2.05	**16**
Arroyo Paredon	4.14	16	0.612	13	2.48	16	0.8	1.98	**17**
Arroyo Burro	7.21	8	0.538	17	3.72	10	0.5	1.86	**18**
Santa Anita	2.58	21	0.632	12	1.51	22	0.9	1.36	**19**
Tecolotito*	6.76	10	0.398	24	1.93	18	0.4	0.77	**20**
Arroyo Quemado	2.28	22	0.504	20	1.09	23	0.7	0.76	**21**
Gato	3.80	18	0.494	21	1.87	20	0.4	0.75	**22**
Cojo	3.72	19	0.525	18	1.93	19	0.3	0.58	**23**
San Onofre	0.82	24	0.637	10	0.52	24	0.6	0.31	**24**

*Sub-watersheds of the Goleta Slough Watershed

Table 9.3

Chapter 10: References and Personal Communication

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