

Inventory of Historical Structures and Anadromous Fish Passage Conditions in the San Lorenzo River, Santa Cruz County, California

Final Report
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Reference List for Acronyms and Names

Anadromy, Anadromous - Steelhead, coho salmon and lamprey are anadromous, meaning that young fish rear in freshwater habitats for varying lengths of time, migrate out to the ocean to mature, and then return to freshwater to reproduce. The extent of anadromy is the upstream limit that fish migrating from the ocean can reach.

CDFW – California Department of Fish and Wildlife (even if called California Department of Fish and Game at the time)

CFS – cubic feet per second, river discharge measurement

County – County of Santa Cruz

IWRP – Integrated Watershed Restoration Program. A voluntary, collaborative program coordinated by the Resource Conservation District of Santa Cruz County to facilitate the design, permitting and implementation of projects to benefit natural resources.

JSSH Steelhead Monitoring Program – The Juvenile Steelhead and Stream Habitat (JSSH) Monitoring Program is a partner funded monitoring program that collects and tracks juvenile steelhead densities at sites throughout the San Lorenzo River Watershed

NOAA Fisheries – The federal fisheries agency within the National Oceanic and Atmospheric Administration

PAD – Passage Assessment Database, California Department of Fish and Wildlife

RCD - Resource Conservation District of Santa Cruz County

SALMONIDS – refers to both steelhead and coho salmon, both in the salmon family

TBD - To be determined at a later time

USGS – United States Geological Survey, records flow data at Big Trees gage in Felton

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EXECUTIVE SUMMARY

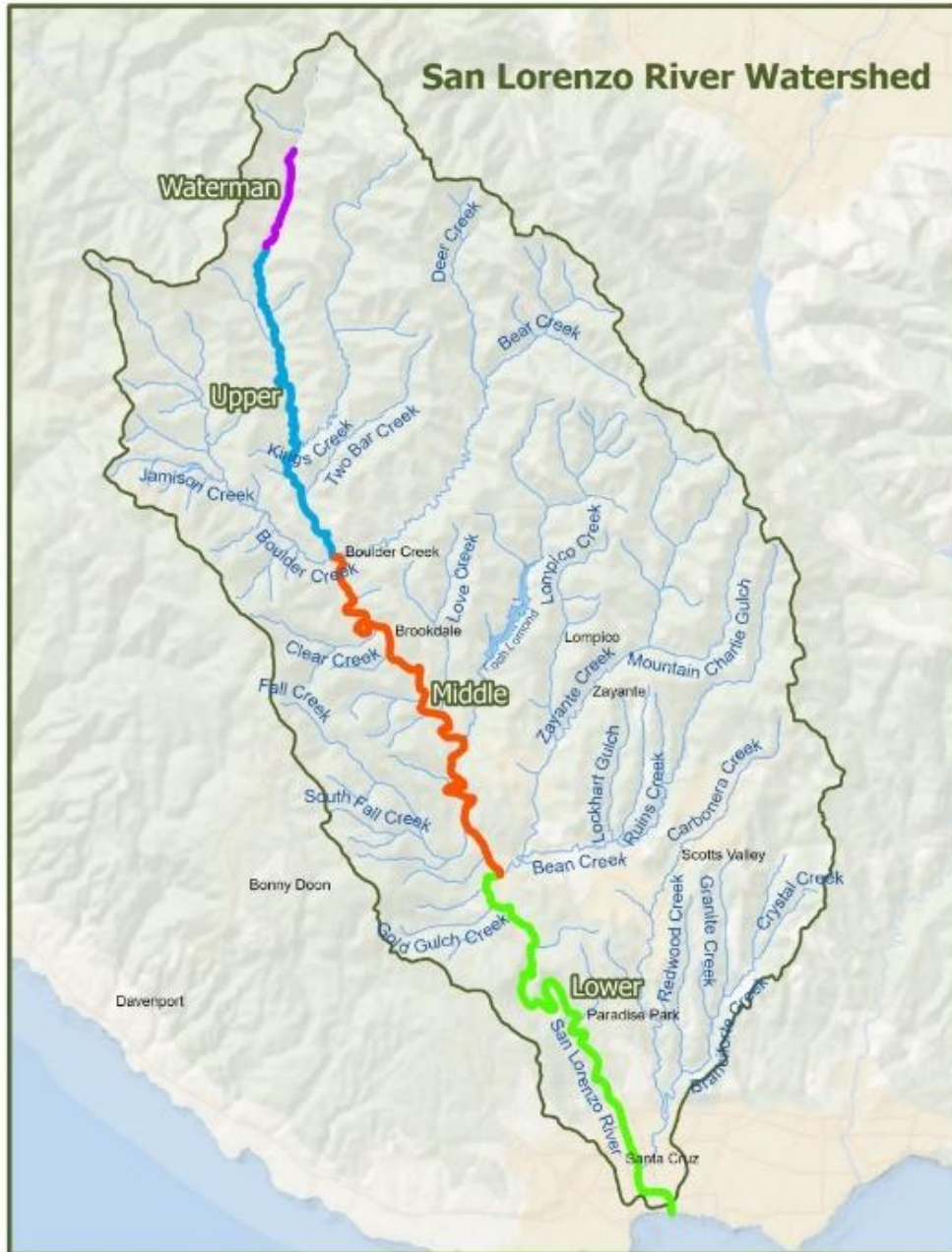
This report provides an inventory of historical, anthropogenic (human-constructed) structures on the San Lorenzo River, Santa Cruz County, that affect the migration passage of steelhead (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and Pacific lamprey (*Entosphenus tridentatus*). Steelhead are listed as threatened under the federal Endangered Species Act (ESA) and coho salmon are listed as endangered under both the state and federal ESA. Pacific lamprey are listed as a California State Species of Special Concern by California Department of Fish and Wildlife (CDFW). These historical structures affect upstream and downstream passage for adults and juveniles, especially during dry years or periods of low base flow in the river.

This study focused on documenting 37 historical structures that completely or partially span the San Lorenzo River. Of those 37 historical structures, 24 structures span the channel and affect passage. The majority of these channel spanning, historical structures are recreational flashboard dams. Of the 24 that affect passage, 7 are within the middle section of the river, between Felton and Bear Creek, and affect passage into the important spawning and rearing areas in Boulder and Bear creeks, as well as the upper San Lorenzo River and tributaries. Within the upper section of the river, 14 historical structures affect passage. In the Waterman Gap section of the river, there are 3 structures that affect passage into the most upstream section of anadromy.

This study also documents natural features that have the potential to affect passage. At least 18 natural features may limit access into the middle and upper watershed, including critical (shallow) riffles, boulder cascades, and bedrock shelves. Natural features are included in the report to provide context for the historical, anthropogenic structures but are not recommended for modification or removal. In general, natural features are passable during storm events with at least 40-100 cubic feet per second (cfs).

This report recommends the removal or modification of channel-spanning historical structures that substantially affect fish passage. Specifically, this report recommends that the County, CDFW, and NOAA Fisheries work together to facilitate the removal or modification of historical structures rated as Medium or High Passage Severity.

As a next step, the County of Santa Cruz Water Resources Program will develop an outreach letter that would be sent to property owners with structures rated as Medium or High Passage Severity. This letter will provide information about this study and ask property owners to consider working with involved agencies and organizations to remove or modify these structures.



River Sections

In this report, the San Lorenzo River is divided into 4 sections: (1) Lower River, (2) Middle River, (3) Upper River and (4) Waterman Gap. Starting at the river terminus at the Pacific Ocean, the **Lower River** extends to the confluence with Zayante Creek in Felton. The **Middle River** extends from the confluence with Zayante Creek to the confluence with Bear Creek. The **Upper River** extends from the confluence with Bear Creek to the Highway 9 crossing in the Waterman Gap area. The **Waterman Gap** section extends from the Highway 9 crossing to the end of anadromy within Castle Rock State Park.

STUDY PURPOSE

The primary purpose of this study is to inventory historical, anthropogenic (human built) structures along the mainstem San Lorenzo River and evaluate any impacts to passage for anadromous fishes including adult and juvenile steelhead (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), and Pacific lamprey (*Entosphenus tridentalis*). Study findings were coordinated with the statewide Passage Assessment Database (PAD), managed by the California Department of Fish and Wildlife (CDFW), which has been updated to reflect this current inventory.

The information in this report is intended to facilitate the removal of these structures to benefit steelhead, coho salmon, and Pacific lamprey migration up and down the San Lorenzo River. All three species need passage for adults migrating upstream from the ocean and for juveniles migrating downstream to the ocean. In addition, adult steelhead that survive spawning need downstream passage to return to the ocean. Juvenile steelhead and coho salmon need upstream passage to find suitable rearing locations and to escape high flows.

For the San Lorenzo River Watershed, the populations of steelhead and coho salmon are identified as independent populations and are critical to the recovery of these fish. The San Lorenzo steelhead population is part of the Central California Coast Distinct Population Segment (DPS), which is listed as threatened under the federal Endangered Species Act (ESA). The San Lorenzo River is a recovery watershed for coho salmon as part of the Central California Coast Evolutionary Significant Unit (ESU), which is listed as endangered under both the federal and state ESAs. Both steelhead and coho salmon belong to the biological salmon family and are referred to as salmonids.

The San Lorenzo River Watershed also supports Pacific lamprey, which are considered a Species of Special Concern by CDFW. Efforts to remove passage barriers for steelhead and coho salmon will often benefit Pacific lamprey. Projects to modify structures should consider lamprey-specific passage capabilities, which differ from those of salmonids. Other native fishes, such as Sacramento sucker (*Catostomous occidentalis*), will also benefit from improved passage conditions along the mainstem.

This study documents the physical characteristics of the structures and includes observations of most structures at different flow conditions. This study does not provide a detailed analysis of streamflow conditions that affect passage at these structures or make any recommendations regarding flow or regulation of flow to improve passage.

BACKGROUND

Most of the historical structures documented in this study are flashboard dams that were constructed in the 1930's to 1950's and are associated with camps, public recreation areas, and private residential properties. The San Lorenzo River has many bedrock outcrops, which made it relatively easy to construct a grouted rock or concrete structure for a flashboard dam. In the summer season, wooden flashboards were installed into the structure to create deeper recreational swimming and boating areas. Most structures are still privately owned with two located at camps, two at public facilities (Ben Lomond and Boulder Creek) and one owned by a homeowner's association.

In general, flashboard dams consist of the abutments, which supports the structure at the riverbanks, the spillway, the lowest area where the dominant river flow occurs, and sometimes an apron, where a concrete section extends downstream from the spillway (see illustration in Appendix D).

For many decades, there have been concerns about how these flashboard dam structures, and their operation, impact fish passage. In 1988, the County of Santa Cruz sent a letter to the California Department of Fish and Game asking them to address the removal of the identified barriers, which included 17 structures on the San Lorenzo River. In addition, community members and local fishery biologists have long advocated for modifying or removing flashboard dams and other passage barriers on the San Lorenzo River.

Steelhead were listed under the federal Endangered Species Act (ESA) as threatened in 1997 and then became a State Species of Special Concern for CDFW. Coho salmon were initially listed under the federal ESA in 1996 as threatened and then listed as endangered in 2005. CDFW listed coho as endangered in 2005 under the California Endangered Species Act (CESA).

These listings led to increased attention by federal and state regulators, and property owners were encouraged to obtain a CDFW Streambed Alteration Agreement to operate their flashboard dams. Starting in 2000, the CDFW received several Streambed Alteration Agreement requests for the operation of flashboard dams on the San Lorenzo River. CDFW requested support from NOAA Fisheries to clarify to property owners the regulatory requirements of operating a flashboard dam. NOAA Fisheries and CDFW wrote letters to these applicants that explained the necessary operating requirements. These requirements included providing for upstream juvenile fish passage while the flashboards were in place, and water quality and biological monitoring during the installation, removal, and operation of the dam. In addition to the design, permitting, and construction of juvenile fish passage structures, monitoring costs were estimated at about \$15-25,000 per year. In response to these new requirements, most property owners elected to cease operation of their flashboard dams. During the 2001 CDFW survey, some of the flashboard dams were still in use. However, by 2006, almost all property owners had discontinued use of these structures.

While the structures are no longer used in the summer season, the remaining dam infrastructure, including the abutments, spillway, and aprons, continue to affect passage conditions throughout the year. The structures affect the flow of water, create hydraulic drops in the channel, and accumulate wood and debris that temporarily restrict or block fish passage. For example, flows across a concrete spillway are faster and shallower than the adjacent river because the abutments squeeze the river flow across the narrow spillway and the concrete generates higher velocities which reduces the depth of flow across the spillway. In addition, there is often a drop on the downstream end of the spillway or apron, which means that fish need to swim up cascading flow or jump up onto the spillway.

In 2001, the CDFW Fisheries Restoration Grants Program funded a survey of anthropogenic structures on the mainstem of the San Lorenzo River. With funding from this grant, the Community Action Board (CAB) surveyed the San Lorenzo River. This inventory provided basic information on most of the historical structures along the river and served as a foundation for this study, the 2004 San Lorenzo Steelhead Enhancement Plan passage recommendations, and work completed by the Resource Conservation District (RCD) of Santa Cruz County.

In 2004, the San Lorenzo Steelhead Enhancement Study (Alley et al. 2004), identified structures throughout the watershed that impact passage and prioritized several structures for modification or removal. The RCD used this information and recommendations from this study to approach and work with property owners.

Between 2004 and 2010, the RCD and the Integrated Watershed Restoration Program (IWRP) invested substantial staff and financial resources to engage property owners at barriers identified as high priority in the 2004 San Lorenzo Steelhead Enhancement Plan. The RCD coordinated resource agency involvement and developed conceptual and draft remediation plans. These efforts resulted in a successful project to modify the Four Rock Cascade within Henry Cowell State Park. However, other efforts with private and public agency property owners have been unsuccessful.

Over time, our understanding of how these structures affect fish passage has changed. At first, these structures were seen as passable during normal and wet years and possible barriers during dry and drought years. However, recent drought years and projected increase in drought conditions due to climate change elevates the urgency to address salmonid passage at these structures. Also, there is now a better understanding of passage needs for Pacific lamprey.

In addition, the condition of these historical structures continues to decline over time. While structural degradation can benefit passage in some cases, it can also increase passage severity. For example, flow piping under the Barker's Dam structure now eliminates flow through the spillway during drier springs, when juveniles are migrating downstream. The historical structure at Manzanita detached from the banks and flipped forward; while this structure currently provides passage, it could easily become blocked with sediment and wood and become a passage barrier.

This study relies on multiple field studies, observations, and professional assessments to evaluate how these structures affect fish passage. The intent is to create a strong framework to address and finally remediate these historical structures to improve upstream and downstream passage for steelhead, coho salmon, Pacific lamprey, and other native fishes.

Steelhead and Coho Salmon Migration

Excerpt from Hagar Environmental Science, 2014. *Assessment of Streamflow Effects on Migration, Spawning, and Rearing Habitat for Anadromous Salmonids in Streams Influenced by the City of Santa Cruz Water Diversions including Newell Creek.*

Steelhead and coho salmon along the central California coast enter freshwater to spawn when winter rains have been sufficient to raise streamflows and breach the sandbars that form at the mouths of many streams during the summer. Increased streamflow during runoff events also appears to provide cues that stimulate migration and allow better conditions for fish to pass obstructions and shallow areas on their way upstream. The season for upstream migration and spawning of steelhead adults lasts from late October through the end of May but typically the bulk of migration (over 95% in Waddell Creek) occurs between mid-December and mid-April (Shapovalov and Taft 1954). Coho salmon have a more abbreviated spawning season that occurs earlier in the winter. In California, coho spawning migrations occur between late October and early March with more southern populations typically spawning slightly later. Between 1933 and 1942, the coho migration in Waddell Creek occurred between early December and early March with 90% of the run completed by early February (Shapovalov and Taft 1954). This relatively early spawning period for coho salmon increases the probability that their embryos will be exposed to severe conditions during high flow episodes and has resulted in very weak year classes in some of the remaining runs south of San Francisco Bay (Anderson 1995).

Steelhead have strong swimming and leaping abilities that allow them to ascend streams into small tributary and headwater reaches. Steelhead can swim at rates of up to 4.5 feet per second (fps) for extended periods of time and can achieve burst speeds of 14 to 26 fps during passage through difficult areas (Bell 1986). Leaping ability is dependent on the size and condition of fish and hydraulic conditions at the jump. Given satisfactory conditions, a conservative estimate of steelhead leaping ability is a height of 6 to 9 feet (Bjornn and Reiser 1991), although other estimates range from 11 feet (Bell 1986) to as high as 15 feet (McEwan 1999). Coho have slightly lower swimming and leaping ability than steelhead, with cruising speeds up to 3.5 fps and burst speed of 10 to 21 fps (Bell 1986). Maximum jumping height for coho is reported by Bell (1986) at just over 7 feet. These differences in swimming ability may limit coho to relatively lower gradient reaches of coastal streams.

STUDY COMPONENTS

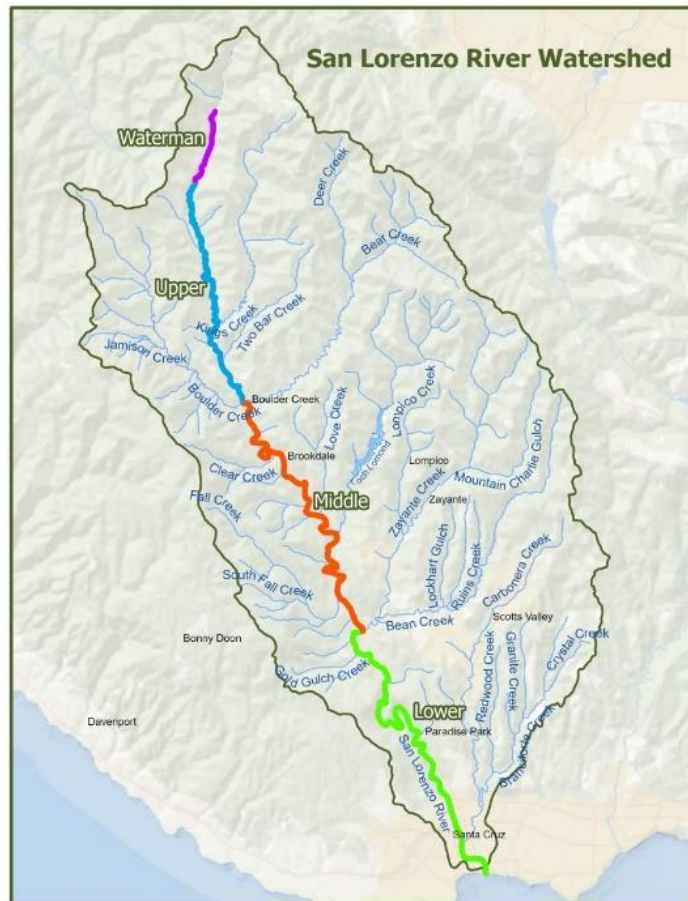
This study integrates multiple surveys and observations (2001-2023) to document historical structures and provide professional judgement about passage conditions along the San Lorenzo River. Previous work to document and evaluate passage on the San Lorenzo River contributed to this study. In addition, results from this study were coordinated with the California Department of Fish and Wildlife's Passage Assessment Database (PAD), which has been updated to reflect study results. The Passage Assessment Database can be accessed at <https://nrm.dfg.ca.gov/PAD/Default.aspx>

River Sections

In this report, the San Lorenzo River is divided into 4 sections and referred to with a capitalized name: (1) Lower River; (2) Middle River, (3) Upper River and (4) Waterman Gap. Starting at the river terminus at the Pacific Ocean, the **Lower River** extends to the confluence with Zayante Creek in Felton. The **Middle River** extends from the confluence with Zayante Creek to the confluence with Bear Creek. The **Upper River** extends from the confluence with Bear Creek to the Highway 9 crossing in the Waterman Gap area. The **Waterman Gap** section extends from the Highway 9 crossing to the end of anadromy within Castle Rock State Park.

2001 CDFW Survey

In 2001, the CDFW Fisheries Restoration Grants Program provided funding to conduct a survey of anthropogenic structures on the mainstem of the San Lorenzo River. A small team from a local job training organization, Community Action Board (CAB), surveyed portions of the San Lorenzo River between Felton and Waterman Gap (Middle and Upper River sections). During the survey, historical structures were located, photographed, and documented with global positioning system (GPS) DWD. The study results included the photos, GPS points, and a table of the barriers with a priority for removal. This study also



documented which structures were actively used in 2001 and provided data to the CDFW's PAD.

The County and the RCD completed a post-2001 survey project to organize the photos in a downstream to upstream order and geolocate the structures. Study errors and omissions, including PAD submissions, were corrected through this study.

2004 Rincon to Eagle Creek Survey

Jennifer Nelson and Serge Glushkoff, CDFW, and Kristen Schroeder Kittleson, County of Santa Cruz, walked from the Rincon area to Eagle Creek within Henry Cowell State Park when the river flow was about 50 cfs. The goal of the fieldwork was to look for critical riffles and structures within the Lower River section and to evaluate passage at natural bedrock riffles and cascades.

2005 Highway 9 to End of Anadromy Survey

In 2005, Jennifer Nelson, CDFW, and Kristen Schroeder Kittleson, County of Santa Cruz, walked from the Highway 9 crossing at Post-Mile 19.2 (Waterman Gap) to the end of anadromy. The end of anadromy is a boulder and bedrock cascade waterfall, approximately 40' high, within Castle Rock State Park.

At this time, there was a substantial partial/temporal barrier in the area upstream of the Kings Creek Truck Trail where a wood and boulder complex blocked the channel. In 2022, the wood had shifted and no longer blocked the channel.

2006 Middle River Kayak Survey

In 2006, Jennifer Nelson, CDFW, and Kristen Schroeder Kittleson, County of Santa Cruz, surveyed the river from Boulder Creek to Felton by kayak with the goal of better locating the structures inventoried in the 2001 survey. Structures were photographed and GPS location data was collected when possible. Natural features such as bedrock shelves and cascades were also noted and photographed.

2014 Upper River Survey

In 2014, Kristen Kittleson and Watershed Stewards surveyed structures in the Upper River and Waterman Gap reaches. Structures identified in the 2001 survey were located, GPS confirmed and photographed. During these surveys, additional structures were discovered in the reach downstream from Camp Campbell; GPS and photos were collected for these additional structures.

2014 Waterman Gap Survey

In 2014, Kristen Kittleson and Watershed Stewards surveyed structures in the Waterman Gap reach. Upstream of the Kings Creek Truck Trail ford crossing, there are a series of small habitat structures that were installed by the County of Santa Cruz. These structures include channel-spanning log structures intended to increase pool formation and habitat complexity.

2015 Lower San Lorenzo

On April 28, 2015, Kristen Kittleson and Brian Spence, NOAA Fisheries, walked downstream from Rincon to Paradise Park.

2008-2018 High Flow Monitoring

Following the 2006 kayak survey, several Middle River structures were photographed at different flows. Following the 2014 Upper River survey, many structures were visited during migration flows and photographed to develop a better understanding of how the structures appeared during different flows.

2001-2022 Additional Observations

In both 2020 and 2022, Watershed Stewards assisted Kristen Kittleson to check Middle and Upper River sites to relocate, photograph current conditions and collect more accurate GPS data points.

2022 Rincon to Eagle Creek Survey

In 2022, a Watershed Steward and a volunteer walked the Rincon to Eagle Creek reach to collect better GPS data and photograph current conditions.

2004-2022 High Flow Site Visits

Kristen Kittleson, County of Santa Cruz, observed and photographed a few of the more accessible structures during high flows throughout the study period.

2004-2022 JSSH Monitoring Program and Additional Observations

Data on juvenile steelhead density from the Juvenile Steelhead and Stream Habitat (JSSH) monitoring program, observations of redds and adult fish, and other research have been incorporated into the report.

Caltrans FishPAC

The Fish Passage Advisory Committee (FishPAC) is a joint effort between the California Department of Transportation (Caltrans), California Department of Fish and Wildlife (CDFW), National Marine Fisheries Service (NOAA Fisheries), US Fish and Wildlife Service (USFWS) and other interested advocates of fish passage efforts. Jennifer Nelson, CDFW, and Kristen Kittleson, County of Santa Cruz, have participated in FishPAC and contributed to the identification of Highway 9 at Waterman Gap as a high priority culvert for fish passage improvement.

Passage Severity

Each structure has been rated for Passage Severity as High, Medium, or Low. Structure ratings are shown in Appendix A, the photo catalogs and on the maps. Passage severity is based on agency guidelines for jump heights, downstream pool depths, and structure condition. Passage severity rating also relies on professional judgement that incorporates observations of the structure at different flows throughout the migration season and reflects assessments from other fishery professionals. Passage conditions for both juveniles and adults are integrated into passage severity rating. While these structures have been inventoried and assessed, they have not been formally evaluated for fish passage using hydraulic modelling.

Determination of Passage Category for CDFW Passage Assessment Database

This study submitted data on natural and historical structures to the CDFW PAD. Each structure was categorized for passage as temporal barriers, partial barriers, a combination of temporal and partial or not as barriers. Passage category incorporates a combination of the field measurements and professional judgment on how stream conditions will change with higher flows and how fish may navigate through or across a structure, with some additional observations during winter storms.

Barrier Categories

The following barrier categories and descriptions align with the CDFW's PAD.

Temporal Barriers. Temporal barriers are not passable at some flows. Within the context of this study, temporal barriers are typically passable during substantial storms with good migration flows. Passage will be difficult or not possible during low flows due to lack of depth across the spillway and at very high flows due to excess velocities. For example, for an adult migrating upstream, a historical dam structure may have insufficient depth across the spillway during low flows. At moderate flows, depths will increase across the spillway and velocities will allow the fish to swim up through the spillway. At higher flows, velocities through the constricted spillway may be too high to swim through. At very high flows, salmonids may be able to leap directly over the structure and bypass the spillway.

Partial Barriers. Partial barriers include structures that are considered a complete barrier to a specific life stage, such as juveniles, during all flows. Specifically, a jump of more than 1-foot is considered a partial barrier to juvenile salmonids at all flows. However, during moderate and high flows, the water surface level increases at the downstream end of structures, which reduces the jump height at these historical structures.

Partial and Temporal. Many structures were categorized as partial and temporal barriers, specifically for juveniles. This category includes structures that have more than a 1-foot jump at the downstream end during low flows (partial barrier) but could be passable at higher flows when this drop would be submerged due to elevated river levels (temporal).

Not a barrier. Historical structures that are currently level with the streambed or provide a space to swim through natural stream substrate were categorized as not a barrier. These include historical sills that sit even with the riverbed and railroad bridge abutments that are within the channel but are located towards one side. However, these structures can still influence natural channel dynamics by catching large woody material or creating increased velocities due to the restriction in channel cross-section.

Complete Barrier. Complete barriers are not passable for juvenile or adult salmonids. Complete barriers are considered the end of anadromy.

RESULTS

This section includes:

- A description of general passage conditions for the San Lorenzo River
- A description of passage severity rating
- Descriptions of structures with medium and high passage severity rating, listed in downstream to upstream order
- Appendix A: Summary Table that lists historical structures and major natural features
- Appendix B: Maps that show the location of the historical structures and other features along the San Lorenzo
- Appendix C: Photo Catalog of Historical Structures identified as Medium to High Passage Severity
- Appendix D: Photo Catalog of all structures, historical and current, and natural features

General Passage Conditions

Passage conditions vary among the four river sections and depend on channel characteristics, flow, and frequency of anthropogenic structures. Data collected through the Juvenile Steelhead and Stream Habitat (JSSH)/Steelhead Monitoring Program reflects steelhead access to different parts of the watershed in different hydrologic conditions and indicates where passage becomes restricted due to flow and historical structures.

There are numerous road crossings across the San Lorenzo River that do not impact fish passage. These include (downstream to upstream) the coastal rail bridge and trestle, three road crossings, and two pedestrian bridge crossings within the City of Santa Cruz in the Lower River. Highway 1 crosses the San Lorenzo in the Lower River; although this bridge has a mid-channel pier, it does not currently impact fish passage. In the Middle and Upper River, there are five Highway 9 bridge crossings that do not impact fish passage. All the state highway crossings, including Highway 9 at PM 19.2 (Waterman Gap), have recently been assessed and have been incorporated into the PAD.

Lower River

Passage into and out of the San Lorenzo River is consistently very good. Due to flows generated from the 138 square-mile watershed, the river is open during most of the migration season. In some years, anadromous fish have access to the San Lorenzo River when other bar-built estuaries are closed, such as in 2013-14 when Scott Creek was closed until February and coho salmon jacks came into the San Lorenzo River (Brian Spence, NOAA Fisheries, pers comm).

Shallow or “critical” riffles in the Lower River can create passage challenges during dry and drought years. For example, during the 1976-77 drought, shallow riffles immediately upstream of the lagoon area were impassable. The CDFW studied critical riffles over several years and

found that critical riffles in the Lower River were passable at approximately 40 cfs (Jankovitz, CDFW, 2020).

The City of Santa Cruz operates a surface water diversion within the Lower River. The Tait Street Diversion, in the reach upstream of Highway 1, includes a channel-spanning concrete weir and intake infrastructure. The weir structure is perforated to allow fish passage when flows are below the weir level. The Tait Street Diversion will be implementing passage improvements by 2035.

The Lower River contains numerous natural features, including riffles, bedrock shelves and boulder cascades, that influence passage conditions up to Zayante Creek, one of the largest tributaries, and the rest of the watershed. Passage can be challenging in the steep river gorge area of the lower River, within Henry Cowell State Park. Riffles, boulder cascades, and bedrock shelves create numerous places where migrating fish would need to swim swiftly into cascading waters or leap vigorously. The Rincon Riffle, a high gradient riffle in the Rincon area of Henry Cowell State Park, provides poor passage conditions in some years when the steep boulder cascade is difficult to swim up. In other years, the boulders shift and allow passage in deeper areas or along the left bank.

Four Rock Cascade is a steep boulder cascade located immediately upstream of the landmark “Four Rock”. This cascade was modified in 2008, as an IWRP project coordinated by the RCD. Initially, State Parks objected to the project since the local superintendent considered the cascade a natural feature. However, historical research showed that blasting for rail construction caused very large boulders to fall into the river at this location and, therefore, the feature was not a “natural feature” (Baldikowski, undated memo). The modification included the destruction of two key boulders in the cascade that allowed a straight leap up the most difficult portion of the cascade. While the modification improved passage, this feature is still considered a temporal barrier.

In the most upstream section of the Lower River, the City of Santa Cruz operates a surface water diversion at the Felton Diversion Dam that includes a channel-spanning weir with inflatable dam and fish passage facilities. The City has proposed providing a bypass flow of 40 cfs to ensure suitable passage conditions through the San Lorenzo Gorge during the migration season. The Felton Diversion Dam will be implementing passage improvements by 2035.

Data from the JSSH Steelhead Monitoring Program indicates that passage into the large Zayante sub-watershed is consistently very good. Even during dry or drought years, steelhead can access Zayante and Bean creeks during limited storm events. Densities of juvenile steelhead at Zayante sites are consistently some of the highest in the watershed, including densities of juveniles less than 75 mm Standard Length, which reflect spawning success. Lamprey adults and redds (nests) are regularly observed upstream of the river gorge, in riffles within Henry Cowell State Park.

Middle River

The Middle River spans from the Zayante Creek confluence to the Bear Creek confluence and runs through the communities of Felton, Ben Lomond, Brookdale, and Boulder Creek. Access into and up through the Middle River provides access to the major tributaries of Fall, Newell, Bear, and Boulder creeks.

The Middle River contains 7 historical structures that span the channel and affect passage conditions. An additional 13 structures are remnants that do not span the channel and do not impact passage conditions. The Middle River also includes many natural features, including bedrock shelves, and bedrock and boulder cascades.

Data from the JSSH Steelhead Monitoring Program indicate that the Middle River is passable to steelhead in most years, with more restricted access during drought years, such as 2015. The owners of the Huckleberry Island dam regularly observed adult steelhead swimming across the spillway in the days following storm events. In January 2012, Chinook salmon (*O. tshawytscha*) entered the San Lorenzo River and spawned immediately downstream of the Ben Lomond Dam, suggesting that the dam structure was a passage barrier at the time. In May 2021, lamprey redds were observed between the Highlands Historical Dam Remnant and the Highlands Bedrock Shelf.

Upper River

The Upper River begins upstream of the Boulder and Bear creek tributaries. This river section has lower peak flows and smaller migration flow windows due to the smaller watershed size. The Upper River is also steeper and more incised than the Middle River and includes numerous natural passage impediments including bedrock shelves and boulder cascades.

Data from the JSSH Steelhead Monitoring Program show that the density of young-of-year steelhead, represented by juvenile steelhead that are less than <75 mm standard length, is higher at Upper River sites during wet years than dry years, indicating some restrictions to passage into the Upper River during drier years.

There are a total of 14 historical structures in the Upper River, all of which span the channel and impact passage conditions.

Despite the more difficult passage conditions, steelhead and salmon can access the upper river when flows are favorable. In 2014, redds (salmonid nests) were observed upstream of Brimblecom #2, a historical dam structure. In November 2021, Chinook salmon adults were observed upstream of Brimblecom #2, following a large storm event that generated about 150 cfs.

Waterman Gap

The Waterman Gap section extends from the Highway 9 culvert crossing up through Castle Rock State Park to the end of anadromy. Passage becomes increasingly difficult in this river section. The reduced watershed size generates smaller peak flows, while the frequency of boulder cascades and/or logjams increases until the end of anadromy at a boulder and bedrock cascade waterfall, approximately 40-foot high, that is impassable at all flows.

The Waterman Gap section contains 3 historical structures and a series of constructed habitat structures in the reach upstream of the Kings Creek Truck Trail.

JSSH Steelhead Monitoring Program has one sampling site upstream of the Kings Creek Truck Trail ford that indicates that steelhead are able to access this upper section of the San Lorenzo River during favorable flow conditions.

Medium and High Passage Severity Structures in the Middle River

In the Middle River, there are 4 High and 3 Medium Passage Severity structures. In the Middle River, some of the historical structures are associated with infrastructure such as bridges or retaining walls that will complicate removal or modification projects. The structures are listed in downstream to upstream order.

Hermosa Avenue Historical Structure PAD ID# 706923 - Medium Passage Severity

This structure is the most downstream channel-spanning historical flashboard dam in the Middle River. There is limited information or observations of this structure. This structure is similar in construction to the Bridge Foundation and North Street structures and a similar approach for modification could possibly be developed for all three structures. The structure functions like a bedrock shelf, with different flow paths across the structure, allowing for more passage options at various flows.

Ben Lomond Park Historical Dam Structure PAD ID# 766539 - Medium Passage Severity

The historical structure at the County of Santa Cruz Ben Lomond Park has been categorized as a Medium passage severity. The historical dam spillway spans the channel and is a temporal barrier at low flows. During very low flows, there is a drop at the downstream edge with very shallow depths across the spillway. Under moderate flow conditions, the apron is submerged and there is no jump pool at the downstream end. However, at low to moderate flows, depths across the dam spillway can be shallow and fast before the entire structure is more submerged. At moderate and high flows, the entire spillway is submerged and vegetation growing on top of the dam spillway provides roughness and velocity variation that aids passage. While this

structure is rated as a Medium Passage Severity, the structure is the second most downstream historical structure and influences passage into a large portion of the watershed.

Of all the historical structures, the Ben Lomond historical dam could be the most complex to remove or remediate due to its connection to a long concrete wall on the left bank that supports County property including a library, a childcare center, and a basketball court. Due to the complexity of removing the entire dam structure, a project to modify only a section of the spillway has been considered. Both the dam structure and the concrete wall are within the 100-year floodplain and subject to very high flow velocities during regular and intense winter storms.

Any fish passage project at this location could be expanded to create public access to the river, which is supported by the community and could increase funding options. A preliminary assessment (Balance Hydrologics) supported the feasibility of removing a section of the concrete wall and providing public access to the river while maintaining most of the concrete wall to support both the buildings (downstream end) and basketball court (upstream end).

North Street Historical Dam PAD ID# 706924 - Medium Passage Severity

This structure is a dam foundation that spans the channel. Structure condition is poor, with flow piping under the right bank side. This structure functions like a bedrock shelf, with a jump pool downstream of the structure. This structure has not been observed during moderate and high flow conditions.

Bridge Foundation PAD ID# 706926 - High Passage Severity

This structure – a bridge with a grade control structure in the channel – is a High Passage Severity due to jump height and position within the Middle River. This structure is the least known significant structure within the Middle River and has not been evaluated under a range of flow conditions. This structure functions as a temporal barrier under low flows and is generally passable at moderate to high flows. The structure could be a partial barrier for upstream juvenile passage due to the jump height.

This structure was identified as a priority project in the San Lorenzo River Enhancement Plan (2004), based in part on the 2001 CDFW study. The Enhancement Plan included conceptual plans to improve passage by notching the bridge foundation towards the left bank, where an existing deep area downstream provides a jump pool. As part of a grant through the County Fish and Game Propagation Fund, the RCD communicated with the property owner, who was concerned that the proposed project could impact the structural integrity of the bridge. Without adequate funding to address these concerns, the property owner declined to work cooperatively with the RCD.

Fieldwork conducted in 2022 confirmed that the structure's condition remains the same as the 2006 fieldwork and, more importantly, discovered that the bridge serves only to support utility

lines. Since this bridge does not provide any vehicle access, it should be feasible to address the property owner's structural concerns.

Huckleberry Island Historical Dam PAD ID# 706929 – High Passage Severity

This structure is rated as a High Passage Severity. Removal or remediation is complicated by how the dam structure is connected to a retaining wall for the house. This structure was identified as a priority project in the San Lorenzo River Enhancement Plan (2004). Following some enforcement by CDFW, IWRP invested a substantial amount of funding and staff resources to develop plans to remediate the dam structure (2014). The property owner was concerned about the scope of the project and project development was halted. As of 2022, there is a new property owner.

In 2019, a large tree fell across the river immediately downstream of the dam and collected other large wood that started to block the spillway. The County of Santa Cruz Stream Wood Program modified the wood but left the large tree across the river.

Barker's Dam Historical Structure PAD ID# 706930 – High Passage Severity

This structure is a priority for removal due to its poor condition and location within the Middle River. In addition to the typical passage challenges, voids have developed in the structure that allow low flows to pipe underneath without crossing the spillway. This condition has been observed as creating a complete barrier during low flows in the spring when smolts and adults are migrating downstream. This structure was identified as a priority project in the San Lorenzo River Enhancement Plan (2004) and the RCD invested a substantial amount of time and energy on landowner outreach in 2016. Unfortunately, one of the four property owners was not interested in this voluntary collaboration and project development was halted.

Boulder Creek Recreation District Dam PAD ID# 706931– High Passage Severity

This structure is rated as High Passage Severity due to the frequency with which the spillway creates either shallow depths or high velocity flow. This structure was identified as a priority project in the 2004 San Lorenzo River Enhancement Plan. Through IWRP, a substantial amount of funding and staff time were invested to work with the Boulder Creek Recreation District to develop plans to remediate the dam structure (2006-2008). Determining whether to completely remove the dam structure or maintain the possibility of using the dam structure in the future was to be decided by the owner, but no decision was made, and project development was halted.

Passage at this structure is possible at low-moderate migration flows. On Feb. 26, 2008, a steelhead adult was observed swimming through the spillway, when the river at Big Trees was 370 cfs. While depth across the spillway was less than 1-foot, the fish easily swam across the spillway along one of the abutments.

Medium and High Passage Severity Structures in the Upper River

In the Upper River, there are 11 High and 3 Medium Passage Severity structures. Structures are named by location or after nearby streets. Structure descriptions include passage details that were collected during surveys. The structures are listed in downstream to upstream order.

Brimblecom #1 PAD ID# 706932 - Medium Passage Severity

This channel-spanning structure includes abutments and a spillway. The 0.5-foot jump has a 3.5-foot deep pool downstream.

Brimblecom #2 PAD ID# 706933 - High Passage Severity

This channel-spanning structure is in poor condition and includes abutments and a spillway. One abutment has collapsed downstream. Passage conditions include a jump pool downstream (3.5-foot), a 3-foot-high jump, and shallow depths over the spillway at low flows.

In 2014, redds were observed upstream of Brimblecom #2, showing that steelhead had access to this area of the Upper River over 2013-14 winter. After a November 9, 2021 storm event with a peak of 157 cfs at Big Trees, about 12 Chinook salmon (*O. tshawytscha*) were observed immediately upstream of this historical structure but downstream of a wood complex on November 21, 2021.

Brimblecom #3 PAD ID# 706934 - High Passage Severity

This channel-spanning structure is in good condition and includes abutments and a spillway. Stream wood has been observed caught on this structure.

Manzanita Structure PAD ID# 706935 - High Passage Severity

The entire flashboard structure, including the abutments and spillway, separated from the banks and flipped forward in the channel. Prior to 2023, fish could swim under the left bank abutment and an adult steelhead was observed in the pool under the structure in 2020. At higher flows, there should be passage towards the right bank, or over the structure, similar to a bedrock shelf. However, this structure has been observed only at low flows. The displaced structure is also directing flow towards the left bank which has resulted in extensive bank erosion. The structure could become a barrier by moving again or getting blocked with sediment or wood.

The previous property owner solicited help from CDFW and has been visited by Jon Jankovitz, a previous CDFW District Fishery Biologist. Since the dam is not connected to bedrock, it should be relatively easy to break up and remove the concrete, especially if access to the site is reasonable. In 2022, a site visit confirmed that equipment access to the structure is feasible

from Manzanita Road. In 2023, the new owner reported that the structure is blocked with sediment and not passable at low flows.

Primavera Historical Dam (PAD ID# pending) - Medium Passage Severity

This structure was observed during other field work and needs a site visit to better understand the existing condition of this structure. There appears to be a jump pool on the downstream end, but there is limited passage until the structure is more submerged at high flows.

Azalea Circle PAD ID# 706936 - High Passage Severity

This channel-spanning structure consists of a concrete slab adjacent to a substantial concrete bank revetment. The approximately 1-foot drop at the downstream edge of the concrete slab is the primary passage concern. Concrete walls downstream and upstream of the structure create high velocities without resting areas in this reach.

Camp Campbell PAD ID# 706937- High Passage Severity

This channel-spanning structure consists of two abutments and a spillway. The jump is 1.2-foot high with shallow pool depths downstream (0.5-foot deep). The structure is within a developed riverside area used by Camp Campbell.

Camp Harmon PAD ID# 766544, Upper River - High Passage Severity

For about 10 years, a sturdy stream wood complex formed on the dam and passage conditions were poor with a 4.5-foot jump over the dam and just a 3-foot jump pool and no passage under the stream wood complex due to the concrete apron, which has prevented bed scour and accumulated sediment upstream of the dam. The Camp cut a center steel beam from the structure and by 2020, the jam had washed out and was replaced by a huge redwood stump that is now adjacent to the structure. Structure removal should include the removal of failing gabion baskets on the right bank, immediately downstream of the structure. Camp Harmon has no plans to use the dam in the future and would like to have it removed.

Either Way Grouted Streambed PAD ID# 706938 - High Passage Severity

This channel-spanning structure appears to be a remnant historical dam structure. The grouted streambed creates a jump and forces fish to swim over a smooth grouted streambed. At moderate flows, passage is likely towards the right bank, where the grouted streambed has degraded and the distance across the structure is shortest.

San Lorenzo Woods Historical Dam #1 PAD ID# 706939 - High Passage Severity

This channel-spanning historical structure is in good condition and served as a recreational facility for the local neighborhood, San Lorenzo Woods. The structure creates a substantial 2.3-foot jump with a 4-foot-deep jump pool.

The County has been developing a project to replace the Fern Drive bridge and remove the dam structure as mitigation. While this project has been delayed due to the recent emergencies, it remains an active project that should be completed by 2025.

San Lorenzo Woods Historical Dam #2 PAD ID# 706940 - Medium Passage Severity

A channel-spanning structure with a low jump and lack of depth downstream. At moderate and high flows, the low structure is submerged, allowing adequate passage conditions.

McGaffigan Mill #1 PAD ID# 706941 - High Passage Severity

This structure is in very poor condition and at low flows, the river pipes under the structure remnants. At moderate and high flows, the river flows over the structure.

McGaffigan Mill #2 PAD ID# 706942- High Passage Severity

This channel-spanning structure lies under the McGaffigan Mill bridge and consists of abutments and an angled spillway. Primary passage concern is shallow depths across the high, angled spillway.

McGaffigan Mill #3 PAD ID# 706943 - High Passage Severity

This channel-spanning structure consists of two abutments that intrude into the channel and a spillway. The jump height is 2.0-feet, with pool depth of 2.3-feet. The structure is connected to a deck.

High Passage Severity Structures in the Waterman Gap Reach

The Waterman Gap reach includes 3 historical structures, all rated as High Passage Severity, and a series of habitat structures, rated as Medium Passage Severity. The structures are listed in downstream to upstream order.

Highway 9 at PM 19.2, Waterman Gap PAD ID# 713774 - High Passage Severity

This structure includes a 12-foot diameter corrugated metal pipe culvert and a wide concrete apron at the downstream end. The concrete apron severely restricts passage at this structure since flows must be very high to create adequate depth across the apron. In 2021, a piece of

the concrete apron broke off and is now blocking a portion of the jump pool at the downstream end of the structure.

This structure has been identified as a priority for fish passage remediation for Caltrans District 5. Caltrans is developing a project to replace the culvert with a spanning bridge and remove the gage weir. Caltrans has received federal infrastructure funding for the project, and State Parks is contributing to the project through its Cannabis Restoration Grant Program.

Replacement of this culvert with a bridge will not only improve fish passage, but also create a new wildlife passage corridor under Highway 9 within Castle Rock State Park.

Historical Stream Gage, Waterman Gap PAD ID# 766545 – High Passage Severity

There is a concrete weir for an inactive stream gage immediately upstream (20 feet) of the Highway 9 crossing. The structure is 1-foot high and does not have a jump pool downstream, which adds difficulty to passage at the Highway 9 crossing. This small structure can easily be removed concurrently with the replacement of the Highway 9 culvert. In 2023, sediment deposition upstream of the culvert crossing has temporarily buried the structure.

Kings Creek Truck Trail, Waterman Gap PAD ID# 766546 - High Passage Severity

The Kings Creek Truck Trail within Castle Rock State Park crosses the San Lorenzo River via a concrete ford. Since 2006, the structure has degraded and is currently in poor condition. Low flows pipe through voids under the structure instead of flowing over the top, limiting passage during low flows. During higher flows, the river flows over the ford, but flows must be high enough to create depth through the small channel or over the ford to allow adult steelhead passage. State Parks is aware of this passage barrier and has recently started a process to design a replacement crossing here.

Waterman Gap Stream Habitat Structures (no PAD ID#) - Medium Passage Severity

Upstream of the Kings Creek Truck Ford, within Castle Rock State Park, there are a series of 18 stream habitat structures. These structures were constructed in the late 1980's or early 1990's, when the property was owned by the San Lorenzo Valley Water District. The structures were constructed following CDFW Salmonid Restoration Habitat Manual designs and were intended to improve pool development by facilitating scour. Some of the structures have been successful at contributing to pool development but most of the structures are in poor condition and many are undercut by the river and inhibiting passage within this reach. A project could be developed to use a hand crew to cut out channel-crossing logs where the structures are in poor condition. The project could also remove frayed cable and loose fabric, which were used in the structure installation. Due to their remote location and small scale, these structures are grouped together and not individually geo-located.

Low Passage Severity Structures in Middle and Upper River

There are 15 Low Passage Severity Structures. Refer to Appendix A, maps and the photo catalogs for locations and more information about Low Passage Severity Structures.

Low Passage Severity include three types of structures:

1. Structures that do not span the channel and allow passage through a portion of natural channel. These structures can still include concrete walls or grouted rock features that affect river process, including concentrating flows and catching stream wood.
2. Structures that are small in scale and are passable at all except the lowest flows, similar to small bedrock shelves.
3. Structures that are flush with the streambed and do not currently present any passage problems.

While these structures are considered Low Passage Severity, there are still benefits to their removal. Benefits include removing concrete from the channel, improving passage for juveniles during droughts and reducing any anthropogenic influence on river process. These structures could be removed when there are opportunities for mitigation or as part of a comprehensive program to remove human-built structures from the river. Low Priority structures that are flush with the streambed are the lowest priority for removal or remediation.

None: No Passage Severity Structures

This study does not advocate for the modification of natural features, which aligns with current CDFW and NOAA Fisheries policy positions. Accordingly, natural features such as bedrock shelves are considered “None/No Passage Severity”.

The City of Santa Cruz Water Department operates two water supply diversions on the San Lorenzo River. Fish passage at these diversions are regulated by multiple agencies, including the CDFW and NOAA Fisheries and are not prioritized as part of this study. Accordingly, both the Tait Street Diversion and the Felton Diversion structures have been categorized as “None: No Passage Severity” in this study.

Structures with Cooperative Property Owners

Over the past 10 years, several property owners have expressed their interest in removing historical structures that are no longer being used or are damaged. These include the privately owned Manzanita and Camp Harmon structures and publicly owned structures including Ben Lomond Park, Highway 9 at Waterman Gap, and State Parks.

Photo Catalogs

Appendix C is a photo catalog that includes only the historical, anthropogenic structures rated as Medium and High Passage Severity. The catalog includes photos that show how different flows influence passage conditions. For each structure, the catalog includes the general location, PAD identification, barrier type and passage severity.

For many of the photos, the flows recorded at the USGS gage at Big Trees (Felton) are included with the date to give a general sense of river flows associated with the photo; these are not actual flows recorded for that specific location.

Appendix D is a photo catalog to show general passage conditions along the entire 29-mile anadromous reach of the San Lorenzo River. The catalog includes all historical, anthropogenic structures, the two City of Santa Cruz diversions and the most substantial natural features along the mainstem of the San Lorenzo River. For each structure or feature, the catalog includes a photo, general location, PAD identification, barrier type and passage severity.

DISCUSSION

This report provides an updated and comprehensive inventory of historical structures along 29 miles of the San Lorenzo River. This report aims to facilitate the removal or modification of the structures that impact anadromous fish passage by providing a whole river context. The urgency to improve passage conditions has increased over the 20+ years of this study, as climate change increases the frequency and duration of droughts and reduces the number of storms that create excellent passage flows for adult and juvenile steelhead, coho salmon, and Pacific lamprey.

There is a long history of efforts to identify and remove these structures to improve fish passage. In 1988, the County of Santa Cruz sent a letter to the California Dept of Fish and Wildlife requesting that they act to remove historical structures. The 2004 San Lorenzo River Enhancement Plan identified many of these historical structures for removal or modification. Between 2004-2016, the Resource Conservation District worked with several property owners that resulted in a passage improvement project at Four-Rock, the cascade feature in Henry Cowell State Park. Both the federal recovery plans for coho salmon and steelhead identify addressing fish passage and addressing fluvial processes as priority actions for species recovery. The implementation of restorative actions is particularly important in the San Lorenzo River watershed because the steelhead and coho salmon are identified as independent populations, which are critical for species recovery.

Passage becomes increasingly difficult in the Upper River and Waterman Gap sections of the river. There are fewer observations of these upper river structures and actual passage conditions could be better or worse than described. Data from the JSSH Steelhead Monitoring Program indicates that steelhead have access to, and spawn successfully, in the Upper River more during wet years than dry years.

Projects that remove structures are expected to benefit all three anadromous fish species – steelhead, coho salmon, and Pacific lamprey. Projects that only modify structures will need to consider lamprey-specific passage needs.

This report advocates for a joint-agency effort to reach out to and work with cooperative property owners to modify or remove structures. This report recommends that property owners with structures identified as Medium or High Passage Severity receive a letter informing them of their stewardship responsibilities and opportunities to remove or modify these structures. Funding for passage projects is currently available through multiple funding sources.

The removal of historical structures will have multiple benefits beyond improving fish passage. These historical structures impede the movement of large wood and sediment and affect river processes such as pool or meander formation. In addition, local habitat conditions such as pool cover, bank erosion, and riparian habitat can be improved through project implementation.

Most of these historical structures were built on bedrock outcrops, which will simplify their removal. In most cases, the removal of the structure can be completed without any additional grade control. Bank stabilization or other in-stream structures may be needed in some cases.

RECOMMENDATIONS and Next Steps

These recommendations are intended to facilitate the removal or modification of all High and Medium Passage Severity structures along the mainstem San Lorenzo River.

1. Identify Program Coordinator

The removal of structures identified as Medium and High Passage Severity is expected to take 15-20 years and will involve multiple agencies, organizations, and funding sources. The Program Coordinator will facilitate the removal of these historical structures by coordinating resource agencies and implementation partners through the project stages such as design, permitting and implementation. The Program Coordinator would also coordinate a Technical Advisory Committee (TAC) to help prioritize locations and review design for projects.

The County of Santa Cruz Water Resources Program will serve as the Program Coordinator unless an agency or implementation partner has the capacity to take on this role.

2. Technical Advisory Committee

The Program Coordinator will convene a TAC that will include representatives from the County, CDFW, and NOAA Fisheries. The TAC will provide technical review of project priorities and designs to remove historical structures.

3. Notify Property Owners with Structures Rated as Medium and High Passage Severity

This action proposes that property owners with structures rated as Medium and High Passage Severity receive a letter that describes stewardship responsibilities and opportunities to work cooperatively with agency and implementation partners to remove or modify barriers. Letters would include information about funding opportunities and permit coordination approaches. Property owners will be asked to respond within 30 days.

4. Prioritize Structures for Removal Among Cooperative Property Owners

Following the 30 days for property owners to respond to the letter, the Technical Advisory Committee will review and prioritize structures from affirmative responses. The Program Coordinator will also help connect property owners to restoration partners and funding to move projects through design, permitting and implementation.

CONCLUSION

This report provides a current, comprehensive inventory of historical structures and road crossings that impact anadromous fish passage within 29 miles of the San Lorenzo River.

This report makes recommendations to work towards the removal or modification of structures rated as High or Medium Passage Severity. Recommendations include identifying a Program Coordinator, sending out a letter to all property owners with structures rated as High or Medium Passage Severity, and then working with cooperative property owners to move projects through design, permitting, and implementation.

APPENDICES

Appendix A: Summary Table

Appendix B: Maps

Appendix C: Photo Catalog of Historical Structures identified as Medium or High Passage Severity

Appendix D: Photo Catalog of all structures, historical and current, and natural features

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REPORT REVIEW DISTRIBUTION

First Draft Review

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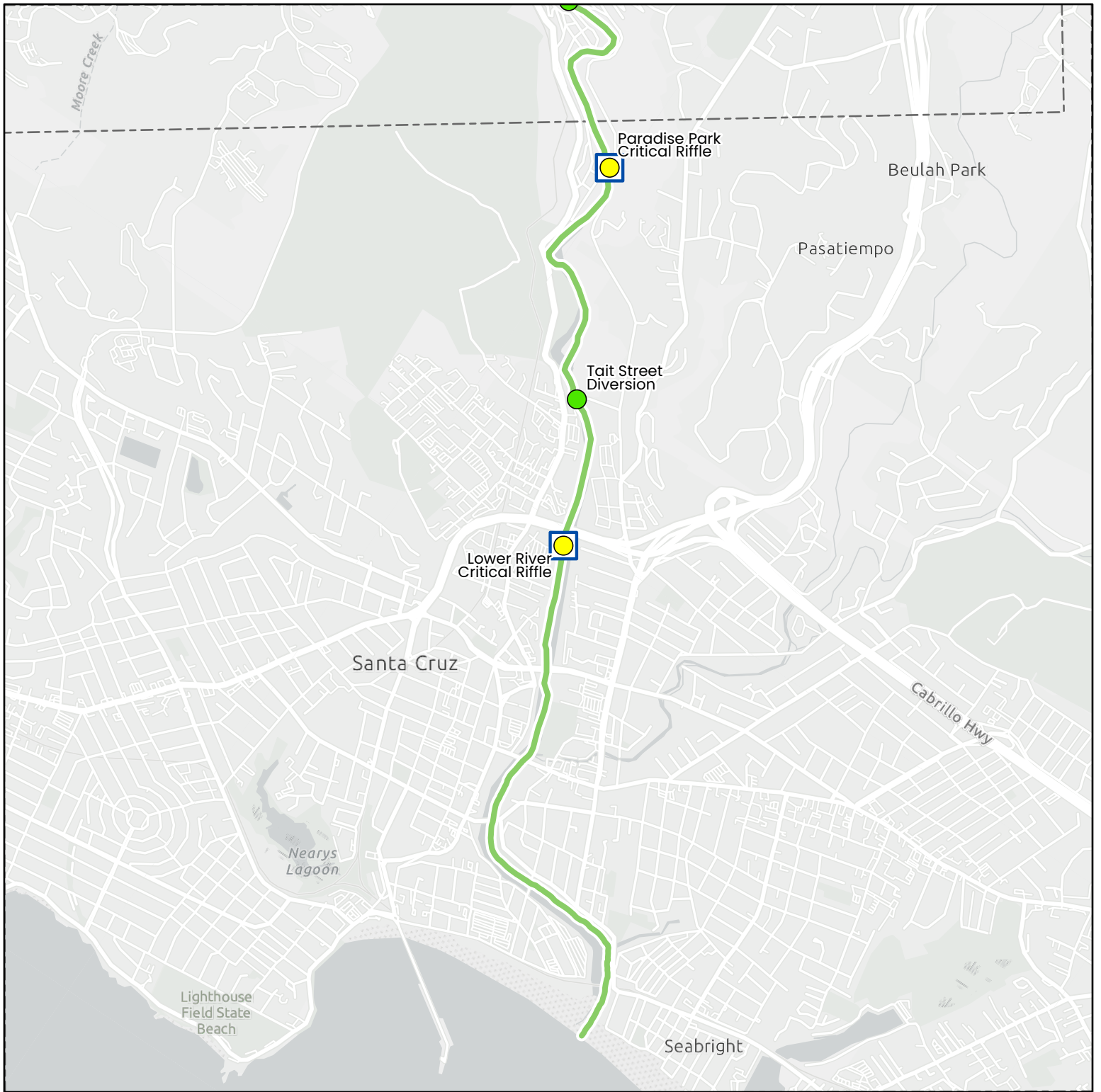
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Appendix A: Summary Table

River Section	PAD_ID	Name	Structure Information			Historical Structure Order (d/s to u/s)	Structures affecting passage Order
			Structure Type	Adult Barrier Status	Passage Severity		
Lower	712751	Tait Street Diversion	dam	not a barrier	none		
	766534	Paradise Park Dam Structure	dam (historical)	not a barrier	none	1	
	713768	Rincon Riffle	natural	temporal	Medium		
	713769	Four Rock Boulder Cascade	natural	temporal	Medium		
	766650	Railroad Pier Henry Cowell	rail crossing (bridge)	not a barrier	none	2	
	706922	Felton Diversion Dam	dam	not a barrier	none		
Middle	706921	Lazy Woods Historical Dam	dam (historical)	not a barrier	none	3	
	766535	Sunnycroft Historical Dam	dam (historical)	not a barrier	none	4	
	706923	Hermosa Ave Historical Dam	dam (historical)	temporal	Medium	5	1
		Small Bedrock Shelf	natural	temporal	none		
	766536	Lorenzo Way Historical Dam Remnant	dam (historical)	not a barrier	none	6	
	766537	Highlands Bedrock Shelf	natural	temporal	Low		
		Highlands Historical Dam Remnant	dam (historical)	not a barrier	none	7	
		Bedrock Cascade	natural	temporal	none		
		Small Bedrock Shelf	natural	temporal	none		
		Bedrock Shelf	natural	temporal	none		
	766649	Ben Lomond Historical Dam Remnant	dam (historical)	not a barrier	Low	8	
	766539	Ben Lomond Park Historical Dam	dam (historical)	temporal	Medium	9	2
	706924	North Street Historical Dam	dam (historical)	temporal	Medium	10	3
	706925	Ben Lomond Bedrock Cascade	natural	temporal	none		
	766540	Old Railroad Bridge Pier #1	rail crossing (historical)	not a barrier	none	11	
	706926	Bridge Foundation	road crossing (historical)	temporal	High	12	4
	766541	Old Railroad Bridge Pier #2	rail crossing (historical)	not a barrier	none	13	
	766542	Larkspur #1 Historical Dam Remnant	dam (historical)	not a barrier	Low	14	
	706927	Larkspur #2 Historical Dam Remnant	dam (historical)	not a barrier	none	15	
	706928	Larkspur #3 Historical Dam	dam (historical)	not a barrier	none	16	
	Brookdale Cascade	natural	temporal	Medium			
NEED PAD ID	Huckleberry Historical Dam Sill Minor	dam (historical)	not a barrier	none	17		
706929	Huckleberry Island Historical Dam	dam (historical)	temporal	High	18	5	
706930	Barker's Historical Dam	dam (historical)	temporal	High	19	6	
706931	Boulder Creek Recreation Historical Dam	dam (historical)	temporal	High	20	7	
Upper	706932	Brimblecom #1 Historical Dam	dam (historical)	temporal	Medium	21	8
	706933	Brimblecom #2 Historical Dam	dam (historical)	temporal	High	22	9
	706934	Brimblecom #3 Historical Dam	dam (historical)	temporal	High	23	10
	706935	Manzanita Historical Dam	dam (historical)	temporal	High	24	11
	NEED PAD ID	Primavera Historical Dam	dam (historical)	temporal	Medium	25	12
	706936	Azalea Circle Historical Dam	dam (historical)	temporal	High	26	13
	706937	Camp Campbell Historical Dam	dam (historical)	temporal	High	27	14
	766544	Camp Harmon Historical Dam	dam (historical)	temporal	High	28	15
	706938	Either Way Historical Dam Remnant	dam (historical)	temporal	High	29	16
	705308	Teihl Bedrock Channel	natural	temporal	none		
	706939	San Lorenzo Woods Historical Dam #1	dam (historical)	temporal	High	30	17
	706940	San Lorenzo Woods Historical Dam #2	dam (historical)	temporal	Medium	31	18
	706941	McGaffigan Mill Historical Dam #1	dam (historical)	temporal	High	32	19
	706942	McGaffigan Mill Historical Dam #2	dam (historical)	temporal	High	33	20
706943	McGaffigan Mill Historical Dam #3	dam (historical)	temporal	High	34	21	
713772	Logjam downstream of Waterman Gap	log debris accumulation	Unknown	Unknown			
713773	Riprap Jam	log debris accumulation	not a barrier	none			
Waterman Gao	713774	Highway 9 at Waterman Gap	road crossing (culvert)	temporal	High	35	22
	766545	Stream Gage Weir	Gage (historical)	temporal	High	36	23
	705309	Log Debris Jam (not present)	log debris accumulation	not a barrier	none		
	766546	Kings Creek Truck Trail Ford	road crossing (Ford)	temporal	High	37	24
		Habitat Enhancement Structures	habitat enhancement	temporal	Medium		
	712300	Waterfall	natural	complete barrier	High		



San Lorenzo River Fish Passage Inventory Report - Page 1

Adult Barrier Status

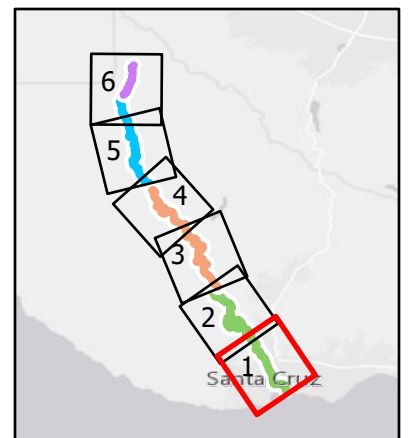
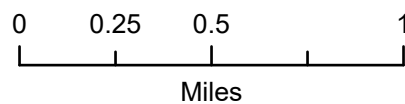
- Unknown passage status
- Complete barrier
- Not a barrier
- Temporal

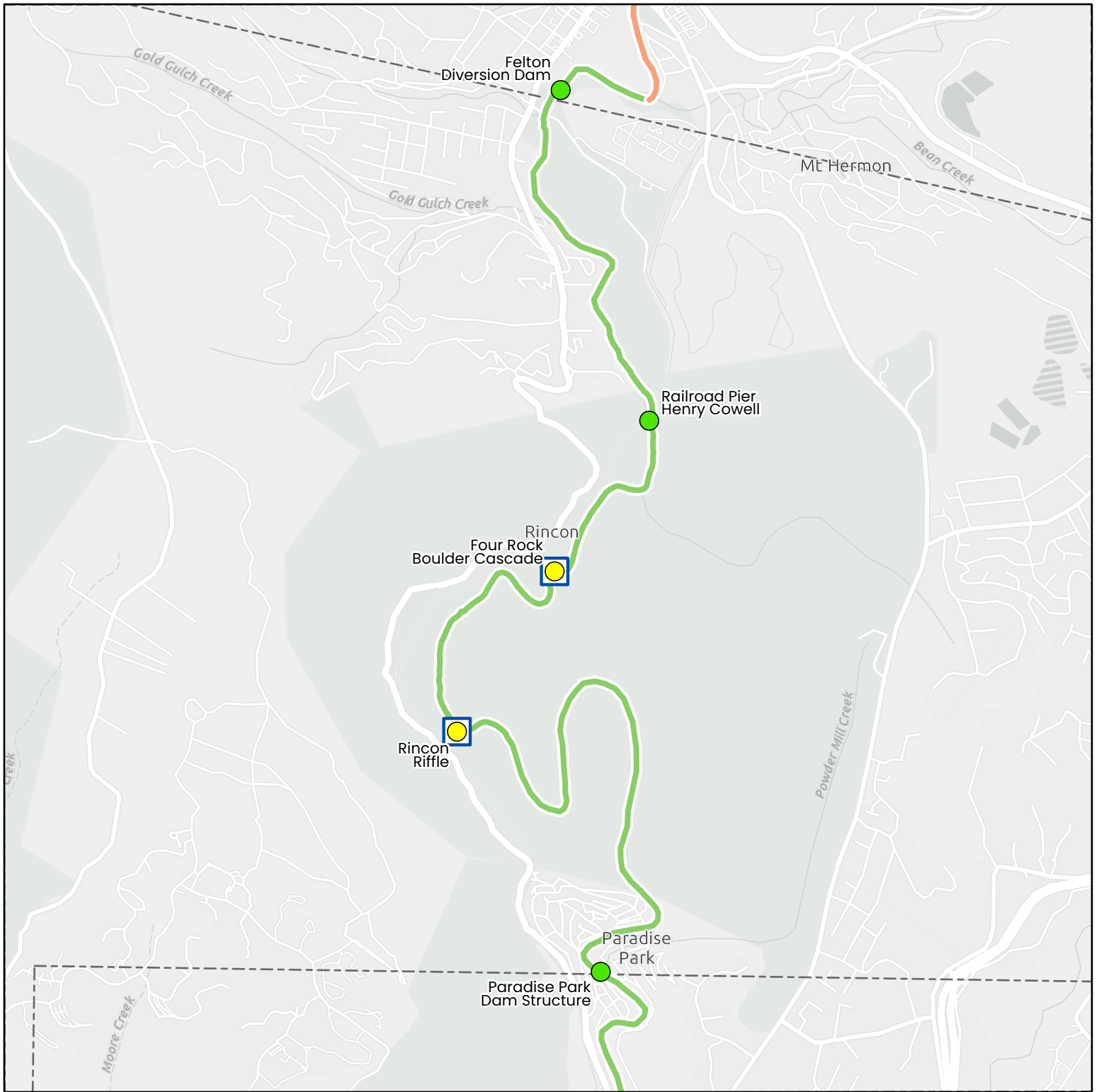
- Lower River
- Middle River

Passage Severity

- High
- Medium

- Upper River
- Waterman Gap





San Lorenzo River Fish Passage Inventory Report - Page 2

Adult Barrier Status

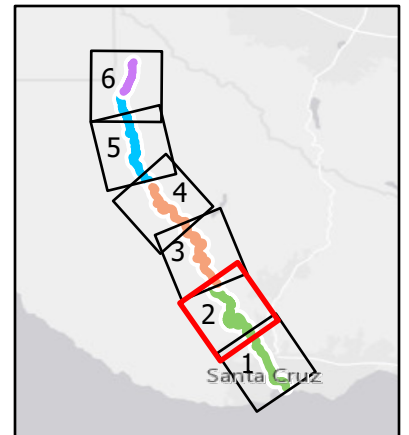
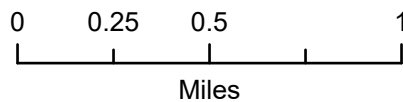
- Unknown passage status
- Complete barrier
- Not a barrier
- Temporal

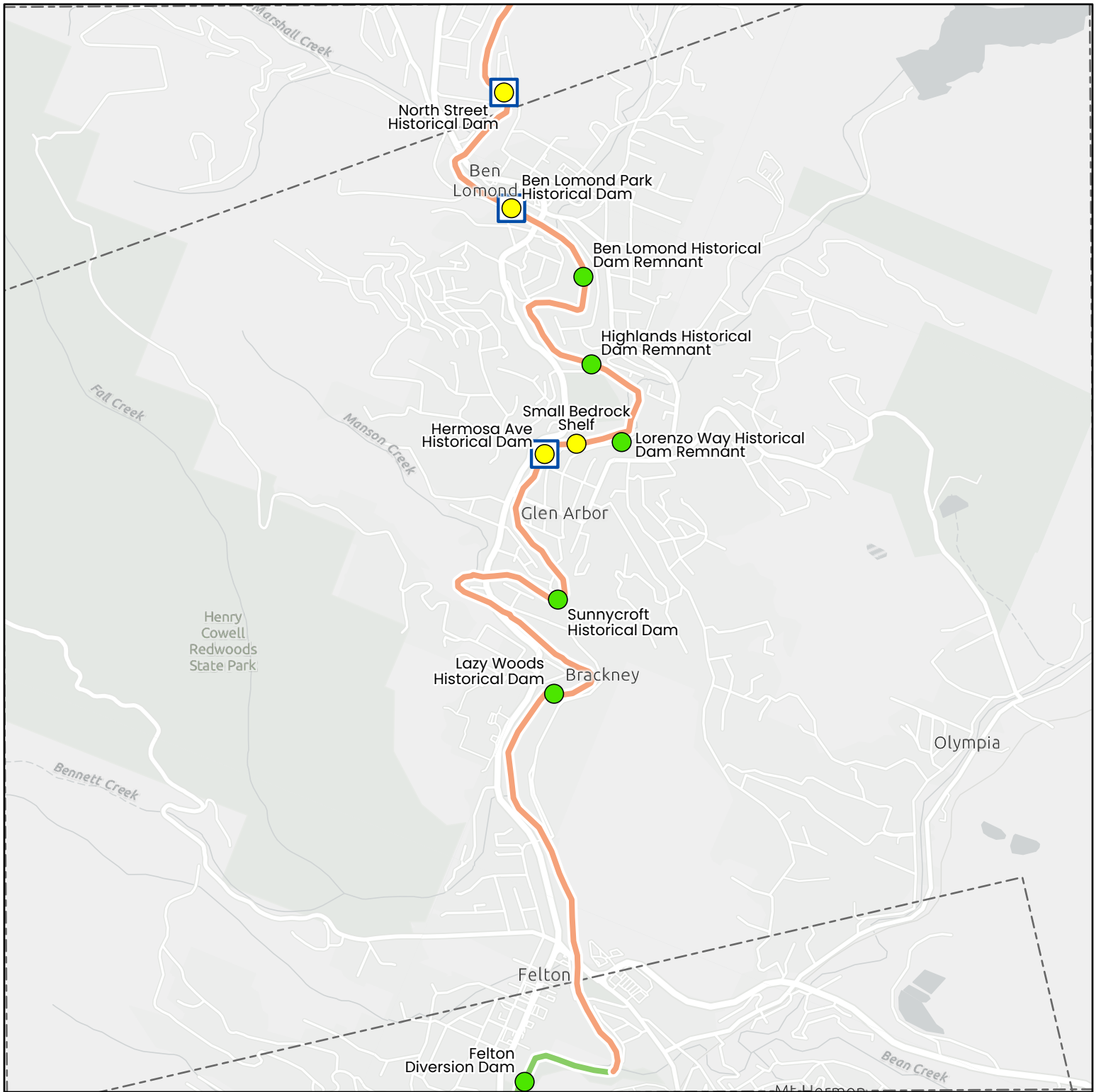
- Lower River
- Middle River

Passage Severity

- High
- Medium

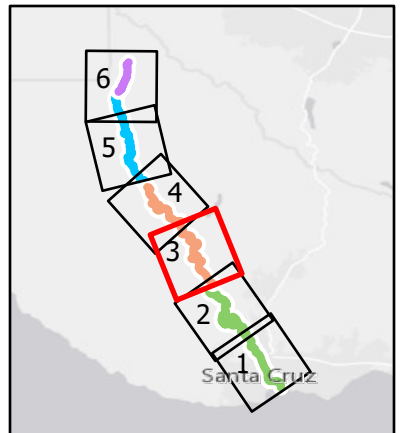
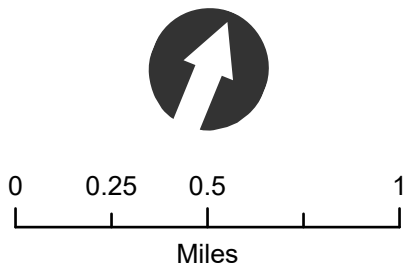
- Upper River
- Waterman Gap





San Lorenzo River Fish Passage Inventory Report - Page 3

- | | | | |
|-----------------------------|--------------|-------------------------|--|
| Adult Barrier Status | | Passage Severity | |
| Unknown passage status | High | Medium | |
| Complete barrier | | | |
| Not a barrier | | | |
| Temporal | | | |
|
 | | | |
| Lower River | Upper River | | |
| Middle River | Waterman Gap | | |





San Lorenzo River Fish Passage Inventory Report - Page 4

Adult Barrier Status

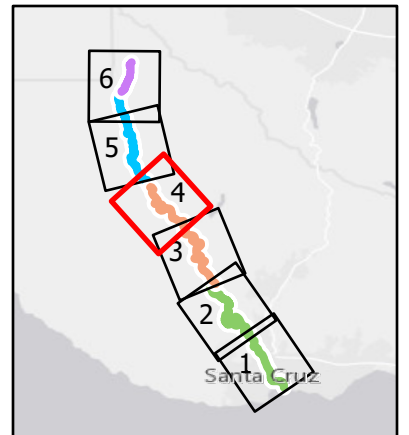
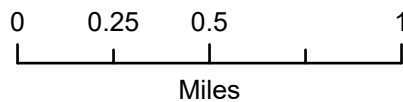
- Unknown passage status
- Complete barrier
- Not a barrier
- Temporal

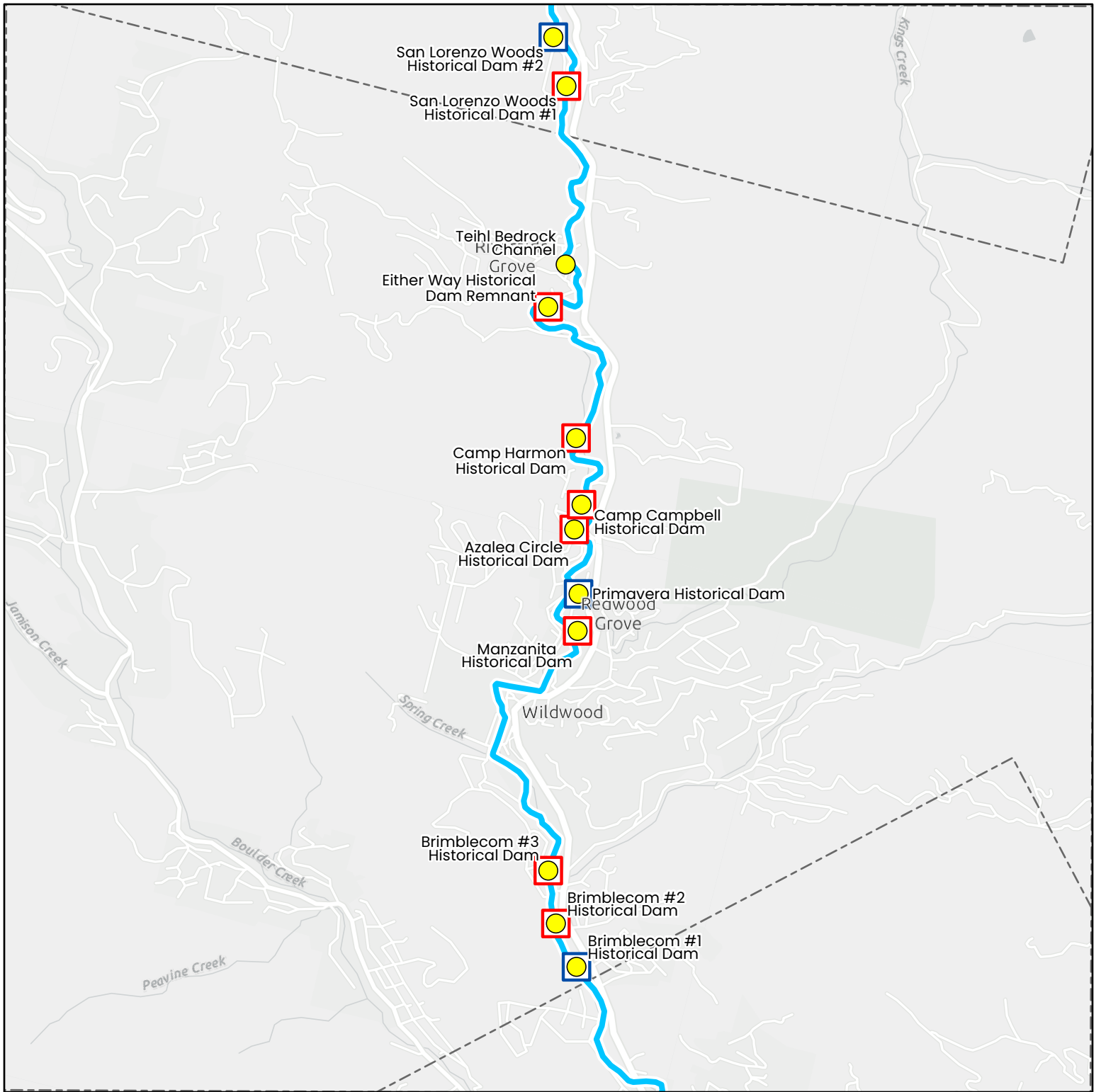
- Lower River
- Middle River

Passage Severity

- High
- Medium

- Upper River
- Waterman Gap





San Lorenzo River Fish Passage Inventory Report - Page 5

Adult Barrier Status

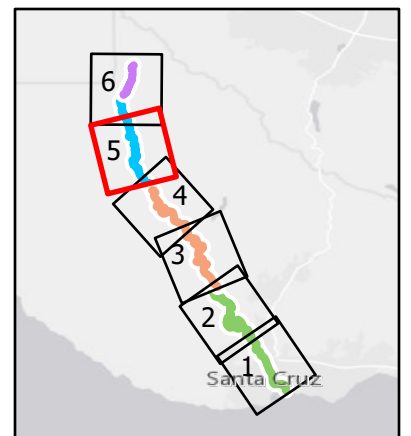
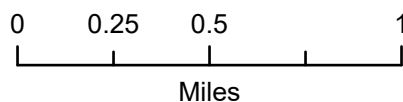
- Unknown passage status
- Complete barrier
- Not a barrier
- Temporal

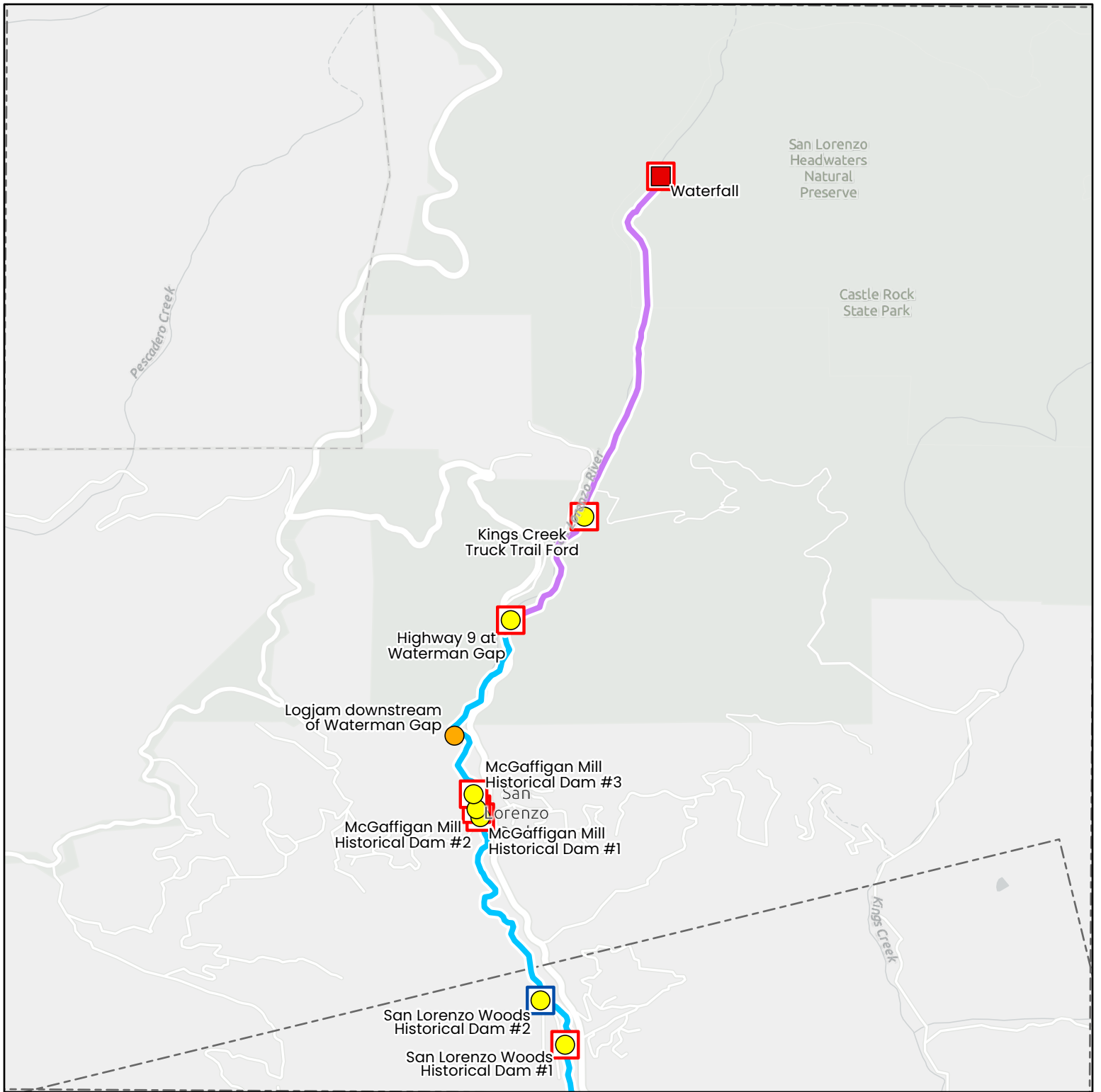
Passage Severity

- High
- Medium

- Lower River
- Middle River

- Upper River
- Waterman Gap





San Lorenzo River Fish Passage Inventory Report - Page 6

Adult Barrier Status

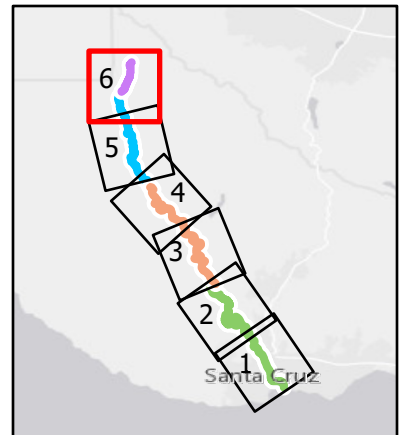
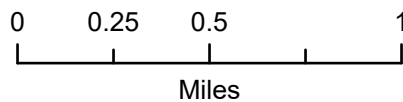
- Unknown passage status
- Complete barrier
- Not a barrier
- Temporal

Passage Severity

- High
- Medium

- Lower River
- Middle River

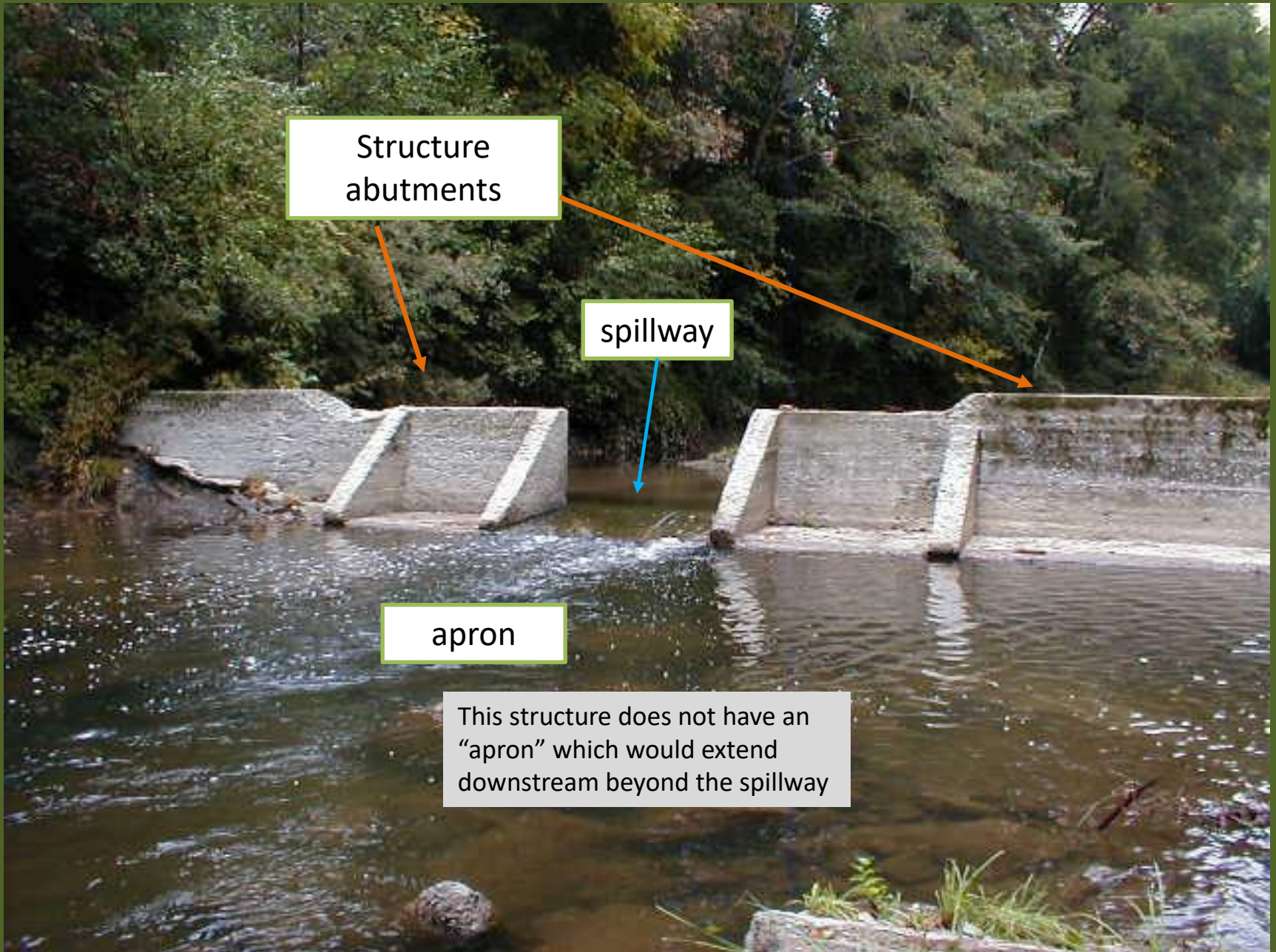
- Upper River
- Waterman Gap



Appendix C
Historical Structures Identified
as Medium to High Passage Severity
on the San Lorenzo River

*Downstream to Upstream
Photo Catalog*

Typical components of a historical flashboard dam structure



Structure
abutments

spillway

apron

This structure does not have an
“apron” which would extend
downstream beyond the spillway

This photo shows how these structures were used historically, by inserting wood flashboards into the spillway to block flow. These actions created a deeper area upstream for swimming and boating during the summer months. Flashboards were removed during the winter season.



Information presented in the photo catalog:

CDFW PAD ID:
Passage assessment
Database #
<https://nrm.dfg.ca.gov/PAD/>

Barrier type

Passage Priority
based on severity
and location

River
Section

Middle River

PAD ID: 706929

Barrier Type: Historical, Temporal

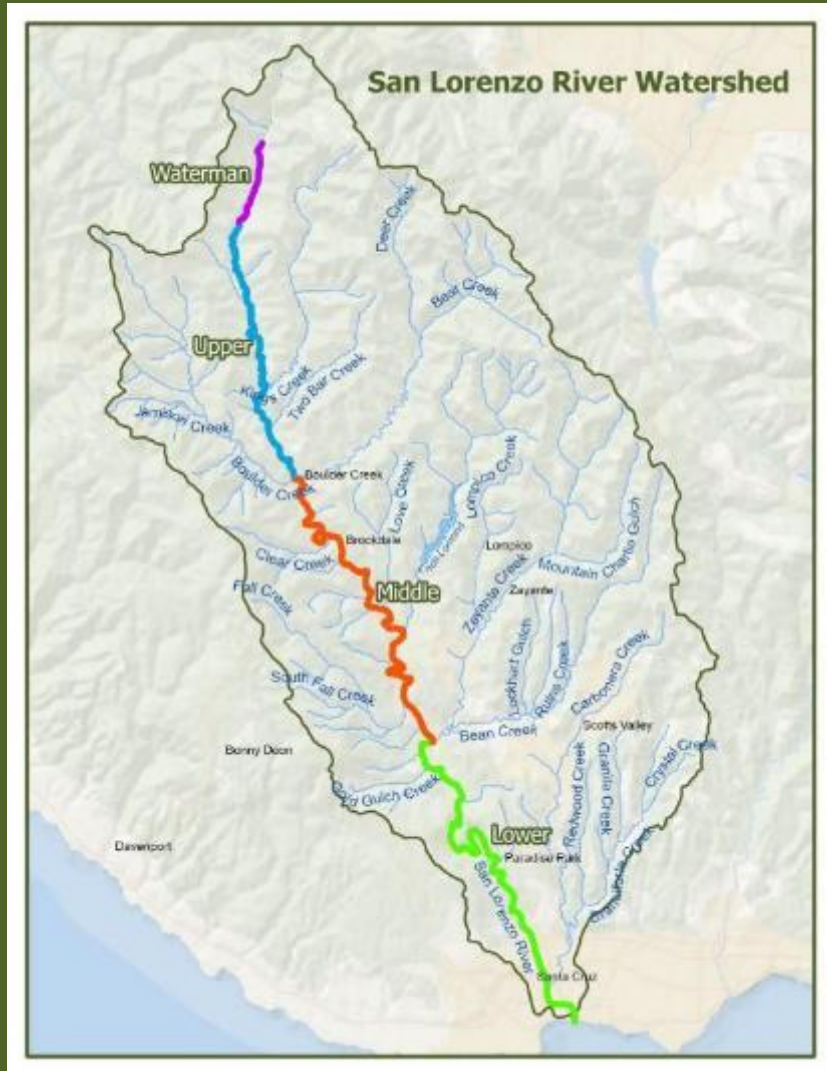
Severity: HIGH

Huckleberry Island Historical Dam

Name used in the
PAD



San Lorenzo River Sections

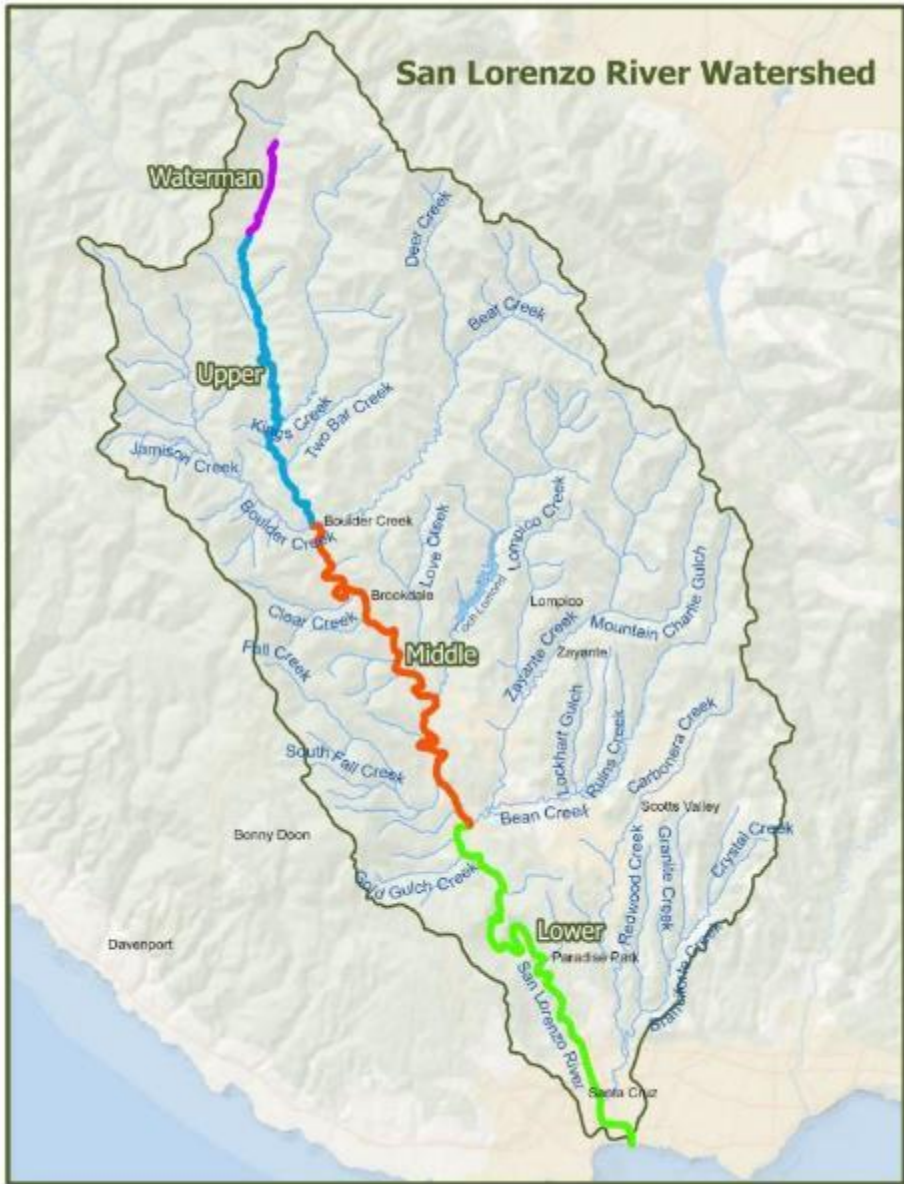


- **Lower River:**
 - mouth to Zayante Creek
- **Middle River:**
 - Zayante Creek to Boulder Creek
- **Upper River:**
 - Bear Creek to Highway 9 crossing
- **Waterman Gap:**
 - Highway 9 crossing to falls
- **Total Mainstem – 29 miles**



No Medium or High Severity Structures

Lower San Lorenzo River



Middle San
Lorenzo
River

Hermosa Ave Historical Structure



Hermosa Ave Historical Structure



6/27/2006, Max CFS 71



6/27/2006, Max CFS 71



7/23/2001, Max CFS 20



7/23/2001, Max CFS 20

Ben Lomond Park Historical Dam



Ben Lomond Park Historical Dam



6/13/2006, Max CFS 98



3/7/2016, Max CFS 3,740



North Street Historical Structure



North Street Historical Structure



Date not identified



7/24/2001, Max CFS 21

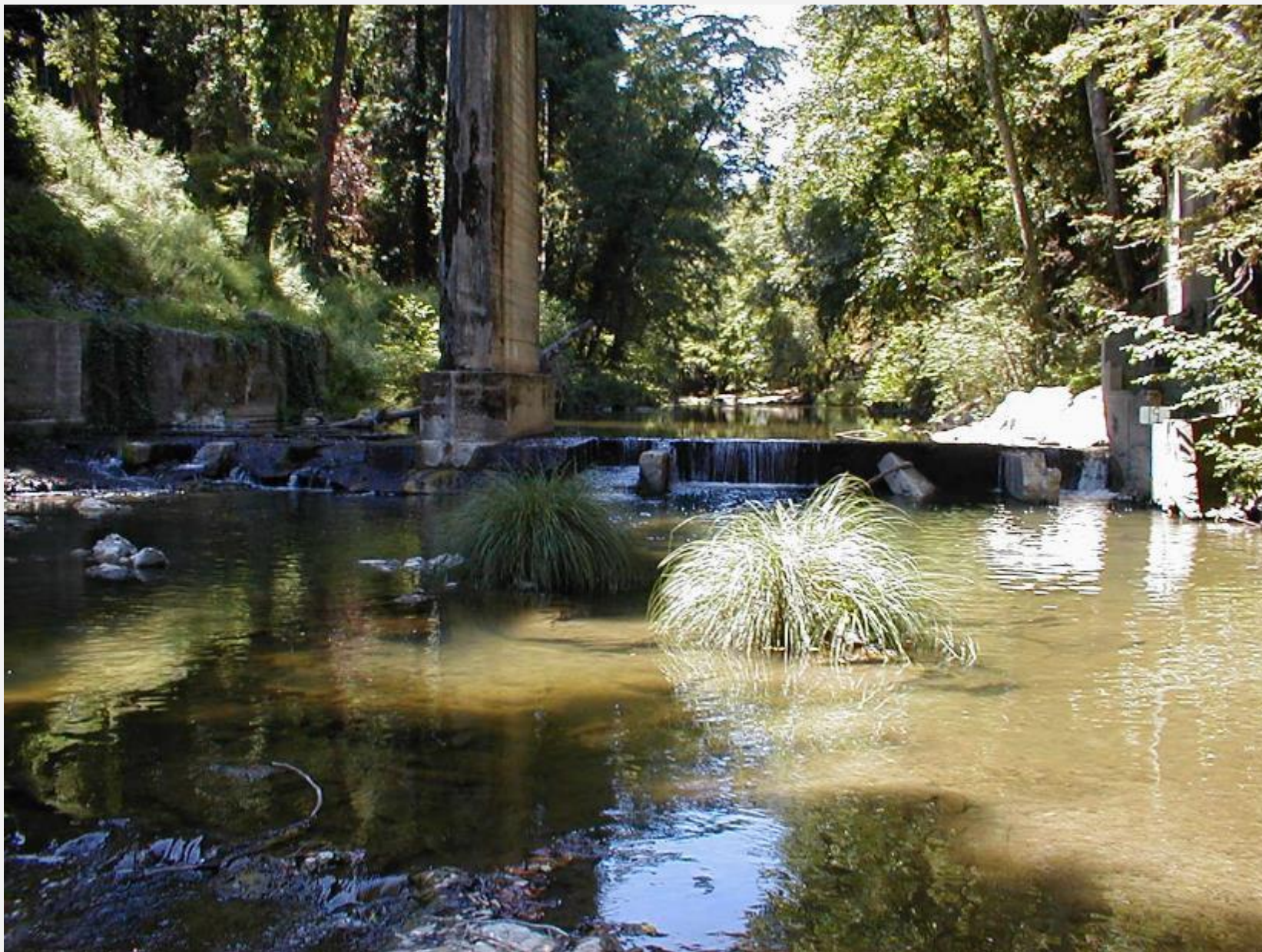


6/13/2006, Max CFS 98



7/24/2001, Max CFS 21

Bridge Foundation



Bridge Foundation



7/24/2001, Max CFS 21



6/13/2006, Max CFS 98

Huckleberry Island Historical Dam



Huckleberry Island Historical Dam



6/13/2006, Max CFS 98



11/4/2004, Max CFS 26



2/2/2005, Max CFS 177



7/18/2001, Max CFS 21

Barker's Dam Historical Structure



Barker's Dam Historical Structure



6/13/2006, Max CFS 98



3/14/2016, Max CFS 3,840



3/24/2014, Max CFS 19.9



3/24/2014, Max CFS 19.9

Boulder Creek Recreation Historical Structure



Boulder Creek Recreation Historical Structure



6/13/2006, Max CFS 98



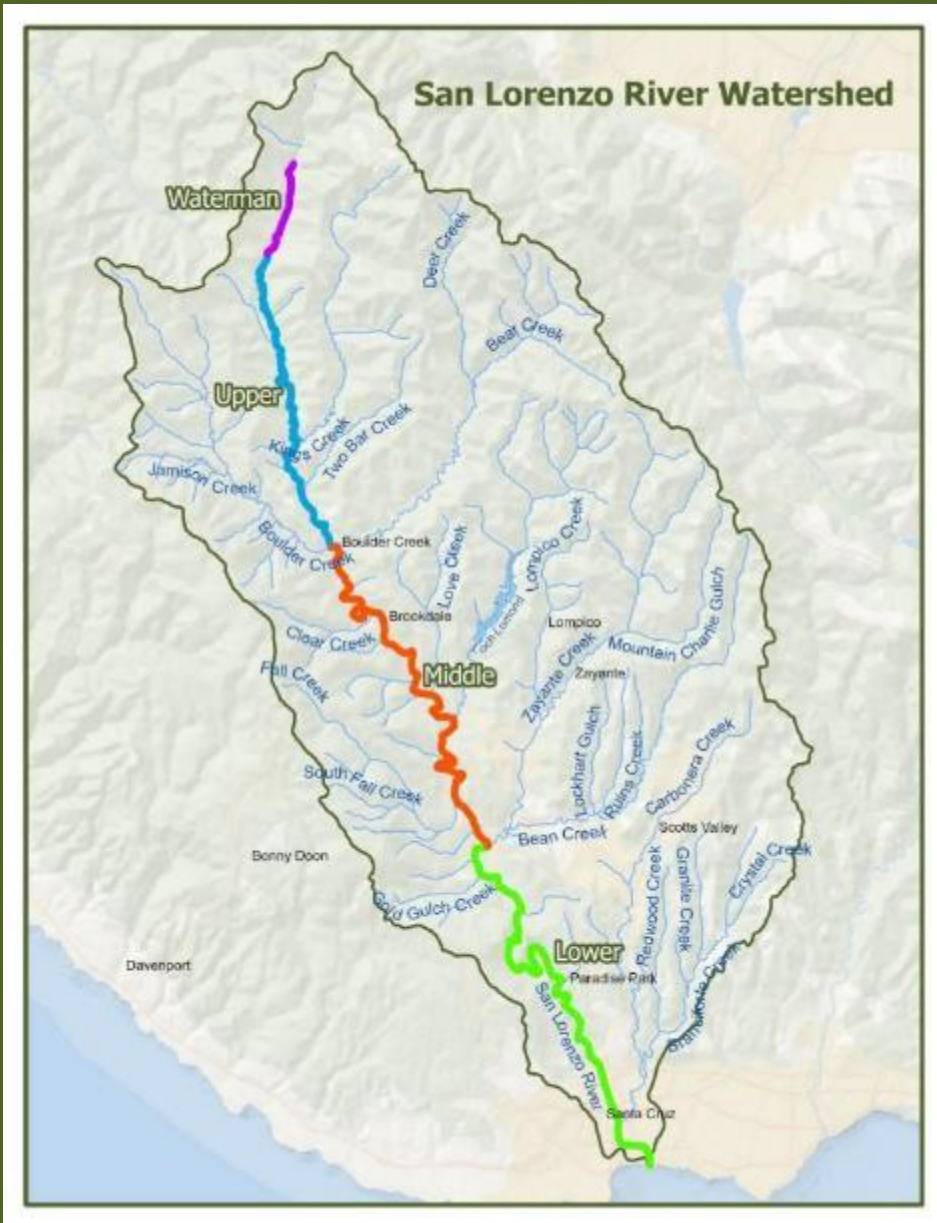
3/20/2018, Max CFS 110



3/14/2016, Max CFS 3,840



4/15/2013, Max CFS 33.1



Upper San Lorenzo River

Brimblecom Historical Structure #1



Brimblecom Historical Structure #1



7/2/2014, Max CFS 10.6



7/2/2014, Max CFS 10.6



7/2/2014, Max CFS 10.6

Brimblecom Historical Structure #2



Brimblecom Historical Structure #2



6/17/2014, Max CFS 10.0



6/17/2014, Max CFS 10.0



7/19/2001, Max CFS 22.0



7/19/2001, Max CFS 22.0

Brimblecom Historical Structure #3



Brimblecom Historical Structure #3



6/10/2014, Max CFS 11.2



7/20/2001, Max CFS 21.0

Manzanita Historical Structure



Manzanita Historical Structure



6/27/2006, Max CFS 71



4/20/2021, Max CFS 20.9



4/20/2021, Max CFS 20.9



7/20/2001, Max CFS 21.0

Primavera Historical Structure



Primavera Historical Structure



9/24/2012, Max CFS 15.9

Azalea Circle Historical Structure



Azalea Circle Historical Structure



6/12/2014, Max CFS 11.6



4/20/2021, Max CFS 20.9



4/20/2021, Max CFS 20.9



4/20/2021, Max CFS 20.9

Camp Campbell Historical Structure



Camp Campbell Historical Structure



3/14/2016, Max CFS 3,840



4/20/2021, Max CFS 20.9



6/10/2014, Max CFS 11.2



6/10/2014, Max CFS 11.2

Camp Harmon Historical Structure



Camp Harmon Historical Structure



2/22/2021, Max CFS 29.7



11/15/2016, Max CFS 19.5



12/16/2016, Max CFS 5,310



12/16/2016, Max CFS 5,310

Either Way Historical Dam Remnant



Either Way Historical Dam Remnant



6/17/2014, Max CFS 10.0



6/17/2014, Max CFS 10.0



6/17/2014, Max CFS 10.0



7/21/2001, Max CFS 21.0

San Lorenzo Woods Historical Structure #1 at Fern Drive



San Lorenzo Woods Historical Structure #1 at Fern Drive



12/1/2014, Max CFS 105



12/16/2014, Max CFS 847



6/17/2014, Max CFS 10



3/7/2016, Max CFS 3,740

San Lorenzo Woods Historical Structure #2



San Lorenzo Woods Historical Structure #2



12/16/2014, Max CFS 847



3/14/2016, Max CFS 3,840



3/7/2016, Max CFS 3,740



6/17/2014, Max CFS 10.0

McGaffigan Mill Historical Structure #1



McGaffigan Mill Historical Structure #1



12/10/2015, Max CFS 70.5



3/7/2016, Max CFS 3,740



6/17/2014, Max CFS 10.0



6/17/2014, Max CFS 10.0

McGaffigan Mill Historical Structure #2



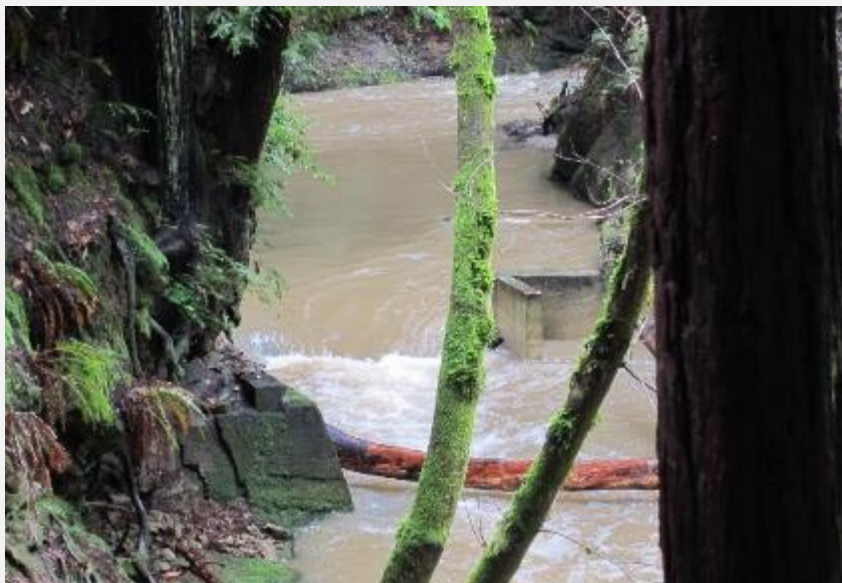
McGaffigan Mill Historical Structure #2



6/17/2014, Max CFS 10.0



6/17/2014, Max CFS 10.0



3/7/2016, Max CFS 3,740



12/10/2015, Max CFS 70.5

McGaffigan Mill Historical Structure #3



McGaffigan Mill Historical Structure #3



6/17/2014, Max CFS 10.0



6/17/2014, Max CFS 10.0



3/7/2016, Max CFS 3,740



7/22/2001, Max CFS 20.0



Waterman San Lorenzo River

Highway 9 Waterman Gap

Severity: HIGH



Highway 9 Waterman Gap

Severity: HIGH



2/5/2014, Max CFS 14.7



3/14/2016, Max CFS 3,840



Date Unknown



12/11/2006, Max CFS 75

Historical Gage Weir



Historical Gage Weir



4/20/2021, Max CFS 20.9

Kings Creek Truck Trail Ford



Kings Creek Truck Trail Ford



2/9/2005, Max CFS 125



8/12/2020, Max CFS 14.2



4/20/2021, Max CFS 20.9

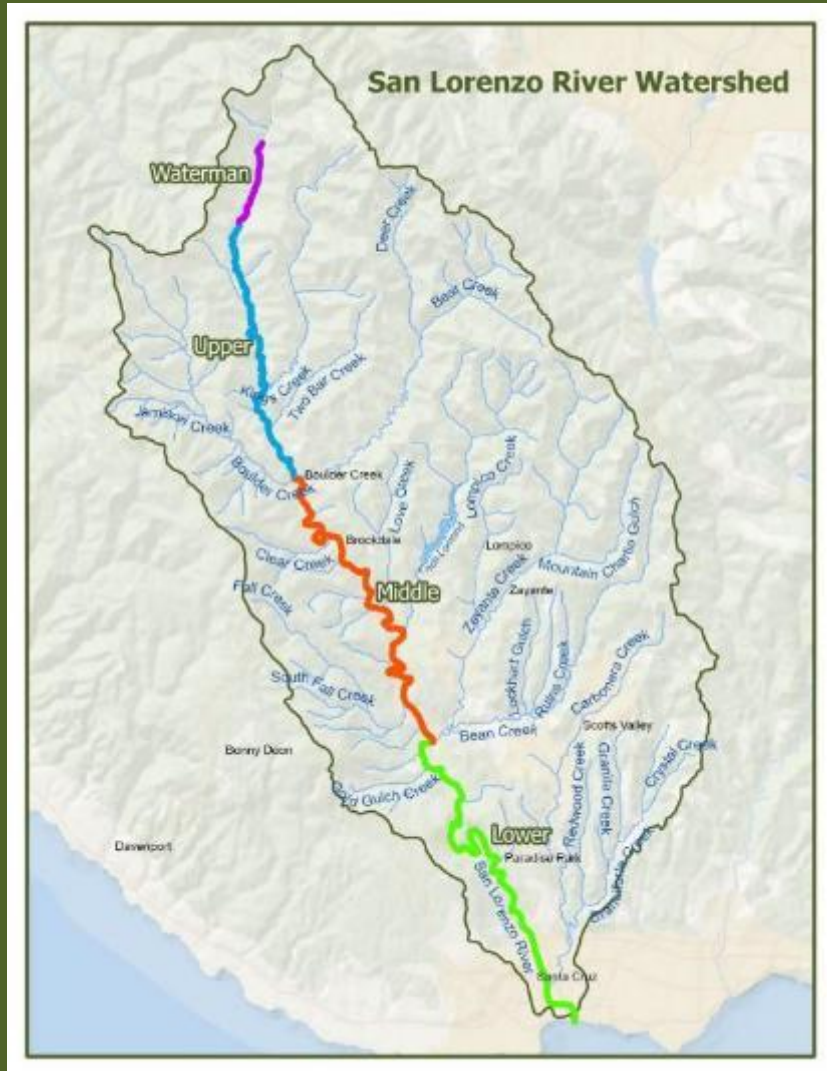


4/20/2021, Max CFS 20.9

Appendix D
All Structures, Historical and Current,
and Natural Features
on the San Lorenzo River

*Downstream to Upstream
Photo Catalog*

San Lorenzo River Sections



- **Lower River:**
 - mouth to Zayante Creek
- **Middle River:**
 - Zayante Creek to Boulder Creek
- **Upper River:**
 - Boulder Creek to Highway 9 crossing
- **Waterman Gap:**
 - Highway 9 crossing to falls
- **Total Mainstem – 29 miles**



Lower San
Lorenzo
River

Lower River

PAD ID:

Barrier Type: Natural, Temporal

Severity: NONE

Critical Riffle #1



Tait Street Diversion – City of Santa Cruz



Lower River

PAD ID: 713768

Barrier Type: Natural, Temporal

Severity: LOW

Critical Riffle #2



Lower River

PAD ID: 766534

Barrier Type: Historical, Not Barrier

Severity: NONE

Paradise Park Historical Dam Structure



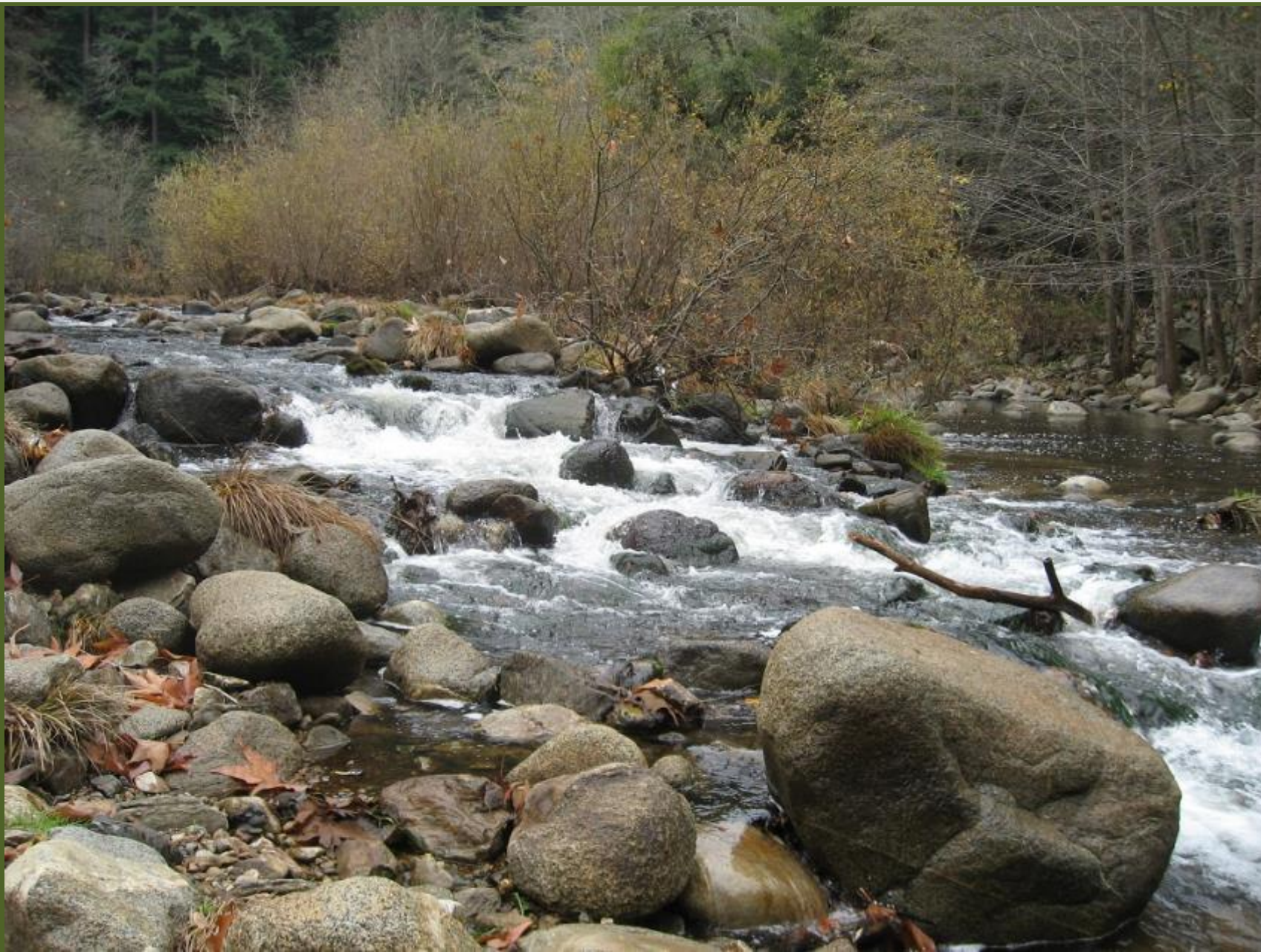
Lower River

PAD ID: 713768

Barrier Type: Natural, Temporal

Severity: MEDIUM

Rincon Riffle



Lower River

PAD ID: 713769

Barrier Type: Natural, Temporal

Severity: MEDIUM

Four Rock Boulder Cascade



Lower River

PAD ID: 766650

Barrier Type: Rail Crossing, Not Barrier

Severity: NONE

Railroad Pier Henry Cowell



Lower River

PAD ID: 706922

Type: Water Diversion, Not Barrier

Severity: NONE

Felton Diversion – City of Santa Cruz





Middle San
Lorenzo
River

Lazy Woods Historical Structure Remnant



Sunnycroft Historical Structure



Hermosa Ave Historical Structure



Middle River

PAD ID: NO

Barrier Type: Natural, Temporal

Severity: NONE

Small Bedrock Shelf #1



Lorenzo Way Historical Structure

Left Bank



View Downstream

Highlands Park Bedrock Shelf



Middle River

PAD ID: TBD

Barrier Type: Historical, Not Barrier

Severity: NONE

Highlands Historical Dam Remnant



2006



2022

Middle River

PAD ID: TBD

Barrier Type: Natural, Temporal

Severity: NONE

Bedrock Cascade



Middle River

PAD ID: TBD

Barrier Type: Natural, Temporal

Severity: NONE

Small Bedrock Shelf #2



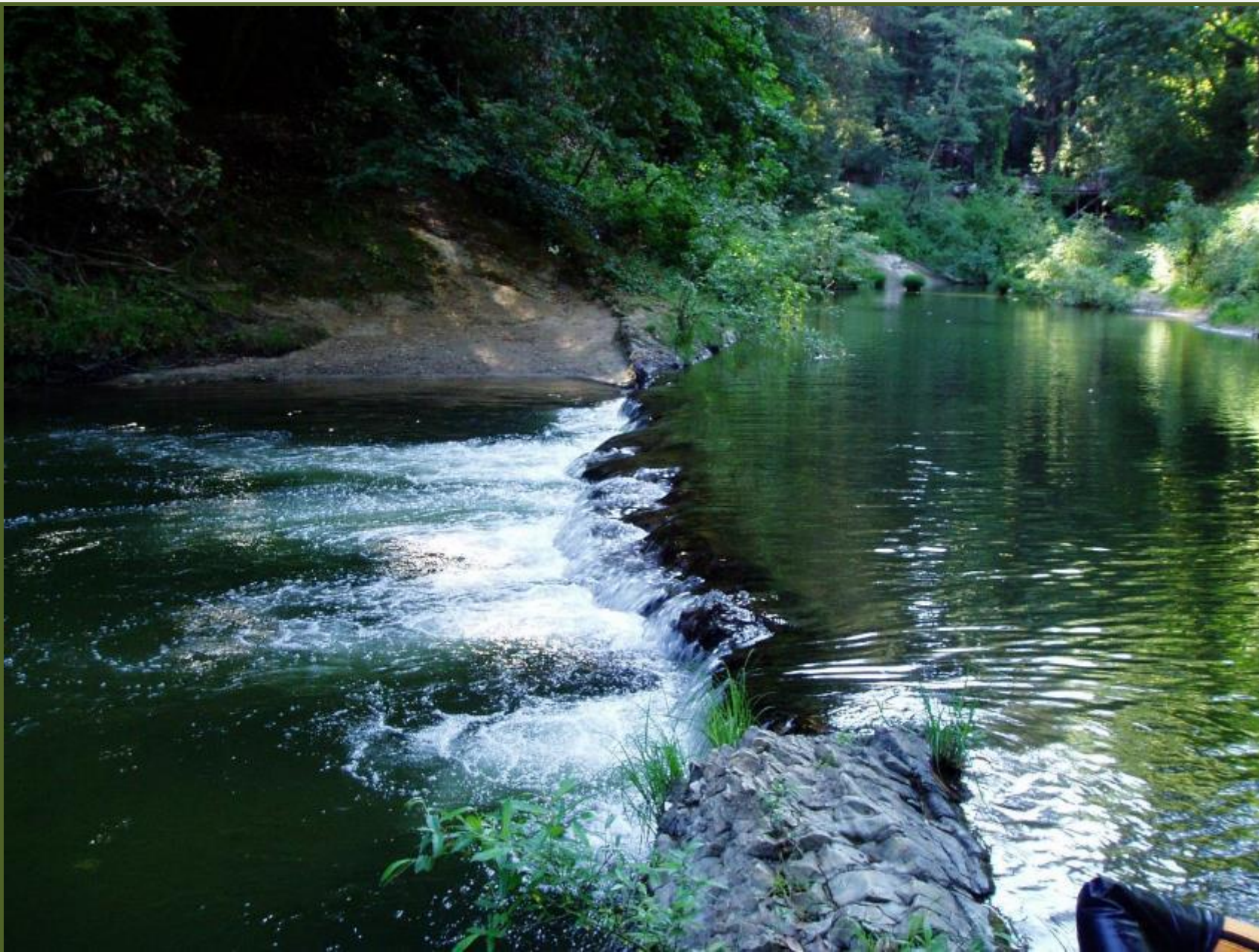
Middle River

PAD ID: TBD

Barrier Type: Natural, Temporal

Severity: NONE

Bedrock Shelf #3



Ben Lomond Historical Dam Remnant



Middle River

PAD ID: 766539

Barrier Type: Historical, Temporal

Severity: MEDIUM

Ben Lomond Park Historical Structure



North Street Historical Structure



Middle River

PAD ID: 706925

Barrier Type: Natural, Temporal

Severity: NONE

Ben Lomond Bedrock Cascade



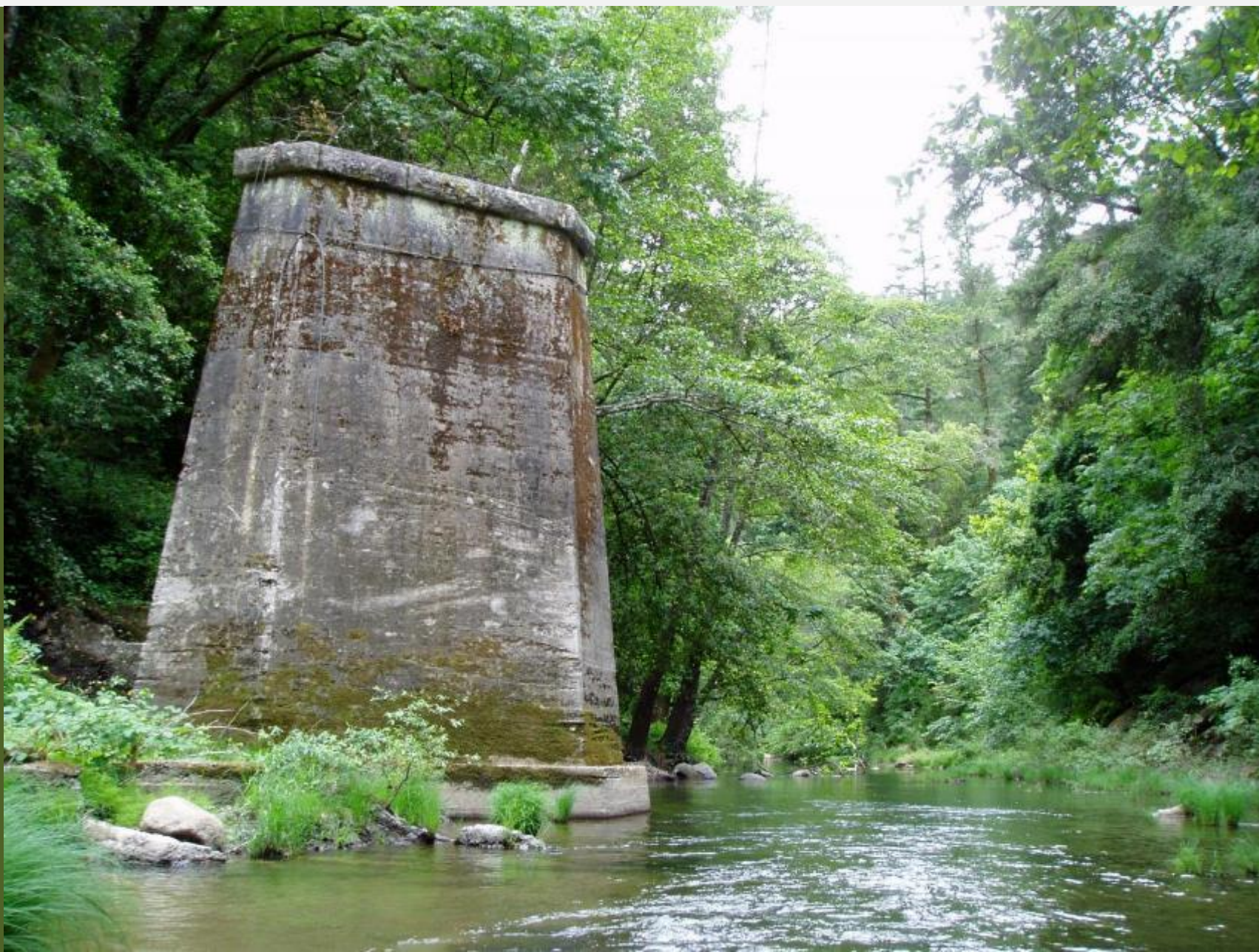
Old RR Bridge Pier #1



Bridge Foundation



Old RR Bridge Pier #2



Larkspur Historical Structure #1



Larkspur Historical Structure #2



Larkspur Historical Structure #3



Middle River

PAD ID: TBD

Barrier Type: Natural, Temporal

Severity: MEDIUM

Brookdale Cascade



Middle River

PAD ID: TBD

Barrier Type: Historical, Not Barrier

Severity: NONE

Huckleberry Sill Minor



Huckleberry Island Historical Dam

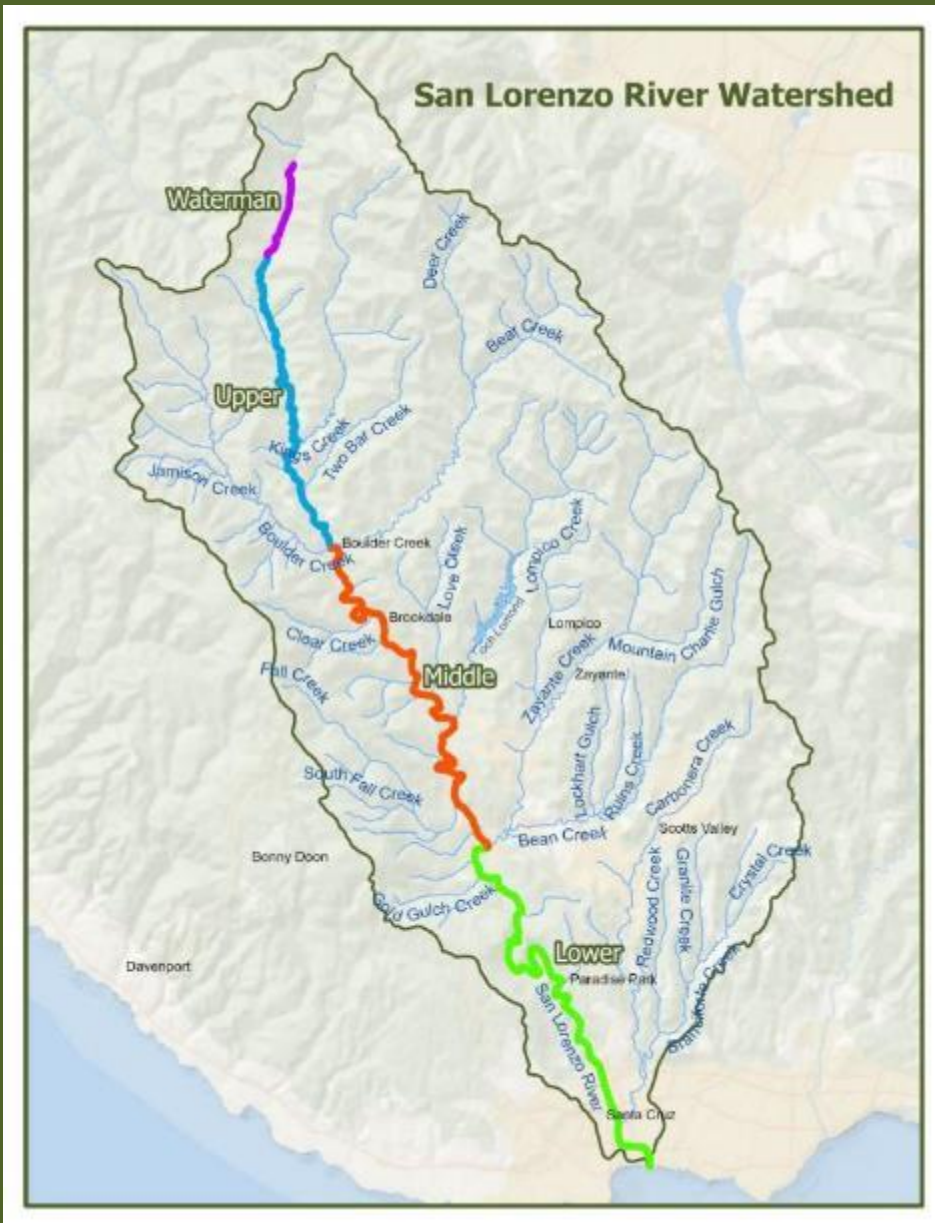


Barker's Dam Historical Structure



Boulder Creek Recreation Historical Structure





Upper San Lorenzo River

Brimblecom Historical Structure #1



Brimblecom Historical Structure #2



Brimblecom Historical Structure #3



Manzanita Historical Structure



Primavera Historical Structure



Azalea Circle Historical Structure



Camp Campbell Historical Structure



Camp Harmon Historical Structure



Either Way Historical Dam Remnant



Upper River

PAD ID: 705308

Barrier Type: Natural, Temporal

Severity: NONE

Teihl Bedrock Channel

This natural feature was not located during this survey and no photo is available.

Upper River

PAD ID: 706939

Barrier Type: Historical, Temporal

Severity: HIGH

San Lorenzo Woods Historical Dam #1 at Fern Drive



San Lorenzo Woods Historical Dam #2



McGaffigan Mill Historical Structure #1



McGaffigan Mill Historical Structure #2



McGaffigan Mill Historical Structure #3



Logjam below Waterman Gap

No evidence was found for a logjam barrier in this section of the river.

Upper River

PAD ID: 713773

Barrier Type: Not Barrier

Severity: NONE

Riprap Jam: this area has a PAD ID for a barrier; no barrier currently present.





Waterman San Lorenzo River

Highway 9 Waterman Gap



Historical Stream Gage Weir



Log Debris Jam

No evidence was found for a logjam barrier in this section of the river.

Kings Creek Truck Trail Ford



Waterman Gap

PAD ID: None

Type: Habitat Enhancement, Temporal

Severity: MEDIUM

Waterman Gap - habitat enhancement structures



Waterman Gap reach of San Lorenzo River



Waterfall



This boulder and bedrock cascade, approximately 40' high, is a complete barrier and the end of anadromy for the San Lorenzo River.