

# STEVENS CREEK FISH PASSAGE ANALYSIS



*Prepared for*

Valley Water  
5750 Almaden Expressway  
San Jose, CA 95118

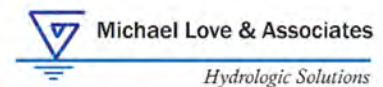
June 2020

*Prepared by*

**AECOM**

AECOM  
300 Lakeside Drive, Suite 400  
Oakland, CA 94612

and



Michael Love & Associates, Inc.  
791 8th Street, Suite R  
Arcata, CA 95521

# TABLE OF CONTENTS

1	INTRODUCTION .....	1
1.1	STUDY OBJECTIVES.....	2
1.2	TERMINOLOGY .....	2
1.3	STUDY AREA .....	3
2	METHODS .....	5
2.1	FIELD RECONNAISSANCE .....	6
2.2	ASSESSMENT SITE SURVEYS .....	7
2.3	FISH PASSAGE ASSESSMENT.....	7
2.3.1	Passage Evaluation Filter .....	7
2.3.2	Fish Passage Assessment Flows .....	8
2.3.3	Hydraulic Modeling .....	9
2.3.4	Fish Routing Modeling.....	10
2.4	SCORING.....	11
3	RESULTS .....	15
3.1	FIELD RECONNAISSANCE .....	15
3.2	PASSAGE CONDITIONS AT ASSESSMENT SITES .....	19
3.3	SCORING.....	22
3.4	DISCUSSION.....	22
4	REFERENCES .....	28
5	LIST OF REPORT PREPARERS .....	30

## Attachments

- Attachment A Valley Water Reconnaissance Surveys
- Attachment B Example Fish Passage Inventory Data Sheet
- Attachment C Spreadsheet Template Used to Standardize Roughness Approach for HEC RAS Models
- Attachment D Results of Fishway Spreadsheet Models
- Attachment E Assessment Site Summary Sheets
- Attachment F Site Ownership

## **Figures**

Figure 1	Study Area and Pre-Identified Sites
Figure 2	Reconnaissance Results
Figure 3	Flows Meeting Passage Assessment Criteria for Adult Steelhead at Each Assessment Site, from Zero to 619 cfs
Figure 4	Assessment Sites with Score Categories

## **Tables**

Table 1	Pre-Identified Sites (prior to the Team's Reconnaissance)
Table 2	Fish Passage Assessment Flows Applied to All Assessment Sites
Table 3	Fish Passage Assessment Criteria
Table 4	Weighting Factors Applied to Each Metric for Scoring of Sites
Table 5	Pre-Identified and Newly Identified Assessment Sites
Table 6	Summary of Fish Passage Assessment Flows Meeting Assessment Criteria for Each Assessment Site
Table 7	Assessment Sites, Scores, and Score Categories
Table 8	List of Study Participants and Report Preparers

## **List of Acronyms and Abbreviations**

CCC	Central California Coast
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESA	Environmental Science Associates
fps	feet per second
FR	Federal Register
FRM	fish routing model
ft	feet
HEC-RAS	Hydrologic Engineering Center River Analysis System
min	minutes
MLA	Michael Love & Associates, Inc.
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PAD	Passage Assessment Database
PAD ID	California Fish Passage Assessment Database Identification Number
PM	post mile on referenced road or highway
Pre-Identified Sites	sites identified by Valley Water for the AECOM-Michael Love & Associates, Inc. Team to consider for fish passage assessment
RM	river mile
SCVWD	Santa Clara Valley Water District (Valley Water)
sec	seconds
Study Team	Stevens Creek Fish Passage Analysis AECOM-Michael Love & Associates, Inc. Team
USFS	United States Forest Service



# 1 INTRODUCTION

The Santa Clara Valley Water District (Valley Water) has been working with stakeholders in the Stevens Creek Watershed to recover steelhead since the late 1990s. In 2004, Valley Water's consultant completed a limiting factors analysis for steelhead; this analysis was undertaken to identify and fill information gaps related to physical and biological factors controlling the population dynamics of steelhead in Stevens Creek (Stillwater Sciences 2004). The limiting factors analysis found that anthropogenic fish passage impediments in Stevens Creek downstream of Stevens Creek Dam could limit access to a substantial amount of habitat for the federally threatened Central California Coast (CCC) Distinct Population Segment (DPS) of steelhead (*Oncorhynchus mykiss*). However, the limiting factors analysis did not quantitatively assess passage at the identified passage impediments, and the degree to which the movement of steelhead in Stevens Creek would be impeded was largely unknown.

Reconnaissance surveys conducted by Valley Water and other stakeholders following completion of the limiting factors analysis narrowed the list of potential fish passage impediments downstream of Stevens Creek Dam that required further evaluation (M. Moore, Valley Water, pers. comm., 2019). Many of these potential fish passage impediments are included in the California Fish Passage Assessment Database (PAD) (CalFish 2019). The PAD is an ongoing map-based inventory of known and potential impediments to anadromous fish passage in California, maintained through a cooperative interagency agreement. The PAD compiles currently available fish passage information from many different sources and allows past and future fish passage assessments to be standardized and stored in one place.

The quantitative Stevens Creek Fish Passage Analysis (Study) described in this report began when Valley Water provided the AECOM-Michael Love & Associates, Inc. (MLA) Team (the Team) with a list of 34 pre-identified sites to consider for fish passage<sup>†</sup> assessment (Pre-Identified Sites) on Stevens Creek along the 12.8 miles of the stream that flows from Stevens Creek Dam to South San Francisco Bay. These sites were identified through the previous efforts described above and are current entries in the PAD (CalFish 2019), or they were identified for inclusion in the Study during recent reconnaissance surveys conducted by Valley Water (see Attachment A for details regarding recent reconnaissance conducted by Valley Water). Two of the Pre-Identified Sites (Sites 2 and 3) were included in an earlier quantitative fish passage assessment (MLA 2016) upon which the passage evaluation methods used in this Study were based. Additional information regarding the Pre-Identified Sites, including their PAD identification (PAD ID) numbers, can be found in the methods section of this report (Section 2).

This Study began with 34 Pre-Identified Sites; however, after initiating the Study, the Team conducted additional reconnaissance surveys to confirm the presence of each Pre-Identified Site and to identify any additional sites for inclusion in the Study. Following the Team's reconnaissance, 30 Assessment Sites were evaluated for upstream juvenile and adult steelhead passage in this Study. The number of Assessment Sites differs from the number of Pre-Identified Sites because some of the Pre-Identified Sites were not found during the Team's reconnaissance (and are therefore assumed to no longer be present), and because at other locations new passage impediments were identified for inclusion in the Study. Information describing all Pre-Identified Sites and Assessment Sites can be found in the reconnaissance results section of this report (Section 3.1). As described in that section, recent reconnaissance conducted by Valley Water, combined with the follow-up reconnaissance conducted by the Team, resulted in complete coverage of Stevens Creek between San Francisco Bay and Stevens Creek Dam. Beginning with results Section 3.2, Passage Conditions at Assessment Sites, this report focuses on the Assessment Sites that were found by the Team to potentially hinder steelhead upstream movement and the analysis conducted at those sites.

---

<sup>†</sup> Although the term "fish passage" is used generally in this report, the passage assessment presented in this report is specific to upstream passage for juvenile and adult steelhead.

This Study fills an important data gap by quantifying the severity of steelhead passage impediments in Stevens Creek between San Francisco Bay and Stevens Creek Dam. Valley Water will use the results of the Study (described in Section 3 of this report) to update the PAD for all Pre-Identified Sites (including instances where a passage impediment in the PAD is no longer present) and Assessment Sites (including creation of new PAD entries for sites not already included in the database). Valley Water will use the information provided in this report, along with other considerations not addressed in this report (e.g., real estate ownership and maintenance requirements) to prioritize the Assessment Sites for passage remediation. This report may also help other stakeholders in the Stevens Creek Watershed prioritize barriers for remediation.

## 1.1 STUDY OBJECTIVES

The goal of this Study was to quantify passage opportunity at identified steelhead passage impediments along Stevens Creek and to provide information for Valley Water to use when prioritizing barriers for removal or remediation based on the degree to which they limit passage, the position of the barrier in the watershed, and the amount of habitat available upstream before the next substantial barrier. Specific objectives are listed below.

1. Perform a quantitative evaluation of steelhead passage impediments in Stevens Creek between San Francisco Bay and Stevens Creek Dam (12.8 miles) based on the assessment protocol for passage of salmonids contained in Part IX of the California Department of Fish and Wildlife's (CDFW's) *California Salmonid Stream Habitat Restoration Manual* (CDFG 2002).
2. For each steelhead passage barrier identified, quantify the amount of habitat, in river miles (RMs), that will be accessible to steelhead if the barrier is removed or made 100 percent passable (i.e., the distance upstream to the next substantial barrier).
3. Based on Objectives 1 and 2 above, as well as the position of each barrier in the watershed, score the barriers based on the degree to which they limit access to Stevens Creek.

Specific methods used to achieve these objectives are described in Section 2.

## 1.2 TERMINOLOGY

This report uses several specific and some general terms to refer to assessed sites and their fish passage status. These terms are defined here so that their use is understood in the same way by all readers.

- **Assessment Site** – A specific term used to refer to fish passage impediments whose presence was confirmed by the Team during the reconnaissance and which were assessed to determine passage conditions for steelhead. Assessment Sites include Pre-Identified Sites and other sites that were identified during the Team's reconnaissance.
- **Fish passage impediment** – A general term used to refer to features that may hinder fish migration or movement for some life stages, or at some flows, but may not be a complete barrier for all life stages or at all flows. Used generally to refer to features whose passability are unknown but believed to potentially hinder fish movement.
- **Partial barrier** – A general term for a barrier that is impassible to some fish species, during one or all life stages, at all flows.
- **Percent passage** – The proportion of passage assessment flows (flow rates, not volumes or durations) meeting assessment criteria, not to be confused with the percentage of the fish

- population that may successfully pass an Assessment Site (see Section 3.2 for additional discussion regarding interpretation of this term).
- Pre-Identified Site – A specific term used to describe passage impediments that were identified by Valley Water for inclusion in this Study, prior to when the Team conducted site reconnaissance.
  - Substantial barrier – A specific term used to describe an Assessment Site with values of percent passage for adult steelhead less than 80 percent.
  - Temporal barrier – A general term for a barrier that is impassible to all fish at certain flow conditions.

### 1.3 STUDY AREA

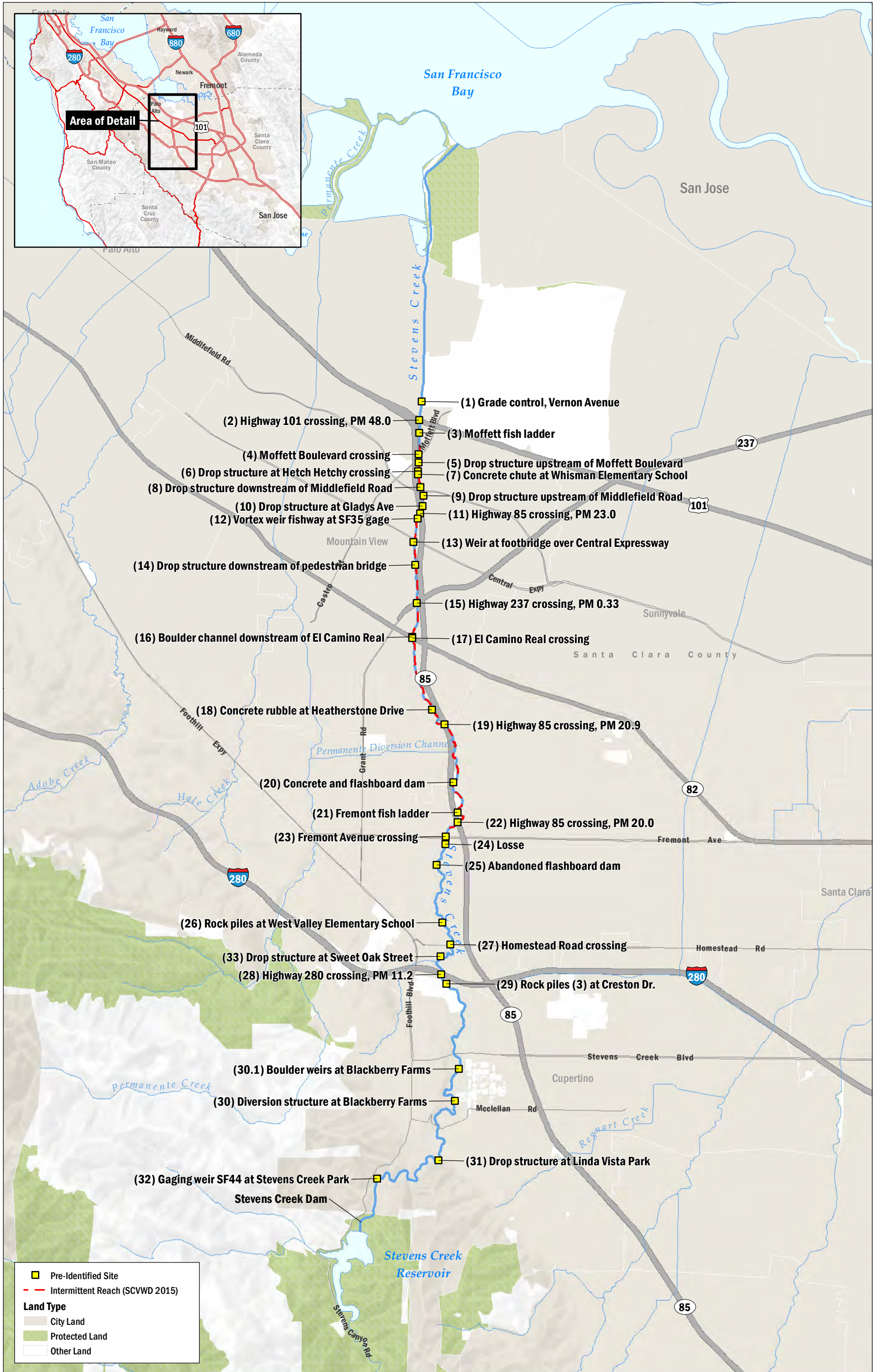
The fish passage assessment Study Area is a stream reach approximately 12.8 miles long, extending from Stevens Creek at South San Francisco Bay upstream to Stevens Creek Dam (Figure 1). This Study identified and evaluated all potential fish passage impediments in the Study Area, except for RMs 3.93 through 4.05. In an effort separate from this Study, Valley Water is currently planning modifications to the Stevens Creek channel between RMs 3.93 and 4.05. The modifications will be designed to mitigate impediments to fish passage. To avoid duplication of effort, that section of Stevens Creek is not analyzed in this Study.

The Stevens Creek watershed is approximately 29 square miles (SCVWD 2015) and lies on the northeastern slopes of the Santa Cruz Mountains in Santa Clara County. Mean annual precipitation varies from a high of approximately 20 to 39 inches on average in the upper slopes of the Santa Cruz Mountains, to a low of approximately 13.5 inches on the valley floor (SCVWD 2015). The majority of precipitation occurs between November and April. All flows from the upper watershed of adjacent Permanente Creek are diverted into Stevens Creek via the Permanente Creek diversion channel, constructed in 1959 for flood protection, bringing the total drainage area of Stevens Creek downstream of the diversion to 46 square miles (SCVWD 2015).

Stevens Creek originates at an elevation of 2,300 feet; it flows easterly as a perennial stream for approximately 8 miles before reaching Stevens Creek Reservoir, which resides at an elevation of 554 feet (SCVWD 2015). The reservoir, constructed in 1935, has a capacity of 3,138 acre-feet and a surface area of 91 acres. The reservoir attenuates flood flows and releases water to control downstream in-stream flows.

The Study Area is entirely downstream of the reservoir, where Stevens Creek runs for 12.8 miles northerly through the Cities of Cupertino, Sunnyvale, and Mountain View before discharging through Whisman Slough into South San Francisco Bay. In most years, Stevens Creek can be characterized as perennial for approximately 5.7 miles downstream of the reservoir, to approximately Fremont Avenue (SCVWD 2015). The stream then dries seasonally and is intermittent from approximately Fremont Avenue to 2 miles downstream of Central Avenue. Eventually, groundwater flow accretes and emerges downstream of Central Avenue, which then keeps the stream perennial again until the South San Francisco Bay. The length of the dry-back area fluctuates year by year, depending on the annual hydrologic cycle, reservoir operations, and local groundwater conditions.

Stevens Creek supports a population of winter steelhead that is part of the CCC DPS. The CCC steelhead DPS is classified as a threatened species under the federal Endangered Species Act (ESA) (62 Federal Register [FR] 43937 August 18, 1997). The freshwater form of *O. mykiss* (i.e., rainbow trout) above impassable barriers is not listed under the federal ESA; however, in Santa Clara Valley, native populations of rainbow trout above barriers are genetically similar to steelhead (Garza and Pearse 2008). Designated critical habitat for the CCC steelhead DPS includes Stevens Creek downstream of Stevens Creek Reservoir (70 FR 52488 September 2, 2005), coincident with the Study Area.



Source: CalFish Passage Assessment Database, 2016; USGS HUC-12 Hydrologic Units, 2013; Imagery, ESRI, 2019.



## 2 METHODS

Valley Water directed the Team to investigate Pre-Identified Sites for fish passage assessment on Stevens Creek along the 12.8 miles of the stream that flows from Stevens Creek Dam to South San Francisco Bay. Through previous efforts by others (see Section 1) and recent reconnaissance conducted by Valley Water (see Attachment A) and the Team (see Section 2.1 and Section 3.1), all anthropogenic structures potentially creating a barrier to steelhead upstream movement were included in the Study.

The overall process for the fish passage assessment involved the following steps:

- **Field Reconnaissance.** The Team visited each of the Pre-Identified Sites to confirm its presence and, if present, to document its condition and outline the approach for future data collection efforts. Pre-Identified Sites confirmed present during the Team's reconnaissance surveys were moved to the list of Assessment Sites. Additionally, unexpected passage impediments encountered while moving between Pre-Identified Sites and during general reconnaissance of the channel were added to the list of Assessment Sites. The Pre-Identified Sites not found, presumably because they are no longer present, were removed from the list of Assessment Sites.
- **Assessment Site Surveys.** Based on information collected during the field reconnaissance, the Team topographically surveyed each Assessment Site. Survey data obtained during this step, along with as-built drawings for some Assessment Sites, were used to build the fish passage analysis Hydrologic Engineering Center River Analysis System (HEC-RAS) models.
- **Fish Passage Assessment.** This step followed methods outlined in the CDFW's *California Salmonid Stream Habitat Restoration Manual, Part IX: Fish Passage Evaluation at Stream Crossings* (CDFG 2004). Upstream passage assessment for juvenile and adult steelhead involved three main steps:
  - **Fish passage evaluation filter.** Passage at each Assessment Site was characterized following CDFW's assessment protocol and the Green-Gray-Red category filter. Characteristics of Green Assessment Sites were documented as detailed in CDFG (2004). All Gray and Red Assessment Sites were further analyzed for fish passage conditions.
  - **HEC-RAS modeling.** Topographic data and field data were used to develop a HEC-RAS hydraulic model of each Assessment Site to evaluate hydraulic conditions.
  - **Fish Passage Analysis.** Hydraulic conditions obtained from the HEC-RAS models were used in a fish routing model (FRM) to determine the passability of each Assessment Site based on the FishXing algorithm.
  - **Scoring.** Scores were calculated for the Assessment Sites to allow for relative comparison of their potential to limit access for steelhead to habitat in Stevens Creek.

Each of these steps is explained in detail in the following sections.

## 2.1 FIELD RECONNAISSANCE

Valley Water provided the Team with a list of 34 Pre-Identified Sites along the Study Area, and their approximate locations (Figure 1, Table 1). As described in Section 1, these sites had been identified and included in the PAD through previous efforts by others (CalFish 2019), or they were identified for inclusion in the Study during recent reconnaissance surveys conducted by Valley Water (see Attachment A). Two of the Pre-Identified Sites (Sites 2 and 3) were included in an earlier quantitative fish passage assessment (MLA 2016) upon which the passage evaluation methods used in this Study were based. As described in Section 1.3, the combined reconnaissance conducted by Valley Water and the Team afforded complete coverage of the Study Area except for the reach between RMs 3.93 and 4.05, where Valley Water is currently planning channel modifications that would mitigate fish passage impediments.

**Table 1. Pre-Identified Sites (prior to the Team’s Reconnaissance)**

	River Mile	Coordinates	Pre-Identified Site No.	PAD Description or other Name (for Sites not in PAD)	PAD ID
	2.64	37.410868, -122.068759	1	Grade control structure at Vernon Avenue	713640
	2.81	37.408345, -122.069111	2	Highway 101 culvert and chute	705646
	2.93	37.406629, -122.069113	3	Moffett fish ladder at grade control structure	707059
	3.13	37.403765, -122.069144	4	Concrete channel at Moffett Avenue bridge	713641
	3.21	37.402642, -122.069119	5	Drop structure at Walker Drive	713642
	3.29	37.401421, -122.069167	6	Drop structure at the Hetch Hetchy pipeline crossing	713643
	3.32	37.401007, -122.069174	7	Concrete chute at Whisman Elementary School	713644
	3.44	37.399298, -122.068750	8	Drop structure, downstream of Middlefield Road	713645
	3.53	37.398158, -122.068170	9	Drop structure, upstream of Middlefield Road	713646
	3.63	37.396752, -122.068327	10	Drop structure at Cypress Point Drive and Easy Street	713647
	3.70	37.395755, -122.068706	11	Drop structure and chute at Highway 85 crossing	713648
	3.76	37.395049, -122.069084	12	Gaging weir (SF35) with drop structure, Central Avenue fish ladder	707058
	3.99	37.391873, -122.069750	13	Weir at footbridge over Central Expressway	713649
	4.20	37.388777, -122.069397	14	Dana Street low flow	713650
	4.56	37.383653, -122.069040	15	Chute at Highway 237 Bridge crossing	713651
	4.89	37.379045, -122.069681	16	Bridge (El Camino Real and Highway 85 bridge)	713652
	4.90	37.378876, -122.069681	17	Chute at El Camino bridge	733959
	5.62	37.369265, -122.066139	18	Concrete rubble at Heatherstone Drive	713653
	5.85	37.367313, -122.063958	19	Chute at Highway 85 Bridge crossing	713654
	6.47	37.359482, -122.062315	20	Concrete and flashboard dam	715100
	6.82	37.355436, -122.061515	21	Fremont fish ladder	707056
	6.96	37.354120, -122.061493	22	Highway 85 bridge (downstream of Fremont Avenue)	733951
	7.15	37.352159, -122.063441	23	Aggraded sediments at Fremont Avenue	713655
	7.24	37.351107, -122.063496	24	Losse	716244
	7.46	37.348288, -122.064913	25	Drop structure at Kircher Court	713656
	7.90	37.340550, -122.063778	26	Rock piles at West Valley Elementary School	713657
	8.37	37.337599, -122.062381	27	Degraded bed armoring downstream of Homestead Road	713658
	8.62	37.335961, -122.063997	33	Drop structure at Sweet Oak Street	NA
	8.82	37.333512, -122.063825	28	Chute at Highway 280 Bridge crossing	713660
	8.92	37.332259, -122.062942	29	Rock piles (3) at Creston Drive	713661
	9.93	37.320811, -122.060600	30.1	Boulder weirs at Blackberry Farm	NA
	10.40	37.316481, -122.061167	30	Diversion structure at Blackberry Farm	713663
	11.26	37.308373, -122.063805	31	Drop structure at Linda Vista Park	713665
	12.28	37.305775, -122.074104	32	Gaging weir (SF44) at Stevens Creek Park	713667

Note:

PAD ID = California Fish Passage Assessment Database Identification Number (CalFish 2019)

Between May 21 and May 23, 2018, with one additional visit on May 9, 2019, the Team visited each of the Pre-Identified Sites and walked much of the channel between the sites. This was done to confirm presence of each Pre-Identified Site, identify additional potential sites that should be evaluated, obtain an overview of each confirmed or additional site, and outline the survey approach for future topographic surveys. The resulting sites, after removing Pre-Identified Sites no longer present, are referred to as the Assessment Sites. An accounting of all Pre-Identified Sites and Assessment Sites, including the Pre-Identified Sites dropped during reconnaissance and new sites found and added during reconnaissance, is provided in the reconnaissance results section (Section 3.1).

During the field reconnaissance, the Team developed a sketch for each Assessment Site. Appropriate locations for surveying channel cross-sections were noted on the field sketches. Channel cross-sections (sections) are the basis of the HEC-RAS models used in the assessments. In general, sections to be surveyed were noted at hydraulic controls (e.g., tailwater crests), in pools immediately below drops, at changes in channel planform (e.g., where the channel widens or constricts), and around infrastructure (e.g., culverts). Assessment Sites were grouped together in reaches to aid in future modeling. There was a desire to group the sites into reaches that could effectively and efficiently be modeled together in HEC-RAS. These reach designations were made in the field, based on proximity of sites to one another, so that single models encompassing multiple sites could be developed (reach designations are provided with other reconnaissance results in Section 3.1).

## 2.2 ASSESSMENT SITE SURVEYS

Surveys of Assessment Sites were conducted by the Team between June and December 2018, with one additional survey conducted in May 2019, to obtain topography and other physical dimensions sufficient to develop a HEC-RAS model and analyze fish passage conditions for each site. To catalogue data collected at each site in a uniform manner, a Fish Passage Inventory Data Sheet (see Attachment B for example form) was completed for each site.

During the surveys, the reconnaissance site sketch was reviewed, and section locations were finalized and surveyed. Surveying was completed using a Total Station, a device consisting of an electronic theodolite and an electronic distance meter, which is used to measure angles and distances. All data were collected on an assumed datum, although benchmarks were installed to allow the survey to be tied to an established coordinate system in the future, if desired. In addition to surveying sections, a profile of the channel was surveyed to obtain distances between sections as well as channel slopes for model boundary conditions. The Team also qualitatively documented the channel roughness, which provides resistance to flow. For reaches that encompassed more than one Assessment Site, additional sections were surveyed between sites to hydraulically connect them in the HEC-RAS model.

## 2.3 FISH PASSAGE ASSESSMENT

This section describes the evaluation steps used to assess fish passage at the Assessment Sites, including the passage evaluation filter, fish passage assessment flows, HEC-RAS model, and FRM. Although the term “fish passage” is used generally, the assessment was conducted specifically for juvenile and adult steelhead upstream movement.

### 2.3.1 PASSAGE EVALUATION FILTER

The first step in the assessment was to apply a fish passage evaluation filter, following the methods and protocols described in CDFW’s *California Salmonid Stream Habitat Restoration Manual, Part IX: Fish Passage Evaluation at Stream Crossings* (CDFG 2004). The Team applied CDFW’s assessment protocol to the passage of adult anadromous and juvenile steelhead, using



data collected during the field reconnaissance and Assessment Site surveys. The CDFW Green-Gray-Red categories are described below:

- **Green:** Condition assumed to be adequate for passage of all salmonid species throughout all salmonid life stages.
- **Gray:** Condition may not be adequate for all salmonid species at all their life stages. FishXing (USFS 2006) methodology and hydraulic modeling are used to determine the extent of barriers for each salmonid life stage.
- **Red:** Condition fails to meet CDFW passage assessment criteria at all passage assessment flows for strongest swimming salmonid species and life stages presumed present.

For all Assessment Sites identified as Gray or Red using the fish passage evaluation filter, the Team evaluated passage conditions using the methods outlined below. Assessment Sites identified as Green were documented as detailed in CDFG (2004).

### 2.3.2 FISH PASSAGE ASSESSMENT FLOWS

High and low fish passage assessment flows were developed following accepted practices and agency guidelines applied to historical Stevens Creek streamflow records. Fish passage assessment flows define the range of stream flows for which fish should be able to move freely past anthropogenic structures. This Study evaluated upstream passage conditions at each Assessment Site between the low and high passage assessment flows for adult anadromous and juvenile steelhead. For example, a site that provides adequate passage conditions at all flows between the low and high passage assessment flows is deemed 100 percent passable; a site that meets assessment criteria for a quarter of the passage assessment flows is considered 25 percent passable.

NMFS (2001) and CDFW (CDFG 2002) define fish passage flows for California based on annual duration of flow, calculated using daily average stream flows. For adult steelhead, the passage range is from the 50 percent exceedance flow to the 1 percent exceedance flow, with an alternative minimum flow of 3 cubic feet per second (cfs) if the 50 percent exceedance flow is less. The 50 percent annual exceedance flow is the daily average flowrate that is equaled or exceeded 50 percent of the time; the 1 percent exceedance flow is equaled or exceeded 1 percent of the time. For juvenile steelhead, the passage range is from the 95 percent exceedance flow to the 10 percent exceedance flow, with an alternative minimum flow of 1 cfs if the 95 percent exceedance flow is less.

The high and low fish passage flows (Table 2) are based on the recorded flows in Stevens Creek and are intended to define the range of flows between which salmonids in Stevens Creek are most likely to migrate upstream. For this Study, the Team used water years 1990 through 2017 to establish the flow record for the analysis because, based on evaluation of historical aerial photographs, this 27-year period represents current, post-urbanization, hydrologic conditions in the lower Stevens Creek watershed. The flow duration curve prepared for Valley Water by AECOM and MLA (2018) for the Moffett Fish Passage Project was used to determine flows for assessing fish passage at Sites 1 through 19, which are downstream of the Permanente Creek Diversion outlet. This flow duration curve was constructed using a Valley Water-provided record of mean daily flows at station SF35 (RM 3.76) on Stevens Creek from water years 1990 through 2017, which represents current (post-urbanization) hydrologic conditions of the lower stream reaches. The low passage assessment flows were defined using the alternative minimum flows described above. The Team prepared a separate flow duration curve using a Valley Water-provided record of mean daily flows at station SF44 on Stevens Creek (RM 12.28) for water years 1990 through 2017. This curve was used to determine flows for assessing fish passage at Sites 20 through 32, which are upstream of the Permanente Creek Diversion confluence. The fish passage assessment flow selection criteria and values are provided in Table 2.

**Table 2. Fish Passage Assessment Flows Applied to All Assessment Sites**

Assessment Sites	Steelhead Lifestage	Low Passage Assessment Flow		High Passage Assessment Flow	
		Criterion	Study Flow	Criterion	Study Flow
1 through 19	Adult	50% Exceedance Flow or 3 cfs <sup>1</sup>	3 cfs	1% Exceedance Flow	203 cfs
	Juvenile	95% Exceedance Flow or 1 cfs <sup>1</sup>	1 cfs	10% Exceedance Flow	29 cfs
20 through 32	Adult	50% Exceedance Flow or 3 cfs <sup>1</sup>	5 cfs	1% Exceedance Flow	130 cfs
	Juvenile	95% Exceedance Flow or 1 cfs <sup>1</sup>	1 cfs	10% Exceedance Flow	21 cfs

Notes:

<sup>1</sup> The criterion resulting in the greater of the two flows is used.

cfs = cubic feet per second

Once the range of fish passage assessment flows is established for each site, the remainder of the passage analysis aims to identify the flows meeting hydraulic criteria (e.g., depth or velocity) between the low and high passage assessment flows. Passage conditions at each site were also evaluated at stream flows greater than the high passage assessment flow to determine whether there were additional passage opportunities. For sites that had suitable passage conditions at higher flows, the assessment was continued up to the 2-year peak flow of 619 cfs, which is based on return period flows estimated using annual peak flow records from station SF35 developed for the Moffett Fish Passage Project; Feasible Alternatives Report (AECOM and MLA 2018).

### 2.3.3 HYDRAULIC MODELING

The primary basis for each fish passage assessment was the hydraulic results of a one-dimensional, steady-state HEC-RAS hydraulic model. The Team used individual HEC-RAS models for 16 reaches, 15 of which were developed using the survey data collected during the Assessment Site surveys. The model used for Reach 2 (Sites 2 and 3) was developed previously (MLA 2016). The HEC-RAS model files were provided to Valley Water for their use following completion of the Study. Where practical, multiple sites were analyzed in a single model. For example, Reach 7 is a single HEC-RAS model that includes Sites 16, 17, and 18. Each model was developed using the surveyed sections, thalweg alignment, and other field data. In addition to these data, as-built drawings (if available) were used to confirm or append the field measurements.

Manning’s roughness coefficients were determined using methods developed by Phillips and Tadayon (2006). This is the same method used in Valley Water’s *Stream Maintenance Guidelines; Draft Year 1 Hydraulic Modeling Report* (ESA 2017). The Phillips and Tadayon (2006) methodology requires selecting values from five roughness categories: base material, channel margin irregularity, channel section variation, effect of obstructions, and vegetation. For each category, a predetermined Manning’s roughness coefficient value is applied based on the selected material or condition (e.g., base material: gravel = 0.028). The roughness coefficients from the five categories are summed to arrive at a composite Manning’s roughness. The final step is to determine whether a multiplier should be applied due to energy loss associated with meanders; in most cases, modeled reaches were relatively straight, so this multiplier was set to “minor,” which equates to negligible energy losses from meandering. In a few instances, cross sections were located in notable channel bends; it is likely that turbulent eddies would occur at these locations. To account for the resulting head loss of these eddies, the meander multiplier was set to either “appreciable” or “severe,” and a multiplying factor was applied accordingly.

Using this approach, a Manning’s roughness coefficient was determined for each section. In general, the channel sections were separated into three subsections: left bank, channel, and right bank. The survey results, photographs, field notes, and other field data for each section were used to select appropriate values for each subsection. For the banks, the only roughness categories applied were base material and vegetation. A spreadsheet template was developed to standardize the approach for each HEC-RAS model. The template is provided in Attachment C.

In the HEC-RAS model, the roughness coefficient values were applied to each section using the *horizontal variation in n values* function. The channel bank markers were placed at the ends of the section so that all the stream flow was between the markers to facilitate the fish passage analysis.

Some sites required additional modeling outside of HEC-RAS. For example, Site 21, which includes a Denil fishway, required development of a spreadsheet model based on accepted fishway equations. The calculation sheets and results from these spreadsheet models are provided in Attachment D. These additional spreadsheet models were used in conjunction with the HEC-RAS model. For Site 16, which contained a rock chute, the Team applied a depth-dependent roughness coefficient based on the Limerinos (1970) roughness equation provided in Appendix XII-B-8 of the CDFW Manual (CDFG 2009). The equation was derived from California stream channel data and presents a Manning’s roughness relationship drawing on the hydraulic radius and measured median particle size.

### 2.3.4 FISH ROUTING MODELING

Once the HEC-RAS analysis of site hydraulics was complete, the results were exported to the FRM. The Team used the FRM to identify the approximate flow range in which the selected passage criteria are satisfied for each steelhead age class. The FRM is a spreadsheet model that follows the U.S. Forest Service FishXing routing algorithm (USFS 2006) and uses the CDFW fish passage assessment criteria (Table 3). Output from the HEC-RAS model, including flows, velocities, water depths, and water surface elevations are entered into the FRM and compared to CDFW fish passage assessment criteria. Results from the fishway spreadsheet models were compared directly to the CDFW fish passage assessment criteria. CDFW fish passage assessment protocol (CDFG 2002) describes minimum required water depths and maximum swimming and leaping speeds for adequate fish passage, as listed in Table 3. Several of these criteria were adjusted, as described below.

**Table 3. Fish Passage Assessment Criteria**

Species and Life Stage	Minimum Water Depth	Prolonged Swimming Mode		Burst Swimming Mode		Maximum Leap Speed	Maximum Water Surface Drop <sup>1</sup>	Minimum Leap Pool Depth
		Maximum Swimming Speed	Time to Exhaustion	Maximum Swimming Speed	Time to Exhaustion			
Adult Steelhead	0.7 ft <sup>(2)</sup>	6.0 fps	30 min	10.0 fps	5 sec	15.0 fps	1.5 ft	> leap height
Juvenile Steelhead	0.3 ft	1.5 fps	30 min	3.0 fps	5 sec	4.0 fps	0.5 ft	> leap height

Notes:

<sup>1</sup> The Study used water surface drop rather than leap speed to evaluate potential leap barriers.

<sup>2</sup> The Study used a 0.7-foot minimum allowable water depth, rather than the 0.8-foot value listed in CDFG (2002)

fps = feet per second

ft = feet

min = minutes

sec = seconds

The Team used the maximum water surface drop in the FRM rather than leap speeds due to HEC-RAS model limitations. Water surface drop is an abrupt change in water surface elevation and is measured as the vertical difference in water surfaces above and below the drop. For juvenile salmonids, the maximum drop criterion was based on CDFW (2002) and NMFS (2001). For adult steelhead, the maximum drop of 1.5 feet was used, based on tests of leap heights using the 15-foot-per-second leap speed in the FishXing software, and based on criteria for maximum water surface drops at fishway entrances for adult anadromous salmonids (NOAA 2011).

Another important criterion is the leap pool depth. The height to which a fish can leap is partially controlled by the depth of the pool from which the leap is initiated. The angle and speed with which the fish can leap is related to the depth of the pool it is leaping from, and a deeper pool is required to execute a higher leap. For this Study, the Team required that the depth of the leap pool be greater than the height of the leap. The requirement that the leap pool depth be greater than the leap height is based on the criteria applied by the FishXing software.

The minimum allowable water depth for adult steelhead was lowered from the value of 0.8 foot given in CDFG (2002) to 0.7 foot for this Study. The change was made to be consistent with Valley Water's minimum depth criteria for critical riffles in Stevens Creek associated with in-stream flow requirements.

To meet fish passage criteria at a specific flow requires that the fish (1) can leap or swim over any vertical feature; (2) have adequate water depth; and (3) can swim through the length of the site without becoming exhausted or swept backward by the water velocities. If the FRM results indicated a fish is unable to navigate a site, the general location and type of the impediment was noted.

The HEC-RAS and FRM analysis was conducted at the fish passage assessment flows. Those sites that provide suitable passage conditions at some assessment flows were considered temporal barriers, requiring additional HEC-RAS and FRM runs to more precisely identify the range of flows at which the site allows passage. In situations where the site was found to be passable at the high passage assessment flow, greater flows were also evaluated to identify the flow threshold for passage up to the 2-year flow event (619 cfs).

## **2.4** SCORING

The Team scored each Assessment Site to allow for easy comparison of quantitative fish passage assessment results across sites. The scoring system is intended to allow quick identification of the sites that have the biggest potential to affect steelhead access to habitat in Stevens Creek. The scoring system did not account for spatial variability in habitat types, habitat quality or water quality, potential life history strategies of juvenile steelhead, the potential for the Assessment Sites to cause fish injury, or other potential factors not specifically captured in the quantitative evaluation methods described above; consideration of these factors was beyond the scope of this Study but could be incorporated into future efforts. Some of these factors are discussed further in Section 3.4.

The scoring was based on a formula developed to highlight sites in the Study Area that create substantial barriers to fish passage and that, if treated, would provide the most access to upstream habitat. The scoring calculation was set up so that a lesser accumulation of points (lower score) would indicate a greater benefit associated with barrier remediation. The scoring system is based on four metrics:

- a. the fish passage assessment results (percent passage) for adult steelhead,
- b. the fish passage assessment results (percent passage) for juvenile steelhead,
- c. the amount of upstream habitat made accessible to adult steelhead if passage conditions at the site were fully remediated, and
- d. the position of the site in the watershed.

For each Assessment Site, metrics a, b, and c were calculated first, and then the score was adjusted based on the site's position in the watershed. Because it was applied last and across the sum of the other scoring metrics, watershed position is the most important metric in this scoring formula, dictating overall Assessment Site scores. These metrics and the scoring formula are described in more detail below.

For metrics a and b, fish passage assessment results were based on the calculated percent passage for adult steelhead and for juvenile steelhead. This is equal to the proportion of flows meeting the Study's passage criteria between the low and high passage assessment flow rates. If all flows between the low and high passage assessment flows met the selected criteria, then the site was considered 100 percent passable. If no flows between the low and high passage assessment flows met the selected criteria, then the site was considered zero percent passable. Those sites that provide suitable passage conditions at some assessment flows were considered temporal barriers and a percent passable value was assigned accordingly. The higher the percentage, the higher score the site would receive. Passage criteria satisfied at flows greater than the high passage assessment flow threshold did not affect the Assessment Site score.

The percent passage metric is based on the percent of fish passage assessment flows meeting the Study's passage criteria rather than percent of time passage criteria are satisfied. Flows at the low end of the passage flow range occur more frequently than higher flows, but this analysis aims to evaluate passage conditions when fish are expected to move. Passage at a site may be available continuously for months at low flows, when steelhead are less likely to be migrating, but passage during less frequent, elevated storm flows that cue steelhead migration is important. The approach used in this Study, and generally accepted by state and federal agencies, is intended to provide equal weight to all flows within the passage flow range, including higher flows that occur less frequently but may be important for fish migration.

The next metric, metric c in the scoring system above, was the amount of upstream habitat made accessible if passage conditions at a site were remediated. This measurement was based on the distance to the next upstream site considered to be a substantial barrier to adult steelhead. The Team defined a substantial barrier as those with values of percent passage for adult steelhead less than 80 percent. The results were then normalized by dividing the distance for each site by the largest value among all the sites, to determine the relative distance to the next upstream barrier.

Metrics a, b, and c were expressed as percentages that could range from 0 to 100 percent. In the scoring calculation the relative distance to the next upstream barrier (metric c in the list above), expressed as a percentage, was subtracted from 100 percent so that, consistent with other scoring metrics, a higher accumulation of points would indicate a lesser benefit associated with barrier remediation. Weighting factors were applied individually to each of these three metrics based on

their relative importance. The products of each metric and its weighting factor were summed before applying watershed position across these three metrics.

The position of the site in the watershed was used to adjust the sum product of the other three scoring metrics described above. Watershed position was based on the stream length downstream of the site as a percentage of the entire Study Area’s length of 12.8 miles, measured along Stevens Creek from south San Francisco Bay to the Stevens Creek Dam. A site farther downstream would receive a lower percentage, and therefore a lower score, emphasizing the importance of addressing barriers lower in the watershed before addressing upstream barriers.

The scoring formula applied to each site was:

$$\text{SCORE} = ([aW_1 + bW_2 + (1-c)W_3]d)100$$

where:

- a = percent passage for adult steelhead
- b = percent passage for juvenile steelhead
- c = relative percentage of upstream habitat made accessible if passage conditions at the site are remediated, calculated as [(RM at the next upstream site qualifying as a substantial barrier – RM at the site) / (the maximum distance in RMs between any site and the next upstream site qualifying as a substantial barrier)<sup>‡</sup>]
- d = percent of potential habitat downstream of the site, calculated as [RM at site / RM at Stevens Creek Dam]<sup>§</sup>
- W<sub>i</sub> = weighting factor for each metric

The final weighting factors for each metric are provided in Table 4.

**Table 4. Weighting Factors Applied to Each Metric for Scoring of Sites**

Weighting Factor		Weight (%)
Variable	Metric Weight is Applied	
W <sub>1</sub>	Adult steelhead percent passage	70
W <sub>2</sub>	Juvenile steelhead percent passage	20
W <sub>3</sub>	Percent of upstream habitat made accessible if passage conditions at the site are remediated	10

The sensitivity of the scores of Assessment Sites to the weighting factor values was tested by iteratively varying each of the individual weighting factors, as well as the threshold percent passage for adult steelhead used to define a substantial barrier. The weighting factor for adult percent passage was varied between 40 and 100 percent. The weighting factor for juvenile percent passage was varied between 0 and 40 percent. The weighting factor for relative percentage of upstream habitat made accessible if passage conditions at the site are remediated was varied between 0 and 30 percent. The threshold percent passage for adult steelhead used to define a substantial barrier was varied between 60 and 90 percent. The tests suggested that small changes in the distribution of the weights generally had negligible influence on the scores of Assessment Sites and that adult passage was the most significant metric affecting variation in the

<sup>‡</sup> The value used for the maximum distance in RMs between any site and the next upstream site qualifying as a substantial barrier (adult passage less than 80 percent) is 3.61 miles, the distance between sites 33.1 and 32.

<sup>§</sup> The value used for RM at Stevens Creek Dam is 12.81.

cumulative scores among sites. Final weighting values were selected in coordination with Valley Water. The sum of the weighting factors is 100 percent.

Once the scores were calculated for each Assessment Site, the sites were grouped into red, yellow, and green categories by score, as follows:

- Red score category – Sites with scores ranging from 1 to 14
- Yellow score category – Sites with scores ranging from 15 to 24
- Green score category – Sites with scores 25 and higher

The lowest scores generally indicate sites lower in the stream system with poor passage conditions for steelhead and where remediation may open more habitat for more steelhead than other sites; therefore, sites with the lowest scores were placed into the red score category.



## 3 RESULTS

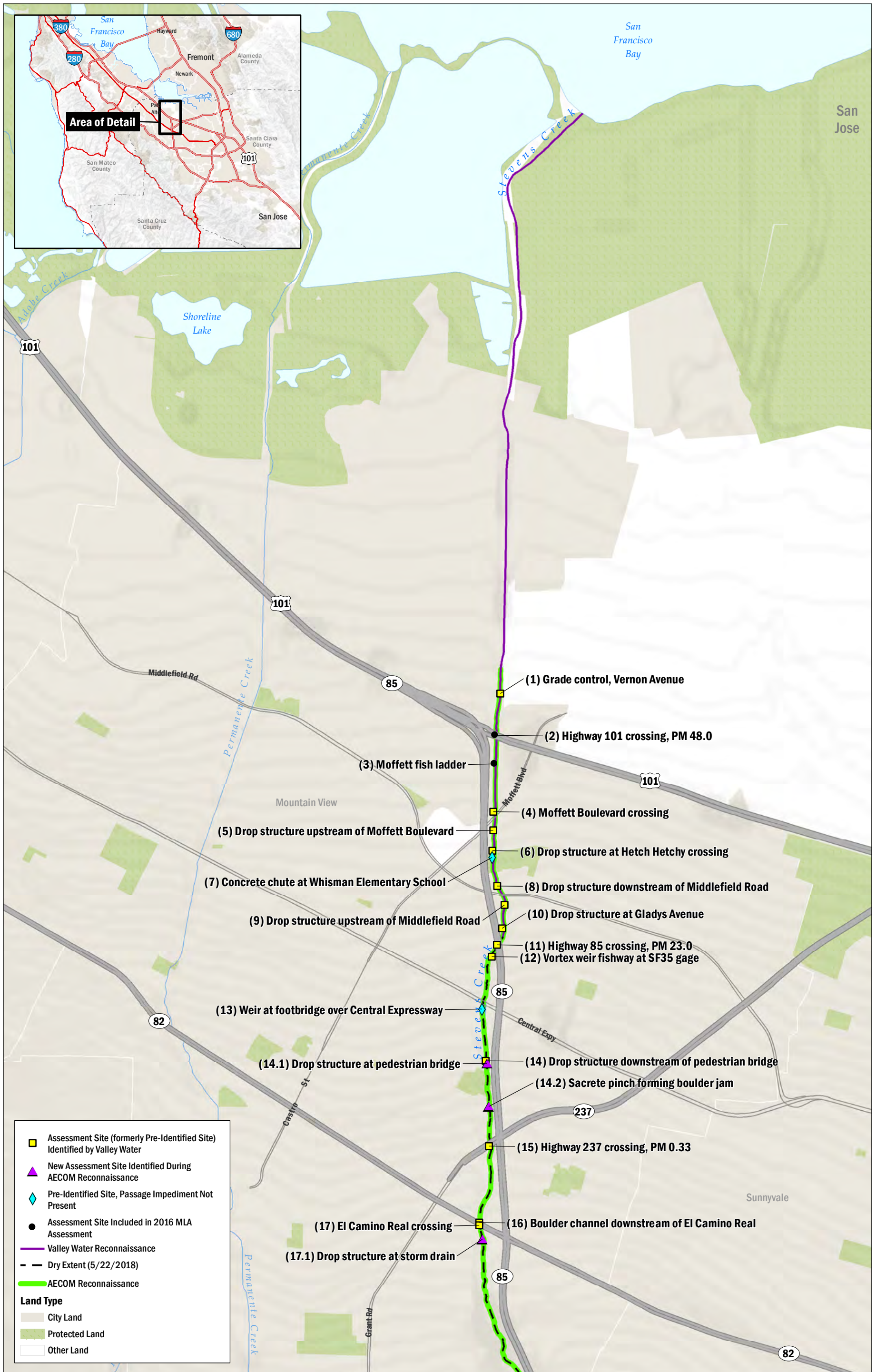
This section presents the results of the Study, including field reconnaissance, passage conditions at the Assessment Sites, and scoring.

### 3.1 FIELD RECONNAISSANCE

The extent of Stevens Creek walked by the Team during the field reconnaissance is shown on Figure 2. Reconnaissance conducted by Valley Water, described in detail in Attachment A, is also shown on Figure 2. As depicted in the figure, the combined extent of the Team's reconnaissance and Valley Water's reconnaissance completely covered the Study Area, from Stevens Creek Dam to San Francisco Bay, except for a short reach between RMs 3.93 and 4.05, where Valley Water is separately planning channel modifications that would mitigate impediments to fish passage.

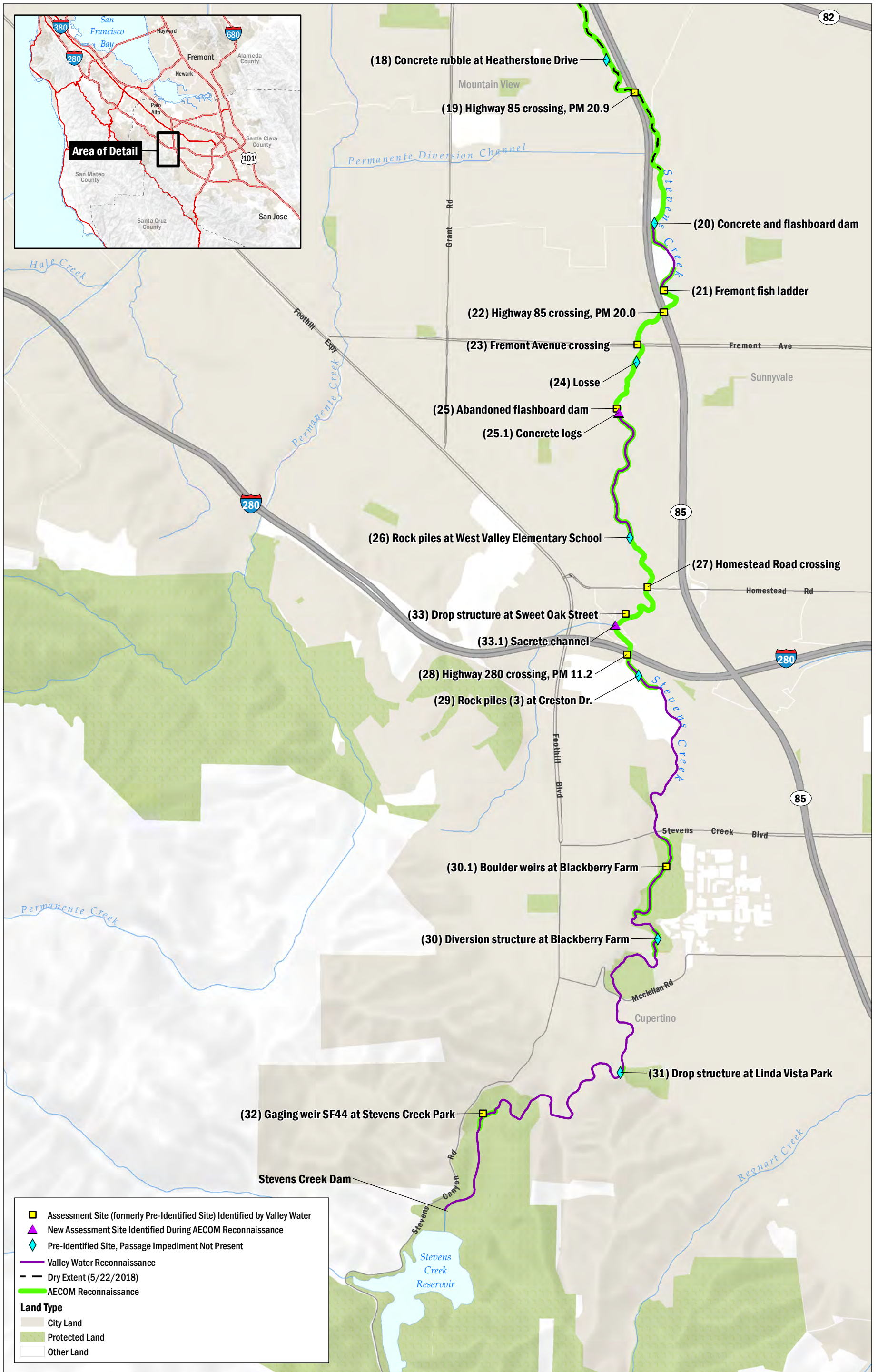
During the Team's reconnaissance, the presence of some Pre-Identified Sites was confirmed, others were dropped from the Study, and new sites were added (Figure 2). Of 34 Pre-Identified Sites, the Team confirmed the presence of 25 and failed to locate 9 (presumably because they no longer exist). The Pre-Identified Sites included some passage impediments that had been directly observed by Valley Water in recent years; they also included passage impediments that had been recorded in the PAD from various sources over the years, some of which may have been removed or modified, or may have changed over time. Additionally, the Team found 5 fish passage impediments during field reconnaissance that were not included in the list of Pre-Identified Sites. The net of the field reconnaissance (34 Pre-Identified Sites, minus 9, plus 5) was a list of 30 sites that moved forward as Assessment Sites. These Assessment Sites, as well as Pre-Identified Sites where no passage impediment was present, are all shown in Figure 2. Figure 2 also shows the section of stream in the intermittent reach that was dry in May 2018 during the Team's reconnaissance surveys.

A complete list of sites considered in the Study is shown in Table 5. This table includes a complete accounting of Pre-Identified Sites, both found and not found, as well as sites added to the Study during field reconnaissance. For all sites, Table 5 includes the flow direction, RM, site number, HEC-RAS model reach, Assessment Site name, latitude and longitude coordinates, and whether the potential barrier was found during the Team's reconnaissance. Sites are listed in order by RM, and the PAD ID is shown for sites already included in the PAD. The PAD ID is the unique identification number given to each site in the CDFW-maintained PAD; newly identified Assessment Sites had not been assigned PAD IDs at the time this report was published. In some cases, the Assessment Site names in Table 5 differ from the PAD Descriptions shown in Table 1. Sites were renamed or given a concise name that the Team found accurately described the feature, because some of the PAD Descriptions did not. Sites in the PAD can be definitively tracked using the PAD ID. Tables and figures shown later in this report include only the Assessment Sites, some of which were previously Pre-Identified Sites and some of which were added incidentally to the Study following field reconnaissance. Moving forward, only the Assessment Site names are used. Results of the steelhead passage assessment completed for the Assessment Sites are presented in the following sections.



Source: CalFish Passage Assessment Database, 2016; USGS HUC-12 Hydrologic Units, 2013; Imagery, ESRI, 2019.





**Table 5. Pre-Identified and Newly Identified Assessment Sites**

	River Mile	Pre-Identified Site No.	Assessment Site No.	Reach No.	Assessment Site Name	Coordinates	Site Found?	PAD ID	
	2.64	1	1	1	Grade control, Vernon Avenue	37.410868, -122.068759	Yes	713640	
	2.81	2	2	2	Highway 101 crossing, PM 48.0	37.408345, -122.069111	Yes	705646	
	2.93	3	3		Moffett fish ladder	37.406629, -122.069113	Yes	707059	
	3.13	4	4	3	Moffett Boulevard crossing	37.403765, -122.069144	Yes	713641	
	3.21	5	5		Drop structure upstream of Moffett Boulevard	37.402642, -122.069119	Yes	713642	
	3.29	6	6		Drop structure at Hetch Hetchy crossing	37.401421, -122.069167	Yes	713643	
	3.32	7	NA		—	37.401007, -122.069174	No	713644	
	3.44	8	8		Drop structure downstream of Middlefield Road	37.399298, -122.068750	Yes	713645	
	3.53	9	9		Drop structure upstream of Middlefield Road	37.398158, -122.068170	Yes	713646	
	3.63	10	10		Drop structure at Gladys Avenue	37.396752, -122.068327	Yes	713647	
	3.7	11	11		Highway 85 crossing, PM 23.0	37.395755, -122.068706	Yes	713648	
	3.76	12	12		Vortex weir fishway at SF35 gage	37.395049, -122.069084	Yes	707058	
	3.99	13	NA		NA	—	37.391873, -122.069750	No <sup>1</sup>	713649
	4.2	14	14		4	Drop structure downstream of pedestrian bridge	37.388777, -122.069397	Yes	713650
	4.21	NA	14.1			Drop structure at pedestrian bridge	37.388636, -122.069289	Yes	—
	4.39	NA	14.2	5	Sacrete pinch forming boulder jam	37.386036, -122.069117	Yes	—	
	4.56	15	15	6	Highway 237 crossing, PM 0.33	37.383653, -122.06904	Yes	713651	
	4.89	16	16	7	Boulder channel downstream of El Camino Real	37.379045, -122.069681	Yes	713652	
	4.9	17	17		El Camino Real crossing	37.378876, -122.069681	Yes	733959	
	4.96	NA	17.1		Drop structure at storm drain	37.378044, -122.069439	Yes	—	
	5.62	18	NA	NA	—	37.369265, -122.066139	No	713653	
	5.85	19	19	8	Highway 85 crossing, PM 20.9	37.367313, -122.063958	Yes	713654	
	6.47	20	NA	NA	—	37.359482, -122.062315	No	715100	
	6.82	21	21	9	Fremont fish ladder	37.355436, -122.061515	Yes	707056	
	6.96	22	22	10	Highway 85 crossing, PM 20.0	37.354120, -122.061493	Yes	733951	
	7.15	23	23	11	Fremont Avenue crossing	37.352159, -122.063441	Yes	713655	
	7.24	24	NA	NA	—	37.351107, -122.063496	No	716244	
	7.46	25	25	12	Abandoned flashboard dam	37.348288, -122.064913	Yes	713656	
	7.48	NA	25.1		Concrete logs	37.348056, -122.064756	Yes	—	
	7.9	26	NA	NA	—	37.34055, -122.063778	No	713657	
	8.37	27	27	13	Homestead Road crossing	37.337599, -122.062381	Yes	713658	
	8.62	33	33	14	Drop structure at Sweet Oak Street	37.335961, -122.063997	Yes	—	
8.67	NA	33.1	Sacrete channel		37.335275, -122.064742	Yes	713659		
8.82	28	28	Highway 280 crossing, PM 11.2		37.333512, -122.063825	Yes	713660		
8.92	29	NA	NA		—	37.332259, -122.062942	No	713661	
9.93	30.1	30.1	16	Boulder weirs at Blackberry Farm	37.320811, -122.060600	Yes	—		
10.4	30	NA	NA	—	37.316481, -122.061167	No	713663		
11.26	31	NA	NA	—	37.308373, -122.063805	No	713665		
12.28	32	32	15	Gaging weir SF44 at Stevens Creek Park	37.305775, -122.074104	Yes	713667		

Note:

1 Pre-Identified Site No. 13, PAD ID 713649, refers to a weir that has been removed. Separate from this study, Valley Water is planning modifications to mitigate impediments to fish passage at that location. To avoid duplication of effort, that section of Stevens Creek is not analyzed in this report.

PAD ID = Passage Assessment Database Identification Number  
 PM = post mile

## 3.2 PASSAGE CONDITIONS AT ASSESSMENT SITES

Two-page assessment summary sheets for each of the Assessment Sites are provided in Attachment E. The summary sheets describe the features and include photographs of each site. They also list the types and locations of passage limitations identified for the site and the flow range during which they persist.

Using the passage evaluation filter, all the Assessment Sites were confirmed as passage impediments (Gray or Red), except for Site 23 (aggraded sediments at Fremont Avenue). Site 23 was classified as “Green,” or not a barrier, based on CDFW protocol for the “Green-Gray-Red” passage evaluation filter.

Flows meeting passage assessment criteria for juvenile and adult anadromous steelhead, along with the percent passage, are provided for each Assessment Site in Table 6. As defined in Section 1.2, percent passage is the proportion of passage assessment flows that meet assessment criteria and should not be confused with the percentage of the fish population that may successfully pass an Assessment Site. Sites identified as partial barriers or complete barriers fail to meet fish passage criteria throughout some or all (respectively) of the fish passage flow range, but the criteria are intentionally conservative. Fish passage criteria are generally intended to identify conditions that accommodate passage of an average or even below-average fish (i.e., in terms of size and swimming and leaping ability), and it is generally understood that some fish are sometimes able to pass sites that are identified as barriers through this type of analysis. In other words, anadromous fish may be present upstream of a site identified through a fish passage analysis as a barrier.

For Site 23, the “Green” site, the percent passage is listed as 100 percent. Additional considerations for some of the sites are noted in the right-hand or “Comments” column. These notes generally describe factors not well represented in the quantitative assessment that may affect fish passage or result in fish injury. Additional discussion related to these notes is provided in Section 3.4.

In addition to the passage assessment results based on the range of defined fish passage flows, flows meeting passage assessment criteria for adults up to 619 cfs (the 2-year return period flow based on annual peak flow records from station SF35 on Stevens Creek from water years 1990 through 2017) are also listed in Table 6. The intent of the column is to indicate the range of flows meeting passage criteria. The upper end of the passage range is reported in some cases as greater than 619 cfs (>619 cfs), indicating suitable passage conditions provided at flows greater than 619 cfs, but the upper flow range was not identified.

The suitable passage windows for adult steelhead are plotted for each site on Figure 3. This figure demonstrates the locations where adult passage may be completely blocked, as well as temporally blocked, and can be used to illustrate the relationships among passage conditions at the Assessment Sites. The figure shows fish passage assessment flows (representing the range of flows between which fish may be more likely to migrate) bound between the black, dashed lines; the range of flows for which each site is passable is shown in blue and those for which each site is impassable are shown in red; sites are organized from downstream on the left to upstream on the right. The plot may be used to consider the routing of migrating adult steelhead to upstream habitat. Imagine a fish beginning in San Francisco Bay and, at a flow of 125 cfs, trying to migrate upstream. Sites 2 and 6 are clearly major impediments to the fish’s migration and would rank high for remediation in any analysis (this is also applicable to Site 14). Assuming those sites have

**Table 6. Summary of Fish Passage Assessment Flows Meeting Assessment Criteria for Each Assessment Site**

River Mile	Site No.	Assessment Site Name	Adult Steelhead			Juvenile Steelhead			Comments
			Passage Flows Meeting Assessment Criteria (cfs)	Adult Percent Passage (a) <sup>1</sup>	Total Passage Range <sup>2</sup> (cfs)	Passage Flows Meeting Assessment Criteria (cfs)	Juvenile Percent Passage (b) <sup>1</sup>	Total Passage Range (cfs)	
2.64	1	Grade control, Vernon Avenue	57 to 203	73%	57 to 374	None	0%	None	
2.81	2	Highway 101 crossing, PM 48.0	None	0%	None	None	0%	None	
2.93	3	Moffett fish ladder	59 to 203	72%	59 to 240	None	0%	None	Frequent debris clogging Denil fishway and poor attraction
3.13	4	Moffett Boulevard crossing	15 to 203	94%	15 to >619	3 to 28	89%	3 to 38	
3.21	5	Drop structure upstream of Moffett Boulevard	46 to 203	79%	46 to 213	None	0%	None	
3.29	6	Drop structure at Hetch Hetchy crossing	None	0%	None	None	0%	None	
3.44	8	Drop structure downstream of Middlefield Road	58 to 203	73%	58 to 240	None	0%	None	
3.53	9	Drop structure upstream of Middlefield Road	49 to 203	77%	49 to 329	None	0%	None	
3.63	10	Drop structure at Gladys Avenue	9 to 203	97%	9 to >619	1 to 16	54%	1 to 16	
3.70	11	Highway 85 crossing, PM 23.0	35 to 203	84%	35 to 250	None	0%	None	
3.76	12	Vortex weir fishway at SF35 gage	3 to 90	44%	1 to 90	None	0%	None	
4.20	14	Drop structure downstream of pedestrian bridge	63 to 67	2%	63 to 67	None	0%	None	Roughness of boulders likely provide adult passage at higher flows than estimated
4.21	14.1	Drop structure at pedestrian bridge	64 to 203	70%	64 to 232	None	0%	None	
4.39	14.2	Sacrete pinch forming boulder jam	14 to 203	95%	14 to 262	None	0%	None	
4.56	15	Highway 237 crossing, PM 0.33	25 to 203	89%	25 to >619	None	0%	None	
4.89	16	Boulder channel downstream of El Camino Real	16 to 203	94%	16 to 330	None	0%	None	Boulders likely provide adult and juvenile passage at higher flows than estimated
4.90	17	El Camino Real crossing	63 to 203	70%	63 to 331	None	0%	None	
4.96	17.1	Drop structure at storm drain	34 to 89	28%	34 to 89	None	0%	None	
5.85	19	Highway 85 crossing, PM 20.9	17 to 203	93%	17 to >619	None	0%	None	Coarse streambed likely provides better passage than estimated for juveniles
6.82	21	Fremont fish ladder	42 to 130	70%	42 to 203	None	0%	None	Frequent debris clogging of Denil fishway
6.96	22	Highway 85 crossing, PM 20.0	68 to 130	50%	68 to >619	None	0%	None	
7.15	23	Fremont Avenue crossing	NA	100%	NA	NA	100%	NA	Site determined to be classified as "Green"
7.46	25	Abandoned flashboard dam	38 to 130	74%	38 to 619	9 to 17	29%	9 to 17	
7.48	25.1	Concrete logs	22 to 130	86%	22 to 558	None	0%	None	Hydraulic complexity likely provides better juvenile passage than estimated
8.37	27	Homestead Road crossing	24 to 130	85%	24 to 277	None	0%	None	Jagged debris among concrete rubble may pose risk of harm to adult fish
8.62	33	Drop structure at Sweet Oak Street	49 to 130	65%	49 to 296	None	0%	None	
8.67	33.1	Sacrete channel	37 to 130	74%	37 to >619	None	0%	None	
8.82	28	Highway 280 crossing, PM 11.2	18 to 130	90%	18 to 360	None	0%	None	Juvenile passage likely better than estimated, given shallow and slow water along the channel
9.93	30.1	Boulder weirs at Blackberry Farm	5 to 130	100%	5 to 494	None	0%	None	Hydraulic complexity likely provides juvenile passage at all assessment flows
12.28	32	Gaging weir SF44 at Stevens Creek Park	None	0%	260 to >619	None	0%	None	

Notes:

<sup>1</sup> Letters a and b refer to scoring calculation described in Section 2.4. "Percent Passage" refers to the proportion of passage assessment flows meeting assessment criteria, not to be confused with the percentage of the fish population that may successfully pass an Assessment Site.

<sup>2</sup> The assessment evaluated passage at flows up to and including 619 cfs, which is the estimated 2-year flow based on data from the SF35 gage. If the site was found to be passable at 619 cfs, then >619 indicates the site is likely passable at flows greater than 619 cfs, which were not assessed.

cfs = cubic feet per second

PM = post mile



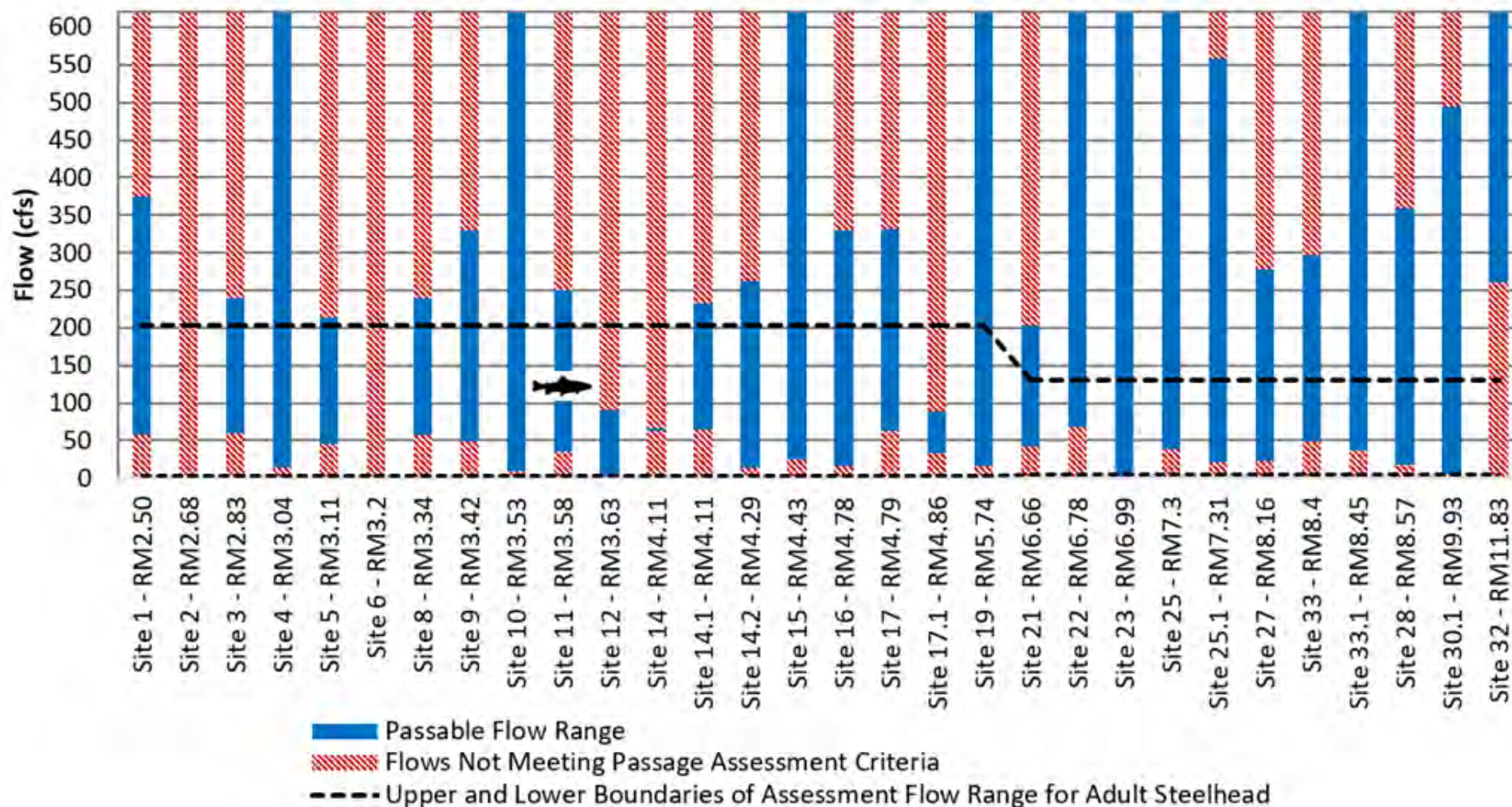


Figure 3. Flows Meeting Passage Assessment Criteria for Adult Steelhead at Each Assessment Site, from Zero to 619 cfs

Note: Sites are arranged from downstream to upstream, with the river mile (RM) indicated. The low and high fish passage assessment flows shown with horizontal dashed lines are 3 cfs and 203 cfs for sites 1 through 19 and 5 cfs and 130 cfs for sites 20 through 32.



been remediated, during its migration the fish could easily swim upstream to Site 12; but because Site 12 is passable only at low flows, the fish would have to hold downstream of Site 12 until flows receded to below 90 cfs, potentially reducing passage opportunities at upstream impediments as flows continue to recede. The same issue may arise at Site 17.1. If an adult steelhead waits at Site 17.1 for flows to recede to a range that allows passage, it may arrive at Site 21 or 22 when flows are too low to provide passage. These scenarios illustrate how the passage flow range at some of the temporal barriers can affect the timing of passage at upstream sites. Although sites such as 12 and 17.1 are passable at lower flows relative to some of the other Assessment Sites, they do not provide passage during the higher end of the fish passage flow range, which may have substantial effect on migration.

### 3.3 SCORING

All Assessment Sites were scored based on the four metrics described in the methods section. The maximum possible score is 100. Each site was placed into its respective scoring category (red, yellow, or green). Site scores and corresponding score categories are listed in Table 7, and Assessment Sites with their score categories denoted are shown on Figure 4. The scores are the result of a specific, repeatable, quantitative analysis; however, other observations related to fish passage and protection that do not lend themselves to this type of quantitative analysis should also be considered when using these results to prioritize Assessment Sites for passage remediation. These additional considerations are described in Section 3.4.

### 3.4 DISCUSSION

This section provides a discussion of the results presented in Section 3.3, specifically of factors related to fish passage and protection that should be considered when the Assessment Sites are prioritized for remediation. As described in Section 2.4, the scoring formula used in this Study heavily weighted watershed position, which was the most important metric dictating overall Assessment Site scores. A reader interested in a particular scoring metric, such as adult passage, can review the tabular results (Table 7) and evaluate any single scoring metric on its own.

Although the assessment scores generally reflect their potential to impede steelhead movement, there are important considerations not captured in the quantitative analysis. Some Assessment Sites provide poor conditions for juvenile and adult steelhead upstream movement (Table 7). Many of the sites in the red score category are low in the watershed (Figure 4). For example, Site 2 (Highway 101 crossing, Post Mile 48.0) received the lowest score. Based on agency criteria, it is a complete barrier and it is very low in the watershed (RM 2.81). Sites in the yellow score category provide some passage for adults and in one case also provides juvenile passage opportunities. Sites in the green score category generally provide reasonable passage conditions for adults, and in some cases provide passage opportunities for juveniles. Deviations from these general trends and additional considerations important to fish passage that should be evaluated when prioritizing sites for remediation are described below, ordered by site number from low to high.

- Site 1 (Grade Control, Vernon Avenue) received a score of 12 and is in the red score category. This is the most downstream of the Assessment Sites, at RM 2.64. Although the analysis shows it passable 73 percent of the time by adults, the passage conditions are not suitable until flows rise to nearly 60 cfs. Meanwhile, many of the Assessment Sites upstream are passable at lower flows. Because of its location in the watershed, this site could prevent adult steelhead from moving upstream following early winter storms, thereby limiting passage opportunities at upstream temporal barriers (see Figure 3).

**Table 7. Assessment Sites, Scores, and Score Categories**

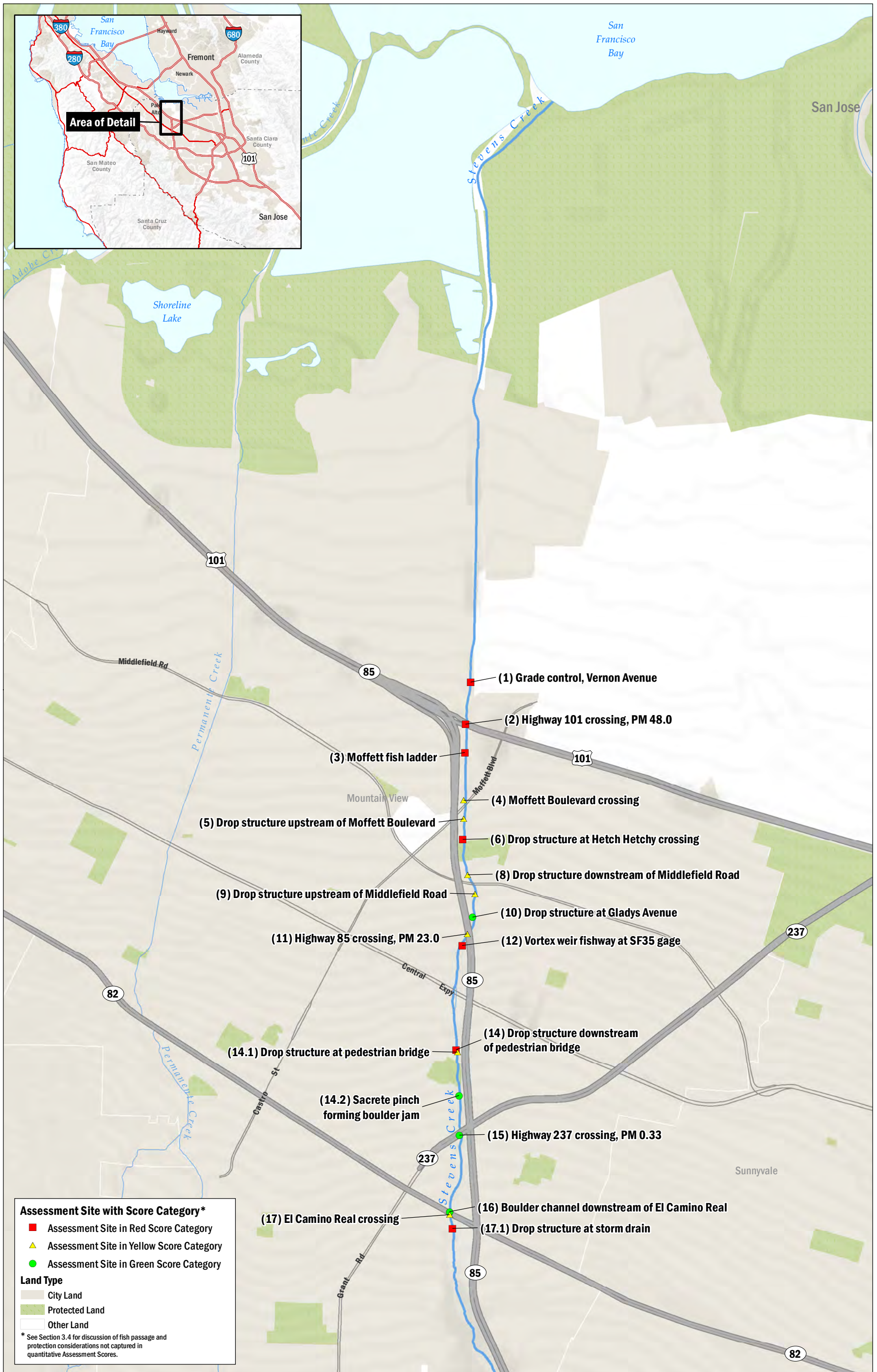
Site No.	River Mile	Assessment Site Name	Adult Percent Passage (a) <sup>1,2</sup>	Juvenile Percent Passage (b) <sup>1,2</sup>	Relative Distance to Next Upstream Barrier (c) <sup>1</sup>	Percentage of Assessment Reach Downstream of Site (d) <sup>1</sup>	Score
<b>Red Score Category (Scores 1-14)</b>							
2	2.81	Highway 101 crossing, PM 48.0	0%	0%	3%	22%	2
6	3.29	Drop structure at Hetch Hetchy crossing	0%	0%	4%	26%	2
14	4.20	Drop structure downstream of pedestrian bridge	2%	0%	0%	33%	4
32	12.28	Gaging weir SF44 at Stevens Creek Park	0%	0%	15%	96%	8
17.1	4.96	Drop structure at storm drain	28%	0%	52%	39%	9
12	3.76	Vortex weir fishway at SF35 gage	44%	0%	12%	29%	12
1	2.64	Grade control, Vernon Avenue	73%	0%	5%	21%	12
3	2.93	Moffett fish ladder	72%	0%	8%	23%	14
<b>Yellow Score Category (Scores 15-24)</b>							
5	3.21	Drop structure upstream of Moffett Boulevard	79%	0%	2%	25%	16
8	3.44	Drop structure downstream of Middlefield Road	73%	0%	2%	27%	16
9	3.53	Drop structure upstream of Middlefield Road	77%	0%	6%	28%	17
14.1	4.21	Drop structure at pedestrian bridge	70%	0%	19%	33%	19
11	3.70	Highway 85 crossing, PM 23.0	84%	0%	2%	29%	20
17	4.90	El Camino Real crossing	70%	0%	2%	38%	23
4	3.13	Moffett Boulevard crossing	94%	89%	2%	24%	23
22	6.96	Highway 85 crossing, PM 20.0	50%	0%	14%	54%	24
<b>Green Score Category (Scores 25-100)</b>							
10	3.63	Drop structure at Gladys Avenue	97%	54%	4%	28%	25
15	4.56	Highway 237 crossing, PM 0.33	89%	0%	9%	36%	25
14.2	4.39	Sacrete pinch forming boulder jam	95%	0%	14%	34%	26
16	4.89	Boulder channel downstream of El Camino Real	94%	0%	0%	38%	29
21	6.82	Fremont fish ladder	70%	0%	4%	53%	31
19	5.85	Highway 85 crossing, PM 20.9	93%	0%	27%	46%	33
33.1	8.67	Sacrete channel	74%	0%	100%	68%	35
33	8.62	Drop structure at Sweet Oak Street	65%	0%	1%	67%	37
25	7.46	Abandoned flashboard dam	74%	29%	32%	58%	37
25.1	7.48	Concrete logs	86%	0%	32%	58%	39
28	8.82	Highway 280 crossing, PM 11.2	90%	0%	96%	69%	43
27	8.37	Homestead Road crossing	85%	0%	7%	65%	45
23	7.15	Fremont Avenue crossing	100%	100%	9%	56%	55
30.1	9.93	Boulder weirs at Blackberry Farm	100%	0%	65%	78%	57

Notes:

1 Letters a, b, c, and d refer to the metrics in the scoring calculation defined in Section 2.4.

2 "Percent Passage" refers to the proportion of passage assessment flows meeting assessment criteria, not to be confused with the percentage of the fish population that may successfully pass an Assessment Site.

PM = post mile



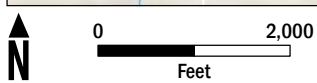
**Assessment Site with Score Category\***

- Assessment Site in Red Score Category
- ▲ Assessment Site in Yellow Score Category
- Assessment Site in Green Score Category

**Land Type**

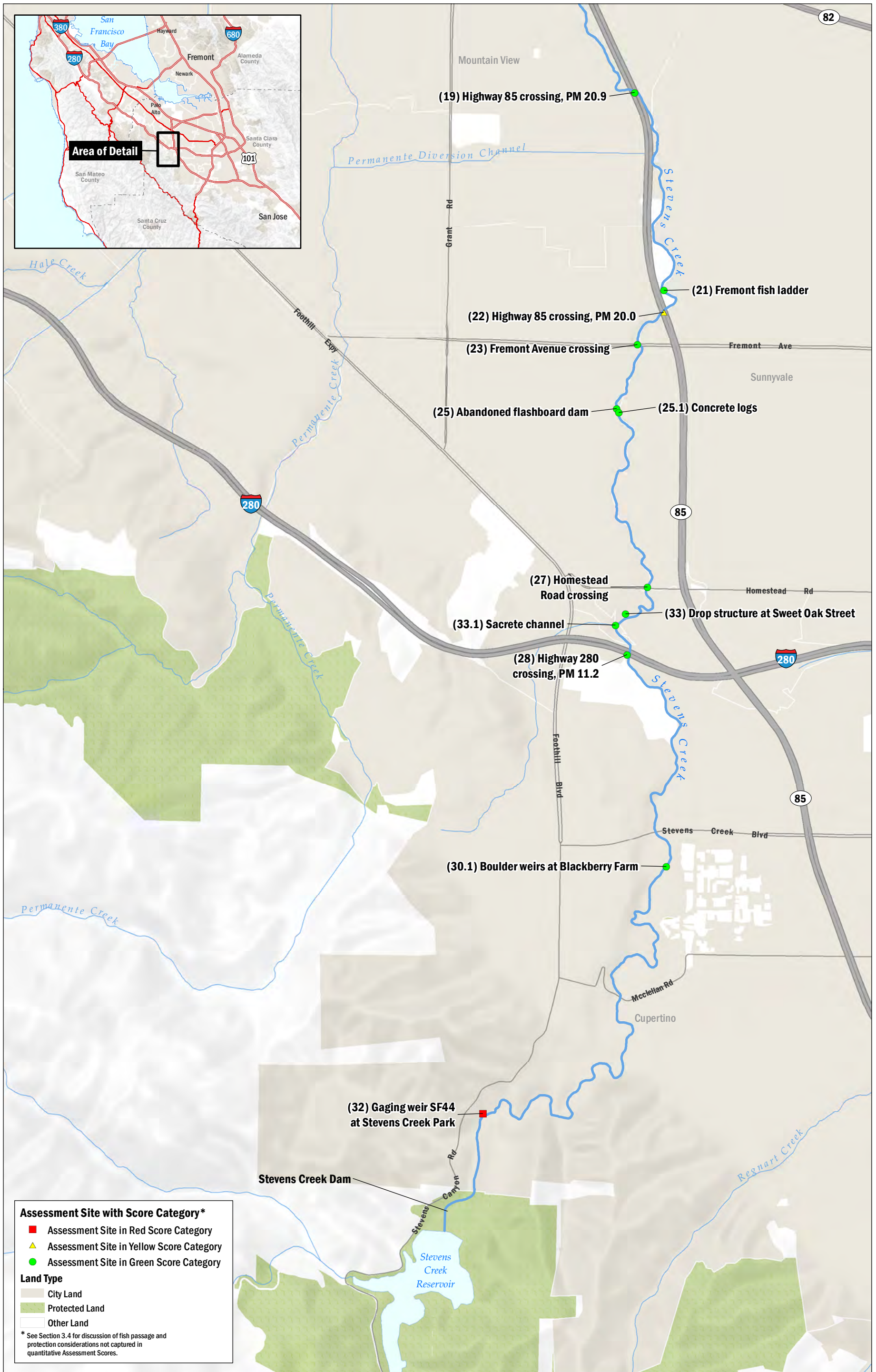
- City Land
- Protected Land
- Other Land

\* See Section 3.4 for discussion of fish passage and protection considerations not captured in quantitative Assessment Scores.



Source: CalFish Passage Assessment Database, 2016; USGS HUC-12 Hydrologic Units, 2013; Imagery, ESRI, 2019.





- Site 3 (Moffett fish ladder) received a score of 14 and is in the red score category. However, observed frequent clogging of the fish ladder with small debris, which makes it impassable much of the migration season, is not captured by the model results. Denil fish ladders (Site 3 and Site 21) have a propensity to clog with sediment and small debris. Maintenance during the migration season is restricted to manual debris removal, which is not always effective or possible during high flows, so these sites may be impassable during substantial portions of the migration season when steelhead are most likely attempting to migrate upstream. Adult passage at this site is likely much lower than the 72 percent suggested by the quantitative analysis.
- Site 4 (Moffett Boulevard crossing) received a score of 23 and is in the yellow score category. The crossing is passable by juveniles and adults at most flows, with insufficient depth at lower flows being the only substantial passage issue. Deposition observed throughout the primary culvert (Attachment E) likely further improves passage conditions. Considering the relatively favorable passage conditions observed at the time of the field survey and evaluated in the Study, the site may not warrant remediation for fish passage; note that its score and placement into the yellow score category were heavily influenced by its position low in the watershed.
- Site 12 (Vortex weir fishway at SF35 gage) received a score of 12 and is in the red score category. The fishway was designed for fish passage and provides reliable passage at lower flows; at flows higher than 90 cfs, however, the water surface drop over the fishway entrance weir (downstream most weir) exceeds the adult passage leap height criterion of 1.5 feet (see Site 12 photographs in Attachment E). In all other ways, the fishway meets passage criteria at all passage assessment flows for adults.

The shape and roughness of the downstream channel and box culvert controls the water level downstream of the entrance weir and thus influences the overall leap height over the weir. Debris may sometimes naturally accumulate downstream of the structure and reduce the height of the leap required to enter the fishway. An additional weir or half-weir immediately downstream of the structure might decrease the leap height and increase the range of flows meeting passage criteria. This structure has been known to result in fish stranding when the channel reach dries in the spring.

- Site 17 (El Camino Real crossing) received a score of 23 and is in the yellow score category. This site is directly upstream of Site 16 (Boulder channel downstream of El Camino Real), which is a long and steep boulder channel. Site 16 is passable at lower flows than Site 17, raising concern that flow at Site 17 could be too shallow when adult steelhead arrive. There is poor holding habitat between the two sites, which could lead to a steelhead reaching the point of exhaustion and falling back down through Site 16.
- Site 21 (Fremont fish ladder) received a score of 31 and is in the green score category. At this site, poor fishway entrance conditions and the overtopping of the fishway sidewall at higher fish passage flows affect conditions for adult passage. The Fremont fish ladder is also a Denil, and clogging and maintenance issues are the same as those described above for Site 3 (Moffett fish ladder). Because these conditions are not captured in the quantitative results, adult passage is likely much lower than the 70 percent suggested by the quantitative analysis.
- Site 27 (Homestead Road crossing) received a score of 45 and is in the green score category. Although modeled results indicate that adult passage criteria are met between 24 and 277 cfs, or 85 percent of the passage assessment flow range, concrete rubble spans the channel at this site and creates a narrow chute that could result in injury to migrating steelhead. There is also

a lot of overhanging concrete in the flow area that is not well reflected in the HEC-RAS model because overhangs could not be modeled. Additional rubble along the banks may fall into the channel in the near-term, further exacerbating fish passage conditions.

- Site 32 (Gaging weir SF44 at Stevens Creek Park) received a score of 8 and is in the red score category. Although this site requires a leap (2.4 feet drop height) that exceeds the height criteria for adult passage at all evaluated flows, the configuration of the site—with a well-concentrated nappe, a relatively deep plunge pool (4.4 feet depth), and a safe landing pool upstream of the weir—likely make passage for an adult steelhead easier than suggested by the quantitative results. This is the most upstream of the Assessment Sites and there is only 0.53 RM between Site 32 and Stevens Creek Dam, a limited amount of habitat with value to steelhead that may be compromised by effects of Stevens Creek Dam and reservoir.
- Site 33 (Drop structure at Sweet Oak Street) received a score of 37. This is the only Assessment Site in the green score category with adult passage less than 70 percent. Adult passage at this site was modeled at 65 percent, but conditions not captured in the model may exacerbate passage conditions or cause fish injury. There is a hole in the concrete apron (visible in the Site 33 photos included in Attachment E) with exposed rebar, which could cause fish injury and fall-back. Additionally, because of its deterioration, the structure tends to catch debris that further affects passage conditions.

The scoring results provided in this Study were developed based largely on the percent of flows passable for adult steelhead at a site and the position of the site in the watershed. The additional considerations listed above for select sites were not used to adjust their scores or score category placements, because category placement was based solely on the quantitative scores calculated for each Assessment Site. However, these additional considerations should inform future efforts to prioritize barriers for remediation. Other biological considerations not accounted for in the scoring could also affect how these sites are prioritized by others for remediation. These considerations may include location of suitable spawning habitat, life history strategies of rearing juvenile steelhead, water quality conditions, and channel drying. If future fisheries studies suggest that additional metrics should be considered, they could be added to the scoring, used to adjust the results, or factored into a future prioritization study, as appropriate. Valley Water will prioritize the Assessment Sites for remediation based on several factors, including the results of this Study, property ownership (Attachment F), and construction cost and logistics.

## 4 REFERENCES

- AECOM and MLA (AECOM and Michael Love & Associates, Inc.). 2018. Moffett Fish Passage Project: Feasible Alternatives Report. Prepared for Santa Clara Valley Water District. October.
- CalFish. 2019. California Fish Passage Assessment Database. An online database that compiles currently available fish passage information from many different sources. Available online at: <https://www.calfish.org/ProgramsData/HabitatandBarriers/CaliforniaFishPassageAssessmentDatabase.aspx>. Accessed February 26, 2019.
- CDFG (California Department of Fish and Game) (now CDFW [California Department of Fish and Wildlife]). 2002. Culvert Criteria for Fish Passage. May.
- CDFG (now CDFW). 2004. California Salmonid Stream Habitat Restoration Manual Part IX: Fish Passage Evaluation at Stream Crossings. March.
- CDFG (now CDFW). 2009. California Salmonid Stream Habitat Restoration Manual Part XII: Fish Passage Design and Implementation. July.
- ESA (Environmental Science Associates). 2017. Santa Clara Valley Water District Stream Maintenance Guidelines: Year 1 Hydraulic Modeling Report. Prepared for Santa Clara Valley Water District. April.
- Garza and Pearse. 2008. Population genetics of *Oncorhynchus mykiss* in the Santa Clara Valley Region. 53 pp.
- Limerinos, J. 1970. Determination of Manning's Coefficient from Measured Bed Roughness, Geological Survey Water Supply Paper 1898-B. U.S. Department of the Interior, Washington D.C.
- MLA (Michael Love & Associates, Inc.). 2016. Stevens Creek Fish Passage Assessment: Highway 101 to Moffett Drop Structure. April.
- Moore, Melissa. 2019. Personal communication between Melissa Moore, Valley Water Project Manager, and the Team (including Jonathan Stead, AECOM Project Manager). June 20.
- NMFS (National Marine Fisheries Service). 2001. Guidelines for Salmonid Passage at Stream Crossings. Southwest Region. September.
- NOAA (National Oceanic and Atmospheric Administration). 2011. National Marine Fisheries Service, Northwest Region: Anadromous Salmonid Passage Facility Design. July.
- Phillips, J.V., and S. Tadayon. 2006. Selection of Manning's Roughness Coefficient for Natural and Construction Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona: U.S. Geological Survey Scientific Investigations Report 2006-5108, 41 pp.
- SCVWD (Santa Clara Valley Water District). 2015. Stevens Creek Evelyn Bridge Fish Passage Project Basis of Design Technical Report. Prepared by Moore, M., B. Hwang, and E. Zedler. Reviewed by Liang, X., and S.M. Ferranti. September.



Stillwater Sciences. 2004. Final Stevens Creek Limiting Factors Analysis. Prepared for Santa Clara Valley Urban Runoff Pollution Prevention Program. September 10.

USFS (United States Forest Service). 2006. FishXing Version 3.0 Beta. Available online at: <https://www.fs.fed.us/biology/nsaec/fishxing/>.

## 5 LIST OF REPORT PREPARERS

The Study was completed for Valley Water by the AECOM-MLA Team, which consists of AECOM as the prime consultant and MLA as the subconsultant. Key staff members contributing to the Study are listed in Table 8 below.

**Table 8. List of Study Participants and Report Preparers**

Staff Member	Affiliation	Study Role
P. Travis James, P.E.	MLA	Technical Staff
Chris Komlos	Valley Water	Reviewing Water Resources Specialist
Clayton Leal	Valley Water	Reviewing Biologist
Michael Love, P.E.	MLA	Fisheries Engineering Lead
Jessica Lovering	Valley Water	Reviewing Engineer
James Manidakos	Valley Water	Reviewing Water Resources Specialist
Katie McLean	AECOM	Technical Staff
Steve McNeely, P.E.	AECOM	Technical Staff
Melissa Moore	Valley Water	Valley Water Project Manager
Jason Nishijima	Valley Water	Reviewing Water Resources Specialist
Kevin Sibley	Valley Water	Valley Water Project Manager
Jonathan Stead	AECOM	Project Manager and Lead Fish Biologist

Qualifications of the key consultant AECOM-MLA Team members are listed below. Other contributing technical staff members included Oliver Light, Sarah Kassem, and Ryan Haines, AECOM; and Antonio Llanos, MLA.

**Jonathan Stead** is a fish and wildlife biologist and senior project manager with more than 20 years of experience, with expertise in fish passage, steelhead biology, and aquatic ecology. He earned his master’s degree studying fish ecology at UC Davis under Dr. Peter Moyle and currently leads multidisciplinary teams on complex stream restoration, fish passage, dam removal, and water infrastructure projects. Jon has been a major contributor to important fish passage and stream restoration projects for various organizations, including the San Francisco Public Utilities Commission, Monterey Peninsula Water Management District, United States Bureau of Reclamation, Stanford University, and Klamath River Renewal Corporation.

**Michael Love, P.E.**, has been the managing principal of Michael Love & Associates, Inc., since 1999. Michael has extensive interdisciplinary experience in fisheries and fluvial geomorphology, design of stream restoration, and technical and nature-like fishways. He was lead developer of the widely used FishXing software and was a primary author of the fish passage assessment and fish passage design and implementation sections of CDFW’s California Salmonid Stream Habitat Restoration Manual (CDFG 2004, CDFG 2009). Michael has been the lead fish passage engineer for more than four dozen passage projects, has led more than two dozen trainings instructing participants on fish passage design and assessment, and regularly collaborates with Humboldt State University to conduct research into fish passage topics.

**Steve McNeely, P.E.**, is a senior water resources engineer, fluvial geomorphologist, and project manager with more than 17 years of experience as an engineering and environmental consultant. Steve has led the planning, design, permitting, and construction supervision of numerous stream restoration projects, as well as the design of fish passage improvement projects ranging from culvert replacements to dam removals.

**P. Travis James, P.E.**, is a licensed civil engineer with extensive experience in water resources engineering, with an emphasis on river systems. His experiences include fluvial geomorphology, fish passage engineering, fish screen systems, watershed hydrology, channel hydraulics, and bank stabilization. Travis has been lead design engineer on many fish passage improvement projects over the past 10 years.

**Katie McLean** is a fisheries and wildlife biologist with experience surveying special-status species, mapping salmonid habitat, and monitoring habitat conditions in restored streams and wetlands.

Attachment A

Valley Water Reconnaissance Surveys



# MEMORANDUM

FC 14 (02-08-19)

**TO:** Mr. Jon Stead, Project Manager, AECOM

**FROM:** Santa Clara Valley Water District

**SUBJECT:** Reconnaissance Surveys for Portions of Stevens Creek to assess the presence of Potential Fish Passage Impediments

**DATE:** May 9, 2019

---

**Objective:** Reconnaissance survey for the presence of potential fish passage impediments for migratory and resident trout within the 12.5 miles of fresh water of Stevens Creek, downstream of Stevens Creek Reservoir. Collection of this data fills in data gaps in the comprehensive fish passage survey of Stevens Creek from the Stevens Creek Reservoir to South San Francisco Bay (Consultant Agreement 4827). The data gaps cover 39,700 linear feet (7.52 miles) of the creek channel, which represents 60.2% of the total study channel length of 66,000 ft (12.5 miles) (Figure 1). The surveys described herein cover all of the data gap areas.

**Dates of Surveys:** February 12, April 11, and May 2 2019

## **FEBRUARY 12, 2019 SURVEY**

**Weather:** Overcast, 55° F

**Discharge:** <sup>1</sup>Gauge 5044 (0.6 miles downstream of Stevens Creek Reservoir-elevation 410 ft.)  
108.3 to 109.9 cfs

<sup>1</sup>Gauge 5035 (Station located between Central Avenue and Highway 85-elevation 62 ft.)  
89.7 to 105.6 cfs

**Staff:** Jessica Lovering, Assistant Engineer II  
James Manidakos, Associate Water Resources Specialist

**Study Area 1:** Stevens Creek channel in Cupertino and unincorporated Santa Clara County, CA. Milepost 67,800 (Stevens Creek Dam) to Milepost 57,420 (McClellan Road).

**Methodology:** The team employed an ocular, walking (adjacent to stream) survey to assess the presence of suspected passage impediments. The team began the survey at the Stevens Creek County Park parking lot and walked the Stevens Creek trail adjacent to the creek upstream to the Stevens Creek Dam. The team then returned to the park parking lot and walked the Stevens Creek trail adjacent to the creek downstream to McClellan Road. Where necessary the team left the trail and walked overland to maintain visual contact with the creek channel throughout the survey area.

## **Results:**

No new potential fish passage impediments were noted. The gauging weir at Stevens Creek Park (44), a previously identified potential impediment, is still present and was confirmed as a potential impediment (see photograph 1).



Photograph 1: Potential fish passage impediment at gauge weir at Stevens Creek Park

#### **APRIL 11, 2019 SURVEY (Study Areas 2, 3, and 4)**

**Weather:** Fair, 66° F

**Discharge:** <sup>1</sup>Gauge 5044:  
40.2 cfs

<sup>1</sup>Gauge 5035:  
36.9-29.2 cfs

**Staff:** Melissa Moore, Senior Water Resources Specialist  
Jessica Lovering, Assistant Engineer II  
James Manidakos, Associate Water Resources Specialist

**Study Area 2:** Stevens Creek channel in Cupertino, CA  
Milepost 57,420 (McClellan Road) to Milepost 51,500 (Steven Creek Boulevard)

**Methodology:** The team began the survey at the upstream limits, McClellan Road, and employed an ocular, walking (adjacent to stream) survey to assess the presence of suspected passage impediments. The team walked the entire channel length of the stream from McClellan Road to Stevens Creek Boulevard. The stream was easily surveyed from the stream banks as instream flows (~40 cfs) made walking instream difficult, however, the stream bed and banks could be easily assessed by walking

*1. This stream gauge data are Preliminary. Most data relayed by telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions and/or physical changes at the measurement site. Subsequent review of this data by SCVWD hydrographers may result in significant revisions to the data.*



adjacent to the channel. A Trimble Geo7x Global Positioning system hand survey instrument was available to record the location of features of interest.

**Results:**

One potential fish passage impediment was noted. Water clarity (i.e. turbidity) made viewing the stream bed during the reconnaissance survey challenging therefore, it was difficult to ascertain what type of structure (i.e. concrete weir, bridge footings) was creating the turbulent condition noted in Photograph 2. The potential passage impediment is located directly downstream of a pedestrian bridge crossing on the creek and therefore it was presumed to be infrastructure related to the bridge crossing. The spatial coordinates for this suspected barrier are as follows; latitude 37.32, longitude -122.06.



Photograph 2. Potential fish passage impediment downstream of footbridge.

*1. This stream gauge data are Preliminary. Most data relayed by telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions and/or physical changes at the measurement site. Subsequent review of this data by SCVWD hydrographers may result in significant revisions to the data.*

**Weather:** Fair, 60° F

**Discharge:** <sup>1</sup>Gauge 44

30.1-25.3 cfs

<sup>1</sup>Gauge 35

19.0-15.3 cfs

**Staff:** Melissa Moore, Senior Water Resources Specialist  
Jessica Lovering, Assistant Engineer II  
James Manidakos, Associate Water Resources Specialist

**Study Areas:** Stevens Creek channel in Cupertino and Los Altos, CA

Study Area 3: Milepost 51,500 (Stevens Creek Boulevard) to Milepost 46,600 (Interstate 280)

Study Area 4: Milepost 42,200 (West Valley Elementary School) to Milepost 39,300 (Kirchner Court)

**Methodology:** The team began the survey at the upstream limits and employed an ocular, wading (instream) survey to assess the presence of suspected passage impediments. The team waded the entire channel length in areas 3 and 4. A Trimble Geo7x Global Positioning system hand survey instrument was available to record the location of features of interest.

**Results:** No passage impediments were noted in Areas 3 and 4 of surveyed reaches.

#### **MAY 2, 2019 SURVEY (Areas 5 and 6)**

**Weather:** Fair, 72° F

**Discharge:** <sup>1</sup>Gauge 44: 16.9 to 16.5 cfs

<sup>1</sup>Gauge 35: 5.5 to 5.7 cfs

**Staff:**

James Manidakos, Associate Water Resources Specialist  
Chris Komlos, Assistant Water Resources Specialist

**Study Area 5:** Stevens Creek channel in Sunnyvale, CA

Milepost 35,950 (Fremont Fish Ladder) to Milepost 35,100 (850 ft downstream)

**Methodology:** The team began the survey at the Fremont Fish Ladder and proceeded downstream. The team employed an ocular, walking (adjacent to stream) survey to assess the presence of suspected passage impediments. The team walked the entire study reach. A Trimble Geo7x Global Positioning system hand survey instrument was available to record the location of features of interest.

**Results:** No potential fish passage impediments were noted in Study Area 5.

**Study Area 6:** Stevens Creek channel in Mountain View, CA

Milepost 14,750 (Highway 101 culvert) to Milepost 0 (San Francisco Bay)

**Methodology:** The team began the survey at downstream end of the Highway 101 culvert and proceeded downstream to San Francisco Bay. The team employed an ocular, walking (adjacent to stream) survey to assess the presence of suspected passage impediments. The team walked the entire study reach. A Trimble Geo7x Global Positioning system hand survey instrument was used to record the location of features of interest.

*1. This stream gauge data are Preliminary. Most data relayed by telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions and/or physical changes at the measurement site. Subsequent review of this data by SCVWD hydrographers may result in significant revisions to the data.*



**Results:** Two previously recorded potential fish passage impediments were confirmed in Study Area 6: Highway 101 culvert (see Photograph 3) and chute and the grade control structure at Vernon Avenue (see Photograph 4). No other potential fish passage impediments were noted in Study Area 6.



Photograph 3: Highway 101 culvert and chute

*1. This stream gauge data are Preliminary. Most data relayed by telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions and/or physical changes at the measurement site. Subsequent review of this data by SCVWD hydrographers may result in significant revisions to the data.*



Photograph 4: Grade control structure at Vernon Avenue

1. This stream gauge data are Preliminary. Most data relayed by telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions and/or physical changes at the measurement site. Subsequent review of this data by SCVWD hydrographers may result in significant revisions to the data.



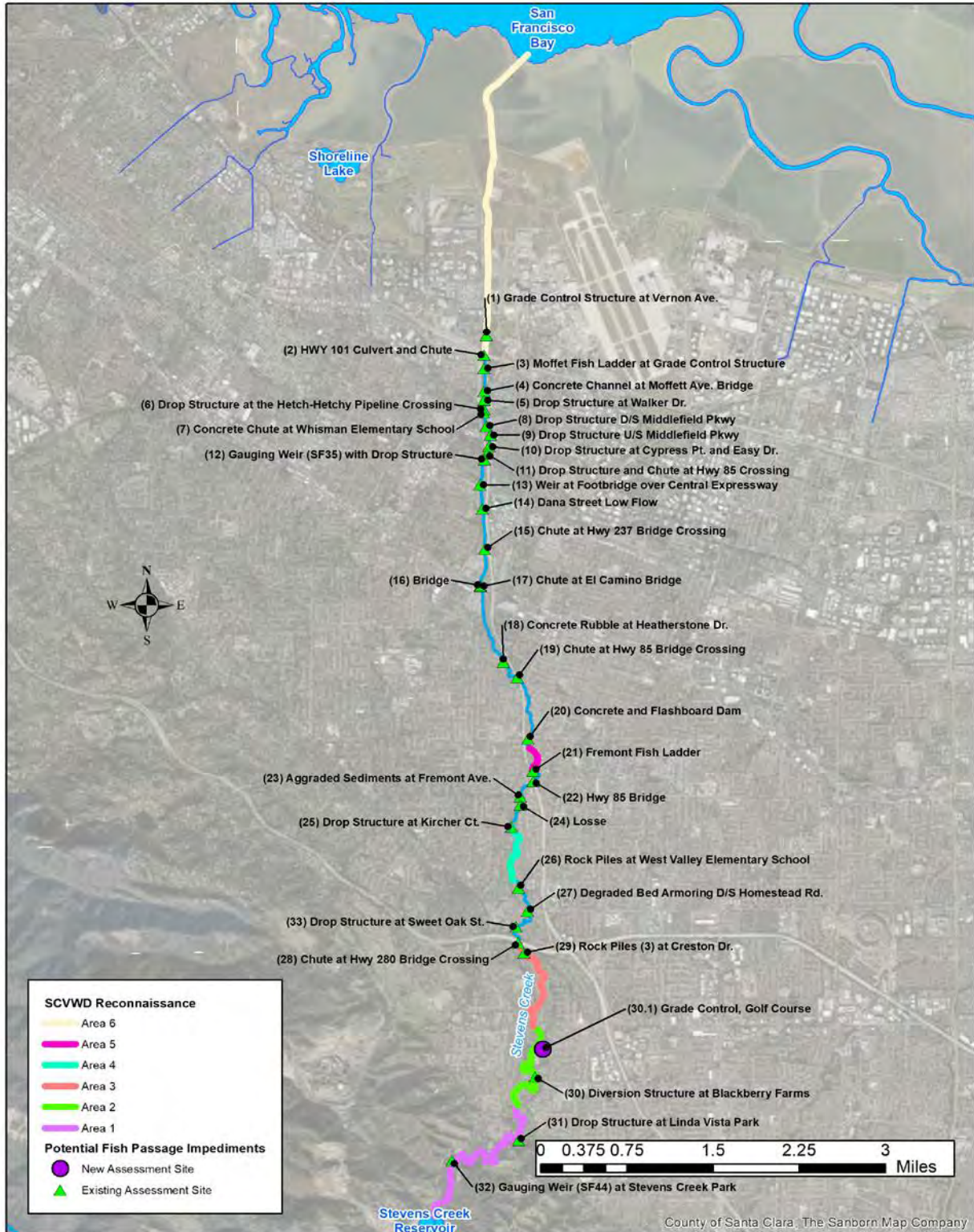


Figure 1. Locations of ocular, pedestrian surveys for potential fish passage impediments, Stevens Creek.

1. This stream gauge data are Preliminary. Most data relayed by telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions and/or physical changes at the measurement site. Subsequent review of this data by SCVWD hydrographers may result in significant revisions to the data.

Attachment B

Example Fish Passage  
Inventory Data Sheet

## FISH PASSAGE INCIDENTAL REPORT (First Pass Data Sheet)

This form is intended to be used for rapid barrier inventorying and barrier data collection. It is not intended for barrier passage assessment and is not meant to replace any existing barrier assessment protocols.

*\* Please fill Section I and II even when no barriers found!*

Send to: Anne Elston, CDFW, 830 S Street, Sacramento, CA 95814 or [Anne.Elston@wildlife.ca.gov](mailto:Anne.Elston@wildlife.ca.gov)

I. GENERAL			
Surveyor(s):		Date:     /     /	Time:     AM/PM
Agency:			
Weather: <input type="checkbox"/> Sunny <input type="checkbox"/> Overcast <input type="checkbox"/> Raining	Water <input type="checkbox"/> Clear Conditions: <input type="checkbox"/> Turbid	Flow <input type="checkbox"/> Continuous Conditions: <input type="checkbox"/> Isolated pools <input type="checkbox"/> Dry	Bank <input type="checkbox"/> Channel erosion Conditions: <input type="checkbox"/> Scour <input type="checkbox"/> Rip/rap
Water Temperature (°C):		Ambient Temperature (°C):	
II. LOCATION			
Latitude:		Longitude:	
Stream Name:		Quad Name:	
Barrier(s) Found?: <input type="checkbox"/> Yes <input type="checkbox"/> No		Tributary To:	
Bank Location (looking downstream): <input type="checkbox"/> Left <input type="checkbox"/> Right <input type="checkbox"/> Both		Stream Segment Surveyed:	
Road Name:		Channel Type: <input type="checkbox"/> V <input type="checkbox"/> U	
Photos Taken: <input type="checkbox"/> Inlet <input type="checkbox"/> Outlet <input type="checkbox"/> Other		SCVWD Milepost:	
Photo Description/Numbers:			
Land Owner:		Structure Owner:	
III. STRUCTURE			
Structure Type: <input type="checkbox"/> Diversion <input type="checkbox"/> Dam <input type="checkbox"/> Arizona crossing (ford) <input type="checkbox"/> Culvert <input type="checkbox"/> Bridge <input type="checkbox"/> Natural <input type="checkbox"/> Other _____			Description:
Passage Status:			
IV. FISH			
Salmonids Observed Downstream? <input type="checkbox"/> Yes <input type="checkbox"/> No		Salmonids Observed Upstream? <input type="checkbox"/> Yes <input type="checkbox"/> No	
V. DIVERSION			
Diversion Type: <input type="checkbox"/> Slant pump <input type="checkbox"/> Floodgate <input type="checkbox"/> Other _____ <input type="checkbox"/> Vertical pump <input type="checkbox"/> Centrifugal pump <input type="checkbox"/> Siphon <input type="checkbox"/> Submersible pump <input type="checkbox"/> Pump other <input type="checkbox"/> Weir			Pump Running? <input type="checkbox"/> Yes <input type="checkbox"/> No
			Pipe Size: <input type="checkbox"/> < 1 ft <input type="checkbox"/> 1 – 2 ft <input type="checkbox"/> > 2 ft
			Screened? <input type="checkbox"/> Yes <input type="checkbox"/> No
VI. DAM			
Dam Type: <input type="checkbox"/> Earth <input type="checkbox"/> Rock/cement <input type="checkbox"/> Other _____		<input type="checkbox"/> Seasonal <input type="checkbox"/> Permanent	
		Dam Height (ft):	Dam Width (ft):
		Passage Facility? <input type="checkbox"/> Yes <input type="checkbox"/> No	
VII. CULVERT			
Culvert Type: <input type="checkbox"/> Box <input type="checkbox"/> Circular <input type="checkbox"/> Open-bottom arch <input type="checkbox"/> Pipe arch <input type="checkbox"/> Other _____ <input type="checkbox"/> Abandoned/Unmaintained		Culvert Material: <input type="checkbox"/> Concrete <input type="checkbox"/> Metal <input type="checkbox"/> Plastic <input type="checkbox"/> Log/wood <input type="checkbox"/> Other _____	
		Number of Barrels/Pipes:	
		Culvert Diameter: <input type="checkbox"/> ≤ 2 ft <input type="checkbox"/> > 2 ft	
		Culvert Height (ft):	Culvert Width (ft):
		Outlet Drop Height: <input type="checkbox"/> < 1 ft <input type="checkbox"/> 1 – 3 ft <input type="checkbox"/> > 3 ft	
		Weirs/Baffles? <input type="checkbox"/> Yes <input type="checkbox"/> No	
		Channel Width (ft):	
VIII. BRIDGE			
Bridge Type: <input type="checkbox"/> Free span <input type="checkbox"/> Instream structure		<input type="checkbox"/> Active <input type="checkbox"/> Abandoned	
		Apron? <input type="checkbox"/> Yes <input type="checkbox"/> No	
IX. NATURAL			
Natural Barrier Type: <input type="checkbox"/> Waterfall <input type="checkbox"/> Grade <input type="checkbox"/> Landslide <input type="checkbox"/> Log jam <input type="checkbox"/> Other _____			
Waterfall Drop: <input type="checkbox"/> ≤ 8 ft <input type="checkbox"/> > 8 ft			
X. ADDITIONAL NOTES			
Does this site needs treatment? What are specific treatment recommendations? (Please use other side if needed for additional notes).			

## INSTRUCTIONS TO FISH PASSAGE INCIDENTAL REPORT

### I. GENERAL

**Surveyor** - Enter the names of people conducting the survey.

**Date/Time** - Enter the day's date (mm/dd/yy) and the time of the survey.

**Agency** - Enter the agency name.

**Weather** - Check the box that best describes weather conditions on the day of the survey.

#### Water Conditions

**Clear** - Free from pollution or cloudiness.

**Turbid** - Muddy or cloudy water.

#### Flow Conditions

**Continuous** - Free flowing water.

**Isolated pools** - Pools are present but they are not connected by free flowing water.

**Dry** - No water at all.

#### Bank Conditions

**Channel erosion** - Channel bank is eroded.

**Scour** - Severe bank erosion and unstable bank caused by the physical action of flowing water.

**Rip rap** - Material, mostly rocks, placed on banks to improve the bank stabilization.

**Water Temperature/Ambient Temperature** - Enter the water and air temperature in the area of the survey.

### II. LOCATION

**Latitude/Longitude** - North American Datum 1983.

**Quad Name** - U.S.G.S. 7.5 minute quadrangle name if known.

**Stream Name** - Enter the stream name as it appears on the 7.5 minute quadrangle map. If name not available, enter local name or '*unnamed*'.

**Tributary To** - Enter the name of the receiving stream, river lake or ocean.

**Barrier(s) Found** - Mark *No* if barrier(s) not found. If a barrier is found, please fill in the rest of the form.

**Stream Segment Surveyed** - Record the length of the surveyed stream segment or reach where no barriers found.

**Bank Location** - Where in the stream the structure is located, looking downstream.

#### Channel Type

**V** - For general description purposes, is the channel shaped like a V

**U** - For general description purposes, is the channel shaped like a U, bank slopes more gradual than V channel

**Road Name** - Enter road name and/or number.

**SCVWD Milepost** - Location of barrier based on the Santa Clara Valley Water District Creek Route GIS data. The outlet of Stevens Creek at the San Francisco Estuary is at 0.00 miles, and milepost numbers increase moving upstream.

**Photos Taken** - Mark when pictures of the inlet, outlet or other parts of a barrier were taken. , please provide the

**Photos Description/Numbers** - Describe each picture orientation. Please provide photos with this form. **Land**

**Owner** - May be private, public, tribal, or unknown-if known, put down owners name and contact info.

**Structure Owner** - May be different from land owner- if known, put down owners name and contact info.

### III. STRUCTURE

#### Structure Type

**Diversion** - A man-made structure or installation for transferring water from a stream by a pipe, canal, well, or other conduit to another watercourse or to the land. Surface diversions fall into two general categories: pump and gravity.

**Dam** - A man-made barrier constructed across a stream and designed to control water flow or create a reservoir.

**Arizona Crossing** - A road crossing that allows the river to run over a road.

**Culvert** - A pipe that allows streams, rivers, or runoff to pass under a road.

**Bridge** - A structure conveying a road or pathway over a stream, river, or a depression.

**Natural** - A barrier that is not man-made, such as: waterfall, beaver dam, insufficient flow, landslide, velocity, etc.

**Other** - Anything that is not described in the above categories.

**Description** - Any additional significant details about the structure.



**Passage Status** - Based on your field observations describe the impact on adult and juvenile salmonid fish passage. (estimate to your best judgment).

#### IV. FISH

**Salmonids Observed Downstream?** - Were salmonids observed in the creek below the barrier?

**Salmonids Observed Upstream?** - Were salmonids observed above the barrier?

#### V. DIVERSION

##### Diversion Type

**Vertical** - The pump is vertically oriented and pulls water straight up.

**Submersible** - The pump for diverting water is submerged under the water or bank and is not visible.

**Slant** - Both the pump and intake pipe are angled at a slant up the river bank.

**Centrifugal** - Old style pump which has a similar visual appearance to a snail shell (spiral or circular).

**Pump other** - Water diversion where type of pump used is unknown but use of a pump is certain.

**Floodgate** - Water diversion where water is diverted by gravity flow and controlled via a screwgate.

**Siphon** - Common in the Delta, not usually seen anywhere else.

**Weir** - Type of dam structure, usually spanning both banks, where flashboards are used to create head for the pump.

**Other** - Anything that is not described in the above categories.

**Pipe Size** - Inside diameter of the diversion intake or drain.

**Screened** - Fish screens are supposed to keep fish from being taken out of a stream or river by a water diversion.

**Pump Running** - Check *Yes* if the diversion was running in the time of the survey.

#### VI. DAM

**Dam Type** - Specify the material the dam is made from.

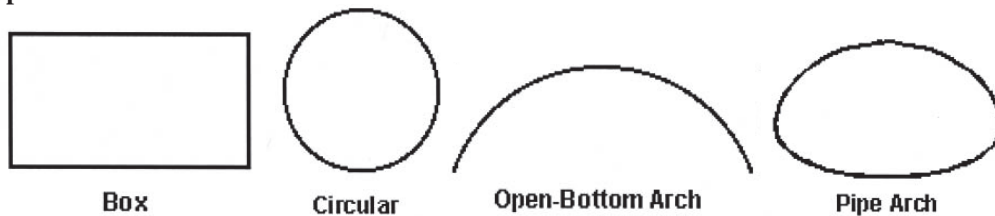
**Dam Width/Dam Height** - Provide the dam's dimensions in feet if possible.

**Seasonal/Permanent** - Is the dam operational all year long or seasonally?

**Facility** - Is there a fish ladder, natural fishway bypass, or some other structure in place to improve fish passage?

#### VII. CULVERT

##### Culvert Type



**Abandoned/Unmaintained** - Check if the culvert appears to be abandoned and/or not maintained.

**Culvert Material** - Check the box that most accurately describes the culvert's construction material. Check multiple boxes if the culvert is composed of two or more materials.

**Metal** - Includes the Corrugated Metal (Steel) Pipe (CMP) = single sheet pipe of corrugated galvanized steel; Structural Steel Plate (SSP) = multiple plates of corrugated galvanized steel bolted together, and corrugated aluminium. Both the pump and intake pipe are angled at a slant up the river bank.

**Plastic** - Culvert of various types of high-impact plastics, usually with shallow corrugations.

**Concrete** - Most county and state roads box culverts. Some circular and arch pipes are made of concrete, generally no corrugations.

**Log/wood** - Mostly old log stringer bridges and Humboldt crossings, occasionally also box and old circular pipe.

**Other** - Explain if none of the materials accurately describes the culvert.

**Number of Barrels/Pipes** - If a culvert consists of numerous barrels or pipe, list the total number.

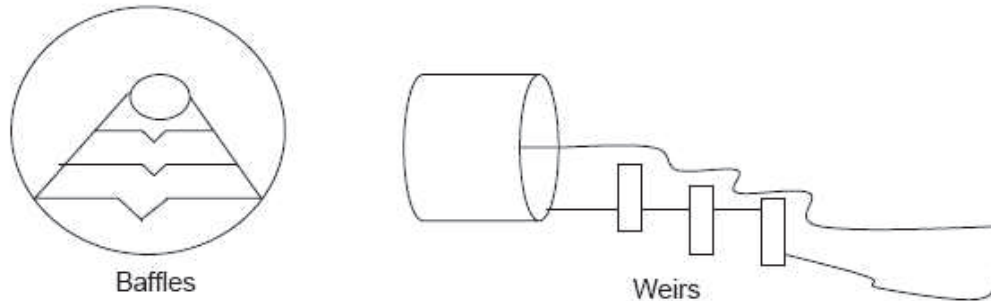
**Culvert Diameter** - Check whether inside culvert diameter is bigger or smaller than 2 ft. If multiple culverts, check the diameter of the largest one.

**Culvert Height/Width** - Provide the culvert dimensions. If multiple culverts, enter the size of the largest one.

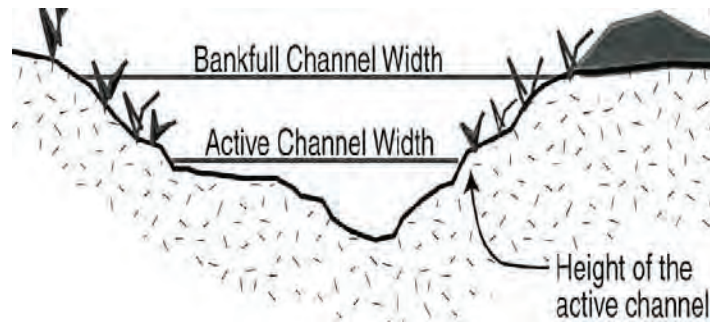
**Outlet Drop Height** - Measure the height at the center of the culvert outlet (e.g. downstream end of the culvert).



**Weirs/Baffles** - These are generally structures that are added as a retrofit to a culvert (baffles), or placed in the stream (weirs) to reduce velocity or improve fish passage in some way.



**Channel Width** - The active channel width is identified by locating the height of annual scour along banks developed by annual fluctuations of stream flow.



### VIII. BRIDGE

#### Bridge Type

**Free span** - No part of the bridge is in the stream.

**Instream structure** - An abutment, pier, or some other part of the bridge is in the stream.

**Active/Abandoned** - Is the bridge still utilized for vehicular or pedestrian traffic, or is it abandoned?

**Apron** - A protective shield, usually made of concrete, to protect against erosion, may be around piers or abutments or span the entire creek.

### IX. NATURAL

#### Natural Barrier Type

**Waterfall** - A sudden, nearly vertical drop in a stream, as it flows over rock.

**Grade** - The topography of the streambed is too steep for fish to ascend. Specify details of species and life-stages the grade is too steep for, in the notes section, and/or estimate the slope.

**Landslide** - Movement of earth down a steep slope into a stream that blocks fish passage.

**Log jam** - Log debris in a stream such that it blocks fish passage.

**Waterfall Drop** - Check the appropriate box.

### X. ADDITIONAL NOTES

Please provide any additional notes and comments that may help to describe the structure, to determine the need for detail fish passage assessment and needs for barrier remediation. Use other side of the form is needed. Mail or email filled form(s) to:

**DFW Passage Assessment Database Project, 830 S Street, Sacramento, CA 95814, Anne.Elston@wildlife.ca.gov**

## Attachment C

Spreadsheet Template Used to Standardize Roughness  
Approach for HEC RAS Models

Blue cells to be entered/selected by modeler.

Reach:	
Modeler:	

Based on Phillips and Tadayan (2006), Jarrett (1985) which are modifications of Cowen (1956) and Chow (1959).

Roughness Table	
Roughness Category	n
Base material	
Concrete	0.015
Sakrete	0.020
Bedrock	0.025
Firm Earth	0.022
Coarse Sand (1-2 mm)	0.024
Fine Gravel (2-8 mm)	0.024
Gravel (8-16 mm)	0.026
Coarse Gravel (16-64 mm)	0.028
Cobble (64-256 mm)	0.036
Chnl Margin Irregularity (Channel Only)	
None	0.000
Minor	0.005
Moderate	0.010
Severe	0.020
Channel Section Variation (Channel Only)	
Gradual	0.000
Alternating occasionally	0.005
Alternating frequently	0.015
Effect of Obstructions (Channel Only)	
Negligible	0.000
Minor	0.010
Appreciable	0.025
Severe	0.050
Vegetation	
Negligible	0.000
Low	0.010
Medium	0.020
High	0.035
Very High	0.075
Extremely High	0.150
Degree of Meandering (Multiplier)	
Minor	1.00
Appreciable	1.15
Severe	1.30

Model Reach 1:		Upstream River Station		Downstream River Station		
Roughness Element	Left Bank	Channel	Right Bank			
Base material	Cobble (64-256 mm)	0.036	Coarse Gravel (16-64 mm)	0.028	Firm Earth	0.022
Chnl Margin Irregularity	NA		Moderate	0.010	NA	
Variation in section			Gradual	0.000		
Effect of Obstructions			Negligible	0.000		
Vegetation	High	0.035	Negligible	0.000	Medium	0.020
Subtotals	0.071		0.038		0.042	
Meander Multiplier	NA		Minor	1.00	NA	
Final Mannings	0.071		0.038		0.042	

Model Reach 1: Notes

Modeled Reach 2:		Upstream River Station		Downstream River Station		
Roughness Element	Left Bank	Channel	Right Bank			
Base material	Sakrete	0.020	Gravel (8-16 mm)	0.026	Sakrete	0.020
Chnl Margin Irregularity	NA		None	0.000	NA	
Variation in section			Gradual	0.000		
Effect of Obstructions			Negligible	0.000		
Vegetation	Negligible	0.000	Low	0.010	Negligible	0.000
Subtotals	0.020		0.036		0.020	
Meander Multiplier	NA		Minor	1.00	NA	
Final Mannings	0.020		0.036		0.020	

Modeled Reach 2: Notes

Modeled Reach 3:		Upstream River Station		Downstream River Station		
Roughness Element	Left Bank	Channel	Right Bank			
Base material	Concrete	0.015	Concrete	0.015	Concrete	0.015
Chnl Margin Irregularity	NA		None	0.000	NA	
Variation in section			Gradual	0.000		
Effect of Obstructions			Minor	0.010		
Vegetation	Negligible	0.000	Low	0.010	Negligible	0.000
Subtotals	0.015		0.035		0.015	
Meander Multiplier	NA		Minor	1.00	NA	
Final Mannings	0.015		0.035		0.015	

Modeled Reach 3: Notes

Modeled Reach 4:		Upstream River Station		Downstream River Station		
Roughness Element	Left Bank	Channel	Right Bank			
Base material	Concrete	0.015	Fine Gravel (2-8 mm)	0.024	Concrete	0.015
Chnl Margin Irregularity	NA		None	0.000	NA	
Variation in section			Alternating frequently	0.015		
Effect of Obstructions			Negligible	0.000		
Vegetation	Negligible	0.000	Medium	0.020	Negligible	0.000
Subtotals	0.015		0.059		0.015	
Meander Multiplier	NA		Minor	1.00	NA	
Final Mannings	0.015		0.059		0.015	

Modeled Reach 4: Notes

## Attachment D

### Results of Fishway Spreadsheet Models

# ATTACHMENT D RESULTS OF FISHWAY SPREADSHEET MODELS

## TABLE OF CONTENTS

DENIL FISHWAY CALCULATIONS FOR SITES 3 AND 21 .....	D-1
DENIL FISHWAY HYDRAULICS.....	D-2
SITE 3, MOFFETT FISH LADDER AT GRADE CONTROL STRUCTURE.....	D-3
SITE 21, FREMONT FISH LADDER .....	D-6
POOL AND CHUTE FISHWAY CALCULATIONS FOR SITE 12 .....	D-9
FISHWAY WEIR HYDRAULICS .....	D-10
LOOK-UP CHART FOR CALCULATING PLUNGING-STREAMING TRANSITION	
DEPTH OVER WEIR .....	D-11
RESULTS .....	D-12
PLUNGING FLOW HYDRAULIC CALCULATIONS.....	D-12
STREAMING FLOW HYDRAULIC CALCULATIONS (CHEZY).....	D-13
SUMMARY TABLE.....	D-14
TAILWATER RATING CURVE FOR CALCULATING WATER SURFACE DROP	
OVER VORTEX POOL AND CHUTE ENTRANCE WEIR.....	D-15
CHEZY COEFFICIENT VS. DEPTH OVER VORTEX WEIR.....	D-16
ATTACHMENT D REFERENCES .....	D-17



Denil Fishway Calculations for Sites 3 and 21

## Denil Fishway Hydraulics

Standard Denil fishway hydraulics have been extensively studied (Rajaratnam and Katopodis 1984, Katopodis et al. 1997, Haro et al. 1999, Kamul and Barthel 2000, Larinier 2002, Odeh 2003). For this assessment, the following fishway equation by Odeh (2003) was used to estimate the flow in the Denil fishway at varying headwater depths.

$$Q = C_d d^{1.75} b^{0.75} \sqrt{g S_o}$$

Where:  $Q$  = Fishway flow (cfs)

$C_d$  = Discharge coefficient (unitless), where  $C_d = 1.34 - 1.84 S_o$ , where  $0.10 \leq S_o \leq 0.25$

$d$  = Headwater depth, measured from the vee invert of the last (upstream) baffle measured in the fishway exit (ft)

$b$  = Weir opening width (ft)

$g$  = Gravitational constant (32.2 ft/s<sup>2</sup>)

$S_o$  = Fishway floor slope (ft/ft)

Larinier (2002) presented equations for calculating the upper and lower operating limit of the standard Denil fishway:

$$\text{Lower Operating Limit} = \frac{[d + k_2 \sin(\theta)]}{B} = 0.5$$

$$\text{Upper Operating Limit} = \frac{(d + k_2 \sin(\theta))}{B} = 1.1$$

Where:  $k_2$  = Height of vee (ft)

$\theta$  = Baffle angle (degrees)

$B$  = Fishway width (ft)

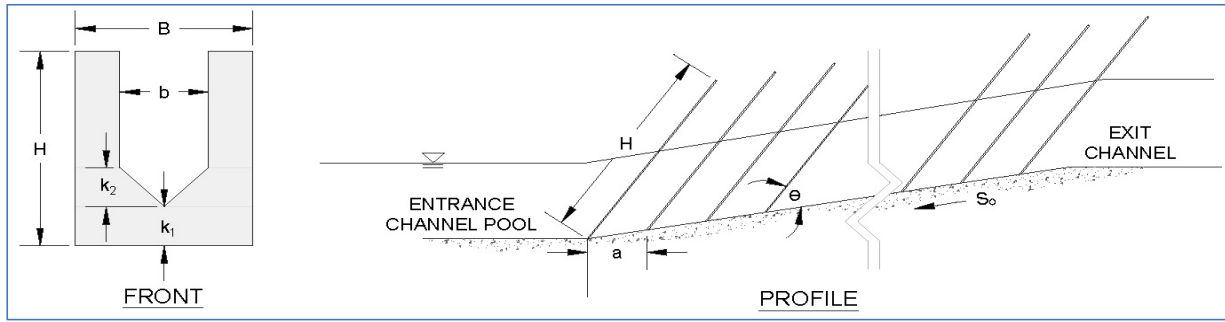
The velocity within a Denil fishway varies with depth. Relatively low velocities exist near the baffle and increase towards the surface. For this assessment the following for the mean velocity in the Denil fishway equation developed by Rajaratnam and Katopodis (1984) was used.

$$V = \frac{Q}{b \left( d - \frac{k_2 \sin(\theta)}{2} \right)}$$

Where:  $V$  = Fishway mean velocity (fps)

Site 3 Denil Fishway Input Variables	
Variable	Value
Slope, $S_o$ (ft/ft)	0.17
Ladder width, $B$ (ft)	4.00
Open width, $b$ (ft)	2.33
Notch height, $k_1$ (ft)	1.00
Notch height, $k_1'$ (ft)	0.71
Baffle Angle, $\theta$ (deg)	45.00
Notch Top, $k_2$ (ft)	1.00
Notch height, $k_2'$ (ft)	0.71
Baffle Height, $T$ (ft)	5.00
Baffle Spacing, $a$ (ft)	2.67
US Baffle Invert Elev. (ft)	31.10
Number of Baffles, $N$	17.00
Fishway Length (ft)	48.00
Odeh $C_d$	1.03
Gravity, $g$ (ft/s <sup>2</sup> )	32.20

Site 3 Denil Fishway Operating Limits	
Variable	Value
Lower Larinier Op. Depth Limit (ft)	1.2
Lower Larinier Op. Flow Limit (cfs)	6.2
Upper Larinier Op. Depth Limit (ft)	3.5
Upper Larinier Op. Flow Limit (cfs)	40.6



Results of Denil Fishway Assessment at Site 3, 1 of 2					
Forebay Elevation (ft)	Depth, <i>d</i> (ft)	Ratio <i>d/b</i> *	Larinier (2002) Operation Range (Unitless)**	Odeh (2003)	Rajaratnam and Katopodis (1984)
				Flow (cfs)	Velocity (fps)
31.2	0.1	0.0	0.23	0.1	
31.3	0.2	0.1	0.25	0.3	
31.4	0.3	0.1	0.28	0.6	
31.5	0.4	0.2	0.30	0.9	
31.6	0.5	0.2	0.33	1.3	9.2
31.7	0.6	0.3	0.35	1.9	7.5
31.8	0.7	0.3	0.38	2.4	7.0
31.9	0.8	0.3	0.40	3.1	6.9
32.0	0.9	0.4	0.43	3.8	6.9
32.1	1.0	0.4	0.45	4.5	7.0
32.2	1.1	0.5	0.48	5.4	7.2
32.3	1.2	0.5	0.50	6.2	7.4
32.4	1.3	0.6	0.53	7.2	7.6
32.5	1.4	0.6	0.55	8.2	7.8
32.6	1.5	0.6	0.58	9.2	8.0
32.7	1.6	0.7	0.60	10.3	8.3
32.8	1.7	0.7	0.63	11.5	8.5
32.9	1.8	0.8	0.65	12.7	8.8
33.0	1.9	0.8	0.68	14.0	9.0
33.1	2.0	0.9	0.70	15.3	9.3
33.2	2.1	0.9	0.73	16.6	9.5
33.3	2.2	0.9	0.75	18.0	9.8
33.4	2.3	1.0	0.78	19.5	10.0
33.5	2.4	1.0	0.80	21.0	10.3
33.6	2.5	1.1	0.83	22.6	10.5
33.7	2.6	1.1	0.85	24.2	10.8
33.8	2.7	1.2	0.88	25.8	11.0
33.9	2.8	1.2	0.90	27.5	11.2
34.0	2.9	1.2	0.93	29.2	11.5
34.1	3.0	1.3	0.95	31.0	11.7
34.2	3.1	1.3	0.98	32.9	12.0
34.3	3.2	1.4	1.00	34.7	12.2
34.4	3.3	1.4	1.03	36.7	12.4
34.5	3.4	1.5	1.05	38.6	12.7
34.6	3.5	1.5	1.08	40.6	12.9
34.7	3.6	1.5	1.10	42.7	13.1
34.8	3.7	1.6	1.13	44.8	13.4
34.9	3.8	1.6	1.15	46.9	13.6
35.0	3.9	1.7	1.18	49.1	13.8
35.1	4.0	1.7	1.20	51.3	14.1
35.2	4.1	1.8	1.23	53.6	14.3
35.3	4.2	1.8	1.25	55.9	14.5

\**b* = denil opening width

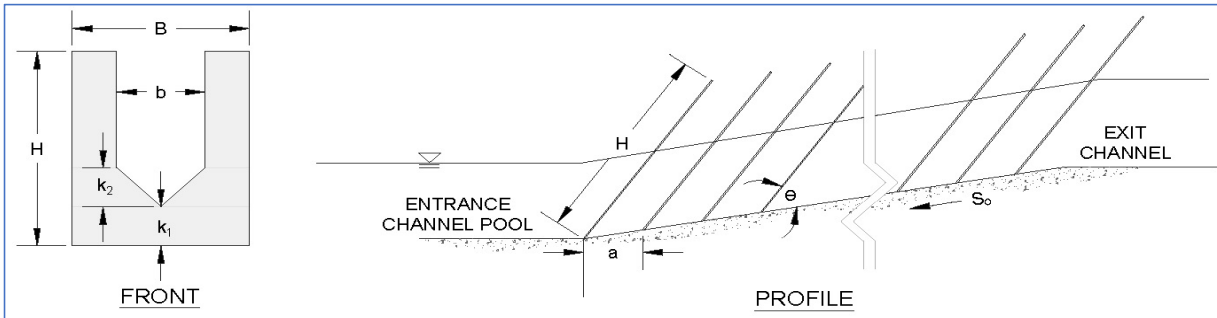
\*\*Red indicates out of operating range

Results of Denil Fishway Assessment at Site 3, 2 of 2				
Stevens Creek Flow (cfs)	Forebay Elevation (ft)	Denil Flow (cfs)	Denil Velocity (fps), Rajaratnam (1984)	Fishway Attraction Flow
1	31.87	1.0		
3	31.87	3.0		
8	31.98	3.6	6.9	45.1%
14	32.06	4.3	7.0	30.4%
16	32.09	4.4	7.0	27.8%
38	32.37	6.2	7.4	16.1%
70	32.55	8.7	7.9	12.4%
139	32.95	13.3	8.9	9.6%
203	33.25	17.3	9.6	8.5%
250	33.45	20.2	10.1	8.1%
300	33.64	23.2	10.6	7.7%
400	34	29.2	11.5	7.3%
450	34.16	32.1	11.9	7.1%
644	34.72	34.0	12.1	5.3%
680	34.81	45.0	13.4	6.6%
700	34.86	46.1	13.5	6.6%



Site 21 Denil Fishway Input Variables	
Variable	Value
Slope, $S_o$ (ft/ft)	0.17
Ladder width, $B$ (ft)	3.50
Open width, $b$ (ft)	2.00
Notch height, $k_1$ (ft)	0.88
Notch height, $k_1'$ (ft)	0.62
Baffle Angle, $\theta$ (deg)	45.00
Notch Top, $k_2$ (ft)	0.88
Notch height, $k_2'$ (ft)	0.62
Baffle Height, $H$ (ft)	5.00
Baffle Spacing, $a$ (ft)	2.33
US Baffle Invert Elev. (ft)	113.48
Number of Baffles, $N$ (ft)	32.00
Fishway Length (ft)	72.00
Odeh $C_d$	1.03
Gravity, $g$ (ft/s <sup>2</sup> )	32.20

Site 21 Denil Fishway Operating Limits	
Variable	Value
Lower Larinier Op. Depth Limit (ft)	1.1
Lower Larinier Op. Flow Limit (cfs)	4.8
Upper Larinier Op. Depth Limit (ft)	3.1
Upper Larinier Op. Flow Limit (cfs)	29.2



Site 21, Femont Fish Ladder

Results of Denil Fishway Assessment at Site 21, 1 of 2					
Forebay Elevation (ft)	Depth, <i>d</i> (ft)	Ratio <i>d/b</i> *	Larinier (2002)	Odeh (2003)	Rajaratnam and Katopodis (1984)
			Operation Range (Unitless)**	Flow (cfs)	Velocity (fps)
113.6	0.1	0.1	0.23	0.07	
113.7	0.2	0.1	0.26	0.2	
113.8	0.3	0.2	0.29	0.5	
113.9	0.4	0.2	0.32	0.8	4.47
114.0	0.5	0.3	0.34	1.2	3.14
114.1	0.6	0.3	0.37	1.6	2.83
114.2	0.7	0.4	0.40	2.2	2.76
114.3	0.8	0.4	0.43	2.7	2.78
114.4	0.9	0.5	0.46	3.3	2.84
114.5	1.0	0.5	0.49	4.0	2.92
114.6	1.1	0.6	0.52	4.8	3.01
114.7	1.2	0.6	0.54	5.5	3.11
114.8	1.3	0.7	0.57	6.4	3.22
114.9	1.4	0.7	0.60	7.3	3.33
115.0	1.5	0.8	0.63	8.2	3.44
115.1	1.6	0.8	0.66	9.2	3.55
115.2	1.7	0.9	0.69	10.2	3.67
115.3	1.8	0.9	0.72	11.3	3.78
115.4	1.9	1.0	0.74	12.4	3.89
115.5	2.0	1.0	0.77	13.5	4.01
115.6	2.1	1.1	0.80	14.8	4.12
115.7	2.2	1.1	0.83	16.0	4.23
115.8	2.3	1.2	0.86	17.3	4.35
115.9	2.4	1.2	0.89	18.6	4.46
116.0	2.5	1.3	0.92	20.0	4.57
116.1	2.6	1.3	0.94	21.4	4.68
116.2	2.7	1.4	0.97	22.9	4.79
116.3	2.8	1.4	1.00	24.4	4.90
116.4	2.9	1.5	1.03	26.0	5.01
116.5	3.0	1.5	1.06	27.5	5.12
116.6	3.1	1.6	1.09	29.2	5.23
116.7	3.2	1.6	1.12	30.8	5.33
116.8	3.3	1.7	1.14	32.5	5.44
116.9	3.4	1.7	1.17	34.3	5.55
117.0	3.5	1.8	1.20	36.1	5.65
117.1	3.6	1.8	1.23	37.9	5.76
117.2	3.7	1.9	1.26	39.8	5.86
117.3	3.8	1.9	1.29	41.7	5.97
117.4	3.9	2.0	1.32	43.6	6.07
117.5	4.0	2.0	1.34	45.6	6.17
117.6	4.1	2.1	1.37	47.6	6.28
117.7	4.2	2.1	1.40	49.6	6.38

\**b* = denil opening width

\*\*Red indicates out of operating range

Results of Denil Fishway Assessment at Site 21, 2 of 2				
Stevens Creek Flow (cfs)	Forebay Elevation (ft)	Denil Flow (cfs)	Denil Velocity (fps), Rajaratnam and Katopodis (1984)	Fishway Attraction Flow
1	114.9	1.0		100%
3	114.9	3.0		100%
5.5	114.9	5.5	3.0	100%
8	114.93	7.5	3.3	94%
14	115.07	8.8	3.5	63%
18	115.14	9.5	3.6	53%
29.0	115.3	11.2	3.8	39%
70	115.72	16.3	4.4	23%
119	116.12	21.7	5.0	18%
130	116.2	22.9	5.1	18%
165	116.44	26.6	5.3	16%
203	116.65	30.0	5.5	15%
212	116.7	30.8	5.5	15%

## Pool and Chute Fishway Calculations for Site 12

## Fishway Weir Hydraulics

Project: **Stevens Creek Fish Passage Assessment**

Date: 7/9/19

**Site 12 Vortex Weir Fishway at SF35 Gage**

Site: **Gauging Weir (SF35) with Drop Structure Central Ave. Fish Ladder**

By: ML

### DESIGN INPUTS

**Weir Type: Vortex Pool and Chute**

<i>Fishway</i>	Fishway Slope	So	<b>0.037</b>	ft/ft	
	Drop height	dH	<b>0.89</b>	ft	
	Total Fishway Width (at end of weirs)	T	<b>35.6</b>	ft	
	Pool Spacing On-Center	L(oc)	<b>23.95</b>	ft	
	Effective Pool Length (max 8 ft)	L(eff)	<b>10.00</b>	ft	
	Crest Height from channel bottom	P	<b>4.00</b>	ft	
	Depth over Weir when Fishway Fully Wetted	Hb	<b>6.98</b>	ft	
	Fishway Floor Slope (enter 0 if stepped)	Sfloor	<b>0.037</b>	ft/ft	
	Pool Bottom Width	Wb	<b>12.20</b>	ft	
	Side Slope of Side Walls (for trap. Channels)	Ss_walls	<b>1.00</b>	h:1V	
<i>Chute</i>	Chute bottom width	b	<b>0.00</b>	ft	
	Chute Depth	hc	<b>0.00</b>	ft	
	Lateral Slope of Chute	Sc	<b>0.00</b>	h:1v	
	V-notch angle of chute	Θc	0.0	deg	
	Top Width of chute	Tc	0.00	ft	
	Area of Wetted Chute	Ac	0.00		
	Wetted Perimeter of Full Chute	Pc	0.00		
	Triangular Weir Coefficient (for sloping sides)	CV_2	0.607		
	<i>Shoulder</i>	Slope along Shoulder Crest	Ss	<b>3.61</b>	h:1v
		Slope along Shoulder Crest	Θ	149.0	deg
Projected Shoulder Slope		Ssp	2.6	h:1v	
Projected Shoulder Slope		Θp	137.2	deg	
Triangular Weir Coefficient		CV_3	0.612		
Shoulder Skew to Flow (mea. from sidewall)		α	<b>45.00</b>	deg	
Shoulder Crest Length		W	25.19	ft	
Shoulder Lateral Distance from Chute to Sidewall		y	17.82	ft	
Shoulder Longitudinal Distance from Chute to Sidewall	x	17.82	ft		

### Head over Weir at Streaming Transition (Ead, 2004)

Plunging Transition	Qst	<b>11.86</b>	cfs/ft
Ratio for X-Axis of Plot	L/P	5.99	ft/ft
Dimensionless Discharge	Qst*	<b>0.48</b>	
<b>Head at Transition</b>	<b>hs</b>	<b>1.52</b>	<b>ft</b>
<b>SET EQUAL TO Qst</b>	<b>Goal</b>	<b>11.86</b>	<b>cfs/ft</b>

### Weir Coefficient Equations

$$Cr = =0.602+0.083(h/P)$$

$$Ctri = =0.6071-0.000874*(\theta)+6.1039*10^{-6}*(\theta)^2 \text{ in deg}$$

### Chezy Coefficient (regression of data from Nyberg et al., 2016)

$$Ch = 27.04(h1)^{-0.377} \text{ ft/s}^2$$

### Constants

Specific Weight of Water	γ	62.4	lb/ft <sup>3</sup>
Discharge Exponent	n(tri)	2.5	Triangular
	n(rect)	1.5	Rectangular
	n(trap)	2.0	Trapezoidal
Gravitational Accel	g	32.2	ft/s <sup>2</sup>

### Design Flows

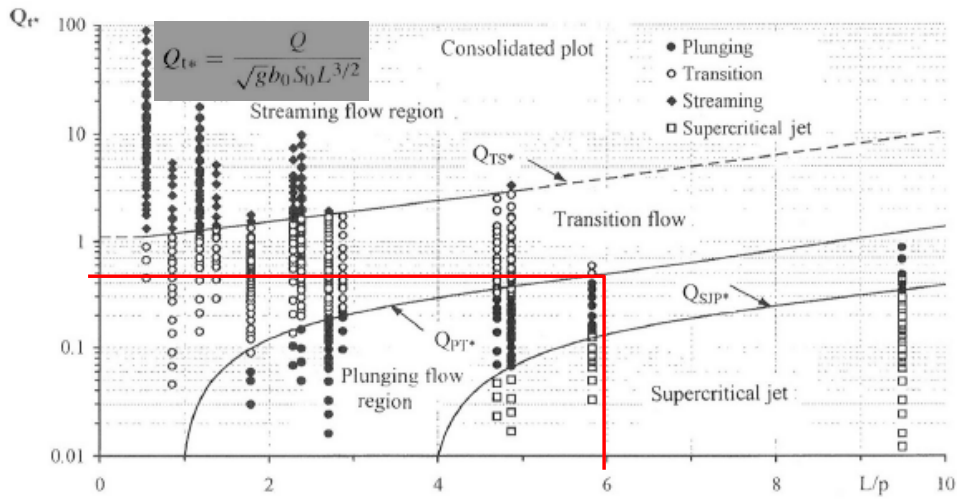
Adult Low Pass Flow	Q <sub>ALP</sub>	<b>3.0</b>	cfs
Adult High Pass Flow	Q <sub>AHP</sub>	<b>203.0</b>	cfs (Q1%)
Juv. Low Pass Flow	Q <sub>JLP</sub>	<b>1.0</b>	cfs
Juv High Pass Flow	Q <sub>JHP</sub>	<b>29.0</b>	cfs (Q10%)

### Design Elevations

Fishway Exit Elev.	El(exit)	<b>54.30</b>	ft (NAVD88)
Fishway Entrance Weir Elev.	El(entr)	<b>51.64</b>	ft (NAVD88)
Fishway Tailwater Control Elev.	El(twc)	<b>50.85</b>	ft (NAVD88)
Fishway Overall Drop		<b>3.44</b>	ft
Number of Weirs		<b>4</b>	



Look-up Chart for Calculating Plunging-Streaming Transition Depth over Weir



From Ead (2004)

**INSTRUCTIONS**

1. set fishway dimensions
2. Look-up  $Q_{pt^*}$  on chart for ratio  $L/p$
3. change  $h_s$  to set goal =  $Q_{st}$

Fish Passage Flow		Q <sub>lp_juv</sub>	Q <sub>lp_adult</sub>	P-S Trans	Q <sub>hp_juv</sub>	1 ft Entr Drop	Max Entr Drop	Q <sub>hp_adult</sub>	Max EDF	2-ft Dry Weir	Fully Wetted	
WSEexit	Water Surface Elevation at Fishway Exit:	54.7	54.9	55.8	56.2	56.4	57.5	58.8	59.4	60.9	61.5	ft
TWE	Tailwater Elevation from Rating Curve:	52.1	52.1	52.4	52.5	52.5	53.1	53.7	53.9	53.8	53.7	ft
dHentr	Water Surface Drop across Entrance Weir	-0.1	0.1	0.8	0.9	1.0	1.5	2.2	2.7	4.2	4.9	ft
Qfishway	TOTAL FLOW IN FISHWAY:	1.0	3.0	23.9	29.0	35.5	93.5	203.0	267.3	470.3	561.6	cfs
h <sub>1</sub>	HEAD ABOVE CREST:	0.40	0.63	1.52	1.73	1.90	3.00	4.32	4.92	6.42	6.98	ft

### RESULTS

Relative Submergence (Pool Depth/Weir Height)		0.99	1.05	1.27	1.32	1.36	1.64	1.97	2.12	2.49	2.63	
Fishway Flow Regime		Plunge	Plunge	Plunge	Stream	Stream	Stream	Stream	Stream	Stream	Stream	
Qshoulders	Plunging flow over Shoulders (for EDF)	0.96	2.98	23.92	23.08	22.39	22.75	24.71	25.15	25.79	25.95	cfs
EDF	Energy Dissipation Factor:	0.1	0.2	1.5	1.5	1.4	1.7	2.9	4.0	11.2	19.7	lb/ft <sup>2</sup> -s
Ldry	Dry Shoulder Length per Side:	23.8	22.9	19.7	19.0	18.3	14.4	9.6	7.4	2.0	0.0	ft

### PLUNGING FLOW HYDRAULIC CALCULATIONS

#### Section 1 (notch-rectangular section)

Q1	nonsubmerged Flow:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q1sub	Flow w/Submergence	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	cfs

#### Section 2 (Notch-triangular section)

Q2	nonsubmerged Flow (untruncated V):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q2untrunc_sub	Flow w/Submergence (untruncated V):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q2trunc	Truncated Portion of Flow (nonsubmerged):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q2trunc_sub	Truncated Portion of Flow w/Submergence:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q2sub	Total Flow w/ Submergence:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	cfs

#### Section 3 (Shoulders)

Q3	nonsubmerged Flow (untruncated one-sided V):	0.96	2.98	26.95	27.04	27.04	27.04	27.04	27.04	27.04	27.04	
Q3untrunc_sub	Flow w/Submergence (untruncated V):	0.96	2.98	23.92	23.08	22.39	22.75	24.71	25.15	25.79	25.95	
Q3trunc	Truncated Portion of Flow (nonsubmerged):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q3trunc_sub	Truncated Portion of Flow w/Submergence:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Q3sub	Total Flow on Shoulders w/ Submergence:	0.96	2.98	23.92	23.08	22.39	22.75	24.71	25.15	25.79	25.95	cfs

Plunging Flow Only												
Qfishway-plung	(does not include Sec 1 and 2 when streaming)	1.0	3.0	23.9	23.1	22.4	22.8	24.7	25.1	25.8	25.9	cfs

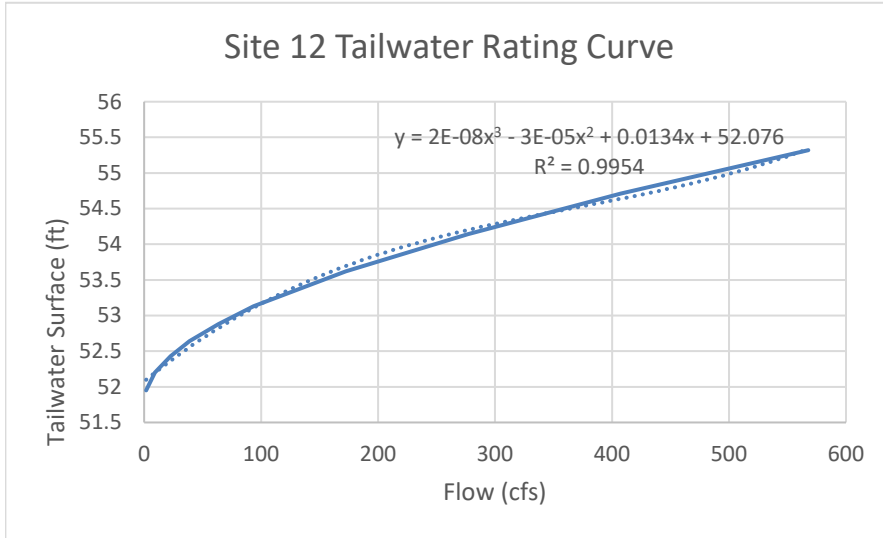
<b>h<sub>1</sub></b>	<b>HEAD ABOVE CREST:</b>	<b>0.40</b>	<b>0.63</b>	<b>1.52</b>	<b>1.73</b>	<b>1.90</b>	<b>3.00</b>	<b>4.32</b>	<b>4.92</b>	<b>6.42</b>	<b>6.98</b>	<b>ft</b>
<b>STREAMING FLOW HYDRAULIC CALCULATIONS (CHEZY)</b>												
<i>Within Chute: (h&lt;hc)</i>												
	Wetted Area (Trapezoid)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ft <sup>2</sup>
	Wetted Perimeter (Trapezoid)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ft
<i>Above Chute:</i>												
	Wetted Area (rectangle)	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	ft <sup>2</sup>
<i>On Shoulders (h&gt;hc)</i>												
	Wetted Area (shoulders)	0.4	1.0	5.9	7.6	9.2	23.0	47.7	61.8	105.2	124.3	ft <sup>2</sup>
	Wetted Perimeter (shoulders)	2.2	3.5	8.3	9.5	10.4	16.4	23.7	27.0	35.2	38.3	ft <sup>2</sup>
	<b>Total Flow Area</b>	<b>0.4</b>	<b>1.0</b>	<b>5.9</b>	<b>7.6</b>	<b>9.2</b>	<b>23.0</b>	<b>47.7</b>	<b>61.8</b>	<b>105.2</b>	<b>124.3</b>	<b>ft<sup>2</sup></b>
	<b>Total Wetted Perimeter</b>	<b>2.2</b>	<b>3.5</b>	<b>8.3</b>	<b>9.5</b>	<b>10.4</b>	<b>16.4</b>	<b>23.7</b>	<b>27.0</b>	<b>35.2</b>	<b>38.3</b>	<b>ft</b>
<b>Average water velocity within fishway</b>		<b>n/a</b>	<b>n/a</b>	<b>n/a</b>	<b>3.8</b>	<b>3.8</b>	<b>4.1</b>	<b>4.3</b>	<b>4.3</b>	<b>4.5</b>	<b>4.5</b>	<b>ft/s</b>
<b>Chezy Coef.</b>		<b>Plunging</b>	<b>Plunging</b>	<b>Plunging</b>	<b>22.0</b>	<b>21.2</b>	<b>17.9</b>	<b>15.6</b>	<b>14.8</b>	<b>13.4</b>	<b>13.0</b>	<b>ft<sup>0.5</sup>/s</b>
<b>Equivalent manning's n from chezy</b>		<b>0.040</b>	<b>0.043</b>	<b>0.056</b>	<b>0.065</b>	<b>0.069</b>	<b>0.088</b>	<b>0.108</b>	<b>0.115</b>	<b>0.133</b>	<b>0.140</b>	
<b>Equivalent manning's n for shoulders only</b>		0.040	0.043	0.056	0.424	0.564	1.876	4.573	6.349	12.584	15.630	
<b>Qfishway-stream Total Fishway when Streaming (excluding orifice)</b>		<b>Plunge</b>	<b>Plunge</b>	<b>Plunge</b>	<b>29.0</b>	<b>35.5</b>	<b>93.5</b>	<b>203.0</b>	<b>267.3</b>	<b>470.3</b>	<b>561.6</b>	<b>cfs</b>
<i>Effective Pool Volume for Plunging Flow:</i>												
	Length along Shoulder in Streaming per side, Lstream	0.00	0.00	0.00	0.74	1.36	5.34	10.11	12.27	17.68	19.70	ft
	Streaming Width per side, Wstream	0.0	0.0	0.0	0.5	1.0	3.8	7.1	8.7	12.5	13.9	ft
	Effective Pool Bottom Width per side, Bp	6.1	6.1	6.1	5.6	5.1	2.3	0.0	0.0	0.0	0.0	ft
	Eff Pool Max Depth, d	3.96	4.19	5.08	5.28	5.46	6.56	6.83	5.90	3.57	2.70	ft
	Effective Pool Top Width per side, Wp	10.1	10.3	11.2	10.9	10.6	8.9	6.8	5.9	3.6	2.7	ft
	Effective Pool XS Area per side, Apool	31.9	34.3	43.8	43.4	42.9	36.7	23.3	17.4	6.4	3.7	sf
<b>Vol</b>	Pool Volume for EDF	639	686	877	868	858	735	466	348	128	73	cf
<b>U<sub>pool</sub></b>	Velocity in Effective Pool	0.03	0.09	0.55	0.53	0.52	0.62	1.06	1.44	4.04	7.10	ft/s

## Summary Table

Description	Juvenile Low Passage Flow	Adult Low Passage Flow	Transition to Streaming	Juvenile High Passage	Entrance Drop = 1 ft	Entrance Drop = 1.5 ft	Adult High Passage	Max EDF	2-ft Dry Shoulder per Side	Shoulders Fully Wetted
Fishway Flow	1 cfs	3 cfs	24 cfs	29 cfs	35 cfs	94 cfs	203 cfs	267 cfs	470 cfs	562 cfs
Fishway Entrance Weir Water Surface Drop	-0.1 ft	0.1 ft	0.8 ft	0.9 ft	1 ft	1.5 ft	2.2 ft	2.7 ft	4.2 ft	4.9 ft
Depth over Weir	0.4 ft	0.6 ft	1.5 ft	1.7 ft	1.9 ft	3 ft	4.3 ft	4.9 ft	6.4 ft	7 ft
Length of Dry Shoulder per Side	23.8 ft	22.9 ft	19.7 ft	19 ft	18.3 ft	14.4 ft	9.6 ft	7.4 ft	2 ft	0 ft
Flow Regime in Chute	Plunge	Plunge	Plunge	Stream	Stream	Stream	Stream	Stream	Stream	Stream
EDF in Effective Pool (ft-lb/s/ft <sup>3</sup> )	0.1	0.2	1.5	1.5	1.4	1.7	2.9	4.0	11.2	19.7
Velocity in Effective Pool	0 fps	0.1 fps	0.5 fps	0.5 fps	0.5 fps	0.6 fps	1.1 fps	1.4 fps	4 fps	7.1 fps

**FROM REACH 3 RAS**

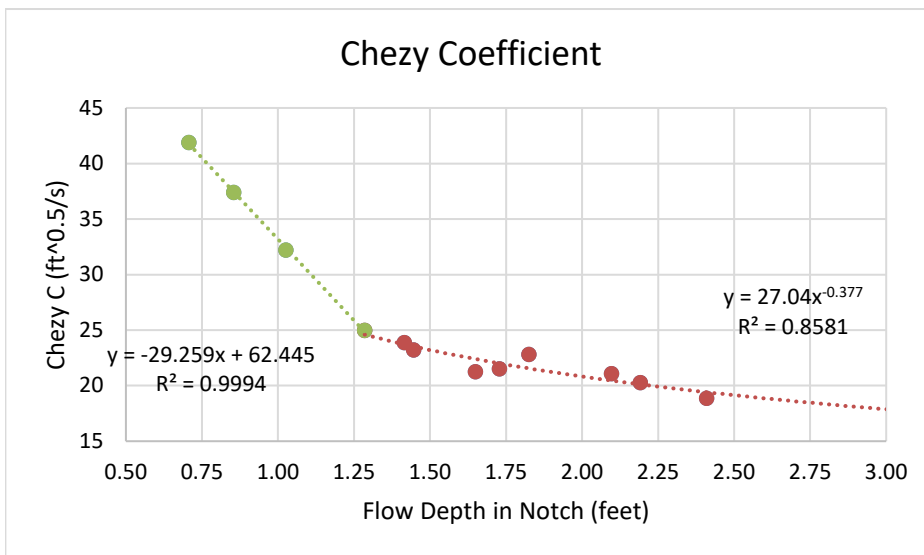
Flow (cfs)	TWC in RAS	WSE (ft)	TWC Elev	Adjusted WSE (ft)
1.7	120.1	121.2	50.85	51.95
9.3	120.1	121.45	50.85	52.2
22.7	120.1	121.68	50.85	52.43
38.7	120.1	121.89	50.85	52.64
63.5	120.1	122.13	50.85	52.88
93.5	120.1	122.38	50.85	53.13
172.3	120.1	122.87	50.85	53.62
276.7	120.1	123.39	50.85	54.14
407.4	120.1	123.96	50.85	54.71
567.8	120.1	124.57	50.85	55.32





From Nyberg et al. (2016)

Run #	Qmodel (cfs)	Qproto (cfs)	CST (ft1/2/s)	CS/P (ft1/2/s)	HWEIR AVG, Prototype (ft)
Run #1	0.068	58.8	---	41.9	0.71
Run #2	0.085	73.9	---	37.4	0.85
Run #3	0.103	89.8	---	32.2	1.03
Run #4	0.122	106.5	39.2	25.0	1.29
Run #6	0.137	119.8	33.0	23.9	1.42
Run #7	0.165	143.5	26.3	21.3	1.65
Run #9	0.208	181.2	27.2	22.8	1.82
Run #10	0.253	220.2	23.6	21.1	2.10
Run #12	0.325	283.1	22.3	18.9	2.41
Run #5p	0.122	106.5	30.4	23.2	1.45
Run #8p	0.165	143.5	25.6	21.5	1.73
Run #11p	0.253	220.2	22.5	20.3	2.19



Nyberg, M, B. Draeger, B. Weekly, E. Cashman, and M. Love. 2016. Analysis of vortex pool-and-chute fishway. American Journal of Undergraduate Research. Vol. 13, Issue 4, Dec. 2016, pp 37-57.

## Attachment D References

- Ead, S. A., Katopodis, C., Sikora, G. J., & Rajaratnam, N. (2004). Flow regimes and structure in pool and weir fishways. *Journal of environmental engineering and science*, 3, 379-390.
- Haro, A., Odeh, M., Mufeed-Santos, T., & Koreika, J. (1999). Effect of Slope and Headpond on Passage of American Shad and Blueback Herring through Simpl Denil and Deepened Alaska Steeppass Fishways. *North*, 51-58.
- Kamula, R., & Barthel, J. (2000). Effects of modifications on the hydraulics of Denil fishways. *Boreal Environmental Research*, 67-79.
- Katopodis, C., Rajaratnam, N., Wu, S., & Tovell, D. (1997). Denil fishways of varying geometry. *Journal of Hydraulic Engineering*, 123, 624-631.
- Larinier, M. (2002). Baffle Fishways. *Knowledge & Management of Aquatic Ecosystems*, 83-101. doi:<http://dx.doi.org/10.1051/kmae/2002109>
- Nyberg, M., Draeger, B., Weekly, B., Cashman, E., & Love, M. (2016). Analysis of Vortex Pool-and-Chute Fishway.
- Odeh, M. (2003). Discharge rating equation and hydraulic characteristics of standard Denil fishways. *Journal of Hydraulic Engineering*, 129, 341-348. doi:10.1061
- Rajaratnam, N., & Katopodis, C. (1984). Hydraulics of Denil Fishways. *Journal of Hydraulic Engineering*, 110, 1219-1233.

Attachment E

Assessment Site Summary Sheets

## Stevens Creek Fish Passage Assessment

### Drop Structure Report

<b>Site:</b>	1	<b>Survey Date:</b>	9/18/2018	<b>Analyzed By:</b>	S.McNeely
<b>River Mile:</b>	2.64	<b>Surveyors:</b>	S.McNeely, O.Light, J.Burg,	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	1		E.Popuch		
<b>Site Name:</b>	Grade control, Vernon Avenue				
<b>Latitude:</b>	37.411011	<b>Longitude:</b>	-122.068817	<b>PAD ID:</b>	713640

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Grade control		
<b>Material Forming Drop:</b>	Concrete with Downstream Grouted Rock Veins		
<b>Current Drop Condition:</b>	Good.		
<b>Drop Structure Width (ft):</b>	25.5 ft	(bottom width)	
<b>Residual Drop Height (ft):</b>	3.8 ft		
<b>Scour Pool Residual Depth (ft):</b>	No pool		
<b>Pool Length (ft):</b>	No pool		
<b>Active Channel Width (ft):</b>	22.9 ft		
<b>Is there a fish ladder?</b>	No		

#### Additional Site Description:

Trapezoidal section with 45 deg. concrete drop structure located downstream of highway 101 crossing. Grouted rock veins located downstream of drop.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<8 cfs	All Flows	All Flows	<27 cfs
Adult	<57 cfs	>373 cfs	>373 cfs	<27 cfs and >374 cfs

##### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	57 to 203	73%	57 to 374

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The grouted rock veins and concrete drop structure provide insufficient depths for juveniles and adults at lower to moderate flows and excessive velocities for juveniles at all flows. The grouted channel bottom below the drop creates insufficient depth for leaping at flows up to 27 cfs. The drop is a leap barrier for juveniles at all flows. A hydraulic jump forms at 375 cfs and higher flows leading to an adult velocity, depth, and leap barrier.

**Stevens Creek Fish Passage Assessment (Continued)**  
**Drop Structure Site Photos**

Site: 1  
River Mile: 2.64  
Reach: 1  
Site Name: Grade control, Vernon Avenue  
Latitude: 37.411011 Longitude: -122.068817 PAD ID: 713640

**View from downstream looking upstream at grouted rock veins and concrete drop structure**



**View from upstream looking downstream at drop structure**



## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

Site:	2	Survey Date:	2/5/2016	Analyzed By:	pTJames
River Mile:	2.81	Surveyors:	M. Love, pT. James	Reviewer(s):	M. Love
Reach:	2				
Site Name:	Highway 101 crossing, PM 48.0				
Latitude:	37.408317	Longitude:	-122.06896	PAD ID:	705646

#### Crossing Description

Culvert 1: West (left)		Culvert 2: East (right)	
Shape	Box	Culvert Shape	Box
Material	Concrete	Culvert Material	Concrete
Bottom Material	Gravel/Concrete	Culvert Bottom Material	Gravel/Concrete
Length (ft)	226, 121*	Length (ft)	226, 121*
Height/Diameter (ft)	16	Height/Diameter (ft)	16
Embedment Depth (ft)	0	Embedment Depth (ft)	0
Width (ft)	11, 28**	Width (ft)	17
Bottom Slope	0.01%	Bottom Slope	0.01%
Inlet Type (e.g. Wingwall)	Straight	Inlet Type (e.g. Wingwall)	Straight
Outlet Type (e.g. Wingwall)	Straight	Outlet Type (e.g. Wingwall)	Straight
Residual Outlet Drop (ft)	1.5	Residual Outlet Drop (ft)	1.5
Outlet Pool Residual Depth (ft)	0.0	Outlet Pool Residual Depth (ft)	0.0
Active Channel Width (ft):	26		

#### Additional Site Description:

\*Length of culvert bay approximately 226 ft. Length of outlet apron approximately 121 ft.

\*\*Distance between center wall and top of trail bank is 11 ft. Full width, including the trail, is approximately 28 ft.

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flow Ranges by Barrier Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<19 cfs	All	All	All
Adult	<165 cfs	>49 cfs	None	All

##### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	None	0%	None

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Leap height over edge of apron was calculated using water level downstream of hydraulic jump. Insufficient pool depth downstream of apron requires fish to swim up water surface drop rather than leap. The drop off of the apron with insufficient pool depth and the shallow and fast flow on the apron are the primary barriers for adults.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 2  
River Mile: 2.81  
Reach: 2  
Site Name: Highway 101 crossing, PM 48.0  
Latitude: 37.408317 Longitude: -122.06896

PAD ID: 705646

Looking downstream at Highway 101 inlet (a) west culvert and (b) east culvert, with inlet drop in foreground



a.



b.

Highway 101 (a) culvert outlet looking upstream and (b) grouted rock veins looking downstream



a.



b.

## Stevens Creek Fish Passage Assessment

### Channel Report

<b>Site:</b>	3	<b>Survey Date:</b>	2/5/2016	<b>Analyzed By:</b>	pTJames
<b>River Mile:</b>	2.93	<b>Surveyors:</b>	M. Love, pTJames	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	2				
<b>Site Name:</b>	Moffett fish ladder				
<b>Latitude:</b>	37.406618	<b>Longitude:</b>	-122.069042	<b>PAD ID:</b>	707059

#### Channel Description

<b>Channel Length (ft)</b>	434
<b>Average Channel Slope (%)</b>	0.10%
<b>Channel Material (Size etc.)</b>	Concrete with patches of gravel
<b>Channel Bottom Width (ft)</b>	20 (bottom width)
<b>Bank Material (e.g. Earth, RSP)</b>	Concrete
<b>Bank Slope (H:V)</b>	1.25
<b>Drop?</b>	No
<b>Residual Drop Height (ft)</b>	NA
<b>Scour Pool Residual Depth (ft):</b>	NA
<b>Active Channel Width (ft):</b>	26

#### **Additional Site Description:**

Site 3 consists of the concrete channel and upstream drop structure, which is described on an separate summary sheet. The trapezoidal concrete channel extends from the Moffett Drop structure downstream to the Highway 101 crossing structure.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### **Barrier Flows by Type**

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<11 cfs	>2 cfs	NA	NA
Adult	<59 cfs	None	NA	NA

##### **Passable Flow Ranges**

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	59 to 203	72%	59 to 329

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Flow is uniform through concrete channel. Depths are too shallow for adult and juvenile fish at low to moderate flows. Velocity are excessive for juveniles, but adults are able to swim the entire length without getting exhausted at the high passage flow (203 cfs). Site overall passage window for adults is 59 cfs to 203 cfs (72% passage), not accounting for low attraction flow and frequent debris clogging of Denil fishway.

## Stevens Creek Fish Passage Assessment (Continued)

### Channel Site Photos

Site: 3

River Mile: 2.93

Reach: 2

Site Name: Moffett fish ladder

Latitude: 37.406618 Longitude: -122.069042

PAD ID: 707059

Concrete channel downstream of Moffett Drop Structure, looking downstream to Highway 101 crossing (Site 2)



Concrete channel looking upstream to drop structure



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	3	Survey Date:	2/5/2016		Analyzed By: pTJames
River Mile:	2.93	Surveyors:	MLove, pTJames		Reviewer(s): M. Love
Reach:	2				
Site Name:	Moffett fish ladder				
Latitude:	37.406618	Longitude:	-122.069042		PAD ID: 707059

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Grade Control, Infrastructure Protection
<b>Material Forming Drop:</b>	Concrete
<b>Current Drop Condition:</b>	Weathered but fair condition
<b>Drop Structure Width (ft):</b>	34.0
<b>Residual Drop Height (ft):</b>	6.0
<b>Scour Pool Residual Depth (ft):</b>	0.0
<b>Pool Length (ft):</b>	0.0
<b>Active Channel Width (ft):</b>	26
<b>Is there a fish ladder?</b>	Yes, Denil

#### Additional Site Description:

Site 3 consists of the drop structure and the downstream concrete channel, which is described on an separate summary sheet. The Denil fishway overcomes 6 vertical feet and was installed circa 1984. The dimensions of the fishway fall within the "standard" Denil dimension relationships (Odeh, 2003; Bates, 1992). See images.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<3 cfs	>6 cfs	NA	NA
Adult	<38 cfs	>240 cfs	NA	NA

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	3 to 6	11%	3 to 6
Adult	38 to 203	83%	38 to 240

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Fish passage conditions are for passage through the Denil fishway. The drop structure is a complete barrier to all lifestages. The fishway's attraction flow (portion of streamflow in fishway) is <10% (min. recommended value) for all flows >128 cfs. Juvenile passage only occurs at low flows when fishway hydraulics function as pools and weirs. Observations of the Denil fishway has frequently found it plugged with debris and impassible.



## Stevens Creek Fish Passage Assessment (Continued)

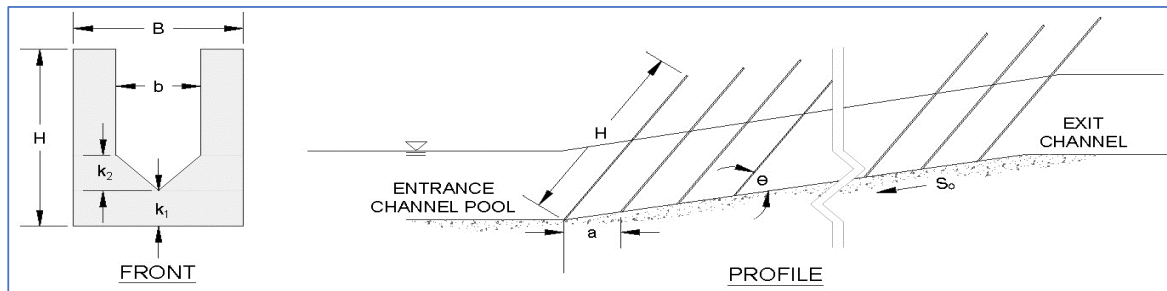
### Drop Structure Site Photos

**Site:** 3  
**River Mile:** 2.93  
**Reach:** 2  
**Site Name:** Moffett fish ladder  
**Latitude:** 37.406618    **Longitude:** -122.069042    **PAD ID:** 707059

**Moffett drop structure and denil fishway, looking upstream.**



#### The Denil fishway's dimensions



Variable	Value
Slope, $S_o$ (ft/ft)	0.17
Width, $B$ (ft)	4.0
Open width, $b$ (ft)	2.33
Vee invert, $k_1$ (ft)	1
Top of vee, $k_2$ (ft)	1
Spacing, $a$ (ft)	2.67
Baffle angle, $\theta$ (deg.)	45
Baffle height, $H$ (ft)	5
Fishway Length, $L$ (ft)	48
Number of baffles	17

## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

Site:	4	Survey Date:	8/7/2018	Analyzed By:	O.Light
River Mile:	3.13	Surveyors:	S. McNeely, O. Light, S. Kassem	Reviewer(s):	M. Love
Reach:	Reach 3				
Site Name:	Moffett Boulevard crossing				
Latitude:	37.403503	Longitude:	-122.069337	PAD ID:	713641

#### Crossing Description

Culvert 1 (Right)		Culvert 2 (Left)	
Shape	Rectangular	Culvert Shape	Rectangular
Material	Concrete	Culvert Material	Concrete
Bottom Material	Gravel over Concrete	Culvert Bottom Material	Gravel over Concrete
Length (ft)	200	Length (ft)	200
Height/Diameter (ft)	15	Height/Diameter (ft)	15
Embedment Depth (ft)	<1	Embedment Depth (ft)	<1
Width (ft)	15	Width (ft)	15
Bottom Slope	0.10%	Bottom Slope	0.20%
Inlet Type (e.g. Wingwall)	Wingwall	Inlet Type (e.g. Wingwall)	Wingwall
Outlet Type (e.g. Wingwall)	Wingwall	Outlet Type (e.g. Wingwall)	Wingwall
Residual Outlet Drop (ft)	None	Residual Outlet Drop (ft)	None
Outlet Pool Residual Depth (ft)	NA	Outlet Pool Residual Depth (ft)	NA
Active Channel Width (ft):	22		

#### Additional Site Description:

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flow Ranges by Barrier Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<3 cfs	>28 cfs	NA	NA
Adult	< 15 cfs	None	NA	NA

#### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	3 to 28	89%	3 to 28
Adult	15 to 203	94%	15 to >619

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Deposition in primary culvert that forms gravel/cobble banks and roughness along the wetted edge may be transitory. The crossing is passable by juveniles and adults at most flows, with insufficient depth at lower flows being the only substantial passage issue with this site.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 4  
River Mile: 3.13  
Reach: Reach 3  
Site Name: Moffett Boulevard crossing  
Latitude: 37.403503 Longitude: -122.069337 PAD ID: 713641

**Culvert 1: Primary passage culvert, looking downstream. Note low-flow channel shape provides suitable depth.**



**Culvert outlets looking upstream, primary passage culvert on left**



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

<b>Site:</b> 5	<b>Survey Date:</b> 8/7/2018	<b>Analyzed By:</b> O.Light
<b>River Mile:</b> 3.21	<b>Surveyors:</b> S. McNeely, O. Light, S. Kassem	<b>Reviewer(s):</b> M. Love
<b>Reach:</b> Reach 3		
<b>Site Name:</b> Drop structure upstream of Moffett Boulevard		
<b>Latitude:</b> 37.402569	<b>Longitude:</b> -122.069111	<b>PAD ID:</b> 713642

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Grade control
<b>Material Forming Drop:</b>	Concrete
<b>Current Drop Condition:</b>	Good
<b>Drop Structure Width (ft):</b>	15.0
<b>Residual Drop Height (ft):</b>	2.5
<b>Scour Pool Residual Depth (ft):</b>	0.4
<b>Pool Length (ft):</b>	125.0
<b>Active Channel Width (ft):</b>	23
<b>Is there a fish ladder?</b>	No

#### Additional Site Description:

Concrete channel starting at this drop structure and leading to Site 4 at the Moffett Ave. box culverts. Upstream is earthen channel.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<11 cfs	>4 cfs	N/A	N/A
Adult	<46	None	N/A	N/A

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	46 to 203	79%	46 to 213

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Analysis assumes fish would swim over this sloping drop structure rather than leap. The sloping and flat portions of the drop structure create a depth barrier at low to moderate flows and a velocity barrier for juveniles at most flows.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

**Site:** 5  
**River Mile:** 3.21  
**Reach:** Reach 3  
**Site Name:** Drop structure upstream of Moffett Boulevard  
**Latitude:** 37.402569    **Longitude:** -122.069111    **PAD ID:** 713642

**Looking upstream to drop structure**



**Looking downstream from top of drop structure**



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	6	Survey Date:	8/7/2018		Analyzed By:	O.Light
River Mile:	3.29	Surveyors:	S. McNeely, O. Light, S.		Reviewer(s):	M. Love
Reach:	3		Kassem			
Site Name:	Drop structure at Hetch Hetchy crossing					
Latitude:	37.401344	Longitude:	-122.069073		PAD ID:	713643

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Grade control at pipeline crossing
<b>Material Forming Drop:</b>	Concrete
<b>Current Drop Condition:</b>	Moderate to good, slightly scoured
<b>Drop Structure Width (ft):</b>	15.0 (bottom width)
<b>Residual Drop Height (ft):</b>	3.3
<b>Scour Pool Residual Depth (ft):</b>	0.5
<b>Pool Length (ft):</b>	11.0
<b>Active Channel Width (ft):</b>	30.6
<b>Is there a fish ladder?</b>	No

#### Additional Site Description:

Drop structure with weir downstream to create pool. Upstream of the drop the channel bed and banks alternate between concrete and sacrete for roughly 100 feet.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<11 cfs	All passage flows	All passage flows	<33
Adult	<50 cfs	>110 cfs	All passage flows	<33

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	None	0%	None

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The drop height is excessive at all flows for all fish, and the pool depth for leaping is too shallow at flows less than 33 cfs. The concrete/sacrete channel upstream of the drop structure creates a depth barrier at low to moderate flows and a velocity barrier at all flows for juveniles and at high flows for adults.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

Site: 6

River Mile: 3.29

Reach: 3

Site Name: Drop structure at Hetch Hetchy crossing

Latitude: 37.401344 Longitude: -122.069073

PAD ID: 713643

Looking upstream at the drop structure with pool and weir



Looking upstream and concrete and sacrete channel above drop structure



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site: 8 Survey Date: 8/14/2018 Analyzed By: O.Light  
River Mile: 3.44 Surveyors: S. McNeely, K. McLean, S. Reviewer(s): M. Love  
Reach: 3 Kassem  
Site Name: Drop structure downstream of Middlefield Road  
Latitude: 37.399328 Longitude: -122.068765 PAD ID: 713645

#### Drop Structure Description

Drop Structure Assumed Purpose: Grade control  
Material Forming Drop: Concrete  
Current Drop Condition: Good  
Drop Structure Width (ft): 15.0 (bottom width)  
Residual Drop Height (ft): 0.6  
Scour Pool Residual Depth (ft): 1.1  
Pool Length (ft): 74.0  
Active Channel Width (ft): 29  
Is there a fish ladder? No

#### Additional Site Description:

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<13 cfs	All passage flows	None	None
Adult	<58 cfs	None	None	None

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	58 to 203	73%	58 to 240

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The concrete forms a depth barrier at low and moderate flows for both juveniles and adults. Backwatering eliminates the water surface drop at 7 cfs, allowing fish to attempt to swim rather than leap onto the drop structure.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

Site: 8

River Mile: 3.44

Reach: 3

Site Name: Drop structure downstream of Middlefield Road

Latitude: 37.399328 Longitude: -122.068765

PAD ID: 713645

Looking upstream to drop structure



Looking downstream from above drop structure and concrete channel bed



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

<b>Site:</b>	9	<b>Survey Date:</b>	8/15/2018	<b>Analyzed By:</b>	O.Light
<b>River Mile:</b>	3.53	<b>Surveyors:</b>	S. McNeely, K. McLean, S. Kassem	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	3				
<b>Site Name:</b>	Drop structure upstream of Middlefield Road				
<b>Latitude:</b>	37.39815	<b>Longitude:</b>	-122.068092	<b>PAD ID:</b>	713646

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Grade control	
<b>Material Forming Drop:</b>	Concrete	
<b>Current Drop Condition:</b>	Good	
<b>Drop Structure Width (ft):</b>	15.0	(bottom width)
<b>Residual Drop Height (ft):</b>	1.5	
<b>Scour Pool Residual Depth (ft):</b>	0.6	
<b>Pool Length (ft):</b>	53.5	
<b>Active Channel Width (ft):</b>	31.9	
<b>Is there a fish ladder?</b>	No	

#### Additional Site Description:

Assessed site includes upstream concrete and sacrete channel. Upstream of drop structure the left channel bank experienced severe erosion and retreat, and the channel could potentially flank this grade control if the erosion is left unchecked.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<14 cfs	>1 cfs	All passage flows	<2 cfs
Adult	<49 cfs	None	None	None

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	49 to 203	77%	49 to 329

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The concrete forming the drop structure creates a depth barrier for juveniles and adults at low to moderate flows, and a velocity barrier for juveniles at nearly all flows.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

Site: 9

River Mile: 3.53

Reach: 3

Site Name: Drop structure upstream of Middlefield Road

Latitude: 37.39815

Longitude: -122.068092

PAD ID: 713646

Looking upstream to drop structure



Looking upstream to above drop structure



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	10	Survey Date:	8/21/2018	Analyzed By:	O.Light
River Mile:	3.63	Surveyors:	S. McNeely, O. Light, E.	Reviewer(s):	M. Love
Reach:	Reach 3		Popuch		
Site Name:	Drop Structure at Gladys Avenue				
Latitude:	37.396664	Longitude:	-122.068217	PAD ID:	713647

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Grade control	
<b>Material Forming Drop:</b>	Concrete	
<b>Current Drop Condition:</b>	Good	
<b>Drop Structure Width (ft):</b>	15.0	(bottom width)
<b>Residual Drop Height (ft):</b>	-0.3	(backwatered by downstream gravel tailout)
<b>Scour Pool Residual Depth (ft):</b>	2.4	
<b>Pool Length (ft):</b>	76.0	
<b>Active Channel Width (ft):</b>	23.2	
<b>Is there a fish ladder?</b>	No	

#### Additional Site Description:

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	None	>16	NA	NA
Adult	<9 cfs	None	NA	NA

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	1 to 16	54%	1 to 16
Adult	9 to 203	97%	9 to >619

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

When stream is flowing, the downstream gravel tailout completely backwaters the drop structure, allowing fish to swim through it rather than leap. Water depth over the structure is too shallow at low flows for adults and water velocities too high for juveniles at higher flows.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

Site: 10

River Mile: 3.63

Reach: Reach 3

Site Name: Drop Structure at Gladys Avenue

Latitude: 37.396664 Longitude: -122.068217

PAD ID: 713647

Looking upstream to drop structure



Looking downstream from above drop structure



## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

<b>Site:</b>	11	<b>Survey Date:</b>	8/21/2018	<b>Analyzed By:</b>	O. Light
<b>River Mile:</b>	3.7	<b>Surveyors:</b>	S. McNeely, O. Light, E. Popuch	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	3				
<b>Site Name:</b>	Highway 85 crossing, PM 23.0				
<b>Latitude:</b>	37.395957	<b>Longitude:</b>	-122.068446	<b>PAD ID:</b>	713648

#### Crossing Description

##### **Culvert**

<b>Shape</b>	Rectangular bridge crossing
<b>Material</b>	Concrete
<b>Bottom Material</b>	Gravel, sacrete and concrete
<b>Length (ft)</b>	230
<b>Height/Diameter (ft)</b>	20
<b>Width (ft)</b>	20
<b>Bottom Slope</b>	0.95% at steepest
<b>Inlet Type (e.g. Wingwall)</b>	Sacrete sloped abutments
<b>Outlet Type (e.g. Wingwall)</b>	Sacrete sloped abutments and concrete drop structure
<b>Residual Outlet Drop (ft)</b>	1.7
<b>Outlet Pool Residual Depth (ft)</b>	1.1

##### **Additional Site Description:**

Site 11 consists of a 230 feet bridge crossing with a mix of sacrete and gravel bed and banks. The outlet consists of a concrete drop structure with a pool tailwater pool formed by a small v-notch weir. Average active channel width measured upstream of the fishway upstream (Site 12) is 19.9 feet.

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### **Barrier Flow Ranges by Barrier Type**

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<5 cfs	>2 cfs	All passage flows	<3 cfs
Adult	<35 cfs	None	None	None

#### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	35 to 203	84%	35 to 250

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Culvert with sacrete invert creates the low-flow depth barrier, the drop structure causes the leap barriers, and at very low flows the plunge pool is too shallow for juveniles to make the leap.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 11  
River Mile: 3.7  
Reach: 3  
Site Name: Highway 85 crossing, PM 23.0  
Latitude: 37.395957 Longitude: -122.068446 PAD ID: 713648

**Looking upstream to drop structure and bridge, with v-weir in foreground**



**Looking downstream to drop structure from within culvert with sacrete invert**



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	12	Survey Date:	8/21/2018	Analyzed By:	M. Love
River Mile:	3.76	Surveyors:	S. McNeely, O. Light, E. Popuch	Reviewer(s):	S. McNeely
Reach:	Reach 3				
Site Name:	Vortex weir fishway at SF35 gage				
Latitude:	37.396664	Longitude:	-122.068217	PAD ID:	707058

#### Drop Structure Description

Drop Structure Assumed Purpose:	Grade control	<u>Fishway Configuration</u>
Material Forming Drop:	Concrete	Fishway Overall Slope: 3.75%
Current Drop Condition:	Good	No. of Weirs: 4
Drop Structure Width (ft):	15.0	Drop Across Weirs (ft): 0.9
Overall Drop Height (ft):	3.44	Weir Spacing (ft): 25.2
Downstream Pool Residual Depth (ft):	4.2	Slope Along Weir Crest: 3.6H:1V
Downstream Pool Length (ft):	20.3	Residual Pool Depth (ft): 3.1
Active Channel Width (ft):	23.2	Skew of Weir to Flow: 45 deg
Is there a fish ladder?	Yes, Vortex Pool and Chute	

#### Additional Site Description:

Fishway built in 2002 to replace original grade control structure. Fishway tailwater controlled by a horizontal concrete and sacrete sill and downstream sedimentation. Immediately downstream is the Highway 85 bridge crossings (Site

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	None	None	All	None
Adult	None	None	>90 cfs	None

##### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	3 to 90	44%	1 to 90

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Design drop height between weirs is excessive for juveniles. The water surface differential between the entrance weir and tailwater pool becomes greater than 1.0 ft at flows greater than 35 cfs and greater than the 1.5 ft maximum for adults at flows greater than 90 cfs. This is caused by the difference in cross-sectional shape between the v-weir and the horizontal sill controlling the tailwater.



Stevens Creek Fish Passage Assessment (Continued)  
Drop Structure Site Photos

Site: 12  
River Mile: 3.76  
Reach: Reach 3  
Site Name: Vortex weir fishway at SF35 gage  
Latitude: 37.396664 Longitude: -122.068217 PAD ID: 713647

Looking upstream at fishway with entrance weir in foreground, and water surface drops increasing from upstream to downstream as a result of the low tailwater



Looking upstream through the fishway from concrete/sacrete tailwater control



## Stevens Creek Fish Passage Assessment

### Channel Report

<b>Site:</b>	14.0	<b>Survey Date:</b>	7/18/2018	<b>Analyzed By:</b>	pTJames
<b>River Mile:</b>	4.20	<b>Surveyors:</b>	OL, SMc, SK	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	4				
<b>Site Name:</b>	Drop structure downstream of pedestrian bridge				
<b>Latitude:</b>	37.388716	<b>Longitude:</b>	-122.069286	<b>PAD ID:</b>	713650

#### Channel Description

<b>Channel Length (ft)</b>	28.3
<b>Average Channel Slope (%)</b>	6.1%
<b>Channel Material (Size etc.)</b>	Concrete; Boulders, 1 to 3 feet in size
<b>Channel Bottom Width (ft)</b>	19
<b>Bank Material (e.g. Earth, Riprap)</b>	Riprap/Earth
<b>Bank Slope (H:1V)</b>	2.2
<b>Drop?</b>	Yes
<b>Residual Drop Height (ft)</b>	0.9
<b>Scour Pool Residual Depth (ft):</b>	0
<b>Active Channel Width (ft):</b>	22

#### **Additional Site Description:**

Concrete grade control sill with short concrete apron and boulder chute downstream.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### **Barrier Flows by Type**

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<16 cfs	>5 cfs	<6 cfs	< 5 cfs
Adult	<63 cfs	>67 cfs	None	<5 cfs

#### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	63 to 67	2%	63 to 67

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The drop structure becomes backwatered at approximately 30 cfs. At very low flows the concrete apron below the drop provides insufficient pool depth for leaping and swimming. The upstream end of the boulder chute creates excess velocities for adults and juveniles. The analysis likely under estimates passage conditions for adults given flow diversity in the boulder chute at high flows.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Channel Site Photos**

Site: 14  
River Mile: 4.20  
Reach: 4

Site Name: Drop structure downstream of pedestrian bridge  
Latitude: 37.388716 Longitude: -122.069286

PAD ID: 713650

**Concrete grade control with boulder chute below, looking upstream**



**Boulder chute looking upstream**



Stevens Creek Fish Passage Assessment  
Drop Structure Report

Site: 14.1 Survey Date: 7/18/2018  
 River Mile: 4.21 Surveyors: OL, SMc, SK  
 Reach: 4  
 Site Name: Drop structure at pedestrian bridge  
 Latitude: 37.388637 Longitude: -122.069288

Analyzed By: pTJames  
 Reviewer(s): M.Love

PAD ID:

Drop Structure Description

Drop Structure Assumed Purpose: Grade Control  
 Material Forming Drop: Grouted Boulders  
 Current Drop Condition: Fair  
 Drop Structure Width (ft): 30.0  
 Residual Drop Height (ft): 0.6  
 Scour Pool Residual Depth (ft): 1.6  
 Pool Length (ft): 43.0  
 Active Channel Width (ft): 22  
 Is there a fish ladder? No

Additional Site Description:

The drop feature is a channel wide, grouted, boulder structure. River left bank is comprised of native material while river right is a sacrete revetment. The drop feature is not impounding sediment upstream.

Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

Existing Fish Passage Conditions

Barrier Flows by Type

Age Class	Depth Barrier	Velocity		Insufficient Pool Depth
		Barrier	Leap Barrier	
Juvenile	<6 cfs	>3 cfs	NA	NA
Adult	<64 cfs	None	NA	NA

Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
	Juvenile		None
Adult	64 to 203	70%	64 to 232

\*Up to the 2-year flow event (619 cfs)

Additional Notes

The downstream face of the grouted rock structure is backwatered and the top of grouted rock has a sloping face, so no leap is required. Instead, fish are assumed to attempt to swim over it. The analysis found the depth over the grouted rock is too shallow at low and moderate flows, and became too fast for juveniles at only 4 cfs.



Stevens Creek Fish Passage Assessment (Continued)  
Drop Structure Site Photos

Site: 14.1  
River Mile: 4.21  
Reach: 4  
Site Name: Drop structure at pedestrian bridge  
Latitude: 37.388637 Longitude: -122.069288 PAD ID:

Grouted boulder drop structure looking upstream



Right bank sacrete revetment with undermined toe, looking downstream from grouted boulders



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site: 14.2 Survey Date: 9/4/2018  
River Mile: 4.39  
Reach: 5 Surveyors: SK, OL, SM  
Site Name: Sacrete pinch forming boulder jam  
Latitude: 37.386035 Longitude: -122.069116

Analyzed By: Llanos  
Reviewer(s): M. Love

PAD ID:

#### Drop Structure Description

Drop Structure Assumed Purpose: None, Self-formed Boulder Jam  
Material Forming Drop: Large Boulders  
Current Drop Condition: Fair  
Drop Structure Width (ft): 12.0  
Residual Drop Height (ft): 1.7  
Scour Pool Residual Depth (ft): 0.3  
Pool Length (ft): 50.0  
Active Channel Width (ft): 16.1  
Is there a fish ladder? No

#### Additional Site Description:

Reach constructed by left bank sacrete revetment and imported large boulders. Boulders mobilized to form a channel spanning boulder drop. The left bank is earthen material with vegetation.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	None	>3cfs	All Passage Flows	All Passage Flows
Adult	<6 cfs	>262 cfs	<7 cfs	<14 cfs

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	14 to 203	95%	14 to 262

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The drop over the boulders creates a velocity and leap barrier for juveniles at all flows. The shallow pool depth up to 14 cfs creates a barrier for adults attempting to leap.

Stevens Creek Fish Passage Assessment (Continued)  
Drop Structure Site Photos

Site: 14.2

River Mile: 4.39

Reach: 5

Site Name: Sacrete pinch forming boulder jam

Latitude: 37.386035 Longitude: -122.069116

PAD ID:

Looking upstream at boulder jam



Looking downstream from top of boulder jam





## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

Site: 15      Survey Date: 8/29/2018      Analyzed By: Llanos/pTJames  
River Mile: 4.56      Surveyors: SK, OL, SM      Reviewer(s): M. Love  
Reach: 6  
Site Name: Highway 237 crossing, PM 0.33  
Latitude: 37.383605      Longitude: -122.068958      PAD ID: 713651

#### Crossing Description

##### Culvert 1

Shape: Box  
Material: Concrete  
Bottom Material: Cobble, Gravel, Sand  
Length (ft): 200  
Height/Diameter (ft): 40  
Embedment Depth (ft): Unknown  
Width (ft): 24  
Bottom Slope: -0.60%  
Inlet Type (e.g. Wingwall): Straight Wingwall  
Outlet Type (e.g. Wingwall): Straight Wingwall  
Residual Outlet Drop (ft): None  
Outlet Pool Residual Depth (ft): None

Active Channel Width (ft): 15.8

##### Additional Site Description:

Bridge crossings with continuous concrete walls on both sides and natural channel bed material.

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flow Ranges by Barrier Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<7 cfs	>3 cfs	NA	NA
Adult	<25 cfs	None	NA	NA

#### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	25 to 203	89%	25 to 619

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

The flat over widened channel bed creates a low-flow depth barrier for adults and juveniles. The lack of bed form and low roughness of the bed and concrete walls also creates a velocity barrier for juveniles.

Stevens Creek Fish Passage Assessment (Continued)  
Culvert Crossing Site Photos

Site: 15  
River Mile: 4.56  
Reach: 6  
Site Name: Highway 237 crossing, PM 0.33  
Latitude: 37.383605 Longitude: -122.068958 PAD ID: 713651

**Culvert inlet looking downstream**



**Mid culvert looking upstream**





## Stevens Creek Fish Passage Assessment

### Channel Report

<b>Site:</b>	16	<b>Survey Date:</b>	11/9/2018	<b>Analyzed By:</b>	S.McNeely
<b>River Mile:</b>	4.89	<b>Surveyors:</b>	S.McNeely, O.Light, S.Kassem	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	7				
<b>Site Name:</b>	Boulder channel downstream of El Camino Real				
<b>Latitude:</b>	37.379266	<b>Longitude:</b>	-122.069645	<b>PAD ID:</b>	733959

#### Channel Description

<b>Channel Length (ft)</b>	727
<b>Average Channel Slope (%)</b>	1.5% (steeper sections at 4%)
<b>Channel Material (Size etc.)</b>	Boulders (Median Size = 1.6 ft.) with gravel/cobble mix at downstream end
<b>Channel Bottom Width (ft)</b>	Varies. Approximately 20.
<b>Bank Material (e.g. Earth, RSP)</b>	Sandy gravel or soil with medium to thick vegetation.
<b>Bank Slope (H:V)</b>	Varies. Approximately 2:1.
<b>Drop?</b>	No
<b>Residual Drop Height (ft)</b>	NA
<b>Scour Pool Residual Depth (ft):</b>	NA
<b>Active Channel Width (ft):</b>	22.1

#### **Additional Site Description:**

Boulder lined reach extending downstream from the end of the concrete apron at the El Camino Real crossing. Boulders appeared to be installed to stabilize incising stream channel downstream of the road crossing.

#### Steelhead Passage Flows (cfs)

<b>Age Class</b>	<b>Low</b>	<b>High</b>
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### **Barrier Flows by Type**

<b>Age Class</b>	<b>Depth Barrier</b>	<b>Velocity Barrier</b>	<b>Leap Barrier</b>	<b>Insufficient Pool Depth</b>
Juvenile	<4 cfs	All Passage Flows	NA	NA
Adult	<16 cfs	>330 cfs	NA	NA

##### **Passable Flow Ranges**

<b>Age Class</b>	<b>Passage Flows Meeting Assessment Criteria (cfs)</b>	<b>Percent of Passage Flows</b>	<b>All Flows Meeting Assessment Criteria* (cfs)</b>
Juvenile	None	0%	None
Adult	16 to 203	94%	16 to 330

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Hydraulic diversity from the boulders likely creates low-velocity pathways that juveniles could use to swim through this reach at most passage flows. This analysis does not account for variability in velocities across the channel width.

## Stevens Creek Fish Passage Assessment (Continued)

### Channel Site Photos

Site: 16

River Mile: 4.89

Reach: 7

Site Name: Boulder channel downstream of El Camino Real

Latitude: 37.379266 Longitude: -122.069645

PAD ID: 733959

Looking downstream at boulder lined channel



Looking upstream at downstream end of boulder channel and 2018 bank stabilization project



## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

<b>Site:</b>	17	<b>Survey Date:</b>	11/8/2018	<b>Analyzed By:</b>	S.McNeely
<b>River Mile:</b>	4.9	<b>Surveyors:</b>	S.McNeely, O.Light, S.Kassem	<b>Reviewer(s):</b>	M. Love
<b>Reach:</b>	7				
<b>Site Name:</b>	El Camino Real crossing				
<b>Latitude:</b>	37.378827	<b>Longitude:</b>	-122.069665	<b>PAD ID:</b>	713652

#### Crossing Description

##### **Culvert**

<b>Shape</b>	Arch
<b>Material</b>	Concrete
<b>Bottom Material</b>	Concrete
<b>Length (ft)</b>	162
<b>Height/Diameter (ft)</b>	20 +/-
<b>Embedment Depth (ft)</b>	0
<b>Width (ft)</b>	30
<b>Bottom Slope</b>	0.34%
<b>Inlet Type (e.g. Wingwall)</b>	~30deg. wingwall on right
<b>Outlet Type (e.g. Wingwall)</b>	~15deg. wingwall both sides
<b>Residual Outlet Drop (ft)</b>	0.44
<b>Outlet Pool Residual Depth (ft)</b>	None

**Active Channel Width (ft):** 22 ft upstream of culvert, 22.1 ft upstream of Site 17.1

##### **Additional Site Description:**

Crossing consists of three concrete arch segments with bridge deck segments as part of extensions on both ends. Minor bend to right in culvert.

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### **Barrier Flow Ranges by Barrier Type**

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<20 cfs	≥1 cfs	None	<2 cfs
Adult	<63 cfs	>331	None	None

##### **Passable Flow Ranges**

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	63 to 203	70%	63 to 331

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Shallow depths on concrete floor is a barrier to adults at low to moderate flows. Velocities are excessive on concrete for juveniles at most flows.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 17

River Mile: 4.9

Reach: 7

Site Name: El Camino Real crossing

Latitude: 37.378827 Longitude: -122.069665

PAD ID: 713652

Looking downstream at culvert inlet



Looking upstream at culvert outlet with boulder channel (site 16) downstream of apron



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	17.1	Survey Date:	11/18/2018	Analyzed By:	S.McNeely
River Mile:	4.96	Surveyors:	S.McNeely, O.Light, S.Kassem	Reviewer(s):	M. Love
Reach:	7				
Site Name:	Drop structure at storm drain				
Latitude:	37.378044	Longitude:	-122.06943	PAD ID:	

#### Drop Structure Description

Drop Structure Assumed Purpose:	Grade Control, Drainage Outfall Protection
Material Forming Drop:	Sacrete and Concrete
Current Drop Condition:	Eroding Sacrete, Moderate to Poor
Drop Structure Width (ft):	22.3
Residual Drop Height (ft):	None (backwatered from Site 17)
Scour Pool Residual Depth (ft):	3.4
Pool Length (ft):	821.0
Active Channel Width (ft):	22.1
Is there a fish ladder?	No

#### Additional Site Description:

Trapezoidal section of sacrete set in concrete with approx. 48" diameter culvert outlet located approximately halfway up the right bank. At low flows the drop structure is slightly backwatered by the culvert inlet apron from El Camino Real (site 17), located several hundred feet downstream.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	29
Adult	3	203

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<5 cfs	>1 cfs	None	None
Adult	<34 cfs	>89 cfs	None	None

##### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	34 to 89	28%	34 to 89

\*Up to the 2-year flow event (619 cfs)

#### Additional Notes

Depth is shallow, creating a barrier at low and moderate flows. Velocities accelerate across the sacrete as flow goes supercritical, creating a velocity barrier for juveniles and adults.



Stevens Creek Fish Passage Assessment (Continued)  
Drop Structure Site Photos

Site: 17.1  
River Mile: 4.96  
Reach: 7  
Site Name: Drop structure at storm drain  
Latitude: 37.378044 Longitude: -122.06943 PAD ID:

Looking upstream at drop structure/drainage outfall protection



Looking downstream at drop structure/drainage outfall protection



**Stevens Creek Fish Passage Assessment**  
**Culvert Crossing Report**

Site: 19      Survey Date: 8/28/2018      Analyzed By: pTJames  
River Mile: 5.85      Surveyors: SK, OL, SM      Reviewer(s): M. Love  
Reach: 8  
Site Name: Highway 85 crossing, PM 20.9  
Latitude: 37.366815      Longitude: -122.063793      PAD ID: 713654

**Crossing Description**

**Culvert 1**

Shape: Rectangle  
Material: Concrete  
Bottom Material: Gravel and Cobble with Areas of Exposed Concrete  
Length (ft): 155  
Height/Diameter (ft): ~20  
Embedment Depth (ft): Varies (0 to 2.5)  
Width (ft): 25  
Bottom Slope: 0.10%  
Inlet Type (e.g. Wingwall): Headwall/Wingwall  
Outlet Type (e.g. Wingwall): Headwall  
Residual Outlet Drop (ft): None  
Outlet Pool Residual Depth (ft): None

Active Channel Width (ft): 16

**Additional Site Description:**

Culvert bends slightly to the left. Upstream of culvert inlet an concrete encased pipeline (assumed), exposed at stream grade, spans the channel.

**Steelhead Passage Flow Ranges (cfs)**

Age Class	Low	High
Juvenile	1	29
Adult	3	203

**Existing Fish Passage Conditions**

**Barrier Flow Ranges by Barrier Type**

Age Class	Depth Barrier	Velocity	Insufficient	
		Barrier	Leap Barrier	Pool Depth
Juvenile	<4 cfs	All Passage Flows	NA	NA
Adult	<17 cfs	None	NA	NA

**Passable Flow Ranges**

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
	Juvenile	None	0%
Adult	17 to 203	93%	17 to >619

\*Up to the 2-year flow event (619 cfs)

**Additional Notes**

The concrete pipeline crossing is in a pool and not a barrier. At low flows a riffle in the lower half of the culvert creates a low flow depth barrier and velocity barrier for juveniles. Due to size of the bed material within culvert, juveniles are likely able to find low velocity passageways through this riffle, which is not accounted for in this analysis.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 19  
River Mile: 5.85  
Reach: 8  
Site Name: Highway 85 crossing, PM 20.9  
Latitude: 37.366815 Longitude: -122.063793 PAD ID: 713654

**Culvert outlet, looking upstream with some concrete exposure on outside of bend**



**Looking (a) downstream within culvert and (b) at exposed concrete spanning channel upstream of culvert**



(a)



(b)

## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	21	Survey Date:	9/19/2018	Analyzed By:	pTJames
River Mile:	6.82	Surveyors:	OL, EP, SM	Reviewer(s):	M. Love
Reach:	9				
Site Name:	Fremont fish ladder				
Latitude:	37.355448	Longitude:	-122.061686	PAD ID:	707056

#### Drop Structure Description

Drop Structure Assumed Purpose:	Grade Control	<u>Fish Ladder</u>
Material Forming Drop:	Concrete	Length (ft): 72
Current Drop Condition:	Good	Slope: 16.7%
Drop Structure Width (ft):	27, including ladder	Width (ft): 3.5
Residual Drop Height (ft):	13.0	No. of Baffles: 32
Scour Pool Residual Depth (ft):	3.3	Baffle Spacing (ft): 2.33
Pool Length (ft):	39.0	Open Width of Baffles (ft): 2.0
Active Channel Width (ft):	17.2	
Is there a fish ladder?	Yes	

#### Additional Site Description:

Denil fishway is located on right of drop structure. The dimensions of the fishway fall within "standard" Denil dimension relationships. Grouted rock located at toe of drop and ladder entrance. Ladder has entrance pool. Ladder exit located on inside of bend and there is some sedimentation upstream of the exit.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<21 cfs	All Flows	<6 cfs	<15 cfs
Adult	<42 cfs	203 cfs	None	<18 cfs

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	42 to 130*	70%	42 to 203**

\*Up to 619 cfs

#### Additional Notes

Grouted rock apron and fishway both create juvenile velocity barriers at all flows. Grouted rock apron creates depth barrier and poor entrance conditions at low to moderate flows for adults.

\*\*The Denil fishway length exceeds criteria, and should have two intermediate resting pools. At approximately 165 cfs, flows at top of apron overtop the fishway wall, and spills into the fishway, likely creating a barrier. Debris also likely clogs fishway exit during adult fish migration flows.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

Site: 21

River Mile: 6.82

Reach: 9

Site Name: Fremont fish ladder

Latitude: 37.355448 Longitude: -122.061686

PAD ID: 707056

Looking upstream at Denil fish ladder entrance on left and grouted rock apron



Looking downstream at top of drop structure with Denil fish ladder exit on right



## Stevens Creek Fish Passage Assessment Culvert Crossing Report

Site:	22	Survey Date:	9/5/2018	Analyzed By:	SK
River Mile:	6.96	Surveyors:	SK, OL, SM	Reviewer(s):	M. Love
Reach:	10				
Site Name:	Highway 85 crossing, PM 20.0				
Latitude:	37.354203	Longitude:	-122.06148	PAD ID:	733951

### Crossing Description

#### **Culvert 1 (Bridge)**

Shape	Rectangular
Material	Concrete
Bottom Material	Cobble & gravel
Length (ft)	185
Height/Diameter (ft)	20
Embedment Depth (ft)	NA (natural bottom)
Width (ft)	46
Bottom Slope	0.31%
Inlet Type (e.g. Wingwall)	Sloping earth abutment
Outlet Type (e.g. Wingwall)	Sloping earth abutment
Residual Outlet Drop (ft)	None
Outlet Pool Residual Depth (ft)	None

Active Channel Width (ft): 23.75

#### **Additional Site Description:**

Large bridge crossing with three bents. Active channel through center.

### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

### Existing Fish Passage Conditions

#### **Barrier Flow Ranges by Barrier Type**

Age Class	Depth Barrier	Velocity		Insufficient Pool Depth
		Barrier	Leap Barrier	
Juvenile	<20	>1 cfs	N/A	N/A
Adult	<68	None	N/A	N/A

### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
	Juvenile		None
Adult	68 to 130	50%	68 to >619

\*Up to 619 cfs

### Additional Notes

The channel is over-widened under the bridge, resulting in a depth barrier for adults and juveniles up to moderate flows. The analysis found velocity barriers for juveniles within the riffle near the outlet due to lack of roughness.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 22

River Mile: 6.96

Reach: 10

Site Name: Highway 85 crossing, PM 20.0

Latitude: 37.354203 Longitude: -122.06148

PAD ID: 733951

**Bridge outlet looking upstream**



**Inside bridge, looking downstream.**



## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

Site:	23	Survey Date:	12/7/2018	Analyzed By:	SK
River Mile:	7.15	Surveyors:	OL, SMc	Reviewer(s):	SMc
Reach:	11			PAD ID:	713655
Site Name:	Fremont Avenue crossing				
Latitude:	37.352123	Longitude:	-122.063271		

#### Crossing Description

Culvert 1	Culvert 2 (if applicable)
Shape	Open bottom arch
Material	Concrete
Bottom Material	Cobble/gravel
Length (ft)	47
Height/Diameter (ft)	n/a
Embedment Depth (ft)	n/a
Width (ft)	n/a
Bottom Slope	n/a
Inlet Type (e.g. Wingwall)	n/a
Outlet Type (e.g. Wingwall)	n/a
Residual Outlet Drop (ft)	n/a
Outlet Pool Residual Depth (ft)	n/a
Active Channel Width (ft):	17.6

#### Additional Site Description:

Crossing was deemed not a barrier according to CDFW Green-Gray-Red evaluation. Crossing has well defined thalweg and active channel widths equal to inlet width

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flow Ranges by Barrier Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	all passage flows	all passage flows	N/A	N/A
Adult	all passage flows	all passage flows	N/A	N/A

##### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	all passage flows	100%	all flows
Adult	all passage flows	100%	all flows

\*Up to 619 cfs

#### Additional Notes



Stevens Creek Fish Passage Assessment (Continued)  
Culvert Crossing Site Photos

Site: 23  
River Mile: 7.15  
Reach: 11  
Site Name: Fremont Avenue crossing  
Latitude: 37.352123 Longitude: -122.063271

Culvert outlet facing upstream



Inside culvert, facing upstream



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

<b>Site:</b> 25	<b>Survey Date:</b> 9/6/2018	<b>Analyzed By:</b> pTJames
<b>River Mile:</b> 7.46	<b>Surveyors:</b> SK, OL, SM	<b>Reviewer(s):</b> MLove
<b>Reach:</b> 12		
<b>Site Name:</b> Abandoned flashboard dam		
<b>Latitude:</b> 37.348253	<b>Longitude:</b> -122.064682	<b>PAD ID:</b> 713656

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Sill of Abandoned Flashboard Dam
<b>Material Forming Drop:</b>	Concrete
<b>Current Drop Condition:</b>	Fair
<b>Drop Structure Width (ft):</b>	21.0
<b>Residual Drop Height (ft):</b>	0.8
<b>Scour Pool Residual Depth (ft):</b>	0.7
<b>Pool Length (ft):</b>	90.0
<b>Active Channel Width (ft):</b>	17
<b>Is there a fish ladder?</b>	No

#### Additional Site Description:

Concrete retaining walls along both sides of channel extend high up the bank.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<4 cfs	>17 cfs	<9 cfs	None
Adult	<38 cfs	None	None	None

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	9 to 17	29%	9 to 17
Adult	38 to 130	74%	38 to >619

\*Up to 619 cfs

#### Additional Notes

Depth over the concrete sill is insufficient at low flows for adults. At low flows the weir is a leap barrier for juveniles and at higher flows the site presents a velocity barrier for juveniles.



## Stevens Creek Fish Passage Assessment (Continued)

### Drop Structure Site Photos

Site: 25

River Mile: 7.46

Reach: 12

Site Name: Abandoned flashboard dam

Latitude: 37.348253 Longitude: -122.064682

PAD ID: 713656

Drop structure looking upstream.



Tailwater control and drop structure pool, looking upstream.



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site: 25.1      Survey Date: 9/6/2019      Analyzed By: pTJames  
River Mile: 7.48      Surveyors: SK, OL, SM      Reviewer(s): M. Love  
Reach: 12  
Site Name: Concrete logs  
Latitude: 37.348057      Longitude: -122.064755      PAD ID:

#### Drop Structure Description

**Drop Structure Assumed Purpose:** Grade Control and Possibly Habitat  
**Material Forming Drop:** Concrete Logs and Wooden Logs  
**Current Drop Condition:** Original Configuration Unknown, but Logs appear to have shifted  
**Drop Structure Width (ft):** 11.4  
**Residual Drop Height (ft):** 0.6  
**Scour Pool Residual Depth (ft):** 1.0  
**Pool Length (ft):** 8.9  
**Active Channel Width (ft):** 15.1  
**Is there a fish ladder?** No

#### Additional Site Description:

A channel spanning concrete log and wooden log structure with a pool downstream controlled by imported boulder. A secondary concrete and wooden log structure runs parallel to flow and appears have shifted (assuming it originally spanned the channel).

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<4 cfs	>2 cfs	<3 cfs	None
Adult	<22 cfs	>558 cfs	None	None

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	22 to 130	86%	22 to 558

\*Up to 619 cfs

#### Additional Notes

High velocities over the channel spanning concrete log create a juvenile barrier. Shallow depths over the log create a low-flow depth barrier for adults. The hydraulic complexity of the structure likely provides suitable passage routes at most lower flows for juveniles and adults.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Drop Structure Site Photos**

Site: 25.1  
River Mile: 7.48  
Reach: 12  
Site Name: Concrete logs  
Latitude: 37.348057 Longitude: -122.064755 PAD ID:

Concrete and wooden log structures, looking upstream.



Looking downstream with concrete and wooden log structures in center



## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

Site:	27	Survey Date:	9/12/2018	Analyzed By:	pTJames
River Mile:	8.37	Surveyors:	SK, OL, SM	Reviewer(s):	M. Love
Reach:	13				
Site Name:	Homestead Road crossing				
Latitude:	37.337629	Longitude:	-122.06227	PAD ID:	713658

#### Crossing Description

##### **Culvert 1**

Shape	Box
Material	Concrete
Bottom Material	Natural
Length (ft)	76
Height/Diameter (ft)	~25 ft
Embedment Depth (ft)	NA
Width (ft)	38
Bottom Slope	1.64%
Inlet Type (e.g. Wingwall)	Wingwall
Outlet Type (e.g. Wingwall)	Wingwall
Residual Outlet Drop (ft)	1.1
Outlet Pool Residual Depth (ft)	0.5

**Active Channel Width (ft):** 13.7

##### **Additional Site Description:**

Downstream of the road crossing channel is clogged with large concrete rubble associated with an abandoned concrete structure, assumed to be associated with a previous stream crossing.

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### **Barrier Flow Ranges by Barrier Type**

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<6 cfs	>1 cfs	None	None
Adult	<24 cfs	>277 cfs	None	None

##### **Passable Flow Ranges**

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	24 to 130	85%	24 to 277

\*Up to 619 cfs

#### Additional Notes

At low flows small drops have insufficient pool depth for leaping, although this would likely not inhibit fish passage. High velocities through concrete rubble create juvenile barrier. Jagged debris within rubble posse risk of harm to adult fish.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

Site: 27  
River Mile: 8.37  
Reach: 13  
Site Name: Homestead Road crossing  
Latitude: 37.337629 Longitude: -122.06227 PAD ID: 713658

**Looking upstream from crossing outlet**



**Looking upstream at concrete rubble across channel located downstream of the crossing**



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

Site:	33	Survey Date:	7/16/2018	Analyzed By:	T. James
River Mile:	8.62	Surveyors:	M. Love, T. James, S. McNeely, O. Light, S. Kassem	Reviewer(s):	M. Love
Reach:	14				
Site Name:	Drop structure at Sweet Oak Street				
Latitude:	37.335696	Longitude:	-122.064032	PAD ID:	

#### Drop Structure Description

Drop Structure Assumed Purpose:	Abandoned Flashboard Dam
Material Forming Drop:	Concrete
Current Drop Condition:	Poor
Drop Structure Width (ft):	17.7
Residual Drop Height (ft):	1.7
Scour Pool Residual Depth (ft):	1.5
Pool Length (ft):	48.0
Is there a fish ladder?	No
Active Channel Width (ft):	16.1 (Measured downstream of site.)

#### Additional Site Description:

Abandoned flashboard dam. Structure partially failed and sagging in center. Hole in concrete apron with exposed rebar. Debris deposited upstream of hole.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<6 cfs	All Passage Flows	All Passage Flows	None
Adult	<49 cfs	>296 cfs	None	None

##### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	49 to 130	65%	49 to 296

\*Up to 619 cfs

#### Additional Notes

Structure has already partially failed and currently serves no purpose. Hole in concrete apron and exposed rebar further exacerbates passage conditions due to fallback potential and risk of fish injury. Removal of this structure will likely increase drop at downstream end of concrete channel at next site upstream.



Stevens Creek Fish Passage Assessment (Continued)  
Drop Structure Site Photos

Site: 33  
River Mile: 8.62  
Reach: 14  
Site Name: Drop structure at Sweet Oak Street  
Latitude: 37.335696 Longitude: -122.064032 PAD ID:

Drop structure looking upstream from right bank



Drop structure looking upstream from scour pool



## Stevens Creek Fish Passage Assessment

### Channel Report

Site:	33.1	Survey Date:	7/16/2018	Analyzed By:	T. James
River Mile:	8.67	Surveyors:	M. Love, T. James, S. McNeely, O. Light, S. Kassem	Reviewer(s):	M. Love
Reach:	14				
Site Name:	Sacrete channel				
Latitude:	37.335276	Longitude:	-122.064743	PAD ID:	

#### Channel Description

Channel Length (ft)	270
Average Channel Slope (%)	0.65%
Channel Material (Size etc.)	Sacrete with gravel and fines
Channel Bottom Width (ft)	6
Bank Material (e.g. Earth, RSP)	Left: Sacrete, Right: Earth
Bank Slope (H:V)	Left 1.7:1, Right 1.7:1
Outlet Drop?	Yes
Residual Outlet Drop Height (ft)	0.4
Scour Pool Residual Depth (ft):	2.9
Active Channel Width (ft):	7.9

#### Additional Site Description:

Channel bends to right with sacrete bottom along thalweg and left edge of channel. Right side of channel has deposition and vegetation growing on top of the sacrete, constricting the main channel against the left sacrete revetment. Large storm drain entering and small drop into scour pool at downstream end of sacrete.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<11 cfs	All Passage Flows	None	None
Adult	<37 cfs	None	None	None

#### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	37 to 130	74%	37 to >619

\*Up to 619 cfs

#### Additional Notes

Tailwater control of scour pool influenced by downstream flashboard dam at RM 8.62 (Site 33). Removal of the flashboard dam would increase drop at end of sacrete channel at this site. Extensive depth barrier due to shallow depth on sacrete and concrete apron at downstream end. Velocities are also excessive for juveniles throughout channel at all flows.



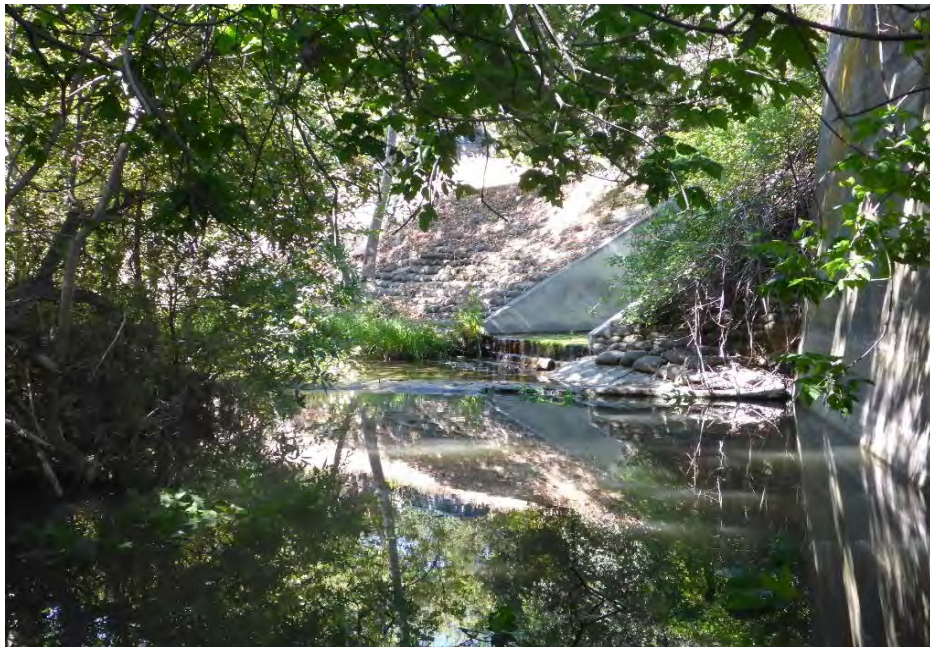
Stevens Creek Fish Passage Assessment (Continued)  
Channel Site Photos

Site: 33.1  
River Mile: 8.67  
Reach: 14  
Site Name: Sacrete channel  
Latitude: 37.335276 Longitude: -122.064743 PAD ID:

Mid-channel reach looking upstream



Looking upstream at downstream end of sacrete channel and storm drain entering on right of photo



## Stevens Creek Fish Passage Assessment

### Culvert Crossing Report

Site:	28	Survey Date:	7/16/2018	Analyzed By:	T. James
River Mile:	8.82	Surveyors:	M. Love, T. James, S. McNeely,	Reviewer(s):	M. Love
Reach:	14		O. Light, S. Kassem		
Site Name:	Highway 280 crossing, PM 11.2				
Latitude:	37.333662	Longitude:	-122.064036	PAD ID:	713660

#### Crossing Description

Culvert 1	Culvert 2
Shape	Culvert Shape
Material	Culvert Material
Bottom Material	Culvert Bottom Material
Length (ft)	Length (ft)
Height/Diameter (ft)	Height/Diameter (ft)
Width (ft)	Width (ft)
Bottom Slope	Bottom Slope
Inlet Type (e.g. Wingwall)	Inlet Type (e.g. Wingwall)
Outlet Type (e.g. Wingwall)	Outlet Type (e.g. Wingwall)
Residual Outlet Drop (ft)	Residual Outlet Drop (ft)
Outlet Pool Residual Depth (ft)	Outlet Pool Residual Depth (ft)
Active Channel Width (ft):	

#### **Additional Site Description:**

Standard Caltrans concrete arch culvert with concrete floor embedded below gravel channel bed. Gravel bed has 2-foot deep pool downstream of inlet followed by 200 foot long riffle extending to outlet. Deep outlet scour pool present against right wingwall at bend in channel.

#### Steelhead Passage Flow Ranges (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### **Barrier Flow Ranges by Barrier Type**

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<3 cfs	>2 cfs	None	None
Adult	<18 cfs	>360 cfs	None	None

#### Passable Flow Ranges

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	18 to 130	90%	18 to 360

\*Up to 619 cfs

#### Additional Notes

Juvenile fish likely able to pass this culvert at nearly all fish passage flows due to velocity diversity. A low flow channel along the right side of the culvert helps concentrate flows to provide adequate depth. This passage analysis fails to account for the areas of low velocity close to the bed of the channel.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Culvert Crossing Site Photos**

**Site:** 28

**River Mile:** 8.82

**Reach:** 14

**Site Name:** Highway 280 crossing, PM 11.2

**Latitude:** 37.333662      **Longitude:** -122.064036

**PAD ID:** 713660

**Culvert inlets looking downstream, primary passage culvert on left**



**Primary passage culvert's outlet, looking downstream. Note low-flow channel shape provides suitable depth.**



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

**Site:** 30.1      **Survey Date:** 5/9/2019      **Analyzed By:** O. Light  
**River Mile:** 9.93      **Surveyors:** S. McNeely, O. Light, J. Stead      **Reviewer(s):** M. Love  
**Reach:** 16  
**Site Name:** Boulder Weirs at Blackberry Farms  
**Latitude:** 37.320902      **Longitude:** -122.060571      **PAD ID:**

#### Drop Structure Description

**Drop Structure Assumed Purpose:** Grade control/stream restoration  
**Material Forming Drop:** Boulders  
**Current Structure Condition:** Good  
**Drop Structure Width (ft):** 18.0  
**Residual Drop Height (ft):** 0.6 (upper weir), 0.4 (lower weir)  
**Scour Pool Residual Depth (ft):** 2.6 (below upper weir), 3.1 (below lower weir)  
**Pool Length (ft):** 52 (upper), 36 (lower)  
**Active Channel Width (ft):** 13  
**Is there a fish ladder?** No

#### Additional Site Description:

Two constructed boulder weir drop structures built with 1 to 3 foot diameter rock placed downstream of recently constructed pedestrian bridge. Structures create pool habitat.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	None	>1 cfs	All passage flows	None
Adult	None	None	None	None

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	5 to 130	100%	5 to 494

\*Up to 619 cfs

#### Additional Notes

The primary barriers are the leap height over the weir for juveniles and the velocity for juveniles. At juvenile low passage flow there is a 0.7 ft of drawdown across the weir that forms the leap barrier. Given the hydraulic complexity and multiple pathways provided by the boulder weirs, it is likely that juveniles fish can swim or leap over these weirs at all juvenile passage flows. This hydraulic complexity is not accounted for in the analysis.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Drop Structure Site Photos**

**Site:** 30.1

**River Mile:** 9.93

**Reach:** 16

**Site Name:** Boulder Weirs at Blackberry Farms

**Latitude:** 37.320902    **Longitude:** -122.060571

**PAD ID:**

**Looking upstream from downstream of lower weir**



**Looking downstream from upstream of upper weir**



## Stevens Creek Fish Passage Assessment

### Drop Structure Report

<b>Site:</b> 32	<b>Survey Date:</b> 9/13/2018	<b>Analyzed By:</b> O. Light
<b>River Mile:</b> 12.28	<b>Surveyors:</b> S. McNeely, O. Light, S. Kassem	<b>Reviewer(s):</b> M. Love
<b>Reach:</b> 15		
<b>Site Name:</b> Gaging weir SF44 at Stevens Creek Park		
<b>Latitude:</b> 37.305596	<b>Longitude:</b> -122.07425	<b>PAD ID:</b> 713667

#### Drop Structure Description

<b>Drop Structure Assumed Purpose:</b>	Streamflow gage
<b>Material Forming Drop:</b>	Concrete with steel lip
<b>Current Structure Condition:</b>	Moderate. Some Undermining
<b>Drop Structure Width (ft):</b>	38.5
<b>Residual Drop Height (ft):</b>	2.4
<b>Scour Pool Residual Depth (ft):</b>	4.4
<b>Pool Length (ft):</b>	39.0
<b>Active Channel Width (ft):</b>	18.3
<b>Is there a fish ladder?</b>	No

#### Additional Site Description:

Low angled v-notch gaging weir used by SCVWD to gage in-stream flows below the Stevens Creek Reservoir. Very deep scour pool, but rough concrete protrudes into plunging flow at low flows.

#### Steelhead Passage Flows (cfs)

Age Class	Low	High
Juvenile	1	21
Adult	5	130

#### Existing Fish Passage Conditions

##### Barrier Flows by Type

Age Class	Depth Barrier	Velocity Barrier	Leap Barrier	Insufficient Pool Depth
Juvenile	<3 cfs	>8 cfs	All passage flows	None
Adult	<17 cfs	None	All passage flows	None

#### Passable Flows

Age Class	Passage Flows Meeting Assessment Criteria (cfs)	Percent of Passage Flows	All Flows Meeting Assessment Criteria* (cfs)
Juvenile	None	0%	None
Adult	None	0%	260 to >619

\*Up to 619 cfs

#### Additional Notes

The primary barrier is the leap height over the weir. At adult high passage flow there is a 2 ft drawdown across the weir that forms the leap barrier. At very high flows tailwater becomes high enough for adults to swim across the weir rather than leap.



**Stevens Creek Fish Passage Assessment (Continued)**  
**Drop Structure Site Photos**

**Site:** 32

**River Mile:** 12.28

**Reach:** 15

**Site Name:** Gaging weir SF44 at Stevens Creek Park

**Latitude:** 37.305596 **Longitude:** -122.07425

**PAD ID:** 713667

**Looking upstream to gaging weir**



**Looking upstream at riffle control of pool below gaging weir**



Attachment F

Site Ownership

Attachment F  
Site Ownership as Provided by Valley Water

Assessment Site No.	Description	Landowner / APN or Caltrans Parcel No. / SCVWD Easement ID*	NOTES
1	Grade control, Vernon Avenue	City Mtn View / 116-16-062 / 828	SCVWD fee IDs 351, 11616035, 11616068
		SCVWD / 116-16-035 / none	
		SCVWD / 116-16-068 / none	
		SCVWD / 116-17-005 / none	
2	Highway 101 crossing, PM 48.0	Caltrans / 99, 11880 / none	
3	Moffett fish ladder	SCVWD / 153-19-006 / none	SCVWD Fee ID 15319006
		City of Mountain View / 153-19-005 / 781, 890	
4	Moffett Boulevard crossing	Caltrans / 13563, 21040 / 5031	
5	Drop structure upstream of Moffett Boulevard	City of Mtn View / 160-04-001 / 807, 889	
6	Drop structure at Hetch Hetchy crossing	CC of San Francisco/ 160-040-019 / none	Hetch-Hetchy Crossing
8	Drop Structure downstream of Middlefield Road	SCVWD / 160-23-006 / none	SCVWD Fee ID 16023006
9	Drop Structure upstream of Middlefield Road	City of Mountain View / 160-37-008 / 804	SCVWD Fee ID 16037009
		SCVWD / 160-37-009/ none	
10	Drop Structure at Gladys Avenue	SCVWD / 160-37-006 / none	SCVWD Fee ID 16037006
		City of Mountain View / 160-37-002 / 893	
11	Highway 85 crossing, PM 23.0	Caltrans / 13536, 13618 /907, 908, 5020	Highway 85 crossing between MiddlefieldRd and Central Exwy, partial SCVWD easement
12	Vortex Fish Weir at SF35 Gage	SCVWD / 158-48-002 / none	SCVWD Fee ID 358
14	Drop Structure Downstream of Pedestrian Bridge	City of Mtn View / 158-32-001/ 853	
14.1	Drop Structure at Pedestrian Bridge	City of Mtn View / 158-32-001/ 853	
14.2	Sacrete pinch forming boulder jam	Ralston Capital Multi-family V LLC / 158-32-005 / 805	
15	Highway 237 Crossing, PM 0.33	Caltrans / 13633 / none	
16	Boulder channel downstream of El Camino Real	PG&E / 161-02-011 / none	SCVWD Fee on east and west banks (not channel) 16102003, 16102004
17	El Camino Real crossing	Caltrans / 91 / none	
17.1	Drop structure at storm drain	City of Mtn View / 197-43-001 / none	SCVWD easement on west bank (not channel) 783
19	Highway 85 crossing, PM 20.9	Caltrans / 20901 / none	
21	Fremont fish ladder	City of Sunnyvale / 202-38-042 / 846	
22	Highway 85 crossing, PM 20.0	Caltrans / 13515, 20884 / none	
23	Fremont Avenue crossing	SCVWD / 318-21-042 / none	SCVWD ID no. 31821042
		City of Sunnyvale / 320-07-005 / 842	
		Stauffer Chemical Co. / No APN / 831	
25	Abandoned flashboard dam	City of Sunnyvale / 320-07-005 / 842	

Attachment F  
Site Ownership as Provided by Valley Water

Assessment Site No.	Description	Landowner / APN or Caltrans Parcel No. / SCVWD Easement ID*	NOTES
25.1	Concrete logs	Albert S. Penilla / 318-22-040 / 784	
27	Homestead Road crossing	Bridge: No info / APN Missing / none	Homestead Road crossing, likely City of Sunnyvale fee; SCVWD Fee IDs 32001001, 32601002
		Downstream: SCVWD / 320-01-011 / none	
		Upstream: SCVWD / 326-01-002 / none	
33	Drop structure at Sweet Oak Street	SCVWD / 326-35-040 / none	SCVWD Fee ID 32635040
33.1	Sacrete channel	SCVWD / 326-35-064 / none	SCVWD Fee ID 32635064
28	Highway 280 crossing, PM 11.2	Caltrans / 13806, 13807, 13808, 29630, / none	
30.1	Boulder weirs at Blackberry Farms	City of Cupertino 357-10-007 / none	
		City of Cupertino 357-09-053 / none	
32	Gaging weir SF44 at Stevens Creek Park	Santa Clara County / 351-10-042 / 1002	SCVWD access easement does not include creek channel

\* This dataset was developed by Valley Water for its internal purposes only and is not designed or intended for general use by members of the public. Valley Water makes no representation or warranty as to its accuracy, timeliness, or completeness. Valley Water makes no warranty of merchantability or warranty for fitness of use for a particular purpose, expressed or implied, with respect to this dataset or the underlying data. Any user of this data accepts same as is, with all faults, and assumes all responsibility for the use thereof, and further covenants and agrees to defend, indemnify, and hold Valley Water harmless from and against all damage, loss, or liability, arising from any use of this product, in consideration of Valley Water having made this information available. Independent verification of all data contained herein should be obtained by any user of these products, or the underlying data. Valley Water disclaims, and shall not be held liable for, any and all damage, loss, or liability, whether direct, indirect, or consequential, which arises or may arise from these products or the use thereof by any person or entity.

DATA SOURCE: SCVWD GIS Server and Caltrans District 4 Right of Way Maps  
(<https://caltrans.maps.arcgis.com/apps/webappviewer/index.html?id=04efb9a9f14c4da2aab99ce36b7dda48>)