

FISHERIES HABITAT INVENTORY & ASSESSMENT FOR LOWER WILDCAT CREEK

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PREPARED FOR: THE URBAN CREEKS COUNCIL

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1.0 EXECUTIVE SUMMARY

The East Bay Regional Park District, (EBRPD) conducted a fisheries habitat assessment of the lower Wildcat Creek Watershed during 2005 and 2006. This study was designed to identify and assess barriers to salmonid migration, identify existing spawning and rearing habitat, assess existing fisheries populations and suggest enhancement to existing habitat conditions.

EBRPD controls over 2/3rds of the Wildcat Creek watershed, (Tilden and Wildcat Canyon Regional Parks), upstream of the Cities of Richmond and San Pablo. Rainbow trout, (*Oncorhynchus mykiss*), once native to the watershed, were extirpated in the early 1900's following dam building and other development. Native rainbow trout were reintroduced to Wildcat Creek in 1983 and quickly reproduced and spread throughout the creek's 13.5 mile run. This successful reintroduction of native rainbow trout also carried with it the potential for a portion of these fish to revert back to an anadromous lifecycle thereby creating a steelhead run in Wildcat Creek. Annual surveys of the rainbow trout and three-spined stickleback, (*Gasterosteus aculeatus*) population in Wildcat Creek have been conducted since 1995 primarily within the Park sections where rearing conditions are more suitable.

The surveys of lower Wildcat Creek consisted of 9 sections starting from the fish ladder, located downstream of the Burlington Northern-Santa Fe Railroad Trestle bridge, and running upstream to Interstate 80. Each section was surveyed using a Smith-Root electrofisher in conjunction with EPA Rapid Bioassessment Methodology during each of two periods, Early Summer and Late Summer. Overall, lower Wildcat Creek was found to have a high magnitude of channelization and reduced sinuosity based on its primary role as a flood control conduit. Wetted area throughout the creek was significantly diminished by the Late Summer period leaving adequate trout rearing habitat in only two of the nine sections. Instream habitat variability defined by pebble counts, degree of embeddedness, and riffle/ pool/glide ratios indicated that much of lower Wildcat Creek was sub-optimal as a whole for salmonid spawning and rearing. However, the Vale and Church sections exhibited the best physical attributes as well as water quality and quantity levels of this survey. It is not surprising that healthy rainbow trout successfully spawned and were able to survive in these sections of lower Wildcat Creek. The fact that these two sections benefit from a year round water supply originating from Doctor's Medical Center

well has been essential for the small population of rainbow trout and stickleback that exist there. In spite of this “oasis” in lower Wildcat Creek, densities of rainbow trout found here are only 10% of the densities found in the middle and upper park sections of Wildcat Creek. There is evidence of downstream migration of rainbow trout from the upstream park section, however there has been no evidence to date that anadromous steelhead have ever attempted to migrate into Wildcat Creek.

Lower Wildcat Creek is composed of a high percentage of semi-permanent and permanent culverts, channelization structures and annual deposition of anthropogenic garbage. One of the nine sections of the creek is considered impassable to up migrating steelhead during much of the winter stream flow conditions and two of the nine sections of the creek are considered impassable to up migrating rainbow trout during much of the winter stream flow conditions. Stream bed modifications are needed in several sections to facilitate migration and enhance over-summering habitat. Unfortunately, adding roughness to the Wildcat Creek stream bed to promote biological functions is likely to result in measures deemed unacceptable because they could hamper the creek’s flood control function. In spite of this, procedures to make lower Wildcat Creek more biologically and aesthetically desirable can be accomplished with long term planning and restoration.

A small but healthy population of rainbow trout has maintained itself in lower Wildcat Creek. The areas supporting fish can be expanded and enhanced. The majority of the lower creek can be modified and restored in order to promote a successful upstream as well as downstream migration of rainbow trout and perhaps steelhead.

2.0 BACKGROUND & OBJECTIVES

This report details the results of the East Bay Regional Park District (EBRPD) fisheries study conducted in lower Wildcat Creek,¹ between the west end of the Wildcat Creek fish ladder and the west side of the Interstate 80 overpass box culvert. The purpose of this study is to assess the existing fisheries resources and identify areas where future restoration and enhancement could most substantially improve the overall fisheries outlook in lower Wildcat Creek. This has been accomplished by:

1. Conducting a fisheries habitat assessment that details the upstream and downstream barriers to Pacific salmonid migration, including physical barriers and stream flows;
2. Identifying existing spawning and rearing habitat including perennial flow areas, spawning substrate, riparian cover, and instream cover;
3. Assessing the fisheries conditions by conducting winter spawning surveys, electroshocking surveys in both the early and late summer months and assessing *in situ* fish health during these surveys; and,
4. Compiling historical data on Wildcat Creek, particularly focusing on the study reach.

2.1 Wildcat Creek Setting

Wildcat Creek's headwaters are located in Wildcat Canyon near Vollmer Peak in the hills of Berkeley, California and its mouth is located in the San Pablo Bay, just west of the city of San Pablo and northwest of the city of Richmond. From headwaters to mouth, the creek drops approximately 1900 feet over the course of 13.5 miles and has a watershed of 8.8 square miles (Collins et al 2001). Beginning from its headwaters, the creek passes through the Tilden Regional Park – which includes passage through the Tilden Regional Park Golf Course, the Botanic Garden, a reservoir,² and a nature preserve³ that includes passage through both a working farm⁴ and a second reservoir.⁵ The creek then moves through Wildcat Regional Park, Alvarado Park, and finally into the heavily urbanized city areas of San Pablo and Richmond. In

¹ The lower Wildcat Creek study reach is essentially the Upper Alluvial area, as defined in Collins et al 2001 report, except that the study reach terminates at the west side of I-80. p 15 (Wildcat Sections, Segments and Reaches map). This report will refer to the study area as lower Wildcat Creek.

² Lake Anza.

³ The Tilden Nature Area.

⁴ The EBRPD's Little Farm.

⁵ Jewel Lake.

these areas, the creek passes through a double box culvert running under I-80,⁶ then through a double box culvert running under a parking lot,⁷ past the San Pablo Casino,⁸ the Doctors Medical Center,⁹ through the Vale street box culvert, past a football field, through the Church lane double box culvert, past a convalescent home, through the Van Ness culvert, through the 23rd street double box culvert, through the John Hubert Davis Park double box culvert, under the Rumrill boulevard double box culvert, under the Burlingon Northern-Santa Fe Railroad bridge, through the flood control channel and then through the Wildcat Creek fish ladder¹⁰ (Collins et al, 2001). After the fish ladder, the creek passes through a flood control sediment basin, then moves under the 3rd street bridge, through the Richmond Parkway culvert then, after passing through the Wildcat Marsh and Castro Slough, empties into the San Pablo Bay.

2.2 Historical Fisheries Information (1877 – Present)

There is no hard scientific evidence that corroborates claims of the presence of native rainbow trout in Wildcat Creek; however, anecdotal data do indicate the presence of at least one salmonid species. Specifically, in 1877 the “Sportsman’s Gazetteer and General Guide” included mention of Wildcat Creek.

Those who feel disposed to engage in the invigorating exercise of a good tramp before they cast their lines, should go over to Berkeley, and, taking the San Pablo road, walk over the hills to Wild-cat [sic] Creek, five miles from the University. They will find some excellent sport here.

Additionally, a 1915 publication of “Byways Around San Francisco Bay” provides evidence of trout.

We descend into the cañon [sic] by a well-marked trail, and the shade of the trees is most grateful after our walk in the sun. We follow downstream, where the speckled trout lie hid in the deep pools...

Based on the native presence of rainbow trout in neighboring stream systems, such as San Pablo creek, these “speckled” trout were probably native rainbow trout. However, there is no mention of a steelhead salmon run, but based on the lifecycle tendencies of the rainbow trout, there is a

⁶ The east side of the I-80 culvert is the upstream boundary of this paper’s study reach.

⁷ Under the shopping center parking lot located at 13220 San Pablo Avenue in San Pablo, California.

⁸ Located at 13255 San Pablo Avenue in San Pablo, California.

⁹ Located at 2000 Vale Road in San Pablo, California.

¹⁰ The west side of the Wildcat Creek fish ladder is the downstream border for this paper’s study reach.

high probability that a self-sustaining anadromous¹¹ population of steelhead did exist in the drainage.

Sometime after 1915, the native rainbow trout were extirpated from Wildcat Creek. The exact causes are unknown, but it is hypothesized that the rainbow trouts' population crash was caused by the construction of the dams that created the two Wildcat Canyon reservoirs,¹² in conjunction with increased regional urbanization.¹³ In 1977, and again in 1981, the California Department of Fish and Game (CDFG) conducted electroshocking surveys in the creek and did not find any rainbow trout (Leidy 2005).

In September of 1983, the EBRPD and public volunteers caught 615 native rainbow trout in Redwood Creek.¹⁴ These fish were transplanted into Wildcat Creek between Alvarado Park and the Botanic Garden in Tilden Park (P. Alexander, personal communication, June 1, 2005). Since their reintroduction, the trout have spread throughout the Wildcat Creek watershed and reestablished breeding populations. However, no upstream steelhead migration has been observed since the reintroduction of the rainbow trout; but, during infrequent surveys, sub adult and adult rainbow trout have been documented in the lower reaches of Wildcat Creek as early as 1997. Additionally, since 1984, the EBRPD has conducted annual¹⁵ electroshocking surveys to estimate the overall rainbow trout population and distribution in Wildcat Creek. These results are presented in Figure 1:

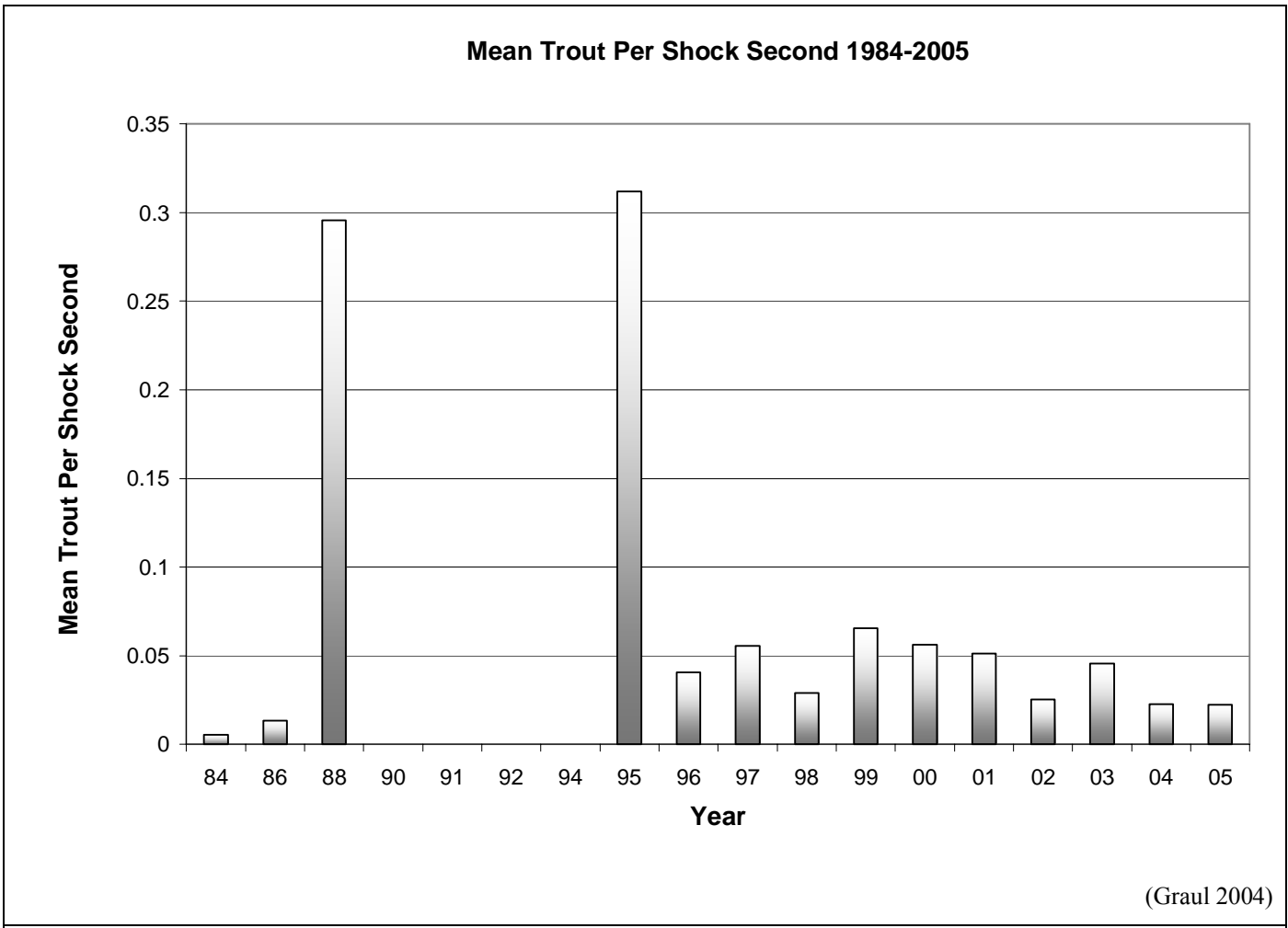
¹¹ Anadromous – (of fish) migrating from salt water to spawn in fresh water.

¹² Jewel Lake construction was completed in 1921 and Lake Anza construction was completed in 1938 (Collins et al p. 48-49).

¹³ Stream filling and heavy channelization in the cities of Richmond and San Pablo, California.

¹⁴ Redwood Creek flows through Redwood Regional Park, which is located in Oakland and San Leandro, California.

¹⁵ Except for the years 1989 through 1994.



(Graul 2004)

Figure 1. This graph shows the number of trout sampled per unit time of “electrical effort,” i.e. the quantity of electricity introduced into the water by the electroshocker over a period of time. This calculation essentially generates a density measurement of the fish. The years 1988 and 1995 are outliers and should not be factored into the overall assessment of the trout population throughout Wildcat Creek.

As of 2006, there are two reproducing native fish populations in Wildcat Creek: the reintroduced native rainbow trout (*Oncorhynchus mykiss*) and the three-spined stickleback (*Gasterosteus aculeatus*). The thriving stickleback have presumably been reproducing in the watershed since before the last existing steelhead run, which is a testament to their ability to exist under adverse conditions. In fact, the stickleback population is quite abundant with distribution throughout Wildcat Creek and many of its tributaries. On average, female adults are approximately 50 millimeters in length, with males being slightly smaller. Their relatively small size, ability to spawn multiple times¹⁶ during a single year, and their high fecundity likely helped them survive during the period when the rainbow trout were extirpated. Additionally, their three dorsal spines

¹⁶ A female can deposit between 50 and 300 eggs per spawn (Moyle 1976).

act as an effective natural defense mechanism and assist the stickleback in fending off trout and aggressive non-native fish in the watershed. Most adults do not typically survive to a second spawning season, but due to their high fecundity, resulting robust population numbers and the fact that they are able to fulfill their entire lifecycle within relatively small geographical areas, the EBRPD is confident that the stickleback population is in no danger of significant population decline.

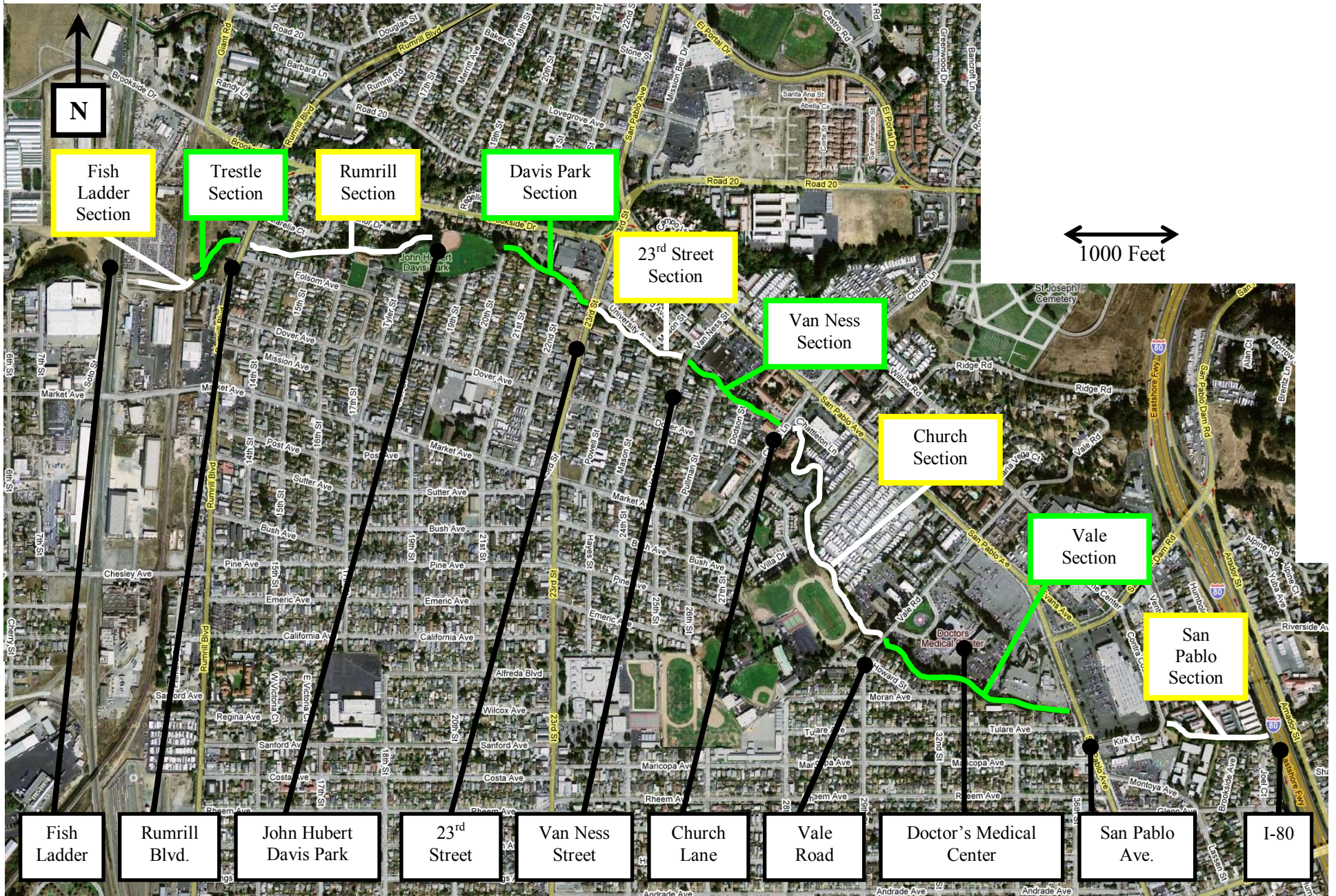
The native rainbow trout occupy most reaches of Wildcat Creek, though their populations are more robust in the mid and upper reaches of the main stem. The population is largely dependent on deep over-summering pools to survive the warm, dry summers. In especially dry years, the overall population numbers have historically decreased due to reduced habitat availability. Additionally, areas of the creek that provide over-summering pools can vary greatly from year to year. This is predominantly due to Wildcat Canyon's easily erodible soils. Specifically, during the rainy season from November through May, a large quantity of sediment is washed into Wildcat Creek. This sediment largely determines the presence or absence of over-summering pools. A pool may be very deep one year but in the next almost entirely filled with sediment. In the following year the pool may again be scoured out and restored to a viable over-summering pool. The native rainbow trout have adapted to this unpredictable habitat and, while localized population decimation may take place as a result of varying degrees of contamination, (spills, etc.), no significant population decline has been observed since the species was restored to the creek in 1983. Fish and invertebrate populations that do experience localized decimation typically recover within 1-2 years as a result of movement of individuals from upstream populations.

3.0 HABITAT ASSESSMENT METHODS

The goal of this fisheries habitat assessment was to determine the current number and distribution of rainbow trout in the study reach and to define biotic and abiotic factors that affect the trouts' utilization of the habitat. Additionally, this assessment was conducted with particular attention devoted toward the quantification of instream migrational barriers that prevent the rainbow trout/steelhead from freely negotiating the study reach.

The study reach encompassed the area from the west end of the Wildcat Creek fish ladder to the west end of the I-80 double box culvert. The study reach was then subdivided into nine separate sections and are nearly identical to those outlined in Figure 20 of Collins et al., 2001. The only substantial difference between the section demarcations involved the Trestle section. Specifically, in this study the Trestle section did not begin at the Burlington Northern-Santa Fe Railroad Trestle bridge but rather approximately 100 feet northeast at the first canopy cover in the study reach. It was determined that the area from the upstream end of the fish ladder to the first canopy cover was an entirely different habitat type and was consequently surveyed as a single unit, called 'Fish Ladder'. All sections were named according to their downstream border and then ran upstream until the next section's downstream border. For example, the Church section was labeled such because the downstream border was Church lane. The Church section then ran upstream until it intersected the next border, which in this example is the upstream side of the Vale road culvert. The Vale section then started at the upstream side of the Vale road culvert. To prevent confusion, it is important to note that the downstream border determines the name of the section, but that the structure itself is not in that reach. Consequently, the Vale culvert is in the Church section and not the Vale section. Figure 2 clarifies how sections were broken up for this study:

Figure 2. Lower Wildcat Creek Study Reach in the Cities of Richmond and San Pablo, California



3.1 Techniques utilized

Overview

The entire habitat assessment was conducted from May 12 through October 16, 2005. During that interval, two separate electroshock surveys were accomplished: the first was in late spring/early summer from May 12 to June 28, 2005.¹⁷ This time period will be referred to as the Early Summer survey. The second electroshock survey was conducted in late summer/early fall from August 29 to October 16, 2005.¹⁸ This time period will be referred to as the Late Summer survey. The Early Summer survey assessed the magnitude and distribution of both the fisheries resources and total wetted area prior to the summer drought. The Late Summer survey assessed the available wetted habitat during the driest period of the year, which provided a worst-case scenario for the available trout habitat.

Electroshocking Methodology

The rainbow trout population electroshocking survey methodology is the standardized *in situ* process utilized by the EBRPD on any stream. The fisheries department intentionally utilized the same techniques for this study so as to enable the comparison of previous EBRPD rainbow trout survey data collected elsewhere in the Wildcat Creek watershed to the data collected for this project.

A two or three-person team was used to conduct the successful electroshocking survey of the study reach beginning at the most downstream portion of the Wildcat Creek fish ladder and working upstream to the west side of the I-80 culvert. One biologist wore a backpack Smith-Root 12-B POW electrofisher¹⁹ – a device that generates electrical current, which is used to stun fish. The second and third biologists used nets to quickly retrieve any stunned fish from the creek and place them in temporary holding buckets. After a stream section²⁰ was shocked, the team collected and recorded specific data on each fish. Specifically, the fish were individually placed on a measuring board and their fork length (in millimeters) was recorded in a field notebook. After being measured, they were individually placed upon a digital scale and

¹⁷ The actual survey dates were as follows: 5/12, 5/27, 5/31, 6/3, 6/7, 6/10, 6/14, 6/22, 6/24, and 6/28/2005.

¹⁸ The actual survey dates were as follows: 8/22, 8/25, 8/29, 9/13, 9/15, and 10/16/2005.

¹⁹ This paper will refer to this device as the “electroshocker” or “shocker.”

²⁰ Here, “section” refers to subunits within one of the nine stream sections. Each subunit was determined by natural barriers in the creek that would largely prevent trout from moving from an unsurveyed to a surveyed subunit.

weighed; these data were then recorded (in grams). Each individual was given a cursory external examination for indicators of health problems, such as lesions or parasites. Finally, the native fish were returned to the creek in the survey section where they were caught and non-native species were removed from the creek.

After inventorying the fish, the shock seconds²¹ from the electroshocker were recorded in the field notebook. Additionally, at each survey site, a measuring tape was used to record the creek's length and width. A meter stick was used to measure the average and maximum stream depths. Dissolved oxygen and temperature were recorded using a YSI 55 Dissolved Oxygen unit while turbidity and canopy cover were visually estimated. It should be noted that the length measurements for the entire reach lack the accuracy of an engineering survey due to the fact that the metric devices employed were not as precise. However, deviations from absolute values were consistent through the project because the same metric devices were used by the same individuals. Though these length values may stray from absolute exact values, they are more than sufficient to convey relative results throughout the study reach.

Environmental Protection Agency's (EPA) Rapid Bioassessment Methodology

During a portion of the Late Summer survey, August 22 – August 29, 2005,²² the EPA Rapid Bioassessment Protocols for Use in Low Gradient Streams were utilized to further examine the lower Wildcat Creek study reach. These protocols were used because they are cost effective, provide a systematic methodology for assessing a variety of biotic and abiotic characteristics in lotic systems and generate enumerated qualitative results that allow for comparisons within or between watersheds. Rapid Bioassessment is achieved by examining specific environmental characteristics and scoring them against predefined criteria. Additionally, throughout the study period, and particularly during the rapid bioassessment survey, potential trout migration obstacles were identified and assessed for passability.

To successfully conduct the Rapid Bioassessment, two biologists walked the length of the study reach and used a pen, clipboard and EPA data sheets entitled "Habitat Assessment Field Data

²¹ Shock seconds are the total number of seconds that electric current was being generated by the electroshocker.

²² The actual survey dates were as follows: 8/22, 8/25, and 8/29, 2005.

Sheet – Low Gradient Streams” to assess a variety of pre-defined habitat characteristics: Epifaunal Substrate, Pool Substrate, Pool Variability, Sediment Deposition, Channel Flow Status, Channel Alteration, Channel Sinuosity, Bank Stability, Vegetative Protection and the Riparian Vegetative Zone Width (Barbour et al 1999).

Pebble Counts

In late July and early August,²³ between the Early and Late Summer surveys, pebble counts and sediment analyses were conducted in the Vale section. To successfully conduct the pebble counts, two biologists laid twenty-two transects – each one nine feet in length – across the gravel bed. Every 1.8 feet along each transect, a particle was assessed. If the particle was large enough and not too embedded, it was picked up and a ruler was used to measure its intermediate axis.²⁴ Based on the length of the particle’s intermediate axis, it was then placed into a pre-determined sediment category on the “Pebble Count Form” (Harris 2005).

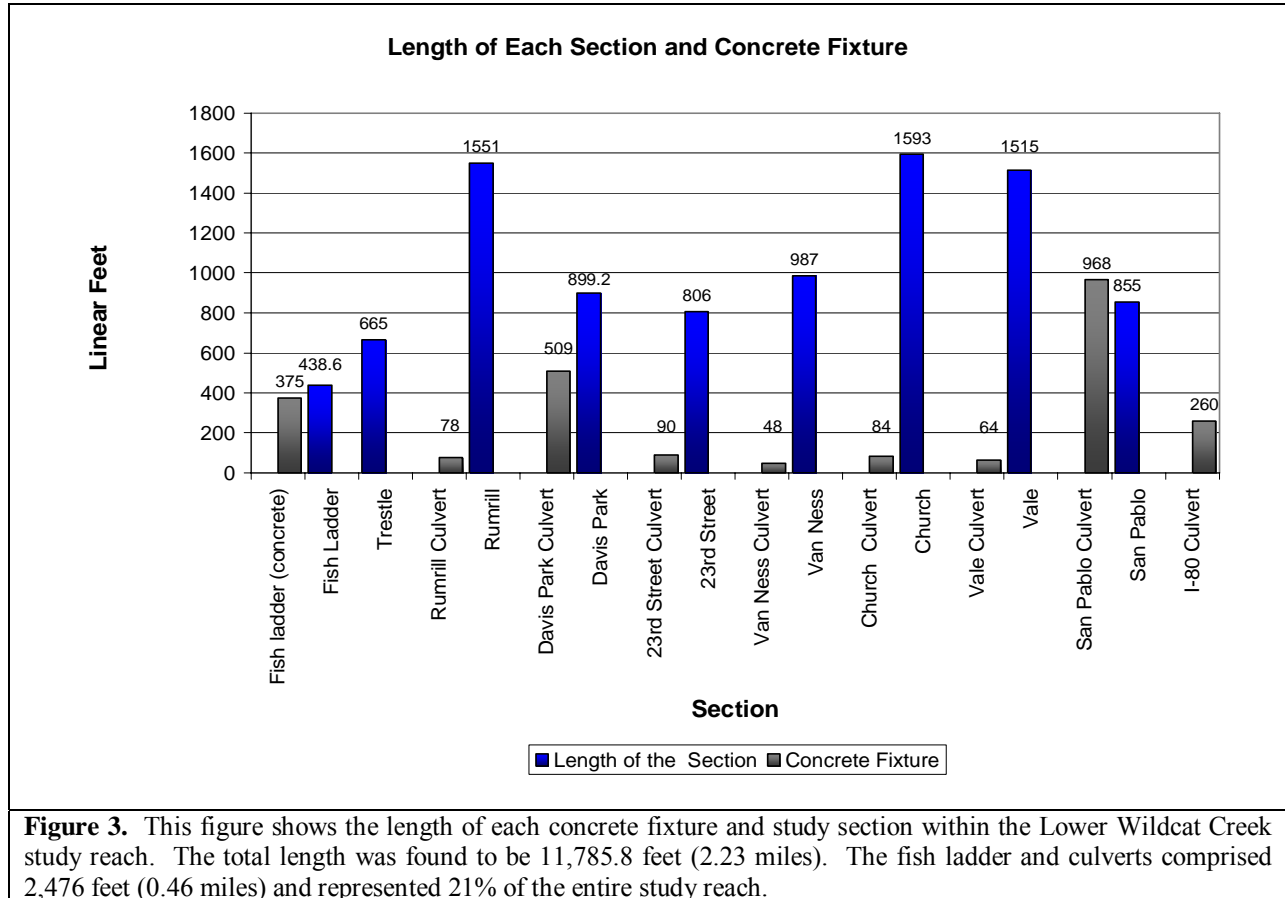
²³ The actual survey dates were as follows 7/26, 7/29 and 8/1/2005.

²⁴ The intermediate axis is the middle-sized axis on a three dimensional stone. For example, on a flat, oval stone, the shortest axis would be the thickness and the longest axis would be the length. Width would be the intermediate axis.

4.0 FISHERIES SURVEY RESULTS

Abiotic Results

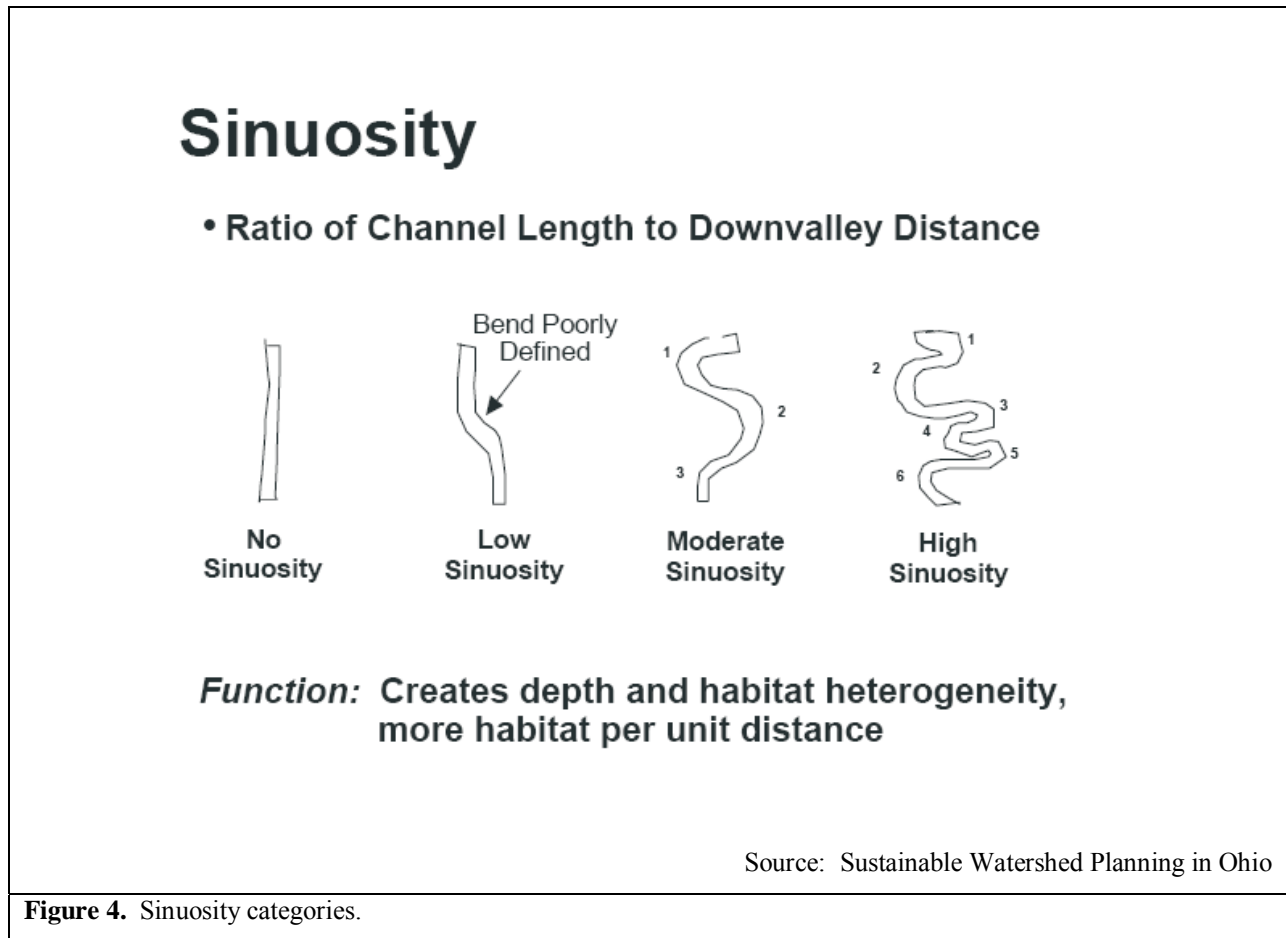
The entire lower Wildcat Creek study area was measured in linear feet using a pull tape. These results are presented in Figure 3:



Knowing the length of each section is critical because it allows all calculations to be weighted based on the quantity of linear feet available in a given section. Additionally, the lengths of the concrete fixtures were used to assess passability for the native rainbow trout. Together, the fish ladder and culverts comprised 2,476 feet (0.46 miles) and represented 21% of the entire study reach. It was estimated that upward of 80%²⁵ of the entire study reach had been subjected to channelization in the form of concrete/sacrete, gabion, or metal walls along the riparian corridor.

²⁵ An exact percentage is attainable, but beyond the scope of this project.

Due to the high magnitude of channelization, lower Wildcat Creek has reduced sinuosity.²⁶ The higher a stream's sinuosity rating the greater the stream length to straight-line distance. Sinuosity creates more habitat heterogeneity and often positively correlates to increases in macroinvertebrate populations. The more heterogeneous the habitat types, the more opportunity there is for variety in biological colonization. This creates more biological diversity and facilitates a richer ecosystem. Additionally, sinuosity typically results in a decrease of overall water velocity. Sinuosity ratings are presented in Figure 4:

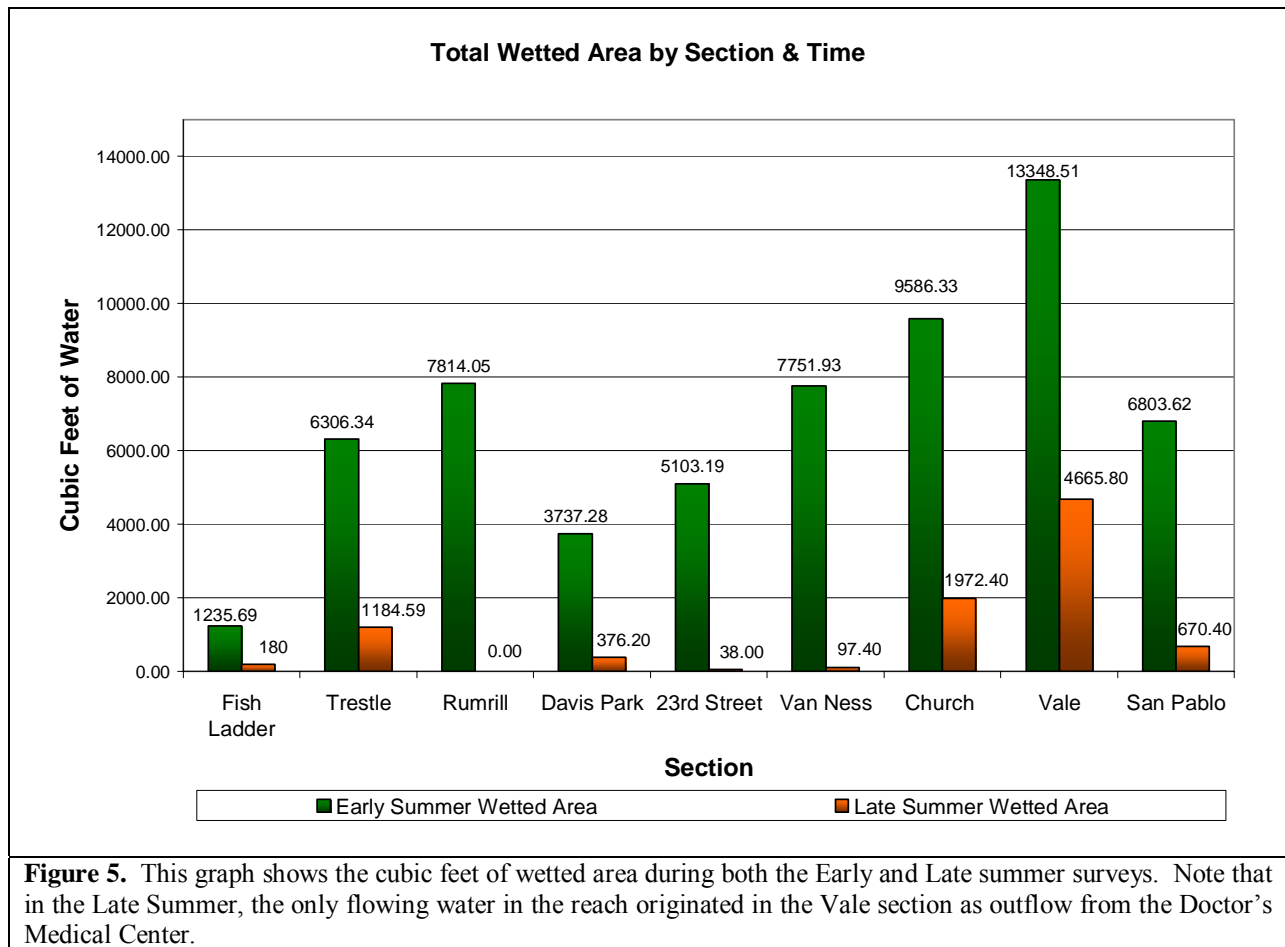


²⁶ Sinuosity is the ratio of channel length to downvalley distance, which is the reach length/straight line distance (Sustainable Watershed Planning in Ohio, no date).

The sinuosity findings for Wildcat Creek are presented in Table 1:

Table 1. Sinuosity of Each Section	
Section	Degree of Sinuosity
Fish Ladder	None
Trestle	None
Rumrill	Low
Davis Park	None
23 rd Street	Low
Van Ness	Low
Church	Moderate
Vale	Low
San Pablo	Low

The Early Summer habitat assessment found the entire length of the study reach to be a contiguous wetted area, with water flowing freely through the reach. Conversely, the Late Summer habitat assessment found the study reach to be largely dry with no naturally flowing water. The wetted area for both the Early and Late Summer surveys was calculated based on the *in situ* measurements of length, width and average depth of each study section. These results are presented in Figure 5:



Between the Early and Late Summer surveys, the wetted area decreased by 85%. These results are presented in Figure 6:

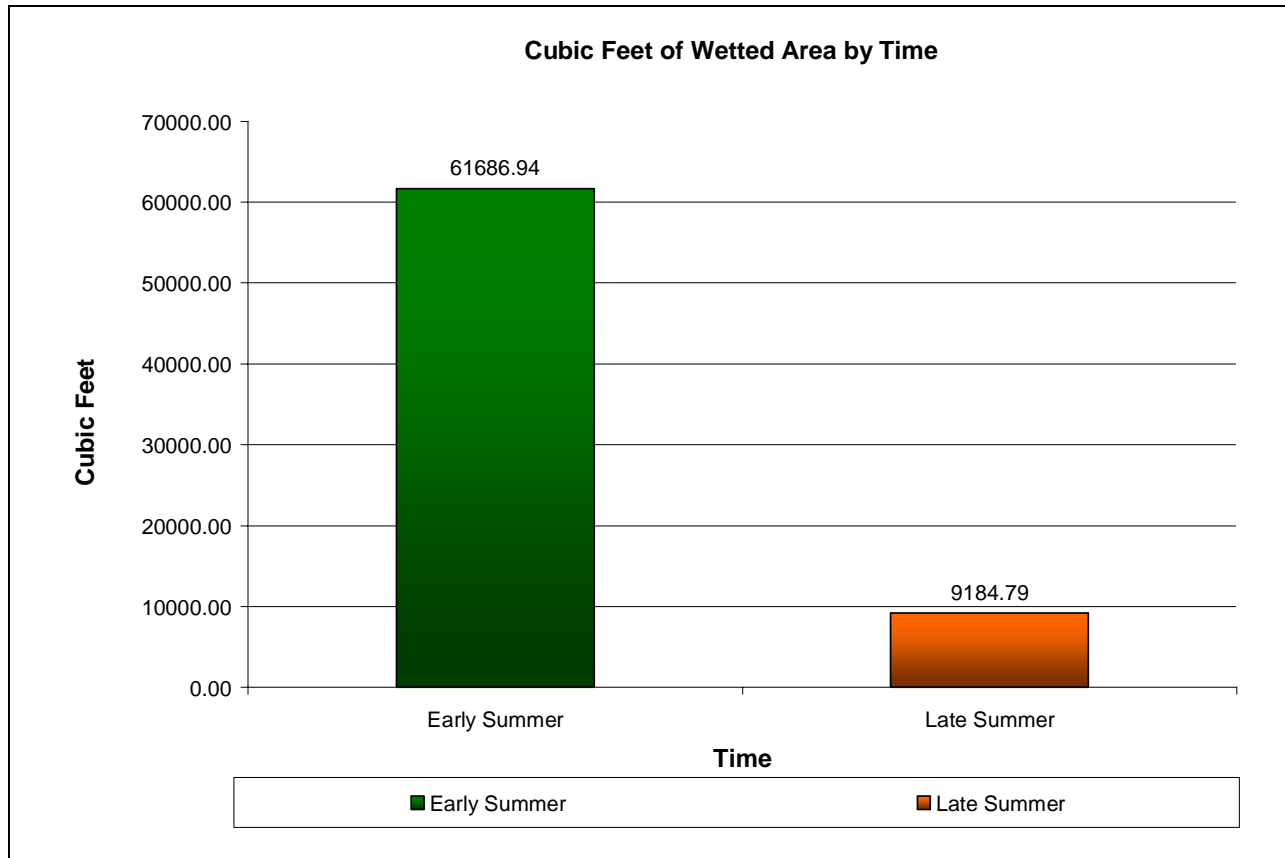


Figure 6. This graph shows the change in cubic feet of wetted area from Early to Late Summer. The overall wetted area decreased by 85%. In gallons,²⁷ the Early Summer value is approximately 461,450 gallons and the Late Summer value is approximately 68,700 gallons, which is a decrease of approximately 392,700 gallons.

The overall decrease in wetted area resulted in significant fragmentation of the study reach's trout habitat by drying up entire creek sections and geographically isolating formerly continuous habitat. The majority of remaining water in the study reach was in the form of standing pools, which became the trouts' over-summering pools.

A significant artificial water source was observed during both the Early and Late summer surveys. Located on the left bank, approximately 530 feet upstream of the Vale culvert, a pipe originating from the San Pablo Campus of the Doctor's Medical Center (DMC)²⁸ spilled water into lower Wildcat Creek with an average outflow of approximately 0.45 gallons per second.²⁹ The pipe outflow was observed on every occasion the survey team was in the Vale section;

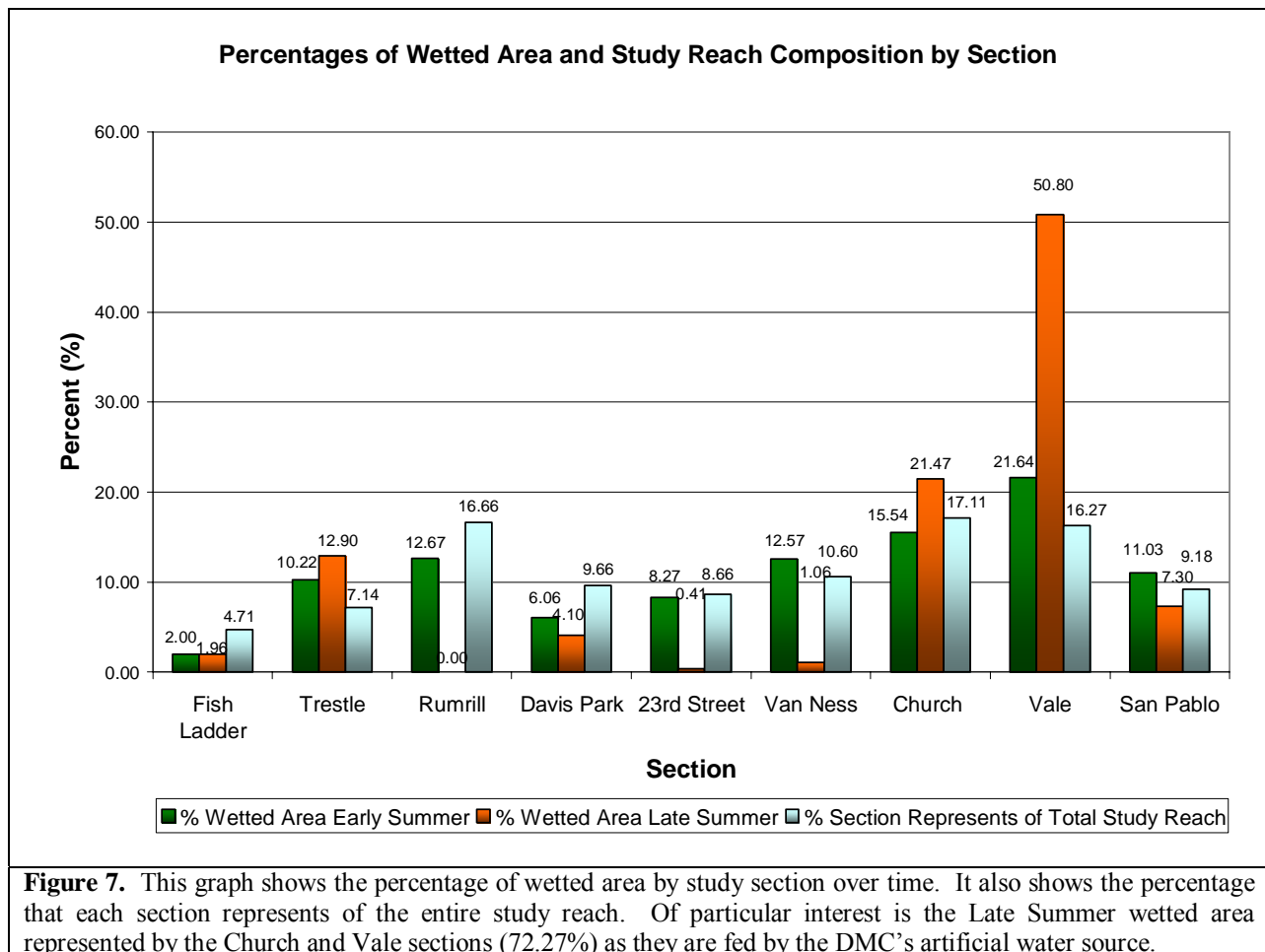
²⁷ One U.S. Gallon = 0.133680556 cubic feet.

²⁸ Formerly known as the Brookside Hospital. Located at 2000 Vale Road in San Pablo, California.

²⁹ On 10/16/2005, The Doctor's Medical Center outflow was measured using a bucket and stopwatch. Three measurements were taken and the values were averaged to generate the flow rate.

however, it is unknown whether the discharge rate changed over time because it was measured on only one occasion. According to Jerry Gordon, the chief engineer for the DMC, the hospital legally pours well water into the creek (Personal communication, 6/15/2006). The exact utility of the water to the DMC is unclear, but nonetheless, this outflow generated the only perennial flow in the study reach and was a significant source of water for the native rainbow trout and other stream biota in the Vale section and the most upstream portion of the Church section.

The Church and Vale sections comprised 33.38% of the entire length of the study reach and, in the Early Summer, they combined to account for 37.18% of the water in the study reach. However, by Late Summer, Vale alone accounted for 50.80% of the total water remaining in the study reach while Church accounted for 21.47%. Though the Church and Vale sections represented just over one-third of the entire study reach (33.38% of the total distance of the reach), they combined to account for 72.27% of the total remaining water in the Late Summer. These results are presented in Figure 7:



Furthermore, the percentage decrease in wetted area between the Early and Late Summer periods was smallest for the Church and Vale sections, with Vale being the wettest area in the study reach in the Late Summer. These results are presented in Figure 8:

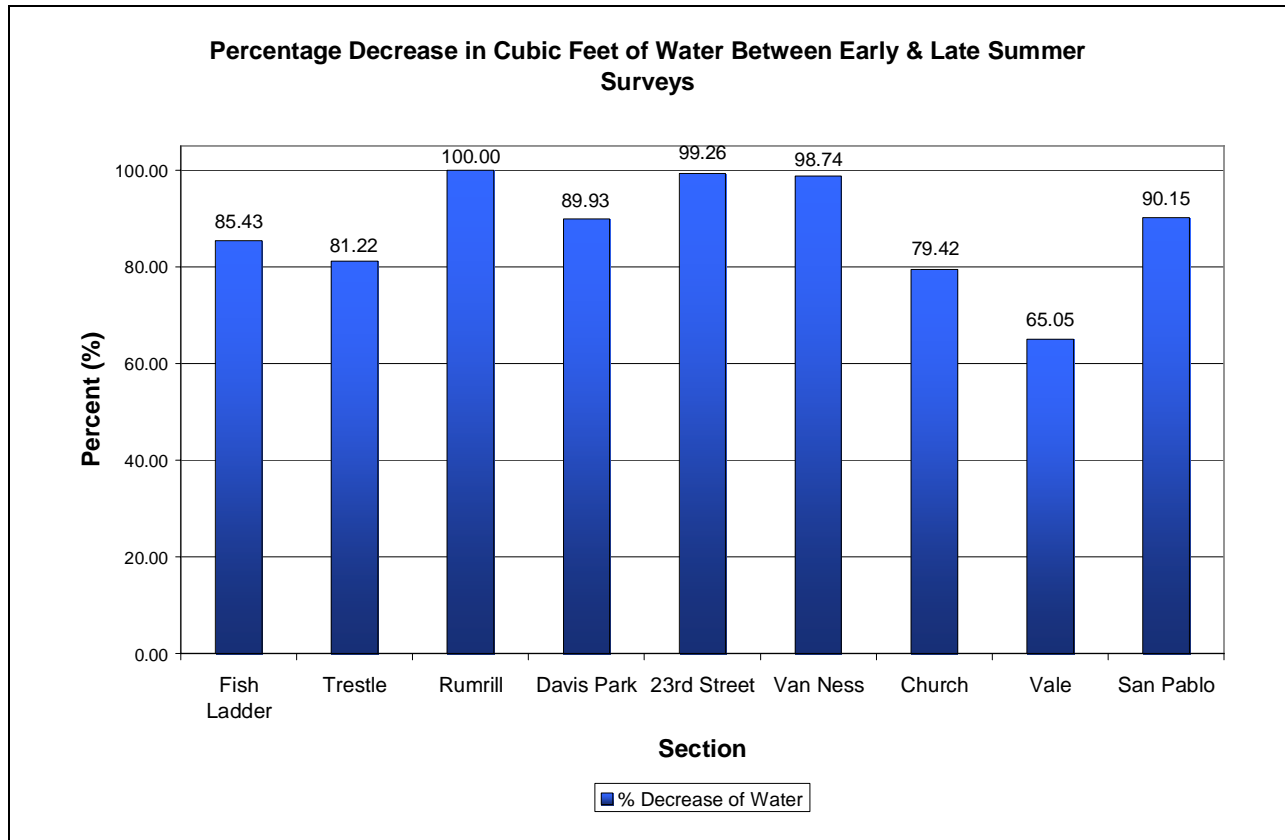


Figure 8. This graph shows the overall percent decrease of cubic water in each study section between the Early and Late Summer surveys. A decrease of 100% means that the section was entirely dry when surveyed in the Late Summer. The DMC outflow, located in the Vale section, is the primary reason for Vale having the smallest decrease between the Early and Late Summer surveys. The DMC’s outflow may have also contributed to the Church section’s reduced decline and certainly provided some water to the upstream portion of the Church section.

In the Late Summer survey, Vale was the only section of the creek that maintained any flowing water, but this was due to the DMC outflow. Based on the section’s topography, if the DMC outflow were to stop, the reach would probably contain several viable trout pools, but not of the number or quality that it currently provides. In fact, without the outflow, it is likely that Vale would mimic the rest of the study reach and experience at least an 80% reduction in wetted area, which would be an additional reduction of approximately 6000 cubic feet (approximately 44,900 gallons) of water.

In the Early Summer, every riffle, pool and glide³⁰ in the study reach was measured. The composition of lower Wildcat Creek’s riffle, pool and glide habitat units are presented in Figure 9:

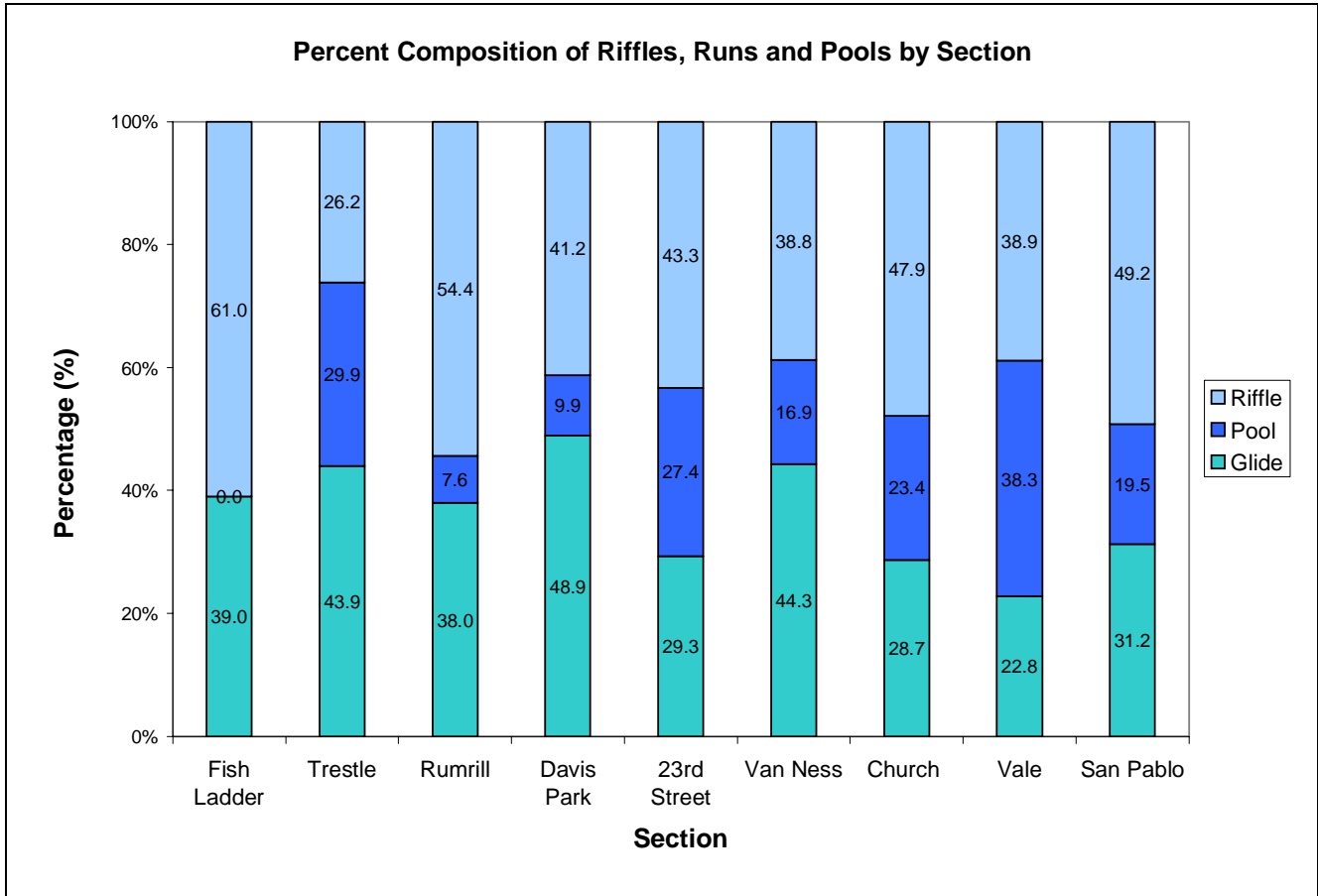


Figure 9. This graph shows the stream composition of each section of the study reach as cataloged during the Early Summer survey. A stream is typically considered to have “good” habitat when it has alternating habitat units distributed throughout its reach and a pool to riffle ratio of approximately 1:1.

Breaking out the physical characteristics of a creek’s various habitat units is instructive because steelhead and rainbow trout require all three stream components at various periods in their lifecycle. For example, pools typically provide resting areas, cover and, due to reduced velocity, a location for fine sediments to settle out. Riffles and glides are typically where spawning activity and early alevin and fry development take place (Hagar 2002). Riffles are also the most productive habitat unit for macroinvertebrates, which comprise a significant portion of the rainbow trout diet. Additionally, continuous and varied units are necessary because they enable

³⁰ Riffle = rough water where ripples are visible on the surface. Pool = a substantially deeper body of water, which, in the Late Summer survey, was considered anything with depth equal to or exceeding 1 foot. Pools were estimated during the Early Summer survey as the creek was still flowing. Glide = slow moving, non-rippling water.

fish to traverse their habitat, move throughout the creek and seek out habitat that will fulfill a given life stage. This mobility is also essential to a population because it allows the fish flexibility in their survival strategies; that is, individuals are able to respond to increases in predation, competition, disturbance, etc. in one area of the creek by moving to other areas where there are fewer environmental pressures.

A stream is typically considered to have “good” habitat when it has alternating habitat units distributed throughout its reach and a pool to riffle ratio of approximately 1:1.³¹ The composition of lower Wildcat Creek’s habitat units are presented in Figure 10:

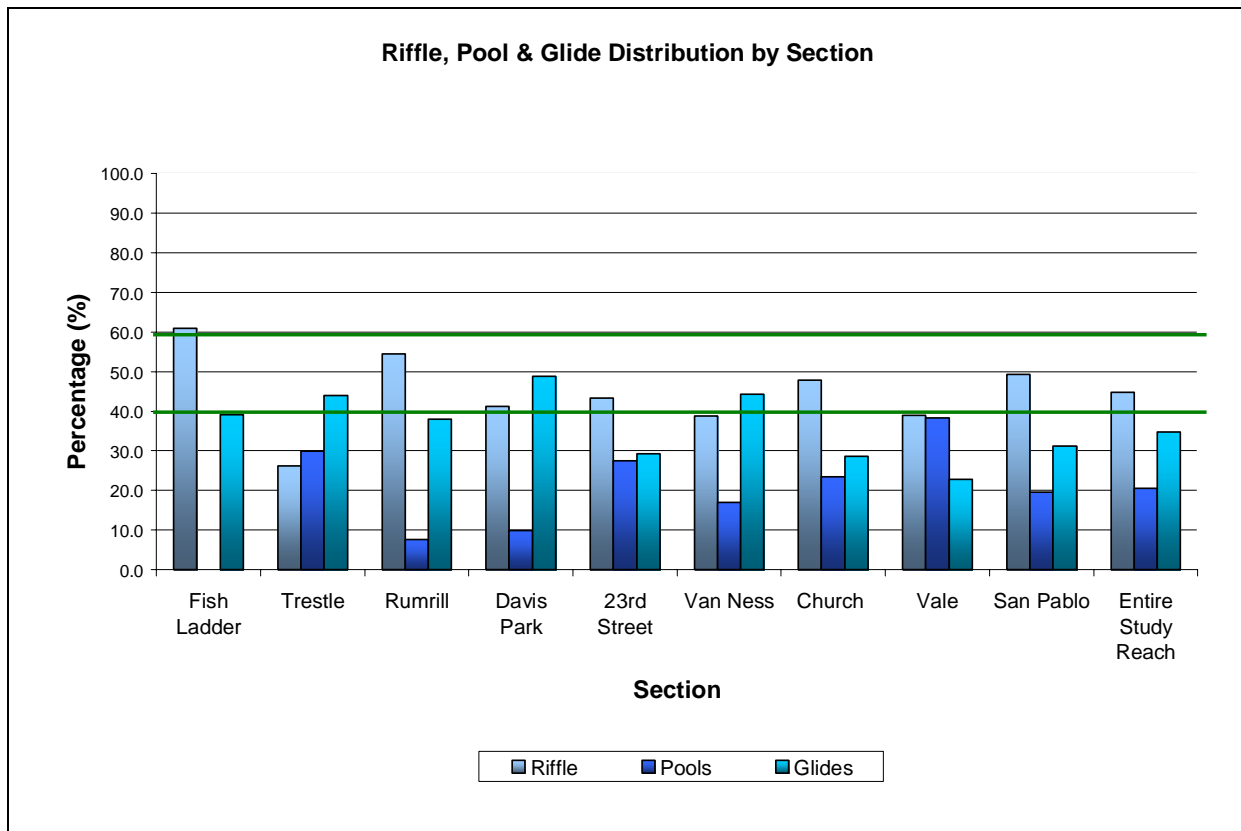
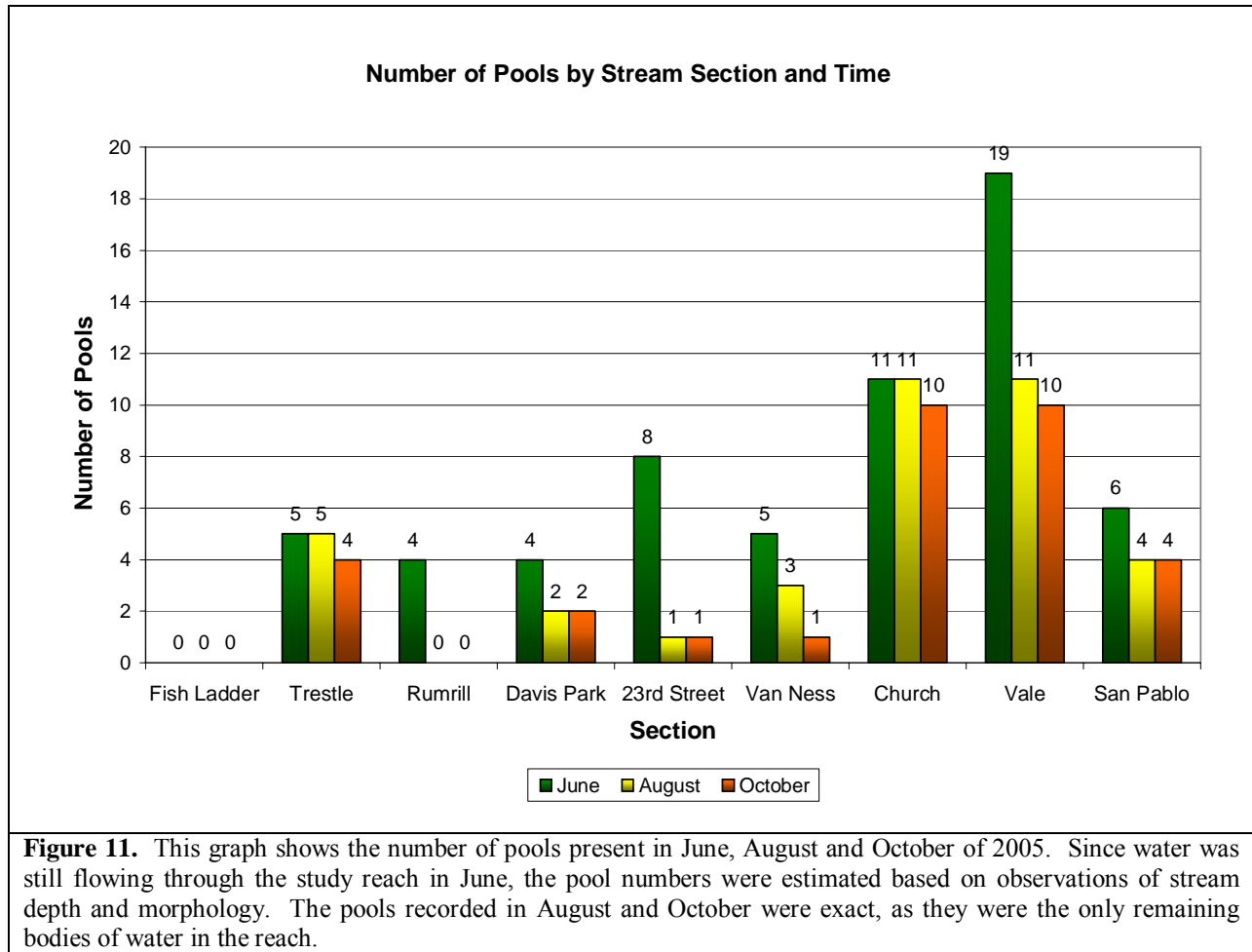


Figure 10. This graph shows the stream composition of each section of the study reach as observed during the Early Summer survey. A 1:1 riffle-to-pool ratio is considered optimal. Additionally, riffle and pool habitat should make up between 40 and 60 percent of the habitat under optimal conditions; this range is illustrated in the above figure by green lines. This figure also shows the entire study reach’s overall habitat unit composition, and while the reach had a good percentage of riffles, it was only comprised of 20% pools.

³¹ A suggested optimal ratio of pool to riffle habitat is 1:1, suggesting that 40-60% by area for each habitat type is a target condition (Rush et al 2000).

As shown in Figure 10, during the Early Summer survey, all the sections except the Fish Ladder showed riffle, glide, and pool variability, but out of the nine sections, only Trestle (0.87) and Vale (1.02) were near the optimal riffle to pool ratio of 1:1. However, despite having a fair riffle to pool ratio, Trestle's riffles and pools comprised 26.2% and 29.9%, respectively, below the 40% optimal condition threshold. Consequently, Trestle's good riffle to pool ratio is outweighed by its large percentage of glide habitat. However, Vale's riffles and pools comprised 38.9% and 38.3%, respectively, barely below the optimal condition threshold. Overall, the entire study reach had a riffle to pool ratio of 2.17, which is considered sub par from a biological productivity perspective and while its riffle habitat was in the optimal range, the pool habitat was 19% shy of the optimal condition threshold.

In the Late Summer survey, the artificial outflow from the DMC generated sufficient flow to create a single glide in the Vale section but, that anomaly aside, the entire study reach was either dry or consisted of a series of pools separated by stretches of dry creek bed: there were no riffles or glides, thereby creating the worst possible riffle to pool ratio – zero – for the entire study reach. Because these over-summering pools are critical habitat for all age classes of trout during the dry summer and early falls months, the pools were counted at three different temporal intervals: June, August and October of 2005. The results of these inventories are presented in Figure 11:



In June, the Church and Vale sections combined for 48.4% of all the pools in the study reach. By August, they combined for 59.5% of the pools, and by October they combined for 62.5% of the remaining pools in the study reach.

Water quality parameter spot data (dissolved oxygen, temperature, and turbidity) were collected using a handheld dissolved oxygen meter during the Early and Late Summer surveys. In the Early Summer survey, all parameters were within the normal range and were found to be conducive for the survival of rainbow trout. Specifically, the average water temperature was 18.13 degrees Celsius³² with a standard deviation of 1.79. The average dissolved oxygen for the

³² The optimum temperature for rainbow/steelhead growth is 15 degrees Celsius. Trout die when water temperature exceeds 25 °C (Summerfelt, No Date). The general rule of thumb for salmonids is that water temperature in excess of 20 °C is suboptimal.

study reach was 9.9 mg/l³³ with a standard deviation of 1.88. Turbidity was very low – clear throughout most of the reach. However, in the Late Summer survey the overall water quality had changed substantially and varied between summer pools. Average water temperature was 17.21 degrees Celsius with a standard deviation of 2.34. This result is a bit unusual because one would expect that the average water temperature would increase, not decrease, as water evaporated out of the study reach.³⁴ Furthermore, turbidity increased in many pools through the reach as they turned stagnant and/or became occluded with algae. Dissolved oxygen results are presented in Figure 12:

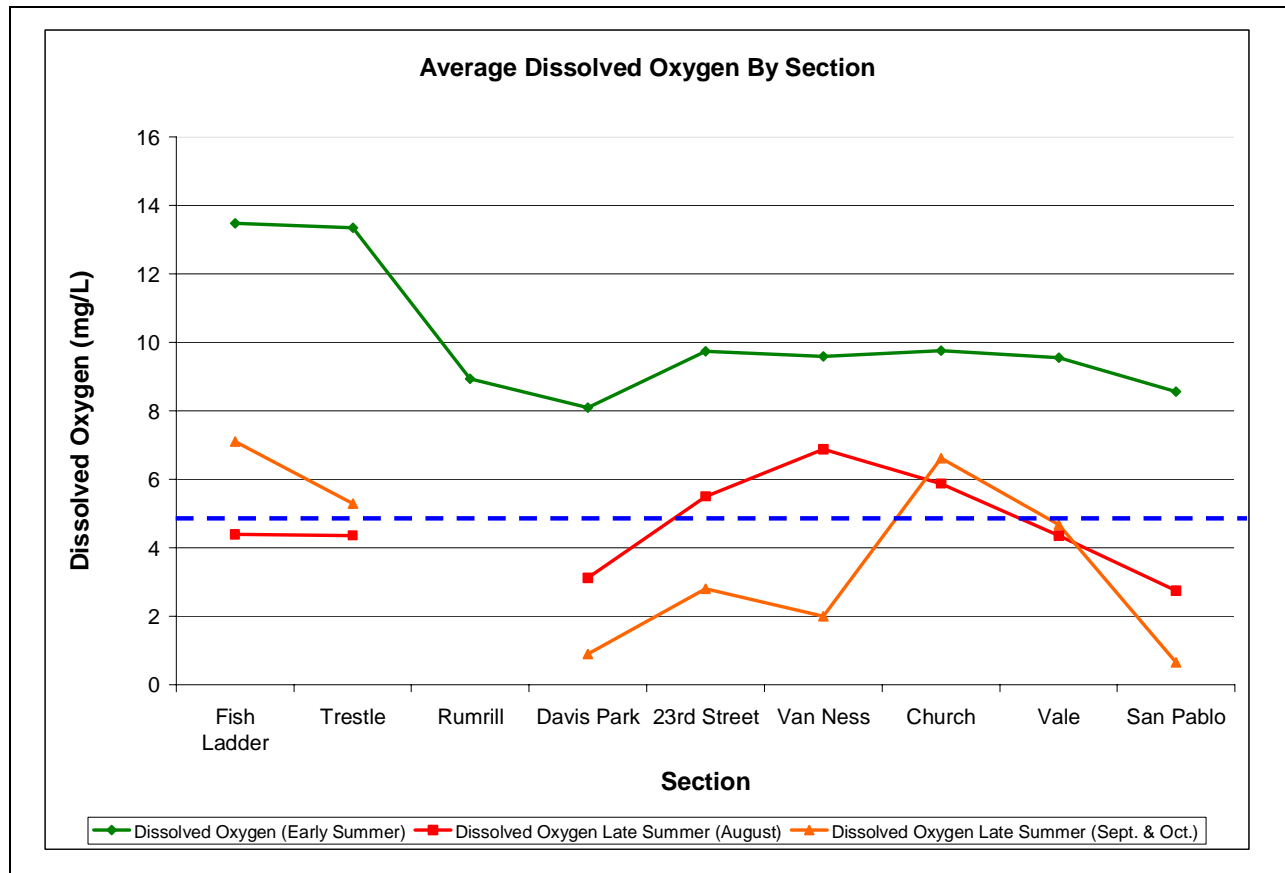


Figure 12. This graph shows the dissolved oxygen trends for each section during the Early and Late Summer surveys. The August, September and October measurements fall into the Late Summer Survey. The Rumrill section was completely dry during the Late Summer survey and consequently had no data values for dissolved oxygen. Standing pools of water, as found in the Late Summer survey are much more likely to have reduced levels of dissolved oxygen than freely flowing water because dissolved oxygen is a function of surface area and flat, standing water has less surface area for the diffusion of oxygen. Additionally, standing pools can be subjected to eutrophication by bacteria and algae, thereby resulting in decreased levels of dissolved oxygen and even reach anoxic levels. The dashed blue line represents the minimum dissolved oxygen (5 mg/l) that rainbow trout require for survival.

³³ At the temperature optimum for rainbow/steelhead growth (15°C), healthy salmonids become stressed when dissolved oxygen levels drop below 5mg/l. Mortality may begin around 3 mg/l. The general rule of thumb for salmonids is that any dissolved oxygen concentration below 5mg/l is considered suboptimal (Summerfelt, No Date).

³⁴ This kind of discrepancy is expected when dealing with spot data because sampling bias is more apparent in smaller sample sizes.

Furthermore, spot temperature data were collected in the Early and Late Summer surveys. These results are presented in Figure 13:

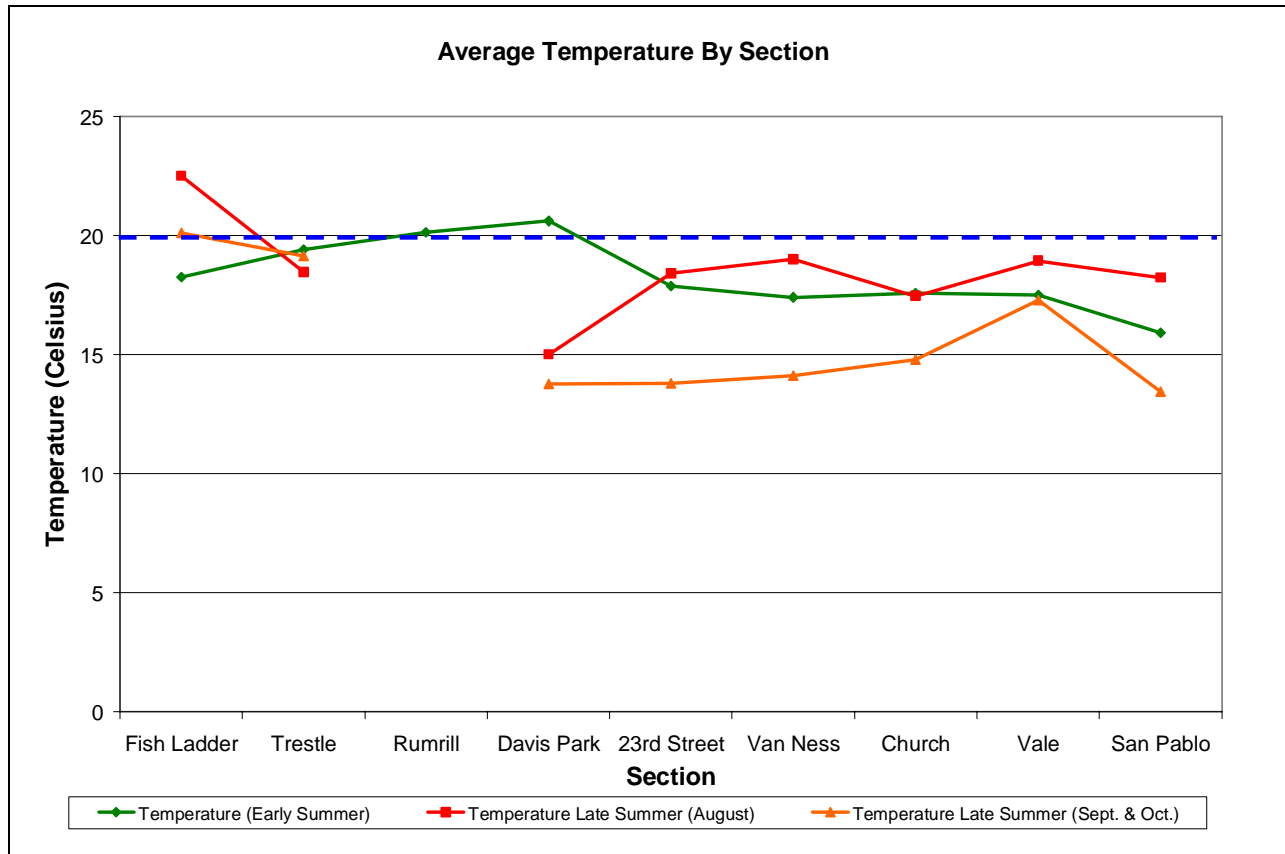


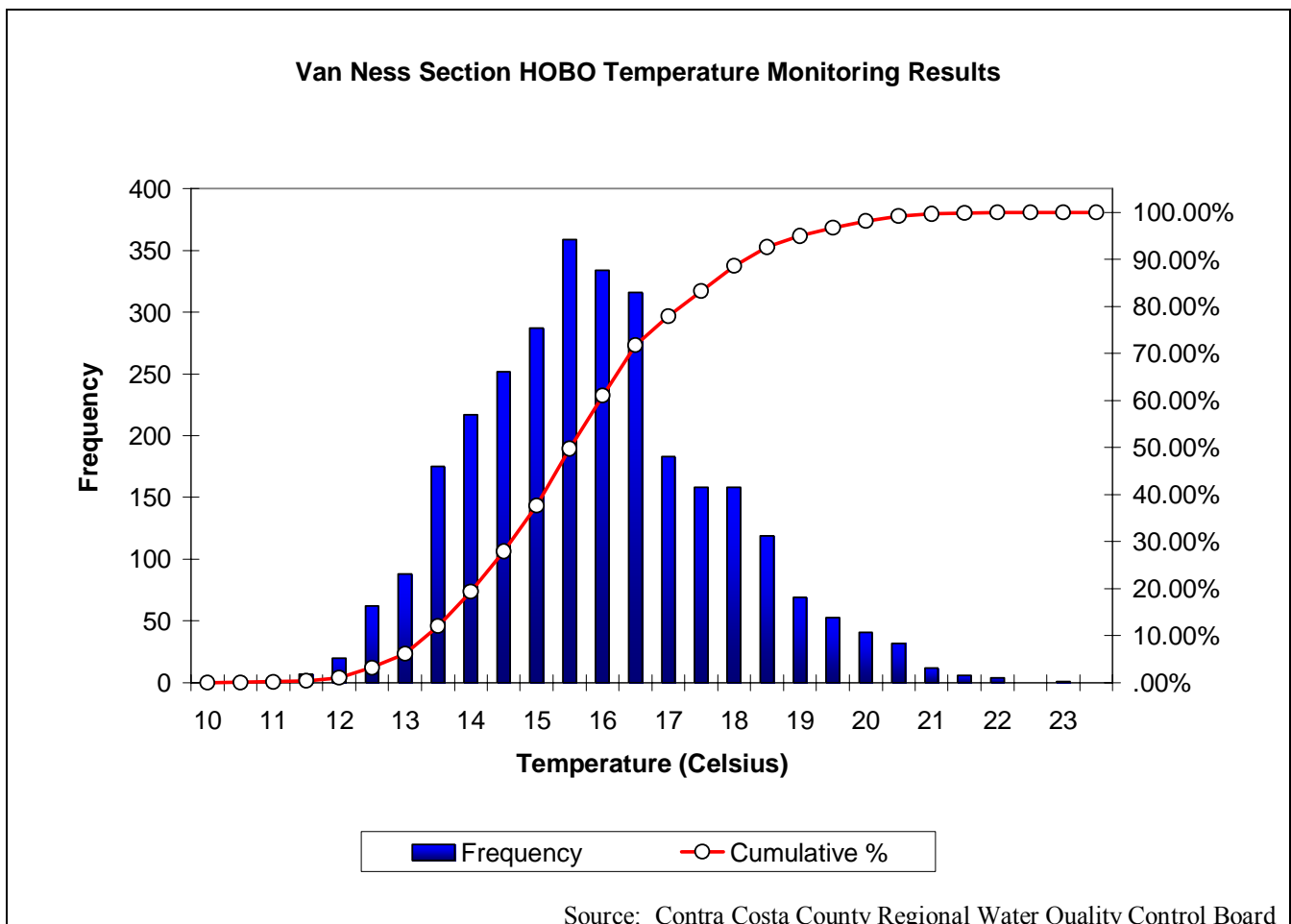
Figure 13. This graph shows the average temperature per section in the study reach. The dashed blue line indicates the 20°C threshold for rainbow trout. Specifically, temperatures under 20°C are adequate for rainbow trout, but as temperatures climb higher they stress the fish. Mortality begins occurring at 25°C. There were no pools in the Rumrill section during the Late Summer survey, so no temperature data were collected.

In the Early Summer survey the average water temperatures dipped above the 20 degree Celsius threshold in the Rumrill and Davis Park sections but since water was still flowing freely throughout the reach, trout could seek other habitat. The higher temperatures in the Fish Ladder section during both of the Late Summer surveys were expected since the water was free standing and there was no canopy cover to block direct sunlight.

Additional temperature data were collected in the study reach. In direct contrast to the spot data collected throughout the study, HOBO water temperature recorders were setup to constantly record water temperature at two locations in the study reach. The advantage of continual

monitoring versus spot data monitoring cannot be overstated. For example, some of the spot data were collected in the morning when water temperatures in the reach are typically lower. Consequently, data confirming that a specific pool was above the 20 degree Celsius threshold would not be collected. HOBO monitors would have all the temperature throughout the day, for every day as long as the study ran.

The first HOBO was placed in the Van Ness section³⁵ and the second in the Vale section.³⁶ Deep pools were chosen with the intent of having water present throughout the dry season. Data were collected continuously from 6/30/2005 through 10/31/2005. The Van Ness HOBO results are presented in Figure 14:



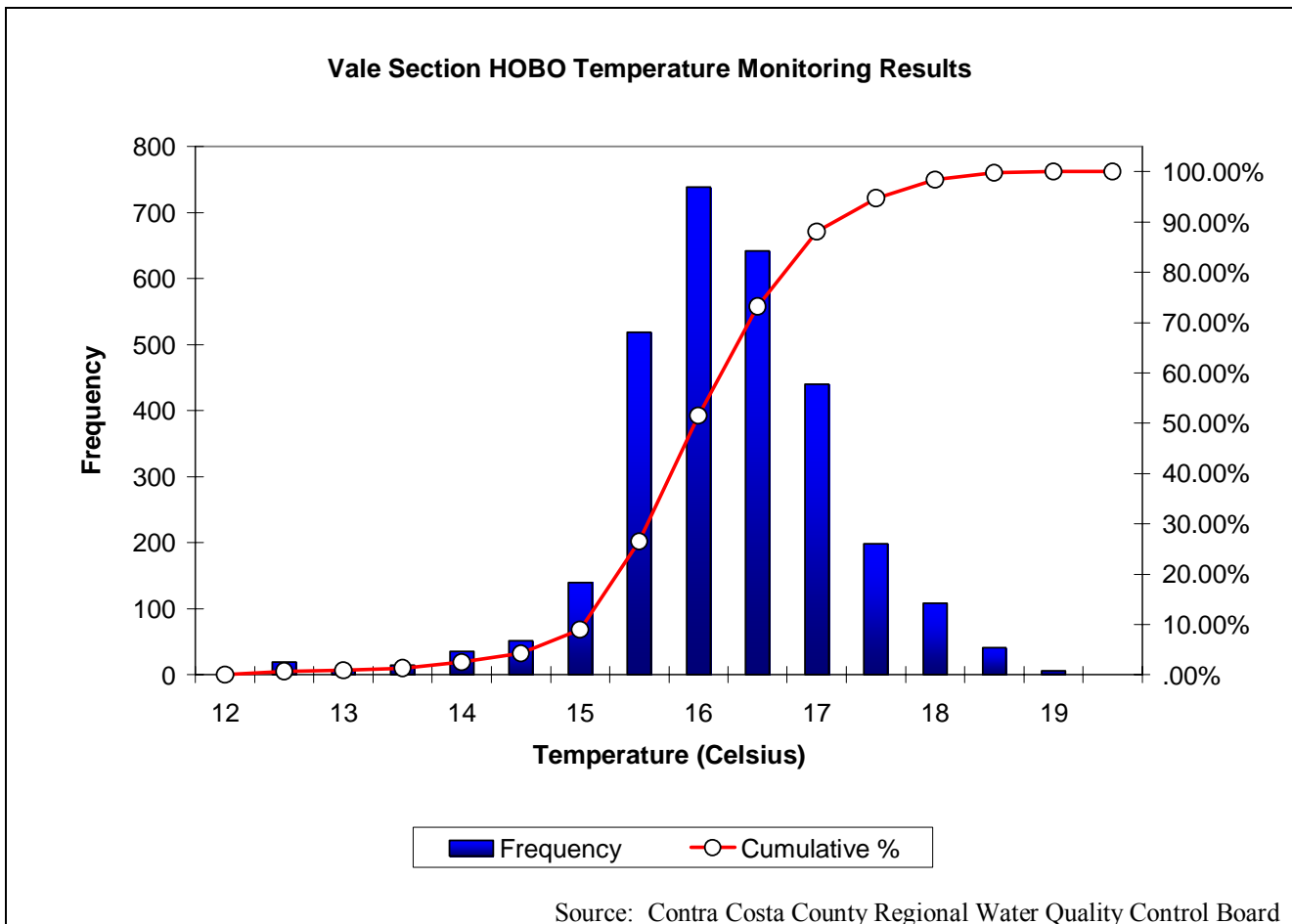
Source: Contra Costa County Regional Water Quality Control Board

Figure 14. This graph shows the HOBO temperature results for a pool located in the Van Ness section. The frequency indicates the number of times that a specific value was measured during the data collection period of 6/30/2005 through 10/31/2005. The red line shows the cumulative percentage that the values represent. For example, approximately 90% of the temperatures recorded were 18°C or lower and approximately 96% of the temperatures recorded were lower than 19.5°C. Overall, for the entire data collection period, there were eleven 30-minute periods where the water temperature exceeded 21°C. Recorded temperature varied between a minimum of 10.3°C and a maximum of 22.8°C.

³⁵ Site identification number WIL055

³⁶ Site identification number WIL060

The Vale section's HOBO results are presented in Figure 15:



Source: Contra Costa County Regional Water Quality Control Board

Figure 15. This graph shows the HOBO temperature results for a pool located in the Vale section. Approximately 90% of the temperatures recorded were 17°C or lower and 100% of the temperatures recorded were lower than 19.5°C. Overall, for the entire data collection period, there were zero 30-minute periods where the water temperature exceeded 21°C. Recorded temperature varied between a minimum of 12.0°C and a maximum of 18.9°C.

By comparing the Van Ness and Vale HOBO temperature results (Figures 14 and 15), the first characteristic that jumps out is the difference in temperature variability. Specifically, the Van Ness pool temperatures oscillated over a much wider range than did the Vale pool. From the perspective of both temperature stability (low variability) and range (all well within the acceptable temperature ranges for rainbow trout), the Vale pool is about as ideal as can be expected in the study reach during the dry summer months. However, the Vale section does benefit from the DMC outflow, which keeps the pool level relatively constant. Unfortunately, this is not reflective of the state of the rest of the study reach. The Van Ness pool is more representative of a typical isolated pool in the reach because temperature fluctuations are to be expected with reduced water quantities. As the water levels continue to drop, those fluctuations

eventually move out of the acceptable trout temperature ranges for longer periods of times. If there had been trout in the Van Ness pool, it is unknown if they would have succumbed as the temperature climbed over 20 degrees Celsius, but as a rule of thumb, when temperature increases, dissolved oxygen decreases. However, an over-summering pool is a complicated system. For example, if a pool was being warmed by sunlight, the increased light may stimulate photosynthesis in aquatic plants, which would then increase the dissolved oxygen in the water even though the overall temperature of the pool was increasing. Whether the Van Ness pool had sufficient direct sunlight and aquatic plants to offset temperature spikes and the resulting decrease in dissolved oxygen is unknown. However, the takeaway message from this specific pool comparison is that each over-summering pool in the study reach becomes its own unique ecosystem once it becomes cut off from the flowing stream. Each pool has different inputs based on the geographic position and internal physical characteristics. Some pools are wider or deeper, have undercut banks, are subjected to soil erosion as people walk on the banks above them, receive direct sunlight or external plant matter, have highly varied substrates that may support more aquatic insects, etc. Consequently, management of restoration activities should be pool specific and not just focus on giving all pools the same general treatment.

Based on the depth of the existing pools, and in conjunction with their dissolved oxygen and temperature measurements, it was possible to determine the number of potentially viable trout pools within the lower Wildcat Creek study reach. These results are presented in Figure 16:

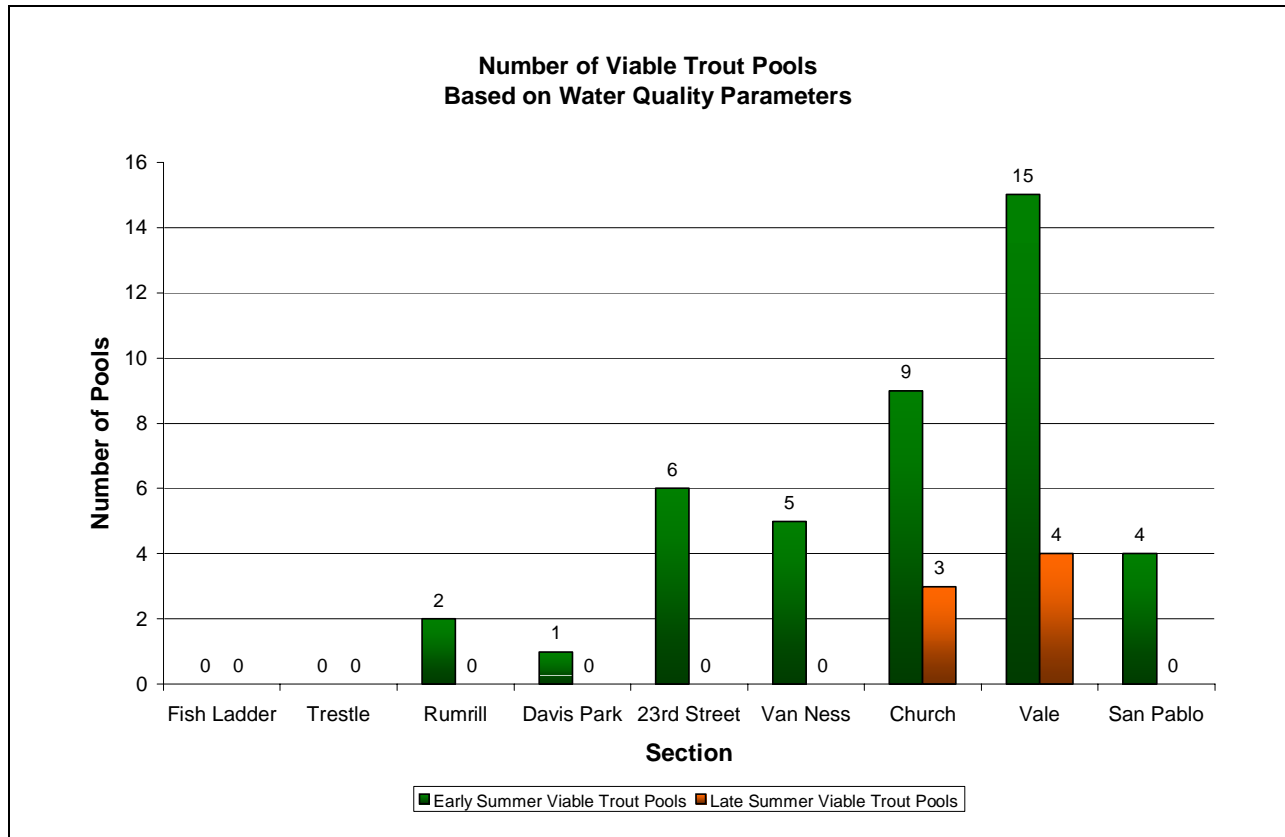


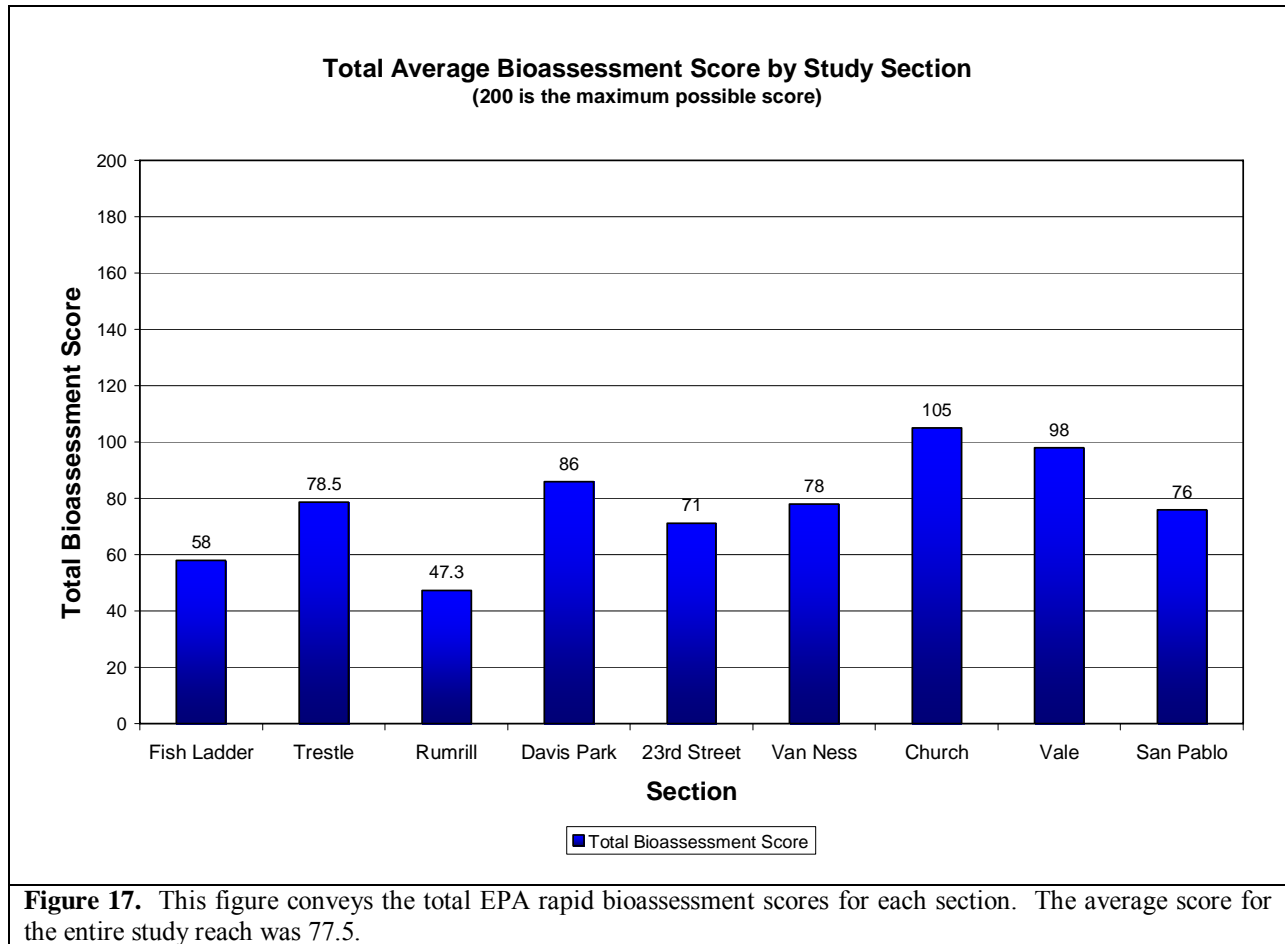
Figure 16. Pools with a minimum depth of 1 foot, dissolved oxygen >5.0 parts per million (ppm)³⁷ and temperature <20 °C were considered to be potentially viable for rainbow trout. Pools with a minimum depth of 1 foot were found to have low turbidity. The Late Summer values combined the August and October data and based the number of viable pools on the worst measurements collected. This rationale was used to establish a worst case assessment of the Late Summer trout pools with the reasoning being that if a metric dipped out of the minimum viable pool criteria, it would likely lead to the demise of any trout within that pool.

Based on the above water quality criteria, there were only seven viable Late Summer trout pools and five of them were in the vicinity of the DMC outflow. In fact, one of Church section’s viable pools was actually underneath the Vale culvert. Only two viable trout pools – both in the Church section – were independent of the DMC outflow. All of the Early Summer pools that met the water quality criteria and were not in the Church or Vale sections were either completely dry or had water quality measurements below the “potentially viable” depth, dissolved oxygen and/or temperature criteria during the Late Summer survey. Consequently, the Church and Vale sections accounted for 100% of the Late Summer viable trout pools.

³⁷ 1 part per million = 1 mg/l for water solutions

Rapid Bioassessment

The EBRPD fisheries department utilized the EPA's rapid bioassessment protocols for use in low gradient streams to further examine the lower Wildcat Creek study reach. At the end of the survey, and based on the EPA protocols, the bioassessment scores were summated to give an indication of the overall quality of each section of the study reach. These findings are presented in Figure 17:



The least hospitable trout habitat in the study reach was the Fish Ladder section, but due to the rapid bioassessment criteria, Rumrill scored lower. This is because the Rumrill section was completely dry, had no epifaunal substrate, was highly channelized and the rapid bioassessment protocols do not consider canopy cover. Because canopy cover was not factored in, these results can be somewhat misleading. However, Fish Ladder aside, the majority of the study reach had an approximate average of 70% canopy cover, which is sufficient for generating allochthonous

input,³⁸ cover and some degree of temperature regulation. Because rapid bioassessment was not designed to specifically gauge trout habitat, it is necessary to focus on a few specific criteria in order to generate trout-specific information.

Of the various habitat characteristics inventoried during the rapid bioassessment, three characteristics were deemed especially critical for native rainbow trout habitat. The first was “epifaunal substrate/available cover”, which is the amount of available instream cover such as submerged logs and snags³⁹ (large woody debris), cobble, and undercut banks. This category enumerates the prevalence of instream habitat available for biotic colonization. The second category was “channel flow status,” which was used to gauge the presence of water, with higher scores indicating a larger prevalence. The third factor was pool variability. While rainbow trout typically prefer deep, cool pools, it is necessary to have a variety of pools for optimal habitat. Specifically, some pools provide different biotic opportunities for smaller fish, macroinvertebrates and algal growth, all of which can affect the availability of trout food sources. The three trout-specific bioassessment metrics are presented in Figure 18:

³⁸ Externally produced organic plant matter that end up in streams and provides nourishment for aquatic organisms, especially macroinvertebrates.

³⁹ Logs and snags are meant to convey fixed habitat – they are not new fall and not transient.

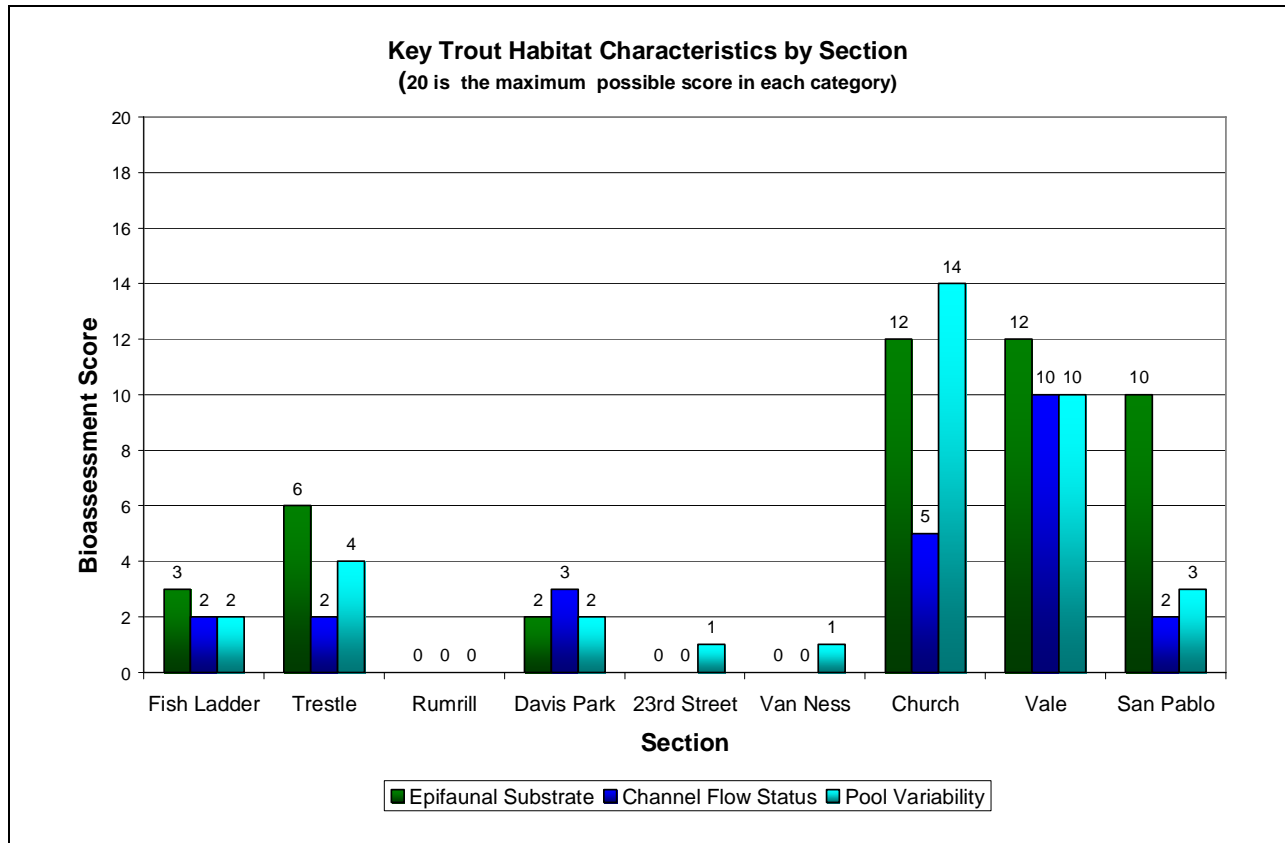


Figure 18. Church, Vale and San Pablo all had the best epifaunal substrate scores, but were still considered sub-par when compared to areas further upstream in Wildcat Creek. Additionally, Church and Vale each had the highest amount of water and highest levels of pool variability. The bioassessment results confirm that the best habitat for rainbow trout in the study reach is found in the Vale section.

Sediment Analysis

The EBRPD fisheries department conducted sediment analyses of the Vale section, which, based on gravel availability and knowledge of the trout population distribution, was hypothesized to be the area where the majority of spawning took place in the study reach. Pebble counts are a useful tool in analyzing sediment because they allow for the rapid identification of surface gravel composition. This information is necessary when analyzing sediment for potential and actual trout spawning habitat. Specifically, rainbow trout and steelhead have similar requirements for spawning habitat, but due to their larger size, steelhead can spawn in larger substrate sizes: they can move larger rock particles because they are larger, stronger fish. The spawning requirements for both rainbow trout and steelhead are presented in Table 2:

Table 2. Spawning Requirements for Steelhead and Rainbow Trout

	Minimum Depth (m)	Water Velocity (m/sec)	Substrate Size Range (mm)	Mean Redd ⁴⁰ Area (m ²)
Rainbow Trout	0.18	0.48 – 0.91	6 – 52	0.2
Steelhead	0.24	0.40 – 0.91	6 – 102	4.4 – 5.4

(Saldi-Caromile 2004)

Two sites were sampled within the Vale section, both of which were in the same general location. Sampling sites would have been more widespread but, due to high levels of sedimentation, quality potential spawning habitat was not prevalent elsewhere in the study reach.

The results of the pebble counts are presented in Figure 19:

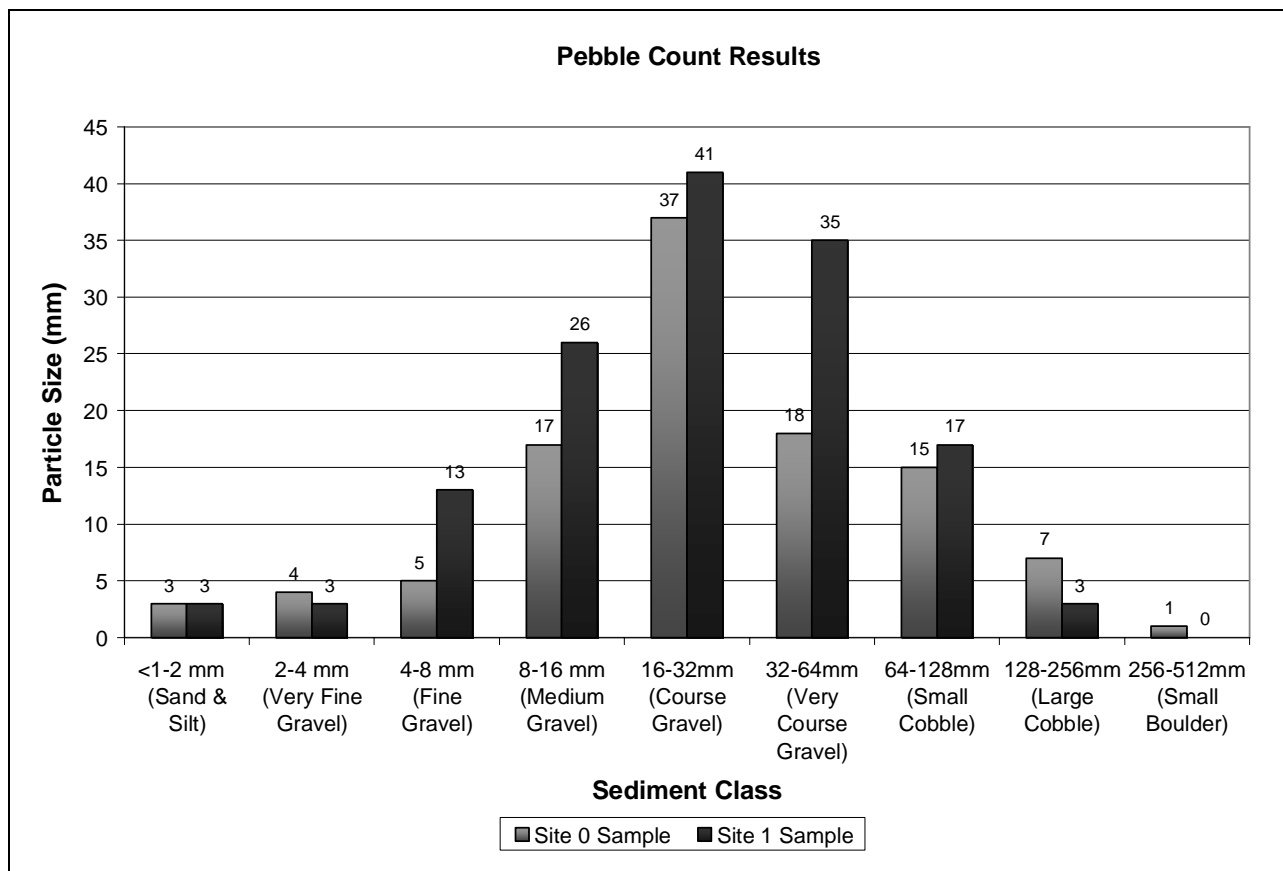
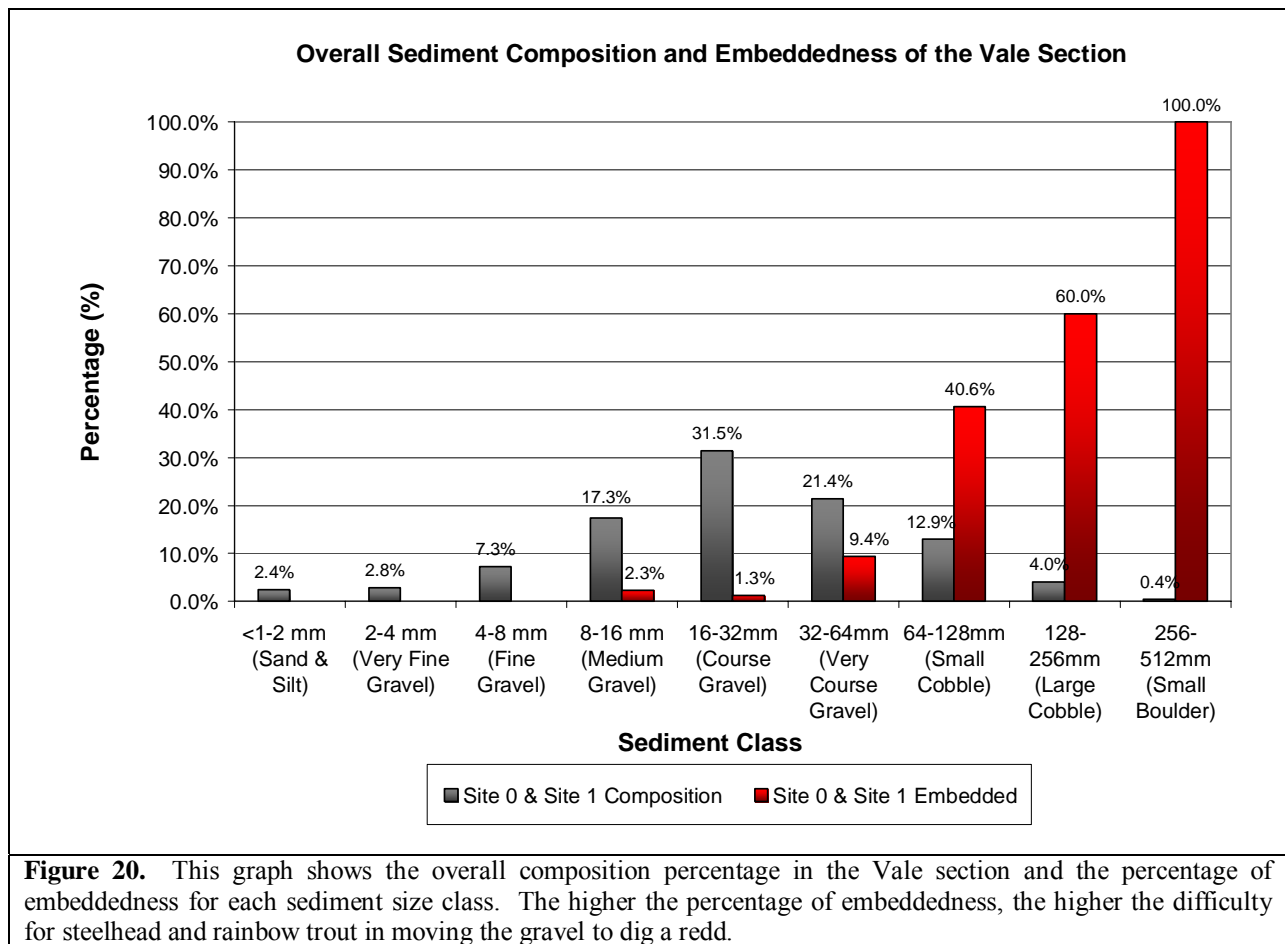


Figure 19. This graph shows the composition of sediment particle size as collected at two sampling locations within the Vale section. Particle sediment class was determined by walking a transect, sampling sediment at fixed points and measuring the intermediate axis⁴¹ of a given particle. Samples at Site 0 and Site 1 were both taken from a contiguous gravel bed, which was approximately 125ft². Spawning rainbow trout require sediment with diameters of approximately 6 – 52 mm in which to lay their eggs and steelhead require a sediment range of approximately 5.08 – 127 mm.

⁴⁰ Redd – the space at the bottom of a stream that a spawning salmon makes for its eggs.

⁴¹ The intermediate axis is the middle-sized axis on a three dimensional stone. For example, on a flat, oval stone, the smallest axis would be the thickness and the largest axis would be the length. Width would be the intermediate axis.

Based on Table 2, there is an acceptable distribution of surface gravel in the Vale section for the current population of rainbow trout and for a small population of steelhead. However, it is also important to know the degree to which the surface gravel is embedded⁴² because the more embedded the particles are, the more difficult they can be for salmonids to move aside when digging redds. The overall composition percentage of Vale’s gravel bed and the percentage that each class was embedded are presented in Figure 20:



Upon further analyzing the data, it is useful to look specifically at the sediment classes that the rainbow trout and steelhead use when spawning. This analysis is presented in Figure 21:

⁴² Embeddedness is a measurement of the degree to which a given particle is covered by smaller particles.

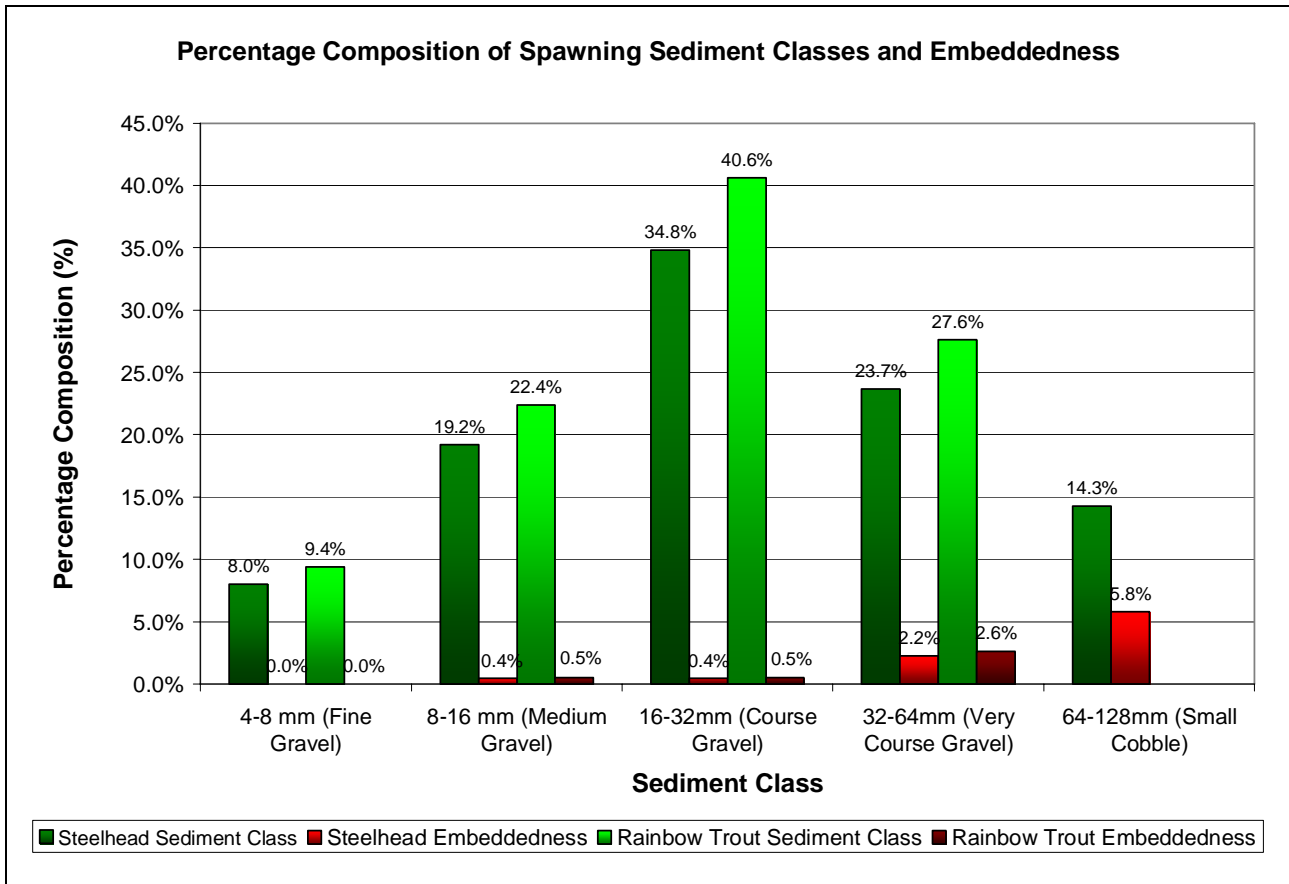


Figure 21. This graph shows the composition percentage of just the spawning gravel that the steelhead and rainbow trout use in spawning. Notice that only Steelhead are large enough to utilize the Small Cobble sediment class. This graph also shows the percentage of the available gravel that is embedded for each sediment class. When the data are viewed this way, the embeddedness of the gravel that the fish will actually use for spawning is low.

The overall sediment composition of the gravel bed in the Vale section was found to have acceptable gravel quality for spawning rainbow trout and steelhead. However, pebble counts only analyze surface gravel and since both rainbow trout and steelhead bury their eggs, it is necessary to examine the sub-surface gravel composition.

The EBRPD fisheries department biologists dug into the Vale gravel bed at two different locations using a McNeil sampler, hand trowel and coffee can. At the first location, the maximum depth attained was 8.4 inches and at the second location the maximum depth attained was 11.5 inches. The EBRPD found it exceedingly difficult to reach these depths, which are near the minimal levels at which rainbow trout (7.1 inches) and steelhead (9.4 inches) bury their eggs. Subsurface obstacles consisted of thickly woven root mats and large embedded particles

that could not be removed by hand.⁴³ These subsurface obstacles may create significant difficulties to spawning trout.

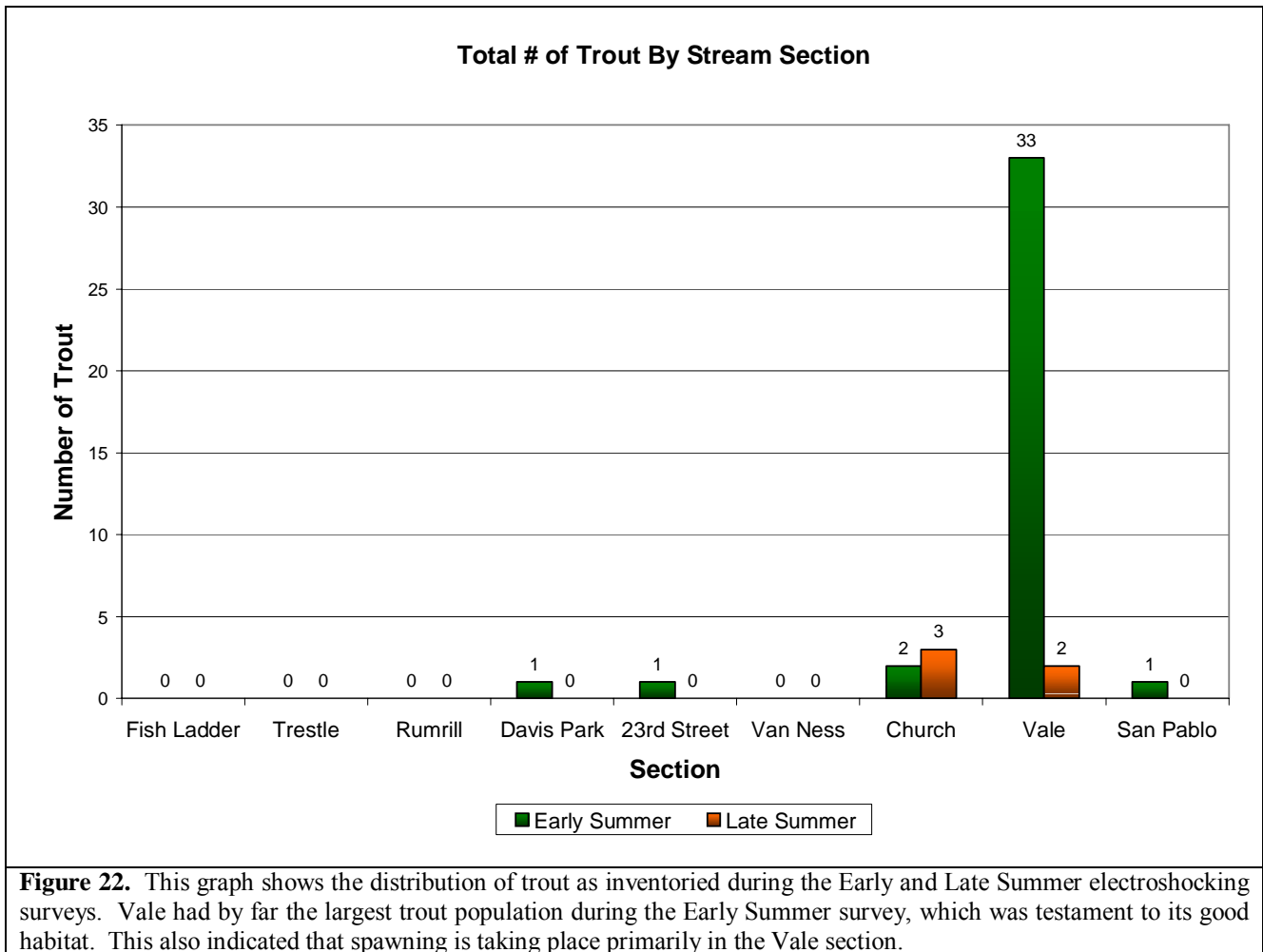
In conclusion, the surface sediment quality was adequate for the needs of both rainbow trout and steelhead. However, the difficulty in achieving the necessary minimal depths for spawning activity is of concern. More samples taken throughout the study reach would improve the overall understanding of the subsurface sediment quality. These sediment samples should be collected and analyzed using bulk sampling protocols as outlined in Harris, 2005. Fine sediment should be closely analyzed because an abundance of fine sediment can lead to suffocation of salmonid embryos (Barnhart 1986). Specifically, “increased fine sediment causes substrate to become embedded. Increased embeddedness reduces pore space between gravel and cobble, which is important habitat for macroinvertebrates and small fish.” Embeddedness can also inhibit the flow of oxygenated waters through the spawning gravel beds, resulting in decreased oxygenation of the eggs.

⁴³ These were not measured because they could not be removed; it was estimated that these impediments likely fell in the large cobble (128 – 256 mm) to small boulder (256 – 512 mm) sediment classes.

Biotic Results

Trout

As illustrated by the findings in the previous section, diminishing flow rates, pool depth, habitat degradation and difficult spawning beds present unique challenges to lower Wildcat Creek's existing population of native rainbow trout. Still, despite these less-than-ideal conditions, the trout continue to survive. The distribution of the 2005 native rainbow trout population at the time of the electroshocking surveys is presented in Figure 22:



The Church and Vale sections supported the largest number of trout in the study reach, which was to be expected based on these sections' abundance of water, good riparian canopy cover, instream cover (woody debris, undercut banks, etc) as well as relatively high bioassessment scores and, based on observation, reduced anthropogenic impacts. Vale had the largest trout population of the two and, not coincidentally, was also the section with the best riffle to run ratio.

Additionally, all surveyed trout were in good health: clear eyes, normal opercula, and no visible parasites, lesions or evidence of erosion on their fins.

Further analyzing the electroshocking data can be instructive in understanding the general abundance of the rainbow trout in each section and the overall study reach. By looking at the total number of fish caught and the total amount of energy exerted by the electroshocker (as expressed in the number of shock seconds) to catch them, the overall amount of fish caught per unit effort can be generated. The Catch per Unit Effort (CPUE) for each section of the study reach is presented in Figure 23:

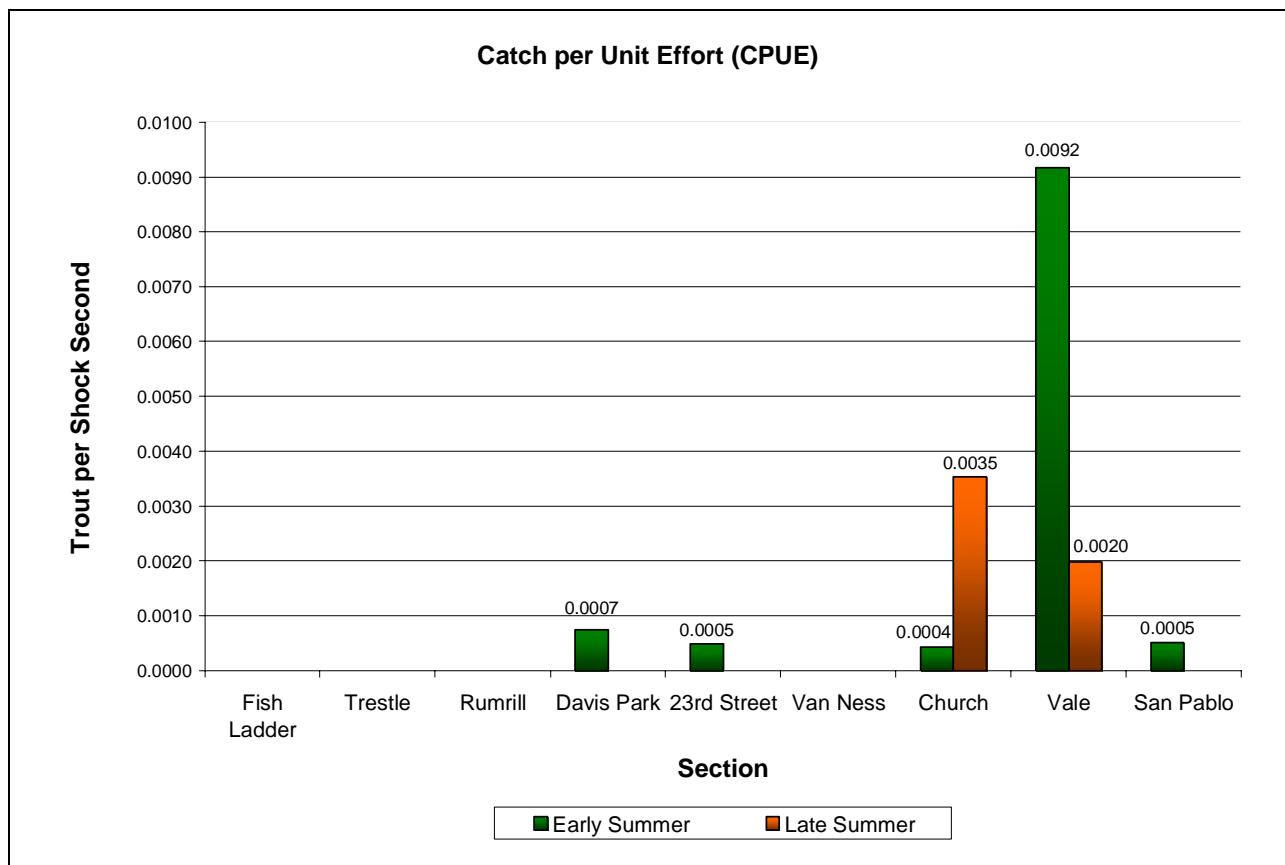
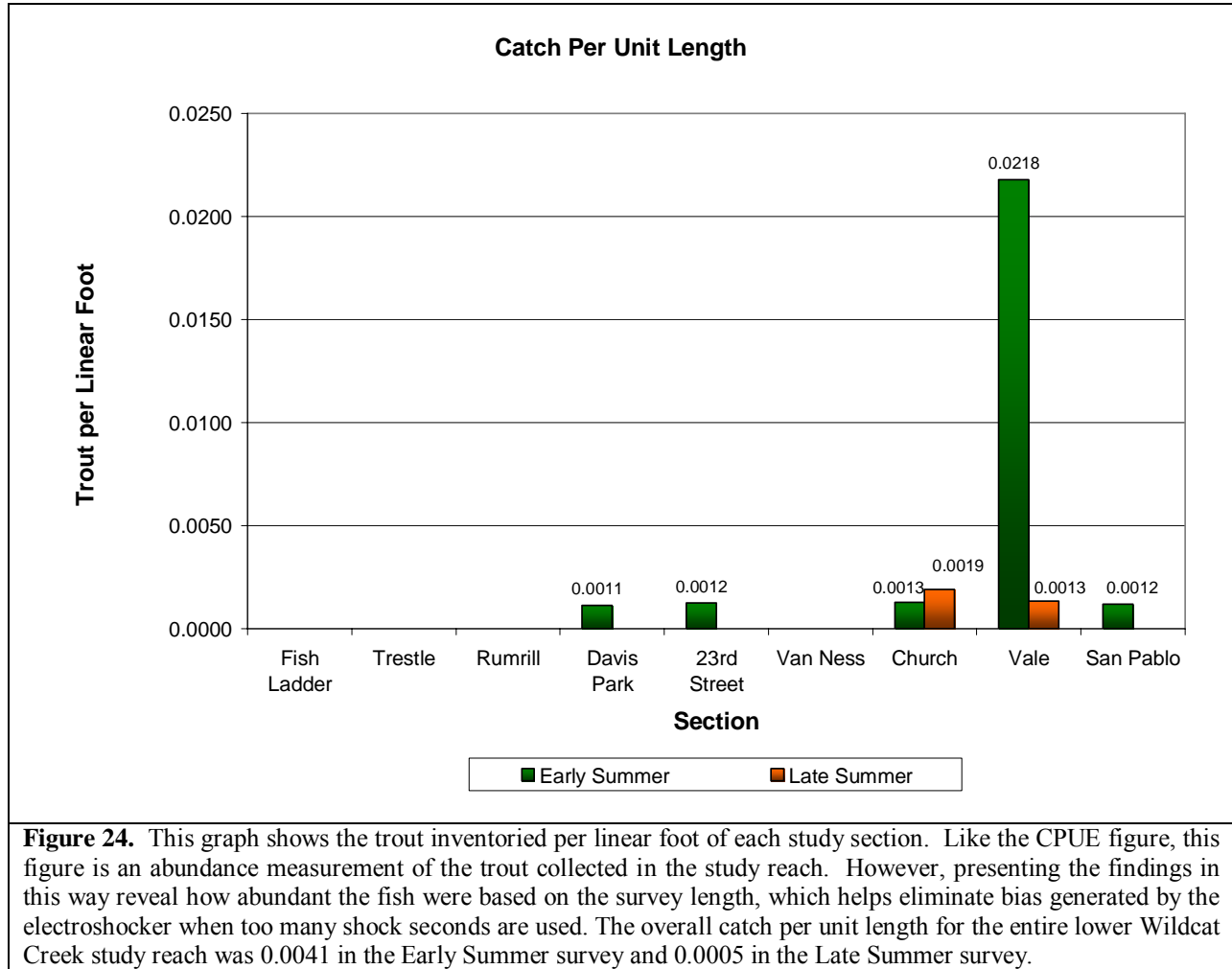


Figure 23. This graph shows the trout inventoried per shock second emitted into the stream. This is essentially an abundance measurement of the trout in the study reach. Based on historical data, the sites farther upstream of the study reach in Wildcat Canyon (Alvarado and Tilden Park,) are oscillating around 0.025 trout per shock second (see Figure 1). The overall catch per unit effort for the entire lower Wildcat Creek study reach was 0.0017 in the Early Summer survey and 0.0016 in the Late Summer survey. The catch per unit effort in the study reach was over ten times lower than that in mid- to upper Wildcat Creek, which means that by this metric, rainbow trout were ten times less abundant in the study reach. Another way of thinking about the result is that if the same amount of energy were exerted to catch fish in both areas of Wildcat Creek, the mid- and upper reaches would yield ten times more fish than the lower.

It is also informative to analyze the number of fish collected by the length of the collection area. By presenting the data in this format, it helps eliminate some of the data bias that can occur by using more than the necessary number of shock seconds. The Catch Per Unit Length (CPUL) results are presented in Figure 24:



To more clearly contextualize Figure 24, in 2004 the CPUL in the more upstream sections of Wildcat Creek from the 2003 and 2004 trout surveys range from 0.11 to 0.44 trout caught per linear foot (Graul 2004). On average, the upstream areas of Wildcat Creek had a CPUL that was approximately 10 times higher than lower Wildcat Creek in the Early Summer and approximately 100 times higher than the study reach in the Late Summer. By the CPUL metric, rainbow trout in the study reach were between 10 and 100 times less abundant than in the upstream areas of Wildcat Creek.

Trout were categorized as young of the year (YOY) if they were less than 4 inches in fork length⁴⁴ and as adults if they were more than 4 inches in fork length. Figure 25 shows the number of trout in each age class and their distribution through the study reach:

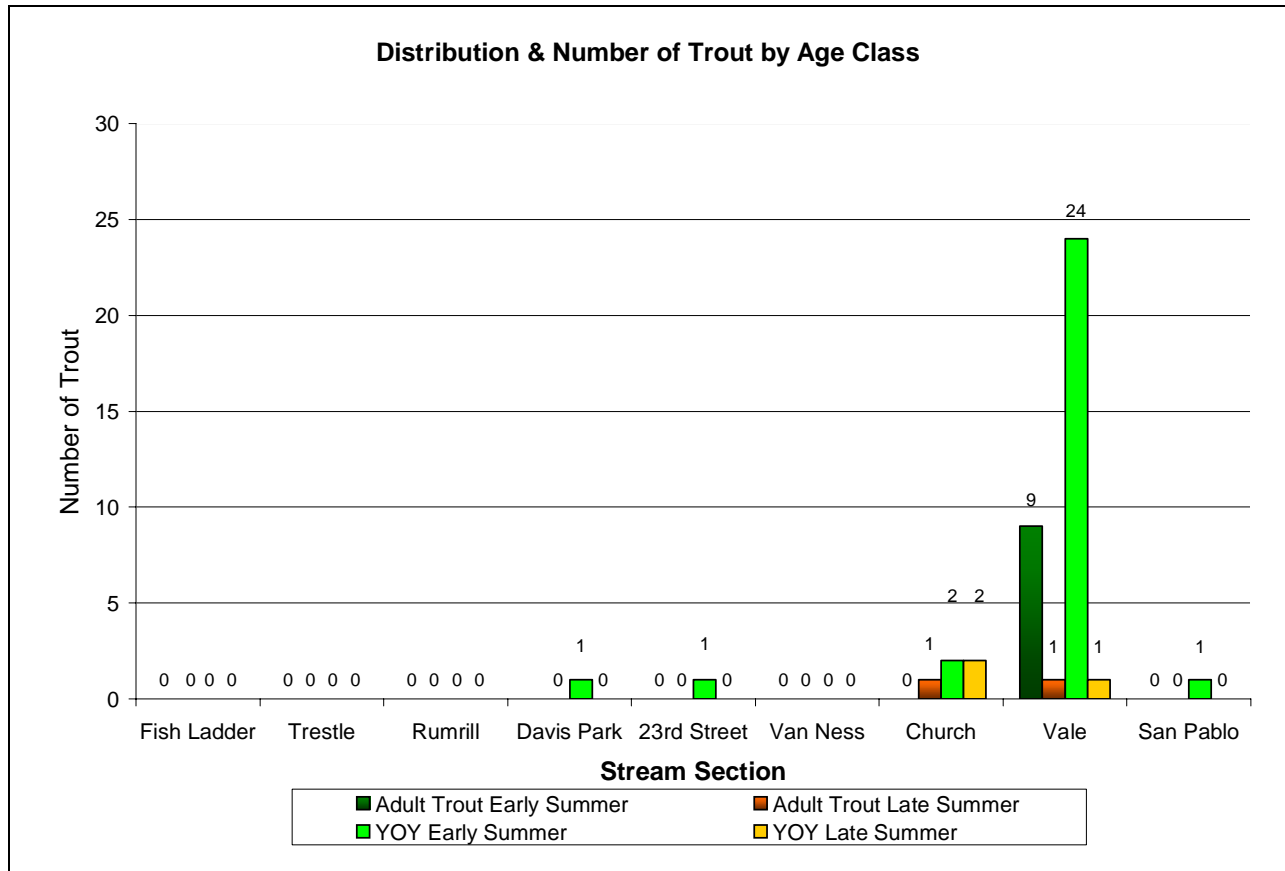


Figure 25. This graph shows the breakdown of trout inventoried by age class in both the Early and Late Summer surveys. Trout that were 4” in fork length or less were categorized as young of the year (YOY) whereas trout that were longer than 4” were categorized as adults. Furthermore, mortality did occur during electroshocking, and ten fish were lost during the Early Summer survey. Specifically, a YOY in the 23rd street section, eight YOY in the Vale section and one adult also in the Vale section did not survive.

Additionally, trout lay more eggs⁴⁵ than are expected to survive. Many eggs normally fail to hatch, but of those that do, many of the emerging fry (alevins) are consumed by predators, including larger trout. Of those young that survive hatching and the initial foray out of gravel beds and into the stream channel proper, it is likely that many of them end up in areas of the

⁴⁴ Fork length is defined as the length of a fish measured from the tip of the nose to the fork of the tail.

⁴⁵ The size and number of trout eggs vary in more or less direct relation to the size of the female. A six-inch trout of a small tributary stream will lay 200 or 300 small, amber-colored eggs, while a large steelhead may produce 6,000 or more (CDFG, No Year).

study reach where they could become trapped in a pool that would eventually dry out entirely. In fact, upon emerging from their gravel beds, salmonid young typically move downstream with the current. In the study reach, this would result in the young moving downstream from the survivable habitat of Vale and Church and into areas that in the Late Summer were either entirely dry or found to be non-viable based on the water quality parameters (see Figure 16). Additionally, because the resources in the study reach are limited by quantity and quality of available habitat, competition for territory could also drive younger, smaller trout into the non-viable downstream areas, which in the Late Summer survey was found to be any section upstream of the San Pablo culvert and downstream of the Church culvert.

It is important to note that the sustainable population is limited not by available habitat, but by the number and quality of over-summering pools. This may partially explain why so few trout were inventoried in the Late Summer survey. Additionally, since the number of available summer pools is so variable from year to year due to the locations and quantity of sediment deposition and overall water availability (correlated to annual rainfall), the study reach's rainbow trout carrying capacity is also highly variable. For example, the EBRPD conducted rainbow trout surveys of the Vale section on 6/30/1997, which would closely articulate with this study's Early Summer survey, and found 3 adult and 1 YOY. Two years later, a second electroshock survey was conducted in the Vale section on 9/20/1999, which would articulate with this study's Late Summer survey, and found 1 adult and 17 YOY. Two years later, a third electroshock survey was conducted in the Vale section on 7/3/2001, which would closely articulate with this study's Early Summer survey, and found 2 adult and 0 YOY.

In the winter of 2004/2005, the EBRPD surveyed the lower Wildcat Creek study area for steelhead spawning activity. No active spawning was observed.

Overall, the rainbow trout have a tenuous hold in lower Wildcat Creek. Without the DMC outflow, a severe drought year could eliminate the entire breeding population. However, with the DMC outflow providing a constant source of water and artificially increasing the number and quality of over-summering pools in the Vale section, the rainbow trout are provided some insurance against a prolonged drought. Furthermore, the rainbow trout that were inventoried

were healthy and robust. Even though they face sub par living conditions, there is no immediate reason to expect a rapid or prolonged diminishment in the current trout population

Non-Natives

Several non-native species were inventoried during the Early and Late Summer surveys. The presence of non-natives in the reach is significant because they are capable of out competing rainbow trout for food and habitat. Non-natives such as sunfish or blue gill are also suspected of consuming trout eggs and the young of the year themselves. When examined as a whole, the non-natives comprised a substantial 15.7% of the extant fish in the study reach.⁴⁶ The non-native metric data are presented in Table 3:

Table 3. Metric Data of the Non-Natives Found in Lower Wildcat Creek				
Common Name	Length (mm)	Weight⁴⁷ (g)	Survey Period	Section
Koi	220	156	Early Summer Survey	Rumrill
Green Sunfish	114	24	Early Summer Survey	Rumrill
Goldfish	101	20	Early Summer Survey	23 rd Street
Bluegill	91	No Data	Early Summer Survey	23 rd Street
Green Sunfish	107	No Data	Early Summer Survey	Vale
Bluegill	91	No Data	Early Summer Survey	Vale
Bluegill	92	No Data	Early Summer Survey	Vale
Green Sunfish	120	No Data	Late Summer Survey	Vale

⁴⁶ This percentage reflects only rainbow trout and non-native fishes; it does not include the prolific three-spined stickleback.

⁴⁷ A weight value of “No Data” was due to a malfunction in the field scale.

Figure 26 shows the distribution of the non-natives species found in the study reach:

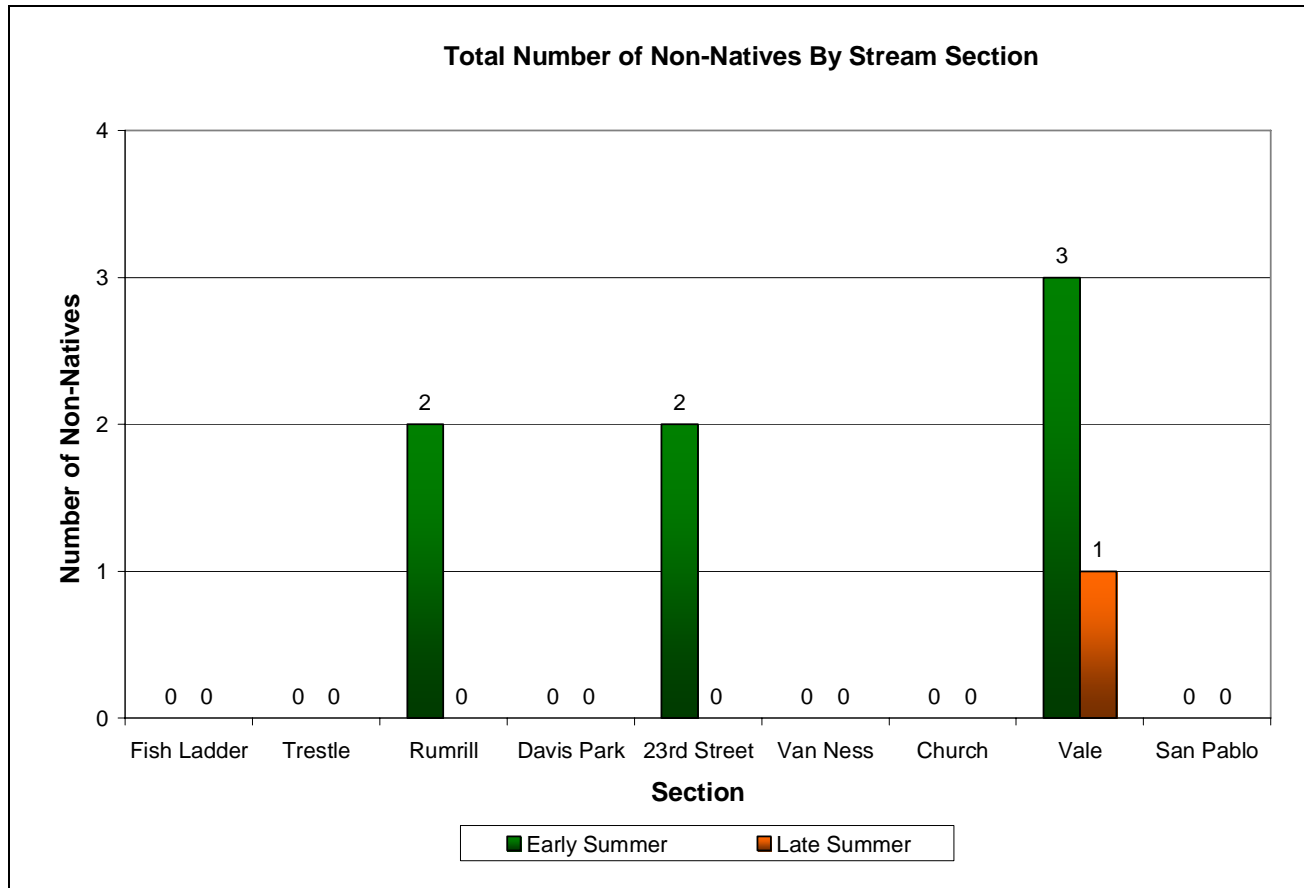


Figure 26. This figure shows the distribution of non-native species found in the study reach.

Bluegill and green sunfish have established breeding populations in the two Wildcat Creek reservoirs where they were introduced as game fish. No non-native species were inventoried in the Vale section in 1997, 1999 or 2001. Therefore, presence of the six bluegill and green sunfish may be higher than normal for 2004/2005 due to the higher intensity rainfall events during the winter period. These events caused higher spillway discharge in the lakes Anza and Jewel, which are the likely origin of these fishes. Furthermore, because there are no known breeding populations of koi or goldfish in Wildcat Creek, those inventoried were probably former pets that had been released by their owners. The effect of competition by these two non-native species with the rainbow trout population is unknown but is hypothesized to be negligible. All inventoried non-natives were removed from the creek.

5.0 MIGRATIONAL BARRIER EVALUATIONS & STREAM SECTION RECOMMENDATIONS

The following tables outline the California Department of Fish and Game’s (CDFG) passability criteria for migrating salmonids based on the minimum flow depth, average water velocity, culvert length and drop distance at culvert outlets:

Table 4. Maximum Average Water Velocity and Minimum Flow Depth		
Species/Lifestage	Maximum Average Water Velocity (fps)	Minimum Flow Depth (ft)
Adult Anadromous Salmonids	See Table 5	1.0
Adult Non-Anadromous Salmonids	See Table 5	0.67
Juvenile Salmonids	1	0.5

Source: CDFG 2002

Table 5. Culvert Length vs. Maximum Average Water Velocity for Adult Salmonids		
Culvert Length (ft)	Adult Non-Anadromous Salmonids (fps)	Adult Anadromous Salmonids (fps)
<60	4	6
60 – 100	4	5
100 – 200	3	4
200 – 300	2	3
>300	2	2

Source: CDFG 2002

Table 6. Maximum Drop at Culvert Outlet	
Species/Lifestage	Maximum Drop (feet)
Adult Anadromous Salmonids	1
Adult Non-Anadromous Salmonids	1
Juvenile Salmonids	0.5

Source: CDFG 2002

The following barriers are presented from downstream to upstream. The associated photographs were taken at different periods throughout the study. Consequently, variables like water depth and algae growth change from picture to picture. These photos are only intended to convey details of the migrational barriers.

Section 1: Fish Ladder **From the Downstream Side of the Fish Ladder to the First Tree Canopy Cover**

The Fish Ladder section comprised 4.71% of the study reach. This section was devoid of salmonid spawning, rearing and over-summering pools. During the Late Summer survey, the average dissolved oxygen levels in this section were below the 5 mg/l threshold necessary for the survival of rainbow trout. Not surprisingly, no rainbow trout were found in this section during any part of the survey. The presence of anthropogenic garbage and debris was minimal.

Fish Ladder Section Recommendations:

- The fish ladder should be entirely removed from the stream corridor because it inhibits the upstream and downstream migration of salmonids.
- Lesser remediation efforts would be more effective in other sections of the study reach. Remediating the Fish Ladder section for salmonids to reside for any length of time would not be cost effective due to the magnitude of the necessary modifications.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season. Water velocity should be monitored in the fish ladder and, if the ladder is removed, in the stream corridor after its removal.

Fish Ladder Section – Migrational Barrier 1 of 1: Wildcat Creek Fish Ladder



Figure 27. This is the downstream end of the Lower Wildcat Creek fish ladder (Denil section) looking upstream from the sediment basin. Both center partitions are visible as well as the fish ladder thalweg.

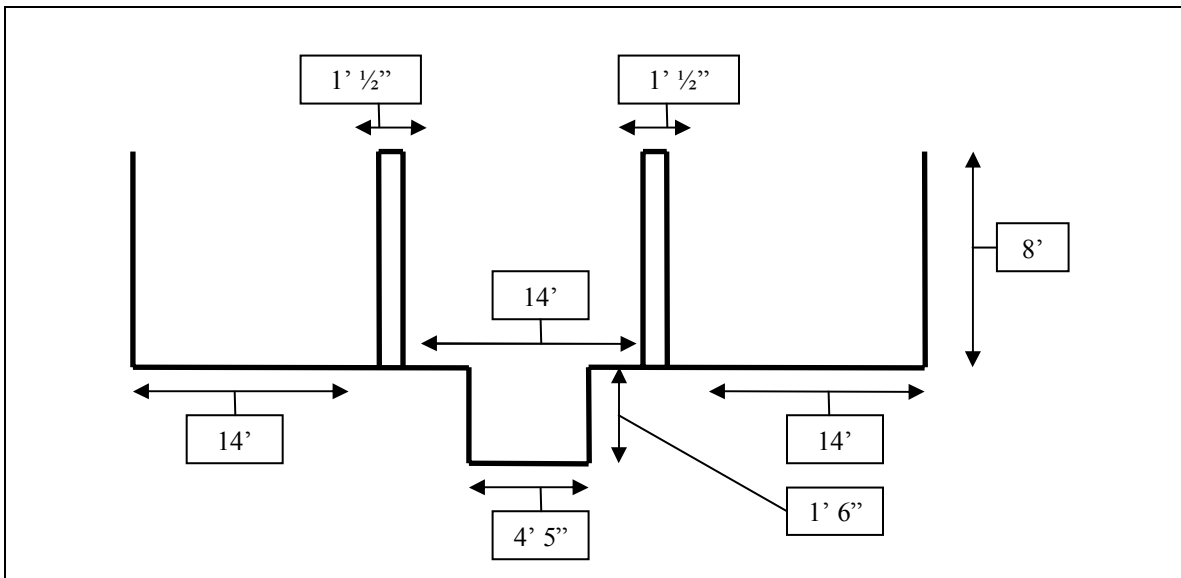


Figure 28. This figure provides the measurements of the downstream end of the Wildcat Creek fish ladder while looking upstream.



Figure 29. Facing upstream, this photo shows the fish ladder's central conduit and thalweg. The Washington baffles in the thalweg are clearly shown. Some debris is stuck in the baffles. In the rainy season, debris occlusion in the baffles may render the fish ladder thalweg impassable to rainbow trout. Graffiti covers nearly every surface of the structure, which speaks to the fish ladder's highly urbanized setting.

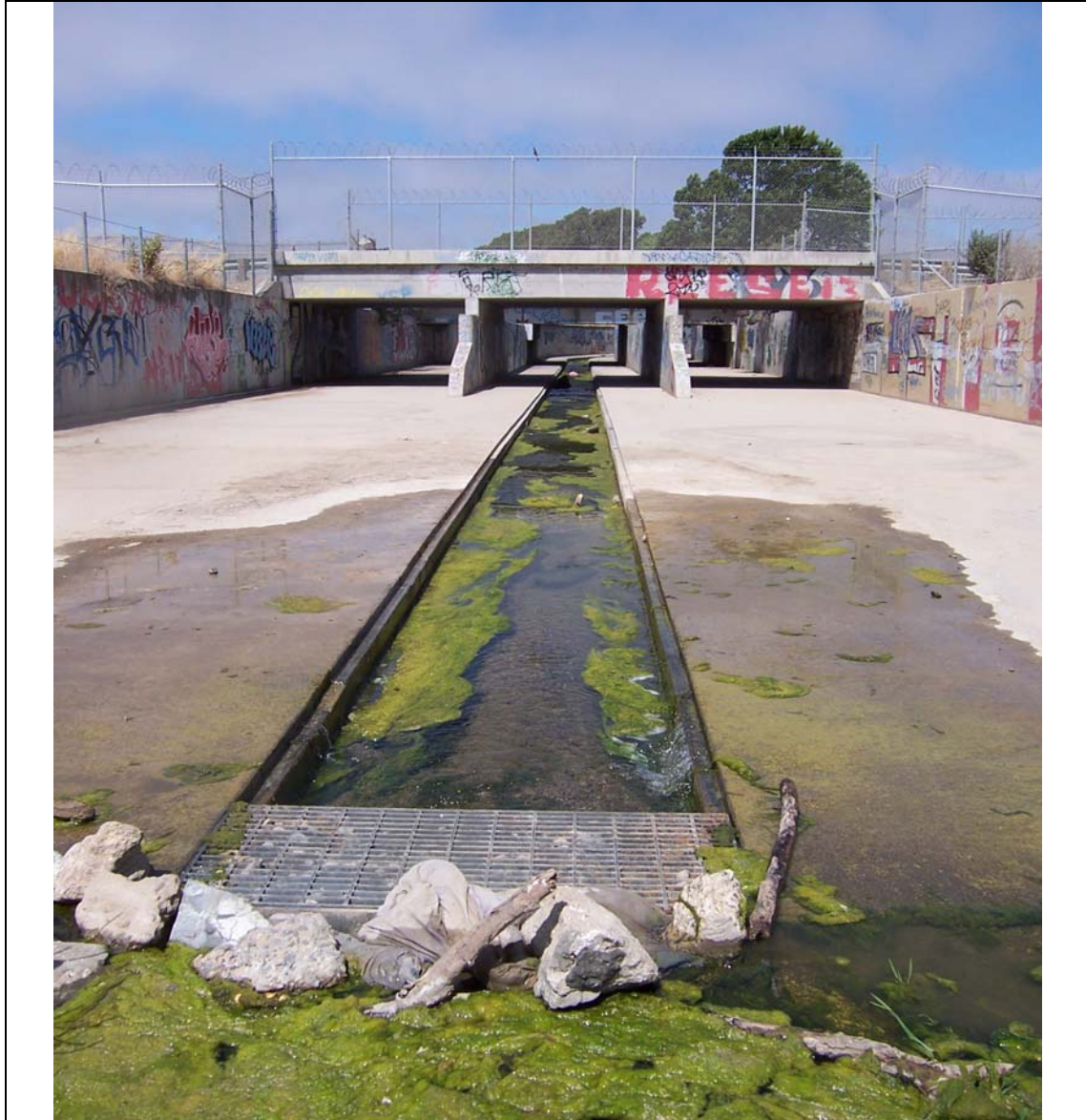


Figure 30. This downstream-facing image shows the upstream end of the fish ladder. The grate in the forefront is the up-stream border of the ladder and is regularly clogged with flow-inhibiting debris. Near the top of the photo is the crosswalk, which is the second of two overpass structures (the first is a railroad bridge). The termination of the two central partitions is also visible.

Table 7. Summary Measurements of the Wildcat Creek Fish Ladder			
	Length (ft.)	Height (ft.)	Width (ft.)
Conduits	320	8	14
Total Length (from downstream end ⁴⁸ to upstream grate)	375	n/a	n/a
Railroad bridge	40	7.42	14
Crosswalk	32	7.42	14
Baffles	Spaced approximately 10 apart	No Data	No Data

Salmonid Migrational Assessment:

The Wildcat Creek fish ladder had a total length of 375 feet. Based on its length, the California Department of Fish and Game’s culvert criteria defined this structure as impassable when water velocity exceeds 2 feet per second (fps) for both adult steelhead and rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG’s culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time.

Barrier Recommendations:

- The fish ladder should be entirely removed from the stream corridor because it hinders the upstream and downstream migration of salmonids. At the very least, it would be beneficial to remove the concrete bottom, which would enable the creek to establish subsurface texture that may result in the development of migrational resting pools.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season. Water velocity should be monitored in the fish ladder and, if the ladder is removed, in the stream corridor after its removal.

⁴⁸ Measured at the base of the downstream center conduit wall

Fish Ladder Section – Migrational Barrier 2 of 2: Railroad Trestle Bridge



Figure 31. This upstream-facing image shows the railroad trestle running across Wildcat Creek. The railroad trestle acts as a clogging mechanism during the rainy season and traps large woody debris and garbage in the support struts. The significance of this structure as a migration obstacle to salmonids varies depending on the quantity of debris constricting stream flow from year to year.

	Length (ft.)	Height (ft.)	Width (ft.)
Railroad Trestle	18	8.5	105

Salmonid Migrational Assessment:

This barrier is likely passable by adult anadromous, non-anadromous and juvenile salmonids when sufficient water levels are available. Passability could be affected by increases in water velocity due to occlusion – that is, as debris becomes trapped in the trestle bridge support struts, the water is forced into smaller conduits by which to move downstream. This constriction may result in an increase in water velocity, which becomes prohibitive to migrating steelhead when it exceeds 8 fps⁴⁹ and to adult rainbow trout when water velocity exceeds 4 fps.

⁴⁹ This is the maximum water velocity that an adult steelhead can handle. It differs from the CDFG culvert criteria for passability.

Barrier Recommendations:

- Though it is likely that migrating salmonids can still bypass the railroad trestle, it does serve as a clogging mechanism because garbage and debris become trapped in the trestle's support struts. When this structure undergoes retrofitting/reengineering due to wear, the support struts should be removed and replaced with an archway. This would eliminate the occlusion problem and allow the migrating salmonids to pass through this structure without incident.
-

Section 2: Trestle
From the first Canopy Cover to the Rumrill Culvert

The Trestle section comprised approximately 7.14% of the study reach and, in the Early Summer survey, was found to have good canopy cover and several good pools. While no trout were found in this section, it was relatively undisturbed and was not as polluted with garbage and anthropogenic debris as many of the other sections. The first 300 feet of this section had one of the highest bioassessment scores in the study reach (94), and Trestle also appeared to have sufficient habitat to support a small number of resident trout. In fact, just behind the Vale section, Trestle had the second best pool to riffle ratio – a good indicator of trout habitat – in the entire study reach. However, while there were a surprising number of pools (four) extant in the Late Summer survey, they either had dissolved oxygen levels that were below the 5 mg/l threshold necessary for the survival of rainbow trout or they did not meet the 1 foot minimum depth criterion. Significantly deepening a couple of the pools may enable the water quality parameters to remain above the trout need threshold throughout the summer. However, due to the high level of erosion in Wildcat Creek, sedimentation is likely to fill in most pool modifications and may present a significant challenge to sustaining deeper pools.

Trestle Section Recommendations:

- Significantly deepening a few of the pools still extant in the Late Summer survey would provide trout with over-summering habitat and could lead to permanent residence for a small number of fish. The placement of large woody debris (epifaunal substrate) in this section would also encourage habitat development and macroinvertebrate colonization.

Trestle Section – Migrational Barrier 1 of 1: Rumrill Double Box Culvert



Figure 32. Upstream-facing image of the Rumrill double box culvert with its concrete bottom. Garbage is visible at the base of the culvert.



Figure 33. This upstream-facing image conveys the difference in sedimentation between the left and right sides of the Rumrill double box culvert. The left side of the culvert is filled with fine sediment that is approximately four feet and five inches deep.

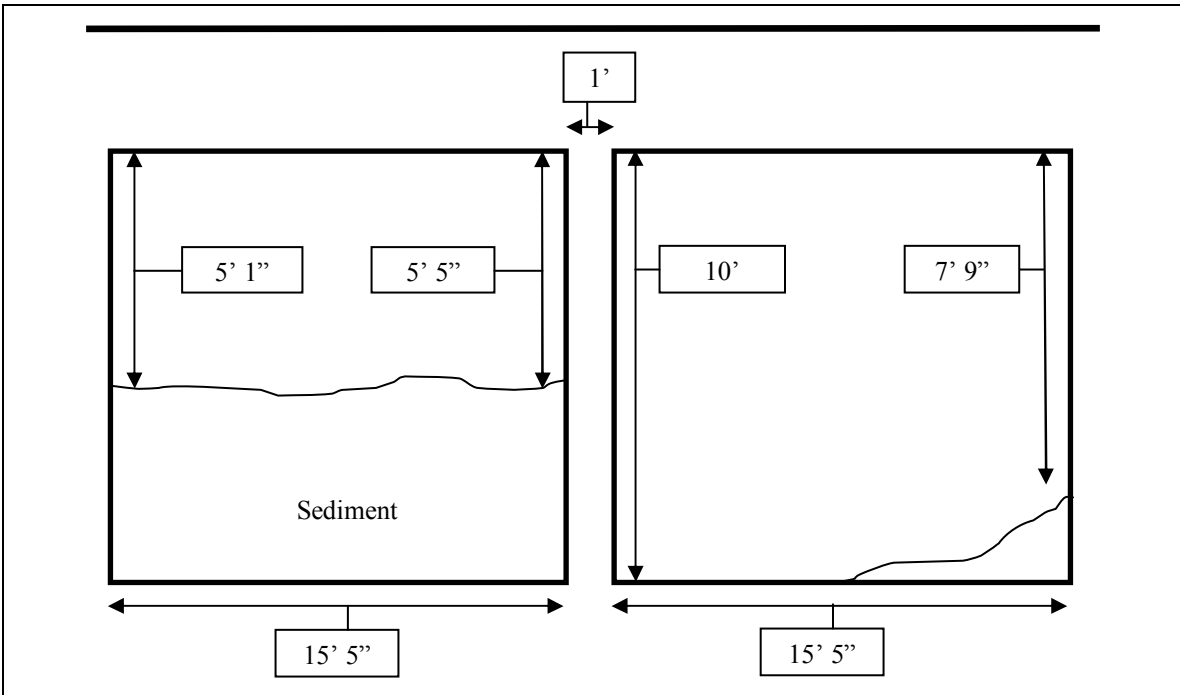


Figure 34. Dimensions of the Rumrill culvert while facing upstream. The total length of the culvert was 78 feet.

Table 9. Summary Measurements of the Rumrill Double Box Culvert			
	Length (ft.)	Height (ft.)	Width (ft.)
Rumrill Culvert	78	10	32

Salmonid Migrational Assessment:

The Rumrill culvert had a total length of 78 feet and, based on CDFG’s culvert criteria, is impassable when water velocities exceed 5 fps for steelhead and 4 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG’s culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time.

Barrier Recommendations:

- Removal of the concrete bottom would increase the roughness of the corridor and allow the creek to establish a natural bottom. Pools may develop and the increased roughness would have a slowing effect on the water, though whether that would be a significant reduction is unknown.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.

**Section 3: Rumrill
From Upstream of Rumrill Culvert to the John Hubert Davis Park Culvert**

The Rumrill section comprised 16.66% of the study reach. This section was found to be heavily channelized and devoid of any salmonid spawning or over-summering pools – it was completely dry during the Late Summer survey and no rainbow trout were found during either survey. Garbage was above average, with used syringes being among the significant anthropogenic findings. Due to the section’s close proximity to Davis Park, the presence of increased anthropogenic influence was not surprising. Additionally, during the Early Summer survey two non-native species were found in this section: a Koi and a large goldfish, both of which were probably released by pet owners. The presence of these species near the Davis Park is probably not a coincidence. Overall, this section had the worst bioassessment score in the study reach and scored a zero in each of the three key trout habitat characteristics, which was again the lowest score in the reach. Consequently, habitat restoration efforts in this section are best directed elsewhere.

Rumrill Section Recommendations:

- Remediation efforts should be focused elsewhere in the study reach.

Rumrill – Migrational Barrier 1 of 2: Concrete Lined Channel



Figure 35. This upstream-facing image shows the channelized area just downstream of the Davis Park bridge (where the concrete ends).

Salmonid Migrational Assessment:

The right bank is stabilized by crudely poured concrete and the left bank is a combination of stacked brickwork and angled concrete. Though this stretch is not a conventional culvert, in terms of the hydrodynamics of the reach, it may act as one. This section is channelized with concrete for a total length of 215 feet and, based on CDFG’s culvert criteria, is impassable when water velocities exceed 3 fps for steelhead and 2 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps. Additionally, this area has an average width of approximately 14 feet.

Based on CDFG’s culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time.

Barrier Recommendations:

- Add baffles or rock weirs to generate heterogeneity in the channel. Investigate the viability of creating and maintaining resting pools within the channel.
- The total length of the corridor from the upstream side of the Rumrill culvert to the Davis Park Bridge is approximately 800 feet. This stretch is devoid of resting pools and is highly channelized with no significant stream meanders. This magnitude of run without resting pools could be a significant barrier to migrating salmonids.
- A flow gauge station should be established in order to determine the water velocity in this channel over the course of the rainy season.

Rumrill – Migrational Barrier 2 of 2: Davis Park Double Box Culvert



Figure 36. This upstream-facing image shows the Davis Park culvert. Sacrete walls line both the right and left banks and extend outward from the culvert approximately 20 feet.

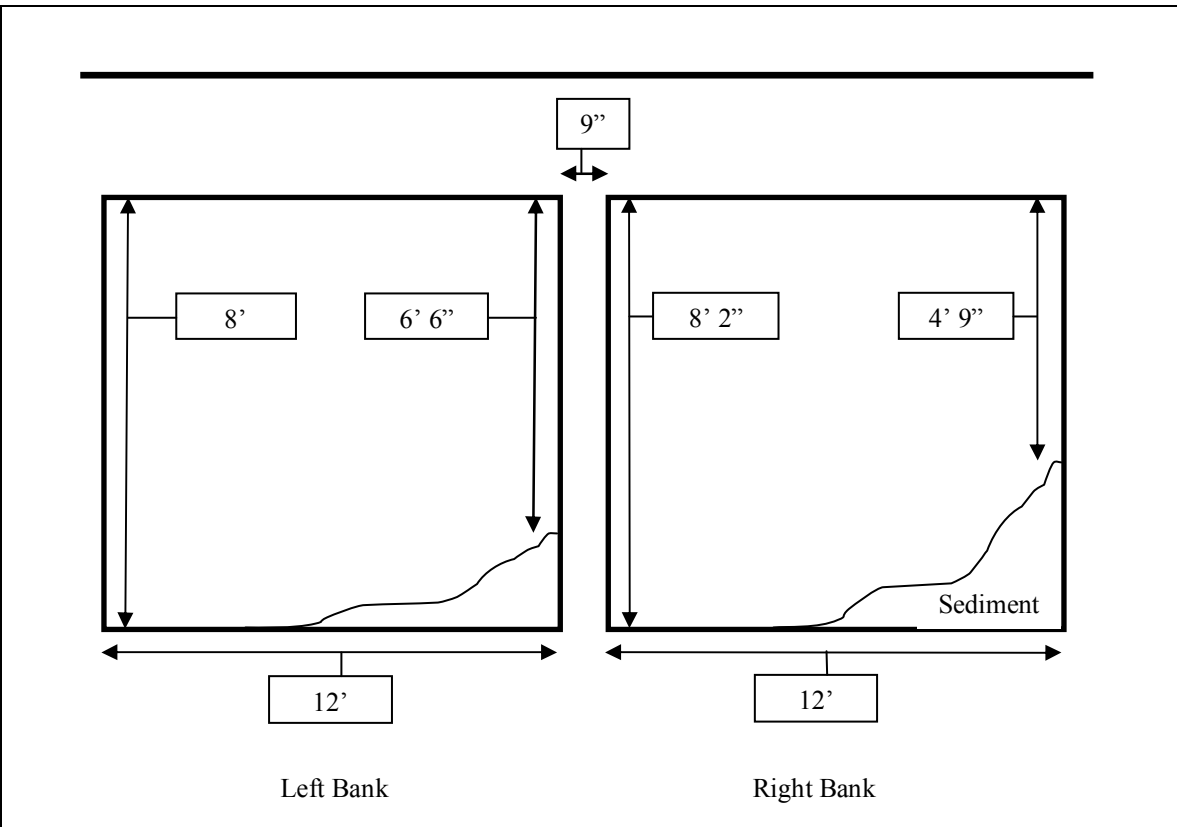


Figure 37. The dimensions of the Davis Park culvert while facing upstream. The total length of the culvert was 509 feet, as measured through the right bank conduit.



Figure 38. This image was taken 240 feet into the right bank conduit of the Davis Park culvert. The culvert bottom was comprised of sediment of various sizes. The average height at this point was 6' 2". Graffiti was found throughout the culvert.

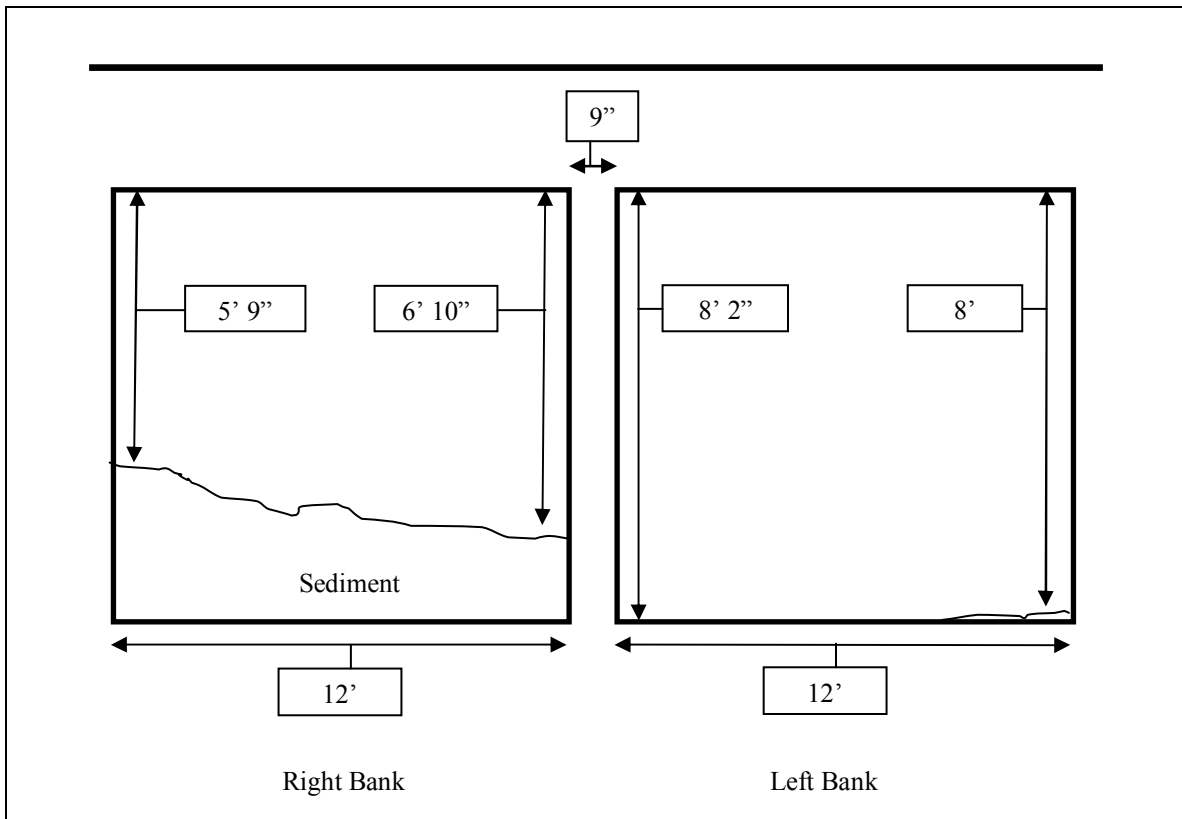


Figure 39. The dimensions of the Davis Park culvert while facing downstream. Based strictly on the deposition patterns of sediment in the culvert and in situ observation, water primarily travels through the left bank conduit.

Distance from downstream end of the culvert (ft.)	Average Height (ft.) in the Right Bank Conduit	Composition (estimated based on surface appearance)
0	6.9	95% fines and 5% pebbles
80	5.5	60% cobble and 20% fines 20% pebbles
160	5.75	75% fines and 25% cobble
240	6.17	60% fines and 25% cobble 15% pebbles
290	6.0	40% rip rap (up to 1' in diameter), 20% fines, 10% cobble and 10% pebbles
370	6.0	90% fines and 10% pebbles
509	7.2	80% fines, 15% pebbles, and 5% cobble

	Length (ft.)	Height (ft.)	Width (ft.)
Davis Park Culvert	509	8.17	24.75

Salmonid Migrational Assessment:

The Davis culvert has a length of 509 feet and, according to CDFG's culvert criteria, is impassable for rainbow trout and steelhead if water velocity exceeds 2 fps. It is impassable for young salmonids at a water velocity exceeding 1 fps.

Due to the substantial length of the culvert and the lack of resting pools, the EBRPD fisheries department hypothesizes that this barrier is probably impassable to up and downstream migrating juvenile or adult rainbow trout during most flow rates. This structure may be passable to upstream migrating steelhead under the proper flow conditions. Additionally, if the salmonids could swim up or downstream through the culvert during optimal flow conditions, it is questionable whether they would choose to do so because there is no illumination within the culvert channel.

Barrier Recommendations:

- Modification of this culvert to render it passable is a difficult prospect due to engineering concerns and the culture of vandalism. For example, according to CDFG, interior lighting should be installed "...in new and replacement culverts that are over 150 feet in length. Where supplemental lighting is required, the spacing between light sources shall not exceed 75 feet" (CDFG 2002). However, based on graffiti found in the study reach and throughout the length of the Davis Park culvert itself, any light sources installed in the culvert would be subjected to vandalism (breakage, spray painting, etc.). An alternative to artificial lighting would be to "daylight" portions of the culvert at carefully chosen intervals. Additionally, adding baffles or creating resting pools lessens the effectiveness of the culvert as a flood control measure and facilitate debris occlusion, but for rainbow trout and steelhead migrations, these additions would be beneficial.
 - Under ideal circumstances, this would be a well-lighted culvert consisting of a natural bottom with regularly spaced resting pools. To render this structure passable, the viability of installing and maintaining either natural or artificial lighting during the spawning season should be investigated.
 - It would be beneficial to remove the concrete bottom, which would enable the creek to establish subsurface texture that may result in the development of migrational resting pools. These resting pools are critical for both steelhead and rainbow trout navigating this culvert.
 - A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.
-

Section 4: Davis Park From Upstream of Davis Park Culvert to the 23rd Street Culvert

The Davis Park section comprised 9.66% of the study reach. This section had some salmonid rearing habitat and while there were four pools in the Early Summer survey, the two remaining pools in the Late Summer survey were considered inviable for rainbow trout because their depth was less than one foot and each pool's average dissolved oxygen levels were below the trouts' necessary 5 mg/l threshold. The Early Summer survey inventoried one young of the year trout and two non-native species, but none were found in the Late Summer Survey. Davis Park did have an above average bioassessment score (86) but had below average scores in the key trout habitat characteristics, epifaunal substrate and pool variability. The presence of garbage and anthropogenic effects was average.

Davis Park Section Recommendations:

- Overall, this section has some trout habitat potential, but is not a high priority target for restoration and is best suited as a migrational corridor; however,
- The deepening of the four pools found in the Late Summer survey as well as the addition of large woody debris would foster the presence of rainbow trout and macroinvertebrates.
- Cultivating the canopy cover downstream of the 23rd Street culvert by planting stabilizing bank trees could lead to the development of undercut, stabilized banks and help improve the prospect of future trout habitat.

Davis Park – Migrational Barrier 1 of 1: 23rd Street Culvert



Figure 40. This upstream-facing image is the 23rd street culvert. The culvert curves toward the left bank.

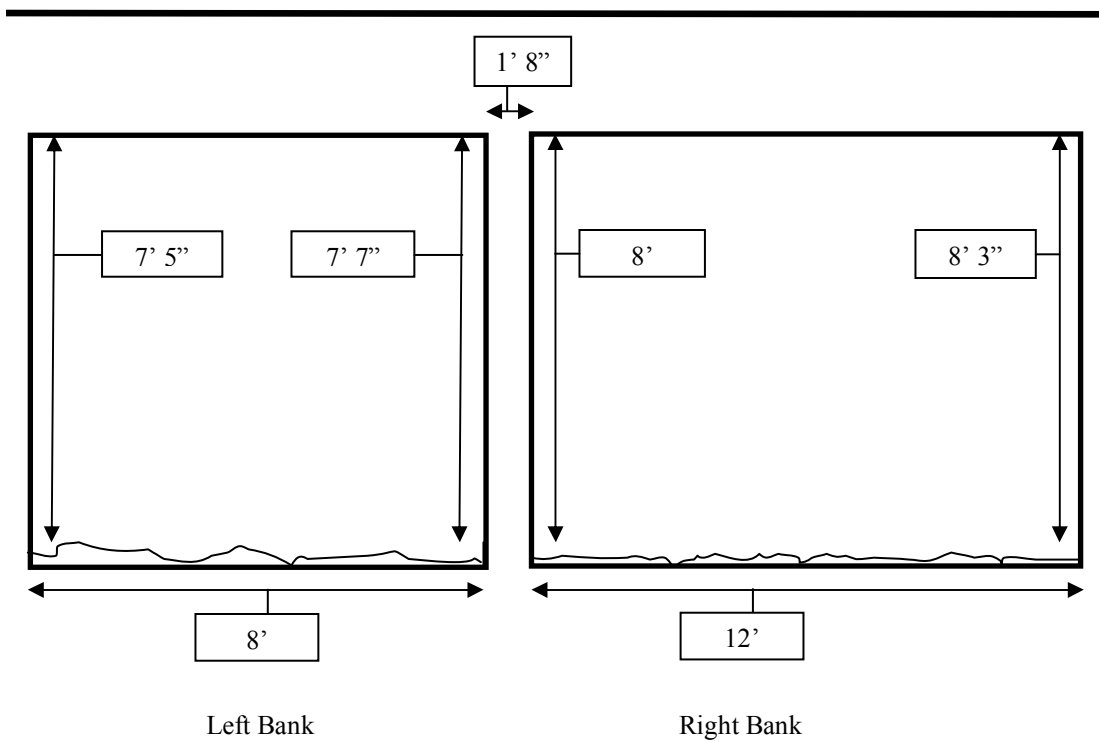


Figure 41. Upstream-facing dimensions of the 23rd St. culvert. The total length of the culvert, as measured through the right bank conduit, was 90 feet.

Salmonid Migrational Assessment:

The 23rd Street culvert had a total length of 90 feet and, based on CDFG's culvert criteria, is impassable when water velocities exceed 5 fps for steelhead and 4 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG's culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability dependent on the water velocity at a specific time.

Barrier Recommendations:

- Removal of the concrete bottom would increase the roughness of the corridor and allow the creek to establish a natural bottom. Pools may develop and the increased roughness would have a slowing effect on the water, though whether that would be a significant reduction is unknown.
 - A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.
-

Section 5: 23rd Street
From Upstream of the 23rd Street Culvert to the Van Ness Culvert

The 23rd Street section comprised 8.66% of the study reach. This section had good rearing habitat and during the Early Summer survey one young of the year trout was inventoried. The canopy cover in this section was good. There were six pools in the Early Summer survey that met the viable trout pool criteria. However, by the Late Summer survey, only one pool remained and it no longer met the minimum criteria to be viable for rainbow trout. The presence of anthropogenic garbage and debris was above average. This section had a slightly below average bioassessment rating.

23rd Street Section Recommendations:

- The 23rd Street section has some trout habitat potential, but is not a high priority target for restoration and is best suited as a migrational corridor; however
- Several of the bank stabilizing apparatuses are beginning to fail and coordinating restoration efforts with their repair or removal could yield a substantial habitat improvement for the rainbow trout.
- Deepening the existing pools and introducing large woody debris would foster the presence of rainbow trout and macroinvertebrates.
- Improve the overall canopy cover in this section by fostering the existing trees and planting new trees on or near the stream banks.

23rd Street – Migrational Barrier 1 of 1: Van Ness Culvert



Figure 44. Upstream-facing image of the Van Ness culvert

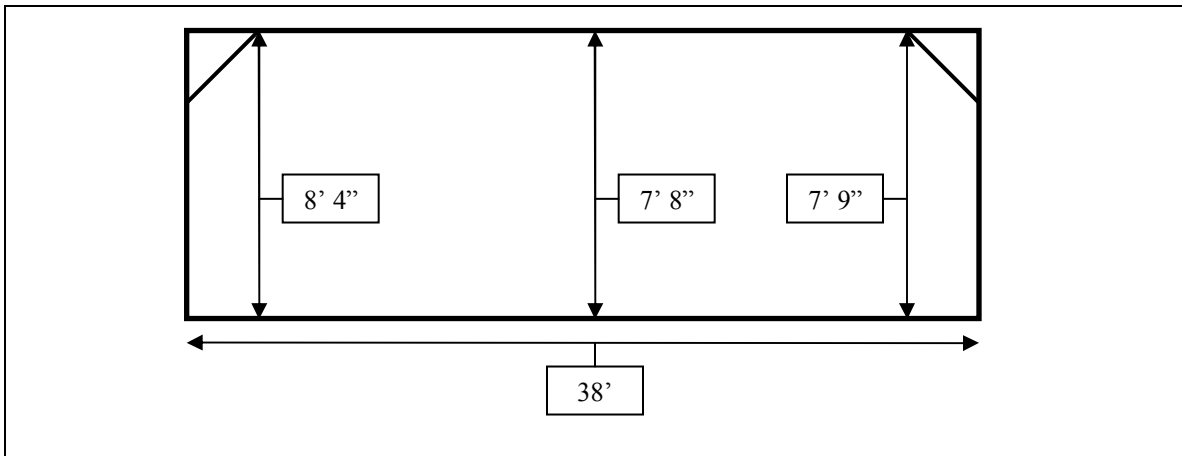


Figure 45. The dimensions of the Van Ness culvert while facing upstream. Three different height measurements were taken under the culvert at the most downstream side. The total length of the culvert was 48', measured in the middle of the culvert.



Figure 46. Upstream-facing image of the channel just downstream of the Van Ness culvert.

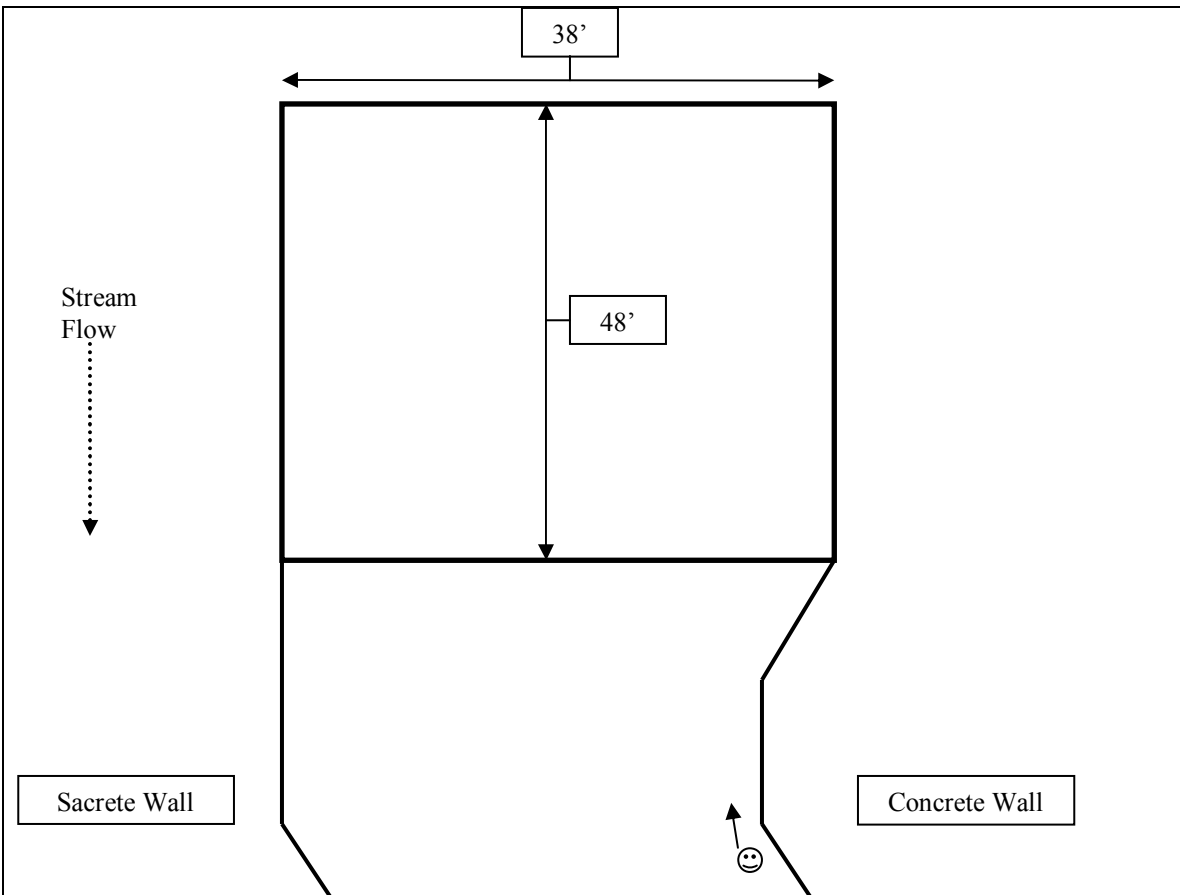


Figure 47. Top view dimensions of the Van Ness culvert. The smiley face and associated arrow indicate where the picture in Figure 46 was taken.

Table 13. Summary Measurements of the Van Ness Culvert			
	Length (ft.)	Height (ft.)	Width (ft.)
Van Ness Culvert	48	7.67	38
Van Ness Culvert Channel	≈85	≈8	≈25

Salmonid Migrational Assessment:

The Van Ness culvert proper had a total length of 48 feet and, based on CDFG’s culvert criteria, is impassable when water velocities exceed 6 fps for steelhead and 4 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps. However, the channel leading toward the culvert is lined with sacrete (left bank) and brick (right bank), which considerably increases the length of the creek that behaves as though it is in a culvert. Consequently, the Van Ness culvert and Van Ness culvert channel had a combined length of approximately 123 feet and, based on CDFG’s culvert criteria, is impassable when water velocities exceed 4 fps for steelhead and 3 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG’s culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time.

Barrier Recommendations:

- Investigate the viability of creating and maintaining resting pools within the channel, especially in the area on the right bank where the channel opens up to the culvert proper.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.

Section 6: Van Ness
From Upstream of the Van Ness Culvert to the Church Culvert

The Van Ness section comprised 10.6% of the study reach. This section had some good rearing habitat but was devoid of over-summering pools. No rainbow trout were found in this section during any of the surveys. There were five pools in the Early Summer survey that met the viable trout pool criteria. However, by the Late Summer survey, only one pool remained and it no longer met the minimum criteria to be viable for rainbow trout. The presence of anthropogenic garbage and debris was average. This section had an average bioassessment rating.

Van Ness Section Recommendations:

- This section has some trout habitat potential, but is not a high priority target for restoration and would be well-suited if left as just a migrational corridor; however,
- Deepening the existing pools and introducing large woody debris would foster the presence of rainbow trout and macroinvertebrates.
- Improve the overall canopy cover in this section by fostering the existing canopy cover and planting new trees on or near the stream banks. The area just downstream of the Church culvert has almost zero canopy cover and would be a good location for planting.

Van Ness – Migrational Barrier 1 of 1: Church Culvert



Figure 48. Upstream-facing picture of the Church culvert with graffiti and trash visible in the right conduit.

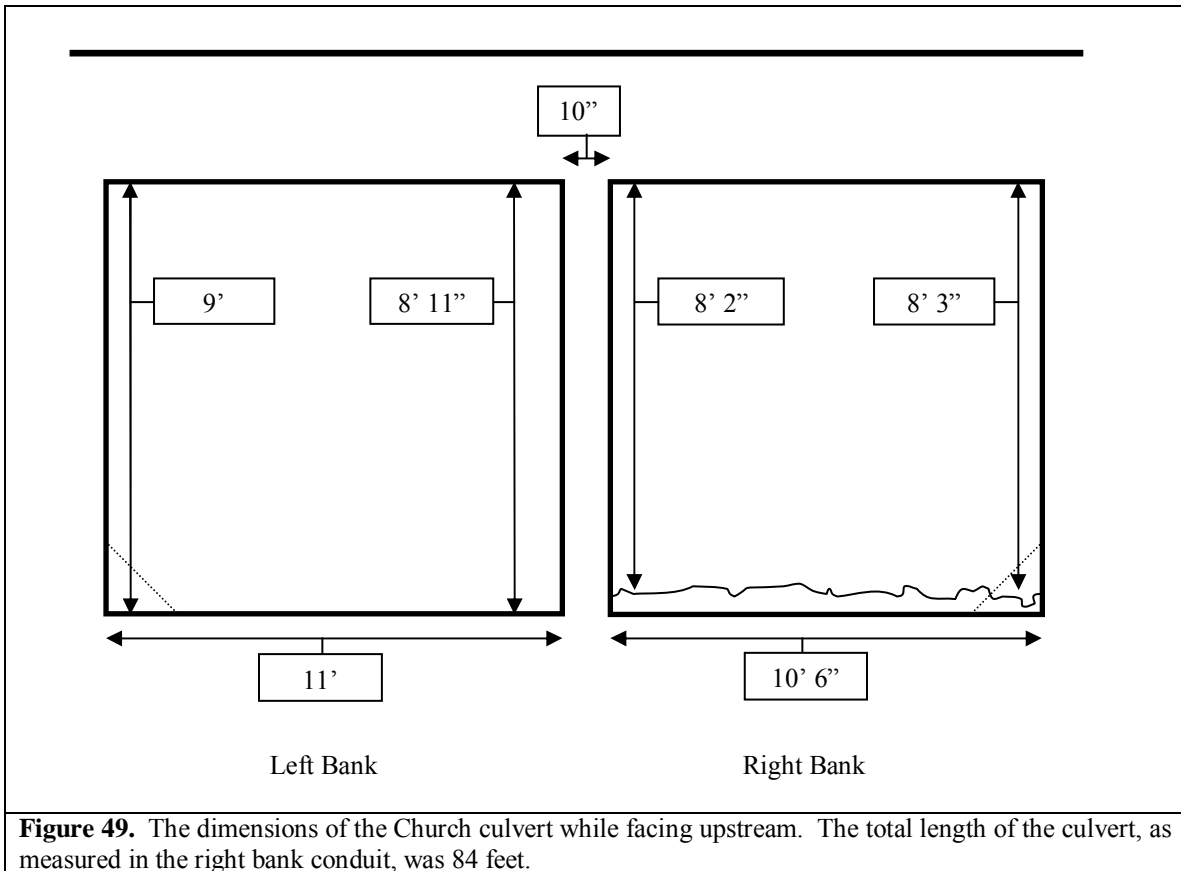


Figure 49. The dimensions of the Church culvert while facing upstream. The total length of the culvert, as measured in the right bank conduit, was 84 feet.

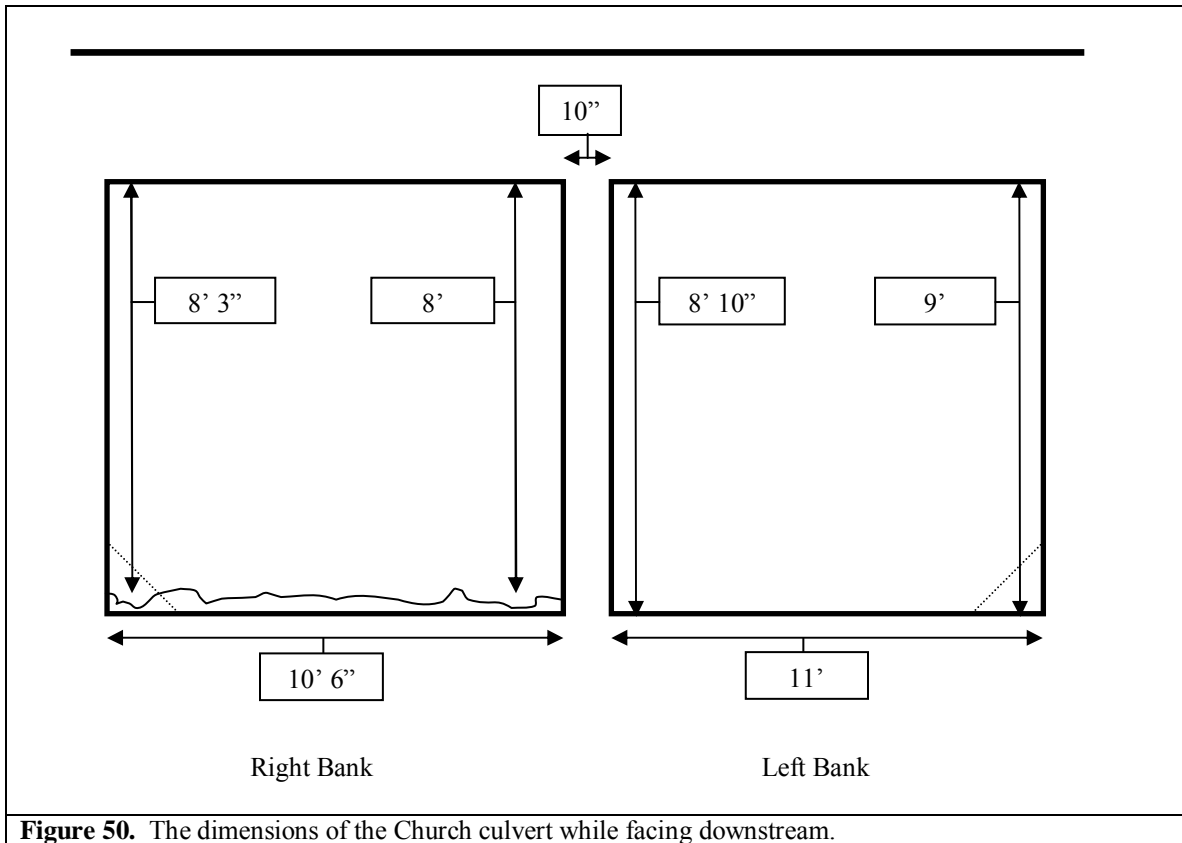


Figure 50. The dimensions of the Church culvert while facing downstream.

Table 14. Summary Measurements of the Church Double Box Culvert			
	Length (ft.)	Height (ft.)	Width (ft.)
Church Culvert	84	8.83	22.33

Salmonid Migrational Assessment:

The Church culvert had a total length of 84 feet and, based on CDFG's culvert criteria, is impassable when water velocities exceed 5 fps for steelhead and 4 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG's culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time.

Barrier Recommendations:

- Add baffles or rock weirs to generate heterogeneity in the channel.
- Investigate the viability of creating and maintaining resting pools within the channel.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.

Section 7: Church **From Upstream of the Church Culvert to the Vale Culvert**

The Church section comprised the largest percent of the study reach (17.11%) and in the Late Summer survey provided the second highest percent of the available wetted area (21.47%). For the study reach, this section had the highest overall bioassessment score and was found to have good canopy cover, pool variability and overall habitat. In the Early Summer survey, this section had the second highest number of pools (11) and, by the Late Summer survey, had the second highest number of viable trout pools (3). Church was found to have a good amount of salmonid rearing habitat, good epifaunal substrate and its average dissolved oxygen levels stayed within the viable range. In the Early Summer survey, two young of the year trout were inventoried in this section, and in the Late Summer survey, three trout were inventoried (one adult and two YOY). The Church section also had the highest degree of stream sinuosity, which is a stream characteristic that encourages habitat heterogeneity. Garbage and anthropogenic effects were below average. Some areas of the corridor were fenced off on both banks, possibly resulting in less riparian intrusion.

Church Section Recommendations:

There are some good targets for pool enhancement in this section.

- Approximately six pools would benefit from deepening, the creation of undercut banks and/or the introduction of large woody debris to foster instream cover. One particular pool is located at the base of a California buckeye. Its lack of depth and instream cover rendered it inviable for rainbow trout in the Late Summer survey but with attentive restoration and habitat modification it could be a boon to the local rainbow trout.
- In areas where sacrete is failing, the viability of planting trees along the stream banks should be investigated.
- Improve the overall canopy cover in this section by fostering the existing canopy cover and planting new trees on or near the stream banks. The area just downstream of the Vale culvert has almost zero canopy cover and would be a good location for planting.

Church – Migrational Barrier 1 of 1: Vale Culvert



Figure 51. Upstream-facing picture of the Vale street culvert. In the foreground is a shopping cart in the Vale street plunge pool.

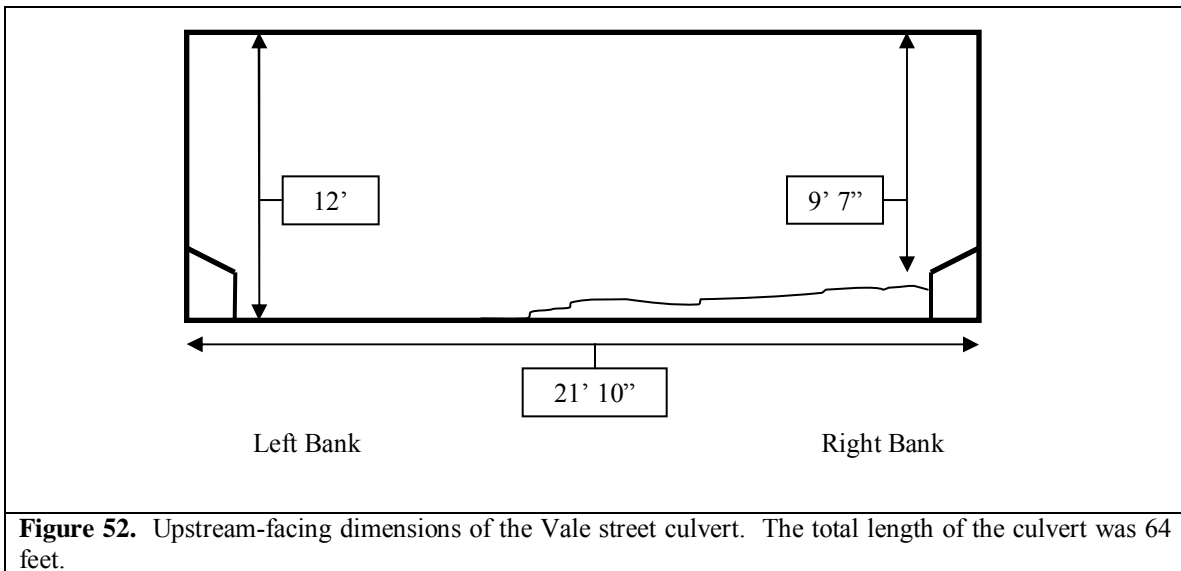


Figure 52. Upstream-facing dimensions of the Vale street culvert. The total length of the culvert was 64 feet.

Table 15. Summary Measurements of the Vale Culvert			
	Length (ft.)	Height (ft.)	Width (ft.)
Vale Culvert	64	12	21.83

Salmonid Migrational Assessment:

The Vale culvert had a total length of 64 feet and, based on CDFG’s culvert criteria, is impassable when water velocities exceed 5 fps for steelhead and 4 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG’s culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time. However, due to well water provided by the DMC outflow, the Vale culvert may be passable to rainbow trout during the dry summer months, but areas downstream of the Vale culvert are considerably less hospitable during these months than those upstream of the culvert and migration into these areas could result in mortality if the pools dried out and the trout could not escape.

Additionally, the barrier between the plunge pool and the Vale culvert spillway is less than 1 foot, so it should be easily navigable for upstream migrating steelhead.

Barrier Recommendations:

- Remove the culvert’s concrete bottom, which would enable the creek to establish subsurface texture that may result in the development of migrational resting pools.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.

Section 8: Vale

From Upstream of the Vale Culvert to the San Pablo Culvert

The Vale section comprised 16.27% of the study reach and in the Late Summer survey provided the highest percentage of the available wetted area (50.8%). In fact, for the entire study reach, this section also had the smallest percent reduction in wetted area (65.05%). This section was clearly the wettest in the study reach, which is attributable to the manmade outflow originating at the Doctor's Medical Center. For the study reach, this section had the second highest overall bioassessment score and was found to have good canopy cover, pool variability and overall habitat. In the Early Summer survey, this section had the highest number of pools (19) and, by the Late Summer survey, had the highest number of viable trout pools (4). Vale was found to have a good amount of salmonid rearing and spawning habitat; in fact, the habitat in this section was the only obvious spawning habitat in the study reach. Vale also had the best riffle to pool ratio in the reach (1.02). Furthermore, this section also had good epifaunal substrate but in the Late Summer survey its average dissolved oxygen levels were just below the viable range for rainbow trout. In the Early Summer survey, nine adult trout and twenty-four young of the year trout were inventoried in this section. There were also three non-natives inventoried. In the Late Summer survey, only one adult and one YOY trout were inventoried. There was also one non-native inventoried. Garbage and anthropogenic effects were below average.

Section Recommendations:

- The Vale pools had downstream of the DMC outflow had good depth, which should be monitored, but they were lacking instream large woody debris. Fostering undercut banks along the DMC outflow-fed pools would dramatically improve the habitat for resident trout.
- Farther upstream, pools should be deepened and cultivated with large woody debris and undercut banks.
- Improve the overall canopy cover in this section by fostering the existing canopy cover and planting new trees on or near the stream banks. The area just downstream of the San Pablo culvert has almost zero canopy cover and would be a good location for planting.

Vale – Migrational Barrier 1 of 1: San Pablo Culvert



Figure 53. This picture shows the downstream side of the San Pablo Culvert. Of note are the five baffles near the culvert outlet

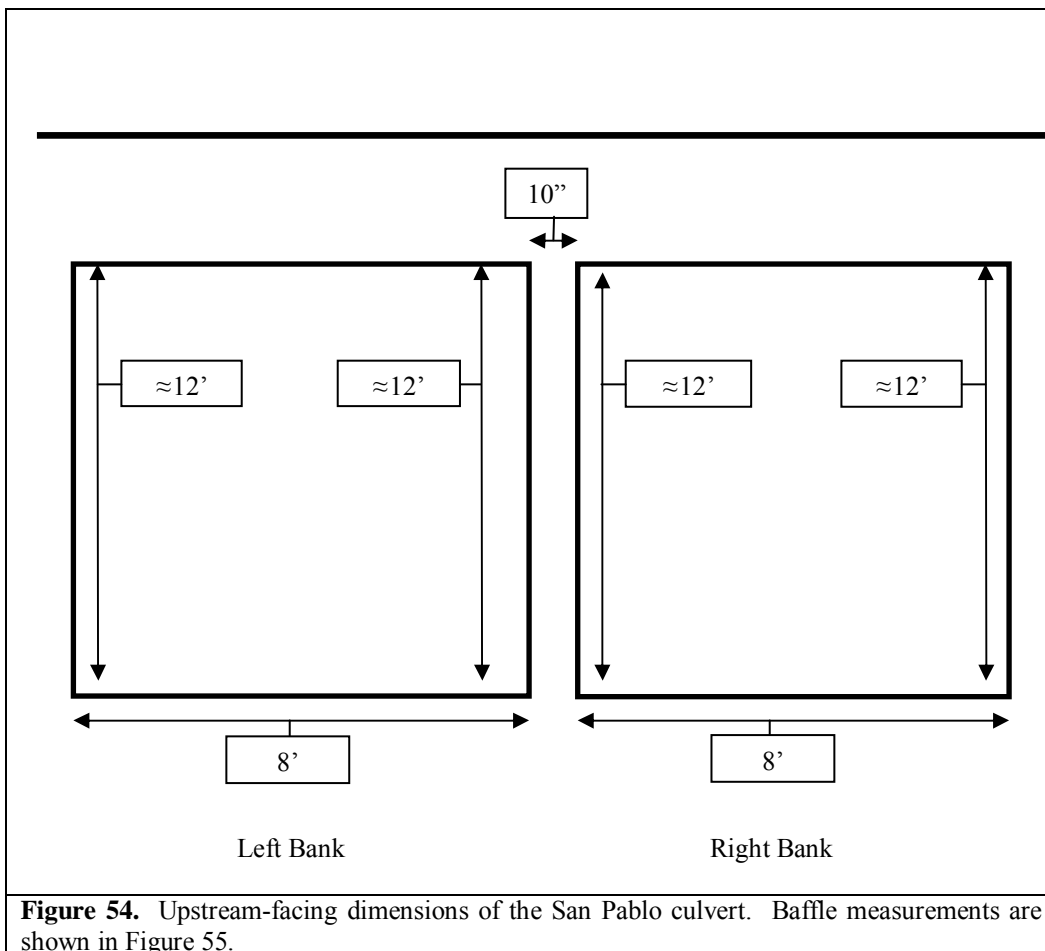


Figure 54. Upstream-facing dimensions of the San Pablo culvert. Baffle measurements are shown in Figure 55.

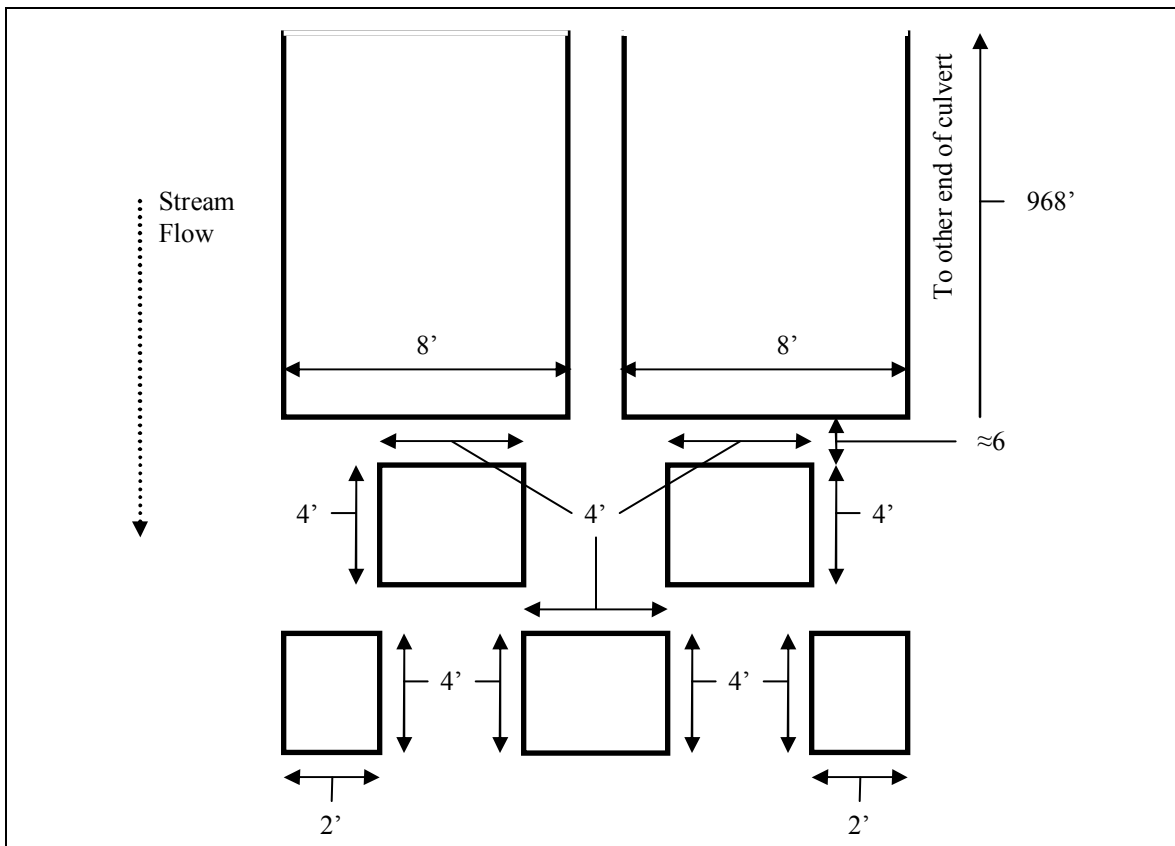


Figure 55. Top view of the San Pablo culvert. In addition to the dimensions shown above, all the baffles have a height of 4 feet.

	Length (ft.)	Height (ft.)	Width (ft.)
San Pablo Culvert	968	≈12	16.83

Salmonid Migrational Assessment:

The San Pablo culvert had a total length of 968 feet. Based on its length, CDFG’s culvert criteria defined this structure as impassable when water velocity exceeds 2 feet per second (fps) for steelhead and adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Due to the sheer length of the culvert and the lack of resting pools, the EBRPD fisheries department hypothesizes that this barrier is impassable to juvenile and adult rainbow trout and probably impassable to upstream migrating steelhead. Additionally, even if the salmonids could swim up or downstream through the culvert during optimal flow conditions, it is questionable whether they would choose to do so because there is no illumination within the culvert channel.

Barrier Recommendations:

- Modification of this culvert to render it passable is a difficult prospect due to engineering concerns and the culture of vandalism. For example, according to CDFG, interior lighting should be installed "...in new and replacement culverts that are over 150 feet in length. Where supplemental lighting is required, the spacing between light sources shall not exceed 75 feet" (CDFG 2002). However, based on graffiti found in the study reach and throughout the length of the Davis Park culvert itself, any light sources installed in the culvert would be subjected to vandalism (breakage, spray painting, etc.). An alternative to artificial lighting would be to "daylight" portions of the culvert at carefully chosen intervals. Additionally, adding baffles or creating resting pools lessens the effectiveness of the culvert as a flood control measure and facilitate debris occlusion, but for rainbow trout and steelhead migrations, these additions would be beneficial.
 - Under ideal circumstances, this would be a well-lighted culvert consisting of a natural bottom with regularly spaced resting pools. To render this structure passable, the viability of installing and maintaining either natural or artificial lighting during the spawning season should be investigated.
 - It would be beneficial to remove the concrete bottom, which would enable the creek to establish subsurface texture that may result in the development of migrational resting pools. These resting pools are critical for both steelhead and rainbow trout navigating this culvert.
 - A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.
-

Section 9: San Pablo
From Upstream of the San Pablo Culvert to the I-80 Culvert

The San Pablo section comprised 9.18% of the study reach. This section had good salmonid rearing habitat but was devoid of any spawning habitat. During the Late Summer survey, the average dissolved oxygen levels in this section were below the 5 mg/l threshold necessary for the survival of rainbow trout, so there were no over-summering pools in this section. Even though San Pablo had good epifaunal substrate, it earned a slightly below average bioassessment score due to the erosion potential of its banks, mediocre pool variability, and low channel sinuosity. During the Early Summer survey one young of the year trout was inventoried. However, despite having four viable trout pools, no trout were found in this section during the Late Summer survey. The presence of anthropogenic garbage and debris was variable between visits. In the Early Summer survey there was a permanent homeless camp on the right bank under a bridge. Garbage was scattered across the bank and into the stream. In the Late Summer survey that camp had been removed and the garbage cleaned up.

Section Recommendations:

- Approximately four pools would benefit from deepening, the creation of undercut banks and/or the introduction of large woody debris to foster instream cover.
- Improve the overall canopy cover in this section by fostering the existing trees and planting new trees on or near the stream banks.

San Pablo – Migrational Barrier 1 of 1: I-80 Culvert



Figure 56. Upstream-facing view of the I-80 culvert.

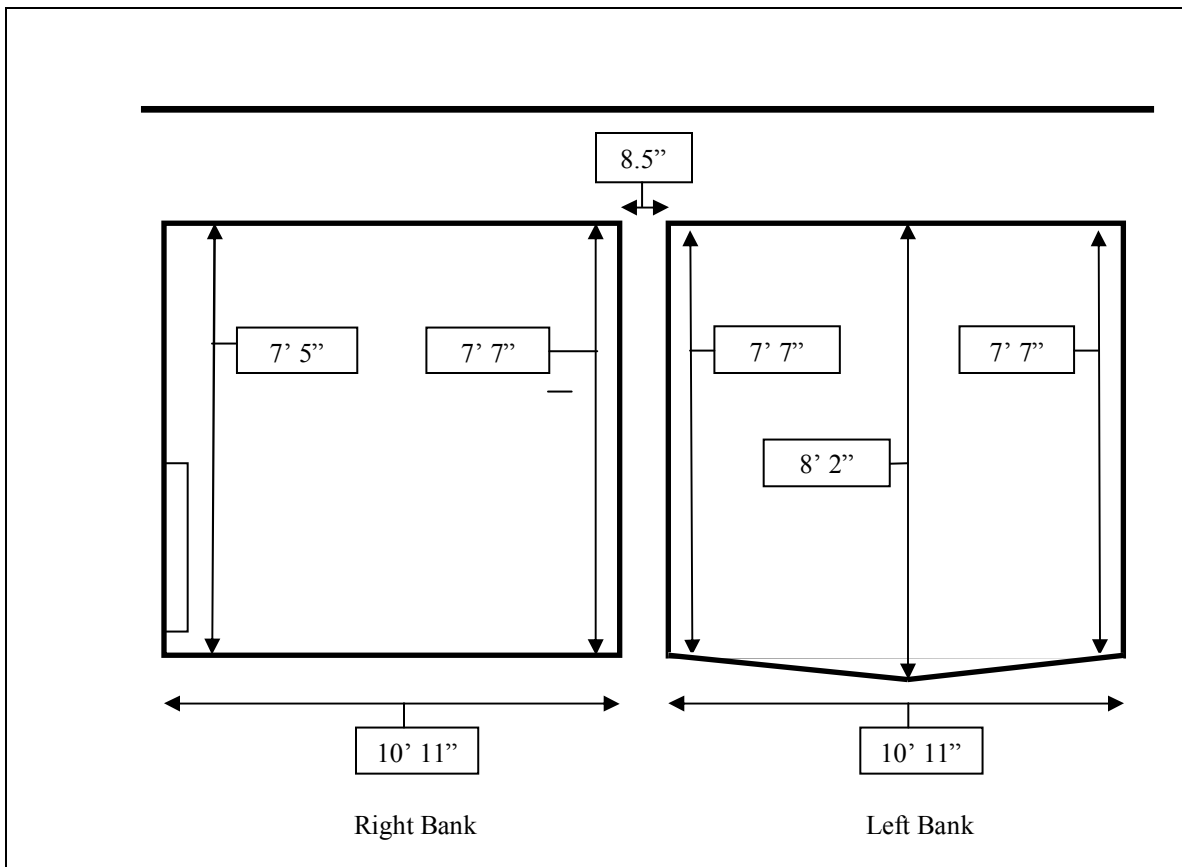


Figure 57. Upstream facing dimensions of the I-80 culvert. Length was 260' measured in the left bank conduit. The culvert had a concrete substrate.

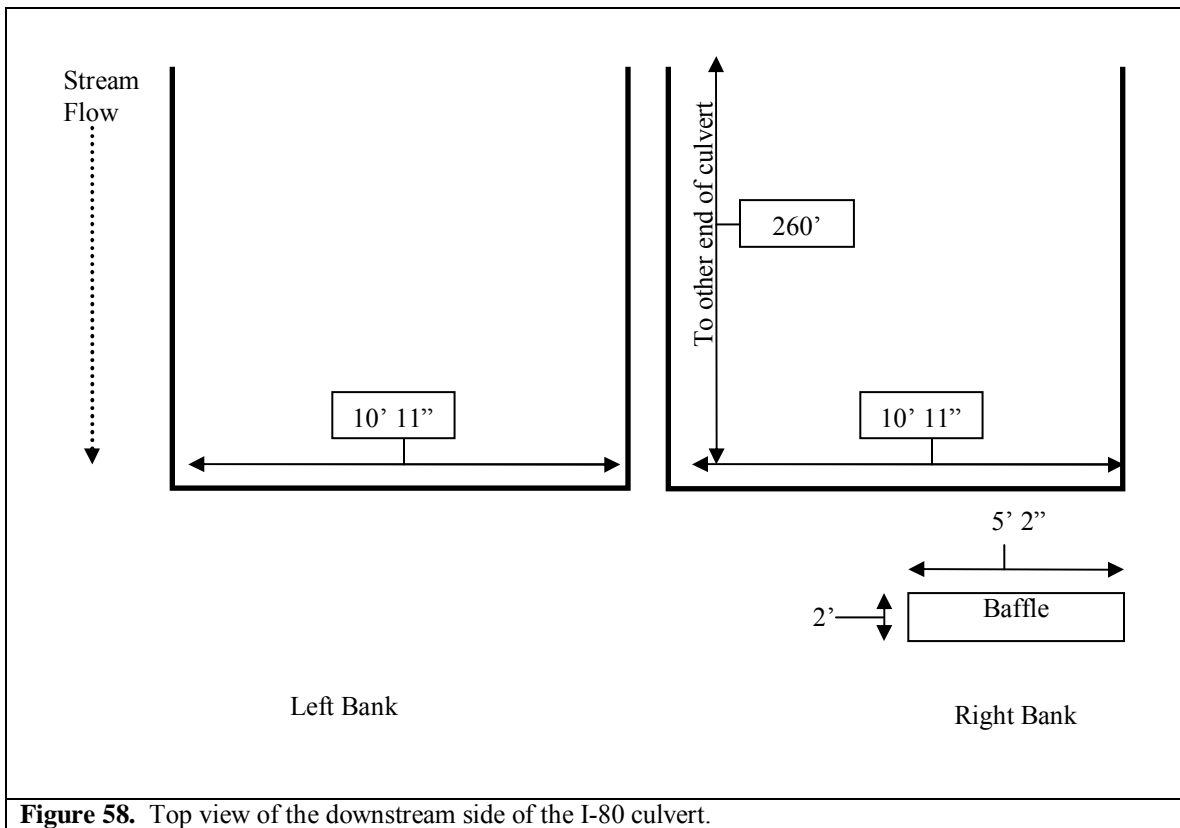


Figure 58. Top view of the downstream side of the I-80 culvert.

Table 17. Summary Measurements of the I-80 Double Box Culvert			
	Length (ft.)	Height (ft.)	Width (ft.)
I-80 Culvert	260	8.17	22.54

Salmonid Migrational Assessment:

The I-80 culvert had a total length of 260 feet and, based on CDFG’s culvert criteria, is impassable when water velocities exceed 3 fps for steelhead and 2 fps for adult rainbow trout. It is impassable for young salmonids when water velocity exceeds 1 fps.

Based on CDFG’s culvert criteria, the EBRPD fisheries department hypothesizes that this structure is intermittently passable year-round with passability being dependent on the water velocity at a specific time.

Barrier Recommendations:

- Add baffles or rock weirs to generate heterogeneity in the channel.
- Investigate the viability of removing the concrete bottom and creating and maintaining resting pools within the channel.
- A flow gauge station should be established in order to determine the water velocity in this structure over the course of the wet season.

Wildcat Creek Passability Calendar by Migrational Barrier												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead Spawning	=====											
Fish Ladder	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Trestle Bridge	Yes	Yes	Yes	Yes	Yes	Yes	*****	*****	*****	*****	Yes	Yes
Rumrill Culvert	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Concrete Channel	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Davis Park Culvert	?	?	?	?	?	?	*****	*****	*****	*****	?	?
23rd Street Culvert	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Van Ness Culvert	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Church Culvert	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Vale Culvert	Int	Int	Int	Int	Int	Int	***** See Note Below *****				Int	Int
San Pablo Culvert	No	No	No	No	No	No	*****	*****	*****	*****	No	No
I-80 Culvert	Int	Int	Int	Int	Int	Int	*****	*****	*****	*****	Int	Int
Key:	=====	= Rainbow trout and steelhead are spawning.										
	Int	= The barriers are intermittently passable when water is present but streamflow is below CDFG criteria.										
	*****	= No available water. The barriers are impassable.										
	Yes	= The barriers are passable.										
	?	= Due to the length of the structure and lack of resting pools, it is impassable to rainbow trout. However, it may be passable to steelhead if the flow is < 2 feet per second.										
	No	= Due to length, lack of resting pools and absence of lighting, the barrier is impassable despite sufficient water.										

Figure 59. This figure conveys the overall passability assessment of the study reach. Only the San Pablo culvert is entirely impassable to up and downstream migrating salmonids. The Davis Park culvert is probably impassable to rainbow trout but may be passable to steelhead under the correct flow conditions. The rest of the migrational barriers are probably intermittently passable based on the presence and behavior of the water in the channel. Setting up flow gauge stations could verify the ‘intermittent’ rating of a specific migrational obstacle. To successfully restore the steelhead run in Wildcat Creek, it is absolutely critical that the water velocity in the study reach be carefully studied. Note: Due to outflow from the DMC, the Vale culvert may be intermittently passable to rainbow trout during the summer months, but areas downstream of the Vale culvert are considerably less hospitable during these months than those upstream of the culvert.

6.0 RECOMMENDATIONS

- To successfully restore the steelhead run in Wildcat Creek, it is absolutely critical that the water velocity in the study reach be carefully studied. Flow gauge stations need to be established at each migrational barrier and monitored throughout the study reach during the rainy season. Besides the Davis Park and San Pablo migrational barriers, the greatest obstacle to upstream steelhead migration is water velocity. Specifically, eight of the eleven migrational barriers identified in the study reach (Figure 59) were designated intermittently passable. This rating was defined as the barrier being passable when there was sufficient water present but with stream flow below CDFG criteria. However, when water availability and stream flow favor one intermittently rated migrational barrier (thus rendering it passable), it may be that another intermittently passable barrier is still impassable because that barrier has substantially different dimensions. A fair analogy would be a series of drawbridges: just because one bridge is down does not mean that the others will be. A careful study of the water velocity throughout the study reach will generate a more thorough understanding of the hydrodynamics in the reach and, if needed, will allow for the sound development of engineering controls.
- Successful remediation of the study reach would be facilitated by a community invested in its success. Based on the garbage and debris in the study reach, there is a general disregard for the health and integrity of Wildcat Creek in the study reach. A concerted cultural campaign to generate a sense of ownership and understanding of the creek, and its native rainbow trout, would reap substantial long-term rewards.
 - Media outlets should be kept apprised of the progress of the program
 - Local schools should be recruited to help with the restoration efforts. Children should be taken on a field trip to upper Wildcat Creek so they could compare it to the area of the study reach.
 - Homeowners and businesses with properties adjacent to the creek should be made aware of the creek restoration effort and invited to participate.
- In conjunction with community outreach, signage should be employed to deter dumping of garbage in the riparian corridor. Educational signage focused on the preservation and

enhancement of the native rainbow trout should be erected at or around the Davis Park bridge.

- In a perfect world, buffer zones of 50 – 100 feet would be established on either side of the riparian corridor to facilitate creating and maintaining a high quality ecosystem. Perhaps a sustained buying program could, over time, reclaim the land immediately adjacent to the riparian corridor and be set aside for renaturalization projects.

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