California Department of Fish and Game
Petaluma River Watershed
Stream Habitat Assessment Reports

Washington Creek

Surveyed 2007

STREAM INVENTORY REPORT

Washington Creek

Surveyed Summer 2007
Report Completed March 2008

INTRODUCTION

A stream inventory was conducted during 7/2/2007 to 9/11/2007 on Washington Creek. The survey began at the confluence with Petaluma River and extended upstream 3.4 miles.

The Washington Creek inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Washington Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions and recommend options for the potential enhancement of habitat for Chinook salmon and steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Washington Creek is a tributary to the Petaluma River, a tributary to San Pablo Bay, and is located in Sonoma County, California (Map 1). Washington Creek's legal description at the confluence with the Petaluma River is T05N R07W S28. Its location is 38°14'43.0" north latitude and 122°38'15.0" west longitude, LLID number 1226374382454. Washington Creek is a second order stream and has approximately 10.72 miles of blue line stream according to the USGS National Hydrography Dataset (NHD). Washington Creek drains a watershed of approximately 4.79 square miles. Elevations range from about 7 feet at the mouth of the creek to 1,266 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily privately owned (98.7%) and the rest is owned by the local government (1.7%). The land use is considered natural 56.3%, agriculture 24.9% and urban 18.8%. Vehicle access exists via East Washington Street east of Petaluma.

METHODS

The habitat inventory conducted in Washington Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Department of Fish and Game (DFG) personnel and Watershed Stewards Project/AmeriCorps (WSP) members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game. This inventory was conducted by a

two-person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest (measured in the thalweg), dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement. All pools except step-pools are fully sampled.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Washington Creek to record measurements and observations. There are eleven components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) near the bottom of the stream survey reach using a Marsh-McBirney Model 2000 flow meter.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity. Channel characteristics are measured using a clinometer, hand level, hip chain, tape measure, and a stadia rod.

3. Temperatures:

Both water and air temperatures are measured and recorded at every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1990). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Washington Creek habitat

typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Washington Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3) and 76 - 100% (value 4). Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide juvenile salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition for prey. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Washington Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully-described habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes and recorded as a one and two, respectively. In addition, the dominant substrate composing the pool tail-outs is recorded for each pool.

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densiometers as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Washington Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or hardwood trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are

usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Washington Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation (including downed trees, logs, and rootwads) was estimated and recorded.

10. Large Woody Debris Count:

Large woody debris (LWD) is an important component of fish habitat and an element in channel forming processes. In each habitat unit all pieces of LWD partially or entirely below the elevation of bankfull discharge are counted and recorded. The minimum size to be considered is twelve inches in diameter and six feet in length. The LWD count is presented by reach and is expressed as an average per 100 feet.

11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Washington Creek. In addition, one site was electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.18, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Game. This program processes and summarizes the data, and produces the following ten tables:

- Riffle, Flatwater, and Pool Habitat Types
- Habitat Types and Measured Parameters
- Pool Types
- Maximum Residual Pool Depths by Habitat Types
- Mean Percent Cover by Habitat Type
- Dominant Substrates by Habitat Type

- Mean Percent Vegetative Cover for Entire Stream
- Fish Habitat Inventory Data Summary by Stream Reach (Table 8)
- Mean Percent Dominant Substrate / Dominant Vegetation Type for Entire Stream
- Mean Percent Shelter Cover Types for Entire Stream

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Washington Creek include:

- Riffle, Flatwater, Pool Habitat Types by Percent Occurrence
- Riffle, Flatwater, Pool Habitat Types by Total Length
- Total Habitat Types by Percent Occurrence
- Pool Types by Percent Occurrence
- Maximum Residual Depth in Pools
- Percent Embeddedness
- Mean Percent Cover Types in Pools
- Substrate Composition in Pool Tail-outs
- Mean Percent Canopy
- Dominant Bank Composition by Composition Type
- Dominant Bank Vegetation by Vegetation Type

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED AT THE END OF THE REPORT *

The habitat inventory of 7/2/2007 to 9/11/2007 was conducted by D. Acomb, H. Fett, (DFG) B. Nedland, and J. Hanson (WSP). The total length of the stream surveyed was 17,852 feet.

Stream flow was not measured on Washington Creek.

Washington Creek is a F6 channel type for 4,067 feet of the stream surveyed (Reach 1), a B1 channel type for 1,272 feet of the stream surveyed (Reach 2), a F6 channel type for 9,189 feet of the stream surveyed (Reach 3) and a F3 channel type for 3,324 feet of the stream surveyed (Reach 4).

F6 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and silt/clay dominant substrates. B1 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and bedrock dominant substrates. F3 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and cobble dominant substrates.

Water temperatures taken during the survey period ranged from 60 to 71 degrees Fahrenheit. Air temperatures ranged from 60 to 78 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 44% flatwater units, 5% pool units, 14% riffle units, 15% culvert units, 22% dry units, (Graph 1). Based on total length of Level II habitat types there were 29% flatwater units, 1% pool units, 4% riffle units, 4% culvert units, 62% dry units (Graph 2).

Six Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 33% Glide units, 15% Culvert units and 22% Dry units (Graph 3). The most frequent habitat types based on percent total length were 62% Dry units, 24% Glide units and 4% Low Gradient Riffle units.

A total of 5 pools were identified (Table 3). Main Channel pools were the most frequently encountered, at 100%, and comprised 100% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Four of the 5 pools (80%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 5 pool tail-outs measured, all 5 had a value of 4 (100%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 0, flatwater habitat types had a mean shelter rating of 4, and pool habitats had a mean shelter rating of 10 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 10 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Terrestrial Vegetation is the dominant cover types in Washington Creek. Graph 7 describes the pool cover in Washington Creek. Terrestrial Vegetation is the dominant pool cover type followed by no shelter.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. A silt/clay substrate type was observed in 40% of pool tail-outs and sand was observed in 40% of pool tail-outs.

The mean percent canopy density for the surveyed length of Washington Creek was 49%. The mean percentages of hardwood and coniferous trees were 100% and 0%, respectively. Fifty-one percent of the canopy was open. Graph 9 describes the mean percent canopy in Washington Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 52%. The mean percent left bank vegetated was 54%. The dominant elements composing the structure of the stream banks consisted of 10% bedrock, 3% boulder and 87% sand/silt/clay (Graph 10). Grass

was the dominant vegetation type observed in 48% of the units surveyed. Additionally, 32% of the units surveyed had deciduous trees as the dominant vegetation type, and 11% had brush as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

One site was electrofished for species composition and distribution in Washington Creek on September 19, 2007. The water temperature was taken during the electrofishing period as 54 degrees Fahrenheit. The air temperature was 62 degrees Fahrenheit. The sites were sampled by B. Nedland (WSP) and J. Hanson (WSP).

In reach 2, one site was sampled starting at approximately at Habitat Unit 41 and ending in Habitat Unit 41. The reach sites two hundred three-spine stickleback.

The following chart displays the information yielded from these sites:

2007 Washington Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/ Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
09/19/2007	615	WP 27	80	0	0	0	200 three-spine stickleback

DISCUSSION

Washington Creek is a F6 channel type for the first 4,067 feet of stream surveyed (Reach 1) and a B1 channel type for the next 1272 feet (Reach 2), a F6 channel type for 9,189 feet (Reach 3), and a F3 channel type the remaining 3,324 feet (Reach 4).

The suitability of F6 channel types for fish habitat improvement structures is as follows: good for bank placed boulders, fair for plunge weirs; boulder clusters; single and opposing wing deflectors; log cover. The suitability of B1 channel types for fish habitat improvement structures is as follows: excellent for bank-placed boulders; good for log cover; and poor for plunge weirs, single and opposing wing-deflectors and boulder clusters. The suitability of F3 channel types for fish habitat improvement structures is as follows: good for bank-placed boulders and single and opposing wing-deflectors; and fair for plunge weirs, boulder clusters, channel constrictors and log cover.

The water temperatures recorded on the survey days 7/2/2007 to 9/11/2007, ranged from 0 to 71 degrees Fahrenheit. Air temperatures ranged from 60 to 78 degrees Fahrenheit. To make any

further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 29% of the total length of this survey, riffles 4%, and pools 1%. The pools are relatively deep, with only 4 of the 5 (80%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum residual depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width Installing structures that will increase or deepen pool habitat is recommended for locations where their installation will not be threatened by high stream energy, or where their installation will not conflict with the modification of the numerous log debris accumulations (LDA's) in the stream.

None of the 5 pool tail-outs measured had embeddedness ratings of 1 or 2. Five of the pool tail-outs had embeddedness ratings of 3 or 4. None of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Washington Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Five of the 5 pool tail-outs had silt, sand, large cobble, boulders or bedrock as the dominant substrate. This is generally considered unsuitable for spawning salmonids.

The mean shelter rating for pools was 10. The shelter rating in the flatwater habitats was 4. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Terrestrial Vegetation in Washington Creek. Terrestrial Vegetation is the dominant cover type in pools followed by aquatic vegetation. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 49%. Reach 1 had a canopy density of 33%, Reach 2 had a canopy density of 40%, Reach 3 had a canopy density of 61% and Reach 4 had a canopy density of 64%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was moderate at 52% and 54%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

GENERAL RECOMMENDATIONS

Washington Creek should be managed as an anadromous, natural production stream.

Winter storms often bring down large trees and other woody debris into the stream, which increases the number and quality of pools. This woody debris, if left undisturbed, will provide fish shelter and rearing habitat, and offset channel incision. Landowners should be sensitive about the natural and positive role woody debris plays in the system, and encourages not to remove woody debris from the stream, except under extreme buildup and only under guidance by a fishery professional.

RECOMMENDATIONS

1) Water quantity is an on-going issue in many of the Petaluma River tributaries. Water conservation measures should be explored with the landowners and developed where possible.

2) Access for migrating salmonids should be assessed, monitored and improved along the stream, particularly at all road crossings and culverts. Where needed crossings and culverts should be replaced or modified to improve fish passage. Potential barriers noted in the assessment were located at the following locations: the mouth, Ely Road and Adobe Road culverts.

3) Increase the canopy on Washington Creek by planting appropriate native vegetation like willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable levels. The reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.

4) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.

5) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from Terrestrial Vegetation. Adding high quality complexity with woody cover in the pools is desirable.

6) Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

7) The limited water temperature data available suggest that maximum temperatures are above the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the May through October temperature extreme period should be performed for 3 to 5 years.

8) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

Position	Habitat Unit #	Comments
0	0001.00	Start of Survey: Start survey at confluence with the Petaluma River. At the mouth of Washington, 10' boulder riprap (for grade control) begins HU001, followed by cement apron 2.5' high by 15' long. WP018: 38.24549, 122.63790
544	0007.00	General Comment: Concrete apron outlet broken with scouring.
783	0012.00	General Comment: Out of the tidal influence.
884	0013.00	Structures: Bridge #1, Ellis Rd., H.: 11ft, W.: 80ft, L.: 36, no down cutting.
920	0014.00	General Comment: Boulder structures in stream bed, creek bottom turns to concrete.
1250	0015.00	Structures: Culvert #1, Madison Rd., 3 culverts, H.: 9ft, W.: 25ft, L.: 65ft, plunge height: 0ft, max depth w/in 5ft of outlet: 0.5, culvert slope ~ 0%, good condition, not a possible barrier to juveniles or adults.
1315	0016.00	General Comment: Western Pond Turtle and large algae blooms present.
2190	0024.00	General Comment: Ivy on left bank
2581	0028.00	Structures: Bridge # 2: "101 off ramp". Its dimensions are: 6 feet high, 100 feet wide and 25 feet long. There is zero down cutting and the bridge is not retaining gravel.
3006	0034.00	Structures: Bridge # 3: the dimensions of the bridge are: 6 feet high, 50 feet wide and 45 feet long. There is zero down cutting, no height to sill, and the bridge is not retaining gravel.
3083	0036.00	Structures: Bridge # 4: the dimensions of the bridge are: 6 feet high, 50 ft wide and 45 ft long. There is zero down cutting, no height to sill, and the bridge is not retaining gravel.
3140	0037.00	General Comment: This unit is characterized as being one long straight channel.
3936	0038.00	Structures: There are several weirs made with cemented rip-rap in this unit. The downstream weir is 1 foot high and the upstream weir is 2.5 feet high. There is a triangular cut in the middle of both weirs.
4067	0040.00	General Comment: Channel Type Change: F6=>B1, R1=>R2. B1 channel type is represented by a concrete drainage ditch running along the side of East Washington Street in Petaluma.

Position	Habitat Unit #	Comments
5393	0043.00	Access Points / Location: (Culvert) Culvert #2, Maria Drive road crossing. Concrete double box culvert, H6', W21', L54'. A maximum depth of 1.2' within 5' of outlet. Culvert slope is approximately 0%. Right bank box needs clearing; it's fully blocked with sediments. Left bank box is fine. WP025: 38.25262, 122.62306
5447	0044.00	Bio Sample: (Bank Observation) 418' into unit large Arundo patch extending for 80', WP027: 38.25366,122.62199.
7133	0051.00	Bio Sample: (Bank Observation) Tadpoles and non-salmonid fish observed.
7141	0052.00	Fish Passage: (Culvert) Concrete culvert under Ely Rd. has a slope of 0.5% and length is 128'. (H6', W12'. L128') No weirs or baffles in culvert. Jump height is 3.3' (2.5 plunge height + 0.8 max depth within 5' of outlet). After culvert, Cemented riprap after culvert.
7141	0052.00	Access Points / Location: (Culvert) Culvert #3, Ely Road crossing. Concrete single box culvert, H6', W21', L128'. Plunge height at outlet is 2.5’ and maximum depth within 5 ft of the outlet is 0.8’ deep. Slope = 0.5%. It is currently in good condition, is not retaining gravel, But possible barrier due to steep slope.
7269	0053.00	Structures: First 30' of unit has banks made of cemented riprap.
9857	0054.00	Access Points / Location: (Bridge) Bridge #6, foot bridge in city park/golf course. Not affecting the creek in any visible way. (H8.5', W35', L7') WP030: 38.26179, 122.61585.
9974	0058.00	Structures: Many bank-placed boulders throughout unit.
10182	0062.00	Access Points / Location: (Culvert) Culvert #4, parking lot/golf course entrance. Concrete open-bottom arch culvert (H5.5', W22', L30') Culvert is retaining some silt. Otherwise, the slope is near 0% and condition is good. WP031: 38.26246, 122.61526.
11018	0064.00	Access Points / Location: (Bridge) Bridge #7, Rooster Run Gold Course - golf cart bridge. (H8', W57', L10') Not affecting the creek in any visible way.
11424	0066.00	Access Points / Location: (Bridge) Bridge #8, Rooster Run Golf Course - golf cart bridge (2) (H10', W50', L10') Bridge is not effecting the creek in any visible way. WP041: 38.26472, 122.61348.
13777	0068.00	Access Points / Location: (Bridge) Bridge #9, Private Drive. H8', W17', L51'. Bridge is retaining some gravel. WP042: 38.26801, 122.61098
14475	0070.00	Access Points / Location: (Culvert) Culvert #5, Adobe Road crossing. Concrete single-box culvert in good condition with no down cutting. However, a 3' jump appears 20' into unit, a possible barrier to juvenile salmonids. WP043: 38.26933, 122.60961.

Position	Habitat Unit #	Comments
14528	0071.00	General Comment: Channel Type Change: F6=>F3, R3=>R4 (at bottom of unit). WP044: 38.27119, 122.60647 were taken at top of unit.
17852	0095.00	End of Survey: End of Survey due to lack of landowner access. WP0047: 38.27557, 122.60565.

REFERENCES

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McCain, M., D. Fuller, L. Decker and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHC Currents. No.1. U.S. Department of Agriculture. Forest Service, Pacific Southwest Region.

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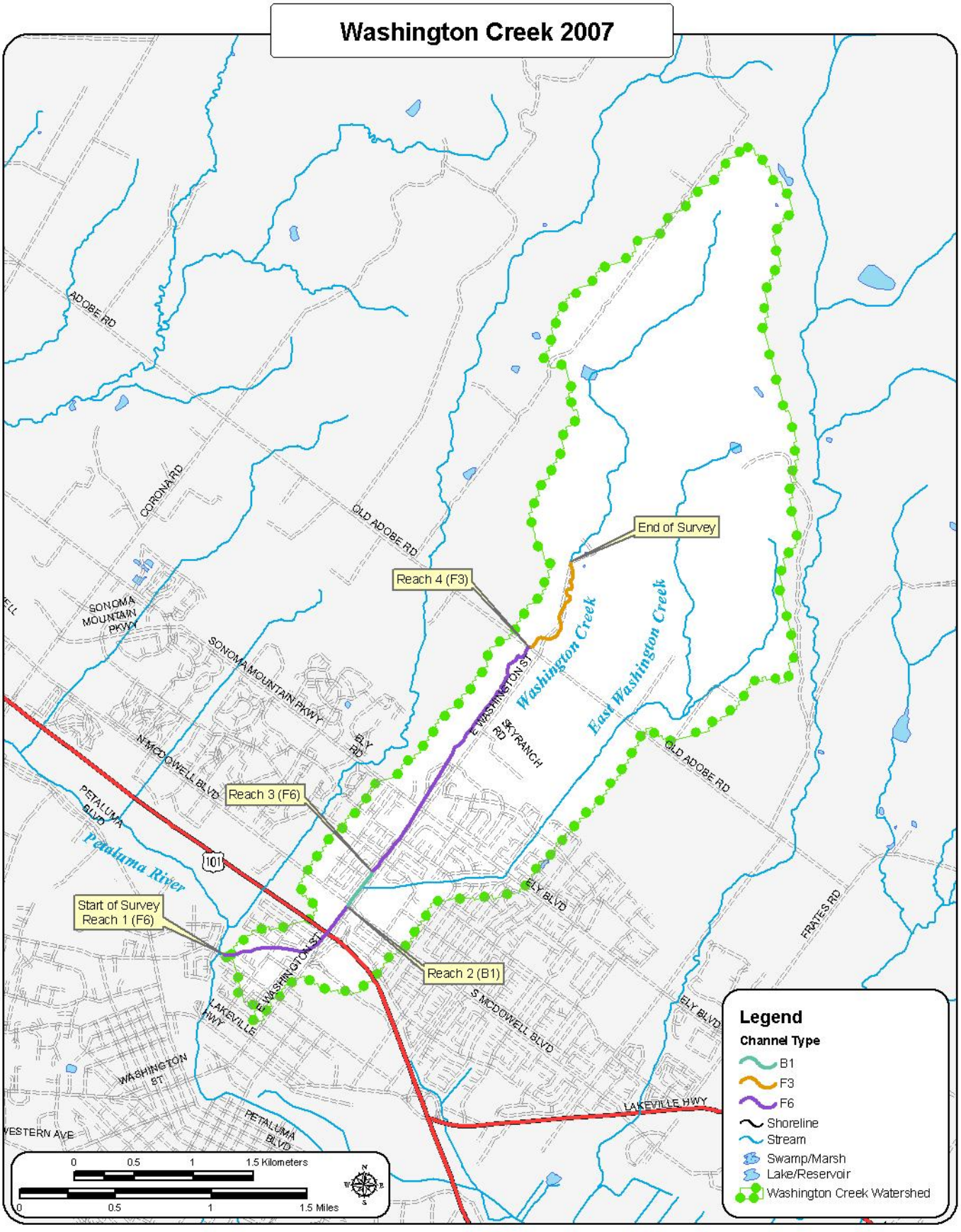

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Prepared by: Scott Webb, December 2007

LEVEL III and LEVEL IV HABITAT TYPES

RIFFLE			
Low Gradient Riffle	(LGR)	[1.1]	{ 1}
High Gradient Riffle	(HGR)	[1.2]	{ 2}
CASCADE			
Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
MAIN CHANNEL POOLS			
Trench Pool	(TRP)	[4.1]	{ 8 }
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOLS			
Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9 }
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{ 4 }
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5 }
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6 }
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7 }
Dammed Pool	(DPL)	[6.5]	{13}
ADDITIONAL UNIT DESIGNATIONS			
Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	

Table 1 - Summary of Riffle, Flatwater, and Pool Habitat Types

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: Quad: COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating
14	0	CULVERT	14.7	48	666	3.7									
21	0	DRY	22.1	528	11082	62.1									
42	21	FLATWATER	44.2	124	5187	29.1	6.7	0.6	1.2	798	33496	556	23355		4
5	5	POOL	5.3	26	128	0.7	11.8	1.5	2.5	371	1854	690	3449	641	10
13	4	RIFFLE	13.7	61	789	4.4	3.3	0.2	0.3	81	1053	16	205		0

Confluence Location: Quad: COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
95	30	17852	36403	27009

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: Quad: COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating	Mean Canopy (%)
13	4	LGR	13.7	61	789	4.4	3.0	0.2	0.5	81	1053	16	205		0	32
31	14	GLD	32.6	136	4203	23.5	8.0	0.8	2.2	1005	31157	756	23439		5	49
7	4	RUN	7.4	71	494	2.8	5.0	0.3	1.5	371	2594	135	947		1	59
4	3	SRN	4.2	122	490	2.7	4.0	0.4	1.1	398	1593	184	735		2	68
5	5	MCP	5.3	26	128	0.7	12.0	1.5	3.3	371	1854	690	3449	641	10	35
21	0	DRY	22.1	528	11082	62.1										62
14	0	CUL	14.7	48	666	3.7										

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
95	30	17852	38251	28775

Table 3 - Summary of Pools Types

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: **Quad:** COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Residual Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Residual Pool Vol (cu.ft.)	Estimated Total Resid. Vol (cu.ft.)	Mean Shelter Rating
5	5	MAIN	100	26	128	100	11.8	1.5	371	1854	641	3204	10

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)

5	5	128	1854	3204

Table 4 - Summary of Maximum Residual Pool Depths By Pool Habitat Types

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: Quad: COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Habitat Units	Habitat Type	Habitat Occurrence (%)	< 1 Foot Maximum Residual Depth	< 1 Foot Percent Occurrence	1 < 2 Feet Maximum Residual Depth	1 < 2 Feet Percent Occurrence	2 < 3 Feet Maximum Residual Depth	2 < 3 Feet Percent Occurrence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence
5	MCP	100	1	20	0	0	1	20	3	60	0	0

Total Units	Total < 1 Foot Max Resid. Depth	Total < 1 Foot % Occurrence	Total 1< 2 Feet Max Resid. Depth	Total 1< 2 Feet % Occurrence	Total 2< 3 Feet Max Resid. Depth	Total 2< 3 Feet % Occurrence	Total 3< 4 Feet Max Resid. Depth	Total 3< 4 Feet % Occurrence	Total >= 4 Feet Max Resid. Depth	Total >= 4 Feet % Occurrence
5	1	20	0	0	1	20	3	60	0	0

Mean Maximum Residual Pool Depth 3(ft.):

Table 5 - Summary of Mean Percent Cover by Habitat Type

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007 **Dry Units:** 21

Confluence Location: **Quad:** COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terrestrial Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges
13	4	LGR	0	0	0	0	0	0	0	0	0
13	4	TOTAL RIFFLE	0	0	0	0	0	0	0	0	0
31	14	GLD	4	0	7	11	7	7	0	7	0
7	4	RUN	0	0	0	20	5	0	0	0	0
4	3	SRN	0	0	0	0	33	0	0	0	0
42	21	TOTAL FLAT	2	0	5	11	10	5	0	5	0
5	5	MCP	12	2	0	16	24	16	0	10	0
5	5	TOTAL POOL	12	2	0	16	24	16	0	10	0
14	0	CUL									
95	30	TOTAL	4	1	3	10	11	6	0	5	0

Table 6 - Summary of Dominant Substrates by Habitat Type

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007 **Dry Units:** 21

Confluence Location: **Quad:** COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Habitat Units	Units Fully Measured	Habitat Type	% Total Silt/Clay Dominant	% Total Sand Dominant	% Total Gravel Dominant	% Total Small Cobble Dominant	% Total Large Cobble Dominant	% Total Boulder Dominant	% Total Bedrock Dominant
13	4	LGR	75	0	0	25	0	0	0
31	14	GLD	93	0	0	0	0	0	7
7	4	RUN	100	0	0	0	0	0	0
4	3	SRN	67	0	0	33	0	0	0
5	5	MCP	100	0	0	0	0	0	0
14	0	CUL	0	0	0	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: **Quad:** COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
49	0	100	6	52	54

Note: Mean percent conifer and hardwood for the entire reach are means of canopy components from units with canopy values greater than zero.

Open units represent habitat units with zero canopy cover.

Table 8 - Fish Habitat Inventory Data Summary

Stream Name: Washington Creek LLID: 1226374382454 Drainage: Petaluma River
Survey Dates: 7/2/2007 to 9/11/2007 Survey Length (ft.): 17852 Main Channel (ft.): 17852 Side Channel (ft.): 0
Confluence Location: Quad: COTATI Legal Description: T05NR07WS28 Latitude: 38:14:43.0N Longitude: 122:38:15.0W

Summary of Fish Habitat Elements by Stream Reach

STREAM REACH: 1

Channel Type: F6
Reach Length (ft.): 4067
Riffle/Flatwater Mean Width (ft.): 7.4
BFW:
Range (ft.): 12 to 24
Mean (ft.): 16.49
Std. Dev.: 4.78
Base Flow (cfs):
Water (F): 60 - 64 Air (F): 60 - 76
Dry Channel (ft.): 0

Canopy Density (%): 32.7
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation: Grass
Vegetative Cover (%): 61.0
Dominant Shelter: Root masses
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles: 0
Pools: 0
Flat: 0

Pools by Stream Length (%): 3.0
Pool Frequency (%): 10.3
Residual Pool Depth (%):
< 2 Feet Deep: 0.0
2 to 2.9 Feet Deep: 25.0
3 to 3.9 Feet Deep: 75.0
>= 4 Feet Deep: 0.0
Mean Max Residual Pool Depth (ft.): 2.975
Mean Pool Shelter Rating: 13

Pool Tail Substrate (%): Silt/Clay: 50.0 Sand: 25.0 Gravel: 0.0 Sm Cobble: 0.0 Lg Cobble: 0.0 Boulder: 25.0 Bedrock: 0.0
Embeddedness Values (%): 1. 0.0 2. 0.0 3. 0.0 4. 100.0 5. 0.0

STREAM REACH: 2

Channel Type: B1
Reach Length (ft.): 1272
Riffle/Flatwater Mean Width (ft.): 12.0
BFW:
Range (ft.): 6 to 17
Mean (ft.): 11.5
Std. Dev.: 5.5
Base Flow (cfs):
Water (F): 64 - 68 Air (F): 76 - 76
Dry Channel (ft.): 821

Canopy Density (%): 40.5
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation:
Vegetative Cover (%): 0.0
Dominant Shelter:
Dominant Bank Substrate Type: Bedrock
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles:
Pools:
Flat: 0

Pools by Stream Length (%): 0.0
Pool Frequency (%): 0.0
Residual Pool Depth (%):
< 2 Feet Deep:
2 to 2.9 Feet Deep:
3 to 3.9 Feet Deep:
>= 4 Feet Deep:
Mean Max Residual Pool Depth (ft.):
Mean Pool Shelter Rating:

Pool Tail Substrate (%): Silt/Clay: Sand: Gravel: Sm Cobble: Lg Cobble: Boulder: Bedrock:
Embeddedness Values (%): 1. 2. 3. 4. 5.

Summary of Fish Habitat Elements by Stream Reach

STREAM REACH: 3

Channel Type: F6
Reach Length (ft.): 9189
Riffle/Flatwater Mean Width (ft.): 5.0
BFW:
Range (ft.): 6 to 17
Mean (ft.): 10.48
Std. Dev.: 4.34
Base Flow (cfs):
Water (F): 68 - 71 Air (F): 69 - 78
Dry Channel (ft.): 8256

Canopy Density (%): 60.6
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation: Grass
Vegetative Cover (%): 27.5
Dominant Shelter: Terrestrial Veg.
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles: 0
Pools: 0
Flat: 0

Pools by Stream Length (%): 0.1
Pool Frequency (%): 3.4
Residual Pool Depth (%):
< 2 Feet Deep: 100.0
2 to 2.9 Feet Deep: 0.0
3 to 3.9 Feet Deep: 0.0
>= 4 Feet Deep: 0.0
Mean Max Residual Pool Depth (ft.): 0.6
Mean Pool Shelter Rating: 0

Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 100. Gravel: 0.0 Sm Cobble: 0.0 Lg Cobble: 0.0 Boulder: 0.0 Bedrock: 0.0
Embeddedness Values (%): 1. 0.0 2. 0.0 3. 0.0 4. 100.0 5. 0.0

STREAM REACH: 4

Channel Type: F3
Reach Length (ft.): 3324
Riffle/Flatwater Mean Width (ft.): 4.3
BFW:
Range (ft.): 15 to 22
Mean (ft.): 17.4
Std. Dev.: 2.42
Base Flow (cfs):
Water (F): 62 - 64 Air (F): 61 - 78
Dry Channel (ft.): 2005

Canopy Density (%): 64.4
Coniferous Component (%): 0.0
Hardwood Component (%): 100.0
Dominant Bank Vegetation: Hardwood Trees
Vegetative Cover (%): 72.5
Dominant Shelter: Large Woody Debris
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 16.7
LWD per 100 ft.:
Riffles: 0
Pools:
Flat: 0

Pools by Stream Length (%): 0.0
Pool Frequency (%): 0.0
Residual Pool Depth (%):
< 2 Feet Deep:
2 to 2.9 Feet Deep:
3 to 3.9 Feet Deep:
>= 4 Feet Deep:
Mean Max Residual Pool Depth (ft.):
Mean Pool Shelter Rating:

Pool Tail Substrate (%): Silt/Clay: Sand: Gravel: Sm Cobble: Lg Cobble: Boulder: Bedrock:
Embeddedness Values (%): 1. 2. 3. 4. 5.

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: **Quad:** COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

Mean Percentage of Dominant Stream Bank Substrate

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage (%)
Bedrock	3	3	9.7
Boulder	1	1	3.2
Cobble/Gravel	0	0	0.0
Sand/Silt/Clay	27	27	87.1

Mean Percentage of Dominant Stream Bank Vegetation

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage (%)
Grass	18	12	48.4
Brush	2	5	11.3
Hardwood Trees	9	11	32.3
Coniferous Trees	0	0	0.0
No Vegetation	2	3	8.1

Total Stream Cobble Embeddedness Values: 4

Table 10 - Mean Percent of Shelter Cover Types for Entire Stream

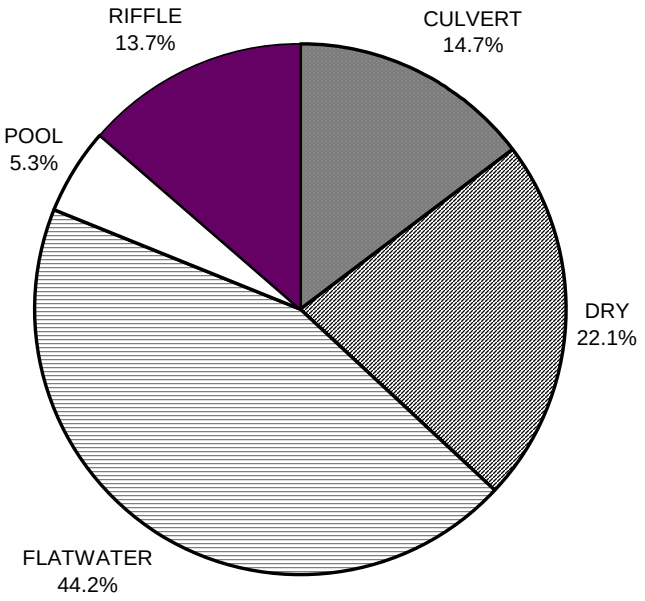
Stream Name: Washington Creek **LLID:** 1226374382454 **Drainage:** Petaluma River

Survey Dates: 7/2/2007 to 9/11/2007

Confluence Location: Quad: COTATI **Legal Description:** T05NR07WS28 **Latitude:** 38:14:43.0N **Longitude:** 122:38:15.0W

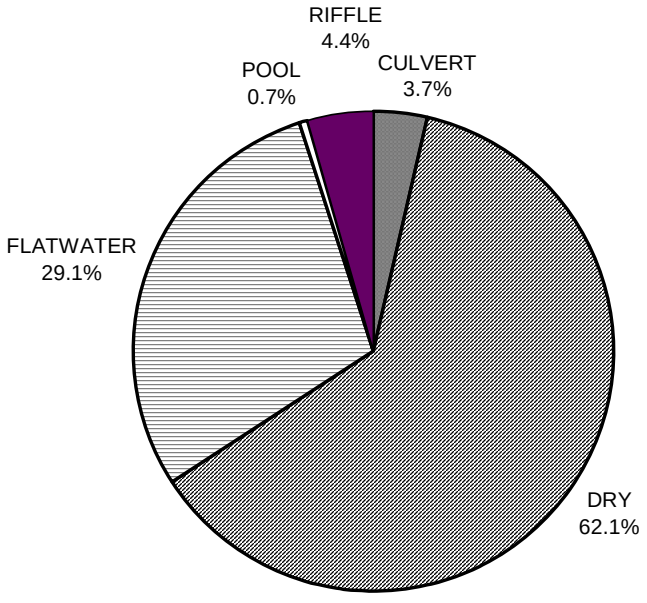
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	2	12
SMALL WOODY DEBRIS (%)	0	0	2
LARGE WOODY DEBRIS (%)	0	5	0
ROOT MASS (%)	0	11	16
TERRESTRIAL VEGETATION (%)	0	10	24
AQUATIC VEGETATION (%)	0	5	16
WHITEWATER (%)	0	0	0
BOULDERS (%)	0	5	10
BEDROCK LEDGES (%)	0	0	0

Washington Creek 2007
HABITAT TYPES BY PERCENT OCCURRENCE



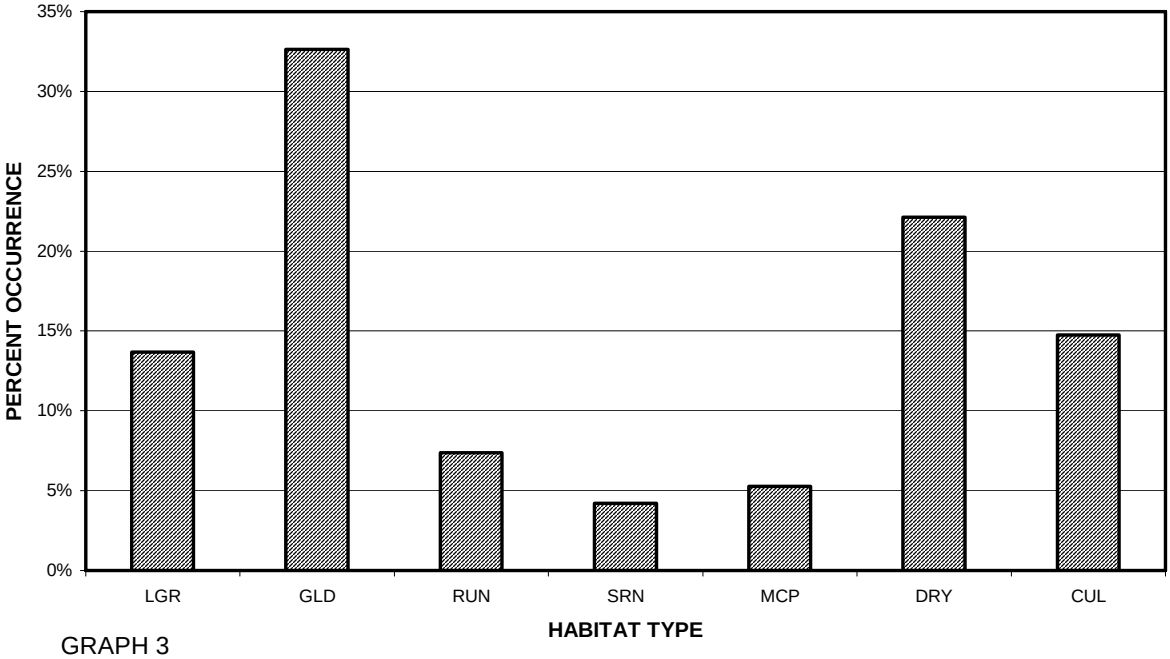
GRAPH 1

Washington Creek 2007
HABITAT TYPES BY PERCENT TOTAL LENGTH



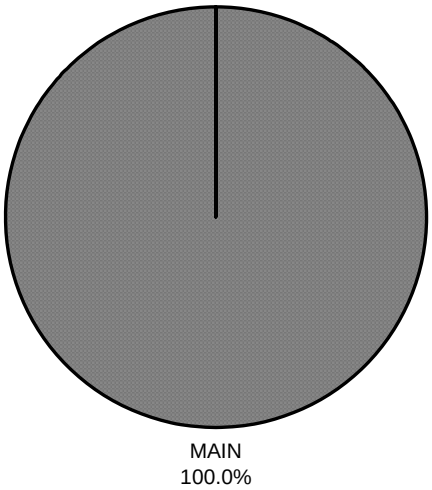
GRAPH 2

Washington Creek 2007
HABITAT TYPES BY PERCENT OCCURRENCE

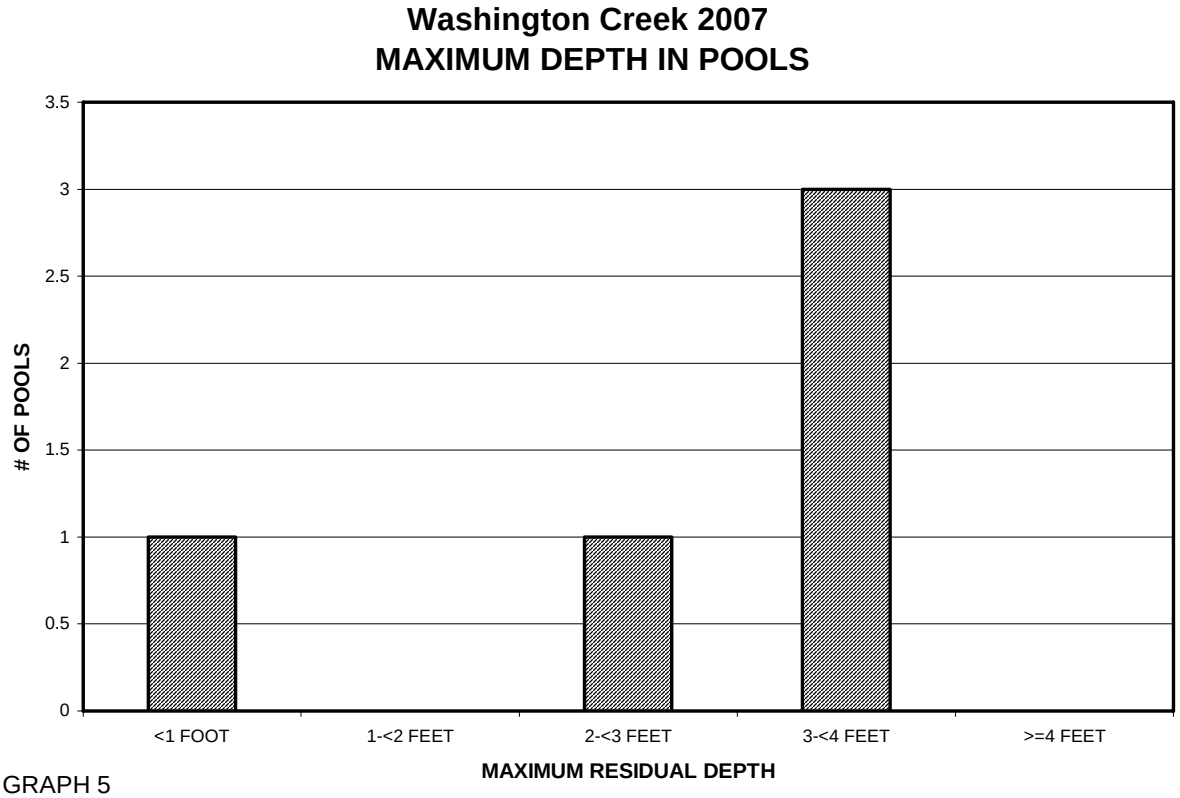


GRAPH 3

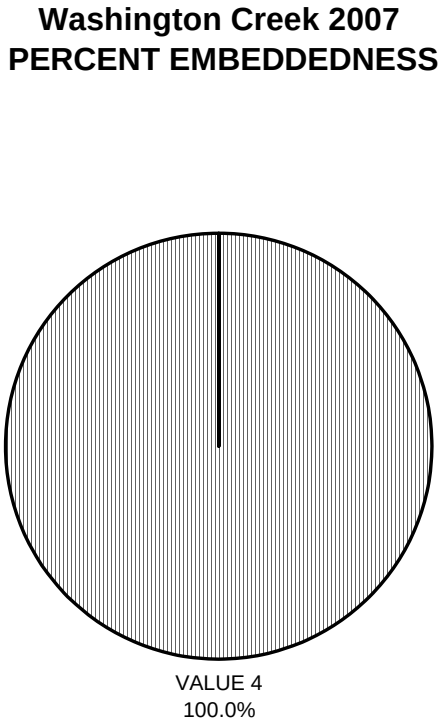
Washington Creek 2007
POOL TYPES BY PERCENT OCCURRENCE



GRAPH 4

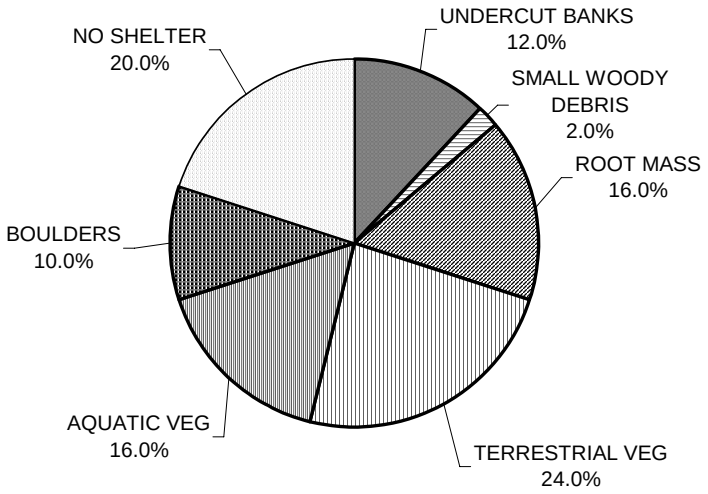


GRAPH 5



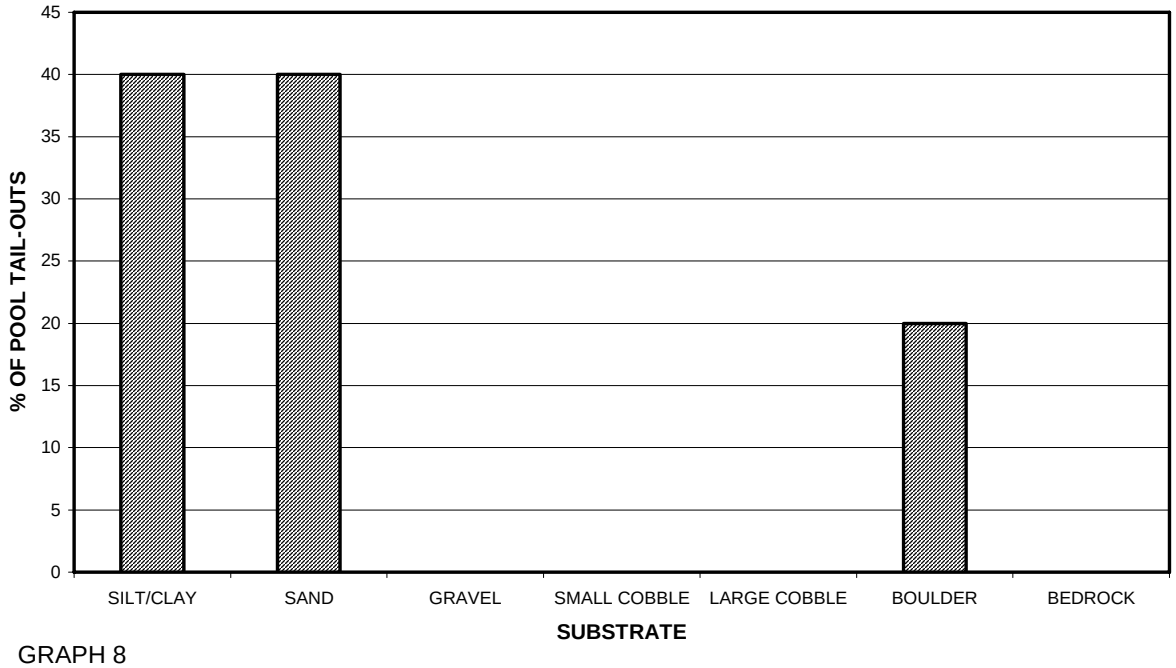
GRAPH 6

Washington Creek 2007
MEAN PERCENT COVER TYPES IN POOLS



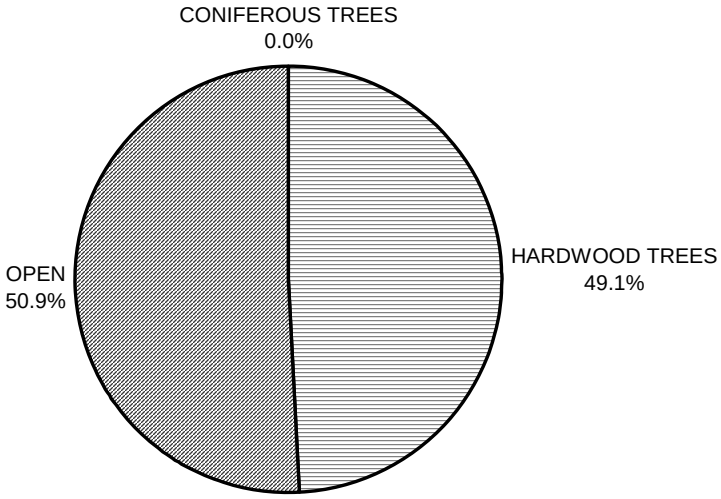
GRAPH 7

Washington Creek 2007
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



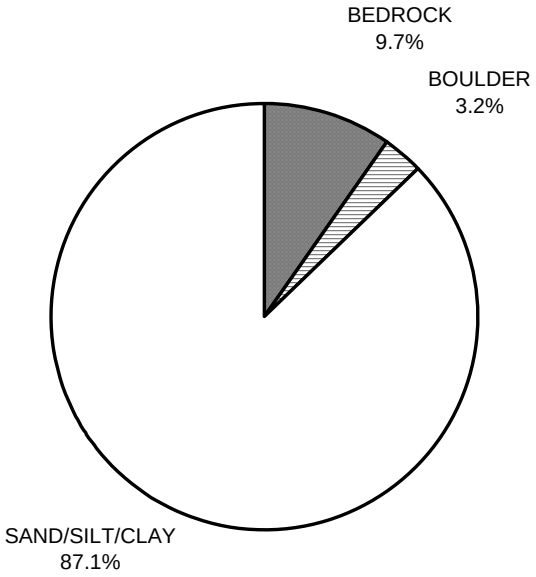
GRAPH 8

Washington Creek 2007
MEAN PERCENT CANOPY



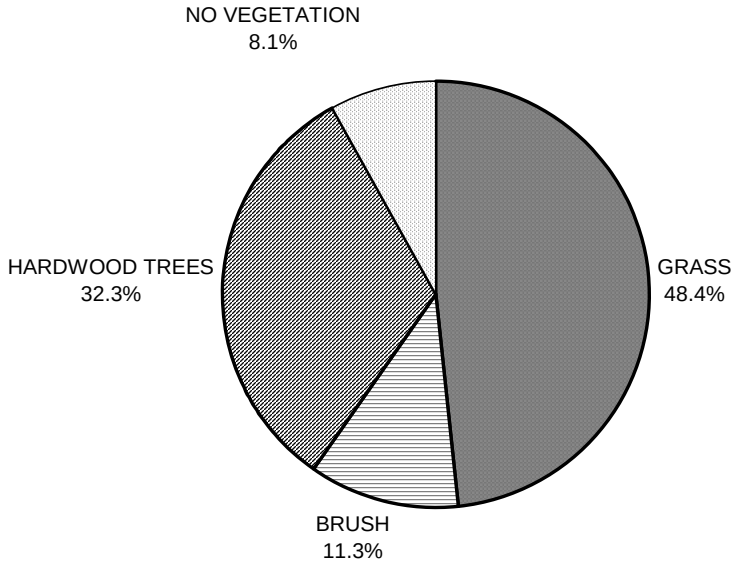
GRAPH 9

Washington Creek 2007
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

Washington Creek 2007
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11