California Department of Fish and Game
East Marin County
San Francisco Bay Watersheds
Stream Habitat Assessment Reports

Carey Camp Creek

Surveyed 2009

STREAM INVENTORY REPORT

Carey Camp Creek
Surveyed 2009
Report completed November 2010

INTRODUCTION

A stream inventory was conducted on 7/28/2009 on Carey Camp Creek. The survey began at the confluence with San Anselmo Creek and extended upstream 1 mile.

The Carey Camp 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 Carey Camp 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 steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Carey Camp Creek is a tributary to San Anselmo Creek, a tributary to Corte Madera Creek, which flows into San Francisco Bay, located in Marin County, California (Map 1). Carey Camp Creek's legal description at the confluence with San Anselmo Creek is T02N R07W S34. Its location is 37°58'43" north latitude and 122°36'56.4" west longitude, LLID number 1226145379786. Carey Camp Creek is a first order stream and has approximately 1.74 miles of blue line stream within its catchment boundary according to the USGS National Hydrography Dataset (NHD). Carey Camp Creek drains a watershed of approximately 0.38 square miles. Elevations range from about 197 feet at the mouth of the creek to 1,450 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily owned by local government and land use is considered 99.8% natural and 0.2% urban. Vehicle access exists via Cascade Drive in Fairfax.

METHODS

The habitat inventory conducted in Carey Camp Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The 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 (DFG). 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 fully measured. All other habitat unit types encountered for the first time in each reach 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.

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 Carey Camp 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". Carey Camp 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 Carey Camp 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 Carey Camp 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 Carey Camp 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 Carey Camp 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 Carey Camp 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 Carey Camp 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 7/28/2009 was conducted by A. Villalobos (WSP) and C. Bell (WSP). The total length of the stream surveyed was 5,461 feet.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.012 cfs on 7/28/2009.

Carey Camp Creek is an F4 channel type for 1,540 feet of the stream surveyed (Reach 1), an A2 channel type for 859 feet of the stream surveyed (Reach 2), and a A4 channel type for the final 3,061 feet of the stream surveyed (Reach 3).

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. A2 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and boulder dominant substrates. A4 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and gravel dominant substrates.

Water temperatures taken during the survey period ranged from 58 to 60 degrees Fahrenheit. Air temperatures ranged from 59 to 76 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 8% dry units, 6% culvert units, 27% flatwater units, 37% riffle units and 23% pool units (Graph 1). Based on total length of Level II habitat types there were 49% dry units, 22% flatwater units, 25% riffle units and 4% pool units (Graph 2).

Eleven Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 31% Low Gradient Riffle units, 21% Step Run units and 12% Plunge Pool units (Graph 3). Based on percent total length there were 49% Dry units, 25% Low Gradient Riffle units and 21% Step Run units.

A total of 12 pools were identified (Table 3). Scour pools were the most frequently encountered at 58% and comprised 66% 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. Two of the 12 pools (17%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 12 pool tail-outs measured, 6 had a value of 1 (50%); 6 had a value of 2 (50%); (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst.

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 2, flatwater habitat types had a mean shelter rating of 5 and pool habitats had a mean shelter rating of 13 (Table 1). Of the pool types, the Scour pools had a mean shelter rating of 12, Main Channel pools had a mean shelter rating of 14 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Carey Camp Creek. Graph 7 describes the pool cover in Carey Camp Creek. Boulders are the dominant pool cover type followed by undercut banks.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel dominance was observed in 92% of pool tail-outs and bedrock dominance was observed in 8% of pool tail-outs.

The mean percent canopy density for the surveyed length of Carey Camp Creek was 96%. The mean percentages of hardwood and coniferous trees were 100% and 0%, respectively. Four percent of the canopy was open. Graph 9 describes the mean percent canopy in Carey Camp Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 35%. The mean percent left bank vegetated was 35%. The dominant elements composing the structure of the stream banks consisted of 33% bedrock and 67% sand/silt/clay (Graph 10). Hardwood trees were the dominant vegetation type observed in 64% of the units surveyed. Additionally, 31% of the units surveyed had brush as the dominant vegetation type, and 6% had no vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

One site was electrofished for species composition and distribution in Carey Camp Creek on September 30, 2009. Water temperatures taken during the electrofishing period ranged from 58 to 60 degrees Fahrenheit. Air temperatures ranged from 65 to 66 degrees Fahrenheit. The sites were sampled by A. Villalobos, C. Bell, and T. Macias (WSP); and D Resnik (DFG).

In reach 1, one site was sampled. This site yielded three young-of-the-year steelhead/rainbow trout (SH/RT), one age 1+ SH/RT and one age 2+ SH/RT. Three California giant salamanders and one unknown species of salamander were also captured at this site.

The following chart displays the information yielded from these sites:

2009 Carey Camp Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/ Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
9/30/2009	722	Reach 1	N/A	3	1	1	3 California Giant Salamander, 1 unknown salamander

DISCUSSION

Carey Camp Creek is an F4 channel type for the first 1,540 feet of stream surveyed, an A2 channel type for the next 859 feet, and an A4 channel type for the remaining 3,062 feet. The suitability of F4 channel types for fish habitat improvement structures is as follows: Good for bank-placed boulders; fair for plunge weirs, single or opposing wing-deflectors, channel constrictors, and log cover; poor for boulder clusters. The suitability of A2 channel types for fish habitat improvement structures is as follows: Generally not suitable for improvement. These are high energy streams with stable banks and poor gravel retention capabilities. The suitability of A4 channel types for fish habitat improvement structures is as follows: Good for bank-placed boulders; fair for plunge weirs, opposing wing-deflectors, and log cover; poor for boulder clusters and single wing-deflectors.

The water temperatures recorded on the survey day 7/28/2009, ranged from 58 to 60 degrees Fahrenheit. Air temperatures ranged from 59 to 76 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 22% of the total length of this survey, riffles 25% and pools 4%. The pools are relatively shallow with only 2 of the 12 (17%) 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 any log debris accumulations (LDA's) in the stream.

All twelve of the pool tail-outs measured had embeddedness ratings of 1 or 2. None of the pool

tail-outs had embeddedness ratings of 3 or 4, and none 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 Carey Camp Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Eleven of the 12 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 13. The shelter rating in the flatwater habitats was 5. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Carey Camp Creek. Boulders are the dominant cover type in pools followed by undercut banks. 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 96%. Reach 1 had a canopy density of 97.8%, Reach 2 had a canopy density of 96.8% and Reach 3 had a canopy density of 94.4%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 35% for both. 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

Carey Camp 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 encouraged not to remove woody debris from the stream, except under extreme buildup and only under guidance by a fishery professional.

RECOMMENDATIONS

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

2) Access for migrating salmonids should be assessed at the mouth, waterfalls and dams. All fish passage assessments should be done according to Part 9 of the California Salmonid Stream Habitat Restoration Manual (Flosi et al, 1998). Where needed and if appropriate, barriers should be modified to improve fish passage.

3) 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 (ft.)	Habitat Unit #	Comments
0	0001.00	Start of Survey at confluence with San Anselmo Creek 37.97871N 122.61651W
0	0001.00	Fish Passage: Rip-rap was recently placed at the mouth of the creek which is a possible barrier to migrating salmonids.
48	0002.00	Access Points / Location: Bridge #1. Footbridge in Cascade Open Space Preserve. W=26' H=3' L=6'. Made of wood. Not retaining gravel, and not down cutting. Not likely a barrier to salmonids.
565	0006.00	Bio Sample: (Bank) Steelhead young of the year observed
592	0007.00	Fish Passage: (Falls) Large boulder creates 5' waterfall.
1,171	0015.00	Bio Sample: (Other) 5" unidentified fish observed.
1,180	0016.00	Erosion Site: (Bank) 15'x20' debris slide on left bank.
1,540	0022.00	General Comment: Channel type change, F4 to A2, Reach 1 to Reach 2.
1,562	0023.00	Tributaries: Right bank tributary #1. Dry, unnamed tributary enters Carey Camp Creek. Water temps downstream: 59F, upstream: 59F & tributary is dry. No fish observed.
1,657	0024.00	Tributaries: Right bank tributary #2. Dry, unnamed tributary enters Carey Camp Creek. Water temps downstream: 59F, upstream: 59F & tributary is dry. Accessible to fish. Checked 50' up tributary. No fish observed.
1,981	0026.00	Bio Sample: (Other) unidentified 3" fish observed
2,399	0030.00	General Comment: Channel type change, A2 to A4, Reach 2 to Reach 3.
2,469	0033.00	Fish Passage: (Falls) 12' vertical waterfall. Possible barrier to salmonids.
2,472	0034.00	Bio Sample: (Other) Salamanders observed
2,880	0043.00	Tributaries: Right bank tributary #3. Dry, unnamed tributary enters Carey Camp Creek. Water temperatures downstream: 62F, upstream: 62F & tributary is dry. Inaccessible to fish. No fish observed. N37.97648 W122.62440
2,880	0043.00	Bio Sample: (Other) Salamanders observed

Position (ft.)	Habitat Unit #	Comments
3,150	0047.00	Fish Passage: (Dam) Dam #1. L=0.5' H=3' W(0)=1' W(d)=6'.This is not a flashboard dam. Gravel is being retained, but there is no down cutting. Possible barrier to salmonids. N37.97643 W122.62460
3150	0048.00	Tributaries: Right bank tributary #4. Pine Mountain Tunnel enters Carey Camp Creek. Discharge estimated at 1cfs. Contributes an estimated 80% of flow to stream. Water temperature upstream was 61F & tributary was 64F. Inaccessible to fish. Checked 50' up tributary. No fish observed.
3,279	0049.00	Bio Sample: (Other) Salamanders observed
3,337	0051.00	Fish Passage: (Dam) Dam #2. L=1' H=9' W(0)=4' W(d)=20'.This is not a flashboard dam. Gravel is being retained, and down cutting is occurring. Height of downcut is 7'. Possible barrier to juvenile and adult salmonids. N37.97644 W122.62516
3,338	0052.00	General Comment: Right bank tributary #5. Dry, unnamed tributary 264' into unit. Discharge is 0 cfs. Water temps downstream, upstream, and tributary are all dry. Accessible to fish. Checked 100' up tributary. No fish observed.
3,338	0052.00	Tributaries: Left bank tributary #1. Dry, unnamed tributary 369' into unit. No water temperatures were taken because all creeks were dry. Inaccessible to fish. Checked 100' up tributary. No fish observed.
3,338	0052.00	Fish Passage: (Other) Left bank tributary #2. Dry, unnamed tributary enters Carey Camp Creek. No water temperatures were taken because all creeks were dry. Inaccessible to fish. Checked 50' up tributary. No fish observed.
5,460	0052.00	End of Survey: Steep waterfall, no way up or around. N37.97551,W122.63126

REFERENCES

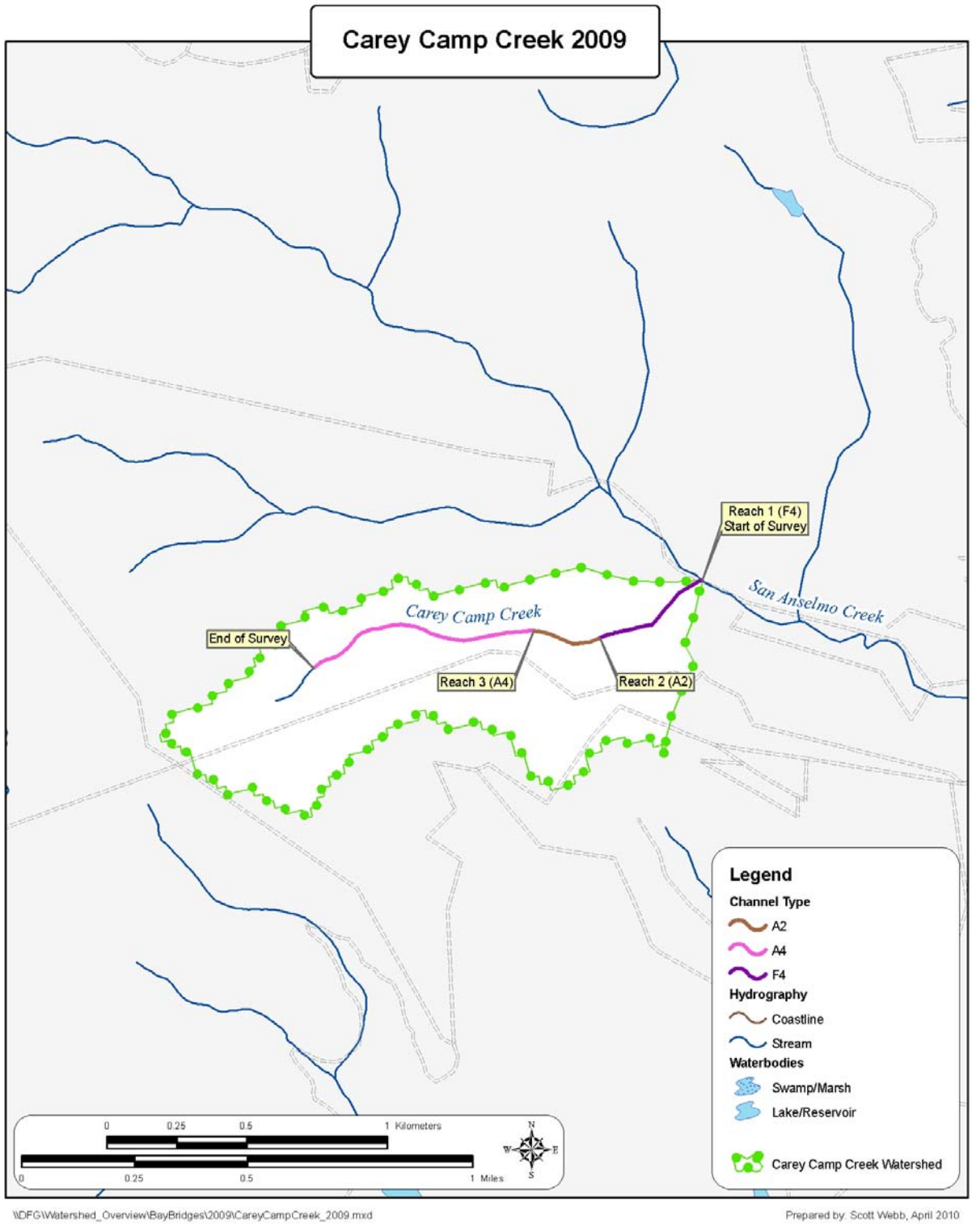
Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

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.

Rosgen, D.L., 1994. A Classification of Natural Rivers. Catena, Vol 22: 169-199, Elsevier Science, B. V. Amsterdam.

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]	


Carey Camp Creek 2009
Reach 1 (F4)
Start of Survey
San Anselmo Creek
Carey Camp Creek
End of Survey
Reach 3 (A4)
Reach 2 (A2)
Legend
Channel Type
A2
A4
F4
Hydrography
Coastline
Stream
Waterbodies
Swamp/Marsh
Lake/Reservoir
Carey Camp Creek Watershed
0 0.25 0.5 1 Kilometers
0 0.25 0.5 1 Miles
N
W
E
S
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Prepared by: Scott Webb, April 2010

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

Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

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
3	0	CULVERT	5.8	2	8	0.1									
4	0	DRY	7.7	664	2658	48.7									
14	14	FLATWATER	26.9	87	1213	22.2	4.1	0.4	0.9	259	3628	108	1519		5
12	12	POOL	23.1	16	192	3.5	6.4	0.8	1.8	99	1184	98	1174	85	13
19	19	RIFFLE	36.5	73	1390	25.5	3.5	0.2	0.7	198	3764	52	991		2

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
52	45	5461	8576	3684

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: Quad: SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

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 (%)
16	16	LGR	30.8	85	1355	24.8	4.0	0.2	1.5	233	3729	62	988		2	97
2	2	CAS	3.8	10	20	0.4	1.0	0.1	1.2	10	20	1	2		0	93
1	1	BRS	1.9	15	15	0.3	1.0	0.1	0.1	15	15	2	2		0	100
1	1	GLD	1.9	43	43	0.8	7.0	0.5	0.7	286	286	143	143			100
2	2	RUN	3.8	23	46	0.8	4.0	0.3	1.2	64	128	20	41		8	93
11	11	SRN	21.2	102	1124	20.6	4.0	0.4	1.3	292	3214	121	1335		5	96
5	5	MCP	9.6	13	66	1.2	6.0	0.6	1.9	82	411	61	307	49	14	96
1	1	LSBo	1.9	27	27	0.5	6.0	0.9	1.6	162	162	162	162	146		100
6	6	PLP	11.5	16	99	1.8	7.0	1.0	4.8	102	611	118	706	105	12	95
4	0	DRY	7.7	664	2658	48.7										100
3	0	CUL	5.8	2	8	0.1										

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume
52	45	5461	8576	3684

Table 3 - Summary of Pool Habitat Types

Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

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	42	13	66	34	6.2	0.6	82	411	49	245	14
7	7	SCOUR	58	18	126	66	6.6	1.0	110	773	111	775	12

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
12	12	192	1184	1020

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

Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

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 Occurence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence
5	MCP	42	2	40	3	60	0	0	0	0	0	0
1	LSBo	8	0	0	1	100	0	0	0	0	0	0
6	PLP	50	0	0	4	67	1	17	0	0	1	17

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
12	2	17	8	67	1	8	0	0	1	8

Mean Maximum Residual Pool Depth (ft.): 2

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Carey Camp Creek **Dry Units:** 4 **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terr. Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges
16	15	LGR	0	1	0	0	0	0	0	33	0
2	2	CAS	0	0	0	0	0	0	0	0	0
1	1	BRS	0	0	0	0	0	0	0	0	0
19	18	TOTAL RIFFLE	0	1	0	0	0	0	0	27	0
1	0	GLD									
2	2	RUN	65	0	0	0	0	0	0	35	0
11	11	SRN	5	3	7	0	0	0	0	49	0
14	13	TOTAL FLAT	14	2	6	0	0	0	0	47	0
5	5	MCP	18	0	0	0	0	0	0	62	20
1	0	LSBo									
6	6	PLP	25	0	0	0	0	0	0	58	0
12	11	TOTAL POOL	22	0	0	0	0	0	0	60	9
3	0	CUL									
52	42	TOTAL	10	1	2	0	0	0	0	42	2

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Carey Camp Creek **Dry Units:** 4 **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

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
16	16	LGR	0	31	38	31	0	0	0
2	2	CAS	0	0	0	0	0	0	100
1	1	BRS	0	0	0	0	0	0	100
1	1	GLD	0	100	0	0	0	0	0
2	2	RUN	0	0	50	0	0	0	50
11	11	SRN	0	64	18	9	0	0	9
5	5	MCP	0	20	40	0	20	0	20
1	1	LSBo	0	100	0	0	0	0	0
6	6	PLP	0	50	33	0	0	0	17
3	0	CUL	0	0	0	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
96	0	100	0	35	35

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 Carey Camp Creek LLID: 1226145379786 Drainage San Rafael

Survey Dates: 7/28/2009 to 7/28/2009 Survey Length (ft.): 5460.5 Main Channel (ft.): 5460.5 Side Channel (ft.): 0

Confluence Location: Quad SAN RAFAEL Legal Description: T02NR07WS34 Latitude: 37:58:43.3N Longitude: 122:36:52.5W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F4
Reach Length (ft.): 1540
Riffle/Flatwater Mean Width (ft.): 4.5
BFW:
Range (ft.): 16.00 to 26.00
Mean (ft.): 18.38
Std. Dev.: 2.59
Base Flow (cfs): 0.012
Water (F): 58 - 58 Air (F): 59 - 64
Dry Channel (ft.): 536

Canopy Density (%): 97.8
Coniferous Component (%): 0.0
Hardwood Component 100.0
Dominant Bank Hardwood Trees
Vegetative Cover (%): 35.7
Dominant Boulders
Dominant Bank Substrate Sand/Silt/Clay
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles: 0
Pools: 6
Flat: 4

Pools by Stream Length 4.4
Pool Frequency (%): 19.0
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 1.2
Mean Pool Shelter 17

Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 0.0 Gravel: 100. Sm Cobble: 0.0 Lg Cobble: 0.0 Boulder 0.0 Bedrock: 0.0
Embeddedness Values (%): 1. 75.0 2. 25.0 3. 0.0 4. 0.0 5. 0.0

STREAM REACH: 2

Channel Type: A2
Reach Length (ft.): 859
Riffle/Flatwater Mean Width (ft.): 3.4
BFW:
Range (ft.): 26.00 to 26.00
Mean (ft.): 26.00
Std. Dev.: 0.00
Base Flow (cfs): 0.012
Water (F): 58 - 58 Air (F): 64 - 64
Dry Channel (ft.): 0

Canopy Density (%): 96.8
Coniferous Component (%): 1.3
Hardwood Component 98.8
Dominant Bank Hardwood Trees
Vegetative Cover (%): 45.4
Dominant Boulders
Dominant Bank Substrate Sand/Silt/Clay
Occurrence of LWD (%): 10.0
LWD per 100 ft.:
Riffles: 2
Pools: 0
Flat: 3

Pools by Stream Length 2.6
Pool Frequency (%): 12.5
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 1.9
Mean Pool Shelter 5

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

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 3

Channel Type: A4
Reach Length (ft.): 3062
Riffle/Flatwater Mean Width (ft.): 3.2
BFW:
Range (ft.): 12.00 to 26.00
Mean (ft.): 14.57
Std. Dev.: 3.22
Base Flow (cfs): 0.012
Water (F): 58 - 60 Air (F): 64 - 76
Dry Channel (ft.): 2122

Canopy Density (%): 94.4
Coniferous Component (%): 0.0
Hardwood Component 100.0
Dominant Bank Brush
Vegetative Cover (%): 30.4
Dominant Boulders
Dominant Bank Substrate Sand/Silt/Clay
Occurrence of LWD (%): 0.0
LWD per 100 ft.:
Riffles: 0
Pools: 1
Flat: 0

Pools by Stream Length 3.3
Pool Frequency (%): 30.4
Residual Pool Depth (%):
< 2 Feet Deep: 71.4
2 to 2.9 Feet Deep: 14.3
3 to 3.9 Feet Deep: 0.0
>= 4 Feet Deep: 14.3
Mean Max Residual Pool Depth 2.1
Mean Pool Shelter 12

Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 0.0 Gravel: 85.7 Sm Cobble: 0.0 Lg Cobble: 0.0 Boulder 0.0 Bedrock: 14.3
Embeddedness Values (%): 1. 42.9 2. 57.1 3. 0.0 4. 0.0 5. 0.0

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

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	17	12	33.0
Boulder	0	0	0.0
Cobble/Gravel	0	0	0.0
Sand/Silt/Clay	27	32	67.0

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	0	0	0.0
Brush	11	16	30.7
Hardwood	30	26	63.6
Coniferous	0	0	0.0
No Vegetation	3	2	5.7

Total Stream Cobble Embeddedness Values: 2

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

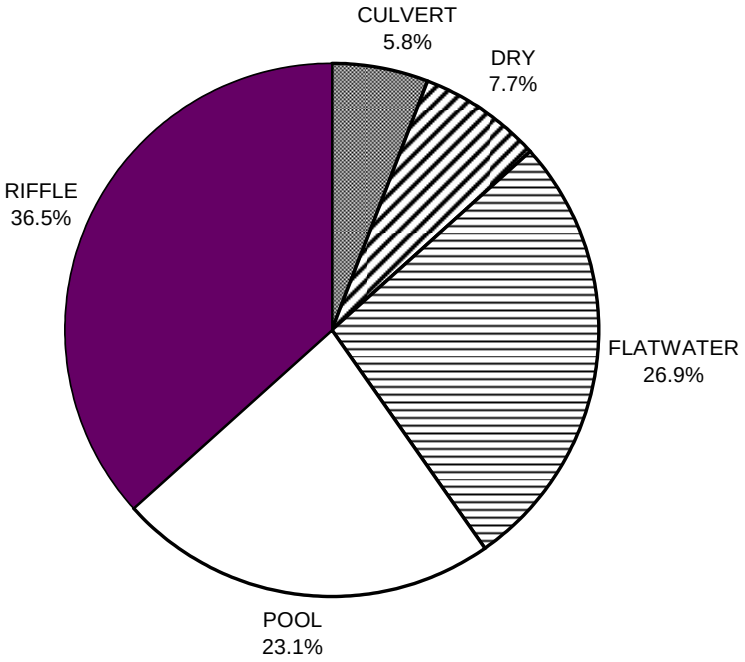
Stream Name: Carey Camp Creek **LLID:** 1226145379786 **Drainage:** San Rafael

Survey 7/28/2009 to 7/28/2009

Confluence Location: **Quad:** SAN RAFAEL **Legal Description:** T02NR07WS34 **Latitude:** 37:58:43.3N **Longitude:** 122:36:52.5W

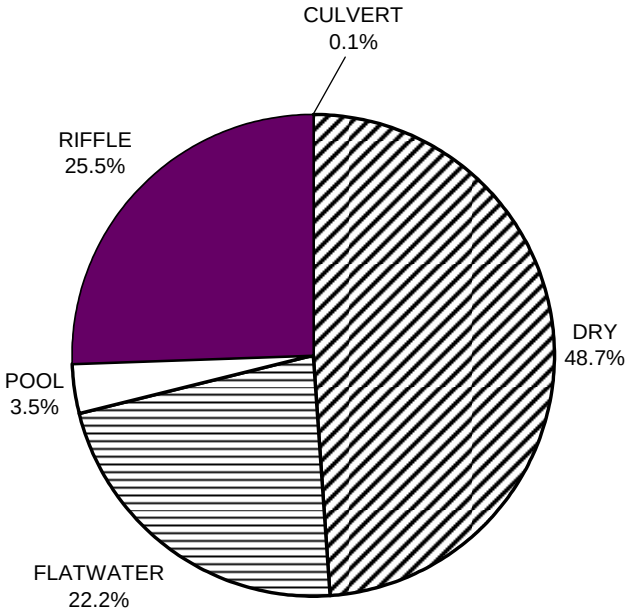
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	14	22
SMALL WOODY DEBRIS (%)	1	2	0
LARGE WOODY DEBRIS (%)	0	6	0
ROOT MASS (%)	0	0	0
TERRESTRIAL VEGETATION	0	0	0
AQUATIC VEGETATION (%)	0	0	0
WHITEWATER (%)	0	0	0
BOULDERS (%)	27	47	60
BEDROCK LEDGES (%)	0	0	9

CAREY CAMP CREEK 2009
HABITAT TYPES BY PERCENT OCCURRENCE



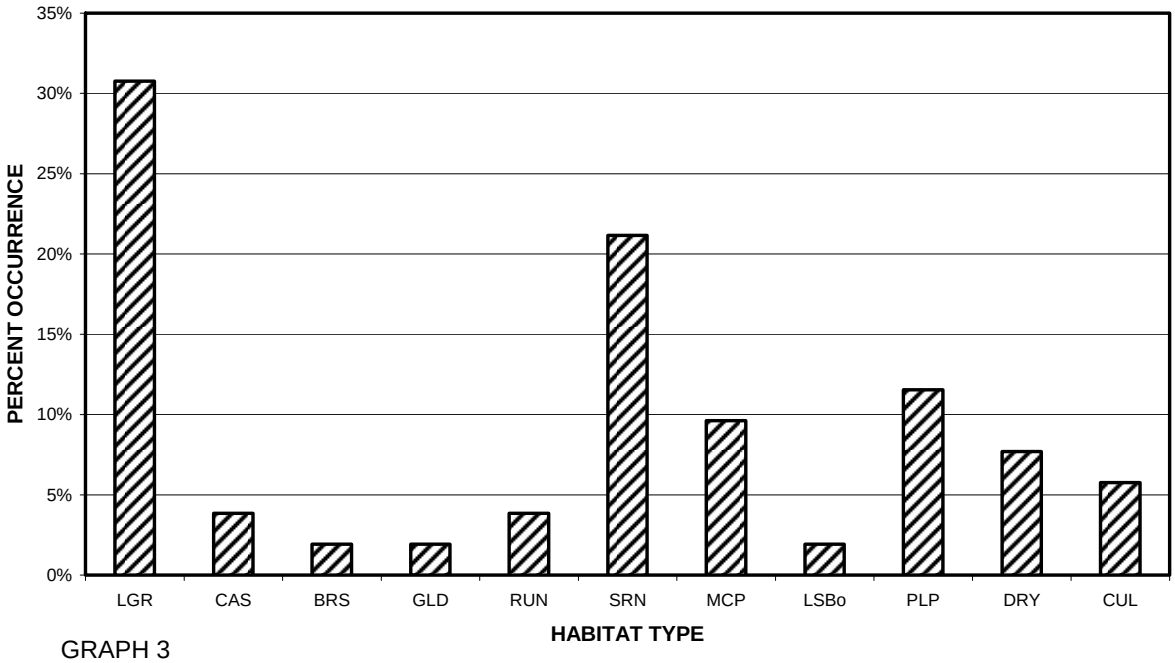
GRAPH 1

CAREY CAMP CREEK 2009
HABITAT TYPES BY PERCENT TOTAL LENGTH



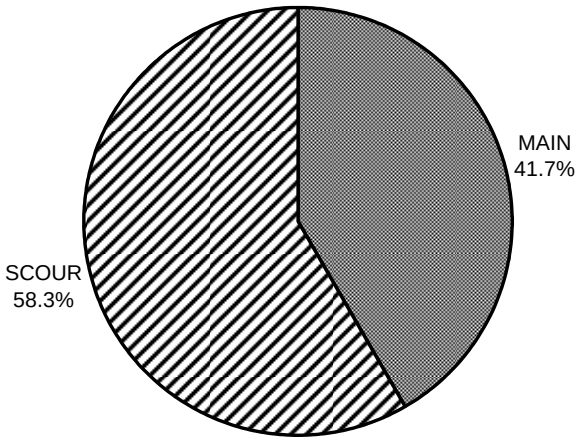
GRAPH 2

CAREY CAMP CREEK 2009
HABITAT TYPES BY PERCENT OCCURRENCE

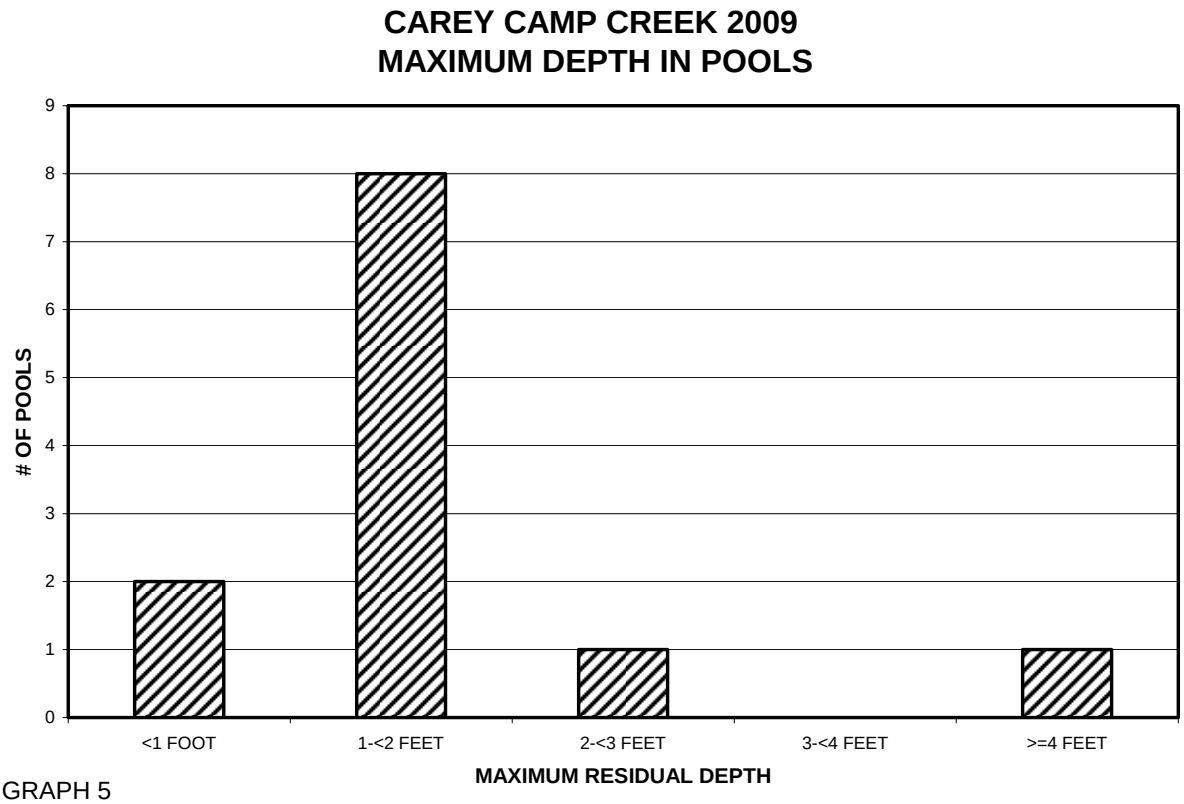


GRAPH 3

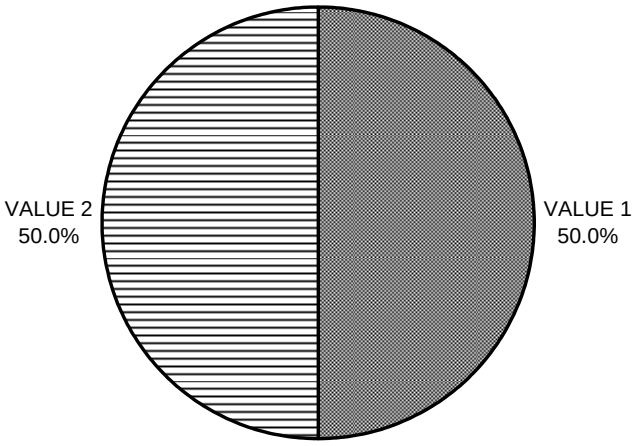
CAREY CAMP CREEK 2009
POOL TYPES BY PERCENT OCCURRENCE



GRAPH 4

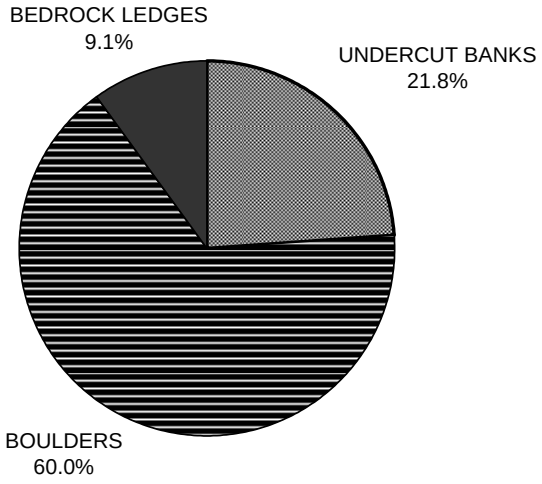


GRAPH 5



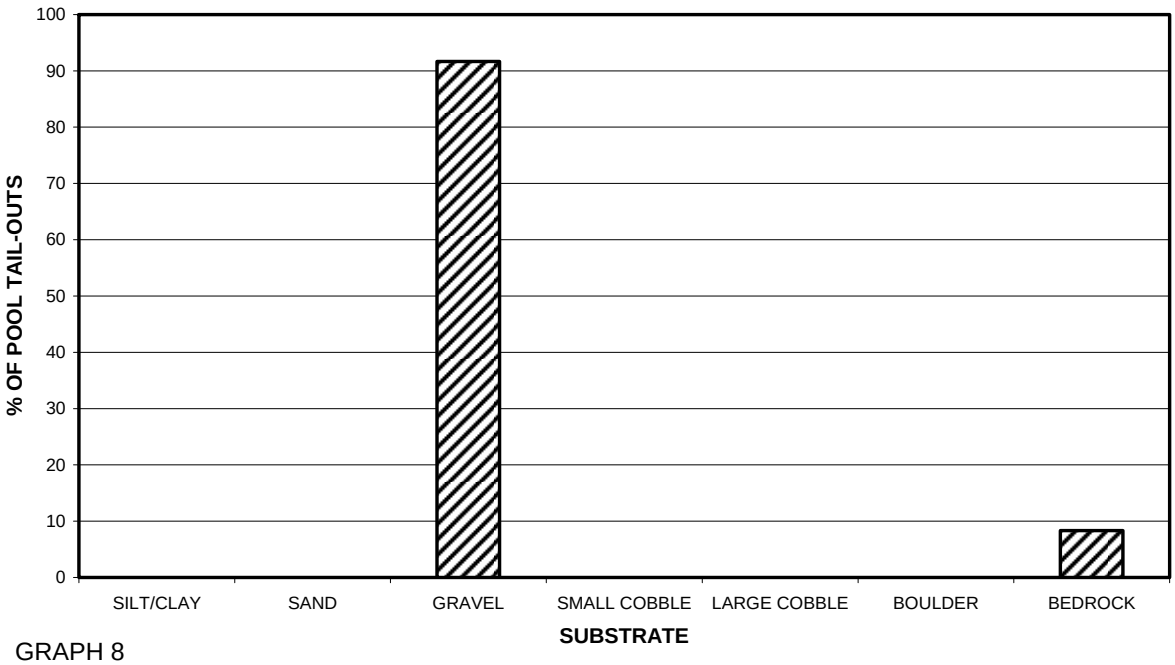
GRAPH 6

CAREY CAMP CREEK 2009
MEAN PERCENT COVER TYPES IN POOLS



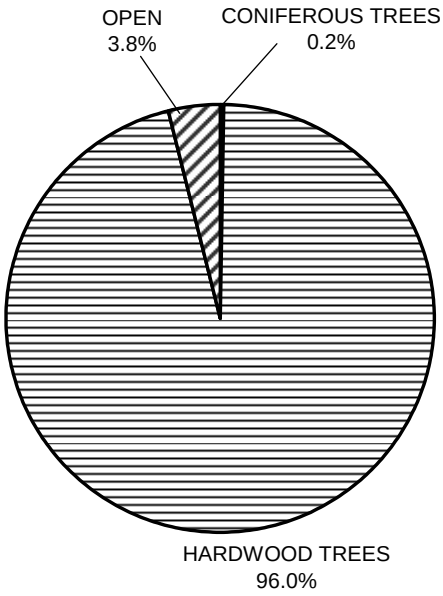
GRAPH 7

CAREY CAMP CREEK 2009
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



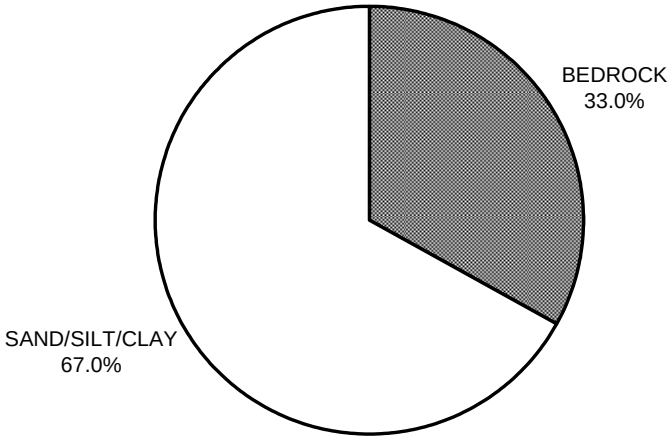
GRAPH 8

CAREY CAMP CREEK 2009
MEAN PERCENT CANOPY



GRAPH 9

CAREY CAMP CREEK 2009
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

CAREY CAMP CREEK 2009
DOMINANT BANK VEGETATION IN SURVEY REACH

GRAPH 11