

Mill Creek



**California Department of Fish and Wildlife
Santa Cruz County
Big Basin Coastal Watersheds
Stream Habitat Assessment Report**

Mill Creek

Surveyed 2010

Report Completed in 2013

STREAM INVENTORY REPORT

Mill Creek

INTRODUCTION

A stream inventory was conducted during 6/22/2010 to 6/23/2010 on Mill Creek. The survey began at the confluence with San Vicente Creek and extended upstream 1.3 miles.

The Mill 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 Mill Creek. The objective of the biological inventory was to document the habitat available to anadromous salmonids in Mill Creek.

The objective of this report is to document the current habitat conditions and recommend options for the potential enhancement of habitat for coho 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

Mill Creek is a tributary to San Vicente Creek, -a tributary to Pacific Ocean, located in Santa Cruz County, California (Map 1). Mill Creek's legal description at the confluence with San Vicente Creek is T10SR03WS22. Its location is 37°02'29" north latitude and 122°10'23" west longitude, LLID number 1221730370414. Mill Creek is a second order stream and has approximately 4.37 miles of blue line stream according to the USGS National Hydrology Dataset (NHD). Mill Creek drains a watershed of approximately 1.86 square miles. Elevations range from about 249 feet at the mouth of the creek to 1,946 feet in the headwater areas. Evergreen forest dominates the watershed which also is characterized by grasslands, shrubland, and low intensity residential. The watershed is primarily privately owned which accounts for 94.1% of the watershed. 92.6% of the watershed is natural, 7.3% is urban and 0.10% is dedicated to resource extraction. Vehicle access exists via Highway 1 and San Vicente Street in Davenport, CA.

METHODS

The habitat inventory conducted in Mill Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Conservation Corps (CCC) Technical Advisors and/or Watershed Stewards Project/AmeriCorps (WSP) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Wildlife (CDFW). 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

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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 Mill 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". Mill 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

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the cobble that is surrounded or buried by fine sediment. In Mill 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 Mill 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 Mill 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 Mill 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:

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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

No biological inventory was done. Fish presence was observed from the stream banks during the stream inventory.

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 Wildlife. 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 Mill 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

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- 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 6/22/2010 to 6/23/2010 was conducted by Bell, Chris and Griffin, Andrew (WSP). The total length of the stream surveyed was 6,687 feet with an additional 273 feet of side channel.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 1.16 cfs on 06/22/2010.

Mill Creek is a B3 channel type for 2,347 feet of the stream surveyed (Reach 1) and an A2 channel type for 4,340 feet of the stream surveyed (Reach 2).

B3 channels are moderately entrenched, moderately gradient, riffle dominated channel with frequently spaced pools; very stable plan and profile; stable banks; cobble dominate substrate. A2 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and boulder dominant substrates.

Water temperatures taken during the survey period ranged from 54 to 58 degrees Fahrenheit. Air temperatures ranged from 55 to 65 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 27% flatwater units, 44% riffle units, 26% pool units, and 2% culvert units (Graph 1). Based on total length of Level II habitat types there were 28% flatwater units, 58% riffle units, 13% pool units, and 1% culvert units (Graph 2).

Fourteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 31% High Gradient Riffle units, 15% Step Run units, and 11% Run units (Graph 3). The most frequent habitat types based on percent total length were 48% High Gradient Riffle units, 19% Step Run units and 9% Run units.

A total of 37 pools were identified (Table 3). Main Channel pools were the most frequently encountered, at 54%, and comprised 65% 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. One of the 37 pools (3%) had a residual depth of two feet or greater (Graph 5).

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The depth of cobble embeddedness was estimated at pool tail-outs. Of the 37 pool tail-outs measured, 4 had a value of 1 (10.8%); 7 had a value of 2 (18.9%); 6 had a value of 3 (16.2%); 1 had a value of 4 (2.7%); 19 had a value of 5 (51.4%); (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 9, flatwater habitat types had a mean shelter rating of 11, and pool habitats had a mean shelter rating of 22 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 20 and Scour pools had a mean shelter rating of 24 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover types in Mill Creek. Graph 7 describes the pool cover in Mill Creek. Boulders are the dominant pool cover type followed by whitewater.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs, sand observed in 43% of pool tail-outs and boulders observed in 19% of pool tail-outs.

The mean percent canopy density for the surveyed length of Mill Creek was 88%. The mean percentages of hardwood and coniferous trees were 29% and 71%, respectively. Twelve percent of the canopy was open. Graph 9 describes the mean percent canopy in Mill Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 63%. The mean percent left bank vegetated was 60%. The dominant elements composing the structure of the stream banks consisted of 3% bedrock, 34% boulder, 22% cobble/gravel, and 41% sand/silt/clay (Graph 10). Coniferous trees were the dominant vegetation type observed in 40.5% of the units surveyed. Additionally, 35.0% of the units surveyed had hardwood trees as the dominant vegetation type, 23.4% had brush as the dominant vegetation and 0.4% had grass as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

There were several bank observations of salmonids from Habitat Unit #3 to Dam #1 (Habitat Unit # 54).

DISCUSSION

Mill Creek is a B3 channel type for the first 2,403 feet of stream surveyed, including 56 feet of side channel, and an A2 channel type for the next 4,557 feet, including 217 feet of side channel. The suitability of B3 and A2 channel types for fish habitat improvement structures is as follows:

B3 channel type is excellent for plunge weirs; boulder clusters and bank placed boulder; single and opposing wing-deflectors; and log cover.

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A2 channel type is generally not suitable. They are high energy streams with stable stream banks, and poor gravel retention capabilities.

The water temperatures recorded on the survey days 6/22/2010 to 6/23/2010, ranged from 54 to 58 degrees Fahrenheit. Air temperatures ranged from 55 to 65 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 28% of the total length of this survey, riffles 58%, and pools 13%. The pools are relatively shallow, with only 1 of the 37 (3%) 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.

Eleven of the 37 pool tail-outs measured had embeddedness ratings of 1 or 2. Seven of the pool tail-outs had embeddedness ratings of 3 or 4. Nineteen 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 Mill Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Thirty of the 37 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 22. The shelter rating in the flatwater habitats was 11. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Boulders in Mill Creek. Boulders are the dominant cover type in pools followed by whitewater. 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 88%. Reach 1 had a canopy density of 88.9% and Reach 2 had a canopy density of 86.9%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was at 63% and 60%, 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.

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GENERAL RECOMMENDATIONS

Mill 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) 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.
- 2) 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.
- 3) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Reach 2, in particular, was identified as a section of concern. Identified sites should then be treated to reduce the amount of fine sediments entering the stream. 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.
- 4) Suitable size spawning substrate on Mill Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.
- 5) Due to the natural high gradient of the stream from Reach 2 upstream to the headwaters, access for migrating salmonids is an ongoing potential problem. Good water temperature and flow regimes exist in the stream and it offers good conditions for rearing fish. Fish passage should be monitored and improved where possible.
- 6) There are several log debris accumulations present in Reach 2 on Mill Creek, which are associated with the high gradient of the stream channel. They are retaining large quantities of fine sediment and can pose as potential fish barriers. The modification of these debris accumulations may be desirable, but must be done carefully, over time, to avoid excessive sediment loading in downstream reaches.
- 7) Access for migrating salmonids should be assessed at all road crossings and dams. Sites of particular concern include the two identified Dam sites which are located between the first 1,500 feet of Reach 2. All fish passage assessments should be done according to Part 9 of the California Salmonid Stream Habitat Restoration Manual

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(Flosi et al, 1998). Where needed, crossings should be replaced or modified to improve fish passage.

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 the confluence with San Vicente Creek. WP #62 N37.04124 W122.17393
56	0002.00	30' into unit is 1' diameter pipe spans stream 4' above thalweg
116	0003.00	1+ salmonid observed
443	0009.00	Pampas grass on left bank
668	0012.00	Several salmonids observed
1508	0031.00	Old road on left bank looks unused.
1713	0035.00	1+ salmonid observed
2021	0043.00	salmonid young of year observed
2244	0047.00	Right bank tributary #1 is unnamed and enters Mill Creek. It is flowing with a discharge <1cfs, and contributes 5% of flow to the receiving stream. Water temperature in the tributary is 56F. The survey crew checked 200' up and found it was not accessible to fish, with a slope= 10%. No fish observed. WP #67 N37.04197 W122.16795
2347	0051.00	Change from reach 1 (B3) to reach 2 (A2)
2396	0053.00	Salmonid young of year observed.
2412	0054.00	The upstream side of Dam #1 is silted to the top.
2412	0054.00	Dam #1 has a length=3', a height=11', and a width(d)=37'. It has no Flashboards but is down cutting with a height of down cut at the outlet =6'. The top of the sill to the water level =0.5'. The dam is retaining gravel, and is a possible barrier to salmonids. WP#68. N37.04204 W122.16750
2908	0059.00	On the left bank is an erosion site= 10'H x 25'L. Undercutting redwood trees.
3336	0066.00	50' into the unit a 4' diameter redwood fallen across stream, which is retaining cobbles, and is a possible barrier.
3336	0066.00	Bullfrog adult observed.
3527	0069.00	Two 3' diameter redwoods have fallen across the stream and are retaining sediment. This could be a possible barrier

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Position (ft.)	Habitat Unit #	Comments:
3665	0073.00	Olive/ brown color unidentified 6" larval salamander observed.
3996	0078.00	Dam # 2 is creating a pond on the left bank which only spans half of the dam; it has a length= 35 feet, a width= 25 feet, and a depth= 3 feet. The Dam is retaining silt from the bottom of the channel to the top of dam over-flow.
3996	0078.00	Dam #2 has a length=3', a height=15', a width(0)=25', and a width(d)=47'. The flashboards are not installed but it is creating down cutting with a height at the outlet of 7'. The sill of the dam is level with the water, but it is retaining gravel, and is a possible barrier to juvenile and adult salmonids. WP #71 N37.04106 W122.16285
4028	0080.00	Right bank tributary #2 is unnamed and enters Mill Creek. It is flowing, with a discharge <1cfs, and contributes 5% of flow to the receiving stream. The Water temperature downstream= 55, upstream temperature= 56, and the temperature within the tributary=54F. Survey crew checked 50' up and found it is not accessible to fish, with a Slope >10%. No fish observed. WP#73 N37.04134 W122.16271
4323	0087.00	6" larval salamander observed
5234	0104.00	Four, 3 foot diameter redwoods create possible barrier at bottom of unit, creating six foot jump, and retaining cobbles.
5884	0116.00	Fifteen foot vertical drop in this unit.
6273	0127.00	Log debris accumulation #1 has a height=12', a width 45', and a length 48'. It has 18 pieces, and water flows through, with visible gaps, and sediment retention of sand and gravel. The stored sediment has dimensions =20' Width, 10' length, and 12' depth. It could be a potential barrier to salmonids due to the 12' jump.
6670	0137.00	End of survey due to 15 foot vertical cascade and bedrock at top of unit; unit is wet with algae all over. WP #79 N37.04000 W122.15559

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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.

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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 }

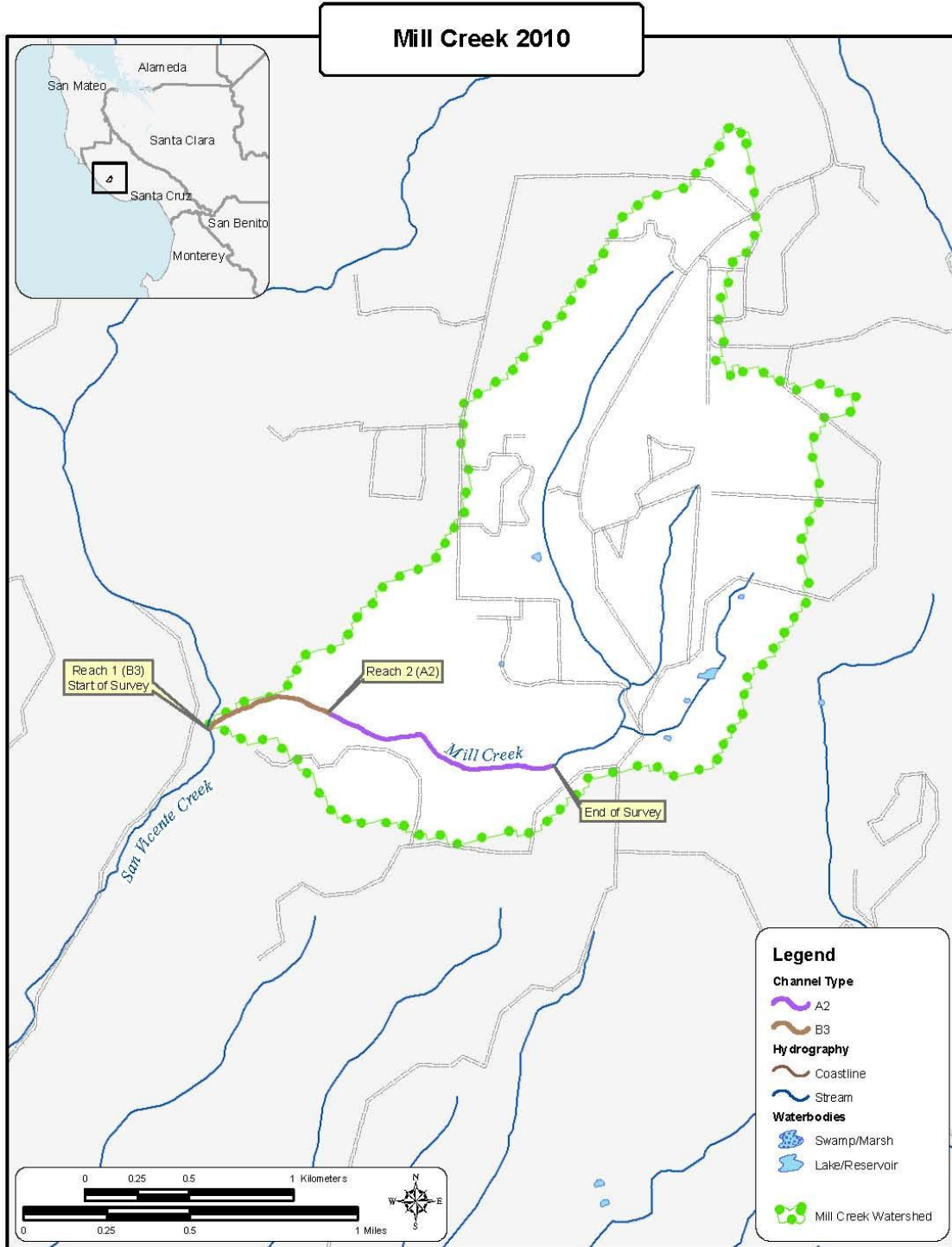
BACKWATER POOLS

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]	

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

Stream Name: Mill Creek

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location: Quad: DAVENPORT

Legal Description: T10SR03WS22

Latitude: 37:02:29.0N

Longitude: 122:10:23.0W

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
3	1	CULVERT	2.1	18	54	0.8									0
38	38	FLATWATER	27.1	52	1969	28.3	9.3	0.6	1.0	438	16638	249	9450		11
37	37	POOL	26.4	24	890	12.8	9.7	0.3	0.9	213	7897	168	6207	60	22
62	62	RIFFLE	44.3	65	4047	58.1	11.4	0.5	0.9	576	35711	306	18959		9
Total Units	Total Units Fully Measured				Total Length (ft.)						Total Area (sq.ft.)		Total Volume (cu.ft.)		
140	138				6960						60246		34617		

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Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Mill Creek

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location: Quad: DAVENPORT

Legal Description: T10SR03WS22

Latitude: 37:02:29.0N

Longitude: 122:10:23.0W

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 (%)
11	11	LGR	7.9	46	506	7.3	11.0	0.4	1.2	392	4313	170	1866		10	87
43	43	HGR	30.7	77	3311	47.6	12.0	0.5	1.3	686	29497	376	16162		9	87
7	7	CAS	5.0	30	212	3.0	10.0	0.5	1.4	228	1595	129	900		3	82
1	1	BRS	0.7	18	18	0.3	17.0	0.1	0.3	306	306	31	31		0	92
1	1	GLD	0.7	29	29	0.4	15.0	0.6	1.5	392	392	235	235			82
16	16	RUN	11.4	39	627	9.0	8.0	0.5	1.3	297	4750	167	2672		6	89
21	21	SRN	15.0	63	1313	18.9	10.0	0.6	1.5	547	11497	312	6544		14	87
11	11	MCP	7.9	17	182	2.6	10.0	0.2	2.1	157	1732	117	1289	39	16	89
1	1	CCP	0.7	12	12	0.2	7.0	0.6	1.2	84	84	101	101	50	40	82
8	8	STP	5.7	48	384	5.5	8.0	0.2	1.4	371	2965	282	2253	75	24	91
1	1	LSL	0.7	20	20	0.3	15.0	-0.1	0.4	300	300	120	120	-30	40	84
1	1	LSR	0.7	12	12	0.2	7.0	0.3	0.7	84	84	59	59	25	10	100
2	2	LSBo	1.4	14	27	0.4	8.0	0.3	1.3	107	215	100	200	36	35	92
13	13	PLP	9.3	19	253	3.6	11.0	0.4	1.7	194	2518	168	2185	79	22	87
3	1	CUL	2.1	18	54	0.8	0.0			0	0				0	
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)			Total Volume (cu.ft.)			
140	138				6960					60246			34617			

Mill Creek

Table 3 - Summary of Pool Habitat Types

Stream Name: Mill Creek

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location: Quad: DAVENPORT

Legal Description: T10SR03WS22

Latitude: 37:02:29.0N

Longitude: 122:10:23.0W

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
20	20	MAIN	54	29	578	65	9.1	0.2	239	4780	54	923	20
17	17	SCOUR	46	18	312	35	10.4	0.3	183	3117	66	1055	24
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)		Total Volume (cu.ft.)	
37	37				890					7897		1979	

Mill Creek

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

Stream Name: Mill Creek

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location: Quad: DAVENPORT

Legal Description: T10SR03WS22

Latitude: 37:02:29.0N

Longitude: 122:10:23.0W

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
11	MCP	30	9	82	1	9	1	9	0	0	0	0
1	CCP	3	0	0	1	100	0	0	0	0	0	0
8	STP	22	3	38	5	63	0	0	0	0	0	0
1	LSL	3	1	100	0	0	0	0	0	0	0	0
1	LSR	3	1	100	0	0	0	0	0	0	0	0
2	LSBo	5	1	50	1	50	0	0	0	0	0	0
13	PLP	35	6	46	7	54	0	0	0	0	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
37			21	57	15	41	1	3	0	0	0	0
Mean Maximum Residual Pool Depth (ft.):			1									

Mill Creek

Table 5 - Summary of Mean Percent Cover By Habitat

Stream Name:		Mill Creek		Dry Units:			LLID: 1221730370414			Drainage:		Santa Cruz	
Survey Dates:		6/22/2010 to 6/23/2010		Legal Description:			T10SR03WS22			Latitude:		37:02:29.0N	
Confluence Location:		Quad: DAVENPORT		Longitude:			122:10:23.0W						
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		
11	11	LGR	0	3	5	0	5	0	0	60	0		
43	43	HGR	0	2	0	0	0	0	6	63	0		
7	7	CAS	0	0	14	0	0	0	11	3	0		
1	1	BRS	0	0	0	0	0	0	0	0	0		
62	62	TOTAL RIFFLE	0	2	3	0	1	0	5	55	0		
1	0	GLD											
16	16	RUN	0	4	3	0	1	0	4	57	0		
21	21	SRN	0	8	2	0	1	0	15	74	0		
38	37	TOTAL FLAT	0	6	2	0	1	0	10	66	0		
11	11	MCP	0	9	6	0	0	0	23	62	0		
1	1	CCP	0	0	0	0	0	0	40	60	0		
8	8	STP	0	9	8	0	0	0	28	56	0		
1	1	LSL	0	40	60	0	0	0	0	0	0		
1	1	LSR	0	0	0	0	0	0	0	100	0		
2	2	LSBo	30	0	0	20	0	0	5	45	0		
13	13	PLP	0	8	9	0	0	0	31	52	0		
37	37	TOTAL POOL	2	8	8	1	0	0	25	56	0		
3	1	CUL	0	0	0	0	0	0	0	0	0		
140	137	TOTAL	0	5	4	0	1	0	12	58	0		

Mill Creek

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Mill Creek

Dry Units:

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location:		Quad: DAVENPORT	Legal Description: T10SR03WS22				Latitude: 37:02:29.0N	Longitude: 122:10:23.0W	
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
11	11	LGR	0	9	0	64	27	0	0
43	43	HGR	0	0	0	9	65	26	0
7	7	CAS	0	0	0	0	43	57	0
1	1	BRS	0	0	0	0	0	0	100
1	1	GLD	100	0	0	0	0	0	0
16	16	RUN	0	50	0	38	13	0	0
21	21	SRN	0	52	0	19	19	10	0
11	11	MCP	0	100	0	0	0	0	0
1	1	CCP	0	100	0	0	0	0	0
8	8	STP	0	88	0	13	0	0	0
1	1	LSL	100	0	0	0	0	0	0
1	1	LSR	0	100	0	0	0	0	0
2	2	LSBo	0	100	0	0	0	0	0
13	13	PLP	0	100	0	0	0	0	0
3	0	CUL	0	0	0	0	0	0	0

Mill Creek

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Mill Creek

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location: Quad: DAVENPORT

Legal Description: T10SR03WS22

Latitude: 37:02:29.0N

Longitude: 122:10:23.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
88	71	29	0	63	60

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.

Mill Creek

Table 8 - Fish Habitat Inventory Data Summary

Stream Name: Mill Creek LLID:1221730370414 Drainage: Santa Cruz
 Survey Dates: 6/22/2010 to 6/23/2010 Survey Length (ft.): 6960 Main Channel (ft.): 6687 Side Channel (ft.): 273
 Confluence Location: Quad: DAVENPORT Legal Description: T10SR03WS22 Latitude: 37:02:29.0N
 Longitude: 122:10:23.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: B3	Canopy Density (%): 88.9	Pools by Stream Length (%): 10.6
Reach Length (ft.): 2347	Coniferous Component (%): 51.0	Pool Frequency (%): 21.6
Riffle/Flatwater Mean Width (ft.): 9.1	Hardwood Component (%): 49.0	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 100.0
Range (ft.): 10.00 to 16.00	Vegetative Cover (%): 66.1	2 to 2.9 Feet Deep: 0.0
Mean (ft.): 11.69	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 0.0
Std. Dev.: 1.60	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 0.0
Base Flow (cfs): 1.16	Occurrence of LWD (%): 2.4	Mean Max Residual Pool Depth (ft.): 0.90
Water (F): 54 - 58 Air (F): 56 - 65	LWD per 100 ft.:	Mean Pool Shelter Rating: 26
Dry Channel (ft.): 0	Riffles: 2	
	Pools: 2	
	Flat: 1	
Pool Tail Substrate (%):	Silt/Clay: 0.0 Sand: 54.5 Gravel: 18.2 Sm Cobble: 9.1 Lg Cobble: 9.1	
Boulder: 9.1	Bedrock: 0.0	
Embeddedness Values (%):	1. 18.2 2. 45.5 3. 9.1 4. 0.0 5. 27.3	

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 2

Channel Type: A2	Canopy Density (%): 86.9	Pools by Stream Length (%): 14.0
Reach Length (ft.): 4340	Coniferous Component (%): 82.6	Pool Frequency (%): 29.2
Riffle/Flatwater Mean Width (ft.): 11.6	Hardwood Component (%): 17.4	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Coniferous Trees	< 2 Feet Deep: 96.2
Range (ft.): 12.00 to 27.00	Vegetative Cover (%): 58.2	2 to 2.9 Feet Deep: 3.8
Mean (ft.): 16.56	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 0.0
Std. Dev.: 4.19	Dominant Bank Substrate Type: Boulder	>= 4 Feet Deep: 0.0
Base Flow (cfs): 1.16	Occurrence of LWD (%): 5.1	Mean Max Residual Pool Depth (ft.): 0.94
Water (F): 55 - 58 Air (F): 55 - 65	LWD per 100 ft.:	Mean Pool Shelter Rating: 20
Dry Channel (ft.):	0 Riffles: 2	
	Pools: 4	
	Flat: 2	
Pool Tail Substrate (%):	Silt/Clay: 3.8 Sand: 38.5 Gravel: 0.0 Sm Cobble: 15.4 Lg Cobble: 19.2	
Boulder: 23.1	Bedrock: 0.0	
Embeddedness Values (%):	1. 7.7 2. 7.7 3. 19.2 4. 3.8 5. 61.5	

Mill Creek

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Mill Creek **LLID:** 1221730370414 **Drainage:** Santa Cruz
Survey Dates: 6/22/2010 to 6/23/2010
Confluence Location: Quad: DAVENPORT **Legal Description:** T10SR03WS22 **Latitude:** 37:02:29.0N **Longitude:** 122:10:23.0W

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	6	3.3
Boulder	50	44	34.3
Cobble/Gravel	32	28	21.9
Sand/Silt/Clay	52	59	40.5

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	1	0	0.4
Brush	36	28	23.4
Hardwood Trees	48	48	35.0
Coniferous Trees	51	60	40.5
No Vegetation	1	1	0.7

Total Stream Cobble Embeddedness Values: 4

Mill Creek

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

Stream Name: Mill Creek

LLID: 1221730370414

Drainage: Santa Cruz

Survey Dates: 6/22/2010 to 6/23/2010

Confluence Location: Quad: DAVENPORT

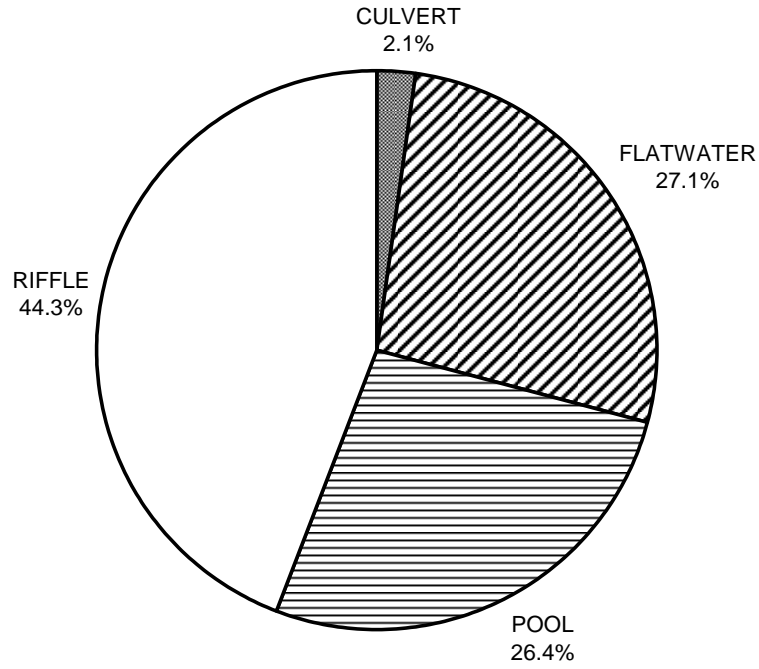
Legal Description: T10SR03WS22

Latitude: 37:02:29.0N

Longitude: 122:10:23.0W

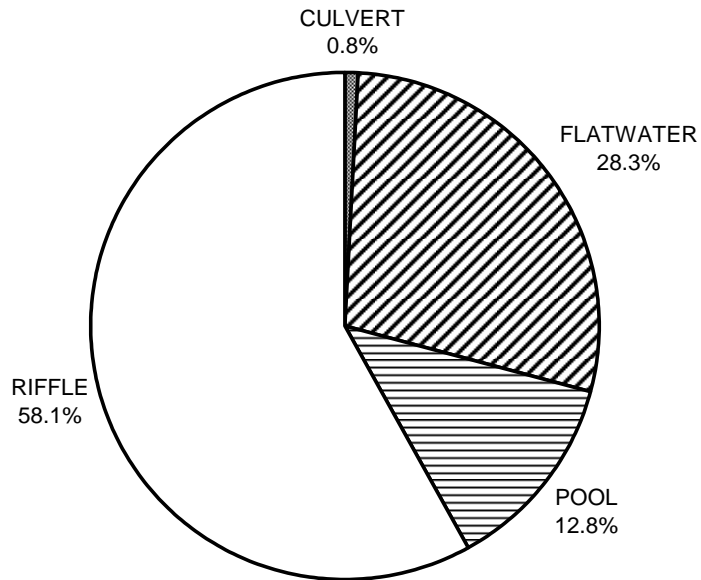
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	0	2
SMALL WOODY DEBRIS (%)	2	6	8
LARGE WOODY DEBRIS (%)	3	2	8
ROOT MASS (%)	0	0	1
TERRESTRIAL VEGETATION (%)	1	1	0
AQUATIC VEGETATION (%)	0	0	0
WHITEWATER (%)	5	10	25
BOULDERS (%)	55	66	56
BEDROCK LEDGES (%)	0	0	0

**MILL CREEK 2010
HABITAT TYPES BY PERCENT OCCURRENCE**



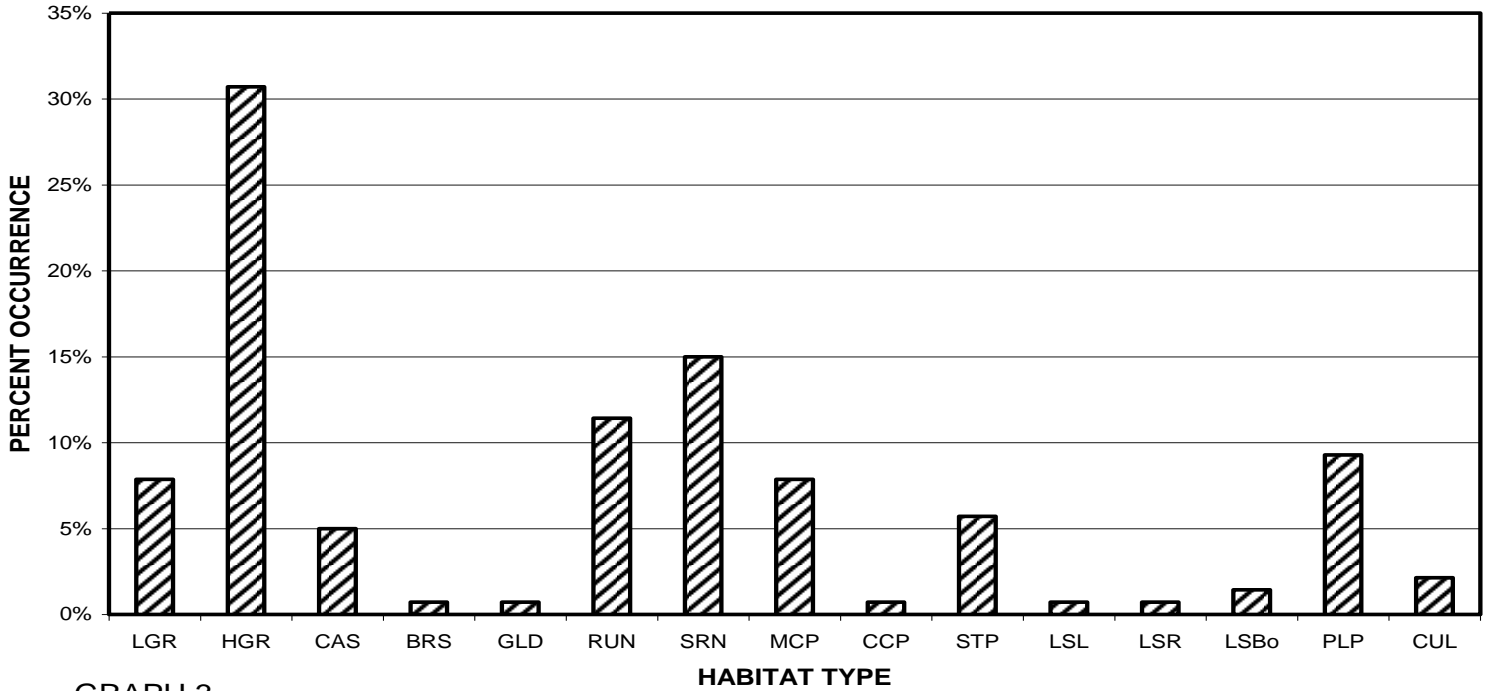
GRAPH 1

**MILL CREEK 2010
HABITAT TYPES BY PERCENT TOTAL LENGTH**



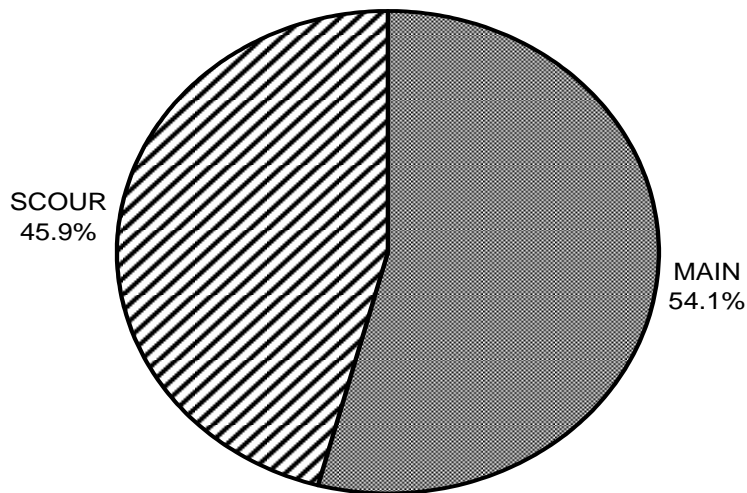
GRAPH 2

MILL CREEK 2010 HABITAT TYPES BY PERCENT OCCURRENCE



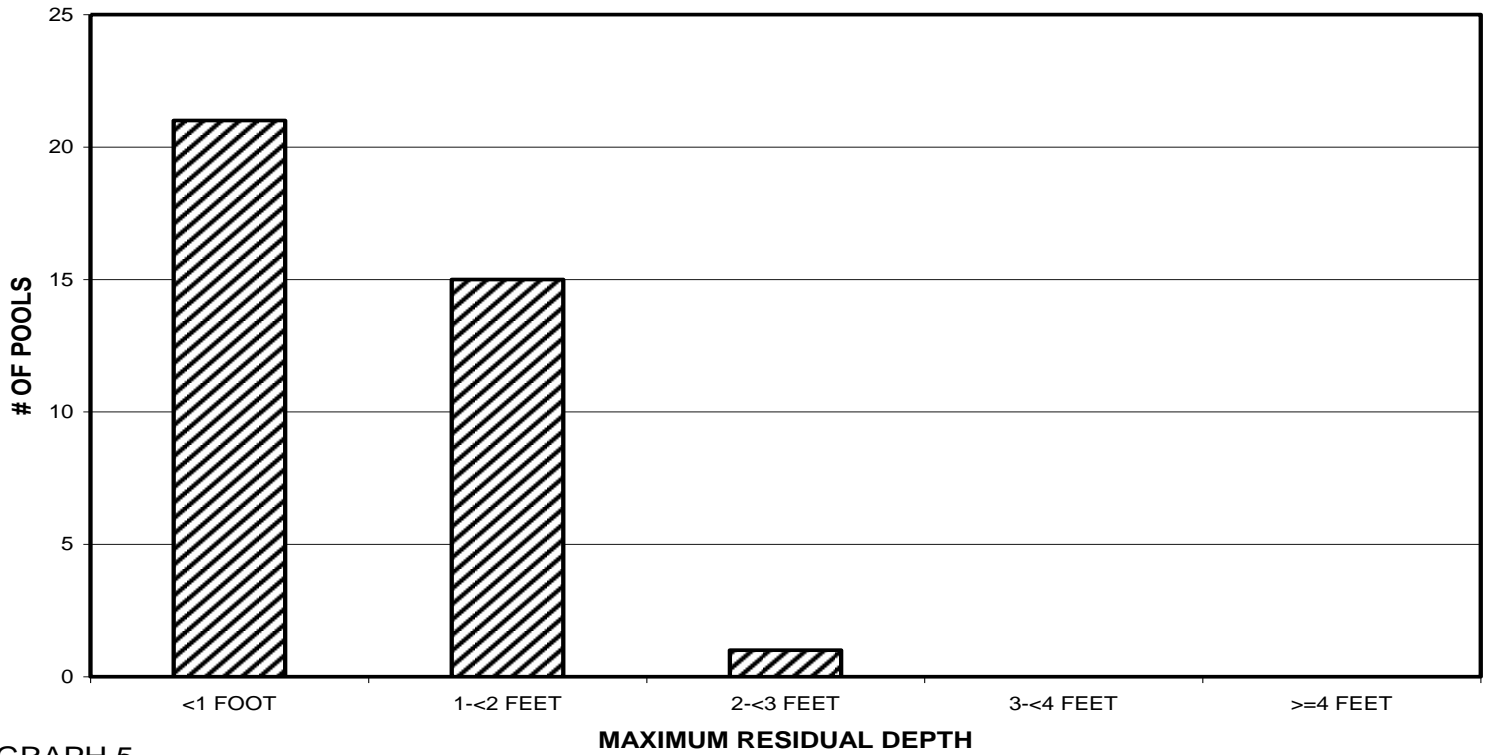
GRAPH 3

MILL CREEK 2010 POOL TYPES BY PERCENT OCCURRENCE



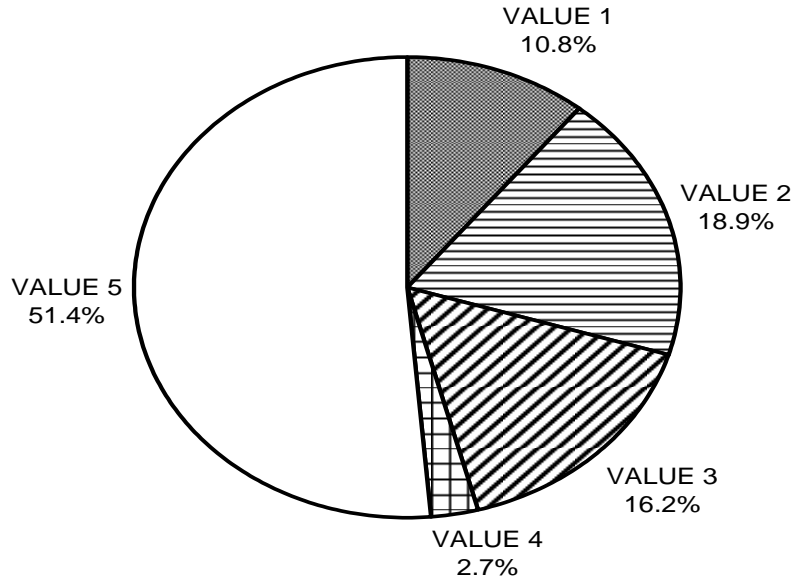
GRAPH 4

MILL CREEK 2010 MAXIMUM DEPTH IN POOLS



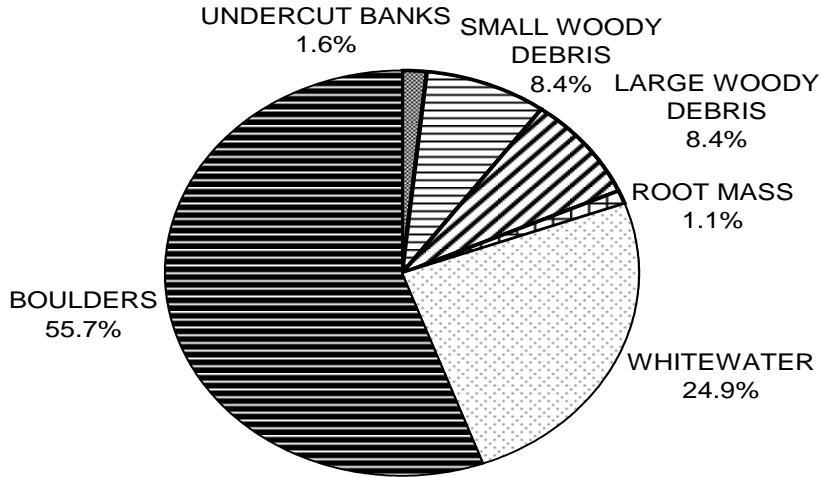
GRAPH 5

MILL CREEK 2010 PERCENT EMBEDDEDNESS



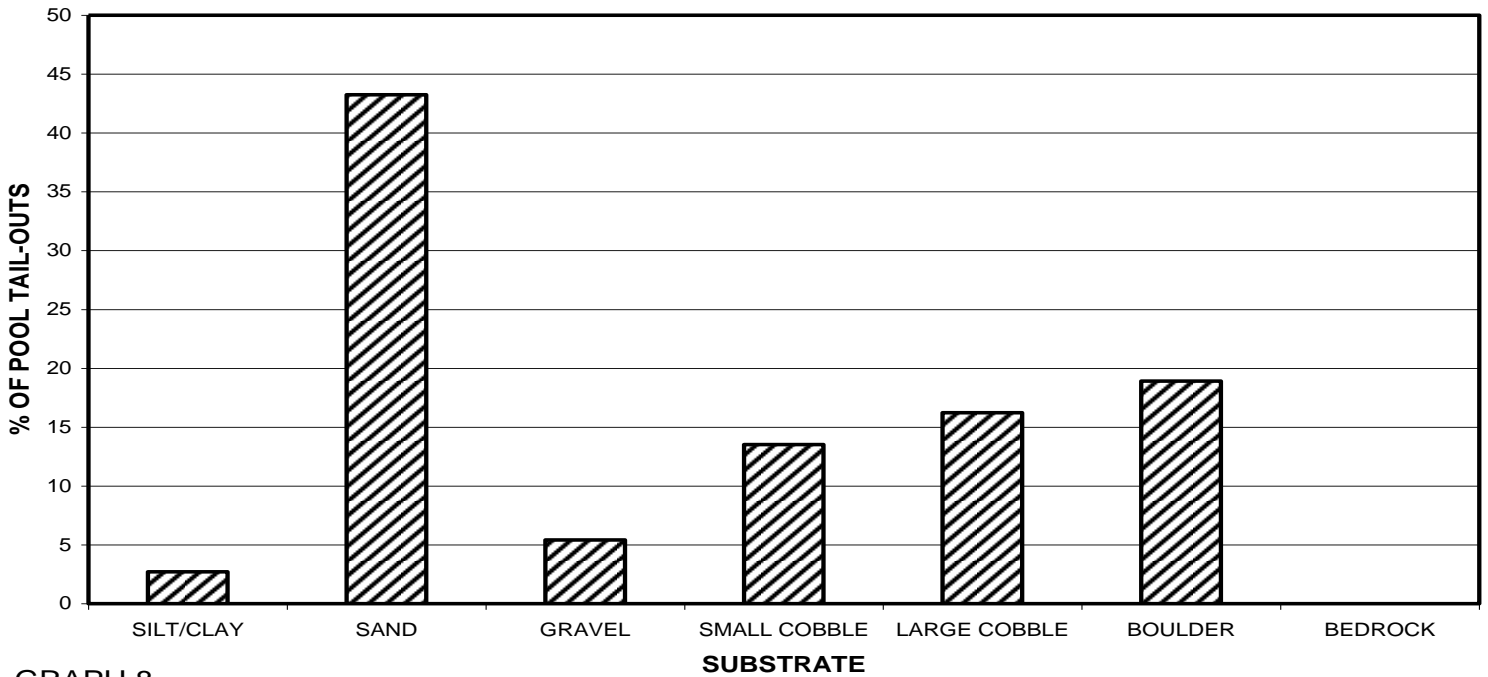
GRAPH 6

**MILL CREEK 2010
MEAN PERCENT COVER TYPES IN POOLS**



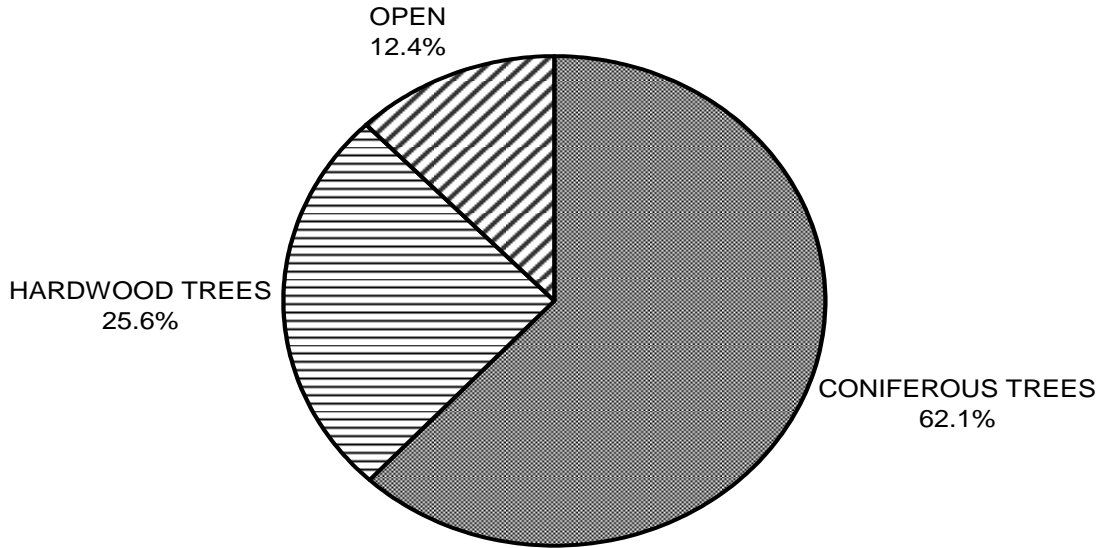
GRAPH 7

**MILL CREEK 2010
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS**



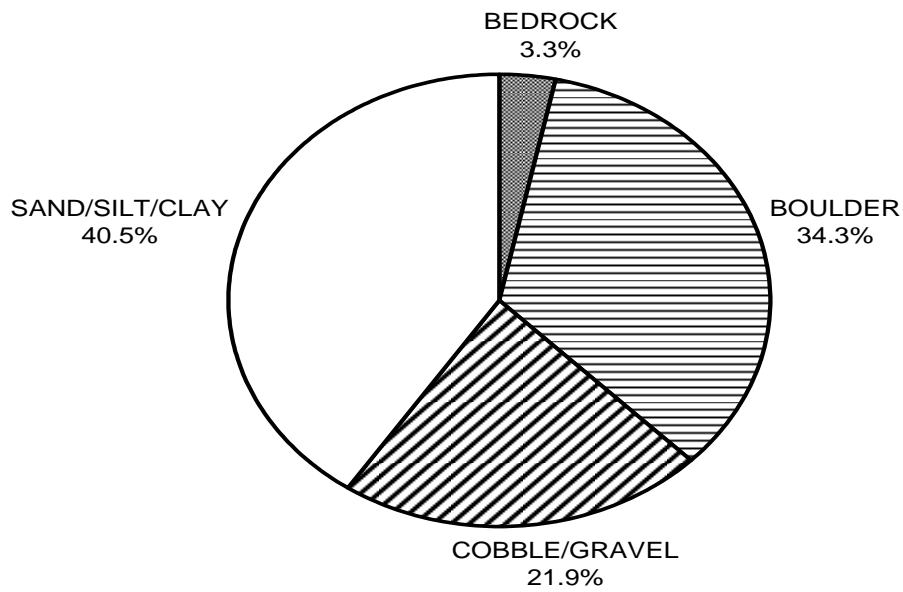
GRAPH 8

MILL CREEK 2010 MEAN PERCENT CANOPY



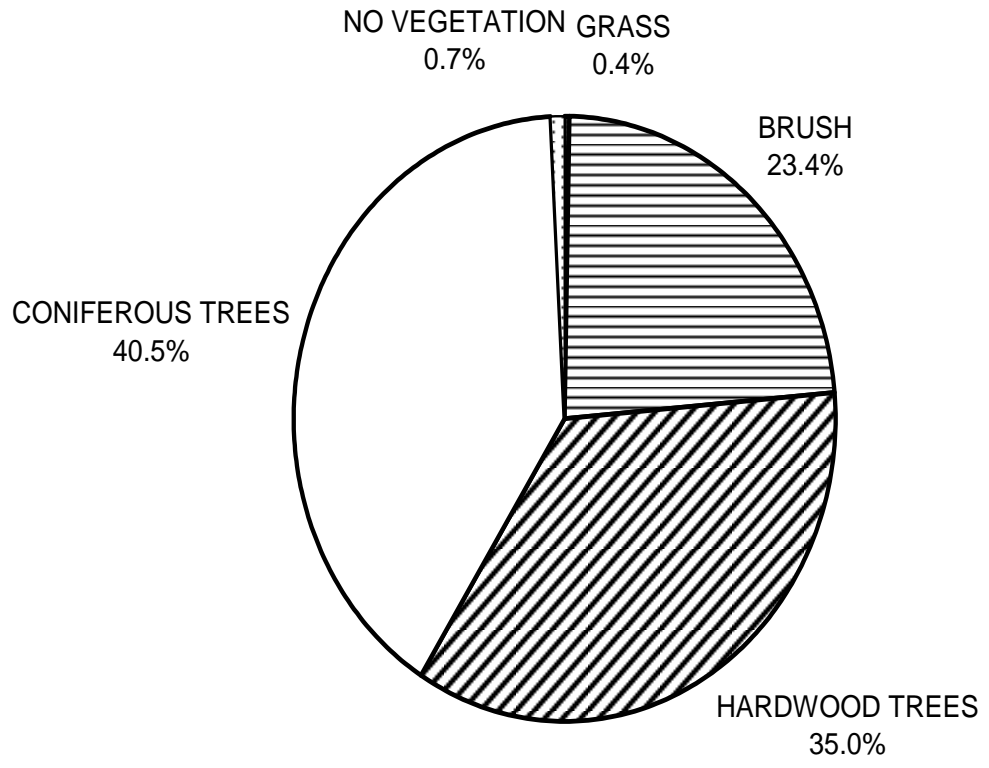
GRAPH 9

MILL CREEK 2010 DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

MILL CREEK 2010 DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11