

STREAM INVENTORY REPORT

Horse Creek

INTRODUCTION

A stream inventory was conducted from September 28 to October 5, 2010 on Horse Creek. The survey began at the confluence with Rancheria Creek and extended upstream 2.7 miles.

The Horse 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 Horse 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 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

Horse Creek is a tributary to Rancheria Creek, a tributary to the Navarro River, which drains to the Pacific Ocean. It is located in Mendocino County, California (Map 1). Horse Creek's legal description at the confluence with Rancheria Creek is T13N R15W S01. Its location is 39.01026 degrees north latitude and 123.45935 degrees west longitude, LLID number 1234581390104. Horse Creek is a first order stream and has approximately 2.7 miles of blue line stream according to the USGS Cold Spring 7.5 minute quadrangle. Horse Creek drains a watershed of approximately 4.0 square miles. Elevations range from about 370 feet at the mouth of the creek to 2,270 feet in the headwater areas. Mixed conifer forest dominates the watershed. The watershed is privately owned and is managed for timber production. Vehicle access exists via Highway 128 to Mountain View Road near Philo.

METHODS

The habitat inventory conducted in Horse 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 measured for maximum depth, depth of pool tail crest (measured in the thalweg), dominant substrate composing the pool tail crest, and

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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.

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 Horse 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". Horse 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.

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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 Horse 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 not suitable 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 Horse 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 densimeters as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Horse 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 Horse 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.

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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 Horse Creek. In addition, underwater observations were made at 20 sites using techniques discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.19, 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

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Graphics are produced from the tables using Microsoft Excel. Graphics developed for Horse 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 September 28 to October 5, 2010, was conducted by A. Glasgow and M. Groff (WSP). The total length of the stream surveyed was 14,295 feet.

Stream flow was measured near the bottom of the survey reach with a Marsh-McBirney Model 2000 flowmeter at 0.45 cfs on October 4, 2010.

Horse Creek is a B4 channel type for 9,508 feet of the stream surveyed (Reach 1), an undetermined channel type for 1,800 (this reach was not surveyed due to lack of access [Reach 2]), a G4 channel type for 2,103 feet of the stream surveyed (Reach 3), and an A4 channel type for 884 feet of the stream surveyed (Reach 4). B4 channels are moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile, stable banks and gravel-dominant substrates. G4 channel types are entrenched “gully” step-pool channels on moderate gradients with low width /depth ratios and gravel-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 53 to 56 degrees Fahrenheit. Air temperatures ranged from 53 to 72 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 45% pool units, 43% flatwater units, 10% riffle units, 2% unsurveyed units, and 1% dry units (Graph 1). Based on total length of Level II habitat types there were 58% flatwater units, 23% pool units, 13% unsurveyed units, 4% riffle units, and 2% dry units (Graph 2).

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Nine Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were mid-channel pool units, 44%; step run units, 35%; and low gradient riffle units, 8% (Graph 3). Based on percent total length, step run units made up 53%, mid-channel pool units 22%, and unsurveyed units 13%.

A total of 99 pools were identified (Table 3). Main channel pools were the most frequently encountered at 100% (Graph 4), and comprised 100% of the total length of all pools (Table 3).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Twenty-three of the 99 pools (23%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 100 pool tail-outs measured, 30 had a value of 1 (30%); 56 had a value of 2 (56%); 6 had a value of 3 (6%); 8 had a value of 5 (8%) (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 not suitable 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 15, and pool habitats had a mean shelter rating of 58 (Table 1). Of the pool types, the main channel pools had a mean shelter rating of 58 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Terrestrial vegetation is the dominant cover type in Horse Creek. Graph 7 describes the pool cover in Horse Creek. Terrestrial vegetation is the dominant pool cover type followed by boulders.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel was the dominant substrate observed in 77% of the pool tail-outs. Small cobble was the next most frequently observed dominant substrate type and occurred in 11% of the pool tail-outs.

The mean percent canopy density for the surveyed length of Horse Creek was 84%. Sixteen percent of the canopy was open. Of the canopy present, the mean percentages of hardwood and coniferous trees were 48% and 52%, respectively. Graph 9 describes the mean percent canopy in Horse Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 88%. The mean percent left bank vegetated was 83%. The dominant elements composing the structure of the stream banks consisted of 40% sand/silt/clay, 28% cobble/gravel, 24% bedrock, and 8% boulder (Graph 10). Hardwood trees were the dominant vegetation type observed in 51% of the units surveyed. Additionally, 43% of the units surveyed had coniferous trees as the dominant vegetation type, and 4% had brush as the dominant vegetation type (Graph 11).

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BIOLOGICAL INVENTORY RESULTS

Survey teams conducted a snorkel survey at 20 sites for species composition and distribution in Horse Creek on October 6, 2010. Water temperatures taken during the survey period of 1015 hours to 1137 hours were 52 degrees Fahrenheit. Air temperatures ranged from 66 to 68 degrees Fahrenheit. The sites were sampled by I. Mikus (DFG), and A. Glasgow (WSP).

In reach 1, which comprised the first 9,508 feet of stream, 10 sites were sampled. The reach sites yielded 51 young-of-the-year steelhead/rainbow trout (SH/RT), 4 age 1+ SH/RT, 1 age 2+ SH/RT, and 1 California roach.

In reach 3, 10 sites were sampled starting approximately 11,308 feet from the confluence with Rancheria Creek and continuing upstream 2,103 feet. The reach sites yielded 44 young-of-the-year SH/RT.

The following chart displays the information yielded from these sites:

2010 Horse Creek underwater observations.

Date	Survey Site #	Habitat Unit #	Habitat Type	Approx. Dist. from mouth (ft.)	SH/RT			Coho	
					YOY	1+	2+	YOY	1+
Reach 1: B4 Channel Type									
10/06/10	1	004	Pool	67	2	0	0	0	0
	2	006	Pool	119	2	0	0	0	0
	3	010	Pool	340	5	0	1	0	0
	4	012	Pool	404	7	0	0	0	0
	5	014	Pool	799	4	0	0	0	0
	6	017	Pool	948	8	1	0	0	0
	7	019	Pool	1236	8	3	0	0	0
	8	021	Pool	1319	6	0	0	0	0
	9	051	Pool	2857	3	0	0	0	0
	10	100	Pool	5779	6	0	0	0	0
Reach 3: G4 Channel Type									
	11	162	Pool	11333	4	0	0	0	0
	12	165	Pool	11454	0	0	0	0	0
	13	167	Pool	11519	3	0	0	0	0
	14	170	Pool	11619	6	0	0	0	0
	15	175	Pool	11887	3	0	0	0	0

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	16	177	Pool	11972	14	0	0	0	0
	17	179	Pool	12159	14	0	0	0	0
	18	185	Pool	12438	0	0	0	0	0
	19	187	Pool	12568	0	0	0	0	0
	20	191	Pool	12904	0	0	0	0	0

DISCUSSION

Horse Creek is a B4 channel type for the first 9,508 feet of stream surveyed, the next 1,800 feet of stream was not surveyed due to lack of access, a G4 channel type for the next 2,103 feet, and an A4 channel type for the remaining 884 feet. The suitability of B4, G4, and A4 channel types for fish habitat improvement structures is as follows: B4 channel types are excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors, and log cover. G4 channel types are good for bank-placed boulders and fair for plunge weirs, opposing wing-deflectors, and log cover. A4 channel types are generally not suitable for fish habitat improvement structures.

The water temperatures recorded on the survey days September 28 to October 5, 2010, ranged from 53 to 56 degrees Fahrenheit. Air temperatures ranged from 53 to 72 degrees Fahrenheit. This is a suitable water temperature range for salmonids. To make any further conclusions, temperatures need to be monitored throughout the warm summer months, and more extensive biological sampling needs to be conducted.

Flatwater habitat types comprised 58% of the total length of this survey, riffles 4%, and pools 23%. Twenty-three of the 99 (23%) pools had 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 within the B4 and G4 stream reaches.

Eighty-six of the 100 pool tail-outs measured had embeddedness ratings of 1 or 2. Six of the pool tail-outs had embeddedness ratings of 3 or 4. Eight 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.

Eighty-eight of the 100 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 is 58. The shelter rating in the flatwater habitats is 15. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by terrestrial vegetation in Horse Creek. Terrestrial vegetation is the dominant cover type in pools followed by boulders. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover

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structures provide rearing fry with protection from predation, rest from water velocity, and also divide territorial units to reduce density related competition.

The mean percent canopy density for the stream was 84%. Reach 1 had a canopy density of 83%, Reach 3 had a canopy density of 85%, and Reach 4 had a canopy density of 90%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 88% and 83%, 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.

RECOMMENDATIONS

- 1) Horse Creek should be managed as an anadromous, natural production stream.
- 2) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.
- 3) 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.
- 4) 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.
- 5) 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.

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 Rancheria Creek. The channel is a B4.
53	0004.00	There is mostly bedrock on the left bank.

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799	0015.00	Instream structure is a large log bolted to a boulder.
1186	0019.00	Instream fish habitat structure.
1347	0023.00	Instream fish habitat structure. A right bank slide measures 30' high x 20' long; it is contributing sand and gravel to the channel.
1805	0032.00	Tributary #01 enters on the right bank. It contributes approximately 1% to Horse Creek's flow. The water temperature downstream and upstream of the tributary is 53 degrees Fahrenheit; the water temperature of the tributary is 54 degrees Fahrenheit. The tributary is not accessible to salmonids; there is a 15' high bedrock sheet at the mouth.
2026	0038.00	Instream fish habitat structure.
2287	0042.00	There is active left bank erosion, 10' long and 20' high. It is contributing sand and gravel to the channel.
2620	0047.00	Six pieces of large wood lying on the right bank. An unnamed road spans the channel. The crossing is a 10' wide x 12.5' high x 52' long metal bridge. It is not a possible barrier to salmonids.
2716	0049.00	The road is 10' from the right bank.
2746	0050.00	There is a dry tributary on the right bank with a 2' diameter culvert.
4123	0072.00	Erosion on left bank is 35' long x 60' high.
4448	0076.00	Left bank fish habitat structure.
4605	0080.00	Tributary #02 enters on the right bank. It contributes approximately 0.5% to Horse Creek's flow. The water temperature downstream and upstream of the tributary is 56 degrees Fahrenheit; the water temperature of the tributary is 55 degrees Fahrenheit. The slope of the tributary is approximately 8%. The tributary is accessible to salmonids, but no fish were observed. The road is 25' from the right bank. There is a fish habitat structure on the left bank.
4705	0083.00	Left bank erosion site measures 35' long x 35' high. It is contributing sand and gravel to the channel.
5531	0095.00	Bank erosion site measures 40' long x 30' high. It is contributing sand and gravel to the channel.

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5779	0101.00	Log debris accumulation (LDA) #01 contains 34 pieces of large woody debris (LWD) and measures 6.5' high x 42' wide x 20' long. Water flows through the LDA and there are no visible gaps in it. The LDA is not retaining sediment. It is a possible barrier to juvenile and adult salmonids. Fish were observed above the LDA.
6451	0116.00	Left bank erosion site measures 70' long x 30' high.
7029	0123.00	Left bank erosion site measures 25' long x 13' high. It is contributing sand and gravel to the channel.
7105	0125.00	Left bank erosion site measures 40' long x 30' high. It is contributing sand and gravel to the channel
7195	0128.00	Left bank erosion site measures 30' long x 50' high. It is contributing sand and gravel to the channel.
7895	0138.00	Right bank erosion measures 40' long x 20' high. It is contributing sand and small cobble to the channel.
8510	0148.00	Tributary #03 enters on the right bank. It contributes approximately 10% to Horse Creek's flow. The water temperature downstream and upstream of the tributary is 57 degrees Fahrenheit; the water temperature of the tributary is 55 degrees Fahrenheit. The slope of the tributary is approximately 2.5%. The tributary is accessible to salmonids, but no fish were observed.
8899	0154.00	Tributary #04 enters on the right bank. It contributes approximately 20% to Horse Creek's flow. The water temperature downstream and upstream of the tributary is 59 degrees Fahrenheit; the water temperature of the tributary is 56 degrees Fahrenheit. The slope of the tributary is approximately 2.5%. The tributary is accessible to salmonids, but no fish were observed.
8911	0155.00	Right bank erosion site measures 30' long x 60' high.
9392	0159.00	Right bank erosion site measures 5' long x 40' high.
9508	0161.00	Start of unsurveyed reach. The unsurveyed section extends upstream 1,800 feet. The channel type is unknown.
11308	0162.00	End of unsurveyed reach. The channel is a G4.
11591	0170.00	Eight pieces of LWD have accumulated in the channel.

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11770	0173.00	LDA #02 contains 15 pieces of LWD and measures 8' high x 26' wide x 13' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from sand to small cobble and measures 17' wide x 13' long x 5' deep. The LDA is a possible barrier to juvenile and adult salmonids. Fish were observed above the LDA.
11876	0175.00	LWD and small wood accumulation.
12159	0180.00	Tributary #05 enters on the right bank. It contributes approximately 35% to Horse Creek's flow. The water temperature downstream and upstream of the tributary is 55 degrees Fahrenheit; the water temperature of the tributary is 52 degrees Fahrenheit. The slope of the tributary is approximately 1%. The tributary is accessible to fish. A salmonid was observed.
12286	0183.00	LDA #03 contains six pieces of LWD and measures 6' high x 11' wide x 19' long. Water flows through the LDA and there are visible gaps in it. Retained sediment ranges from sand to small cobble and measures 4' wide x 6' long x 2' deep. The LDA is a possible barrier to juvenile and adult salmonids. Fish were observed above the LDA.
12697	0189.00	LDA #04 contains 12 pieces of LWD and measures 7' high x 34' wide x 20' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from sand to small cobble and measures 15' wide x 11' long x 5' deep. The LDA is a possible barrier to juvenile and adult salmonids. Fish were not observed above the LDA.
12904	0192.00	There is a 20' long bedrock sheet with a 5' jump and a shallow jump pool below. Possible fish barrier,
13222	0200.00	Dry tributary on the left bank. There are many pieces of large wood.
13339	0201.00	The channel changes from a G4 to an A4.
13490	0202.00	Dry tributary on the left bank.
14181	0217.00	LDA #05 contains four pieces of LWD and measures 4.5' high x 31' wide x 5' long. Water flows through the LDA and there are no visible gaps in it. Retained sediment ranges from sand to small cobble and measures 19' wide x 25' long x 3.5' deep. The LDA is a possible barrier to juvenile and adult salmonids.
14295	0220.00	End of survey at end of access. Gradient is increasing and approaching 4%. No fish have been observed for the last 1,000', since the bedrock sheet at habitat unit #192.

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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.

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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]	

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

Stream Name: Horse Creek

LLID: 1234581390104 Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Confluence Location: Quad: COLD SPRING Legal Description: T13NR15WS01 Latitude: 39:00:37.0N Longitude: 123:27:29.0W

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
2	0	DRY	0.9	134	268	1.9									
94	18	FLATWATER	42.7	88	8295	58.0	7.4	0.4	1.0	442	41561	191	17924		15
4	0	NOSURVEY	1.8	463	1853	13.0									
99	99	POOL	45.0	33	3300	23.1	9.8	0.9	1.7	319	31625	373	36959	321	58
21	6	RIFFLE	9.5	28	579	4.1	5.5	0.2	0.6	69	1459	17	357		0
Total Units	Total Units Fully Measured				Total Length (ft.)					Total Area (sq.ft.)			Total Volume (cu.ft.)		
220	123				14295					74644			55239		

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Horse Creek

LLID: 1234581390104

Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Confluence Location: Quad: COLD SPRING

Legal Description: T13NR15WS01

Latitude: 39:00:37.0N

Longitude: 123:27:29.0W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	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 (%)
17	3	LGR	7.7	30	514	3.6	6	0.2	0.7	87	1471	22	366		0	83
1	1	HGR	0.5	21	21	0.1	2	0.5	0.9	42	42	21	21		0	98
3	2	BRS	1.4	15	44	0.3	6	0.2	0.8	58	173	8	24		0	94
15	4	RUN	6.8	37	548	3.8	7	0.5	0.9	211	3159	100	1504		23	87
78	14	SRN	35.5	98	7612	53.2	7	0.4	4	508	39647	217	16888		13	87
1	0	EDW	0.5	135	135	0.9										
96	96	MCP	43.6	33	3185	22.3	10	0.9	5.1	319	30602	373	35774	322	57	83
3	3	STP	1.4	38	115	0.8	10	0.9	2.4	341	1022	395	1185	301	60	88
2	0	DRY	0.9	134	268	1.9										
4	0	NS	1.8	463	1853	13.0										

Total Units
220

Total Units Fully Measured
123

Total Length (ft.)
14295

Total Area (sq.ft.)
76116

Total Volume (cu.ft.)
55762

Table 3 - Summary of Pool Types

Stream Name: Horse Creek

LLID: 1234581390104

Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Confluence Location: Quad: COLD SPRING

Legal Description: T13NR15WS01

Latitude: 39:00:37.0N

Longitude: 123:27:29.0W

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
99	99	MAIN	100	33	3300	100	9.8	0.9	319	31625	321	31788	58

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
99	99	3300	31625	31788

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

Stream Name: Horse Creek LLID: 1234581390104 Drainage: Navarro River
 Survey Dates: 9/28/2010 to 10/5/2010
 Confluence Location: Quad: COLD SPRING Legal Description: T13NR15WS01 Latitude: 39:00:37.0N Longitude: 123:27:29.0W

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
96	MCP	97	2	2	72	75	20	21	0	0	2	2
3	STP	3	0	0	2	67	1	33	0	0	0	0

Total Units	Total < 1 Foot Max Resid. Depth	Total < 1 Foot % Occurrence	Total 1< 2 Foot Max Resid. Depth	Total 1< 2 Foot % Occurrence	Total 2< 3 Foot Max Resid. Depth	Total 2< 3 Foot % Occurrence	Total 3< 4 Foot Max Resid. Depth	Total 3< 4 Foot % Occurrence	Total >= 4 Foot Max Resid. Depth	Total >= 4 Foot % Occurrence
99	2	2	74	75	21	21	0	0	2	2

Mean Maximum Residual Pool Depth (ft.): 1.7

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Horse Creek

LLID: 1234581390104

Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Dry Units: 2

Confluence Location: Quad: COLD SPRING

Legal Description: T13NR15WS01

Latitude: 39:00:37.0N

Longitude: 123:27:29.0W

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
17	3	LGR	0	0	0	0	0	0	0	0	0
1	1	HGR	0	0	0	0	0	0	0	0	0
3	2	BRS	0	0	0	0	0	0	0	0	0
21	6	TOTAL RIFFLE	0	0	0	0	0	0	0	0	0
15	4	RUN	0	10	40	0	50	0	0	0	0
78	14	SRN	1	19	21	0	42	0	0	17	0
1	0	EDW									
94	18	TOTAL FLAT	1	17	24	0	43	0	0	14	0
96	96	MCP	3	17	20	8	24	1	5	19	2
3	3	STP	17	5	0	7	5	0	12	52	3
99	99	TOTAL POOL	4	16	20	8	24	1	5	20	2
4	0	NS									
220	123	TOTAL	3	16	20	8	26	1	5	19	2

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Horse Creek LLID: 1234581390104 Drainage: Navarro River
 Survey Dates: 9/28/2010 to 10/5/2010 Dry Units: 2
 Confluence Location: Quad: COLD SPRING Legal Description: T13NR15WS01 Latitude: 39:00:37.0N Longitude: 123:27:29.0W

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
17	3	LGR	0	0	100	0	0	0	0
1	1	HGR	0	0	0	100	0	0	0
3	2	BRS	0	0	0	0	0	0	100
15	4	RUN	0	0	75	0	25	0	0
78	14	SRN	0	0	50	36	14	0	0
1	0	EDW	0	0	0	0	0	0	0
96	96	MCP	0	1	73	17	4	2	3
3	3	STP	0	0	33	67	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Horse Creek

LLID: 1234581390104

Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Confluence Location: Quad: COLD SPRING

Legal Description: T13NR15WS01

Latitude: 39:00:37.0N

Longitude: 123:27:29.0W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
84	52	48	0	88	83

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: Horse Creek LLID: 1234581390104 Drainage: Navarro River
 Survey Dates: 9/28/2010 to 10/5/2010 Survey Length (ft.): 14295 Main Channel (ft.): 14295 Side Channel (ft.): 0
 Confluence Location: Quad: COLD SPRING Legal Description: T13NR15WS01 Latitude: 39:00:37.0N Longitude: 123:27:29.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: B4	Canopy Density (%): 83.3	Pools by Stream Length (%): 29.0
Reach Length (ft.): 9508	Coniferous Component (%): 51.6	Pool Frequency (%): 47.5
Riffle/Flatwater Mean Width (ft.): 7.7	Hardwood Component (%): 48.4	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 74
Range (ft.): 9 to 22	Vegetative Cover (%): 84.4	2 to 2.9 Feet Deep: 24
Mean (ft.): 16	Dominant Shelter: Terrestrial Veg.	3 to 3.9 Feet Deep: 0
Std. Dev.: 4	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 3
Base Flow (cfs.): 0.5	Occurrence of LWD (%): 16	Mean Max Residual Pool Depth (ft.): 1.8
Water (F): 53 - 56 Air (F): 53 - 67	LWD per 100 ft.:	Mean Pool Shelter Rating: 58
Dry Channel (ft): 0	Riffles: 1	
	Pools: 5	
	Flat: 2	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 74 Sm Cobble: 12 Lg Cobble: 1 Boulder: 8 Bedrock: 5		
Embeddedness Values (%): 1. 27.3 2. 59.7 3. 3.9 4. 0.0 5. 9.1		

STREAM REACH: 2

Channel Type: NA	Canopy Density (%):	Pools by Stream Length (%): 0.0
Reach Length (ft.): 1800	Coniferous Component (%):	Pool Frequency (%): 0.0
Riffle/Flatwater Mean Width (ft.):	Hardwood Component (%):	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation:	< 2 Feet Deep:
Range (ft.): 22 to 22	Vegetative Cover (%): 0.0	2 to 2.9 Feet Deep:
Mean (ft.): 22	Dominant Shelter:	3 to 3.9 Feet Deep:
Std. Dev.: 0	Dominant Bank Substrate Type:	>= 4 Feet Deep:
Base Flow (cfs.): 0.5	Occurrence of LWD (%):	Mean Max Residual Pool Depth (ft.):
Water (F): 53 - 53 Air (F): 55 - 55	LWD per 100 ft.:	Mean Pool Shelter Rating:
Dry Channel (ft): 0	Riffles:	
	Pools:	
	Flat:	
Pool Tail Substrate (%): Silt/Clay: Sand: Gravel: Sm Cobble: Lg Cobble: Boulder: Bedrock:		
Embeddedness Values (%): 1. 2. 3. 4. 5. 0.0		

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 3

Channel Type: G4	Canopy Density (%): 84.8	Pools by Stream Length (%): 13.9
Reach Length (ft.): 2103	Coniferous Component (%): 51.0	Pool Frequency (%): 35.9
Riffle/Flatwater Mean Width (ft.): 6.6	Hardwood Component (%): 49.0	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Hardwood Trees	< 2 Feet Deep: 86
Range (ft.): 11 to 23	Vegetative Cover (%): 91.1	2 to 2.9 Feet Deep: 14
Mean (ft.): 19	Dominant Shelter: Large Woody Debris	3 to 3.9 Feet Deep: 0
Std. Dev.: 5	Dominant Bank Substrate Type: Bedrock	>= 4 Feet Deep: 0
Base Flow (cfs.): 0.5	Occurrence of LWD (%): 24	Mean Max Residual Pool Depth (ft.): 1.5
Water (F): 53 - 55 Air (F): 55 - 62	LWD per 100 ft.:	Mean Pool Shelter Rating: 59
Dry Channel (ft): 189	Riffles: 3	
	Pools: 13	
	Flat: 5	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 86 Sm Cobble: 14 Lg Cobble: 0 Boulder: 0 Bedrock: 0		
Embeddedness Values (%): 1. 42.9 2. 42.9 3. 14.3 4. 0.0 5. 0.0		

STREAM REACH: 4

Channel Type: A4	Canopy Density (%): 90.3	Pools by Stream Length (%): 28.7
Reach Length (ft.): 884	Coniferous Component (%): 55.8	Pool Frequency (%): 45.0
Riffle/Flatwater Mean Width (ft.): 3.5	Hardwood Component (%): 44.2	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Coniferous Trees	< 2 Feet Deep: 89
Range (ft.): 17 to 23	Vegetative Cover (%): 85.8	2 to 2.9 Feet Deep: 11
Mean (ft.): 20	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 0
Std. Dev.: 3	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 0
Base Flow (cfs.): 0.5	Occurrence of LWD (%): 17	Mean Max Residual Pool Depth (ft.): 1.3
Water (F): 55 - 55 Air (F): 63 - 72	LWD per 100 ft.:	Mean Pool Shelter Rating: 48
Dry Channel (ft): 79	Riffles: 2	
	Pools: 9	
	Flat: 5	
Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 89 Sm Cobble: 0 Lg Cobble: 0 Boulder: 0 Bedrock: 11		
Embeddedness Values (%): 1. 33.3 2. 44.4 3. 11.1 4. 0.0 5. 11.1		

Table 9 - Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Horse Creek

LLID: 1234581390104

Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Confluence Location: Quad: COLD SPRING

Legal Description: T13NR15WS01

Latitude: 39:00:37.0N

Longitude: 123:27:29.0W

Mean Percentage of Dominant Stream Bank Substrate

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Bedrock	25	33	23.6
Boulder	13	7	8.1
Cobble / Gravel	37	33	28.5
Sand / Silt / Clay	48	50	39.8

Mean Percentage of Dominant Stream Bank Vegetation

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percent (%)
Grass	0	6	2.4
Brush	8	1	3.7
Hardwood Trees	51	74	50.8
Coniferous Trees	64	42	43.1
No Vegetation	0	0	0.0

Total Stream Cobble Embeddedness Values: 2

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

StreamName: Horse Creek

LLID: 1234581390104

Drainage: Navarro River

Survey Dates: 9/28/2010 to 10/5/2010

Confluence Location: Quad: COLD SPRING

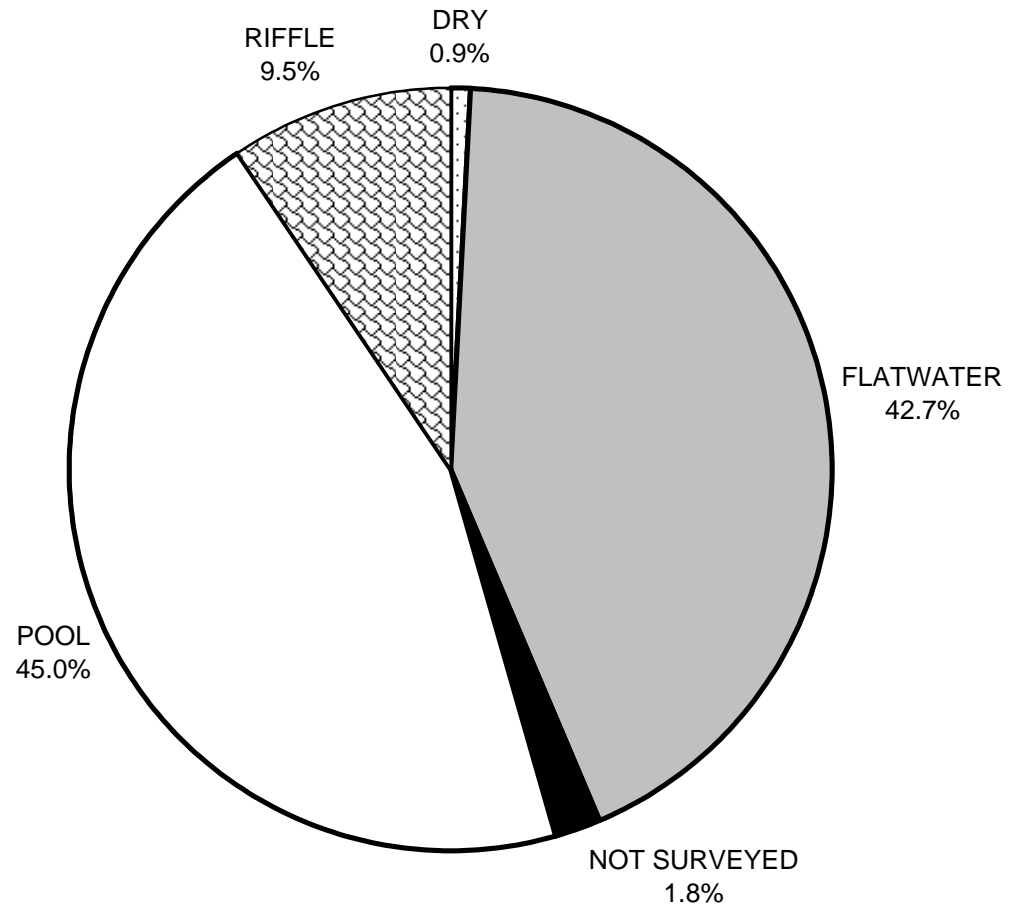
Legal Description: T13NR15WS01

Latitude: 39:00:37.0N

Longitude: 123:27:29.0W

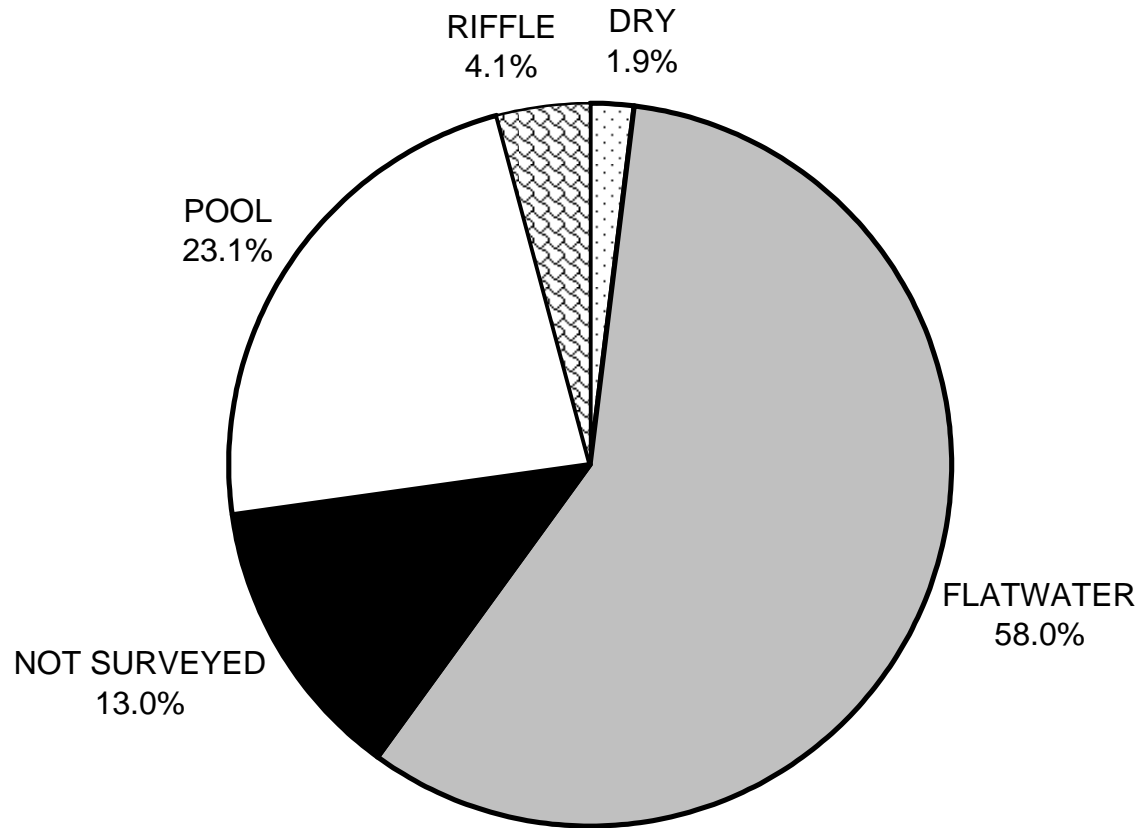
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	1	4
SMALL WOODY DEBRIS (%)	0	17	16
LARGE WOODY DEBRIS (%)	0	24	20
ROOT MASS (%)	0	0	8
TERRESTRIAL VEGETATION (%)	0	43	24
AQUATIC VEGETATION (%)	0	0	1
WHITEWATER (%)	0	0	5
BOULDERS (%)	0	14	20
BEDROCK LEDGES (%)	0	0	2

HORSE CREEK 2010 HABITAT TYPES BY PERCENT OCCURRENCE



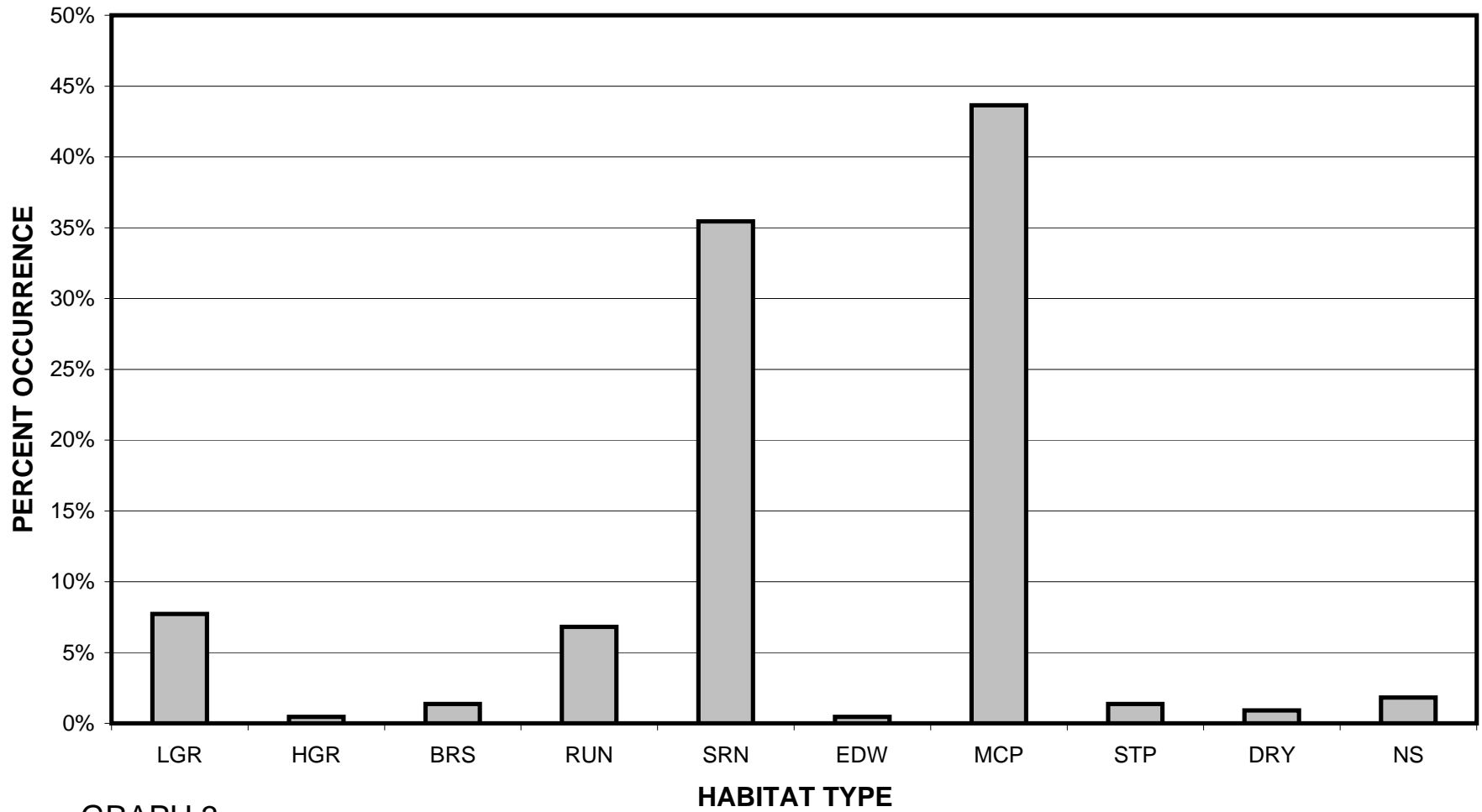
GRAPH 1

HORSE CREEK 2010 HABITAT TYPES BY PERCENT TOTAL LENGTH



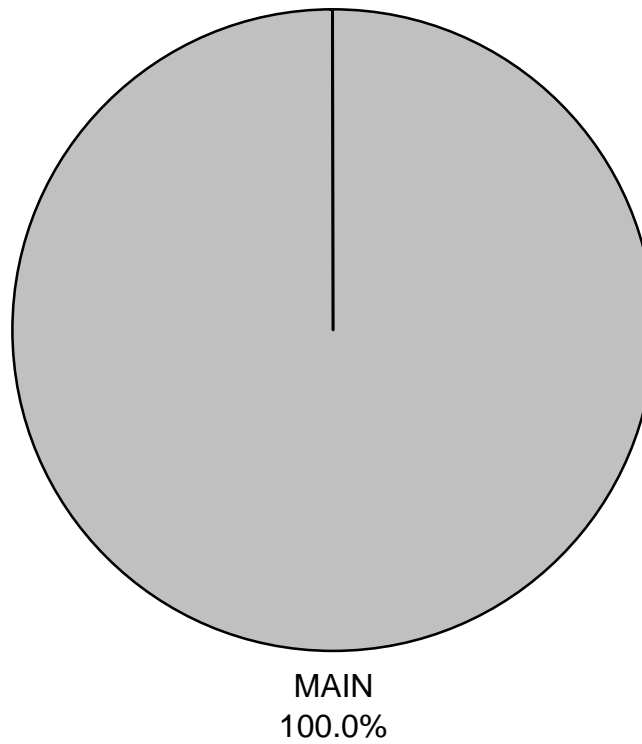
GRAPH 2

HORSE CREEK 2010 HABITAT TYPES BY PERCENT OCCURRENCE



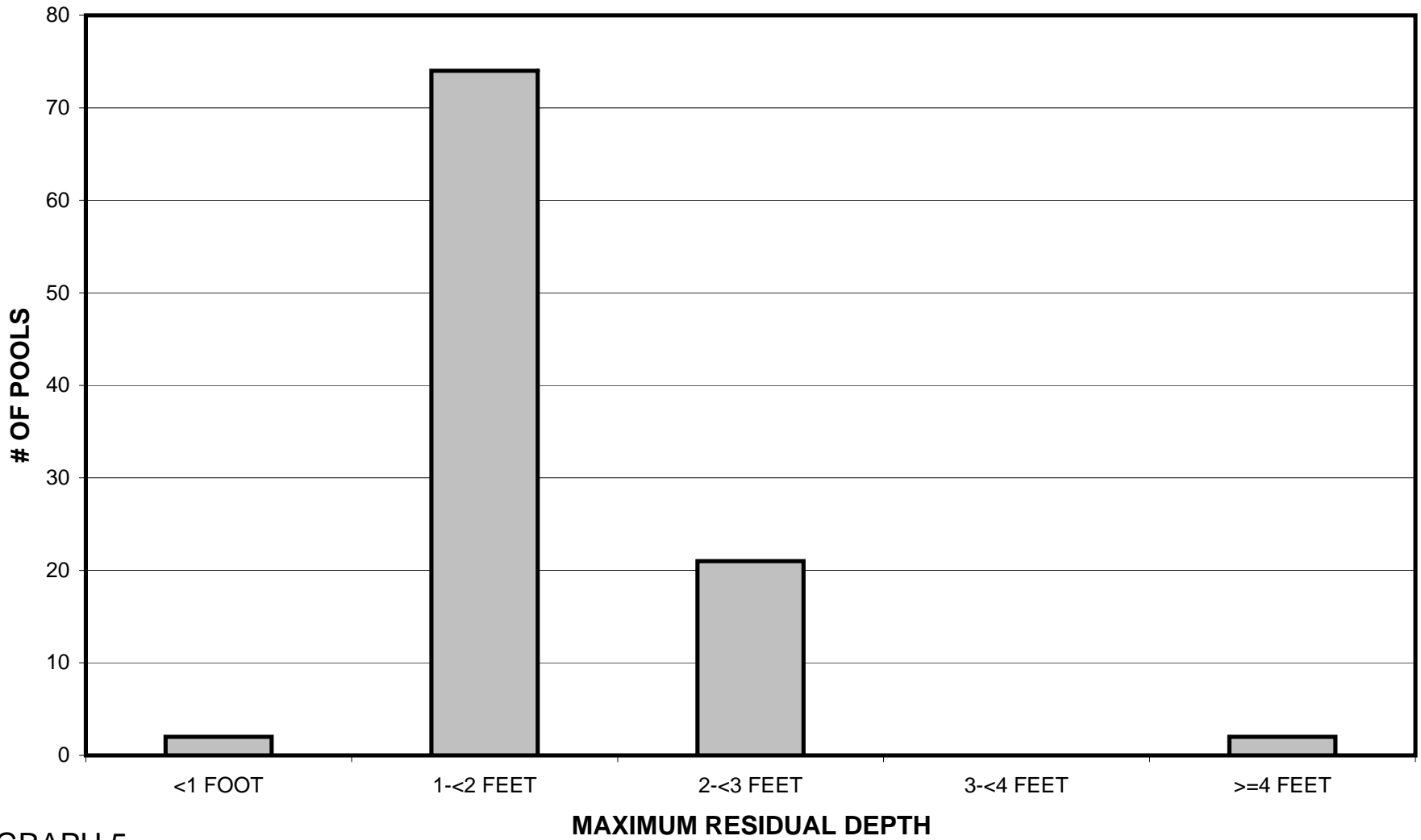
GRAPH 3

**HORSE CREEK 2010
POOL TYPES BY PERCENT OCCURRENCE**



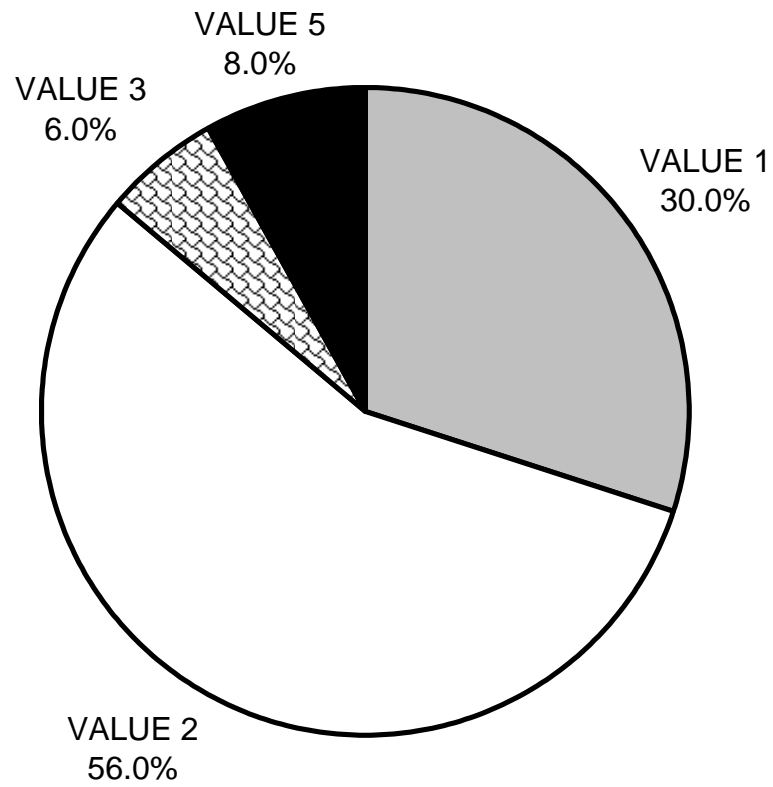
GRAPH 4

HORSE CREEK 2010 MAXIMUM DEPTH IN POOLS



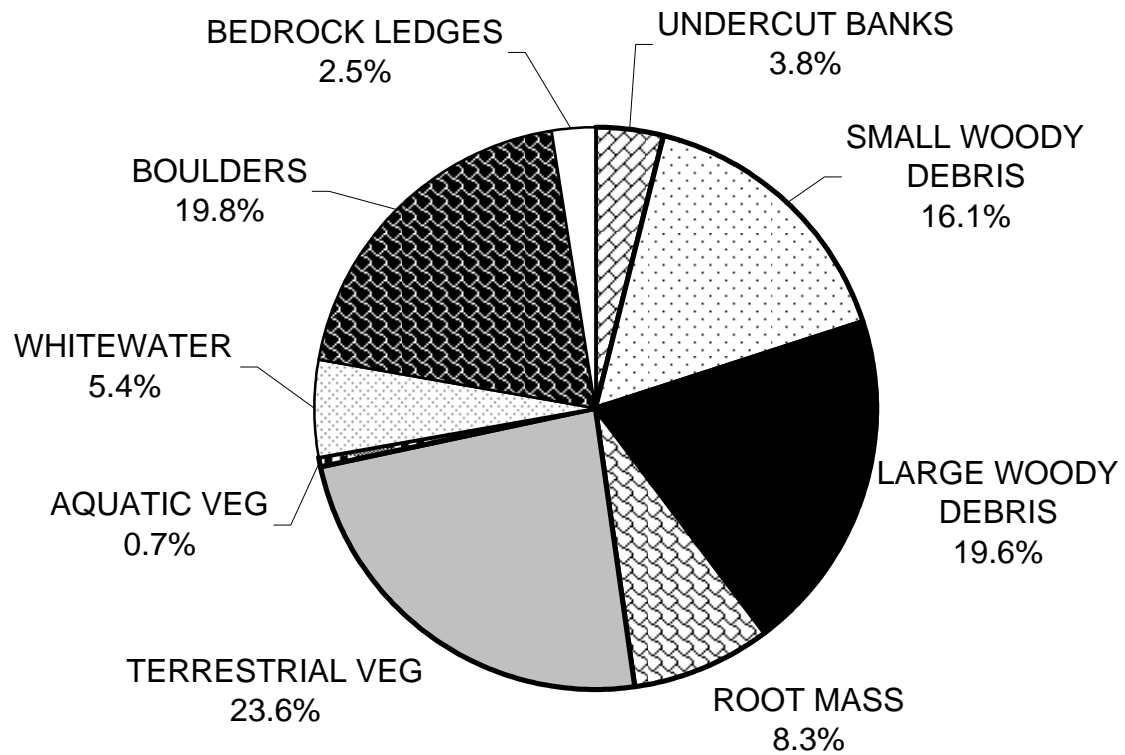
GRAPH 5

HORSE CREEK 2010 PERCENT EMBEDDEDNESS



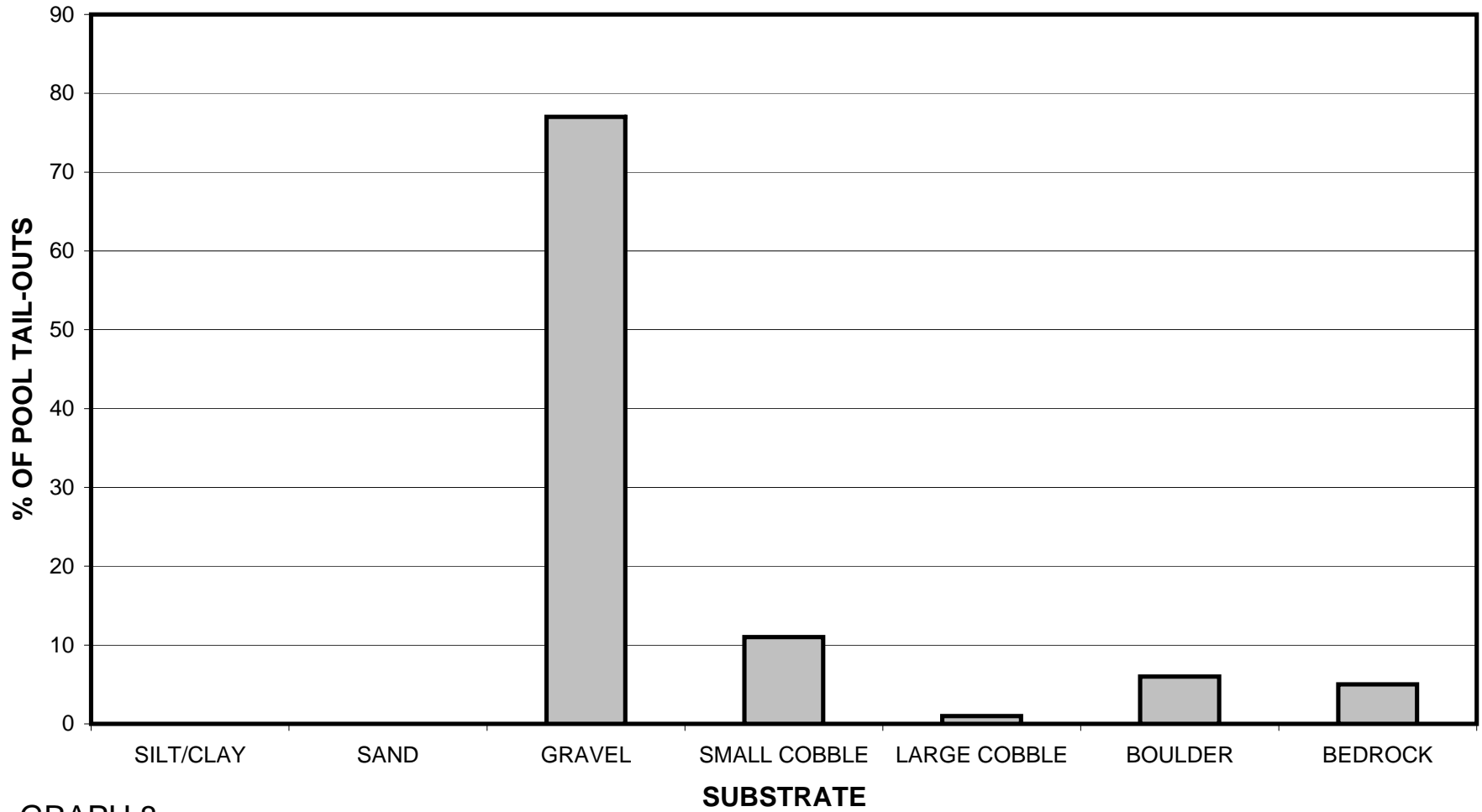
GRAPH 6

HORSE CREEK 2010 MEAN PERCENT COVER TYPES IN POOLS



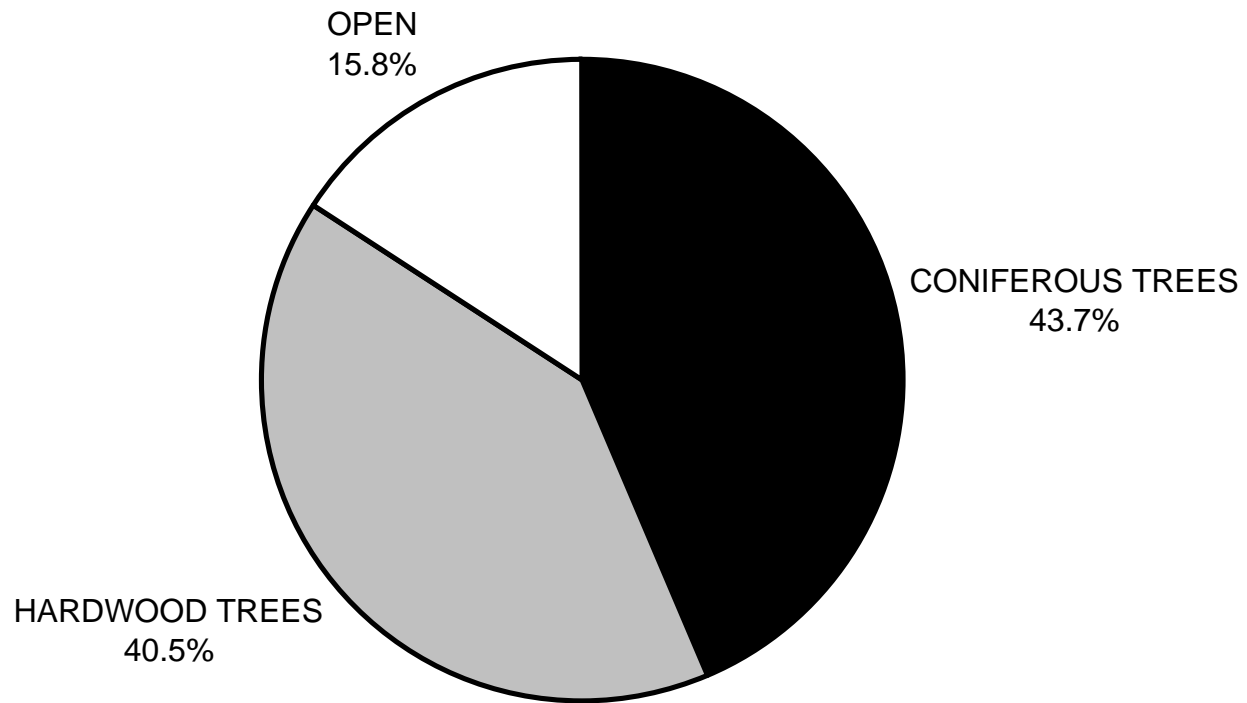
GRAPH 7

HORSE CREEK 2010 SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



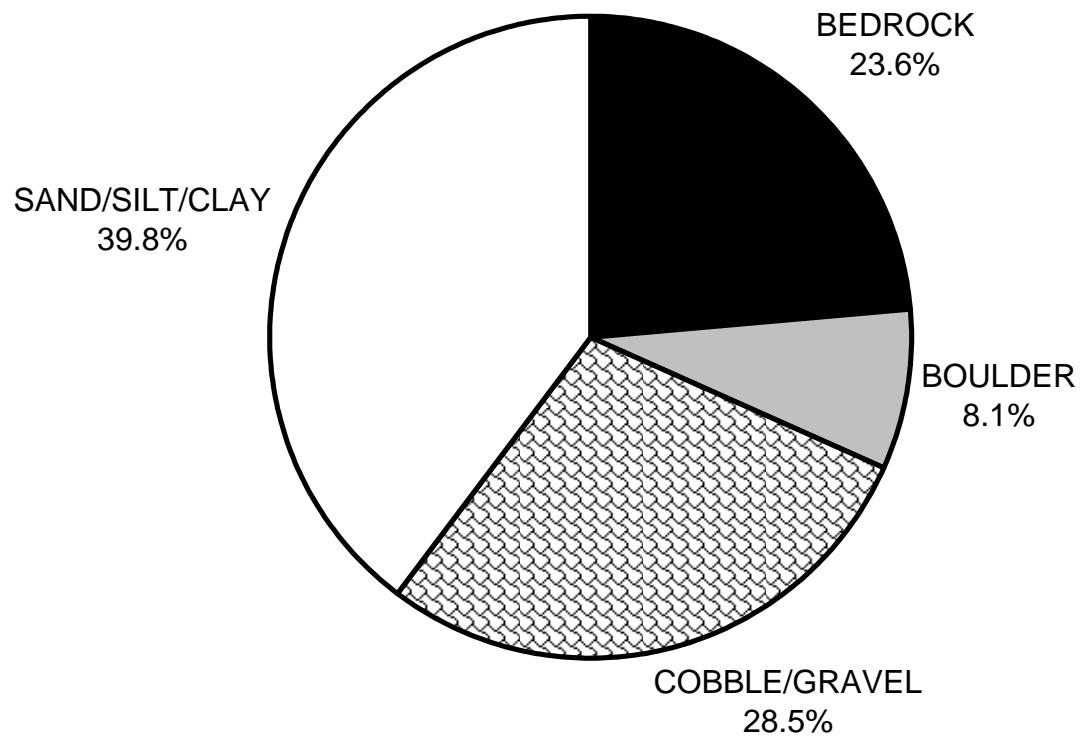
GRAPH 8

HORSE CREEK 2010 MEAN PERCENT CANOPY



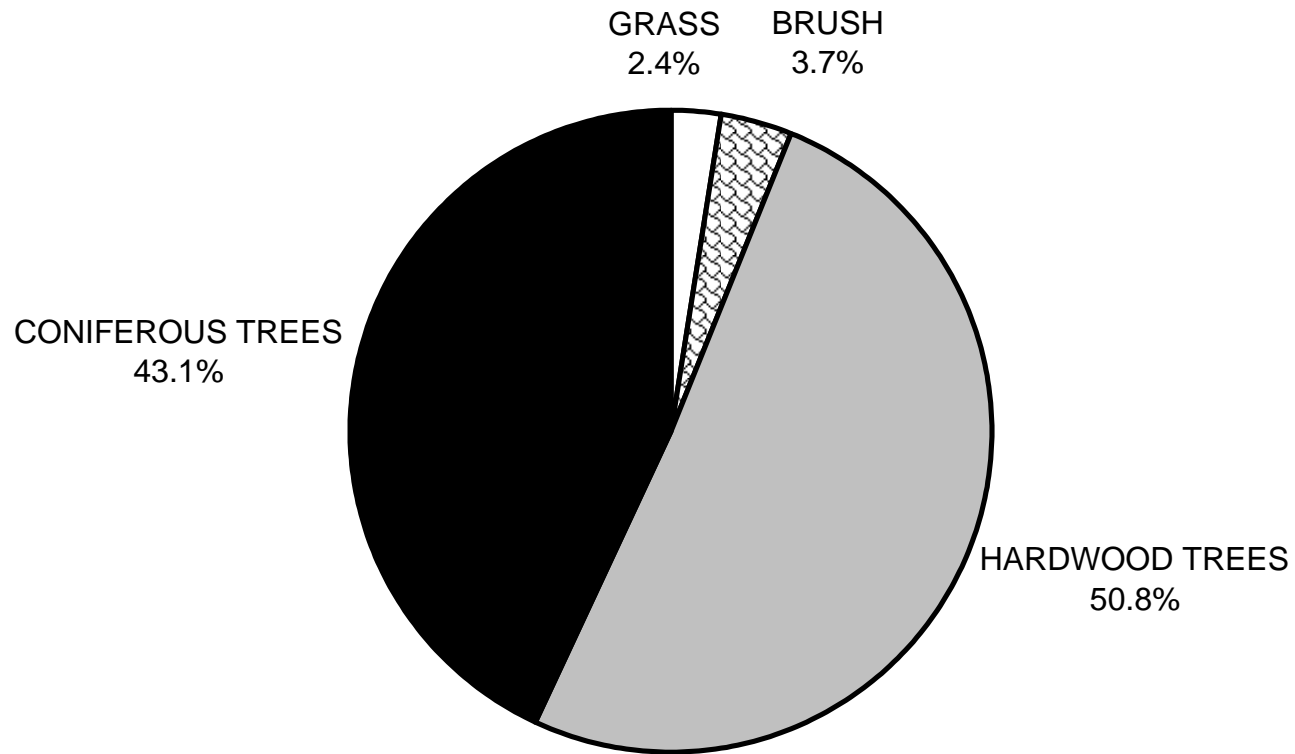
GRAPH 9

HORSE CREEK 2010 DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

HORSE CREEK 2010 DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

