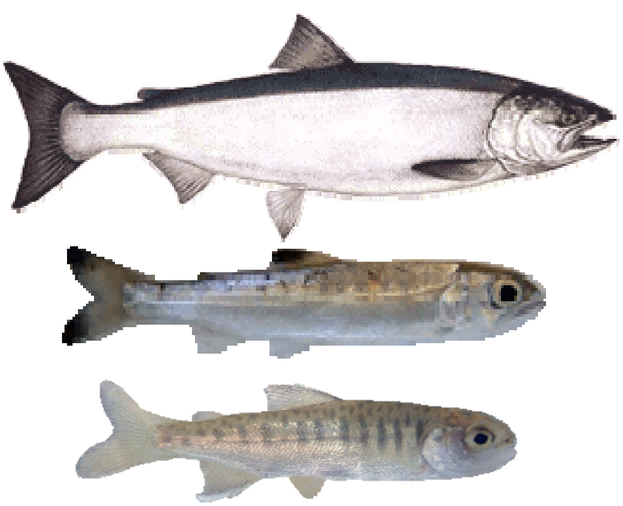
Appendix D-1



Final

Current Conditions Inventory Report

Dry Creek: Warm Springs Dam to Russian River

Sonoma County, CA

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December 2, 2010

EXECUTIVE SUMMARY

Introduction

The Dry Creek Habitat Restoration Feasibility Study is being conducted to explore options for habitat enhancement in Dry Creek, a major tributary to the Russian River in Sonoma County, California. The habitat enhancement work is proposed by Sonoma County Water Agency (SCWA) as one component of the larger Russian River Instream Flow and Restoration (RRIFR) effort that addresses river management in relationship to agency operations. In particular, key goals identified for habitat restoration in Dry Creek include development of rearing and refugia habitat for Central California Coast (CCC) coho salmon (*Onchorhynchus kisutch*) and CCC steelhead trout (*O. mykiss*). Coho salmon and steelhead trout are listed under the Endangered Species Act as *endangered* and *threatened*, respectively. Habitat enhancement in Dry Creek is seen as a significant opportunity for recovery of coho and steelhead in the region due to the relative abundance of cool water in the late summer months which is atypical of streams in the region. Late summer rearing conditions are considered a critical bottleneck for species recovery. Minimum habitat restoration goals for Dry Creek are discussed later in this document and detailed more specifically in the Final Biological Opinion for Water Supply, Flood Control and Channel Maintenance Activities (RRBO: NMFS 2008).

The feasibility study follows a two-phase approach. Phase 1 includes inventory and assessment of current conditions in the study reach between Warm Springs Dam and the confluence with the Russian River (hereafter referred to as 'lower Dry Creek'). Phase 2 will include detailed feasibility assessment and conceptual design of habitat enhancement opportunities identified during the current conditions inventory. This document summarizes Phase 1 of the study.

Watershed Context

The Dry Creek watershed is located in the interior coast range of northern Sonoma and southern Mendocino counties, approximately 30 miles from the Pacific Ocean and 60 miles north of San Francisco Bay. Warm Springs Dam is located on Dry Creek at river mile 13.9, at the confluence of Dry and Warm Springs Creeks. The Dry Creek watershed lies within a region of Mediterranean climate, characterized by warm, dry summers and cool wet winters.

The characteristic pattern of the natural flow regime for Dry Creek prior to operation of the dam (before 1984) was seasonal with the creek running nearly dry each year in the summer and early fall. Flow rates under natural conditions increased three orders of magnitude during the winter. After operation of the dam commenced in 1984, the flow regime changed to a perennial stream with much less variation in flow rates between summer and winter. Summers have consistent base flow while winter peak flows are reduced relative to natural flow conditions.

The present condition of lower Dry Creek expresses the legacy of management in the basin, which extends back to the settlement of the valley starting in the 1850s. Gravel mining began in the Russian River near Healdsburg about 1900, and continued in various locations within the mainstem until the late 1960s, and then shifted to the Russian River terraces below Healdsburg. The Potter Valley project was constructed in the early 1900s, which supplemented flow in the Russian River with water from the Eel River in northern California. Gravel mining also occurred along lower Dry Creek from the 1950s to the 1970s near the Mill Street bridge (approximately 2 miles above the creek mouth). In conjunction with the construction of Healdsburg (1952) and Coyote (1959) Dams on the Russian River which served to reduce downstream supplies of gravel, gravel mining and other activities resulted in a significant lowering of the base level for Dry Creek, which resulted in significant degradation in the main channel of lower Dry Creek, and subsequently in the tributaries (Army Corps of Engineers 1987).

Current Geomorphology of Dry Creek

The current geomorphology of lower Dry Creek is a result of the interaction of local geology, watershed characteristics, hydrology, and vegetative characteristics; the legacy of channel evolution and response to land management changes; and the ongoing influence of flow management. Lower Dry Creek is an incised, perennial, alluvial gravel bed stream that has responded to significant human induced hydrologic and geomorphic change over the past 150 years. At the time of this report, the study reach is primarily composed of pool-riffle and plane-bed morphology (Montgomery and Buffington 1997) with an average channel gradient of 0.18%. The channel corridor is generally narrow relative to the active channel width, and relatively uniform in width over most of the study reach, with periodic wider reaches.

Widespread, systemic incision occurred historically in response to base-level lowering and other factors. Assessments completed in close proximity to the time of dam closure concluded that systemic degradation of lower Dry Creek had generally ceased by the time the dam came online (Harvey and Schumm 1985). The primary determinant of current geomorphic conditions is the influence of the dam, expressed through modified sediment supply, altered hydrology and the growth of riparian vegetation. Dam construction ceased delivery of bed material from the upper 60% of the watershed. The hydrologic regime has been converted from a seasonal runoff-based regime to a regime that combines moderate winter floods, year-round flows, and sustained, relatively high baseflow conditions. The change in hydrology has also resulted in increased growth of riparian trees that influence bank erosion rates.

The reduction in bedload supply is most noticeable in the reach between the dam and the confluence of Dutcher (RM 11.8) and Pena (RM 11) Creeks. The reduction in bed material supply is moderated by successive tributaries entering lower Dry Creek. The most significant of these in terms of bed material supply include Dutcher Creek (RM 11.8), Pena Creek (RM 11), Crane Creek (RM 6.3) and Mill Creek (RM 0.6). The reach between Pena Creek and Westside Bridge (RM 11 to RM 2) did not appear to be actively incising or aggrading, though there are selected areas of active channel adjustment. The reach between Westside Bridge and the confluence appeared to be the most alluvial reach, in which the channel position and shape are most readily shaped by fluvial forces

Regulation has resulted in elevated summer baseflow conditions that when combined with the Mediterranean climate produces near ideal conditions for growth of riparian trees and shrubs. Regulation has also resulted in severe curtailment of major floods, which limits disturbance and removal of newly recruited and established vegetation. This combination of effects has resulted in extensive vegetative colonization of formerly active bar surfaces. Colonization of the bar surfaces serves to limit lateral migration of the active channel within the channel corridor, and has the effect of sequestering a reservoir of gravel within the system.

Vegetative colonization of bar surfaces has also lead to an active channel that is efficient at moving gravel supplied to the stream despite the reduced flood flow hydrology. Mature vegetation and dense understory growth hydraulically roughen over bank areas and concentrate high flow velocities in the channel during high flow events. However, based on field observations, the combination of reduced bed material supply and reduced flood magnitudes and frequencies do not appear to have resulted in incremental systemic degradation or aggradation. It appears that vertical degradation was essentially complete before dam closure. Degradation is also kept in check by features which control the bed grade spaced periodically over the reach, such as bedrock exposures and grade control structures.

Fish Habitat in Dry Creek

The goals of the current habitat inventory were to census aquatic habitat for coho salmon and steelhead trout in Dry Creek downstream of the Warm Springs Dam, to provide context for the development of fish habitat enhancement alternatives, and to establish a basic pre-treatment baseline against which to measure the effects of future fish habitat enhancement projects. Habitat conditions were documented at the summer steady-state operational discharge of approximately 100 cfs.

Dry Creek historically supported populations of coho and steelhead, although it only provided marginal salmon habitat when compared to other Russian River tributaries closer to the coast (Hopkirk and Northen 1980). Coho and steelhead are present in Dry Creek year-round. Adult coho and steelhead enter Dry Creek to spawn in the late fall and winter. Eggs deposited in gravel nests called redds incubate through the winter and early spring, and fry emerge in springtime. Juvenile coho and steelhead rear in Dry Creek for a minimum of one year before emigrating to the sea the following late winter or spring. Furthermore, it should be noted that Dry Creek currently supports a robust population of Chinook salmon (*O. tshawytscha*). Future habitat enhancement efforts will consider interactions with this important population.

The current inventory found that Dry Creek is composed of 26% riffles, 23% pools, 7% scour pools, 44% flatwaters and less than 1% cascades based on the relative frequency of mainstem habitats. Pool depths generally decreased in the downstream direction, with a greater proportion of scour pools in the middle to upstream end of the survey area. Overall, there was far more flatwater than riffle habitat (44% of mainstem habitats by frequency versus 26% for riffles). Although Dry Creek is composed of 26% riffles by frequency, riffles represent only 12% of mainstem habitats by length. A total of 44 alcoves and 27 side channels were measured, with a relatively greater number of off-channel habitats in the lower half of the study reach. The percent cover ranged from 27% associated with pools to 14% associated with riffles.

Pebble counts were conducted at riffles in all surveyed reaches. The substrate sizes in these riffles meet coho and steelhead spawning requirements. The predominant substrate in riffles, flatwaters and pools was gravel. In side channel pools, dominant substrate was most often fine sediment, gravel, or sand.

Instream woody debris (small, medium and large) totaled an average of 183 pieces of wood per mile in lower Dry Creek, with variability from reach to reach, including 63 pieces per mile in Reach 14 to 362 pieces per mile in Reach 10. We also classified wood as living or dead. 46% of all the pieces counted were living, with 44% of the *large* pieces living, and 46% of the *small* and *medium* pieces living. Recent publications highlight the geomorphic and ecological importance of living wood in Northern Californian stream systems.

A moderate amount of cover provided by overhanging terrestrial vegetation (within 6" of the water surface) was found by the 2009 habitat inventory. Average cover in pools (27%) was higher than in flatwaters (22%), and cover was greater in flatwaters than in riffles (14%). Off-channel habitats generally had much higher cover than main channel units. Additionally, the present inventory found complexity values to be high, but moderate to low shelter ratings. Overall, edge habitat was present in 41% of all habitat units. Although we did not specifically measure bank erosion, eroding banks were observed in Reach 1 and in Reach 7. There were a large number of bank stabilization efforts observed in the creek, including riprap, cars, creosote-preserved wood fences, steel I-beams, and chain-link fence.

Fish Habitat Enhancement in Dry Creek

The recommended Reasonable and Prudent Alternative contained in the Biological Opinion on Russian River basin reservoir and river management requires enhancement of six miles of lower Dry Creek to provide near ideal summer rearing conditions for coho and steelhead at the proposed steady state operational discharge (approximately 100 cfs), with an emphasis on coho.

The RRBO offers specific criteria with respect to desired rearing habitat characteristics. These include pool abundance (33% to 67%) and frequency (pool: riffle ratio between 1:2 and 2:1), pool depth (2 ft to 4 ft), pool velocity (<0.2 ft/s), structure and cover (ample large woody debris), and pool size (500 ft^2 to 2700 ft^2). The RRBO also stresses the availability of off-channel habitats in low velocity areas with substantial cover. Finally, the enhancement techniques should consider 'log or rock weirs, deflectors, log jams, constructed alcoves, side channels, backwaters, and dam pools that have successfully increased the quantity and quality of summer and winter rearing habitat for coho and steelhead' (NMFS 2008).

Based on the current fish habitat inventory which was completed at the approximate steady state discharge, the study reach contains 23% pools, 7% scour pools, 26% riffles, and 44% flatwaters by frequency of main channel habitats. Average maximum and residual pool depths were 5.2 and 3.6 feet respectively. The overall quantity of pool habitat falls below the desired range, and the pools may lack sufficient cover and structure. Furthermore, a preliminary analysis indicates that pool velocities ranged from 0.2 to 1.3 ft/s with an average of 0.6 ft/s, generally higher than the 0.2 ft/s target pool velocity listed in the RRBO. By frequency, riffles comprise 26% of main channel habitats, however only comprise 12% of main channel habitats by length. A limited amount of alcove habitat was identified. Based on these results and additional discussion with stakeholders, a suite of proposed enhancements will be developed in successive phases of the project. The proposed enhancements are likely to include combinations of mainstem pool and riffle enhancement, off-channel backwater and alcove enhancement and creation, side-channel enhancement and creation, and enhancement and stabilization of streambanks.

System- and project-scale feasibility will be assessed in the next phase of the study. However, areas of interest for potential enhancement were noted during the geomorphic and habitat inventory fieldwork in August-September 2009. Areas for potential enhancement of pools, riffles and streambanks are numerous along the study reach. Therefore, more effort was focused on identifying locations to enhance and create off-channel alcove and backwater, and side-channel habitat. These types of habitats have been proven to be particularly productive for rearing of coho salmon. While opportunities for these habitat types exist in lower Dry Creek, potential challenges are posed by Dry Creek's narrow, incised reaches, with limited lateral areas within close elevation range of the active channel. Additional constraints on enhancement vary over the length of the study reach, and include local factors such as sediment supply, elevation relative to active channel, local grade control features, and the backwater influence of the Russian River.

Phase 2 of the study will assess the feasibility of habitat enhancement in the areas of interest. Based on the results of the feasibility assessment, a list of project opportunities for which feasibility has been established will be developed. Conceptual designs will be developed for the sites deemed feasible.

ACKNOWLEDGEMENTS

The following contributed significantly to the current conditions inventory and are acknowledged for their respective efforts:

Sonoma County Water Agency Staff
Dry Creek Advisory Group Members
Dry Creek Property Owners
California Department of Fish and Game Staff
National Marine Fisheries Service Staff
U.S. Army Corps of Engineers Staff

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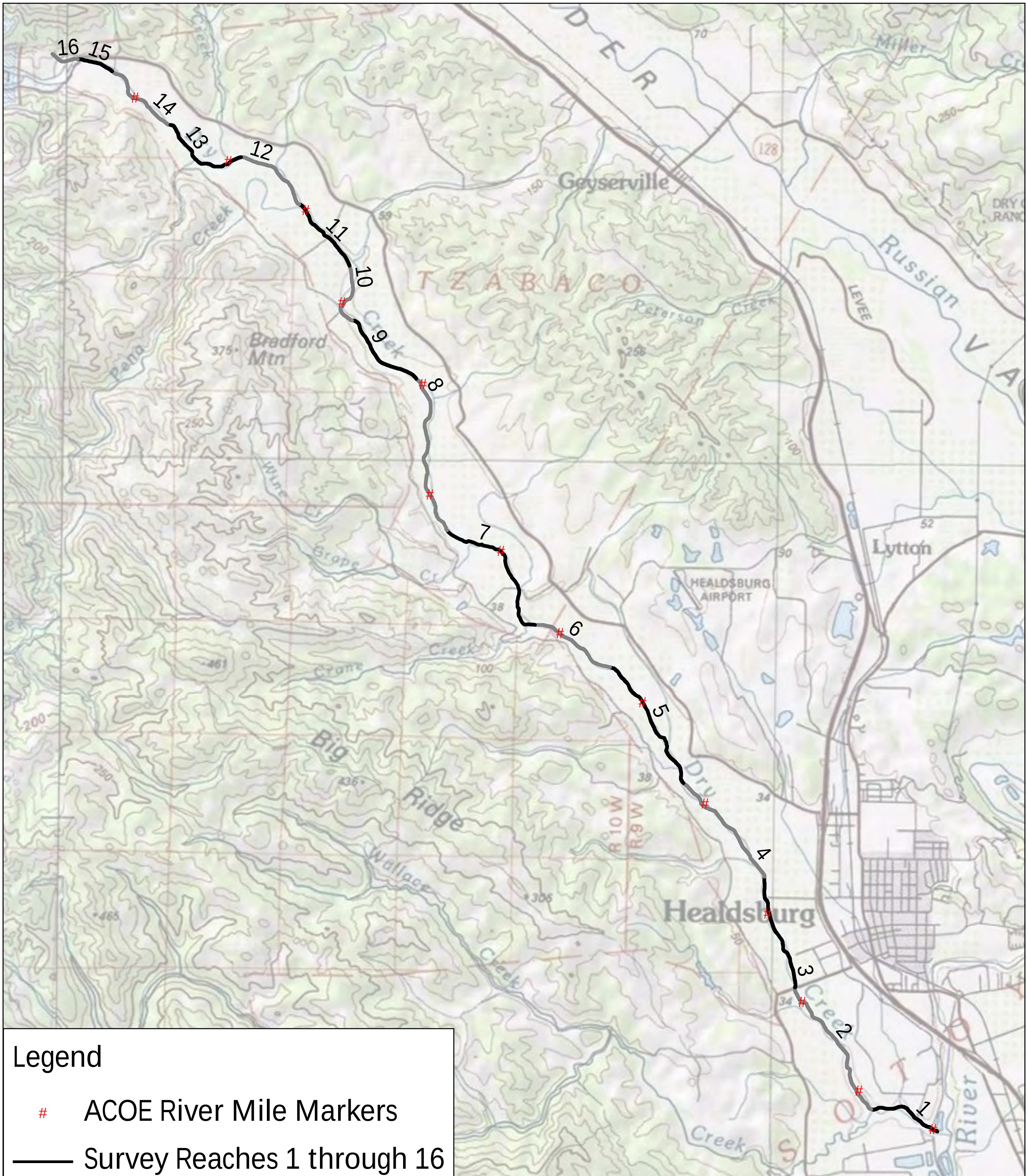
2 SCOPE OF WORK

The feasibility study follows a two-phase approach. Phase 1 includes inventory and assessment of current conditions along Dry Creek between Warm Springs Dam and the confluence with the Russian River (hereafter referred to as ‘lower Dry Creek’). Phase 2 will include detailed feasibility assessment and conceptual design of habitat enhancement opportunities identified during the current conditions inventory.

The present document reports the results of the current conditions inventory. The effort included the following primary tasks:

1. Review of existing data regarding Dry Creek hydrology, geomorphology and habitat conditions.
2. Analysis of Dry Creek basin hydrology.
3. Reconnaissance and analysis of geomorphic conditions in lower Dry Creek.
4. Inventory and analysis of fish habitat present in lower Dry Creek.
5. Identification of potential enhancement sites along lower Dry Creek for further review in the detailed feasibility stage.

The following sections report the results of Phase 1.



DRY CREEK
Current Conditions Inventory
Figure 1: Study Reach

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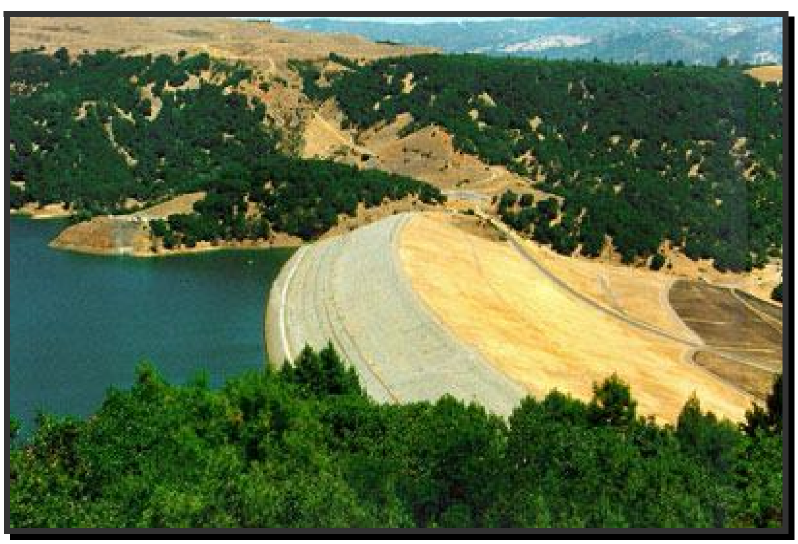
3 DRY CREEK WATERSHED CONTEXT

The following paragraphs provide regional and watershed context for the inventory and analysis reported in the subsequent report sections.

3.1 Regional Setting

The Dry Creek watershed is located in the interior coast range of northern Sonoma and southern Mendocino counties, approximately 30 miles from the Pacific Ocean and 60 miles north of San Francisco Bay. Dry Creek is a fourth-order tributary that drains 217 square miles of rugged terrain in the southwestern portion of the Russian River Basin in a generally northwest to southeast direction, with a watershed which is approximately 32 miles long and 7 miles wide (Simons and Li 1980). Elevations range from 70 feet near the mouth to nearly 3000 feet near the headwaters, with half of the watershed above 1,100 feet in elevation. In terms of annual runoff contribution and drainage area, Dry Creek is the first and the second largest tributary of the Russian River, respectively (Army Corps of Engineers 1984). Downstream of the Dry Creek confluence at Healdsburg (river mile 30.6), the Russian River flows westerly to the Pacific Ocean at Jenner, California.

Warm Springs Dam (WSD; Photograph 1) is located on Dry Creek at river mile 13.9, at the confluence of Dry and Warm Springs Creeks. The 130 square mile watershed located above the dam is characterized by steep, mountainous terrain with basin slopes ranging from 30% to 80% and channel gradient ranging from 8 to 200 feet per mile (0.2 to 3.8%; Army Corps of Engineers 1987a). Downstream of the dam, lower Dry Creek is a gravel bed river that flows through a flat agricultural valley 0.5 to 1 mile wide with approximate average gradient of 0.2%. Principal tributaries entering Dry Creek below WSD include Pena Creek (drainage area 22.3 sq. mi.) and Mill Creek (drainage area 22 sq. mi.). Agricultural production in the lower Dry Creek valley was based on orchard fruit through the 1970s. Grapes are the primary agricultural crop today.



Photograph 1: Warm Springs Dam.

3.2 Geology

3.2.1 Lithology

Review of available geologic mapping and literature sources indicate that the Dry Creek drainage occupies a structurally controlled valley that generally lies on the boundary between sedimentary units of the Great Valley Complex (Healdsburg terrane) to the east and various fault bounded lenses of the Coast Range ophiolite and metamorphic rock units of the Franciscan Complex to the west (Blake, Graymer, and Stamski, 2002). However, sandstone, siltstone, and shale units belonging to the Great Valley Complex are also mapped along the western margin of the valley adjacent to river reaches 6 and 7 and the lower portion of reach 8, in what appears to be a large, west-southwest plunging, synclinal fold. The contact between the sedimentary rock of the Great Valley Complex and the volcanic and intrusive rocks of the Coast Range ophiolite is obscured beneath Quaternary alluvium of the lower Dry Creek floodplain (Figure 2).

Quaternary sedimentary rock units, including siltstone, sandstone, and conglomerates of the Pliocene-Pleistocene Glen Ellen Formation, as well as Pleistocene alluvial and marine terrace deposits, have been mapped along the eastern margin of the Dry Creek valley. The youngest sediments found within the valley are stream channel and floodplain deposits associated with Dry Creek and include up to three terrace deposits, the oldest of which appears to be approximately 1,000 years old (Harvey and Schumm, 1985).

Table 1 summarizes the potential rock types that may underlie the bed of lower Dry Creek based on proximity to various geologic units mapped along the western flank of the valley.

Table 1: Potential rock types that may underlie Dry Creek.

River Reach	Adjacent Bedrock Type	Geologic Unit Affiliation
2	metagraywacke sandstone	Franciscan Complex
3, 4	graywacke sandstone, greenstone, and chert	Franciscan Complex
5	graywacke sandstone, greenstone	Franciscan Complex
5	basalt, diabase, gabbro, diorite, and serpentinite	Coast Range ophiolite
5, 6, 7, 8	sandstone, siltstone, and shale	Great Valley Complex
8	basalt	Coast Range ophiolite
9, 13	diabase, gabbro, and diorite	Coast Range ophiolite
14	diabase, gabbro, diorite, and serpentinite	Coast Range ophiolite
14, 15	graywacke sandstone	Great Valley Complex

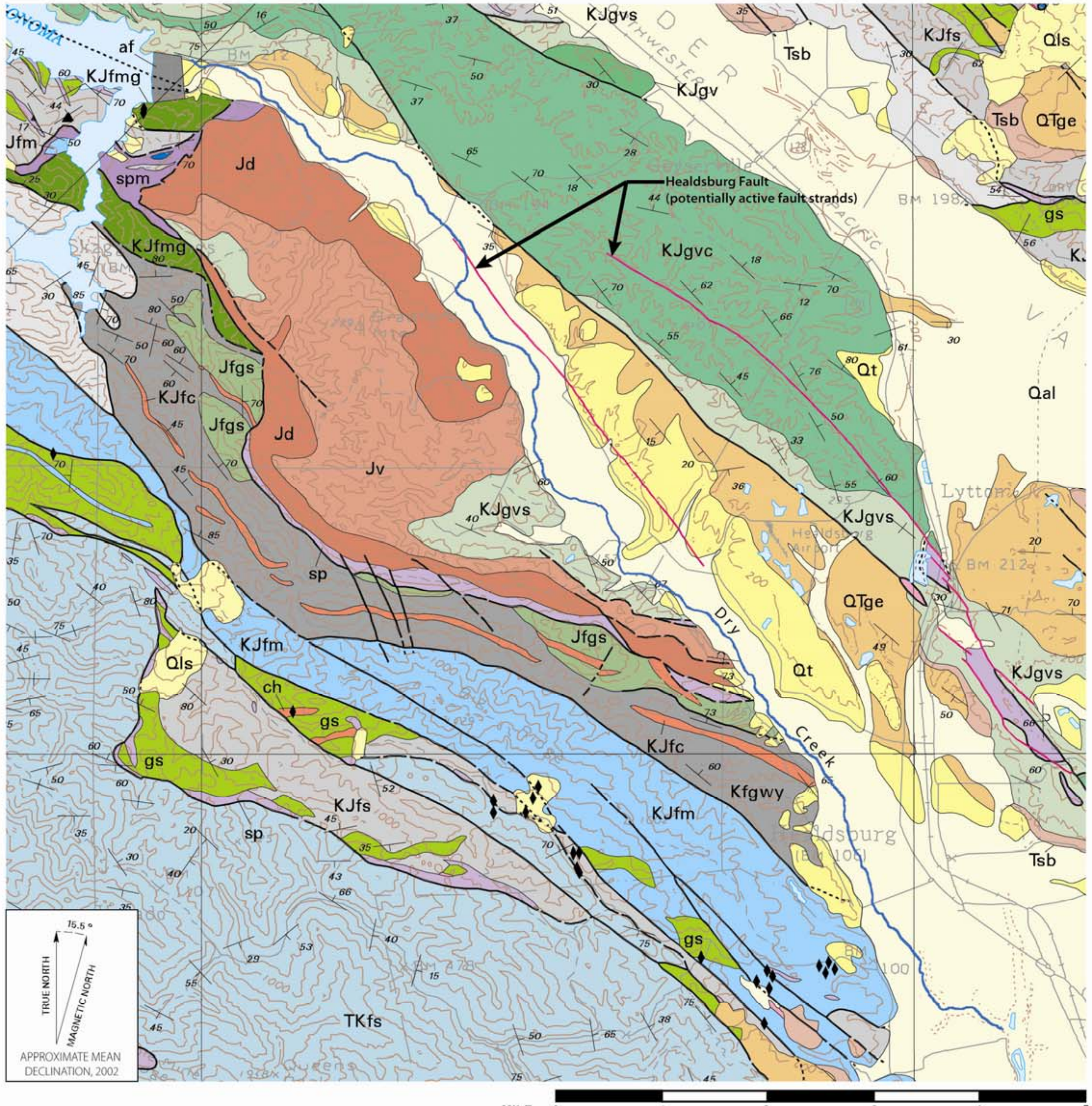


Figure 2:
Geologic Map of the Lower Dry Creek Valley and Surrounding Areas, Sonoma County, California

Exerpted and Modified from:
Geologic Map and Map Database of Western Sonoma, Nothernmost Marin, and Southernmost Mendocino Counties, California
by
M.C. Blake, Jr., R.W. Graymer, and R.E. Stamski
2002

LIST OF MAP UNITS

SURFICIAL DEPOSITS

- Qal — Alluvial fan and fluvial deposits (Quaternary)
- Qt — Alluvial and marine terrace deposits (Pleistocene)
- QTge — Glen Ellen Formation (Pleistocene(?) and Pliocene)
- Qls — Landslide deposits (Quaternary)

BEDROCK UNITS

Sonoma Volcanics (Pliocene and Miocene)

- Tsb — Basalt

Franciscan Complex

- TKfs — Sandstone (late Eocene to Late Cretaceous, Turonian)
- Kfgwy — Sandstone (Late and Early Cretaceous, Cenomanian and (or) late Albian)
- KJfc — Chert (Cretaceous and Jurassic)
- KJfs — Graywacke and mélange (Cretaceous and Jurassic)
- fsr — Mélange
  - gs — Greenstone block
  - ch — Chert block
  - gwy — Graywacke block
  - m — High-grade metamorphic rock block
  - sp — Serpentinite block
- Jfgs — Greenstone (Jurassic)
- KJfm — Metagraywacke (Cretaceous and Jurassic)
- KJfmg — Metabasalt (Cretaceous and Jurassic)

Great Valley complex

- KJgv — Sandstone, shale, and conglomerate (Early Cretaceous and Late Jurassic)
  - KJgvs — Sandstone, siltstone, and shale
  - KJgvc — Conglomerate

Coast Range Ophiolite (Late and Middle Jurassic)

- Jv — Mafic and intermediate volcanic rocks
- Jd — Mafic and intermediate intrusive rocks
- sp — Serpentinite
- spm — Serpentinite matrix mélange

MAP SYMBOLS

- **Contact**-- Depositional or intrusive contact or large mélange block edge; dashed where approximately located; dotted where concealed
- **Fault**-- Dashed where approximately located; small dashes where inferred; dotted where concealed; queried where location is uncertain; magenta denotes Quaternary active fault
- 35 — Strike and dip of bedding
- ♦ — High-grade block, mappped locally
- ▲ — Low-grade block, mapped locally

Harvey and Schumm (1985) note that outcrops of bedrock are almost entirely found where the present channel of Dry Creek is located near the western flank of the valley. The only exception to this occurs near Warm Springs Dam, where Dry Creek abuts the northeastern flank of the valley along exposed outcrops of Great Valley Complex sandstones. However, the contact between the sedimentary rock of the Great Valley Complex and the volcanic and intrusive rocks of the Coast Range ophiolite is thought to be a depositional contact, but obscured beneath Quaternary alluvium of the lower Dry Creek floodplain (Blake, Graymer, and Stamski, 2002). Thus, the bedrock foundation underlying almost any location along lower Dry Creek could potentially be sedimentary rock associated with the Great Valley Complex.

A key component of the geomorphic analysis completed by Harvey and Schumm included an assessment of bedrock exposed at Grape Creek. At this location, they noted the presence of two depositional units (a cemented sand and gravel unit and a very tight, consolidated unit of laminated silts and clays) which lay directly on an erosional unconformity above exposed sedimentary bedrock. Their descriptions of these depositional units are very similar to hydrogeologic descriptions of the Glen Ellen Formation within the Santa Rosa Valley groundwater basin (California Department of Water Resources, 2003). Harvey and Schumm noted that these depositional units are approximately 8 to 10 feet thick and rest on top of a 4- to 5-foot-thick bed of boulders and cobbles which appear to have been derived from the erosion of the underlying bedrock.

Based on their observations at Grape Creek, Harvey and Schumm identified similar cemented depositional units at several other points along the 1985 channel profile of lower Dry Creek (reaches 5 through 8; Figure 1), and inferred that bedrock was approximately 8 to 10 feet below the channel bed. However, Harvey and Schumm noted that the resistant bedrock and/or the cemented sediments were exclusively located on the western side of the valley and considered any estimation of the suballuvial location of bedrock to be highly speculative eastward of these bedrock and resistant alluvial controls.

3.2.2 Structure

Regional geologic mapping, digital imagery available for Google Earth™ through the United States Geological Survey (USGS) Quaternary fault and fold database (http://earthquakes.usgs.gov/regional/qfaults), and the regional fault evaluation report (Bryant, 1982) show several strands of the Healdsburg fault within and immediately adjacent to the Dry Creek drainage. Seismically, the Healdsburg fault comprises a 1 to 2 kilometer wide system of northwest trending, right-lateral strike-slip fault strands. These strands appear to be a northwest extension of the Rodgers Creek fault and define part of a complex seismic stepover with the Maacama fault to the north (McLaughlin and Sarna-Wojcicki, 2003). Both the Rodgers Creek and Maacama fault systems are zoned as active[1] under the State of California Alquist-Priolo (AP) Earthquake Fault Zoning Act (CDMG, 1997).

Although not currently zoned as active under the AP Act, workers mapping in the surrounding region considered some traces of the Healdsburg fault to be “recently active”

1 Active faults are defined as those exhibiting either surface ruptures, topographic features created by faulting, surface displacements of Holocene (younger than about 11,000 years old) deposits, tectonic creep along fault lines, and/or close proximity to linear concentrations or trends of earthquake epicenters.

(Huffman and Armstrong, 1980) or "Quaternary active" (Blake, Graymer, and Stamski, 2002). Based on available paleoseismic studies for the region and the structural relationship of the Healdsburg fault with the active Rodgers Creek and Maacama fault systems, these mapped fault strands should be considered potentially active[2].

3.2.3 Air Photo Analysis

Stereo-paired aerial photographs of the northern portion of lower Dry Creek, from river reach 7 to reach 16, and surrounding areas, were analyzed for the presence of prominent topographic lineaments and geologic structural trends that might adversely impact possible habitat enhancement improvements. The aerial photographs reviewed are 1:12,000 scale, black and white stereo-paired prints taken by Pacific Aerial Surveys in April 2000. A list of photographs reviewed is included in the references. In addition, digital satellite imagery available from Google Earth™ was reviewed to assess the current alignment of lower Dry Creek with respect to mapped Quaternary fault traces available from the USGS Quaternary fault and fold database.

Stereoscopic analysis of the aerial photos and digital imagery suggests that one or more reaches of Dry Creek may be structurally controlled along traces of the Healdsburg fault or other lineaments that we infer may be associated with the fault. Across the site, several sections of lower Dry Creek exhibit unusually low sinuosity for a stream in a dominantly alluvial drainage. These low sinuosity reaches are either coincident with and/or parallel to mapped strands of the Healdsburg fault (Figure 3). In particular, portions of reaches 10 through 12 are located on or along the projected trace of a mapped fault strand. Along the southwestern margin of the drainage, low sinuosity portions of reaches 3-5, 8-9, and 13-15 are all generally aligned along a linear trend that parallels mapped strands of the Healdsburg fault.

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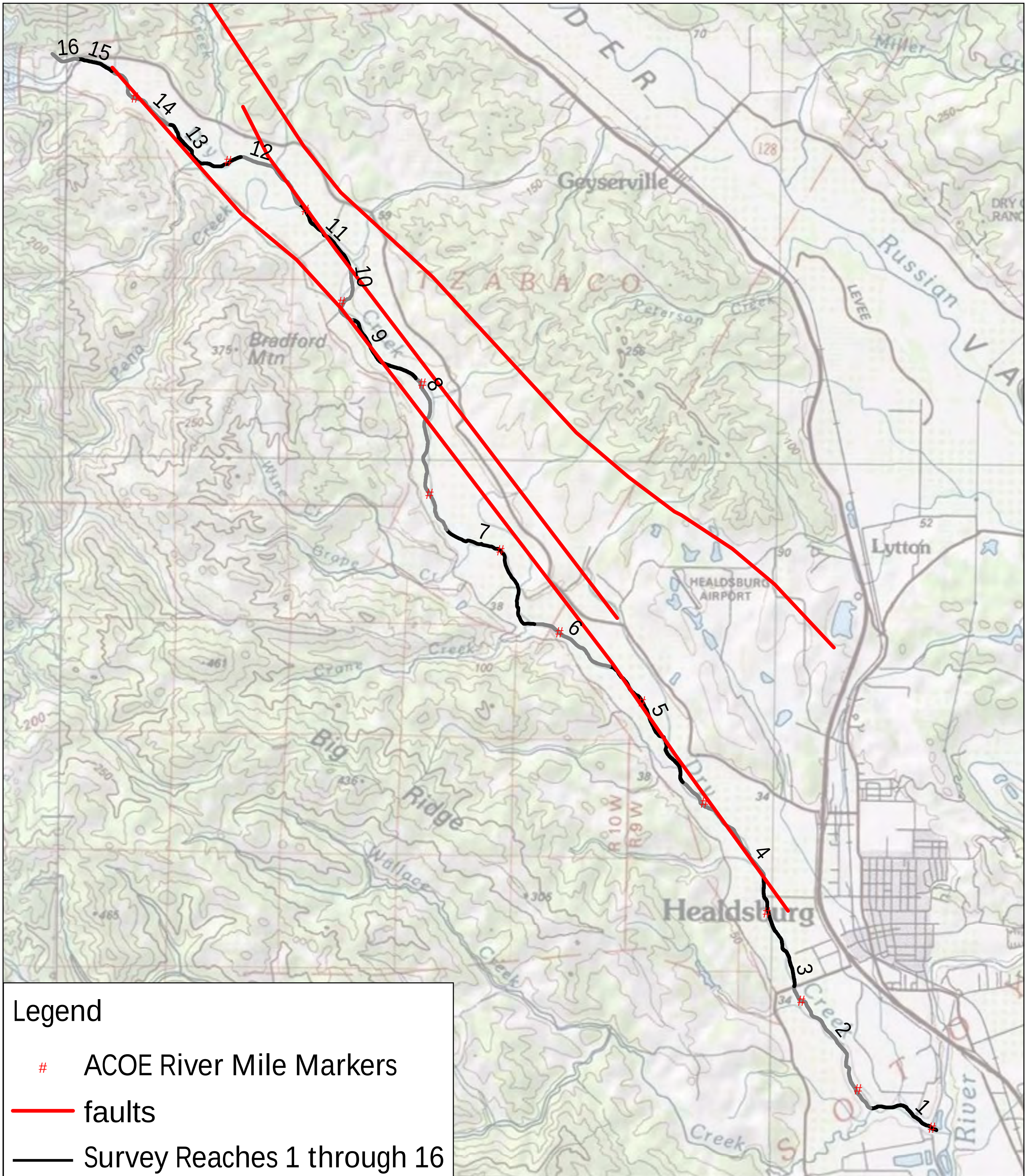
[2] Potentially active faults displace geologic deposits of Pleistocene age (about 2 million to 11,000 years old).



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DRY CREEK
Current Conditions Inventory
Figure 3: Fault Lineaments

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3.3 <u>Climate</u>

The Dry Creek watershed lies within a region of Mediterranean climate, characterized by warm, dry summers and cool wet winters. Average monthly temperatures range from 47 deg. F in December to 70.5 deg. F in July (Figure 4). Mean annual precipitation ranges from 41.3 inches (Healdsburg) to 45.4 inches (Warm Springs Dam) in the vicinity of the study area, to greater than 60 inches in the coastal mountains that form the western boundary of the watershed (Table 2). Over 90% of the precipitation falls between the months of October and April, with approximately 70% occurring between November and February (Table 1; Western Regional Climate Center 2009). Snowfall is uncommon except in the highest elevations of the Coast Range.

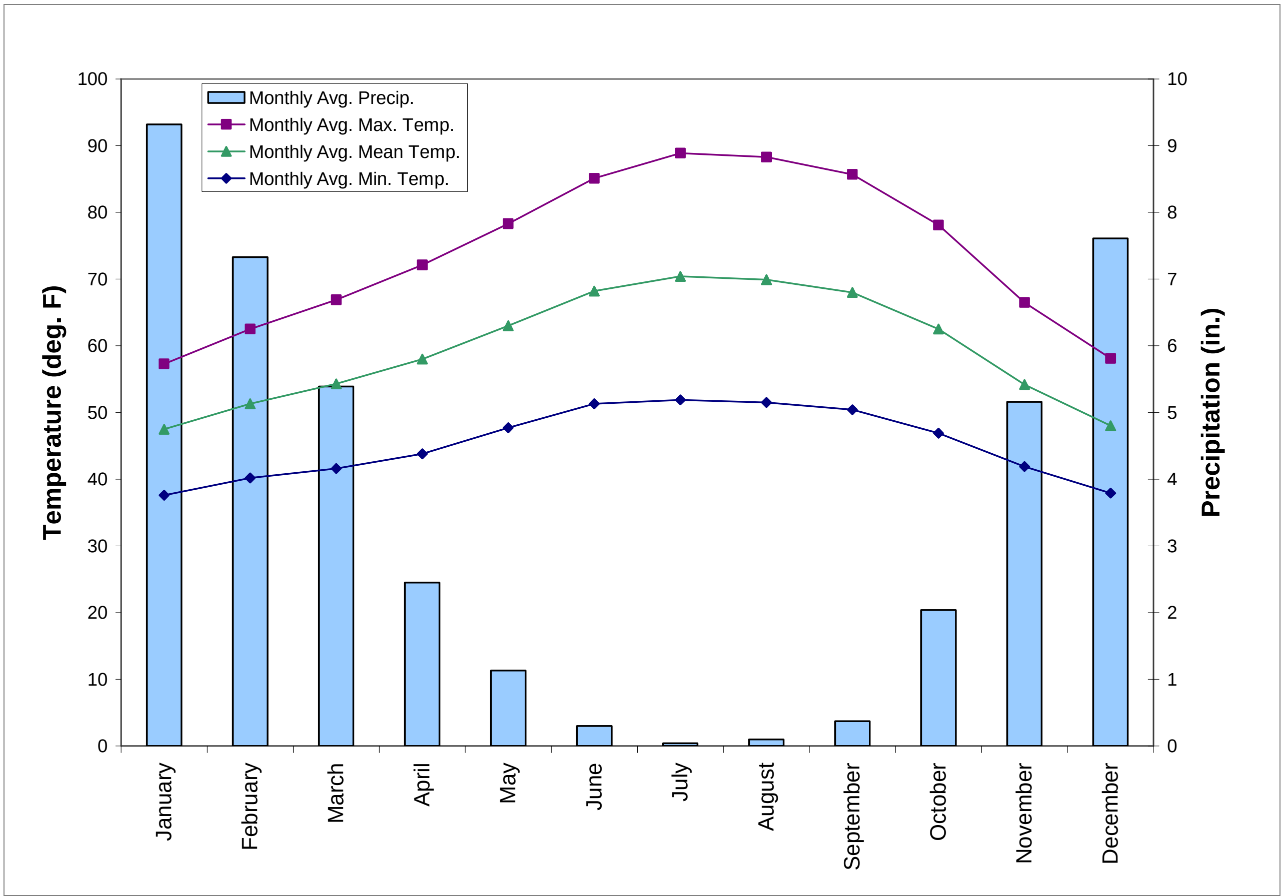


Figure 4: Mean monthly temperature and precipitation at Healdsburg (Station 043875) for the period 1893-2009.

Significant runoff events historically occurred in conjunction with Pacific frontal storms, normally the result of the southerly migration of the Aleutian low pressure system. Rainfall of significant proportions is produced by the combined effect of orographic and frontal convergence lifting mechanisms. Dominant winds associated with major storms are normally from the southwest (Army Corps of Engineers 1984).

Table 2: Average, minimum and maximum mean temperature and precipitation at Healdsburg (Station 043875) for the period 1893-2009.

	Average Temperature			**Average Precipitation**				
	Max.	**Min.**	**Mean**	**Mean**	**High**	**Year**	**Low**	**Year**
	F	**F**	**F**	**in.**	**in.**		**in.**	
Annual	74	45.2	59.6	41.3	96.3	1983	13.7	1976
Winter	59.3	38.6	48.9	24.3	49.4	1969	5.3	1976
Spring	72.4	44.4	58.4	9.0	27.5	1983	0.8	2008
Summer	87.4	51.6	69.5	0.4	3.7	1954	0.0	1893
Fall	76.8	46.4	61.6	7.6	26.7	1973	0.0	1929
January	57.3	37.6	47.5	9.3	33.7	1909	0.4	1976
February	62.5	40.2	51.3	7.3	25.4	1998	0.1	1953
March	66.9	41.6	54.3	5.4	21.1	1907	0.1	1988
April	72.1	43.8	58	2.5	12.9	1948	0.0	1907
May	78.3	47.7	63	1.1	9.5	2005	0.0	1903
June	85.1	51.3	68.2	0.3	2.2	1967	0.0	1893
July	88.9	51.9	70.4	0.0	1.7	1974	0.0	1893
August	88.3	51.5	69.9	0.1	3.2	1954	0.0	1893
September	85.7	50.4	68	0.4	4.5	1959	0.0	1902
October	78.1	46.9	62.5	2.0	10.8	1962	0.0	1905
November	66.5	41.9	54.2	5.2	21.2	1973	0.0	1929
December	58.1	37.9	48	7.6	25.2	2002	0.0	1989

3.4 Dry Creek Watershed Management

The present condition of lower Dry Creek expresses the legacy of management in the basin, which extends back to the settlement of the valley starting in the 1850s. Between 1850 and 1870, approximately 40 percent (approximately 50 sq. mi.) of the forested watershed area was cleared and converted to grazing land. This land use change had the effect of modifying runoff characteristics and sediment production, which led to an initial period of aggradation and subsequent degradation of lower Dry Creek between 1850 and 1900 (Army Corps of Engineers, 1987). At the time of European settlement, lower Dry Creek regularly spilled over its banks onto the historic floodplain, which is the area utilized for agricultural production today. In conjunction with conversion of the former floodplain for agricultural production in the lower reaches of Dry Creek, additional clearing, drainage and manipulation of tributary streams occurred.

Gravel mining began in the Russian River near Healdsburg about 1900, and continued in various locations within the mainstem until the late 1960s, and then shifted to the Russian River terraces below Healdsburg. Gravel mining also occurred along lower Dry Creek from the 1950s to the 1970s near the Mill Street bridge (approximately 2 miles above the creek mouth). The Potter Valley project was constructed in the early 1900s, which supplemented flows in the Russian River with water from the Eel River in northern California. In conjunction with the construction of Healdsburg (1952) and Coyote (1959) Dams on the

Russian River, gravel mining and other activities resulted in a significant lowering of the base level for Dry Creek, which resulting in significant degradation in the main channel of Dry Creek, and subsequently in the tributaries (Army Corps of Engineers 1987). In response to the degradation, significant numbers of bed and bank stabilization measures were installed by landowners and public entities along Dry Creek and its tributaries. This included installation of three grade control structures between river miles 3 and 4 by the Army Corps of Engineers in the early 1980s (Harvey and Schumm 1985). Historic evolution of Dry Creek is discussed further in subsequent sections in this document.
First investigated in the early 1940s, construction of Warm Springs Dam on Dry Creek at approximate river mile 13.9 was authorized under the Flood Control Act of 1962. The construction phase of the project commenced in 1967, with construction of the dam itself commencing in 1970. The dam embankment and outlet works were completed in 1982, and achieved full pool in 1983. With multiple objectives including flood control, water storage and recreation, Warm Springs Dam is a 319 ft tall, 3000 ft long earthen dam with a storage capacity at gross pool of 381,000 acre-feet. This equates to approximately 230% of the mean annual runoff of Dry Creek over the period 1916-1980 (Army Corps of Engineers 1984). Construction of the dam stopped the supply of bed material from the upper watershed and operations reduce the magnitude of all floods with at least a 2-yr return interval by more than 70% (Simons and Li 1980). Although peak flows are reduced, base flows have increased to provide continuous flow throughout the year along this traditionally seasonal stream (ACOE, 1987).

3.5 Lower Dry Creek Reach Delineation

The length of Dry Creek that is the subject of this study extends from WSD to the confluence of Dry Creek with the Russian River, a total stream length of approximately 13.9 miles (lower Dry Creek). Lower Dry Creek was delineated into reaches using existing data to facilitate organization of study field efforts and analyses. The initial delineation was subsequently verified in the field to result in a final delineation of 16 reaches. Reach 16, the trapezoidal channel in the tailwater below the spillway of WSD and upstream of Bord Bridge, was not investigated in the field. The remainder of this document will refer to reaches 1 through 15 where field efforts were focused.

3.5.1 Methods

The reach delineation generally followed the protocol for stream segment identification developed by the State of Washington's Timber, Fish and Wildlife Program (Pleus and Shuett-Hames 1998). In this protocol, the primary factors leading to delineation include geomorphic parameters (relative drainage area, channel gradient and channel confinement) and non-fluvial features (e.g. structures such as bridges). This effort resulted in a preliminary delineation which was field verified during the habitat and geomorphic inventory fieldwork (discussed in subsequent sections of this document), with adjustments made as appropriate.

Relative drainage area was assessed in terms of major tributary junctions, identified based on the Strahler method of stream order determination. A 1:100,000 hydrography GIS layer obtained from the Russian River Interactive Information System (RRIIS) was used as the basis for stream order determination for Dry Creek and the tributaries. At Warm Springs

Dam, Dry Creek was determined to be a 4th order stream. Per the protocol, 2nd or higher order tributaries were then considered as significant tributaries in the reach delineation.

Channel gradient was assessed by sampling 10-m USGS digital elevation (DEM) data along the digitized alignment of Dry Creek at 200 foot intervals (the only terrain data available at the time of delineation). Per the protocol, the channel gradient results were then binned into six categories: 1) <1%, 2) 1-2%, 3) 2-4%, 4) 4-8%, 5) 8-20%, and 6) >20%. The significant majority of gradient values (88%) fell into the <1% bin, with average gradient value of 0.22 %.

Channel confinement was assessed based on the 2004 aerial photography (the most recent high resolution aerial photography available at the time of delineation) and contours (0.25 m contour interval) generated from the 10-m DEM data using GIS. Channel confinement was determined by the ratio of the active channel width of the stream to the width of the attendant floodprone surface. Confinement was determined at 200 foot intervals and binned into three categories: 1) less confined (floodprone width ≥ 4 channel widths), 2) moderately confined (floodprone width ≥2 and <4 channel widths, and 3) confined (floodprone width <2 channel widths). Confinement values most typically fell into the moderately confined category, followed by a balance of confined and unconfined sections. Because Dry Creek is an incised stream, the floodprone surface was contained within the incised channel corridor.

Non-fluvial features were determined from aerial photographs, a GIS road layer, and a GIS surface diversion layer. No diversions were found that were greater than 5 cfs, thus these were eliminated from consideration in the reach delineation. Four road alignments cross lower Dry Creek. The geomorphic and non-fluvial factors were then combined sequentially to delineate the 16 reaches using lumping and splitting rules per the protocol. Delineated reaches were then reviewed in the field to result in the reach delineation reported below.

3.5.2 Results

The delineation includes 16 reaches, for an average length of approximately 0.9 miles. The delineated reaches are reported in Table 3 and are shown on Figure 1.

Table 3: Reach delineation results for lower Dry Creek.

Reach	DS end (RM)	DS end (landmark)	US end (RM)	US end (landmark)	Length (ft)
1	0.0	Dry Creek Mouth	0.7	Mill Creek	3550
2	0.7	Mill Creek	2.0	Westside Road	7000
3	2.0	Westside Road	3.0	Fault lineament 1150' DS Sill 1	5450
4	3.0	Fault lineament 1150' DS Sill 1	4.1	1600' US Sill 3, US end check dam impoundment	5880
5	4.1	1600' US Sill 3, US end check dam impoundment	5.4	Fault lineament, 150' DS Kelley Ck	6640
6	5.4	Fault lineament, 150' DS Kelley Ck	6.2	Bedrock outcrop, 475' DS Crane Ck	4150
7	6.2	Bedrock outcrop, 475' DS Crane Ck	7.5	Bedrock outcrop, 950' US Grape Ck	6940
8	7.5	Bedrock outcrop, 950' US Grape Ck	9.0	Change in relative confinement	7700
9	9.0	Change in relative confinement	9.8	Change in relative confinement, and fault lineament	4220
10	9.8	Change in relative confinement, and fault lineament	10.3	Tributary location	3040
11	10.3	Tributary location	11.0	Pena Ck	3755
12	11.0	Pena Ck	11.7	Gradient shift, 700' DS Dutcher Ck	3700
13	11.7	Gradient shift, 700' DS Dutcher Ck	12.6	Steep riffle	4345
14	12.6	Steep riffle	13.3	Schoolhouse Creek confluence	3930
15	13.3	Schoolhouse Creek confluence	13.7	Bord Bridge	1680
16	13.7	Bord Bridge	13.9	Dam Outlet	1340

4 DRY CREEK HYDROLOGY

Hydrologic analyses were conducted to understand the past and current hydrologic conditions of lower Dry Creek. Current hydrologic conditions in the project reach are regulated by the dam which became operational in 1984. Prior to dam construction and operation, Dry Creek had a natural flow regime typical of Mediterranean streams characterized by rapidly developing peak floods of relatively short duration occurring in conjunction with significant winter precipitation events, and very low summer period base flow. During significant flood events, flow may have increased of 2-3 orders of magnitude over a short timeframe. The hydrologic analyses were also conducted to provide guidance on appropriate design flows for development of habitat restoration concepts for lower Dry Creek. The following sections provide a summary of the available stream gage data and the methods and results of the hydrologic analyses.

4.1 Summary of available data

A number of sub-watersheds and their associated tributaries contribute flow to lower Dry Creek. Table 4 provides drainage areas and river mile locations of WSD, U.S. Geological Survey (USGS) gaging stations, bridges, and inflow of sub-watersheds (and their associated tributaries) along lower Dry Creek from the outlet of WSD to the confluence of the Russian River.

Each gaging station provides daily mean discharge data and annual peak discharge data for their respective periods of record (Table 5). Two of the five gages were primarily used for the current hydrologic analyses discussed in this section. The two gages are: (1) below Warm Springs Dam (USGS No. 11465000) and (2) Yoakim Bridge (USGS No. 11465200). The gage below Warm Springs Dam was chosen because it reflects flow out of the dam without influences from other downstream tributaries. The gage at Yoakim Bridge was chosen because of its long-term data record providing over 20 years of data, both prior to and following construction of the dam. This gage includes flow from the Dutcher Creek and Pena Creek sub-watersheds and reflects their contributions as shown in Figure 5.

The discontinued gages above the dam were not used for the hydrologic analyses because of their location. The gage at the mouth of Dry Creek was not chosen for the hydrologic analyses because it is within the zone of backwater influence of the Russian River during the winter months, and reports discharge values during low flow periods only.

Table 4: Drainage areas and river miles along lower Dry Creek from Warm Springs Dam to the confluence with the Russian River.

USGS Stations, Bridges, Sub-Watersheds (and Associated Tributaries)	Tributary Drainage Area (square miles)[1]	Sub-Watershed Drainage Area (sq. miles)[1]	Dry Creek Drainage Area (sq. miles)[1]	River Mile
Outlet of Warm Springs Dam – USGS Gage No. 11465000	-	-	130.0	13.9
Dutcher Creek Sub-Watershed		8.8	138.8	
Schoolhouse Creek	0.6			
Fall Creek	2.0			
Dutcher Creek	3.0			
Local Drainage	3.2			
Pena Creek Sub-Watershed		22.9	161.7	11.0
Vince's Creek	0.9			
Pena Creek	22.0			
Yoakim Bridge – USGS Gage No. 11465200			162.0	10.7
Lambert Bridge Sub-Watershed		13.7	175.7	6.6
Canyon Road Creek	2.1			
Grape Creek	3.3			
Local Drainage	8.3			
Pine Ridge Canyon Creek Sub-Watershed		10.3	186.0	
Crane Creek	2.4			
Kelly Creek	1.6			
Pine Ridge Canyon	1.2			
Local Drainage	5.1			
Westside Bridge				2.0
Confluence Sub-Watershed		31.0	217.0	0.0
Mill Creek	22.0			
Local Drainage	9.0			

[1] *Source:* Dry Creek Sediment Engineering Investigation, Sediment Transport Studies. U.S. Army Corp of Engineers, Sacramento District. May 1987.

Table 5: Summary of USGS gaging station locations and available observed discharge values.

Station Description	USGS No.	Location	Available Observed Discharge Values
Upstream of reservoir near Yorkville, CA	11464400	38°47'21'' 123°09'16'' NAD27	10/01/73 – 09/30/83
In reservoir near Cloverdale, CA	11464500	38°44'59'' 123°05'28'' NAD27	10/01/41 – 09/30/80
Below Warm Springs Dam near Geyserville, CA	11465000	38°43'11'' 122°59'58'' NAD27	10/1/39 – 09/30/42; and 10/01/81 – present
Yoakim Bridge below Pena Creek near Geyserville, CA	11465200	38°41'55'' 122°57'25'' NAD27	10/01/59 – present
Mouth of Dry Creek at the confluence with the Russian River near Healdsburg, CA	11465350	38°35'15'' 122°51'40'' NAD27	10/01/81 - present

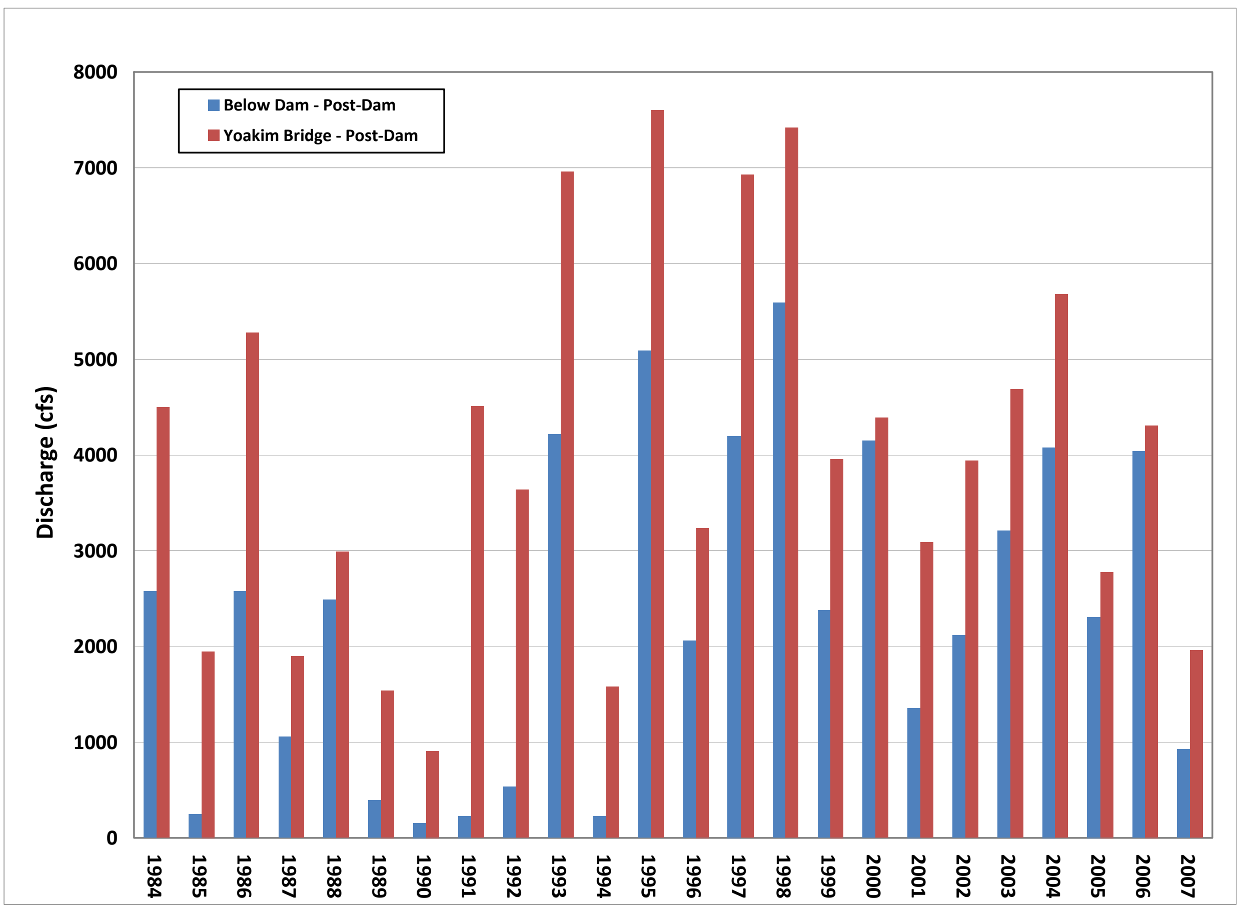


Figure 5: Comparison of post-dam peak discharge values below the dam and at Yoakim Bridge (WYs 1984-2007).

4.2 Methods

4.2.1 Flood Frequency Analysis

Peak flow hydrologic statistics (i.e., flood flows) were reviewed for the project reach. These statistics were developed using peak flow data at the gaging stations below Warm Springs Dam (USGS No. 11465000) and at Yoakim Bridge (USGS No. 11465200). The peak flow data were obtained from the USGS National Water Information System website.

The peak flow data were first estimated using the log-Pearson Type III distribution with a weighted regional skew coefficient which provided statistics for the 1.01, 2, 3, 10, 25, 50, 100, and 200-year return-interval hydrologic events. The statistics were used to plot flood frequency curves for pre- and post-dam hydrology. The post-dam flood frequency estimates produced a poor fit with the observed data due to the regulation of flows by the dam and were not used further in the analysis.

Observed peak discharge data for the gages below the dam and at Yoakim Bridge were compared with post-dam flood frequency return period estimates provided in the effective Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS; FEMA 2006) and in the Warm Springs Dam and Lake Sonoma Water Control Manual (Army Corps of Engineers 1984).

The FEMA FIS provides peak discharges for the 10, 50, 100, and 500-year return period floods at two locations that were generally compared with observed data at the two USGS gaging stations. The locations for the estimates in the FEMA document are: (1) upstream of the confluence with Dutcher Creek (Warm Springs Dam outflow), and (2) upstream of the confluence with Pena Creek. Data from the gage below the dam was compared with the FEMA estimates upstream of the confluence with Dutcher Creek. The USGS gaging station at Yoakim Bridge is downstream of Pena Creek; therefore, peak discharge data cannot be directly compared with the FEMA estimates for the location upstream of the confluence with Pena Creek. The two were generally compared, noting that the gage data includes the flow from Pena Creek while the FEMA estimates do not.

The Water Control Manual provides peak discharge estimates for the 2, 5, 10, 25, 50, 100, 200 and 500-year return interval hydrologic events for pre-dam conditions at Yoakim Bridge and post-dam conditions below Warm Springs Dam. These peak discharge estimates were combined with the FEMA estimates and compared with the two USGS gaging stations.

4.2.2 Flow Duration Analysis

Flow duration statistics for Dry Creek were developed using daily average flow data from the USGS gaging station below the Warm Springs Dam (USGS No. 11465000) and at Yoakim Bridge (USGS No. 11465200). The daily average flow data were obtained from the USGS National Water Information System website. Flow duration curves were developed by ranking daily average flows for the respective periods. Flow duration curves were developed for Yoakim Bridge pre-dam (1960-1983) and post-dam (1984-2008). In addition, a post-dam flow duration curve was developed for the gage below the dam (1984-2007).

4.2.3 Analysis of Flow Regulation

In order to assess the degree of hydrologic alteration caused by the dam, the long-term time series for the Yoakim Bridge gage station was evaluated using the Indicators of Hydrologic Alterations (IHA) methodology (Richter et al. 1996, Richter et al. 1997, Richter et al. 1998) and software (Nature Conservancy, 2009). In their 2003 analysis, Olden and Poff found that the suite of indices resulting from the IHA method adequately characterize the principal components of flow regimes (Olden and Poff, 2003). When pre-dam and post-dam periods are analyzed, the subsequent hydrologic alteration due to the dam's operations can be evaluated (Richter et al. 1996, Richter et al. 1997).

4.3 Results

The characteristic pattern of the natural flow regime for Dry Creek prior to operation of the dam (before 1984) was seasonal with the creek running nearly dry each year in the summer and early fall (Figure 6). Flow rates under natural conditions increased three orders of magnitude during the winter. After operation of the dam commenced in 1984, the flow regime changed to a perennial stream with much less variation in flow rates between summer and winter. Summers have consistent base flow while winter peak flows are reduced relative to natural flow conditions. The following sections describe the results of the flood frequency, flow duration, and IHA analyses. Each of these analyses provides insight into the hydrologic conditions of lower Dry Creek pre- and post-dam.

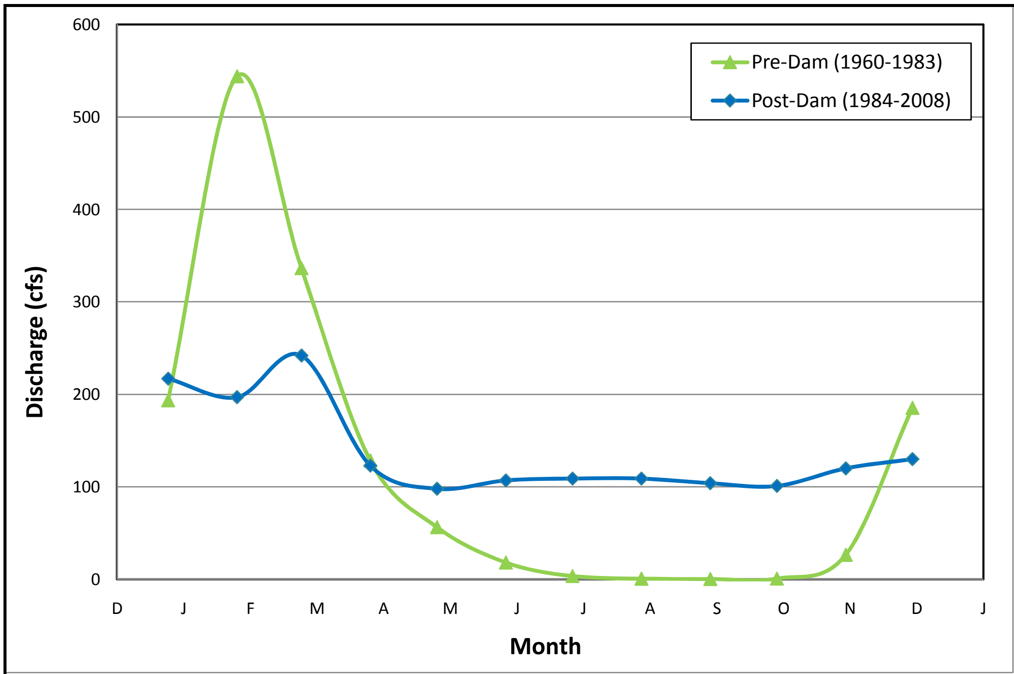


Figure 6: Comparison of monthly median discharges for pre- and post-dam periods at Yoakim Bridge (USGS No. 11465200).

4.3.1 Flood frequency

Pre- and post-dam peak discharge estimates obtained from the FEMA document and the ACOE Water Control Manual document are provided in Table 6.

Table 6: Peak discharge estimates at gages considered in this study.

Flow Event	**Below Dam (USGS No. 11465000)**		**Upstream of the Confluence of Pena Creek**	**Yoakim Bridge (USGS No. 11465200)**
	Post-Dam		**Post-Dam**	**Pre-Dam**
	FEMA	**ACOE**	**FEMA[1]**	**ACOE**
2-year	-	4000	-	23000
5-year	-	4500	-	25000
10-year	6000	6000	6200	30000
25-year	-	6000	-	35000
50-year	6000	6000	6500	38000
100-year	6000	6000	6900	40000
200-year	-	6000	-	45000
500-year	7400	7400	8800	48000

[1] Post-dam peak flow estimates from the FEMA document are from upstream of the confluence with Pena Creek. The Yoakim Bridge gage station is downstream of the confluence of Pena Creek.

Peak discharge estimates below the dam were consistent between the FEMA and ACOE documents. The post-dam peak discharge estimates upstream of the confluence with Pena Creek are higher than estimates below the dam due to flow contributions from the Dutcher Creek sub-watershed. The pre-dam peak discharge estimates at Yoakim Bridge are an order of magnitude higher than post-dam estimates.

Figure 7 shows a comparison of observed peak discharge data (1984-2008) and peak discharge estimates for the post-dam period. The peak discharge estimates below the dam (orange triangles) can be directly compared with gage data below the dam (red squares). The peak discharge estimates upstream of Pena Creek (pink squares) can be generally compared with gage data at Yoakim Bridge (blue diamonds) although the flood frequency estimates do not account for flow from Pena Creek which is measured at Yoakim Bridge. For comparison, the peak discharge estimates at Yoakim Bridge (magenta) for the pre-dam period are also shown.

The observed post-dam peak discharges below the dam have not exceeded the estimated peak discharges for period of operation. Peak discharges at Yoakim Bridge approached the estimated peak discharge values upstream of Pena Creek in 1993, 1995, 1997, and 1998, although the estimated values were not exceeded during the period of operation. This is a conservative comparison since corresponding peak discharge estimates at Yoakim Bridge would be greater than the estimates shown due to the incremental contribution of flow from Pena Creek.

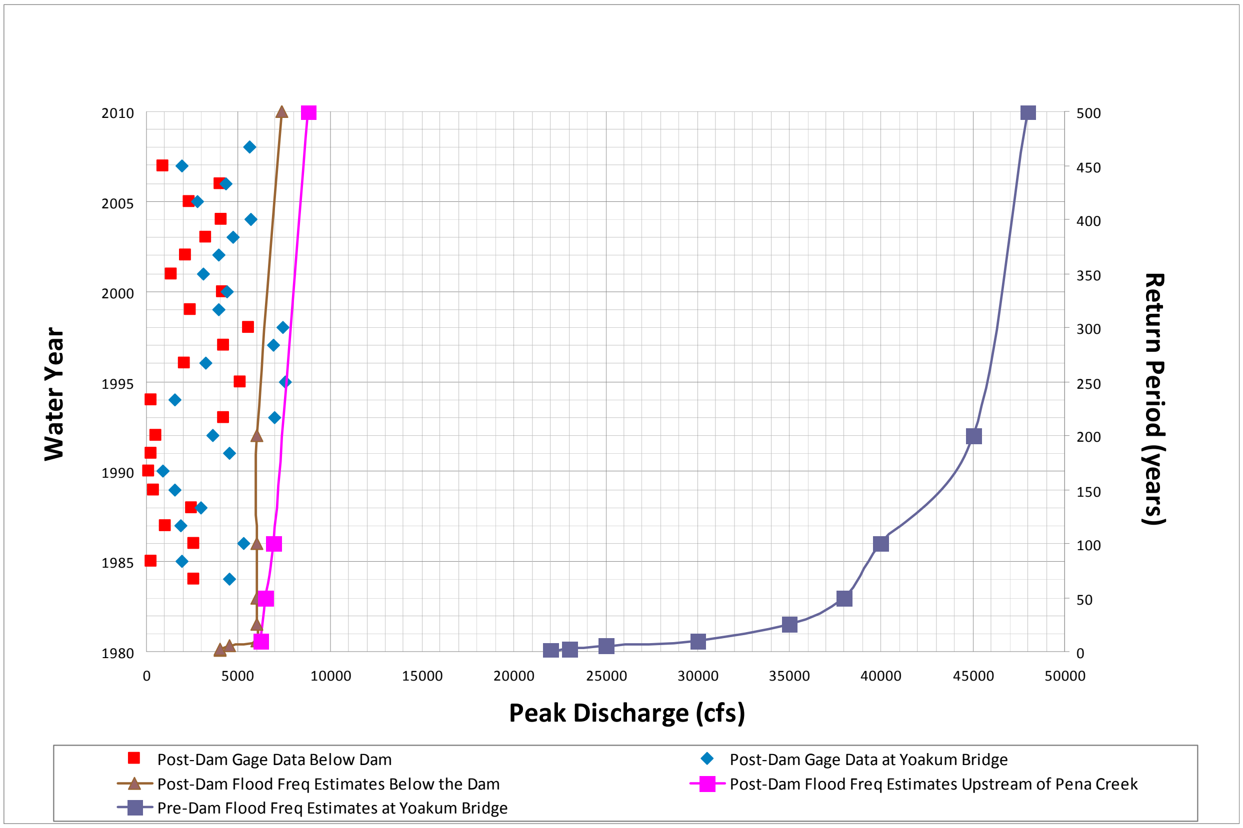


Figure 7: Comparison of pre- and post-dam peak discharge rating curves and measured (actual) peak discharge data for the post-dam period at the gaging stations located below the dam and at Yoakim Bridge. The observed data (points) are plotted against water year (left axis), while the peak discharge estimates (lines) are plotted against return period (right axis).

Figure 8 shows the frequency of occurrence for annual peak flows of varying magnitude over the pre- and post-dam periods. At the dam and the Yoakim Bridge gages for the post-dam periods, the median annual peak floods were 2345 cfs and 3960 cfs, respectively. This compares with a median annual peak flood of 16600 cfs for the pre-dam period at Yoakim Bridge.

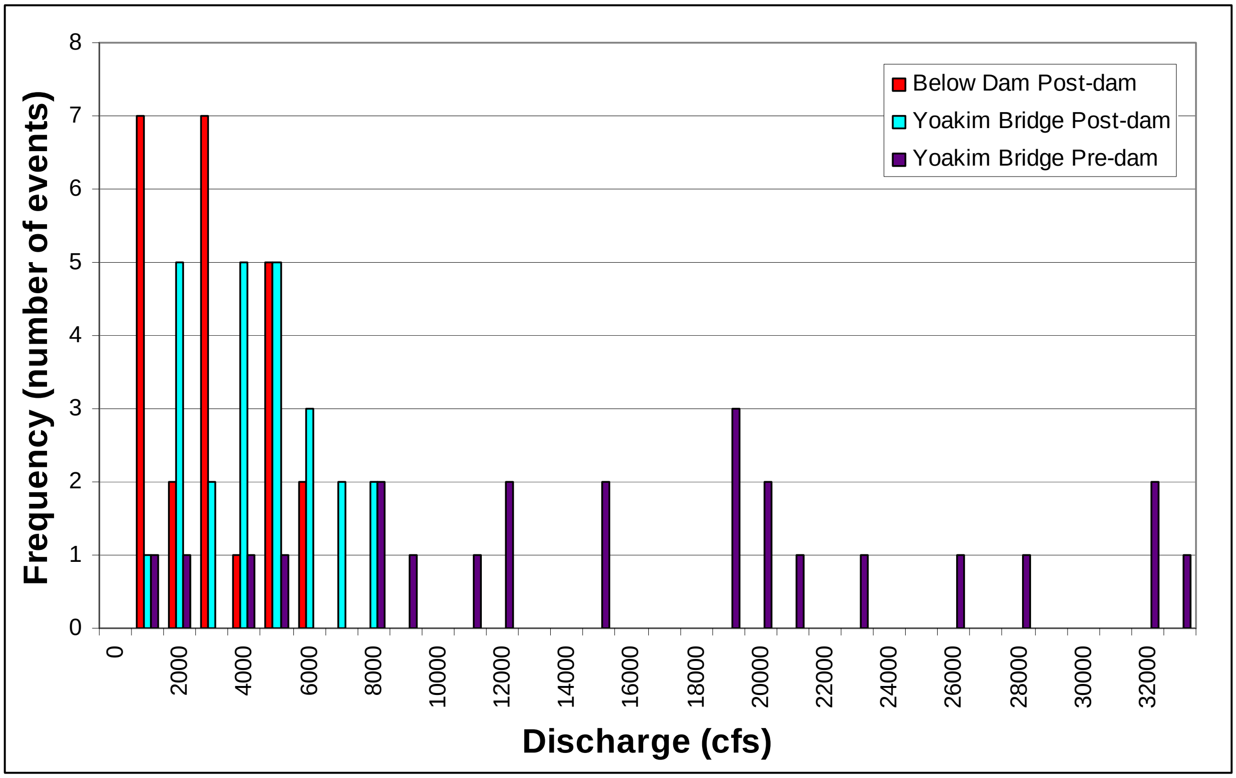


Figure 8: Histogram showing relative frequency of annual peak flows of varying discharge for the pre-dam and post-dam period.

4.3.2 Flow duration

Three flow duration curves were developed using daily flow records from the USGS gaging stations below the dam and at Yoakim Bridge: (1) post-dam, below the dam (1984-2007), (2) post-dam, at Yoakim Bridge (1984-2008), and (3) pre-dam, at Yoakim Bridge (1960-1983). Table 7 provides relevant flow-duration statistics and Figure 9 presents flow-duration curves based on this analysis.

The magnitude and frequency of extreme high and low flows have shifted with regulation by Warm Springs Dam. Table 7 shows that there were significantly more low flow days prior to construction of the dam. Flow exceeded 9.9 cfs only 62.44% of the time during the pre-dam period, while post-dam flow (for both gages) typically exceeds 9.9 cfs 100% of the time. Pre-dam flows included 20 days in the 10000 – 19999 cfs range at Yoakim Bridge, compared to zero days in the post-dam period.

Post-dam flow duration curves for the two gages are similar with a majority of the flows in the 100 cfs range (80% of flows between 70 and 200 cfs below the dam) and no dry periods (Figure 9). The 50% excedence (median) flows at the dam outlet and at Yoakim Bridge for the post-dam period are 105 cfs and 110 cfs, respectively. In contrast, the pre-dam flow duration curve at Yoakim Bridge shows a greater range of flows over the period of record. Prior to regulation, Dry Creek had zero flow in the channel 9% of the time, and more significant and frequent high flows during the period of record from 1960 to 1984, with 50% excedence flow for the Yoakim Bridge gage of 29 cfs.

Table 7: Flow duration statistics using daily discharge data for the two USGS gaging stations evaluated in this report.

Discharge Range (cfs)	Below Dam		Yoakim Bridge			
	Post-Dam		Post-Dam		Pre-Dam	
	Number of Days	% of Time Discharge Range is Exceeded	Number of Days	% of Time Discharge Range is Exceeded	Number of Days	% of Time Discharge Range is Exceeded
0 – 9.9	1	100	0	100	3327	62
10 – 99	3419	61	2690	71	2444	35
100 – 999	4979	4	5877	6	2296	9
1000 – 9999	367	0	565	0	771	0.2
10000 – 19999	0	0	0	0	20	0
Total Days in Record	8766		9132		8858	

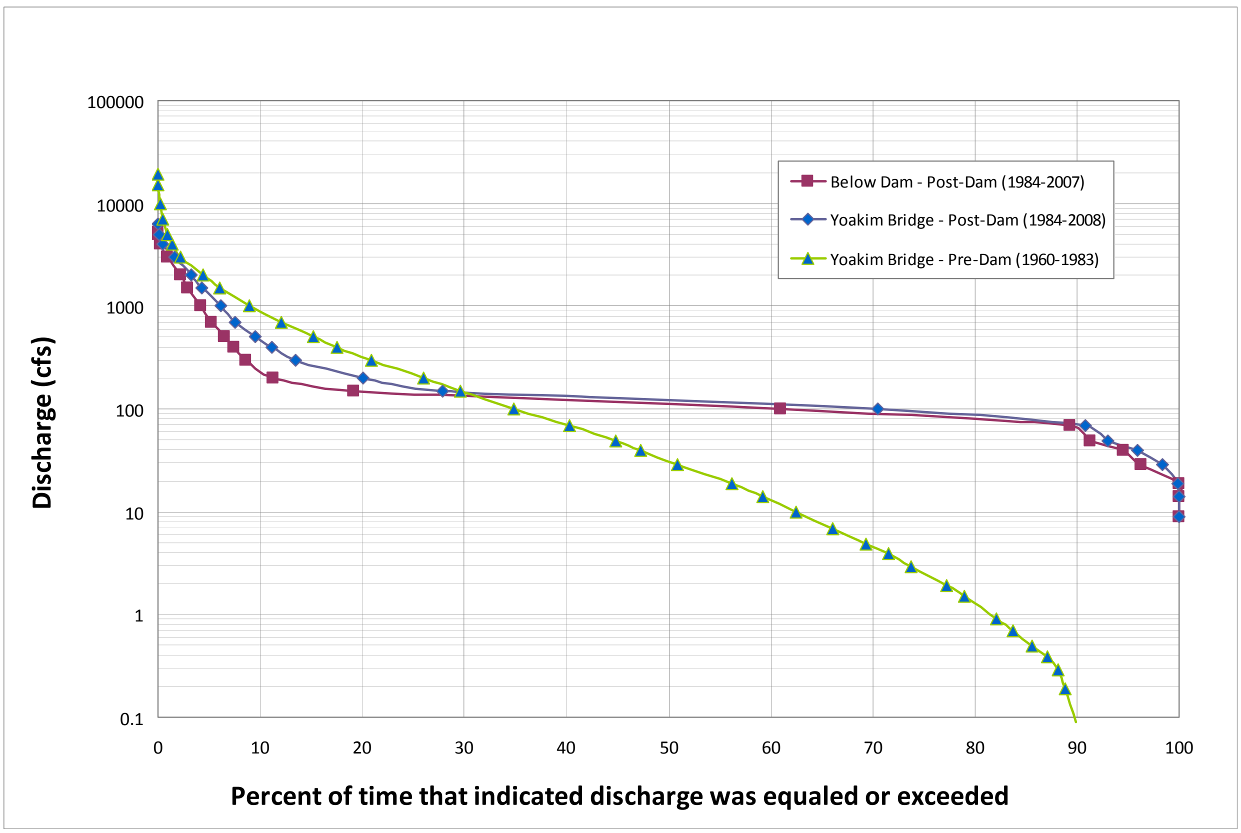


Figure 9: Flow duration curves for Dry Creek at the USGS gage station below the dam (post-dam) and at Yoakim Bridge (pre- and post-dam).

4.3.3 Regulation by Warm Springs Dam

Indicators of Hydrologic Alterations (IHA) analyses were conducted on the pre- and post-dam data at Yoakim Bridge to determine the effects of regulation on hydrology in lower Dry Creek. Selected results of the analysis are provided in Figure 6, Figure 10, and Figure 11.

Figure 6 located at the beginning of Section 4.3 shows a comparison of pre- and post-dam monthly median discharge values at Yoakim Bridge. This demonstrates the significant reduction of high flows during winter, increased minimum flows during summer and early fall, and increased constancy of flows over the year. These results suggest that the physical and ecological processes most dependant on high and low flow magnitude and duration are likely most influenced by Warm Springs Dam operation.

Figure 10 provides comparisons of mean, high-flow and low-flow conditions between pre- and post-dam periods. In particular, it shows the 1-day maximum daily mean discharge values are an order of magnitude greater for the pre-dam period. This demonstrates the significant reduction of high flows that results from regulation. When compared to the pre-dam results, the relatively small difference between the post-dam 1-day and 7-day maximum mean daily discharge results demonstrates the manner in which the dam attenuates peak flows by releasing relatively lower discharges over a more sustained period. Mean annual flow decreases slightly in the post-dam period.

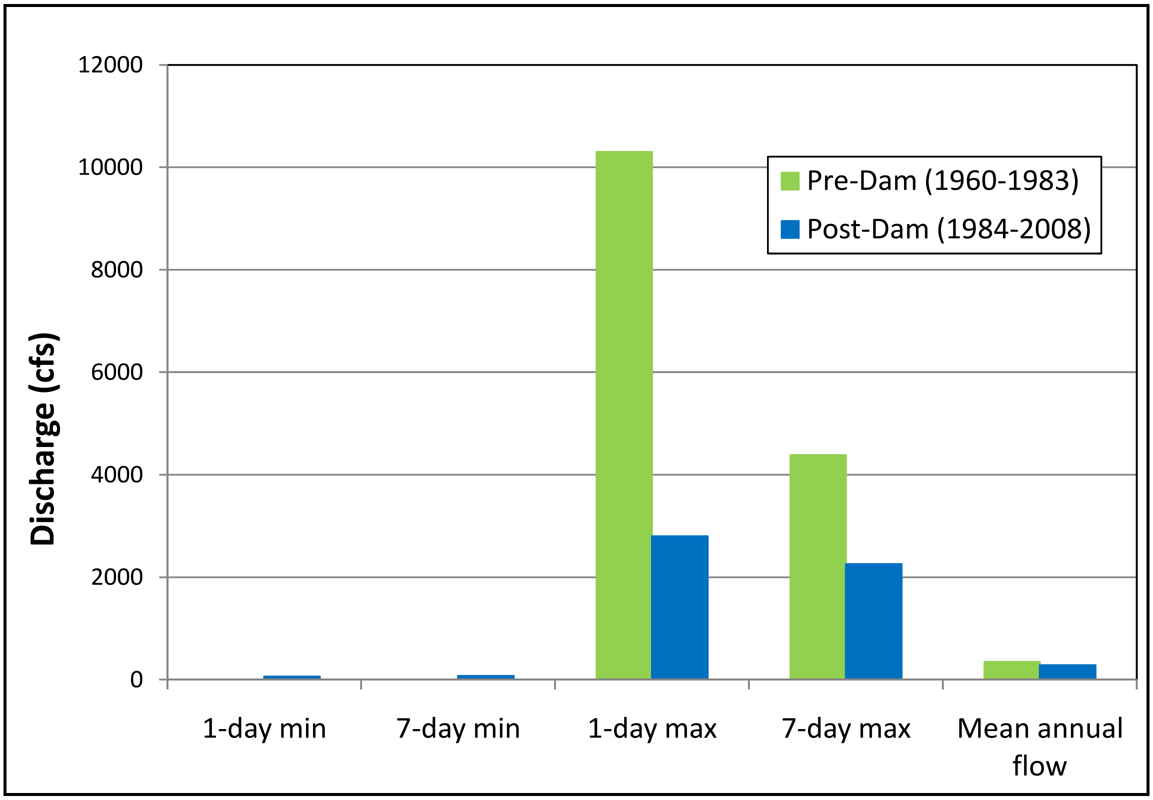


Figure 10: Magnitude and duration of annual extreme water conditions and mean annual flow for Dry Creek at Yoakim Bridge pre- and post-dam.

The alteration of low flow characteristics is examined in Figure 11 which shows an average of one low flow pulse (i.e., flow less than the 25th percentile) lasting a median of 68.5 days during pre-dam conditions, compared to an absence of low flow pulses during the regulated period. This demonstrates the extent to which low flows are supported by dam operation. In addition, the relatively greater rise and fall rates, and equivalent numbers of high flow pulses (i.e., flow greater than the 75th percentile) suggest a more dynamic hydrograph prior to regulation, and an absence of significant ramping during the regulated period, consistent with the facility objectives of flood control and minimal power production.

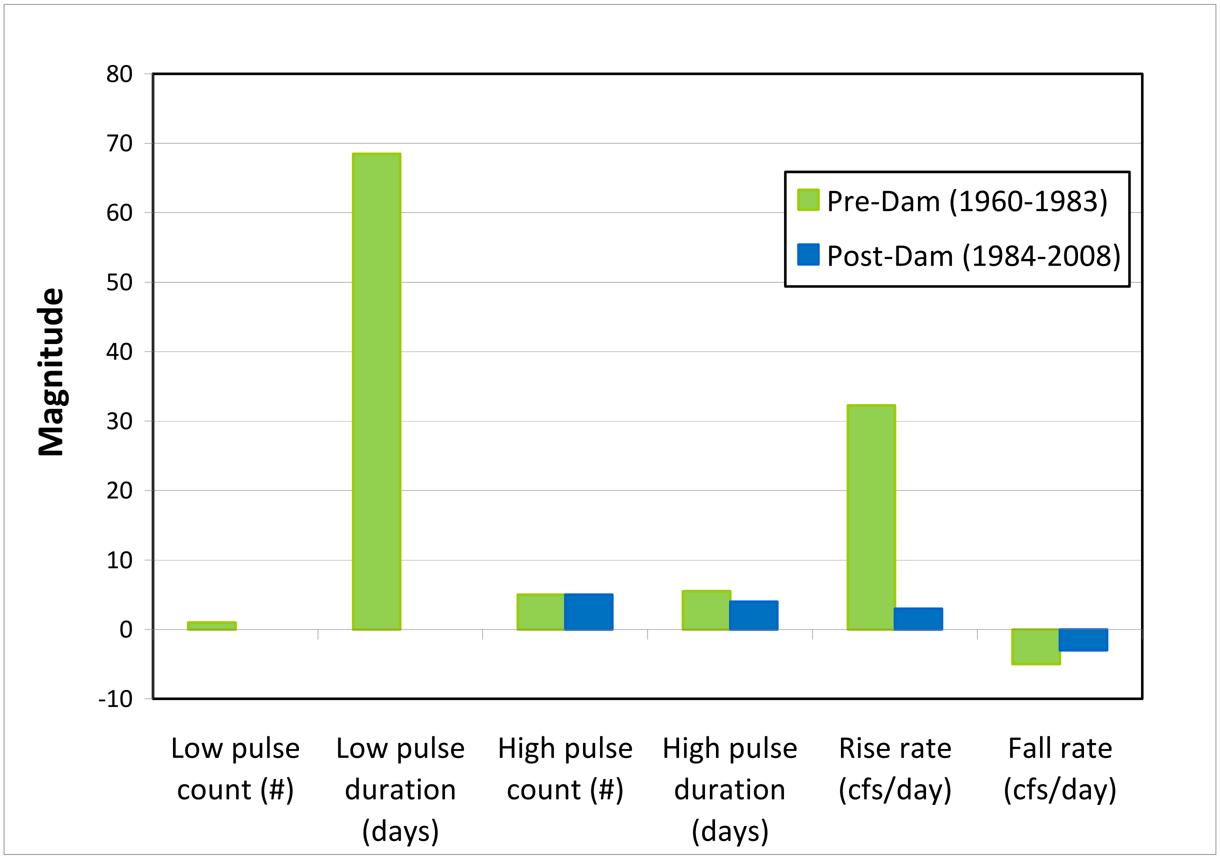


Figure 11: High and Low Flow Pulses and rates of change in discharge for Pre- and Post-Dam Dry Creek at Yoakim Bridge.

5 GEOMORPHOLOGY OF DRY CREEK

5.1 Summary of Prior Studies and Data

The geomorphology of lower Dry Creek has been the subject of several studies, with most of these occurring in conjunction with the planning and construction of Warm Springs Dam. Cleveland and Kelley (1977) conducted an early study on observed bank stability problems along lower Dry Creek. Geomorphic changes in response to land use, gravel mining, and dam operations were assessed initially by Simons and Li (1980), and later and more comprehensively by Harvey and Schumm (1984, 1985, 1987) in a series of field studies in the early to mid-1980s. As a complement to the geomorphic analyses, the Army Corps of Engineers (ACOE) conducted sediment transport modeling studies to determine the effects of the dam on bed material transport and channel evolution (Thomas et al. 1984, ACOE 1987a). Separately, McBride and Strahan (1984a, b) investigated the interaction of geomorphology, vegetative recruitment and flood hydrology with the establishment of pioneering riparian vegetation. ACOE planned and constructed a series of channel improvements (1981, 1988) in response to observed and perceived channel stability problems along lower Dry Creek. Most recently, Gordon and Meentemeyer (2006) utilized the historical aerial photographic record to assess the effects of dam operation and land use changes on channel morphology and riparian vegetation.

Harvey and Schumm (1985, 1987) mapped eleven distinct alluvial surface profiles below the dam based on aerial photo interpretation and repeat cross section surveys by the Corps of Engineers. These profiles included two relic terraces, six thalweg profiles ranging in date from 1964 to 1984, a bar surface profile active in 1984, and a bedrock profile (Figure 12). Least squares regression of these profiles resulted in consistent estimated profile gradients ranging from 0.188 to 0.197 percent, demonstrating a progression of essentially parallel channel profiles through time as the channel responding to base level lowering (Table 8). Based on these profiles, they developed an evolutionary history of lower Dry Creek spanning the period 1850 – 1984 (Figure 12 and Figure 13).

Table 8: Slopes of terrace and channel profiles and mean channel width, depth and width-depth ratio at bankfull stage. Units for slope and mean width/depth are m/m. Units for mean width and mean depth are m. Parentheses indicate standard deviation. Reprinted from Harvey and Schumm (1987).

Profile	Slope	Mean Width (std. dev.) (m)	Mean Depth (std. dev.) (m)	Mean Width/Depth Ratio (std. dev.) (m)	No. of Observations
Terrace II	0.00191	---	---	---	22
Terrace I	0.00188	---	---	---	9
1940 thalweg	0.00180	9.8 (2.7)	3.6 (0.5)	2.8 (1.0)	18
1964 thalweg	0.00188	80.5 (21.9)	4.0 (0.8)	21.6 (8.0)	23
1974 thalweg	0.00194	91.4 (30.5)	4.8 (1.3)	21.1 (9.2)	23
1976 thalweg	0.00196	94.8 (33.2)	5.1 (1.4)	19.8 (8.5)	23
1980 thalweg	0.00194	97.2 (35.1)	5.5 (1.2)	18.5 (7.7)	23
1981 thalweg	0.00195	97.8 (36.0)	5.5 (1.3)	18.6 (8.5)	23
1984 thalweg	0.00194	101.8 (36.0)	5.8 (1.3)	19.0 (10.2)	23

Terrace II was interpreted to represent the floodplain surface at the time of European settlement around 1850. Upon moving to the valley, settlers cleared a significant portion (approximately 40% by 1870) of the forested area of the watershed for grazing and agricultural production. This caused increased runoff and sediment production and resulted in approximately 3 feet of deposition of sands and gravels on top of the pre-settlement floodplain (Terrace II). By 1900, sediment delivery had decreased and the channel had incised and evolved to a new state of equilibrium with mean bed level approximately 12 feet below Terrace II (Figure 13). At this stage of evolution, the active floodplain was the surface that had been the pre-settlement channel bed and would later become Terrace I. Small amounts of gravel mining and record annual runoff prior to 1940 resulted in additional degradation Gravel mining on the Russian River and in the lower reaches of Dry Creek escalated in the 1950s and 1960s, reducing the base level at the downstream end of Dry Creek by approximately 10 ft. This base level change caused extensive channel instability, incision and degradation, to the extent that Dry Creek was found to be the highest sediment yielding tributary to the Russian River at that time (Ritter and Brown 1971). A series of large storms and unusually high runoff coincided with severe fires in the watershed during this period, precipitating rapid response to base level change (Simons and Li 1980). Consistent with trends seen in other degrading streams, repeat surveys of the channel showed an alternating pattern of vertical incision and lateral erosion as the creek attempted to re-establish channel gradient and length that was in equilibrium with the changed downstream base level and input of flow and sediment (Figure 13; Table 8; Harvey and Schumm 1985, 1987; Swanson 2009).

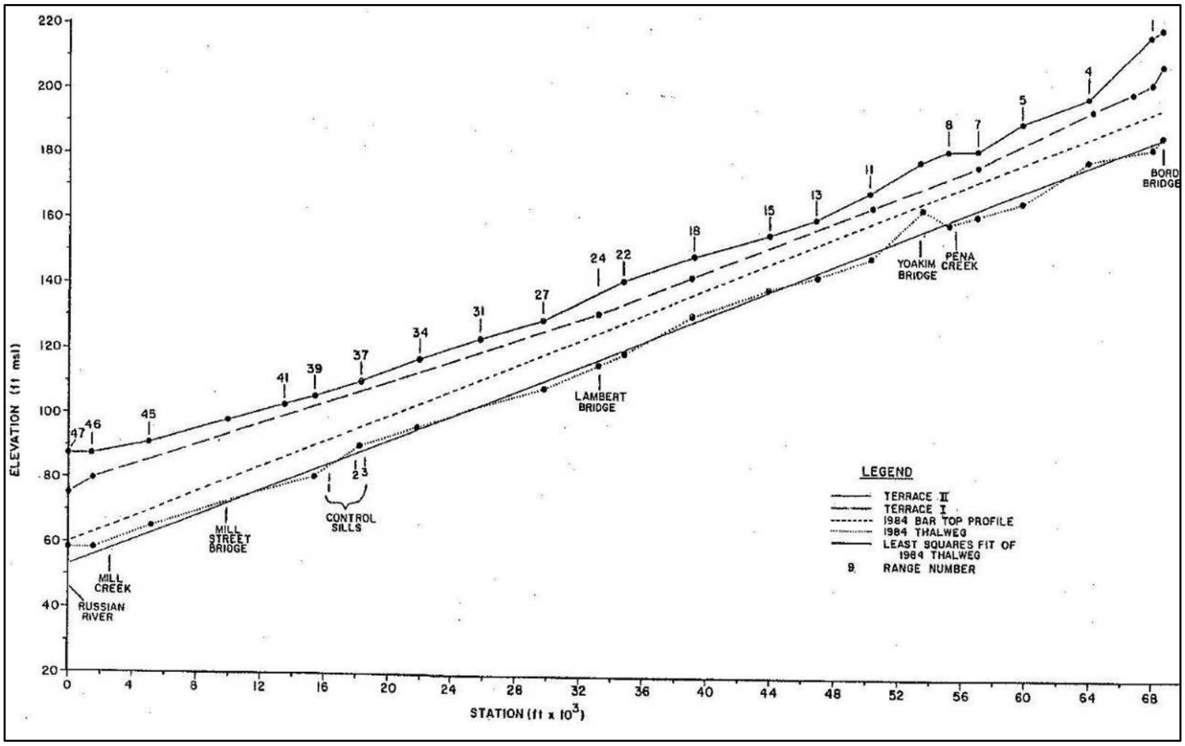


Figure 12: Longitudinal profiles of terrace II, terrace I, 1984 active bar tops, 1984 bed, and least squares regression of 1984 bed of Dry Creek. Reprinted from Harvey and Schumm (1985).

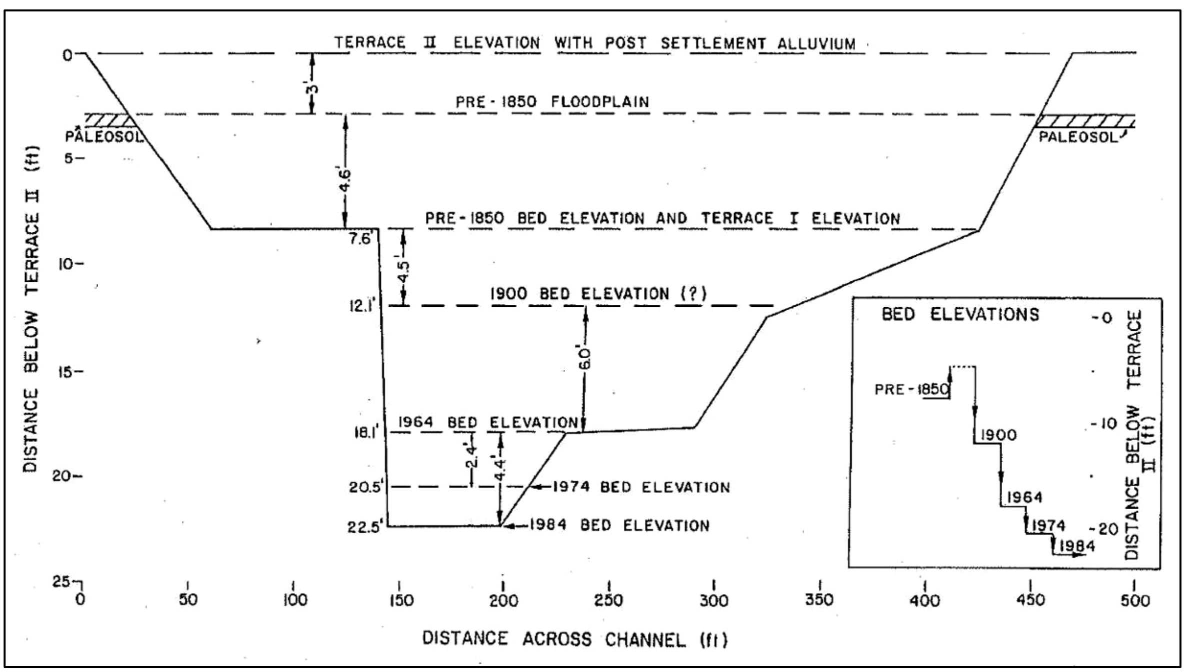


Figure 13: Schematic cross section of Dry Creek showing the chronological evolution of the channel from pre-1850 to 1984. Elevations are mean values for the individual surfaces. Inset is a diagrammatic representation of the bed elevations for Dry Creek through time.

The rate of channel degradation slowed by the late 1970s. Based on comparison of the minimum thalweg elevations at the repeat cross sections, Harvey and Schumm (1985) reported that degradation had ceased by 1974 as far upstream as Yoakim Bridge (RM 10.7). An outcrop of Franciscan Formation was exposed in the bed of the channel in 1974 at Lambert Bridge, which is located 6.6 RM upstream of the mouth (Simons and Li, 1980). Harvey and Schumm report further degradation of the bed of the channel between 1974 and 1981 in the reach upstream of Yoakim Bridge, but no significant change in bed elevation between 1981 and 1984. Harvey and Schumm (1985) further report observation of a new floodplain (tops of bar surfaces) which had formed approximately 4.5 feet above the bed within the incised channel of lower Dry Creek by 1984. Formation of a new floodplain within the incised channel is consistent with the arrival of a new quasi equilibrium condition (Figure 14). The tops of the bar surfaces in 1984 corresponded with the level of the 1964 thalweg (Harvey and Schumm 1987).

Construction and operation of Warm Springs Dam significantly reduces peak discharges and ceased delivery of bedload from the upper 130 sq. mi. of the watershed. The potential responses of the Dry Creek channel to dam closure and operation included: 1) continued channel degradation, and 2) reduction in channel cross-sectional area (Williams and Wolman 1984). Harvey and Schumm (1985, 1987) concluded that channel degradation was unlikely to continue as a result of dam operations. They found that the channel had already armored by 1984 in the first two miles below the dam. In addition, three grouted rock grade-control structures were placed in the mainstem of lower Dry Creek between river miles 3 and 4 in 1981. Further upstream, a bedrock exposure of the Franciscan Formation was providing grade control upstream of the Lambert Bridge (6.4 miles from the mouth) and exposed consolidated sands and gravels overlying bedrock outcrops provided additional resistance to erosion at 7.2 and 11.3 miles upstream from the mouth of Dry Creek. Finally, because base level drop was beginning to affect the tributaries, large amounts of sediment were being delivered to Dry Creek, beginning with Dutcher and Pena Creeks, located 3 river miles below the dam (Harvey and Schumm 1985, 1987).

Results from the sediment transport studies (Thomas et al. 1984, ACOE 1987a) corroborate Harvey and Schumm’s findings (1985, 1987), suggesting that significant future degradation or aggradation along lower Dry Creek would be limited. However, because of the drop in base level along lower Dry Creek, the gradient at the mouths of the tributaries were predicted to increase, resulting in higher flow velocities and greater erosion within the tributaries themselves. Although this increased erosion was thought to provide the necessary gravel to prevent further degradation on lower Dry Creek as mentioned above, the ACOE (1987a) recommended that grade control structures be placed near the mouths of these tributaries to minimize headcutting. Grade control structures were installed in the mouths of several tributaries in the 1980s, including Pena Creek.

Landowner observations (Rued 2009) suggest that local incision within the active ‘bankfull’ channel continued through the early 1990s. This was attributed to extensive colonization of bar surfaces by woody vegetation (white alder, willow) under the post-dam flow regulation regime, which effectively roughened and stabilized sediments on these surfaces and focused proportionally greater flood discharges within the un-vegetated area of the channel.

Harvey and Schumm (1987) concluded that reduction in channel size through sedimentary processes due to the reduction in peak discharges was unlikely due to the significant deepening and widening that had previously occurred in response to base level change, and the development of a new quasi-equilibrium floodplain within the oversized channel. They did acknowledge the potential for vegetative encroachment onto the new floodplain surfaces due to conversion of the creek from an ephemeral to a perennial system, and reduction in the magnitude and frequency of disturbance flows.

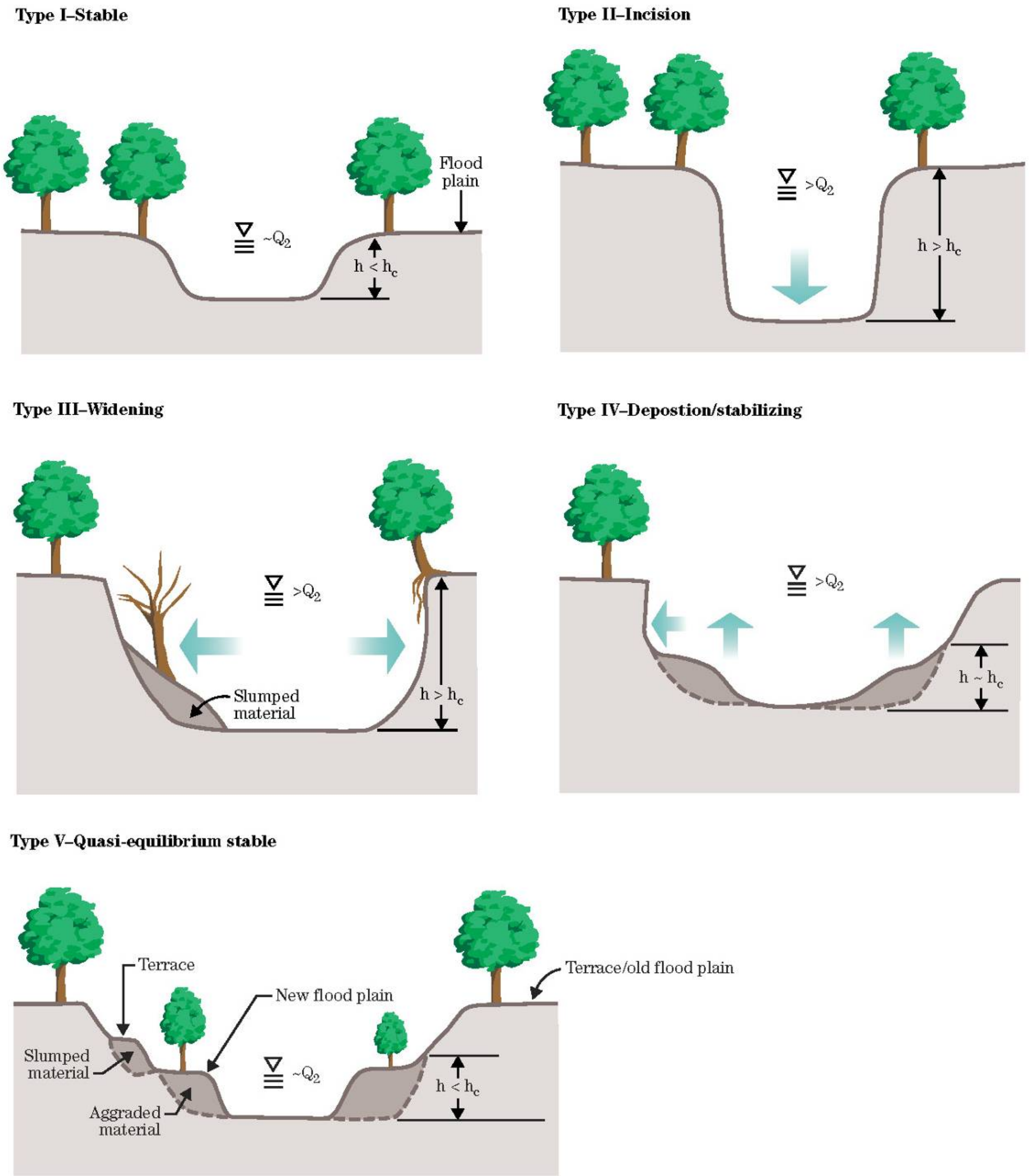


Figure 14: Conceptual model of incising channel evolution developed by Schumm, et al. 1984. Reprinted from USDA-NRCS 2008.

Based on analysis of aerial photography spanning the period 1942-2000, Gordon and Meentemeyer (2006) examined response of the lower Dry Creek channel to dam closure and operation from the tributary junction 1000 feet below Yoakim Bridge (RM 10) to the upstream grade control sill (RM 4). They report an increase in area colonized by riparian vegetation of greater than 70% (Figure 15), and a reduction in the area of the channel corridor occupied by 'active' fluvial features (the stream channel and attendant bare gravel and sand bar surfaces) of over 90%. Additionally, they found that the active channel width decreased in the downstream direction, which is atypical of naturally functioning fluvial systems for which channel width generally increases with watershed area.

Figure 15: Example of vegetative encroachment near Yoakim Bridge. Yoakim Bridge (RM 10.7) is seen at upper left of each frame. Dry Creek flow is from top to bottom of each frame. Left frame is from 1976, right frame is from 2004. Light blue line is estimated limit of active fluvial features in 1976.

Gordon and Meentemeyer also assessed post-dam channel adjustment by comparison of calculated rating curves and measured hydraulic geometry (width, depth, velocity) from discharge measurements made at the Yoakim Bridge gaging station for pre- and post-dam eras. Available discharge measurements for that analysis spanned the period 1960-2003. Comparison of pre-and post-dam rating curves has the potential to provide valuable insights into the trajectory of channel evolution at a gaging station location because they relate basic flow characteristics of stage and discharge. Comparison of hydraulic geometry measured during periodic discharge measurements may also provide valuable insight into channel evolution at the location, provided the measurements are completed at a fixed location through time, such as a cableway or bridge. For their rating curve analysis, Gordon and Meentemeyer developed a single rating curve each from the measurement data for the pre- and post-dam era. Based on their analysis, they concluded that the pre-dam channel was wider and shallower than the post-dam channel, which they attributed to post-dam incision of up to 3.4 feet. They found similar trends in the comparison of pre- and post-dam hydraulic geometry.

However, given that lower Dry Creek was rapidly evolving over the period of record, use of a single rating curve each for both pre- and post-dam conditions could oversimplify the analysis. Given the rapidly evolving channel conditions, new gage ratings would have been developed every few years to maintain the accuracy of gaged discharge data. According to the USGS NWIS database, 35 different rating curves were developed for the gage between 1960 and 1986, and 14 different rating curves were developed over the period 1986-2009. Comparison of the trend in the succession of rating curves would provide a better representation of channel adjustment at the site. Therefore, the results reported by Gordon and Meentemeyer are informative, but should be considered preliminary. The rating tables calculated by the USGS for the period of record were requested for the current study, but were not available at the time of report preparation.

5.2 Field and Analytical Methods

The geomorphic inventory was conducted in two stages. In the initial stage, the senior project geomorphologist floated lower Dry Creek, pausing to review features of note in the channel and on attendant flood prone surfaces. In the second stage, the senior geomorphologist, senior water resources engineer, principal fish biologist and project geologist revisited sites of interest for development of habitat enhancements, based on the initial results of the fish habitat survey and the initial geomorphic inventory. The initial geomorphic inventory was conducted in conjunction with the fish habitat unit inventory (Section 6), with these activities timed to coincide with a typical summer steady state operational discharge. The field geomorphic inventory was combined with subsequent additional analyses for the geomorphic assessment.

5.2.1 Inventory and Assessment

In each of the reaches, the characteristics assessed included 1) basic channel geometry (wetted and active width where appropriate), 2) bed and bank sediment composition, 3) geomorphic indicators of aggradation and degradation, bank erosion, gravel bar development, and floodplain deposition, and 4) areas of interest for locating potential habitat enhancements.

The channel geometry was assessed by measuring representative widths of the channel at riffle locations, their attendant floodprone surfaces and estimated heights of both banks. When possible, geometry measurements were made adjacent to pebble count sample locations. This was repeated within in each reach. Representative measurements of channel geometry were recorded and included in the project database.

Bed sediment surficial size distributions were characterized through Wolman pebble counts (Wolman 1954, Bunte & Abt 2001; Photograph 2). Pebble counts were conducted on select exposed gravel bars as well as within the wetted channel where flow velocities and depths allowed. The planned frequency of pebble counts was approximately 1 per reach, though several additional pebble counts were performed. The location of each pebble count was recorded and included in the project database. Additionally, visual assessments of substrate composition were made for the various habitat types (pools, riffles, and runs) within the reach as a part of the companion fish habitat unit inventory. Bank material composition was visually estimated within each reach.

Photograph 2. Field crew conducting Wolman pebble count.

Areas of active aggradation, degradation, bank erosion, and bar development were identified on field maps and described in field notes. In addition to these characteristics, areas of notable erosion or instability were identified, described, and located on field maps.

Vegetative characteristics were also noted. Occasional incremental tree cores were collected to age trees growing on various ground surfaces within the channel corridor to provide estimates of floodplain and terrace age. Visible bank stabilization installations and grade control structures were also identified, described and located on maps. The results of the inventory were combined with other analyses such as aerial photo interpretation, assessment of hydrologic alteration and basic hydraulic calculations to describe the current function of Lower Dry Creek.

5.3 Results

The current geomorphology of lower Dry Creek expresses the interaction of local geology, watershed characteristics, hydrology, and vegetative characteristics; the legacy of channel evolution and response to land management changes; and the ongoing influence of flow management. Lower Dry Creek is an incised, perennial, alluvial gravel bed stream that has responded to significant human induced hydrologic and geomorphic change over the past 150 years. The following section provides an overview of contemporary geomorphic conditions along Lower Dry Creek between Warm Springs Dam and the creek mouth. More specific details are found on the individual reach summaries found in Appendix A.

5.3.1 General Reach Characteristics

At the time of this report, Lower Dry Creek is primarily composed of pool-riffle and plane-bed morphology (Montgomery and Buffington 1997) with an average channel gradient of 0.18%. The channel planform exhibits relatively low sinuosity (1.13) for a low gradient, alluvial, pool-riffle system, which may in part be influenced by fault lineaments present in the valley (See Section 3.2.3) in addition to past human management. The present active channel has incised within the observed historic meander corridor, which has the capacity to contain maximum flood discharges.

The channel corridor is generally narrow relative to the active channel width, and relatively uniform in width over most of the 16 reaches, with periodic wider sections. The wider sections are a result of bank erosion over time (Figure 16). In general, the wider reaches are located in areas where bank erosion was not effectively controlled by bedrock, bridges, stabilization measures, or vegetation as the channel incised (Photograph 3). Channel planform, flood stages and durations, tributary sediment supply, and backwater from the Russian River are localized influences that have influenced bank erosion through time. Narrow reaches with thin, poorly vegetated riparian zones along lower Dry Creek's deeply incised banks have been and are currently most vulnerable to erosion during higher flood stages. Many segments of terrace banks have been armored by various erosion control methods. However, other segments of terrace banks are currently eroding and are vulnerable during future large floods.

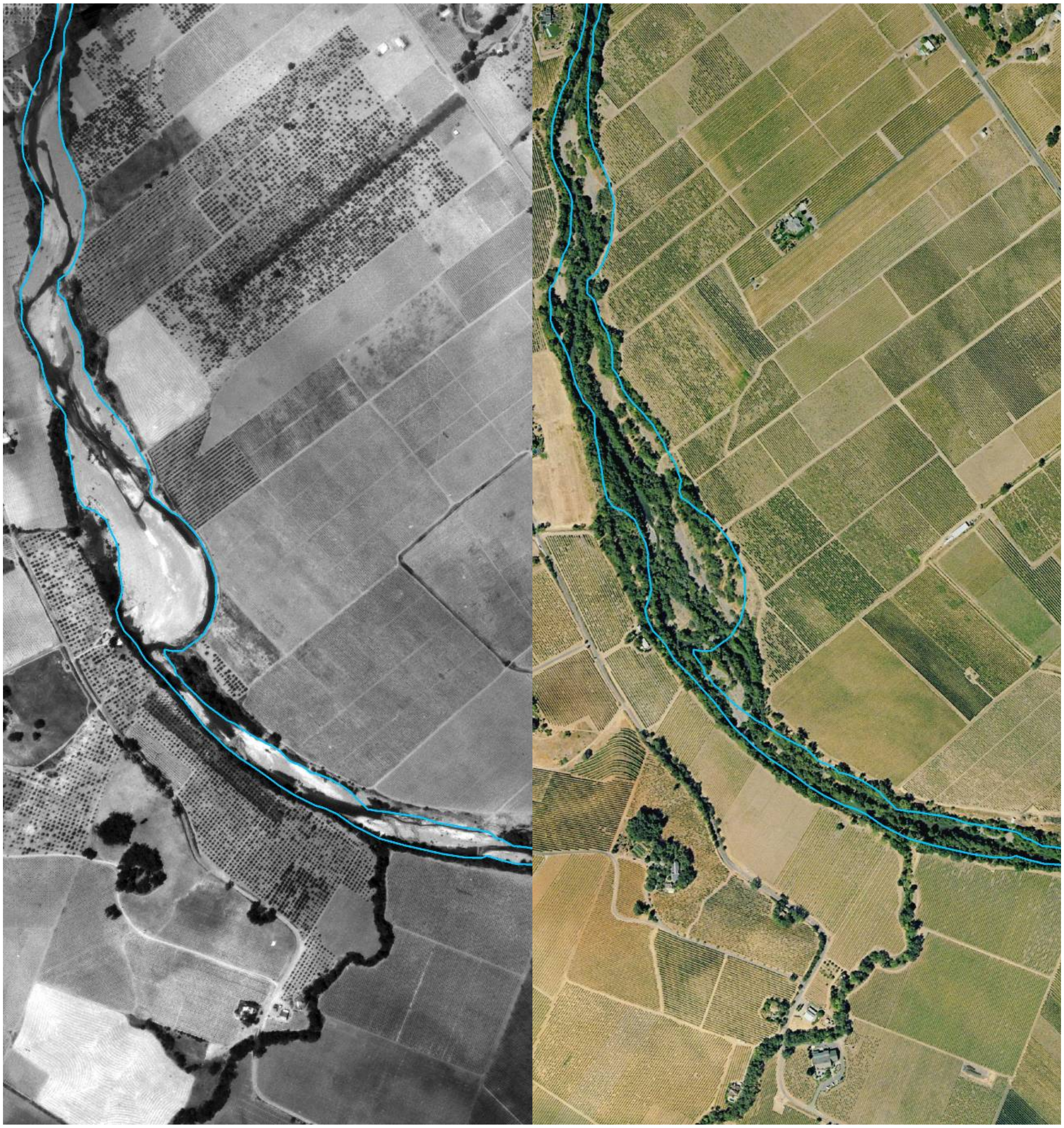
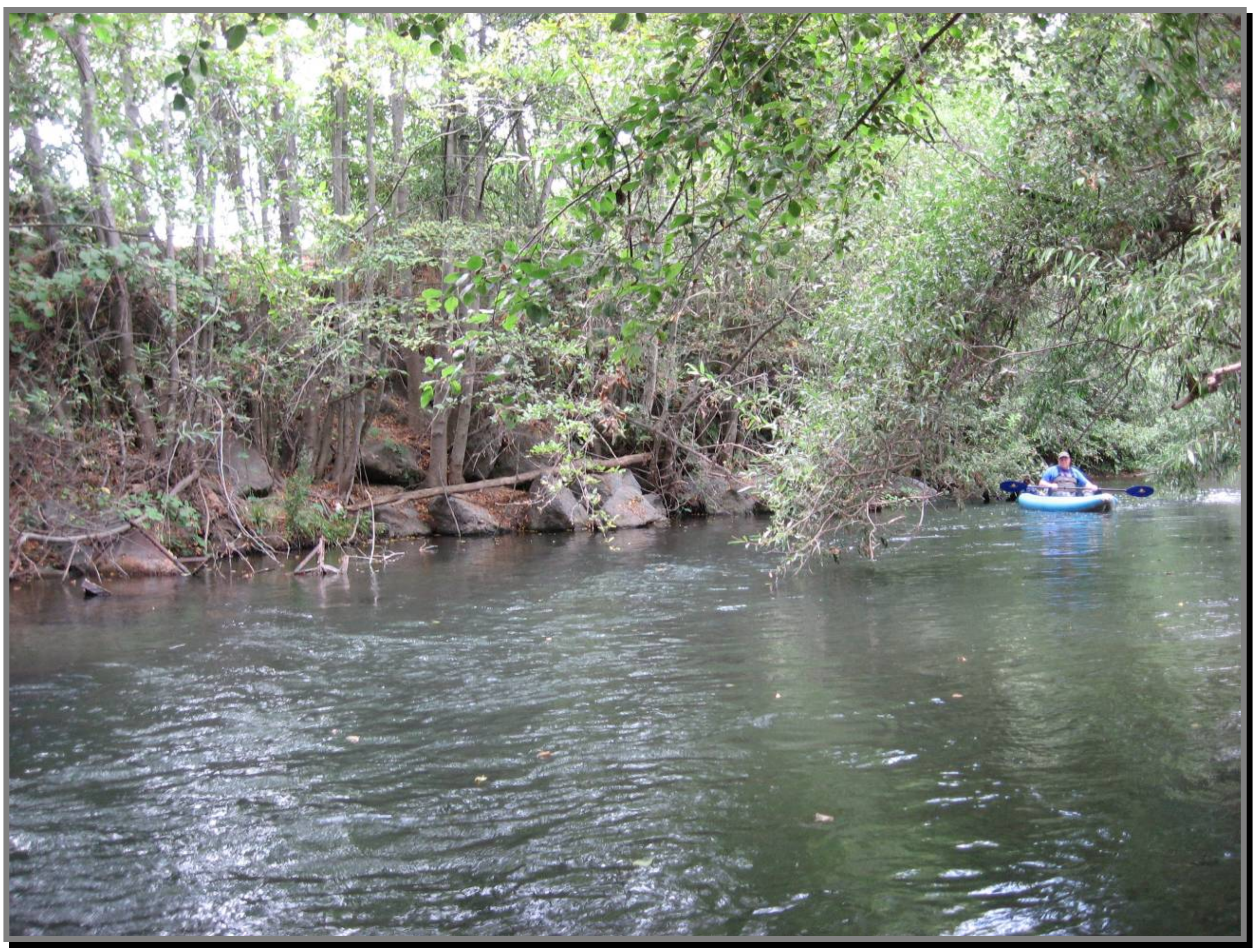


Figure 16: Example of historic bank erosion leading to relatively wider area of channel corridor near confluence of Grape Creek (RM 7.3). Grape Creek is seen at bottom center of each frame. Dry Creek flow is from top to bottom. Left frame is from 1976, right frame is from 2004. Light blue line is estimated limit of active fluvial features in 1976.

For reaches along the western flank of the valley, the available field evidence suggests that the stream bed of lower Dry Creek is founded on (or is within a few feet of) bedrock and/or the resistant depositional units similar to those described by Harvey and Schumm at Grape Creek. Although bedrock outcrops were generally only visible along reach 7, the observations and interpretation made by Harvey and Schumm regarding the two resistant depositional units (possibly associated with the Glen Ellen Formation) and their stratigraphic position relative to the underlying bedrock are consistent with the conditions observed. The suballuvial depth to bedrock (or the resistant depositional units) for reaches located more toward the center of the valley cannot be accurately estimated based on the currently available data, but could be as little as 5 or 6 feet beneath alluvial deposits within the active stream channel. Downstream of the bridge at Westside Road (reaches 1 and 2), bedrock is anticipated to be significantly deeper as the Dry Creek drainage enters the Russian River floodplain.

While grade is clearly controlled by bedrock exposed at the riffle immediately below Lambert Bridge, there are other riffles that may be controlled by bedrock or a resistant depositional unit. Although bedrock is not directly visible in the stream channel, the proximity and orientation of resistant bedrock ridges on the western flank of the valley relative to the position of several larger riffles encountered along the upper reaches of lower Dry Creek suggest that the gradients there may be controlled by bedrock. Downstream, the locations of the three grade control sills constructed in reach 4 are generally coincident with the southward projection of bedrock ridges on the western flank of the valley. These sills may have been constructed on preexisting grade breaks influenced by underlying bedrock highs.



Photograph 3: Historic bank stabilization site.

5.3.2 Sediment Supply and Hydrologic Alteration

As described previously, widespread, systemic incision occurred historically in response to base-level lowering and other factors. Assessments completed in close proximity to the time of dam closure concluded that systemic degradation of Dry Creek had generally ceased by the time the dam came online (Section 5.1 above). The primary determinant of current geomorphic conditions is the influence of the dam, expressed through modified sediment supply and altered hydrology. Dam construction ceased delivery of bed material from the upper 60% of the watershed. The hydrologic regime has been converted from an ephemeral runoff-based regime to a regime that combines typical characteristics of winter rain and mesic groundwater regimes (Poff and Ward 1989), i.e., moderate winter floods and sustained, relatively high baseflow conditions.

The reduction in bedload supply is most noticeable in Dry Creek between the dam and the confluence of Dutcher (RM 11.8) and Pena (RM 11) Creeks (Reaches 16 to 12). In this 2.9 mile stream section, riffles are relatively absent and the bed is relatively armored, with periodic presence of large blocks (1 to 1.5 feet in diameter) that may be derived from underlying parent rock materials or other sources (discussed further below). A steep riffle located 1.3 miles below the dam outlet (RM 12.6, 2000 feet upstream of Fall Creek) appears to provide grade control for the upstream reach. Of all of the reaches assessed, the floodprone surface is most closely linked to the creek elevation above Pena Creek.

The reduction in bed material supply is moderated by successive tributaries entering Dry Creek. The most significant of these in terms of bed material supply include Dutcher Creek (RM 11.8; Photograph 4), Pena Creek (RM 11), Crane Creek (RM 6.3) and Mill Creek (RM 0.6), based on observations of bed material size, angularity and mineralogy near the respective confluences (Photograph 5). Pena, Crane and Mill Creeks all enter Dry Creek from the West, with headwaters in relatively steep topography in Franciscan Formation geology. Pena and Mill Creeks are the two largest tributaries to Dry Creek, each with watershed area of 22 sq. mi., representing nearly 10% of total Dry Creek drainage area (230 sq. mi.) each.

Photograph 4: Evidence of stream bed incision in Dutcher Creek, below the Dutcher Creek Road Bridge.

Photograph 5: Gravel deposit at Pena Creek confluence.

The stream section between Pena Creek and Westside Bridge (RM 11 to RM 2; Reaches 11 to 3) did not appear to be actively incising or aggrading, though there are areas of active channel adjustment (Photograph 6). In this section, a bedrock outcrop provides bed grade control at Lambert Bridge (RM 6.6; Photograph 7), and three grouted rock grade control sills (Photograph 8) located between RM 3.8 and 3.2 provide bed grade control for the stream. The stream section between Westside Bridge and the confluence (Reaches 2 to 1) appeared to be the most alluvial section, in which the channel position and shape are most readily shaped by fluvial forces (Photograph 9). Some signs of aggradation were observed in this section, with the influence of backwater from the Russian River during floods clearly visible from Mill Creek downstream to the confluence (Photograph 10).


Photograph 6: Active channel meandering into relic terrace deposit at RM 6.4.


Photograph 7: Bedrock outcrop beneath Lambert Bridge, RM 6.6.

Photograph 8: Grade control sill, with fish ladder at top right, RM 3.2.

Photograph 9: View looking downstream from Westside Bridge, RM 2.

During the geomorphic inventory, it was apparent that most of the bed materials, excluding the larger cobbles and boulders, are transported by Dry Creek. There was little armoring of gravels on the bed or low bars. Vegetation limits the mobility of gravel on the higher gravel bars, but recently redistributed gravel was observed through the study area downstream from the first tributary (Schoolhouse Creek). The ability of Dry Creek to mobilize bed material varies throughout lower Dry Creek as some areas appear stable and other areas are slightly aggradational (Reaches 1 and 2). The flood stage that deposited the gravel bars also plays a significant role in the future mobility of that material. Gravel deposited during large floods becomes vegetated in the years following deposition, which tends to stabilize the deposits. The corresponding flood terrace is then slowly eroded by intervening lower discharges. Low gravel bars deposited during relatively smaller floods are generally less vegetated and are mobilized annually. These bars are common at and below major tributaries delivering bedload.

Photograph 10: Deposit of gravel across from Mill Creek confluence (RM 0.6), reflecting backwater influence of Russian River.

The hydrologic regime influences the geomorphology of lower Dry Creek. Regulation has resulted in elevated summer baseflow conditions that when combined with the Mediterranean climate produces near ideal conditions for growth of riparian trees and shrubs. Regulation has also resulted in severe curtailment of major floods, which limits disturbance and removal of newly recruited and established vegetation. The estimated highest maximum peak flow release from the dam (6000 cfs) is less than a 1-year flood for the unregulated period. In the reach, even-aged stands of alder trees dating to various eras (confirmed through selected tree coring) mark the elevations of terraces and bar surfaces that were abandoned or active at the time of dam closure (Photograph 11).

Photograph 11: Riparian trees date alluvial features at RM 10.3 near confluence of Canyon Road Creek. The larger tree at left on terrace dated to 1984-86. The smaller tree at right dated to 1995-97.

This combination of effects has resulted in extensive vegetative colonization of formerly active bar surfaces – elevated baseflow nurtures vegetative growth, while the lack of significant disturbance (flood) flows allows vegetation to flourish. Vegetative colonization of the bar surfaces has stabilized the formerly active morphologic features (Photograph 12), which serves to limit lateral migration of the active channel within the channel corridor, and has the effect of sequestering a reservoir of gravel within the system. The expansion of riparian vegetation within the system has also likely led to greater stabilization of channel corridor banks that were frequently destabilized during the period of adjustment to historic channel incision previously discussed. Areas of bank instability which are exceptions to this can be found in the reach and are consistent with what occurred historically before vegetation became a more dominant geomorphic influence (Photograph 13).

Photograph 12: Vegetative colonization of bar surface, RM 12.3

Photograph 13: Slumped high bank at RM 12.3.

Vegetative colonization of bar surfaces has also lead to an active channel that is efficient at moving gravel supplied to the stream despite the reduced flood flow hydrology. Mature vegetation and dense understory growth hydraulically roughen over bank areas and concentrate high flow velocities in the channel during high flow events (Figure 17). Under the current flow regime, high flow events that do occur have longer durations than similar flows that occurred during the pre-dam period, further facilitating transport of sediment. Combined, these factors have likely contributed significantly to areas of local bed scour since the closure of the dam, as observed by long-time Dry Creek landowners (Rued 2009).

Figure 17: Example of vegetative narrowing of channel corridor near Lambert Bridge (RM 6.6). Lambert Bridge is seen at lower right of each frame. Dry Creek flow is from top to bottom. Left frame is from 1976, right frame is from 2004. Light blue line is estimated limit of active fluvial features in 1976.

Based on field observations, the combination of reduced bed material supply and reduced flood magnitudes and frequencies do not appear to have resulted in incremental systemic degradation or aggradation. It appears that vertical degradation was complete before dam closure. These field observations appear consistent with the conclusions reached by Harvey and Schumm (1985, 1987), and with trends seen in select other rivers with similar combinations of post-dam hydrology and sediment supply (Grant et. al. 2003, Schmidt and Wilcock 2008). Degradation is also kept in check by features which control the bed grade spaced periodically over the reach, discussed above.

Given the legacy of channel degradation in lower Dry Creek and the potential impacts of ongoing degradation on proposed habitat enhancements, a subset of the degradation ranges established by the Corps of Engineers in the early 1960s (resurveyed over the period 1964-1984) should be resurveyed in early 2010 and compared to the historical data as a component of the Phase 2 feasibility analysis. Resurvey and analysis of the degradation ranges will provide the quantitative evidence required to confirm preliminary conclusions based only on field observations.

5.3.3 Channel Characteristics and Capacity

The combined factors of regulated hydrology, altered sediment supply and colonization by riparian vegetation have led to evolution of a contemporary channel shape that is significantly smaller than the historic channel. Today’s ‘active’ lower Dry Creek channel is defined as the predominantly open channel, flanked by riparian vegetation in the overbank areas. A similarly-defined channel in an unregulated, undisturbed stream system might be termed a ‘bankfull’ channel, which in many systems typically has capacity ranging from the 1- to 5-year return period flood (Wolman and Miller, 1960), and is used as an indicator for many stream processes. We have purposely avoided the use of the ‘bankfull’ term as a description for the main channel at Dry Creek, to avoid inadvertent comparison of characteristics with those of other unregulated stream systems where the concept is more applicable.

The channel geometry of fluvial systems in equilibrium generally changes consistently in a downstream direction as watershed area increases and tributaries input water and sediment. To assess active channel geometry and capacity for lower Dry Creek, we reviewed measured channel widths and developed estimates of channel capacity at 24 riffle locations spaced over the 16 reaches based on basic field measurements. We then plotted active channel width (Figure 18) and discharge (Figure 19) against drainage area to examine trends.

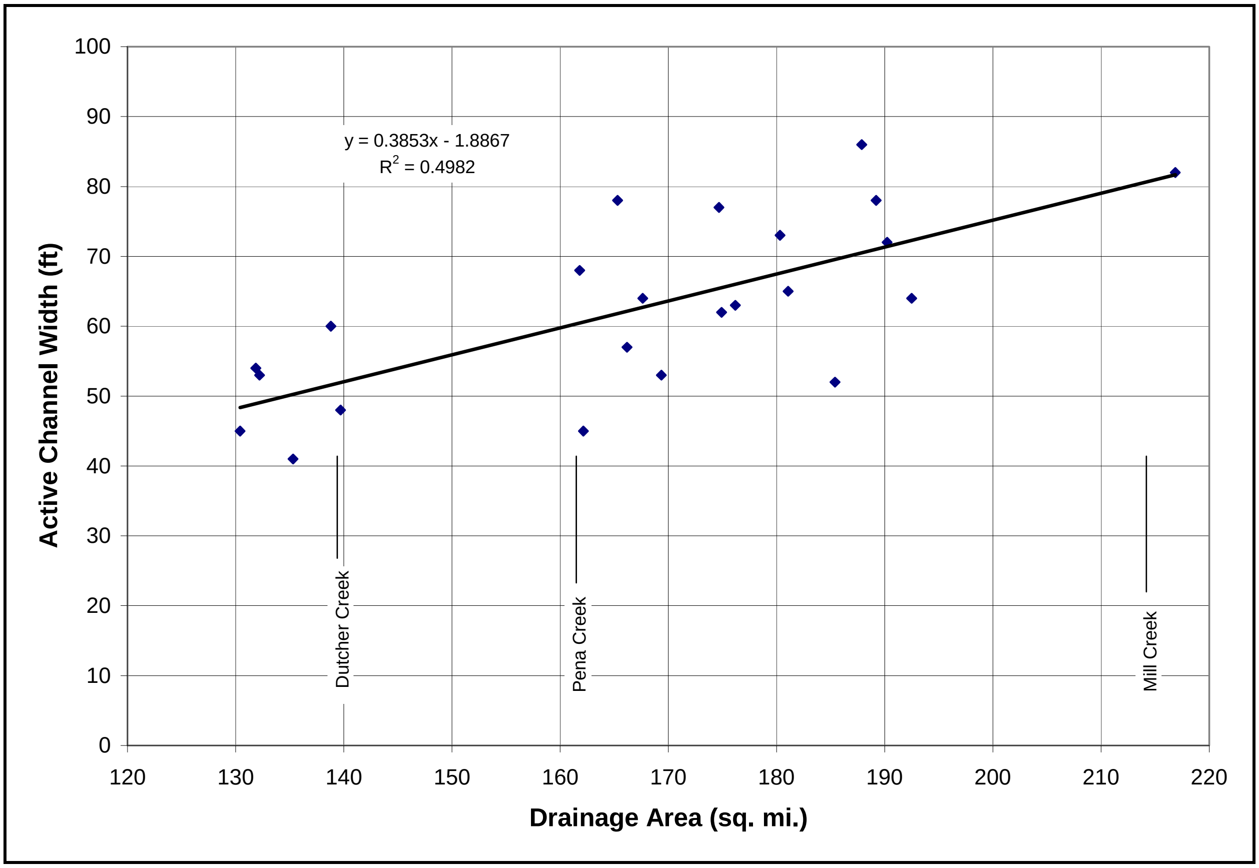


Figure 18: Plot of active channel width vs. drainage area for 24 riffle locations along lower Dry Creek.

The relationship between active channel width and drainage area (Figure 18) shows moderate correlation (R^2=0.5), though scatter is present in the data. In general, channel width at riffles increases with increased drainage area, suggesting the channel is perhaps still evolving towards a condition of equilibrium for the given inputs of water and sediment. The relationship between active channel capacity and drainage area (Figure 19) is poorly correlated (R^2=0.05). This result is not surprising. A strong, positive correlation would assume that the alluvial channel evolved over time with consistent climatically-induced runoff and sediment processes. Many factors which influence lower Dry Creek geomorphology have changed at different rates, some more rapidly than natural conditions, and others which have changed more slowly. The rates of change for a single process may also vary between reaches, due to local factors (e.g., vegetation, variations in corridor width, etc.), and the hydrology for a large segment of the watershed is dissimilar to the downstream tributaries. Although least squares regression suggests a slight decrease in active channel capacity for increase in drainage area, the correlation is too poor to confidently assert this interpretation. The scatter in the data may also be influenced by the approximate discharge estimation method.

The data shown in Figure 19 suggest that the active channel capacity of lower Dry Creek ranges from 300 to 900 cfs, with mean and median values of 559 cfs and 512 cfs, respectively. These values are well below the estimated 2-year peak discharge at the dam of 4000 cfs. Annual peak discharge recorded at the gage below the dam, however, was less than

600 cfs for six of the years between 1985 and 1994, which may reflect a period when the reservoir was being filled. For comparison, the lowest annual peak flow discharge at the Yoakim Bridge gage was 910 cfs in 1990. The range in active channel capacity estimates do correlate well with the mean monthly flow for the months of January – March, which range from 688 to 830 cfs at Yoakim Bridge, and from 464 to 519 cfs below the dam. This comparison suggests that the active channel is primarily controlled by sustained high flow conditions in the winter months, which would also tend to define a limit of woody vegetation.

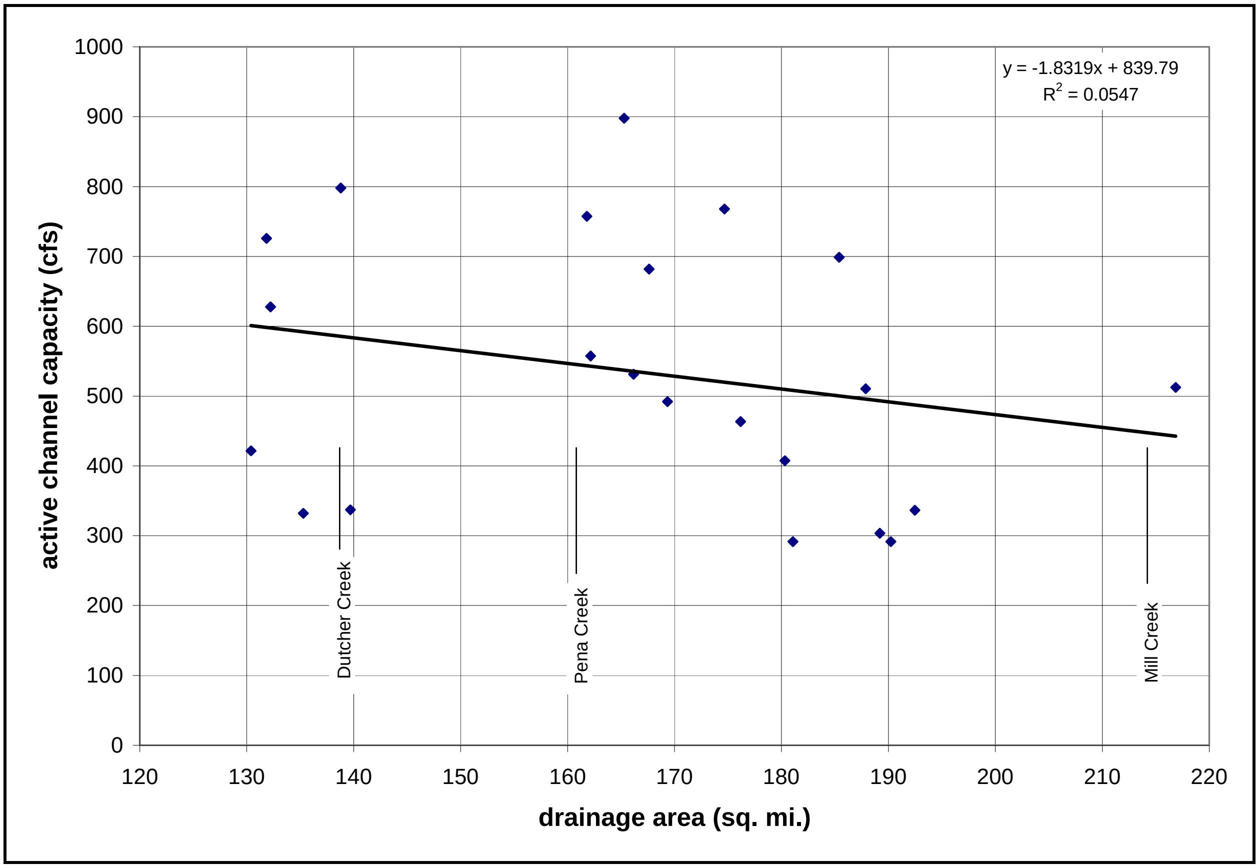


Figure 19: Plot of active channel capacity vs. drainage area for 23 riffle locations along lower Dry Creek.

5.3.2. Bed and Bank Materials
Alluvial terrace and channel deposits in lower Dry Creek are comprised of sand, gravel and cobbles of varying rock types derived from tributaries extending into the adjacent Coast Range ophiolite, Great Valley Complex, and Franciscan Complex.

In the upper reaches of lower Dry Creek (river reach 13 through 15), there are a number of areas in which an array of large blocks (1 to 1.5 feet diameter) are visible along the channel bottom. These blocks are subangular to subrounded, with rounded edges that are not consistent with blocks used in man-made channel armoring (i.e., rip rap). The origin of these blocks is unknown, but one hypothesis is that the blocks are lag deposits from natively derived alluvial fan deposits found in the nearby drainages to the east. Large subangular blocks observed within the exposed stream terraces along these reaches supports this hypothesis. Alternatively, these blocks may be related to the bed of boulders and cobbles noted by Harvey and Schumm at Grape Creek. These materials were located immediately above the bedrock surface. Visual evidence supporting or refuting this possibility was not found during field reconnaissance. In either case, the presence of these larger blocks within the main channel was not observed downstream of the confluence with Dutcher Creek.

A clear increase in maximum size and angularity of rock clasts found within the stream channel, as well as differences in the constituent rock types, was noted at the confluence and downstream of several of the tributaries, including Dutcher, Pena, and Mill Creek. The sharp increase in clast size and relative angularity suggests that some of these tributaries may have a substantial carrying capacity during high flow events and can deliver a significant sediment load into Dry Creek.

With the exception of sandstone outcrops observed at Bord bridge (reach 15), bedrock outcrops observed along the active stream channel were generally limited to river reach 7, beginning just upstream of Grape Creek, continuing down past the bedrock exposures at Lambert Bridge, and ending near the confluence with Crane Creek. The presence of the large boulders along the channel bottom (possibly related to the erosional unconformity identified at Grape Creek by Harvey and Schumm) in reaches 13 through 15 may be indicative of shallow bedrock. In addition, a large embayment formed by a fallen tree in an embankment observed in reach 14 appeared to expose a resistant sedimentary unit which could be related to the cemented depositional units described by Harvey and Schumm.

Observed bedrock exposures in reach 7 are comprised of interbedded layers of weak siltstone and somewhat stronger, thicker beds of sandstone that appear to be consistent with descriptions of the siltstone, sandstone, and shale units of the Great Valley Complex. At Grape Creek, the bedrock was found to be locally folded along a west-southwest plunging axis approximately parallel to the apparent syncline evident in the mapped Great Valley Complex units exposed on the western flank of the valley.

The alluvial bed of Dry Creek is primarily composed of coarse gravel, but ranges from sand to boulders and bedrock. The sand is generally concentrated in the pool bottoms and other backwatered areas, whereas the flatwaters and riffles are dominated by gravel and cobbles. The surface grain sizes of riffles throughout Lower Dry Creek were specifically analyzed. Riffles in each reach were analyzed as well as the riffles downstream of tributaries and of the major tributaries themselves (Table 9). The 16th, 50th, and 84th percentiles of the grain sizes found in the riffles were calculated. Though the surface grain sizes found in riffles does vary throughout Dry Creek, the median grain size primarily ranges between 20 and 30 mm. There is a slight trend towards decreasing grain size with downstream distance from the dam, but this relationship is weak (R^2 = 0.07) (Figure 20). Similarly, the larger grains decrease in size downstream (R^2 = 0.36), ranging from 50 to 70 mm in the upstream half of Lower Dry Creek and 40 to 60 mm in the downstream half. Finer grains are fairly uniform in size throughout Lower Dry Creek at approximately 10 mm.

The bed material contributed to Dry Creek from tributaries does not appear to have a substantial effect on the measured surficial grain size in downstream riffles. The tributaries with larger bed material likely increase the size of bed material in Dry Creek, but a strong relationship is not exhibited in the data. The larger material from Pena Creek may contribute to the spike in grain size about 1.5 miles downstream of the confluence, but at the mouth of Pena Creek, the size of the material is smaller than elsewhere (Table 9). The 84th percentile of bed material in Grape Creek is much greater than elsewhere because of the predominance of bedrock. Large material delivered from Crane Creek may result in a slight increase in size of the 84th percentile of the downstream riffle. Elsewhere, however, there is little impact of tributary bed material input on surficial grain sizes measured at downstream riffles on Dry Creek.

Table 9: Grain sizes for three percentiles of the surficial bed material in riffles throughout lower Dry Creek.

Reach	**Unit #**	**Description**	**D16**	**D50**	**D84**
1	D358	Downstream from Mill Creek	11.4	25.9	47.3
2	D320	Downstream from unnamed tributary	9.4	23.2	45.8
3	D305	Upstream of Westside Road Bridge	11.3	30.9	54.2
3	D289	Middle of reach	9.0	24.0	48.6
4	D256		14.4	31.4	59.8
5	Kelly Creek	Near mouth	4.5	11.4	21.48
5	D228		12.0	30.4	58.5
5	D219		5.7	21.8	49.5
6	D199	Downstream of Crane Creek	11.7	29.7	53.9
7	Crane Creek	Near mouth	1.6	9.7	82.7
7	D196	Upstream of Crane Creek	10.7	29.7	59.9
7	D191		10.8	25.0	52.7
7	D171		7.1	16.2	34.7
7	D167		11.3	25.4	53.7
7	Grape Creek	Near mouth	1.6	26.2	256
8	D123		10.7	34.9	71.7
9	D110		11.3	26.4	61.1
10	D099		11.2	44.3	123.9
11	D088	Downstream of Yoakim Bridge	12.3	30.2	80.5
11	D080		6.9	18.4	42.1
11	Peña Creek	Near mouth	8.0	27.6	70.5
11	Peña Creek	Near West Dry Creek Road bridge	14.5	34.9	62.7
12	D072	Downstream of unnamed tributary	9.4	32.8	77.8
13	D044	Downstream of Fall Creek	10.5	35.0	74.2
13	Fall Creek	Near mouth	3.8	16.0	54.4
14	D013		11.4	28.8	61.9
14	D004	Near mouth of Schoolhouse Creek	3.3	25.4	129.9
15	D001	At Bord Bridge	7.4	31.2	85.7

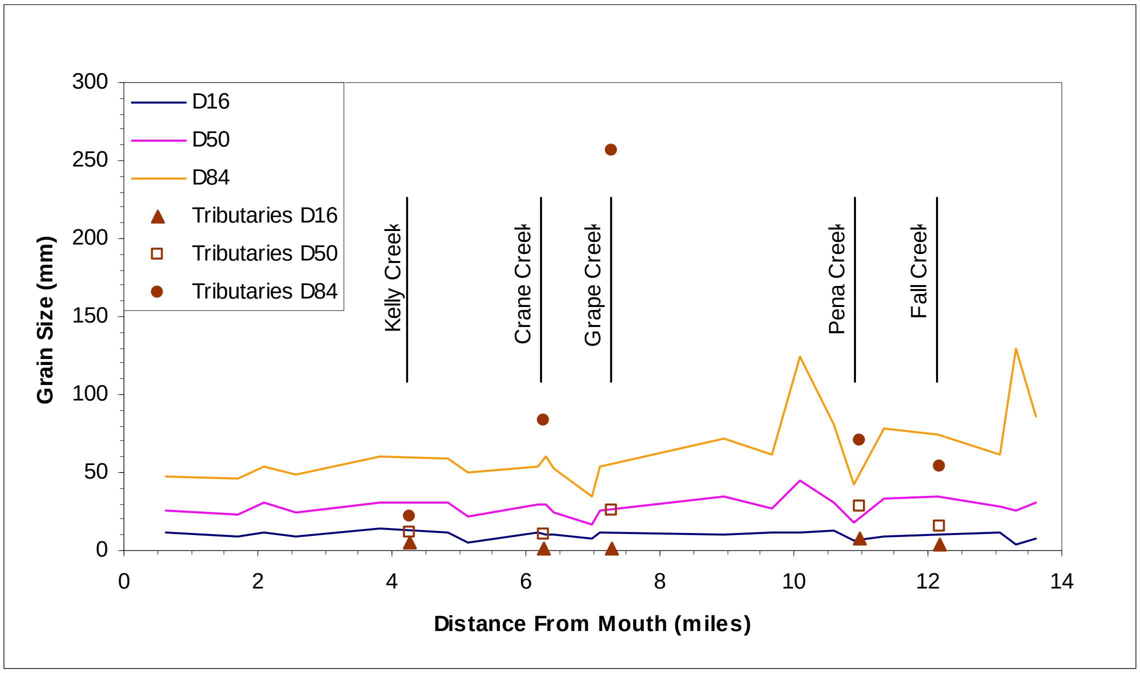


Figure 20: 16th (D16), 50th (D50) and 84th (D84) percentiles of surficial grain size distributions in riffles along Dry Creek and in five tributaries.

5.4 Future Evaluation

Phase 2 of the feasibility analysis will include quantitative evaluation of geomorphic processes in Dry Creek in order to assess enhancement feasibility on a system and project scale. This will include resurvey of a subset of the historic degradation ranges to positively examine whether Dry Creek has degraded further following closure of Warm Springs Dam. These and additional surveyed cross sections will be used to develop a planning level hydraulic model to quantitatively assess trends in fluvial processes, including the continuity of flow and sediment through the project reach.

6 DRY CREEK FISH HABITAT INVENTORY

The goals of this habitat inventory were to census aquatic habitat for coho salmon and steelhead trout in Dry Creek downstream of the Warm Springs Dam, to provide context for the development of fish habitat enhancement alternatives, and to establish a basic pre-treatment baseline against which to measure the effects of future fish habitat enhancement projects.
Between August 26 and September 1, 2009, 13.7 miles of lower Dry Creek were inventoried from Bord Bridge immediately below Warm Springs Dam to the Dry Creek confluence with the Russian River (Reaches 1-15). Habitat conditions were documented at the summer steady-state operational discharge of approximately 100 cfs.

6.1 Salmonids in lower Dry Creek

When Warm Springs Dam was constructed, approximately 153 miles of salmonid habitat was made inaccessible in the upper Dry Creek basin (CDFG 2002). The Warm Springs Hatchery, located at the dam, was built to mitigate for lost fish production from habitat areas above the dam, and is operated by the California Department of Fish and Game (CDFG 2002). The RRBO, which addresses joint river management in the Russian River basin by SCWA, the Army Corps of Engineers and the Mendocino County Flood Control and Water District, requires SCWA to enhance rearing habitat for ESA-listed coho salmon and steelhead trout in lower Dry Creek. This inventory of current habitat conditions was conducted as part of an effort to identify current habitat composition. Measured composition can then be compared to habitat goals and objectives to determine the best course of action for habitat enhancements.

Dry Creek historically supported populations of coho and steelhead, although it only provided marginal salmon habitat when compared to other Russian River tributaries closer to the coast (Hopkirk and Northen 1980). More recently, during 287 electrofishing and 58 spawning surveys in the Russian River over seven field seasons, only 79 coho salmon juveniles and one coho salmon carcass were observed (Coey 2000, in CDFG 2002). Twenty three of the juveniles were found in a single year in one place (Mill Creek, tributary to Dry Creek, Sonoma County: CDFG 2002). In recent years SCWA has been operating downstream migrant traps and conducting electrofishing and snorkel surveys to further document salmonid use. With respect to contemporary conditions in the Russian River basin, lower Dry Creek is seen as a potential resource that is a key component of the regional recovery plan for ESA-listed coho and steelhead. This is due to the relative abundance of cool streamflow during the late summer months, which is regarded as a limiting factor for recovery of these fish in a region where water is scarce during the summer months and typically has water temperatures adverse to salmonid survival. It should be noted that lower Dry Creek also contains a robust population of Chinook salmon. Planning of habitat enhancement efforts will also consider this important species.

Coho and steelhead are present in lower Dry Creek year-round. Adult coho and steelhead enter Dry Creek to spawn in the late fall and winter (Figure 21). Eggs deposited in gravel nests called redds incubate through the winter and early spring, and fry emerge in springtime. Juvenile coho and steelhead rear in lower Dry Creek for a minimum of one year before emigrating to the sea the following late winter or spring.

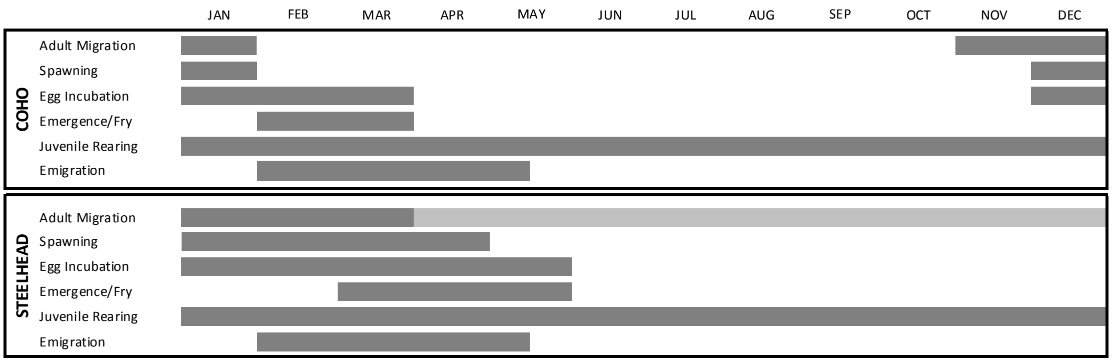


Figure 21: Phenology of Northern Californian coho and steelhead (Entrix, Inc. 2004).

6.2 Habitat Criteria for Coho and Steelhead

Juvenile coho salmon and steelhead tend to use different stream habitats. Coho juveniles prefer the slow velocities found in slackwater pools and backwater areas as well as off channel ponds. Juvenile steelhead prefer areas of higher velocity and are usually found in riffle and run type habitats. Preference criteria for coho and steelhead habitat in Californian salmonid streams have been developed for variables that were measured as part of the habitat inventory (see Table 10).

Other important habitat parameters may include canopy cover, riffle embeddedness, streamflow, water velocity, temperature, water quality (e.g. total suspended solids), instream wood volume, primary productivity, macroinvertebrate abundance and diversity, floating biomass, and other parameters.

Table 10: Preference criteria for coho and steelhead habitat in Californian salmonid streams (CDFG 2002, 2004).

Proportions and Frequencies of Habitat Types

- Pools >3 feet deep comprise >50% of Reach length
- Riffles comprise 15 to 30% of Reach Length
- Pool frequency is >50%

Channel Morphology

- Channel is connected to its floodplain (slightly entrenched)
- Shallow edge habitat is available to fry for rearing
- Side-channels and alcoves are abundant

Water Depth

- Water depth >7.1 inches for adult migration
- Residual pool depth >3 feet
- Water depths between 10 and 48 inches for juvenile rearing

Cover and Complexity

- >40% Instream Shelter Percent Cover[3]
- Instream Shelter Complexity[4] (Shelter Value) >2
- Shelter Rating[5] >100
- Instream Woody Debris is abundant

Substrate

- Spawning gravel sizes (11.4 mm to 128 mm)
- Salmonid Fry Rearing gravel/small cobble sizes (32 mm to 128 mm)
- <10% fine sediment in redds for optimum egg incubation
- <20% fine sediment in riffles for spawning and rearing

[3] Instream Shelter Percent Cover: the area of a habitat unit occupied by instream shelter, estimated from an overhead view.

[4] Instream Shelter Complexity (Shelter Value): a relative measure of the quantity and composition of the instream shelter where 0 is no shelter and 3 is complex shelter.

[5] Shelter Rating: The product of shelter complexity and instream shelter percent cover, values range from 0 – 300.

6.3 Summary of available data

Several prior studies have examined aspects of fish habitat in lower Dry Creek (Table 11). However, no census of habitat unit dimensions, instream cover, and substrate has been conducted. Collectively, these studies serve as a coarse indicator of potential limiting factors and general habitat conditions in Dry Creek.

Table 11: Previous studies on Dry Creek related to coho and steelhead habitat parameters.

Authors, Year	Report Title	Parameters Measured
Winzler & Kelley 2001	Dry Creek Survey, Sonoma County, California	Velocity, Substrate, Channel Shape
CDFG 1953	Rough Fish Control Project – Sonoma County Shocking Survey, August 18-28, 1953	Fish community and abundance
Winzler & Kelley 1978	Evaluation of Fish Habitat and Barriers to Fish Migration, Russian River Mainstem and Lower Dry Creek	Fish passage barriers and fish habitat
Hopkirk & Northen 1980	Technical Report on Fisheries of the Russian River	Fisheries
Baracco/CDFG, 1977	Instream flow requirements in Dry Creek, Sonoma County, below Warm Springs Dam	Fisheries, Flow
McBride & Strahan 1984	Establishment and Survival of Woody Riparian Species on Gravel Bars of an Intermittent Stream	Riparian Vegetation
Gordon & Meetenmeyer, 2006	Effects of dam operation and land use on stream channel morphology and riparian vegetation	Riparian Vegetation
CDFG 2002	Russian River Basin Fisheries Restoration Plan	Limiting Factors, Historical Resources
ENTRIX 2004	Russian River Biological Assessment, Interim Report 8: Russian River Estuary Management Plan	Russian River Coho and Steelhead Life Cycles
ENTRIX 2004, Appendix F	Flow-Habitat Assessment Study	Flow, Velocities, Substrate, Qualitative Estimates of Habitat

6.4 Methods

Habitat survey methods were developed by adapting elements from several published inventory methods in order to balance data needs and repeatability with practicality and efficiency of collection. The methodology used fundamentally follows the techniques described by Bisson et al. (1982), the more recent standards published as the USFS Region 6 Level II stream survey methodology (USFS 2006), and the California Department of Fish and Game methodology (Flosi et al 1998), and were adapted to fit the goals of the study. The inventory methodology began with reach delineation (Section 3.5), then proceeded with field identification and measurement of individual habitat units, and concluded with a synthesis of the data by reach segment.

6.4.1 Habitat Unit Types

In the field, fish habitat units were identified as pools, scour pools, riffles, flatwaters, cascades, alcoves, or side channels and were measured and recorded on standard data sheets (see Appendix C). Individual habitat unit definitions were as follows:

- Main Channel Pool (P): Pools are areas with very low velocities and multiple flow vectors, spanning at least 60% of the channel width, with minimum residual depths of 2.0 feet. Water surfaces are flat.
- Scour Pool (SP): Pools that consist of less than 60% of the channel width and are often associated with large wood, sharp meander bends, or boulders and have residual pool depths of at least 2.0 feet.
- Riffle (R): Riffles have obvious surface turbulence and are typically shallow water with low to moderate slopes (<4%). Water velocities are greater than 1 ft/s.
- Flatwater (F): Flatwaters have little surface turbulence and lack significant residual depth (less than 2 feet), with water velocities greater than pools. Flatwaters are deeper than riffles. Water surfaces are gently sloping, and velocity is less riffles.
- Cascade (C): Cascades are steep gradient (>4%) riffles with short falls, plunges or chutes typically dominated by boulders or bedrock.
- Alcove/Backwater Pool. (A): Alcove/backwater pools are pools located off the main channel in alcove or backwater areas. These units do not have a downstream flow component at the time of the survey.
- Side Channel Pool/Riffle/Flatwater (SC/P, SC/R, or SC/F): Side channels split from the main channel and reconnect downstream. These are categorized as side channel pools, riffles, or flatwaters based on the dominant habitat type in the side channel.

6.4.2 Habitat Unit Measurements

The following measurements were made at each habitat unit identified:

- Unit Length: Unit lengths were measured using a portable hip chain or recorded using survey grade GPS. While actual measured lengths recorded in the field can be expected to be different than those lengths measured off of air photos or topographic mapping, we adjusted the measured data to the river stationing found on the GIS base maps. Regular station locations were recorded using a hand held GPS unit to facilitate accuracy.

- Pool Maximum Depth: The maximum depth in each pool was measured using a stadia rod.
- Pool Tail Crest Depth: The average depth of the pool tail-out crest was measured using a stadia rod.
- Average Depth: Several measurements (ocular and/or with stadia rod) were taken in each riffle and flatwater to define average depth for the unit.
- Average Wetted Width: An ocular measurement of average wetted width was be made at each unit. Ocular measurements were calibrated with physical measurements at each Nth unit (below), consistent with USFS protocol.
- Woody Debris Count: Instream woody debris was defined using modified CDFG criteria. For any wood to be counted, it must have had a minimum length of 6 feet. Wood was categorized as small, medium, or large based on its diameter. Small wood was between 6 and 12 inches diameter, medium wood was between 12 and 20 inches in diameter, and large wood was greater than 20 inches in diameter. In addition, woody debris was classified as living or dead. Number of pieces of qualifying woody debris was tallied for each unit, which was converted to frequency per unit length during post processing.
- Instream Shelter Complexity: Complexity of instream shelter for pools and flatwaters was rated between 0 and 3, analogous to CDFG protocol.
- Percent Cover: The approximate proportion the total area of habitat unit occupied by cover features was estimated, analogous with CDFG protocol.

Photograph 14: Overhanging willows and other vegetation providing cover.

- Dominant and Subdominant Shelter Types: The dominant shelter type (LWD, overhanging vegetation, submerged vegetation, boulders, etc) present within each pool and flatwater was identified along with the subdominant shelter type.
- Edge Habitat Presence/Absence: In each habitat unit, the presence or absence of an area greater than 25 square feet[6] of shallow, slow water habitat less than 5 inches deep was recorded.

Photograph 15: Example of shallow "Edge" habitat in Reach 7.

- Substrate: Dominant and sub-dominant substrate type for each habitat unit was reported, consistent with CDFG protocol. The size classes, where D is the diameter of the b axis of the particle being measured, are listed below:

  F – Fines (D < 0.0625mm)
  S – Sand (0.0625 mm < D < 0.08 in)
  G – Gravel (0.08in < D < 2.5in)
  SC – Small Cobble (2.5in < D < 5in)
  LC – Large Cobble (5in < D < 10in)
  B – Boulders (10in < D)
  W – Bedrock

- Comments: Comments included presence of invasive vegetative species, springs or tributaries, installed structures, other hydromodifications, and other features of note.

6.4.3 Nth Unit Measures

Additional detail on habitat features were recorded at a minimum of 10% of the total units for each habitat type in each reach (Flosi et al 1998, USFS 2006). These surveyed units are termed nth units, and are taken to represent reach-average conditions. Measurements included the following:

- Average Wetted Width: Average width of the wetted portion of the channel was measured with both a physical and an ocular measurement. The physical

[6] Based on pre-inventory field discussions with NMFS.

measurement was used to calibrate ocular measurements made at each habitat unit. Calibration occurred in post-processing of the data, consistent with USFS protocol.

- Other Fisheries Observations: Any fish species observed during the habitat survey was identified, as feasible, and approximate size estimated. These observations were noted in the particular habitat unit in which the fish was observed. Additional habitat features such as areas of spawning gravel accumulation, high quality side channel rearing habitat, and boulder fields within the river channel were noted in the comments section of the data sheets or in field notebooks.

6.5 Results

6.5.1 Aquatic habitat

A summary of results for the habitat inventory of lower Dry Creek are listed in , and are described below for Reaches 1-15. A habitat survey was not conducted for Reach 16, the upper most reach in the tailwater of the dam due to safety considerations. Results are described in greater detail within the individual reach summaries included in Appendix A.

6.5.2 Channel Morphology

Lower Dry Creek flows at an average 0.18% gradient through a channel corridor incised into the former floodplain, which spans nearly the entire width of lower Dry Creek valley. Channel morphology in lower Dry Creek is primarily plain-bed with some reaches displaying pool-riffle morphology (Montgomery and Buffington, 1997). Some downstream reaches resemble C-type channels, with most reaches showing F-type entrenchment levels (Rosgen 1996) Mean active channel metrics were calculated based on measurements taken at riffle crests. The average active channel width was 61.7 feet (stdev 14.8, n=26) and the average active channel depth was 2.3 feet (stdev 0.6, n=26). The average floodprone width was 102.1 (stdev 33.9, n=26). The average active channel width:depth ratio was 26 and the and average entrenchment ratio was 1.7.

6.5.3 Habitat Unit Classification

As a percentage of main channel habitats (Figure 22), 23% of the lower 13.7 miles of Dry Creek are pools, 7% are scour pools, 26% are riffles, 44% are flatwaters, and less than 1% cascades. The proportional amount of riffle habitat appears to correlate moderately with tributaries entering the reach below the dam. Relative increases in percent riffle can be seen downstream of Schoolhouse Creek (between reaches 14 and 15), Pena Creek (between reaches 11 and 12), Crane Creek (downstream end of reach 7) and Mill Creek (between reaches 1 and 2). The two cascades were under Lambert Bridge in Reach 7, and over the upstream sill in Reach 4. While riffles represent 26% of all mainstem habitats by frequency, they represent only 12% of the mainstem length.

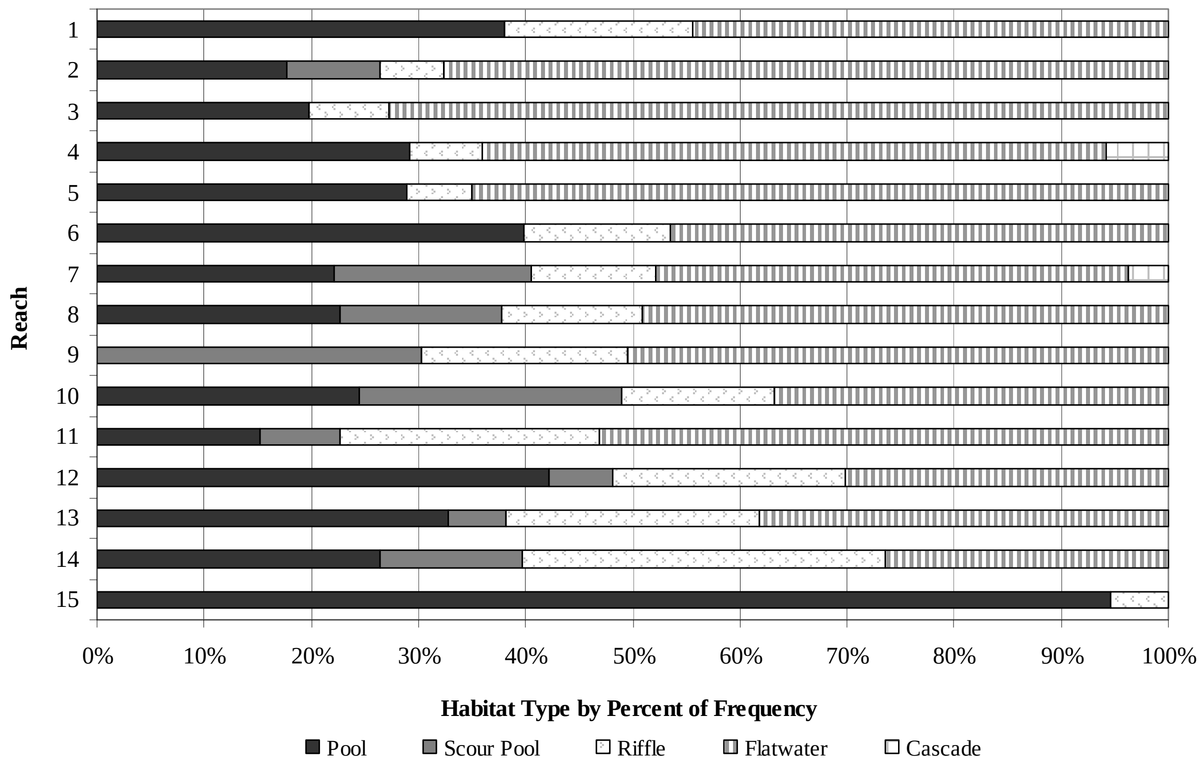


Figure 22: Distribution of habitat types by relative frequency for Reaches 1 through 15.

Table 12: Lower Dry Creek Habitat Inventory Results Summary, reaches 1 through 15.

		REACH 1	REACH 2	REACH 3	REACH 4	REACH 5	REACH 6	REACH 7	REACH 8	REACH 9	REACH 10	REACH 11	REACH 12	REACH 13	REACH 14	REACH 15
	river miles	0 to 0.7	0.7 to 2.0	2.0 to 3.0	3.0 to 4.1	4.1 to 5.4	5.4 to 6.2	6.2 to 7.5	7.5 to 9.0	9.0 to 9.8	9.8 to 10.3	10.3 to 11.0	11.0 to 11.7	11.7 to 12.6	12.6 to 13.3	13.3 to 13.6
	length (miles)	0.7	1.3	1.0	1.1	1.3	0.8	1.3	1.5	1.0	0.6	0.7	0.7	0.8	0.7	0.3
% total l frequency	**main channel pools**	32	16	17	25	26	35	19	19	0	20	13	37	29	25	50
	scour pools	0	8	0	0	0	0	16	13	23	20	7	5	5	13	0
	riffles	32	14	22	20	16	24	23	26	38	30	33	32	33	38	50
	flatwaters	37	62	61	50	58	41	39	42	38	30	47	26	33	25	0
	cascades	0	0	0	5	0	0	3	0	0	0	0	0	0	0	0
	# side channels	2	3	8	3	1	0	3	0	0	1	1	3	0	1	0
	# alcoves	4	6	4	8	2	0	8	1	1	3	1	1	3	2	1
% total length	**main channel pools**	39	18	25	59	30	60	45	36	0	26	13	49	41	26	97
	scour pools	0	3	0	0	0	0	22	21	49	25	2	7	6	12	0
	riffles	15	5	6	6	6	12	10	11	15	12	21	19	21	32	3
	flatwaters	47	73	69	34	64	28	22	32	37	38	64	25	33	30	0
	cascades	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
avg width (feet)	**wetted channel**	45.6	45.6	47.7	51.9	48.4	48.6	47.7	45.8	51.1	47.6	46.5	46.0	43.5	48.1	39.0
	active channel	62.5	68.0	82.0	52.0	69.0	n/a	58.5	58.5	57	78	56.6	54.0	41.0	65.0	45
	floodprone	137.5	140.0	110.0	112.0	86.5	n/a	81.0	70.5	95	87.0	78.0	93.0	62	139.0	126
	avg. active channel depth	2.1	2	1.35	2.15	1.8	n/a	2.5	2.4	2.8	2.4	2.6	2.6	2.3	2.6	2.9
	width:depth	30	40	48	19	39	n/a	24	24	21	32	22	21	18	25	15
	entrenchment	2.2	2.02	1.4	2.2	1.3	n/a	1.6	1.2	1.7	1.1	1.4	1.7	1.5	2.1	2.8
avg depth (feet)	**pools max**	4.0	4.3	4.6	5.3	4.9	5.5	4.8	4.7	4.2	6.3	5.1	5.5	5.7	5.7	7
	pools residual	2.7	2.8	2.4	3.8	3.4	4	3.5	3.4	3.0	5.0	4.3	3.9	3.8	4.4	4.5
	riffle	1.1	0.9	1.1	1.2	1.0	0.9	1.0	1.0	0.9	1.1	1.0	1.4	1.2	1.1	2
	flatwaters	1.4	1.5	1.4	1.3	1.5	1.5	1.4	1.4	1.5	1.9	1.8	2.0	2.2	2.3	
	cascade				0.9			1.1								
	side channel	0.6	1.3	1.8	0.9	0.5		0.8			0.3	1.0	1.6		1.1	
	alcove max	1.0	2.0	1.4	1.7	1.0		2.0	2.0	1.5	2.6	2.3	2.5	2.2	3.5	3
	% cover (mainstem habitats)	17	26	24	22	24	23	26	18	20	25	19	24	19	20	19
	complexity value (mainstem habitats)	2.1	2.7	2.7	2.5	2.6	2.6	2.6	2.6	3.0	3.0	3.0	2.8	2.7	2.7	2.0
	shelter rating (mainstem habitats)	35	69	65	55	61	59	67	47	59	74	56	67	51	54	37
	edge habitat frequency (mainstem habitats)	38%	39%	60%	58%	40%	29%	43%	47%	31%	36%	12%	26%	33%	19%	33%
wood	**pieces per mile**	96.9	141.9	165.4	184.9	233.9	195.6	190.5	193.6	192.8	361.8	269	176.6	159.9	117	62.9
	% live wood	42%	50%	43%	37%	31%	38%	34%	23%	19%	17%	29%	37%	51%	66%	70%
	# pieces S, M, L	41, 14, 9	158, 71, 13	174, 54, 30	177, 66, 15	229, 47, 20	110, 29, 15	231, 57, 8	233, 55, 8	124, 22, 9	171, 55, 9	132, 52, 12	122, 36, 3	100, 35, 6	64, 29, 0	13, 7, 0
	# pebble counts	1	1	2	1	2	1	4	1	1	1	2	1	1	2	1
% frequency in riffles	**spawning gravels** (11.4 to 128 mm)	84%	79%	81%	89%	80%	84%	80%	82%	81%	69%	73%	77%	83%	69%	67%
	fry rearing gravels (32 to 128 mm)	39%	33%	42%	49%	41%	45%	36%	53%	36%	45%	33%	51%	55%	37%	37%

6.5.4 Pool Dimensions

In higher order streams, CDFG categorizes pools greater than 3 feet deep as *primary pools*. Most pools in Dry Creek had maximum depths greater than 3 feet (Figure 23) with an average maximum pool depth of 5.2 feet (stdev 1.4, n=93). Pool depths generally decreased in the downstream direction, with a greater proportion of scour pools in the middle to upstream end of the survey. The channel width for main channel pools (49.0 feet) was slightly higher than that for flatwaters (47.3 feet) or riffles (44.7 feet), but the average width of scour pools was only 45.7 feet. The average pool residual depth was 3.6 feet (stdev 1.3, n=93) with relatively uniform pool crest depths of 1.5 feet (stdev 0.3, n=93) on average.

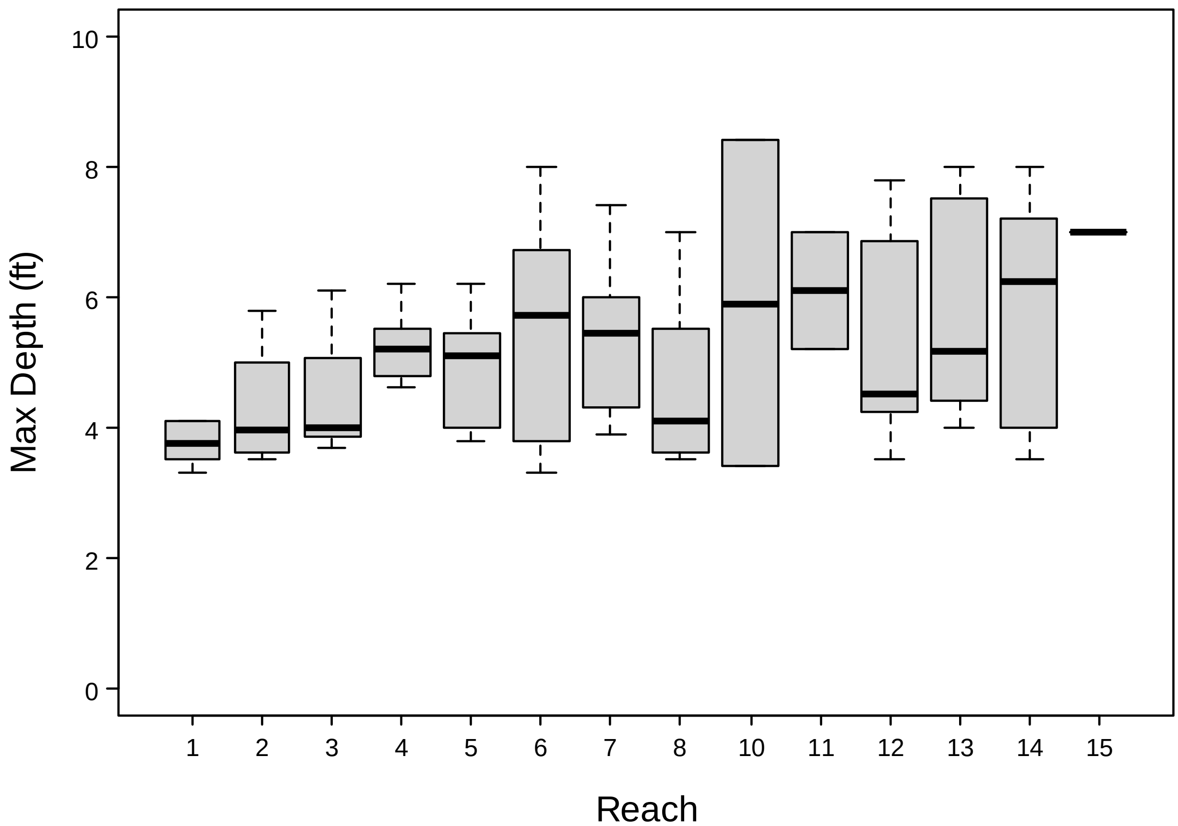


Figure 23: Standard box plot[7] depicting maximum pool depths. Median values are shown by the thick horizontal black lines. The 25th – 75th percentile range is contained within the gray-shaded box.

[7] Standard boxplot: The 25th – 75th percentile range of the data - the 'interquartile range' (IQR) - is contained within each gray-shaded box, and the medians are shown by the thick horizontal black lines. The upper 'whisker' represents the 75th percentile + 1.5*IQR. The lower 'whisker' represents the 25th percentile – 1.5*IQR.

6.5.5 Riffle and Flatwater Dimensions

In lower Dry Creek, the average riffle depth was 1.1 feet (stdev 0.3, n=79) and the average flatwater depth was 1.6 feet (stdev 0.4, n=133). The average riffle depths (Figure 24) were more consistent than flatwater depths (Figure 25), with deeper flatwaters observed in the upstream third of lower Dry Creek. Overall, there was far more flatwater than riffle habitats (44% of the total length versus 12% for riffles). The average riffle width was 44.7 feet (stdev 9.1, n=79) and the average flatwater width was 47.3 feet (stdev 7.5, n=133). Riffles were much shorter than flatwaters, with an average length of 110.1 feet (stdev 76.4, n=79) versus 227.8 feet (stdev 182.07, n=133) for flatwaters. The pool:riffle ratio was 1.2:1 (93 pools to 78 riffles).

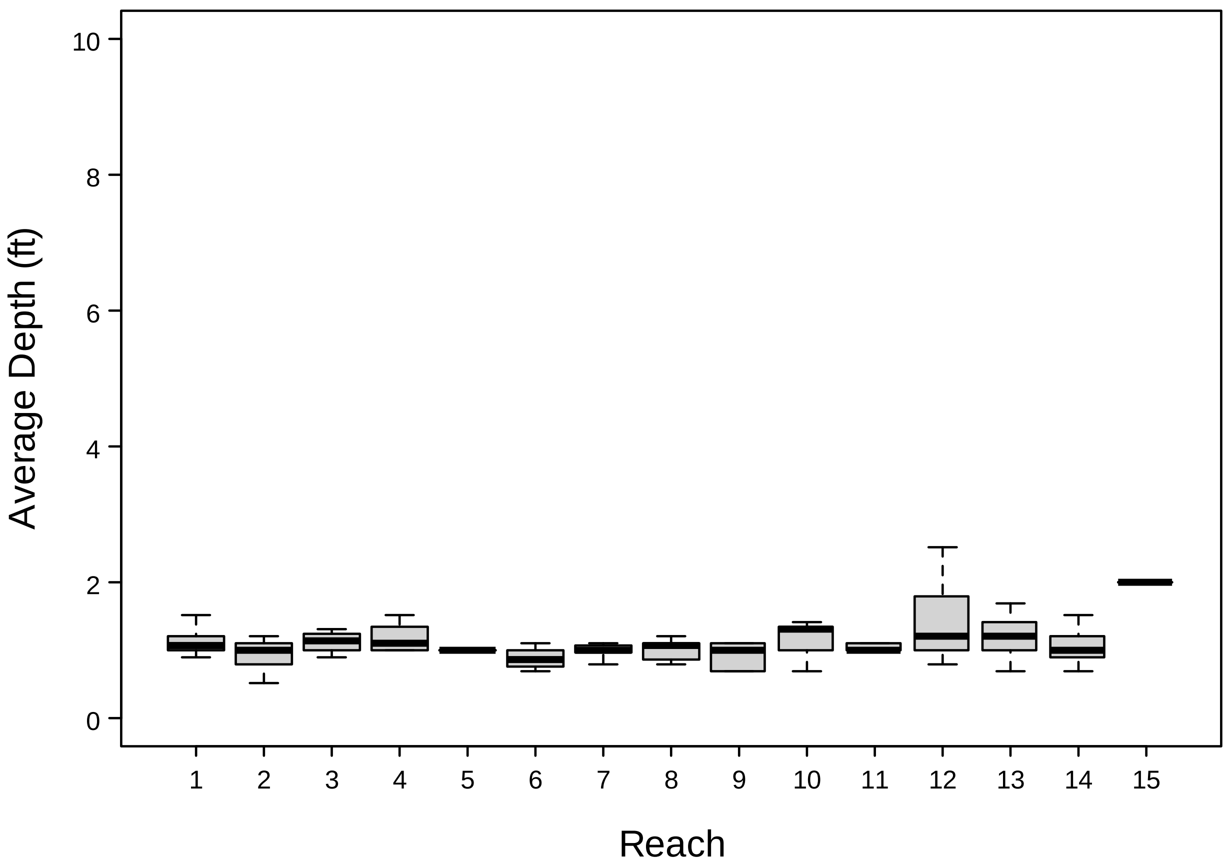


Figure 24: Standard box plot[7] depicting average riffle depths. Median values are shown by the thick horizontal black lines. The 25th – 75th percentile range is contained within the gray-shaded box.

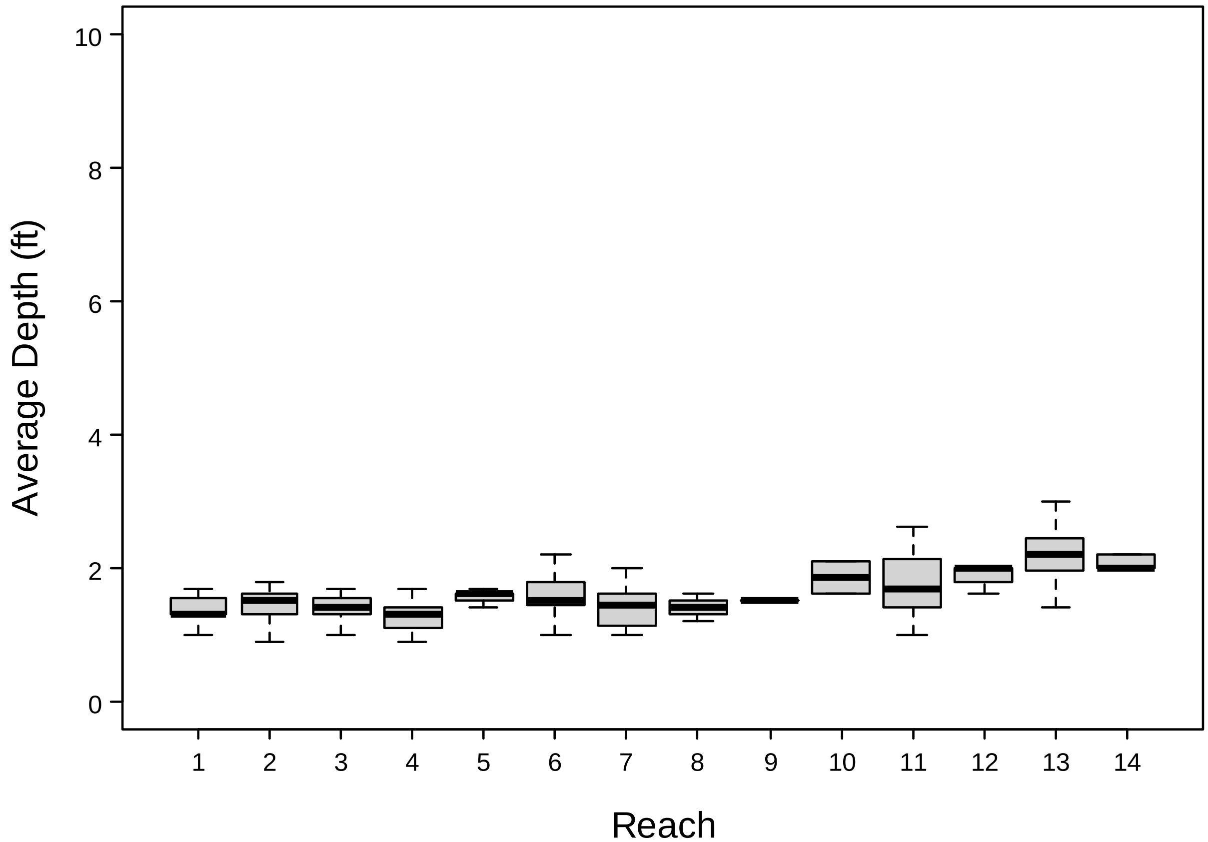


Figure 25: Standard box plot[7] depicting average flatwater depths. Median values are shown by the thick horizontal black lines. The 25th – 75th percentile range is contained within the gray-shaded box.

6.5.6 Substrate

Pebble counts were conducted in riffles in all surveyed reaches (Figure 26). The gravel sizes in the sampled riffles generally meet coho and steelhead spawning requirements, with ample proportion (67% to 89%, with an average of 79%) of ideally sized gravels and cobbles (11.4 to 128mm). In addition, the proportion of ideally-sized substrate for fry rearing (32 to 128 mm) ranged from 33% to 55%, with an average of 42%. Based on the pebble count data, sediment sand-sized and smaller comprised up to 10% of surface substrate in the sampled riffles, with an average sampled proportion of 5%.

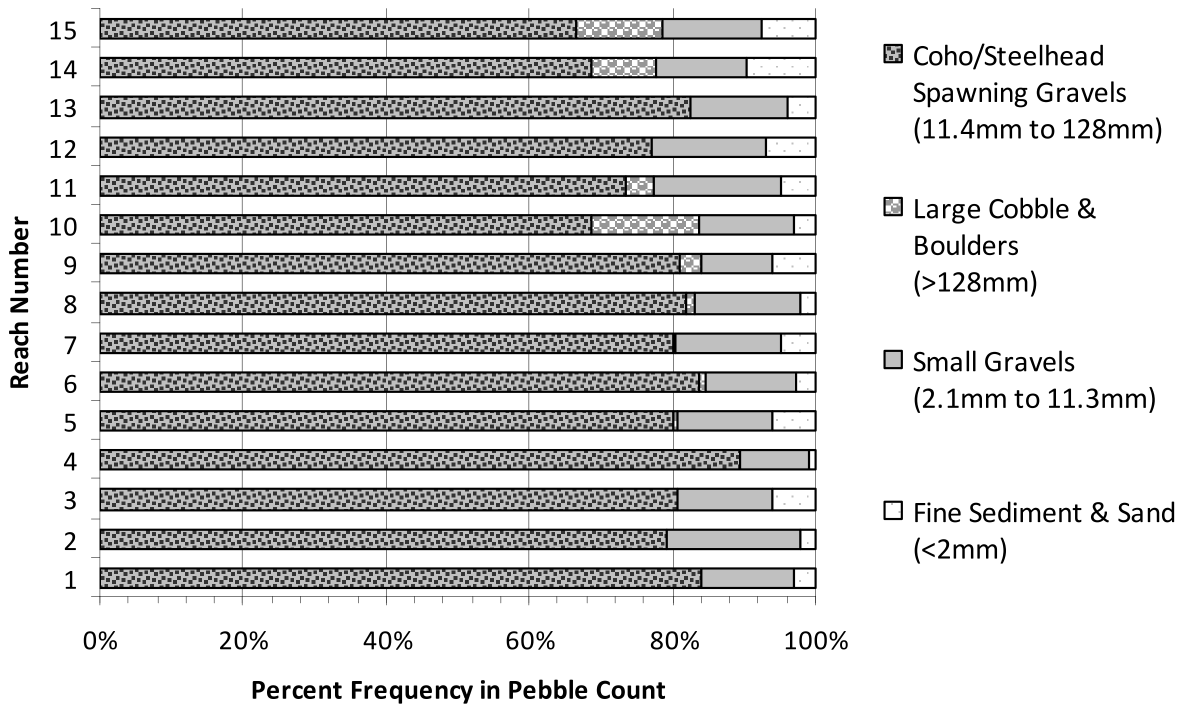


Figure 26: Riffle surface substrate size distribution by reach, based on pebble count sampling of representative riffles in each reach.

Dominant and subdominant substrates were categorized for all habitat units. In 81% of all pools, the dominant substrate was gravel, with sand recorded as the dominant substrate for 13% of pools, and cobble for 3% of pools. The subdominant substrate was primarily sand (64% of pools), with some cobble (20% of pools) and gravel (13% of pools). 3% of pools had some boulder or bedrock substrate.

Riffle beds were most dominated by gravels (81% of riffles) and small cobbles (17% of riffles), with a subdominant substrate of small cobbles (79% of riffles) and gravels (14% of riffles). Dominant flatwater substrate was primarily gravel (93% of flatwaters), with subdominant substrate of sand (49% of flatwaters) and cobble (46% of flatwaters). In the two cascades, dominant substrate was bedrock with boulders, and some cobble.

In side channel pools (SCPs), dominant substrate was most often fine sediment (40% of SCPs), gravel (30% of SCPs), or sand (30%of SCPs), with subdominant substrate of sand (60% of SCPs), cobble (10% of SCPs) and fine sediment (20% of SCPs). In side-channel riffles (SCRs), dominant substrate was gravel (100% of SCRs) with small cobble (75% of SCRs) and sand (25% of SCRs) as subdominant substrates. In side-channel flatwaters (SCFs), dominant substrates were gravels (100% of SCFs), with subdominant substrates of sand (78% of SCFs) or cobble (22% of SCFs). Alcoves were most often lined with fine sediment (52% of alcoves), followed by gravel (37% of alcoves), with occasional sand and small cobble. Subdominant substrate was sand (50% of alcoves), or gravel (27% of alcoves), fine sediment (16% of alcoves) or cobble (7% of alcoves).

In some areas, boulder riprap has fallen or been recruited into the channel bottom providing cover for fish. Where tributaries flow into Dry Creek, smaller gravels and fine sediments are often deposited in small fans. A more detailed description of substrate characteristics can be found in the geomorphic summary included in this report.

6.5.7 Instream Woody Debris

Instream woody debris totaled an average of 183 pieces of wood per mile in lower Dry Creek, with variability from reach to reach, including 63 pieces per mile in Reach 15 to 362 pieces per mile in Reach 10. Figure 27 shows the pieces of small, medium, and large wood per mile by habitat type for all reaches combined. No wood was observed in the two cascade habitat units.

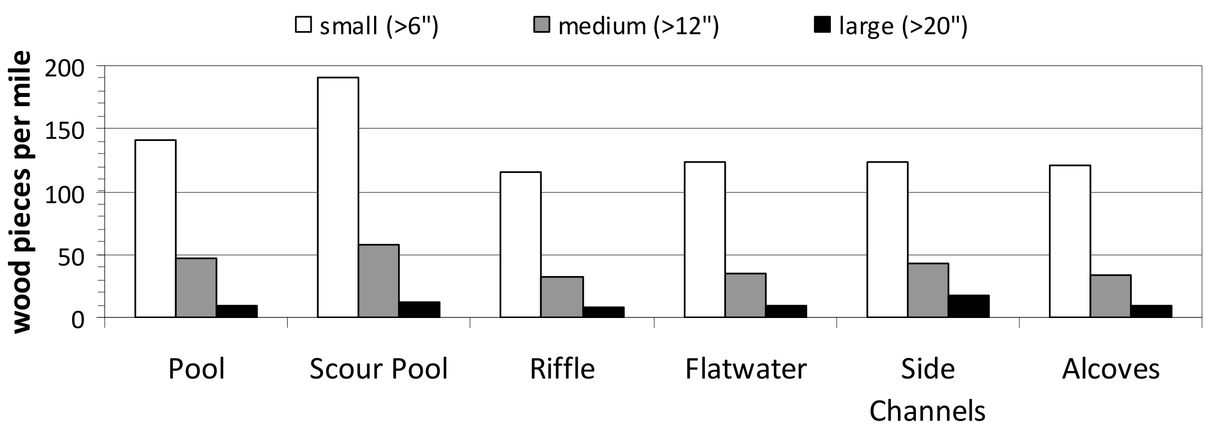


Figure 27: Wood pieces per mile across habitat types.

We also classified wood as living or dead. 46% of all the pieces counted were living, with 44% of the large pieces living, and 46% of the small and medium pieces living. Recent publications by Opperman and others (2005, 2006, 2008) and Thompson et. al. (in press) highlight the geomorphic and ecological importance of living wood in Northern Californian stream systems.

6.5.8 Side Channels & Alcoves

In general, there were a greater number of off-channel habitats in the lower half of lower Dry Creek. A total of 44 alcoves and 27 side channels were measured. In addition, two very small alcoves were described, but not measured. Of the 27 side channels, 10 were side channel pools, and 17 were split between side channel flatwaters and side channel riffles.

20% of the alcoves were over 100 feet long, 34% were less than 50 feet long. One alcove was 1500 feet long. On average, alcoves were 14.4 feet wide (stdev 7.1, n=45) with an average maximum depth of 1.9 feet (stdev 1.1, n=44). The average side channel pool length was 214 feet, with 45% over 100 feet long, and one 2500 feet long. The average side channel pool width was 17.7 feet (stdev 11.3, n=9) and the average maximum depth was 2.2 feet (stdev 1.1, n=9). The average side channel riffle length was 67.5 feet (stdev 36.5, n=8), with a width of 17.6 feet (stdev 8.8, n=8), and a depth of 0.6 feet (stdev 0.3, n=8). The average side channel flatwater was 173.1 feet long (stdev 152.5, n=9), with a width of 15.7 feet (stdev 7.2, n=9), and a depth of 0.9 feet (stdev 0.3, n=9). Six out of the nine side channel flatwaters were over 100 feet long, with one 250 feet long, and another 550 feet long.

6.5.9 Instream Cover & Shelter Complexity

Average cover in pools (27%) was higher than in flatwaters (22%), and cover was greater in flatwaters than in riffles (15%). The two cascade habitat units contained 73% percent cover, due to a high percentage of cover provided by bedrock and boulders that resulted in shelter ratings of 285 and 100. Shown in Figure 28, pools were rated with the highest instream shelter complexity, followed by flatwaters, cascades, and riffles. This complexity was mostly associated with overhanging willows and other vegetation, and with small woody debris.

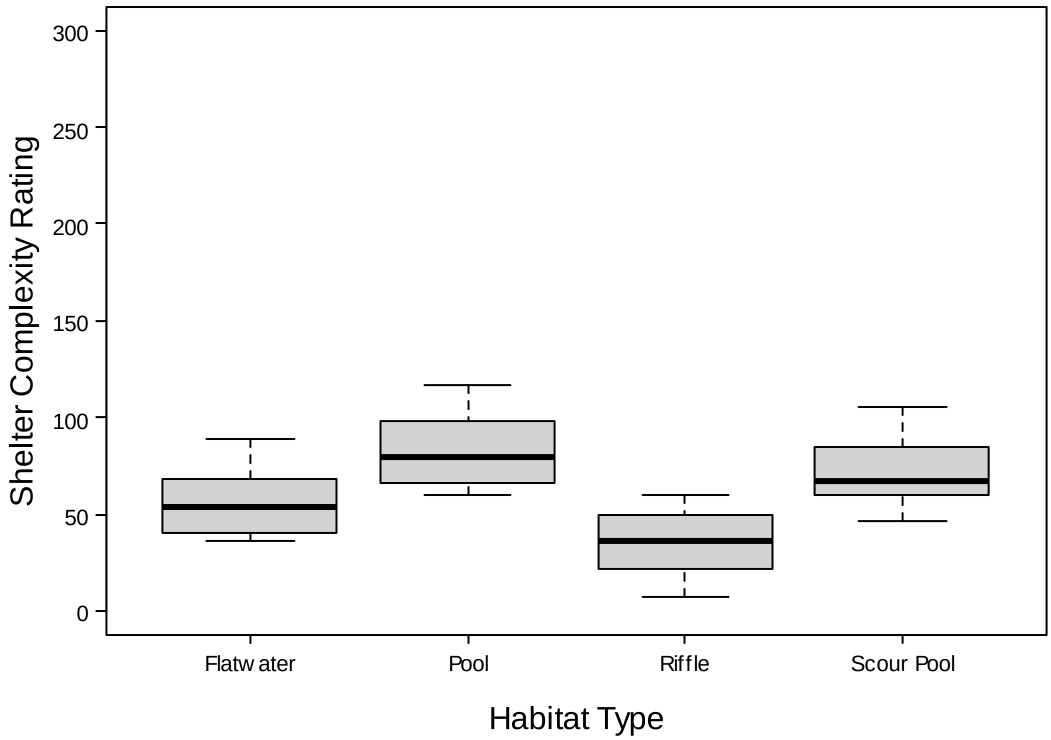


Figure 28: Standard box plot[7] depicting shelter complexity ratings for mainstem habitat types. Median values are shown by the thick horizontal black lines. The 25th – 75th percentile range is contained within the gray-shaded box.

Off-channel habitats generally had much higher cover than main channel units. The average cover in side channels was 41% and in alcoves it was 58%. Higher cover was due to aquatic vegetation, small woody debris, and overhanging shrubs and trees. Shown in Figure 29, Higher complexity values were assigned to side channel pools and alcoves, with side channel flatwaters and side channel riffles receiving the lowest complexity values overall.

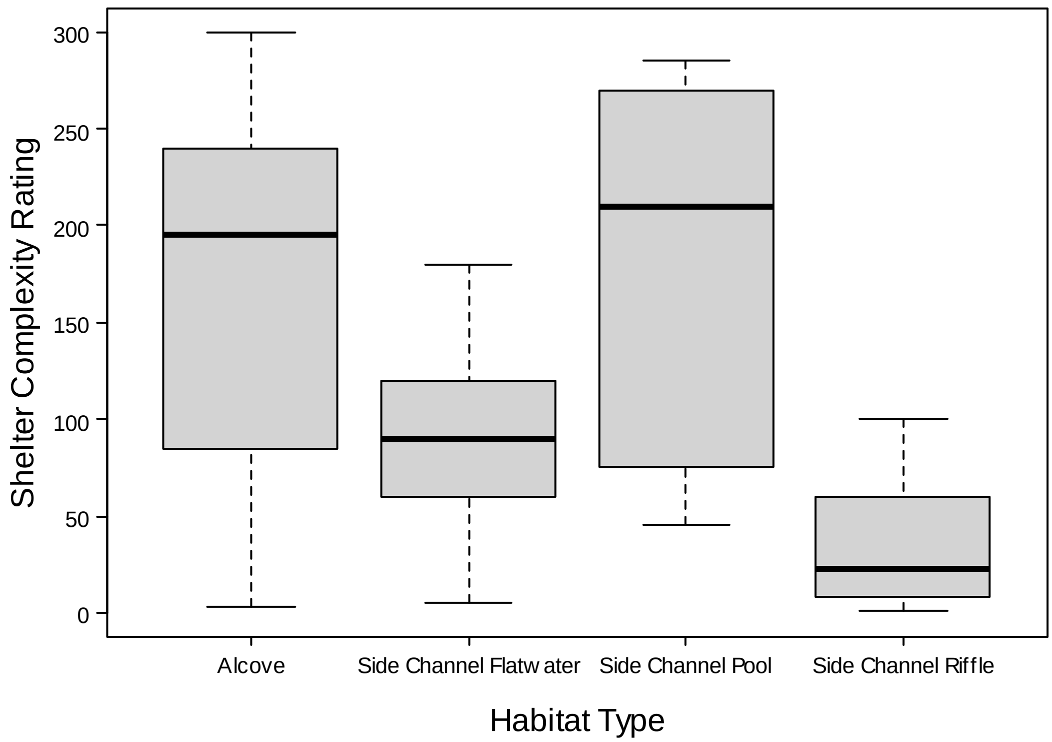


Figure 29: Standard box plot[7] depicting shelter complexity ratings for off-channel habitat types. Median values are shown by the thick horizontal black lines. The 25th – 75th percentile range is contained within the gray-shaded box.

6.5.10 Frequency of Edge Habitat

Overall, edge habitat was present in 41% of all habitat units. Edge habitat was most often associated with side channels (59%) and alcoves (71%). 37% of flatwaters contained edge habitat, whereas it was associated with only 35% of main channel pools and 27% of scour pools. Riffles contained the lowest frequency of edge habitat, with only 18%. One of the two cascades contained edge habitat.

6.5.11 Estimation of Pool Velocities

Water velocities in pools at the time of the habitat inventory were estimated using approximate methods for purposes of general evaluation. Velocity estimates were calculated over the discharge range 80 cfs to 105 cfs, which bracket the discharges observed at the USGS streamgages on lower Dry Creek during the dates of the 2009 habitat inventory field effort. The estimates were based on the average pool width, maximum pool depth, and an assumed creek bed shape approximated by a half-ellipse[8]. Because these estimates were made based on maximum pool depths, they could be considered conservative (i.e. slower) relative to average pool velocities throughout the pool units. Figure 30 shows the results of the velocity estimates for the 93 pools in Dry Creek for discharges of 80 cfs and 105 cfs. The average main channel pool velocity calculated in this manner was 0.46 ft/s (stdev 0.15, n=93) at 80 cfs and 0.61 ft/s (stdev 0.21, n=93) at 105 cfs. While based on approximate methods only, the estimated velocities

[8] For the velocity back-calculation, we assumed the channel was shaped like the bottom half of an ellipse. Area of the ellipse is calculated with the equation: $A = \pi ab$, where a and b are ½ of the width and ½ of the height respectively. By substituting maximum pool depth for b, and average wetted width for a, and multiplying by 0.5 we approximated channel area. Estimated velocity was then calculated as $V=Q/A$, where Q is the stream discharge.

appear to generally concur with the measured velocities reported in the 2001 flow-habitat assessment (Entrix 2004). All of the average velocities for main channel pools measured for the 2001 study and calculated based on the 2009 habitat inventory data exceed the pool velocity criteria stated in the RRBO as optimal for juvenile coho rearing (discussed further below).

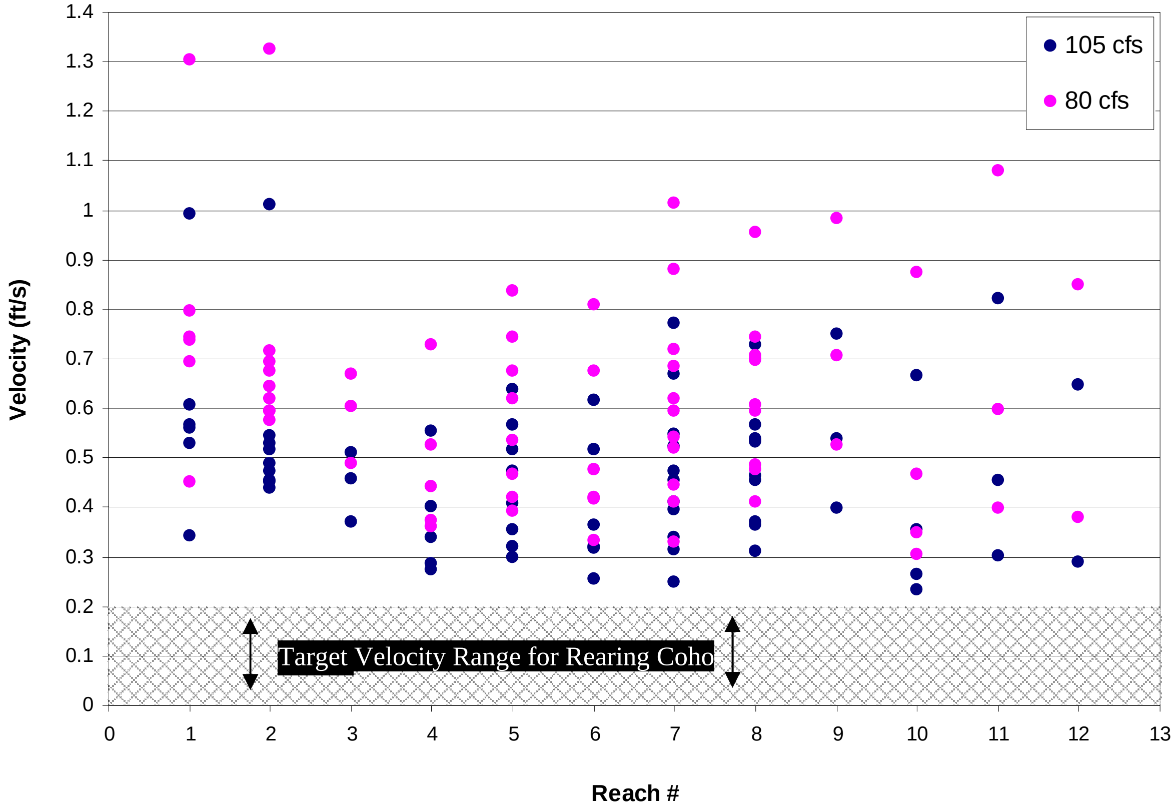


Figure 30: Estimated velocities for lower Dry Creek pools based on 2009 habitat inventory data. Velocities were calculated at 80 and 105 cfs to capture the typical range of discharge in Dry Creek during the time of the habitat inventory. The cross-hatched area is the target velocity range for coho rearing habitat (< 0.2 ft/s).

6.5.12 Man-made Features

Although we did not specifically measure lengths of bank erosion, eroding banks were observed in Reach 1 and in Reach 7. We did record bank stabilization efforts and other man-made features in the creek where visible (Photograph 16). These were added to the existing feature GIS layer, and are described in the Reach Summaries (Appendix A) in greater detail. Overall, there were a high number of bank stabilization efforts using riprap, cars, creosote-preserved wood fences, steel I-beams, and chain-link fence.

Photograph 16: Man-made features in Dry Creek.

6.5.13 Riparian Observations

We did not measure canopy cover, but the riparian forest along lower Dry Creek is one of its most prominent features. In many reaches, it formed a 'green tunnel' completely enclosing the active stream (Photograph 17). Riparian forests are especially important for supporting the food base and providing structure for juvenile salmonids. Species observed along lower Dry Creek included Fremont cottonwood (*Populus fremontii*), Hinds walnut (*Juglasn hindsii*), white alder (*Alnus rhombifolia*), California box elder (*Acernugundo ssp. Californicum*), Oregon ash (Fraxinus latifolia), coast live oak (*Quercus agrifolia*), California bay (*Umbellularia californica*), and abundant willows of various species.

Photograph 17: Dry Creek's riparian forest.

6.5.14 Wildlife Observations

We observed quite a few mergansers, great blue herons, and kingfishers, along with river otter scat. These observations would seem to indicate an available fish-based food base for these fauna. We also observed a great number of young frogs near the mouth of Pena Creek, and a number of turtles. Small, unidentified fish jumped as schools in several pools, and we also observed a number of juvenile rainbow trout.

6.6 Comparison of Habitat Inventory Results to the 2008 RRBO Criteria

The RRBO recommends a Reasonable and Prudent Alternative for lower Dry Creek, including several criteria to guide development of habitat enhancement. These are summarized and compared with results of the 2009 habitat inventory in Table 13. Selected results of the comparison include the following:

- The RRBO specifies that pools should comprise 33-67% of habitat area. Total pools (pools and scour pools) represent 30% of all habitat units, based on the 2009 habitat inventory.
- Pool:riffle ratios that fall within the 0.5 – 2.0 range specified by the RRBO are found in the study reaches. However, only 12% of the length of Dry Creek is comprised of riffles, which highlights the proportional deficit of this habitat type.
- The average residual depth of 3.6 feet for pools in lower Dry Creek falls within the range specified by the RRBO (2 – 4 ft).
- The 2008 RRBO specifies that ample large woody debris should be present. The 2009 habitat inventory found a moderate amount of large woody debris. Abundance of dead woody debris peaks in the middle of the reach, while live woody debris is more evenly distributed. Additional detail of LWD present in lower Dry Creek is discussed in section 6.7.
- The RRBO specifies that off-channel habitat should be available. Dry Creek has an average of 4.7 (stdev 4.1, n=71) off-channel habitats per reach, including alcove, side-channel pool/riffle/flatwater units. Alcove and side channel habitats were more abundant in the lower half of Lower Dry Creek, while edge habitat was also slightly more abundant in the same area. Five of the reaches have no off-channel habitats.
- The RRBO specifies that habitat quality should be near ideal. The current inventory found main channel percent cover and main channel shelter complexity ratings to be less than habitat standards. Additionally, as discussed previously, estimated pool velocities exceed RRBO criteria.

Table 13: Comparison of 2009 Dry Creek Habitat Inventory results with 2008 Russian River Biological Opinion criteria for Dry Creek.

2008 RRBO CRITERIA	Measured Characteristics (2009 Habitat Survey)	Lower Dry Creek Average	REACH 1	REACH 2	REACH 3	REACH 4	REACH 5	REACH 6	REACH 7	REACH 8	REACH 9	REACH 10	REACH 11	REACH 12	REACH 13	REACH 14	REACH 15
Pool Abundance: 33%-67%	Pool Abundance[9]																
	% by Frequency	30%	32%	24%	17%	25%	26%	35%	35%	32%	23%	40%	20%	42%	34%	38%	50%
	% by Habitat Area	46%	39%	21%	26%	62%	30%	62%	69%	57%	45%	53%	13%	60%	48%	39%	99%
Pool Frequency: 0.5 to 2	Pool Frequency (Pools : :Riffles)	1.2	1.0	1.2	0.8	1.3	1.6	1.5	0.9	0.8	0.0	0.7	0.4	1.2	0.9	0.7	1.0
Residual Pool Depth: 2 - 4 ft	Residual Pool Depth (ft)	3.6	2.0 - 4.1	2.1 - 3.9	2.3 - 2.5	3.1 - 4.6	2.3 - 4.7	2.1 - 6.6	2.5 - 6.2	2.0 - 5.8	2.5 - 3.7	2.3 - 7.0	3.5 - 5.0	2.2 - 6.6	2.4 - 6.0	2.4 - 6.8	4.5
Pool Velocity: < 0.2	Pool Velocity (ft/s)[10]	0.5	0.3 – 1.3	0.4 – 1.3	0.4 – 0.7	0.3 – 0.7	0.3 – 0.8	0.3 – 0.8	0.3 – 1.0	0.3 – 1.0	0.4 – 1.0	0.2 – 0.9	0.3 – 1.1	0.3 – 0.9	0.3 – 0.7	0.2 – 0.8	0.3 – 0.4
Pool Size: 500 - 2700 ft^2	Pool Size (ft^2)	22713	12106	7156	22308	40790	12243	21159	21529	20572	31128	19162	8242	13024	13363	8263	89650
Woody Debris: Ample LWD	Woody Debris pieces/mile[11]	182.8	96.9	141.9	165.4	184.9	233.9	195.6	190.5	193.6	192.8	361.8	269	176.6	159.9	117	62.9
Off-Channel Habitat: Available	Off-Channel Habitat # of Side Channels, Alcoves	4.7	6	9	12	11	3	0	11	1	1	4	2	4	3	3	1
	Area (ft^2)	9283	3390	2200	51735	8700	720	-	14450	-	-	490	2500	7020	-	1620	-
Habitat Quality: "Near Ideal"	Habitat Quality % Cover[12] Shelter Rating [13]	32% 88	26% 65	40% 108	42% 122	28% 67	28% 74	22% 59	39% 104	21% 58	38% 114	40% 111	17% 49	35% 104	35% 104	23% 62	39% 112

[9] Includes main channel pools and scour pools
[10] Range of velocities estimated for 80 – 105 cfs is shown for each reach. Velocity calculations are estimates based on discharge and habitat dimensions measured at the time of the 2009 habitat survey, described in Section 6.5.11. Velocities measured in the 2001 Entrix report ranged from 0.4 – 1.3 ft/s.
[11] This includes mainstem habitats only.
[12] Includes main channel, side channel and alcove habitats.
[13] Includes main channel, side channel and alcove habitats.

6.7 Discussion of Woody Debris Loading

The relationship between dead instream wood and salmonid habitat is well recognized for conifer-dominated ecosystems in the West, but recent studies have revealed the important role of living wood in angiosperm-dominated forests in Northern California, where the primary riparian tree species include California bay laurel (*Umbellularia californica*), white alder (*Alnus rhombifolia*), big-leaf maple (*Acer macrophyllum*), canyon live oak (*Quercus chrysolepis*), and willows (*Salix spp*.) (Opperman 2005).

When compared with dead instream wood of similar dimensions, living wood in these ecosystems may be more persistent because of its greater resistance to decay and greater stability due to a living rootmass, and may provide more structural complexity, hydraulic roughness, and retentive capacity (Opperman et al. 2008). In hardwood-dominated ecosystems where riparian tree regeneration from seed is constrained or where dead wood is not produced by very large trees, livewood is expected to alter the scaling relationships between wood dimensions and channel size (Opperman et al. 2008).

Our survey counted a total of 2,865 pieces of wood within the 13.9 mile section of lower Dry Creek. 46% of these wood pieces were living. With the assumption that each piece of wood counted was between 10 and 20 feet long, we estimate between 40 m^3/hectare to 80 m^3/hectare of instream wood was present within the wetted channel of lower Dry Creek.

Thompson et al. (2008) compared instream wood loading across regions of western North America (Table 14). While the 40-80 m^3/ha estimated for lower Dry Creek compares with the average for small streams flowing through private lands in Northern California (42 m^3/ha), it is less than that measured in protected watersheds (115 m^3/ha). While the available woody debris in Dry Creek is found at lower than optimal density, it is an important resource for salmonids and other biota in the creek.

Table 14: Comparison of instream wood loading (m3/ha) across regions of western North America. Reprinted from Thompson et. al. 2008.

Region	n	Mean (SD)	Median (interquartile)	Maximum
Pacific Northwest (BC, WA, OR)[a]	62	752 (810)	535 (315, 858)	4500
Sierra Nevada conifer[b]	12	160 (99)	159 (108, 209)	=382
No. CA hardwood, protected watersheds[c]	9	115 (33)	107 (93, 137)	=173
No. CA hardwood, private land[c]	23	42 (43)	20 (14, 59)	=146
So. CA hardwood (this study)	15	47 (58)	17 (11, 58)	=164

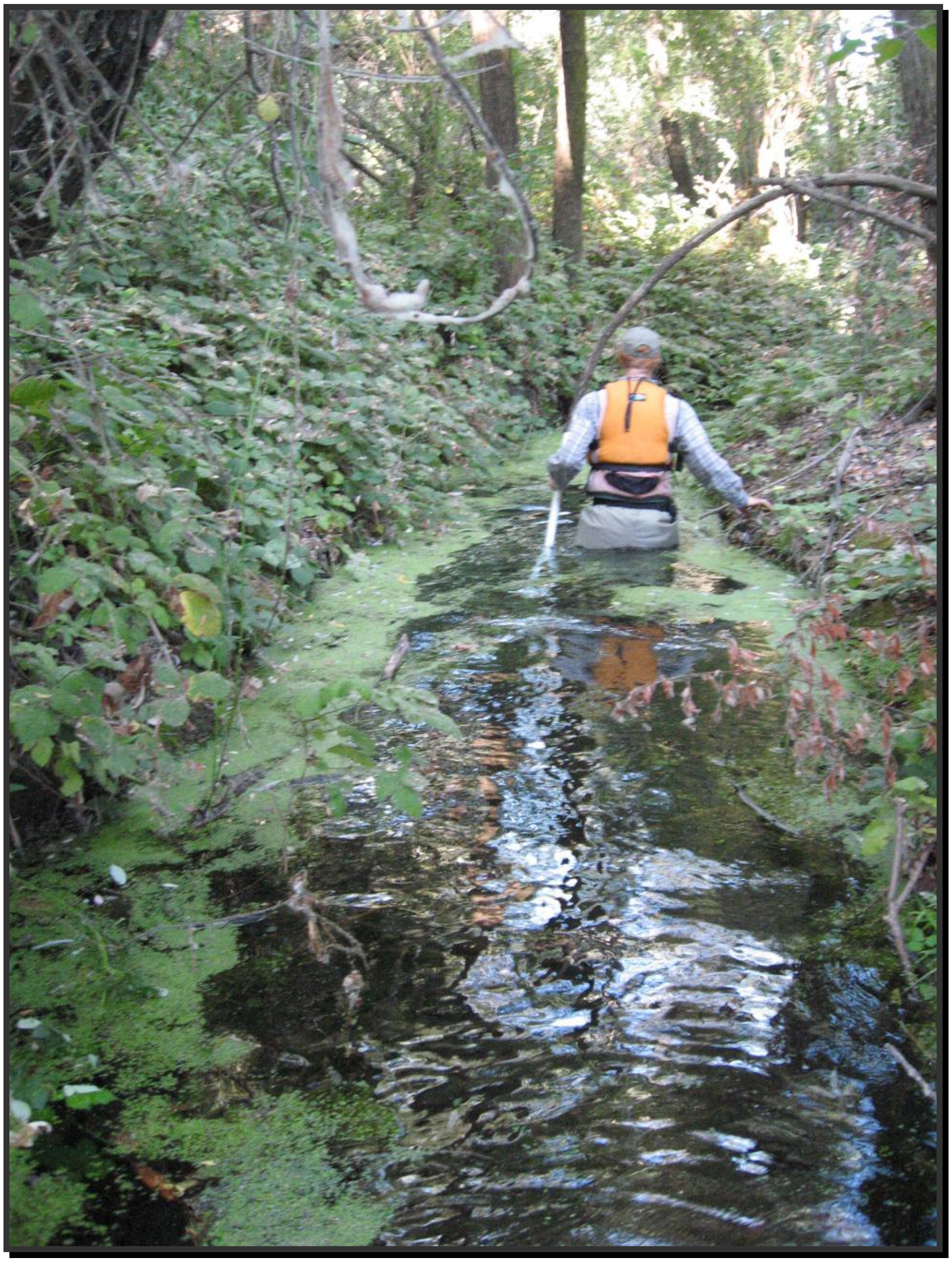
[a] Data from Andrus and others (1988), Harmon and others (1986), and Keller and Tally (1979).
[b] Data from Berg and others (1998)
[c] Data from Opperman (2005)

7 Preview of Enhancement Opportunities

The recommended Reasonable and Prudent Alternative contained in the RRBO requires enhancement of six miles of lower Dry Creek to provide near ideal summer rearing conditions for coho and steelhead at the proposed steady state operational discharge (approximately 100 cfs), with an emphasis on coho. The six miles of enhancements are to be distributed over the 13.9 miles, implemented at a minimum of eight locations on the creek. It is intended that the enhancements for summer rearing will also integrate characteristics to provide winter rearing and refugia habitat. The enhancements are to be implemented with a phased approach which allows for evaluation of the effectiveness of the enhancements as the effort progresses (NMFS 2008).

As discussed above, the RRBO offers specific criteria with respect to desired main channel rearing habitat characteristics. The RRBO also stresses the availability of off-channel habitats in low velocity areas with substantial cover. Finally, the enhancement techniques should consider 'log or rock weirs, deflectors, log jams, constructed alcoves, side channels, backwaters, and dam pools that have successfully increased the quantity and quality of summer and winter rearing habitat for coho and steelhead' (NMFS 2008). The terms identified in the RRBO necessarily focus on criteria at the habitat unit scale over a subset of Lower Dry Creek. However, fluvial systems such as Dry Creek are characterized by longitudinal, vertical, lateral and temporal physical and biological process pathways. It will be necessary to assess feasibility at the system scale (WSD to confluence) to assess continuity in these processes in order to affirm the feasibility and sustainability of the enhancement work which is likely to be implemented at the project scale.

Based on the 2009 fish habitat inventory (Section 6) which was completed at the approximate steady state discharge, Lower Dry Creek currently contains 30% total pools (23% main channel pools and 7% scour pools), 26% riffles, and 44% flatwaters (by relative frequency), with average maximum and average residual pool depths of 5.2 and 3.6 feet, respectively. Overall pool habitat quality does not meet desired characteristics. Additionally, velocity estimates suggest that pool velocities are higher than 0.2 ft/s, falling outside the range described in the RRBO. Furthermore, length of riffle habitat is low, and a limited amount of alcove habitat was identified (Photograph 18). Based on these results and additional discussion with stakeholders, a suite of proposed enhancements will be developed in successive phases of the project. The proposed enhancements are likely to include combinations of mainstem pool and riffle enhancement, off-channel backwater and alcove enhancement and creation (Photograph 19), side-channel enhancement and creation (Photograph 20), and enhancement and stabilization of streambanks using bioengineering or similar techniques where appropriate. For example, based on the results of the habitat survey, enhancement with large woody debris may improve pool quality in terms of percent cover and shelter complexity rating. Enhancements of riffles may include expanding existing riffles or constructing new 'seed' riffles in appropriate locations, which might be considered to supplement sediment supply in certain reaches. Streambank enhancements may address chronic erosion in critical locations and provide additional cover along the channel margins.



Photograph 18: Alcove habitat in Dry Creek.

Photograph 19: Potential backwater channel / side channel analog site on Dry Creek upstream of Westside Bridge, RM 2.2. Additional large woody debris would be included in proposed designs of similar habitat.

Photograph 20: Constructed side channel habitat.

System- and project-scale feasibility will be assessed in the next phase of the study. However, areas of interest for potential enhancement were noted during the geomorphic and habitat inventory fieldwork in August-September 2009. These areas of interest were revisited by the senior project geomorphologist, fish biologist, hydraulic engineer and geologist in October 2009 to review potential enhancement opportunities, constraints, apparent limiting factors and design concepts.

Areas for potential enhancement of pools, riffles and streambanks are numerous along lower Dry Creek. Therefore, more effort was focused on identifying locations to enhance and create off-channel alcove and backwater, and side-channel habitat. These types of habitats have been proven to be particularly productive for rearing of coho salmon. While opportunities for these habitat types exist in lower Dry Creek, potential challenges are posed by Dry Creek's narrow, incised reaches, which lack available lateral areas within close elevation range of the active channel. Additional constraints on enhancement vary over the length of lower Dry Creek and include local factors such as sediment supply, elevation relative to active channel, local grade control features and the backwater influence of the Russian River.

The maps in Appendix B show locations of interest for creation of off-channel and side channel habitat. Also shown are the pools and riffles identified in the habitat unit inventory. Candidate sites for enhancement of streambanks are not specifically shown but are numerous throughout the reach. Streambank enhancements would potentially be implemented in conjunction with off-channel, side-channel and/or pool enhancements, depending on the characteristics of each site. It is anticipated that enhancement 'reaches' will be developed which would include a combination of off-channel / side-channel, mainstem pool and riffle, and bank stabilization enhancements as a package.

Phase 2 of the study will assess the feasibility of habitat enhancement in the areas of interest shown in Appendix B. Based on the results of the feasibility assessment, a list of project opportunities for which feasibility has been established will be developed. Conceptual designs will be developed for the sites deemed feasible. In conjunction with development of conceptual designs, the opportunities will subsequently be ranked based on factors (with appropriate weighting) that may include the following and other considerations:

- anticipated benefit to available habitat,
- distance downstream of the dam,
- distance downstream of a major tributary junction,
- landowner input and recommendations,
- resource agency input and recommendations,
- parcel density, and
- relative cost.

8 BIBLIOGRAPHY

Army Corps of Engineers, 1981. Design Memorandum No. 18: Dry Creek Channel Improvements, Warm Springs Dam and Lake Sonoma Project, Sonoma County, CA. ACOE, San Francisco District, CA. 62 p.

Army Corps of Engineers, 1984. Warm Springs Dam and Lake Sonoma, Dry Creek, California, Water Control Manual Appendix II to Master Water Control Manual Russian River Basin, California. ACOE, Sacramento District, CA. 141.

Army Corps of Engineers, 1987a. Dry Creek Sediment Engineering Investigation, Sediment Transport Studies. ACOE, Sacramento District, CA. 156 p.

Army Corps of Engineers, 1987b. Feasibility Report: Groundwater Conditions of Dry Creek Valley at Don Clausen Fish Hatchery, Warm Springs Project, Sonoma County, CA. ACOE, prepared for Sacramento District by the Walla Walla District. 29 p.

Army Corps of Engineers, 1988. Supplement No. 2 to Design Memorandum No. 18: Warm Springs Dam and Lake Sonoma Project, Sonoma County, CA; Dry Creek Channel Improvements. ACOE, Sacramento District, CA. 83 p.

Army Corps of Engineers, 2001. Draft: Dry Creek Survey, Sonoma County, California. ACOE, San Francisco District, CA. 15 p.

Bisson, P.A.; J.L. Nielsen et al. 1982. A system of naming habitat types in small streams with examples of habitat utilization by salmonids during low streamflow. Pp. 62-73. IN: Armantrout, N.B. (ed.). Symposium on Acquisition and Utilization of Aquatic Habitat Inventory Information. Western Division, Am. Fish. Soc., Portland, OR. (October 28-30, 1982).

Blake, M.C., Graymer, R.W., and Stamski, R.E., 2002, *Geologic Map and Map Database of Western Sonoma, Northwestern Marin, and Southernmost Mendocino Counties, California*: U.S. Geological Survey Miscellaneous Field Studies Map MF-2402, Version 1, 1 sheet, scale 1:100,000.

Bunte, K. and Abt, S.R. 2001. Sampling Surface and Subsurface Particle-Size Distributions in Wadable Gravel- and Cobble-Bed Streams for Analyses in Sediment Transport, Hydraulics and Streambed Monitoring. U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-74. 428 p.

Bryant, W.A., 1982, *Chianti, Healdsburg, Alexander, Maacama and related faults, Sonoma County*: California Division of Mines and Geology Fault Evaluation Report 135, 18 p., scale 1:24,000, parts of 5 quadrangles, scale 1:24,000.

California Department of Fish and Game (CDFG). 1953. Rough Fish Control Project - Sonoma County Electric Shocking Survey, August 18-28, 1953. Intraoffice correspondence from Willis Evans 12/28/53.

California Department of Fish and Game (CDFG). 2002. Russian River Basin Fisheries Restoration Plan - July 2002 Draft . Principal authors are Robert Coey (CDFG), Sarah Nossaman-Pearce (UCCE),and Colin Brooks and Zeb Young (HREC-IHRMP). Healdsburg, CA.

California Department of Fish and Game (CDFG). 2004. Recovery Strategy for California Coho Salmon. Report to the California Fish and Game Commission. Sacramento, CA.

California Department of Water Resources, 2003, *California's Groundwater, Bulletin 118 – Update 2003*. Bulletin 118.

CDMG, 1997, *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps*: Special Publication 42.

Coey, R., Nossaman-Pearce, S., Brooks, C., and Young, Z. 2002. Draft: Russian River Basin Fisheries Restoration Plan. California Department of Fish and Game. 331 p.

Cleveland, G.B. and Kelley, F.R. 1977. Erosion Along Dry Creek, Sonoma County, CA. California Division of Mines, Spec. Rep., Sacramento, CA.

Entrix, Inc. 2004. Russian River Biological Assessment. Prepared for ACOE and SCWA. September 29, 2004. Walnut Creek, CA.

Federal Emergency Management Agency (FEMA). 2006. Flood Insurance Study (FIS) for Sonoma County, California, Unincorporated Areas. Volume 1 of 3. FIS Number 060375V001A. Revised: September 6, 2006.

Flosi, Gary, Scott Downie, James Hopelain, Michael Bird, Robert Coey, And Barry Collins. 1998. California Department of Fish and Game (CDFG). Sacramento, CA.

Gordon, E. and Meentemeyer, R.K. 2006. Effects of Dam Operation and Land Use on Stream Channel Morphology and Riparian Vegetation. *Geomorphology*, 82 (3-4), 412-429.

Grant, G. E., J. C. Schmidt, and S. L. Lewis. 2003. A Geological Framework for Interpreting Downstream Effects of Dams on Rivers. Pages 209-225 *in* A Unique River. American Geophysical Union.

Harrelson, C.C., Rawlins, C.L., and Potyondy, J.P. 1994. Stream Channel Reference Sites: an Illustrated Guide to Field Technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Harvey, M.D. and Schumm, S.A. 1985. Geomorphic Analysis of Dry Creek, Sonoma County, California from Warm Springs Dam to Russian River Confluence. For ACOE, Sacramento District, CA. 134 p.

Harvey, M.D. and Schumm, S.A. 1987. Response of Dry Creek, California, to Land Use Change, Gravel Mining and Dam Closure. *Erosion and Sedimentation in the Pacific Rim* (Proceedings of the Corvallis Symposium, August, 1987). IAHS Publication No. 165, 451-460.

Hopkirk, J. and P. Northen. 1980. Technical Report on Fisheries of the Russian River. Prepared for Sonoma County Planning Department. Sonoma, CA.

Huffman, M.E., and Armstrong, C.F., 1980, *Geology for planning in Sonoma County:* California Division of Mines and Geology Special Report 120, 31 p., 5 pls., scale 1:62,500.

Kiffney, P. M., C. M. Greene, J. E. Hall, and J. R. Davies. 2006. "Tributary streams create spatial discontinuities in habitat, biological productivity, and diversity in mainstem rivers." Can. J. Fish. Aquat. Sci. 63(11): 2518–2530

McBride, J.R. and Strahan, J. 1984a. Establishment and Survival of Woody Riparian Species on Gravel Bars of an Intermittent Stream. *American Midland Naturalist*, 112 (2), 235-245.

McLaughlin, R.J., and Sarna-Wojcicki, A., 2003, *Geology of the Right Stepover Region between the Rodgers Creek, Healdsburg, and Maacama Faults, Northern San Francisco Bay Region – A Contribution to Northern California Geological Society Field Trip Guide, June 6-8, 2003:* U.S. Geological Survey Open-File Report 03-502.

McBride, J.R. and Strahan, J. 1984b. Fluvial Processes and Woodland Succession Along Dry Creek, Sonoma County, California. Warner, R.E. and Hendrix, K.M., editors *California Riparian Systems: Ecology, Conservation, and Productive Management*. University of California Press, Berkeley, CA, http://ark.cdlib.org/ark:/13030/ft1c6003wp/.

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.

Montgomery, D.R., and Buffington, J.M., 1997, Channel-reach morphology in mountain drainage basins: Geological Society of America Bulletin v. 109, no 5, p. 596-611.

NMFS 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps Of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. Southwest Region. September 24.

Nature Conservancy. 2009. Indicators of Hydrologic Alteration (IHA): Software for Understanding Hydrologic Changes in Ecologically-Relevant Terms. *in*. http://www.freshwaters.org/tools/.

Olden, J. D., and N. L. Poff. 2003. Redundancy and the choice of hydrologic indices for characterizing streamflow regimes. River Research and Applications **19**:101-121.

Opperman, J.J. 2005. Large woody debris and land management in California's hardwood-dominated watersheds. Environmental Management 35(1): 1-12.

Opperman, J.J; Merenlender, A.M.; Lewis, D.J. 2006. Maintaining wood in streams: A vital action for fish conservation. University of California Division of Agriculture and Natural Resources 8000 Series, Publication 8157; 11 p. http://anrcatalog.ucdavis.edu/pdf/8157.pdf

Opperman, Jeffrey J. Mark Meleason, Robert A. Francis, and Rob Davies-Colley. 2008. Livewood: Geomorphic and Ecological Functions of Living Trees in River Channels. BioScience. 58 (11) 1069-1078.

Pleus, A.E. and D. Schuett-Hames 1998. TFW Monitoring Program methods manual for stream segment identification. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-98-001. DNR #103. May.

Poff, N. and Ward, J. 1989. Implications of streamflow variability and predictability of lotic community structure: a regional analysis of streamflow patterns. Canadian Journal of Fisheries and Aquatic Sciences, v. 46, number 10, p. 1805-1818.

Richter, B. D., J. F. Baumgartner, J. Powell, and D. P. Braun. 1996. A Method for Assessing Hydrologic Alterations within Ecosystems. Conservation Biology **10**:1163-1174.

Richter, B.D., J.V. Baumgartner, R. Wigington, and D.P. Braun. 1997. How Much Water Does a River Need?. Freshwater Biology. **37**: 231-249.

Richter, B.D., J.V. Baumgartner, D.P. Braun, and J. Powell. 1998. A Spatial Assessment of Hydrologic Alteration Within a River Network. Regulated Rivers **14**: 329-340.

Ritter, J.R and Brown, W.H. 1971. Turbidity and Suspended-Sediment Transport in the Russian River Basin, California. U.S.G.S Open File Report. October 1.

Rosgen, D.L. 1996. Applied river morphology: Wildland Hydrology. Pagosa Springs, CO.

Rued, R. 2009. Personal communication with Richard Rued, Dry Creek Landowner, Rued Vineyards. March 20, 2009.

Rosgen, D.L. 1996. Applied river morphology: Wildland Hydrology. Pagosa Springs, CO.

Schumm, S.A. 1984. Geomorphic Reconnaissance of Dry Creek, Sonoma County, California. Water Engineering and Technology, Inc. Fort Collins, CO, 18 p.

Schumm, S. A., Harvey, M. D., and Watson, C. C. 1984. Incised Channels: Morphology, Dynamics and Control. Water Resources Publications, Littleton, CO.

Schmidt, J. and Wilcock, P. 2008. Metrics for assessing the downstream effects of dams. Water Resources Research, V. 44, W04404.

Simons, D. and R. Li. 1980. Erosion and Sedimentation Analysis of Dry Creek, Sonoma County, California. Simons, Li & Associates, Inc. February, 1980. Fort Collins, CO.

Swanson, M. 2009. Personal Communication with Mitchell Swanson, President, Swanson Hydrology and Geomorphology. March 17, 2009.

Thomas, T., Copeland, R., and MacArthur, B. 1984. Field Inspection of the Sediment Problems on Dry Creek Below Warm Springs Dam. Special Projects Report No. 84-12, ACOE, Sacramento District, 26 p.

Thompson, Lisa C, Jenna L. Voss, Royce E. Larsen, William D. Tietje, Ryan A. Cooper, and Peter B. Moyle. (2008). Role of Hardwood in Forming Habitat for Southern California Steelhead. General Technical Report PSW-GTR-217. http://www.fs.fed.us/psw/publications/documents/psw_gtr217/psw_gtr217_307.pdf

USDA-NRCS 2008. Technical Note No. 2, Stream Water Surface Profile Modification for Wetland Restoration. May.

U.S. Forest Service (USFS). 2006. Stream Inventory Handbook. Level I and II. Version 2.6. Pacific Northwest Region, Region 6. 117 p.

U.S. Geological Survey and California Geological Survey, 2006, *Quaternary fault and fold database for the United States*, accessed February 6, 2008, from USGS web site: http://earthquakes.usgs.gov/regional/qfaults/.

Warner, R.E., and K.M. Hendrix. 1984. California Riparian Systems. Ecology, Conservation, and Productive Management. Berkeley and Los Angeles, CA: University of California Press.

Western Regional Climate Center 2009. General Climate Summary Tables for Period of Record, Healdsburg, Warm Springs Dam, and Skaggs Springs stations. Online database: http://www.wrcc.dri.edu/summary/Climsmnca.html

Winzler and Kelly Consulting Engineers. 1978. Evaluation of fish habitat and barriers to fish migration: Russian River mainstem and Lower Dry Creek. Prepared for U.S. Army Engineer District, San Francisco. Eureka, CA.

Wolman, M.G. 1954. A Method of Sampling Coarse River-Bed Material. *Trans. Am. Geophys. Union*, 35, 951-956.

Wolman, M., and J. Miller. 1960. Magnitude and frequency of forces in geomorphic processes. Journal of Hydrology 69:54-74.

Working Group on California Earthquake Probabilities, 2003, Earthquake Probabilities in the San Francisco Bay Region: 2002 to 2031: U.S. Geological Survey Open-File Report 03-214.

8 APPENDIX A – DETAILED REACH SUMMARIES

REACH 1 (RM 0 to RM 0.7) **Russian River Confluence to Mill Creek Tributary Junction**

Reach 1 is defined by two major confluences: Dry Creek's confluence with the Russian River at Dry Creek river mile 0, and second the confluence of Dry Creek's second largest tributary, Mill Creek, on the right[1] bank at river mile 0.7 (Figure 1). Another confluence occurs at river mile 0.4, where an unnamed tributary enters on the left bank and has deposited small gravels at its mouth. Confluences are often ecological hotspots of diversity and productivity, due to the mixing of cold and warm waters, local heterogeneity in substrate, nutrient inputs, and hydraulics (Kiffney et al. 2006). In the Russian River watershed, Hopkirk and Northen (1980) emphasize the importance of tributary confluences: "Even if the tributary dries up during the summer, it forms an embayment on the mainstem, where water velocity is reduced and young fish and small prey species can seek shelter from mainstem predators. The roach, a small minnow native to the system, was recorded by Pintler and Johnson (1957) as being common on the mainstem [Russian River] only around the mouths of tributaries. Even the tuleperch, a native live-bearing species, enters the mouths of tributaries to deliver its young" (Hopkirk and Northen, 1980). Drastic differences in water temperature between the Russian River

Figure 1: (upper left) looking down the Russian River at the Dry Creek confluence, (upper right) looking up the mouth of Dry Creek, (lower left) the mouth of Mill Creek, and (lower right) the mouth of the unnamed tributary.

[1] In the individual reach summaries, right and left bank designation defined as looking downstream.

and Dry Creek provide cold water refugia for mainstem species.

Extending from the confluence with the Russian River upstream to the Mill Creek confluence, Reach 1 is a single-thread channel with a few vegetated gravel bars. The channel alternates primarily between pools and flatwaters. There are six main channel and two side channel riffles in this reach that range in length from 40 to 80 ft. Although historical incision has occurred (the terraces are 10 to 15 ft above the channel bed), the channel is currently vertically stable. The Russian River provides grade control for this reach, but the backwater created by the Russian River may cause some aggradation with the high sediment load from upstream and from Mill Creek.

Channel change suggested by results from historical aerial photograph analysis was corroborated during the geomorphic investigation. The channel in Reach 1 has been active since the dam was built. The channel has generally become narrower over time, but the channel has migrated frequently through the wide riparian area. The channel is currently less sinuous than in 1983 and 1998 but has a similar sinuosity to the channel in 1993. Some of the abandoned channels are still visible in the floodplain and riparian area and may provide opportunities for habitat enhancement.

Other remarkable features in Reach 1 include the active summertime USGS stream flow gage at river mile 0.16 and the abandoned seasonal Basalt Road crossing at river mile 0.05, where streambanks remain unvegetated. Another exposed area was recorded where Mill Creek enters Dry Creek. Last, a hand-built cobble dam at river mile 0.03 had been breached and did not block fish passage (Figure 2).

Figure 2: (left) A hand-built cobble dam across Dry Creek, (right) Unvegetated streambanks at the Mill Creek confluence.

Habitat Classification

The total length of Reach 1 is 0.7 miles and is comprised of 32% pools, 37% flatwater, and 32% riffles by relative frequency (Figure 3). Riffles comprise only 15% of Reach 1 by length. At the time of the survey, the average wetted width was 45.6 ft. The average active channel width was 62.5 ft and the flood prone width was 137.5 ft.

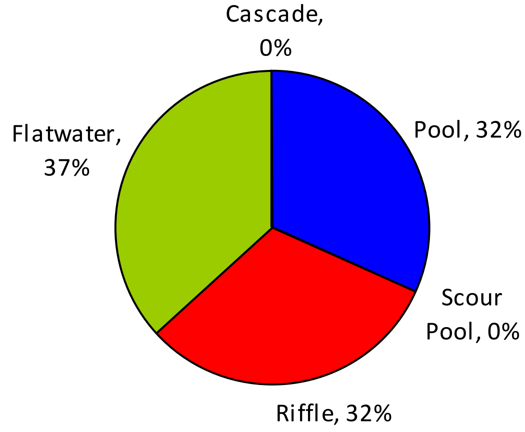


Figure 3: Proportion of Habitat Units by Relative Frequency in Reach 1

Based on a pool-riffle spacing, low confinement, and a gradient of 0.2%, Reach 1 appears to be an alluvial pool-riffle, response reach (Montgomery and Buffington, 1997). Reach 1 resembles a "C4" channel type, with a high active channel width-to-depth ratio of 30 and a moderate entrenchment ratio of 2.2 (Rosgen, 1996). Point bars and gravel islands are common in this reach, and most banks are vegetated with a maturing hardwood riparian forest.

Figure 4: (left) A typical pool in Reach 1 with overhanging vegetation, (right) the 150', glide-dominated side-channel.

Pools

Six pools were measured in Reach 1. The average maximum pool depth was 4.0 feet (Figure 5). Several of these pools resembled flatwaters for short reaches, and several of the flatwaters contained short pools. All of the pools had maximum depth greater than 3 feet. Residual pool depths averaged 2.7 feet, and pool crest depths averaged 1.3 feet. Substrate in pools was most often gravel with sand.

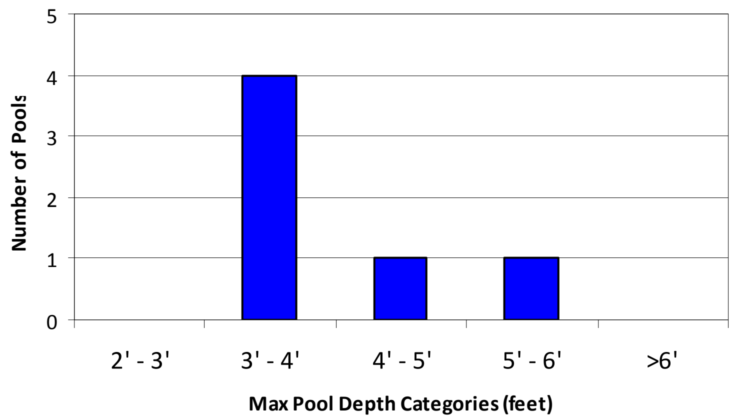


Figure 5: Maximum Pool Depths in Reach 1

Riffles & Flatwaters

There were 6 riffles and 7 flatwaters in Reach 1. The average riffle depth was 1.1 (st.dev. 0.2) and average flatwater depth was 1.4 (st.dev. 0.2). The riffles are composed of coarse gravel and small cobbles and the flatwaters are primarily gravel and sand. The D50 of the bed material in the riffle immediately downstream of Mill Creek is 26 mm, coarse gravel (Figure 6). The majority of the clast sizes were coarse gravel, with only 3% of the samples less than 2 mm (sand/fine sediment). In flatwaters, substrate was most often observed as gravel with small cobble. A greater portion of sand on the streambed was observed in this reach compared with others.

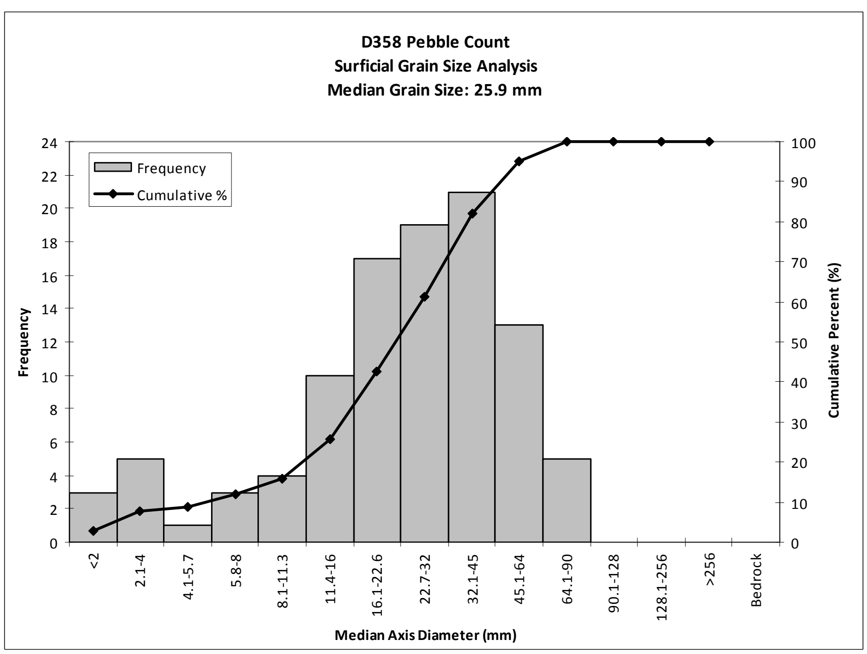


Figure 6: Grain size distribution for riffle downstream from Mill Creek (habitat unit #358).

Side Channels

We measured two side channels in Reach 1. The first side channel, a 150’ flatwater, occurred just upstream of the USGS stream flow gage, where the river splits around a vegetated island. The other side channel, predominantly a riffle, connected a pool with a downstream riffle and was only 60 feet long. There was very little instream cover in either of these side-channels. Gravel with sand was the dominant substrate.

Alcoves

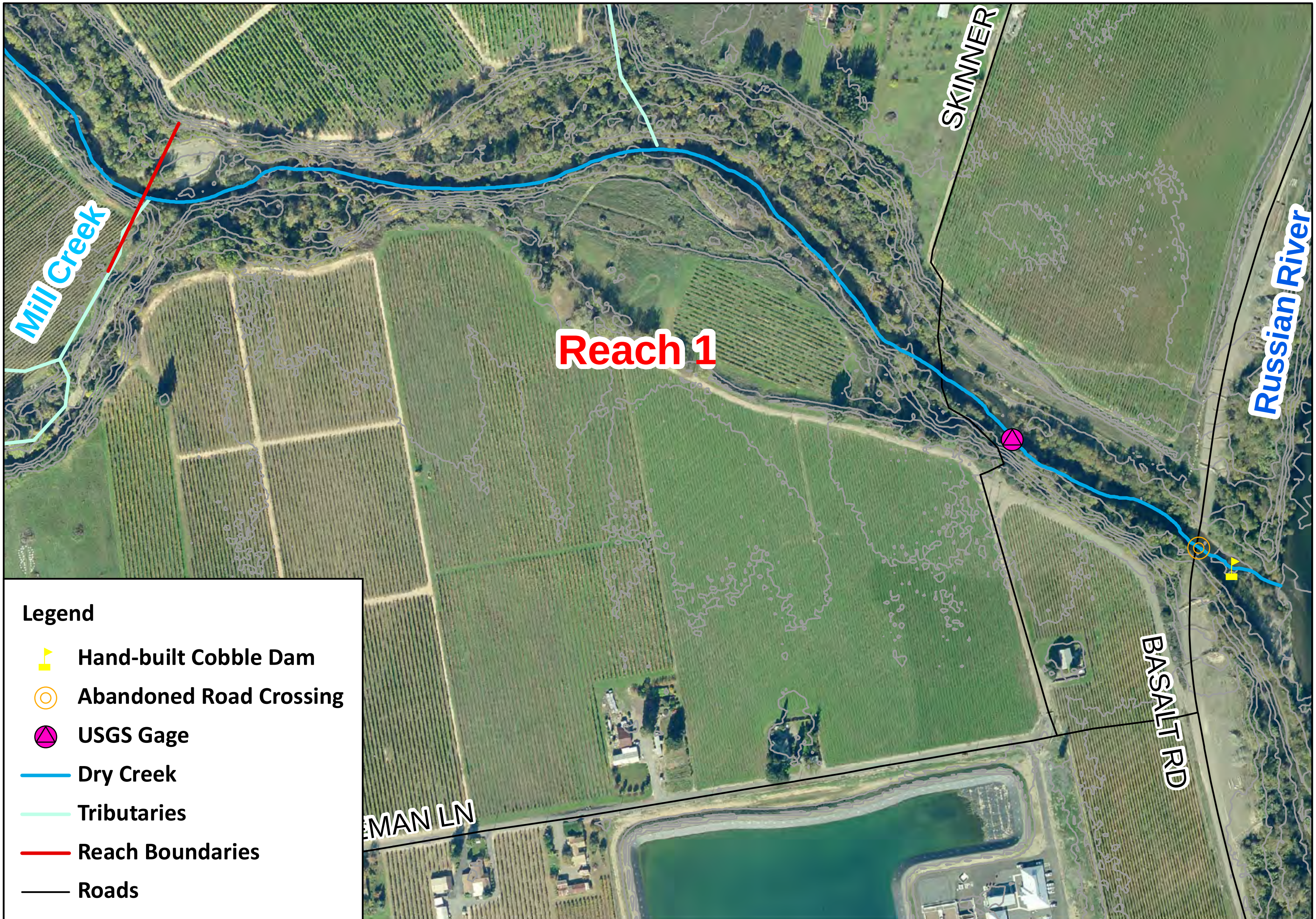
In the four alcoves measured in Reach 1, substrate was fine sediment with gravel. Two alcoves near the mouth of Dry Creek were associated with flatwaters, while the two others are located just downstream of Mill Creek’s confluence, and were associated with pools. These four alcoves are all small and shallow, averaging 425 square feet in area (stdev. 99.8), with an average maximum depth of 1.0 feet (stdev. 0.6). Instream cover in the alcoves is provided by terrestrial vegetation, but also by aquatic plants and algae.

Instream Cover & Woody Debris

Compared with other reaches, Reach 1 contains much less wood (only 86 pieces per mile) and less instream cover and edge habitat. Of the 23 pieces of wood greater than 1’ diameter observed in Reach 1, 13 were found in pools. Pools and alcoves have the highest number of pieces of wood per length. Flatwaters contained slightly more wood than riffles, greater instream cover, as well as a greater frequency of edge habitat. Most cover was provided by willows and other vegetation interacting with the water, and also by small woody debris. In alcoves, aquatic vegetation and algae provided additional cover. CDFG sets desirable criteria for instream cover and shelter rating at >40% and >70, respectively (Coey, 2002), and no habitat type except alcoves met these criteria. Relatively few of the mainstem habitat units contained edge habitat, although side channels and alcoves did provide similar habitat.

Table 1: Instream woody debris, cover, and edge habitat frequency for Reach 1.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	98.8	34.2	15.2	148.1	26%	64	33%
Riffles	10.1	20.2		30.2	8%	13	0%
Flatwaters	40.6	12.2	16.2	53.0	17%	36	43%
Side Channels	25.1			25.1	20%	30	100%
Alcoves	72.0		24.0	96.0	61%	184	75%
	mainstem wood pieces/mile			96.9			

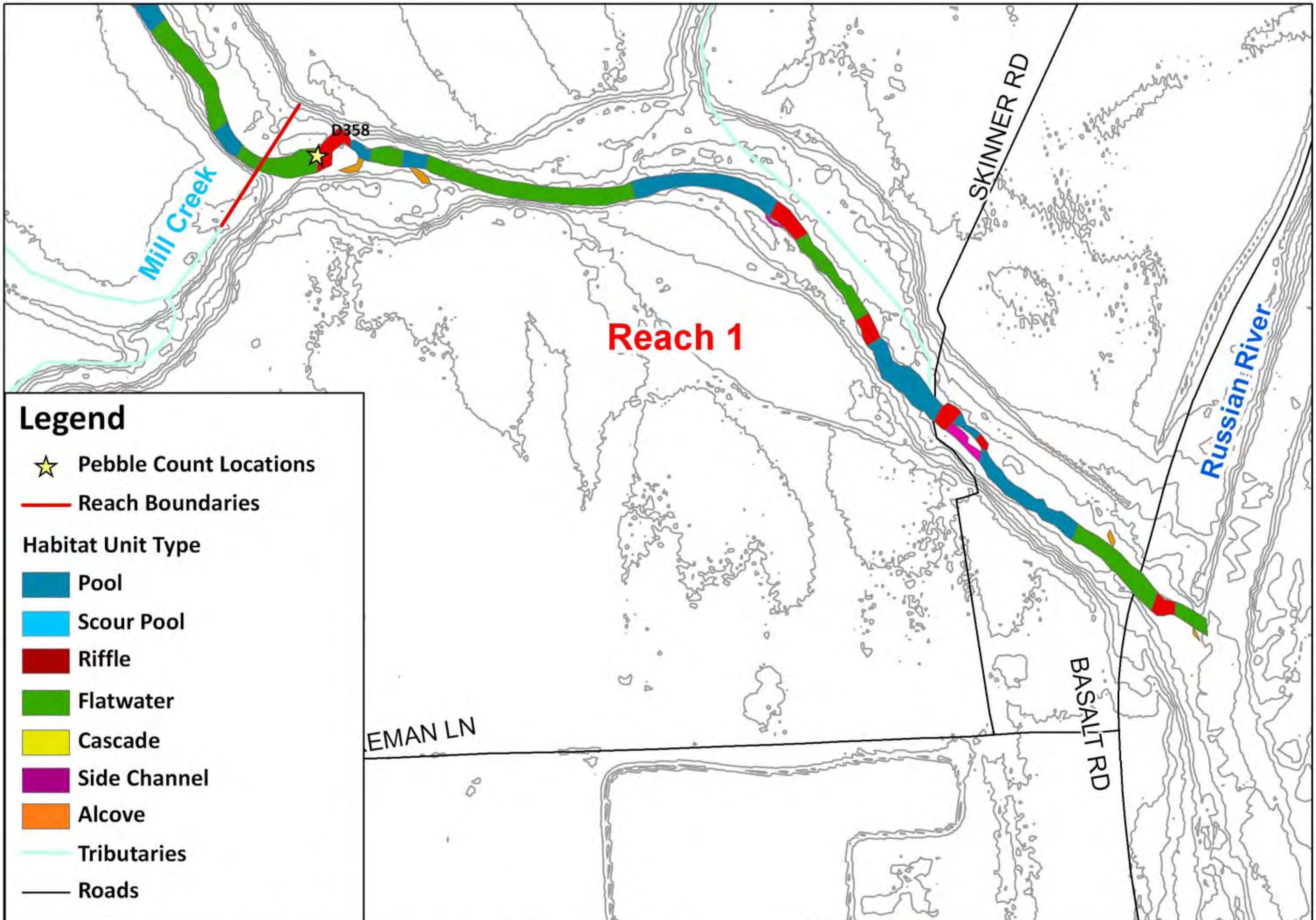


N W E S

0 300 600 Feet

DRY CREEK
Reach 1 Feature Map

inter·fluve
1020 Wasco St., Suite 1
Hood River, OR 97031
541-386-9003
www.interfluve.com



0 400 800 Feet

DRY CREEK
Reach 1 Habitat Units

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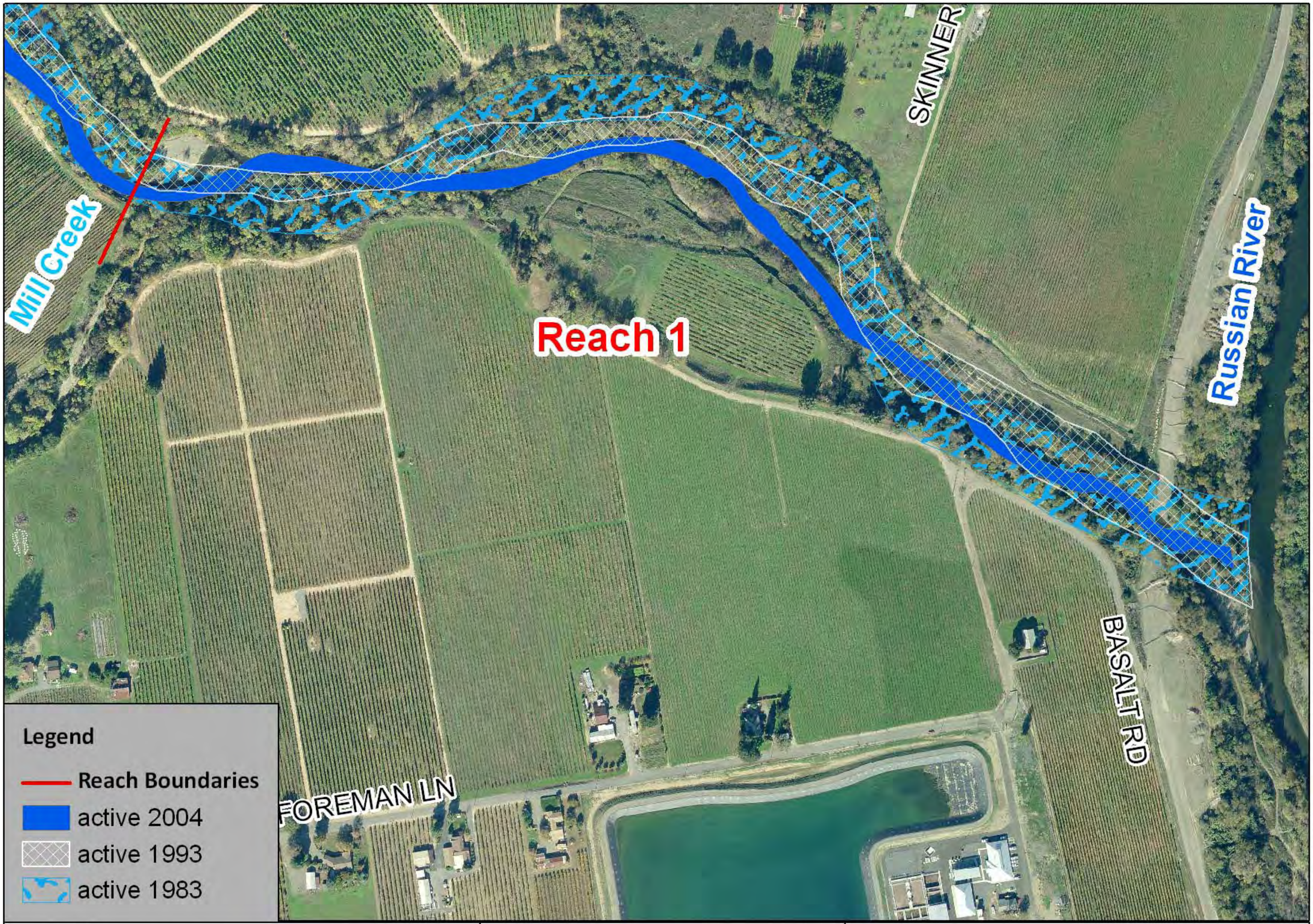

N
W E
S

0 350 700 Feet

DRY CREEK
Reach 1 - Channel Position Map

inter-fluve

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REACH 2 (RM 0.7 to RM 2.0) **Moderately Confined and Well Armored from Mill Creek to the Westside Road Bridge**

Reach 2 of Dry Creek extends from the Mill Creek confluence upstream to about 100 ft downstream from the Westside Road Bridge. Reach 2 was a relatively straight reach with many riprap-armored streambanks. There were several long, narrow side channels and six alcoves, one of which was associated with the inlet of a dry, unnamed tributary at river mile 1.9.

Over the last century the channel has become narrower, but there has been little channel migration. The only location with substantial channel change is from river mile 1.5 to the reach boundary at river mile 2.0. Here, the 1983 channel is now the floodplain and may provide opportunities for constructing backwater channels for habitat. Although the narrowing likely coincided with channel incision (the terrace is approximately 10 to 15 ft above the channel bed), the channel is currently relatively vertically stable. The sediment load through this reach, like Reach 1, is high and there may be some minor aggradation occurring.

Figure 7: (left) Boulder riprap along streambanks, (right) a pool with riprap along the right bank.

Habitat Classification

Reach 2 was 1.3 miles long, primarily comprised of flatwater habitat units (62%), with pools and scour pools representing 24%, and 14% riffles by relative frequency (Figure 8). Riffles comprise only 5% of the total length. There are five riffles with lengths ranging from 60 to 90 ft. The channel geometry is similar to Reach 1. The wetted width is 45.6 ft, and the active channel width is 68 ft with an active channel depth of 1.7 feet. The floodprone widths were 90 and 190 feet.

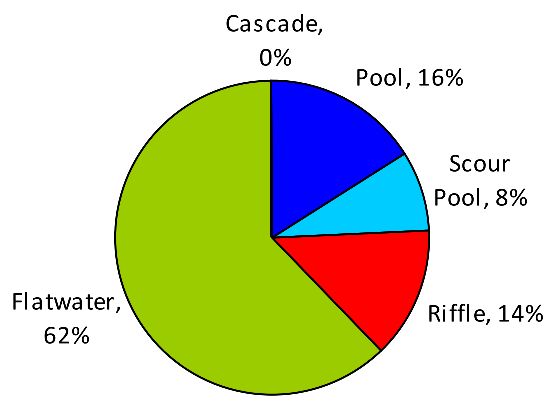


Figure 8: Proportion of Habitat Types by Relative Frequency in Reach 2

The average reach gradient was 0.2%. Reach 2 resembles a plane-bed channel morphology, with long stretches of relatively featureless bed and few gravel bars and no islands (Montgomery and Buffington, 1997). Two different entrenchment ratios were measured in riffles in Reach 2; at the upstream end of the reach entrenchment was 2.6, and in the middle of the reach, the entrenchment ratio was 1.4. A high active channel width:depth ratio was measured at both sites (35 and 46, respectively). Due to the constrained nature of the channel by bank stabilization measures along most of Reach 2, it more resembles an "F4" channel type (Rosgen 1996).

Figure 9: Glide habitat units in Reach 2, with riprap along the banks.

Pools

All of the 6 pools and 3 scour pools in Reach 2 were more than three feet deep, thus qualifying as CGFG primary pools (Coey 2002). The average maximum pool depth was 4.3 feet (st.dev. 0.8). The average residual pool depth was 2.8 feet, with an average pool crest depth of 1.5 feet. Substrate in pools was gravel with sand.

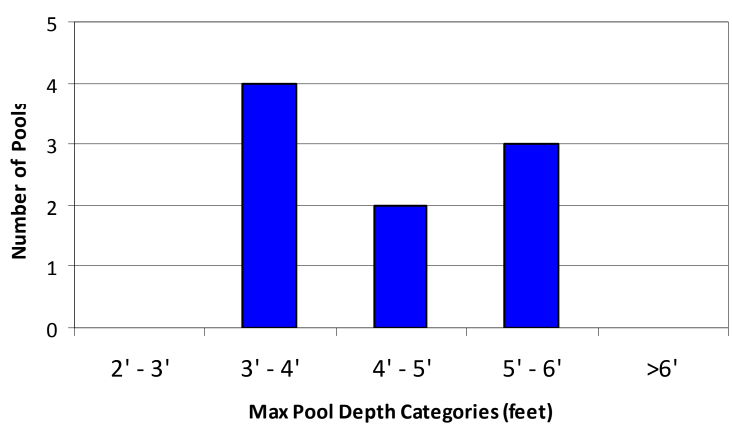


Figure 10: Maximum Pool Depths in Reach 2.

Riffles & Flatwaters

Average riffle depth in Reach 2 was 0.9 feet (st.dev. 0.3). Average flatwater depth was 1.5 feet (st.dev. 0.3). The flatwaters are composed primarily of gravel and sand and the riffles are composed of coarse gravel and small cobbles. The riffle below the tributary at the upstream end of the reach is dominated by medium to very coarse gravel with a median grain size of 23 mm. Substrate in both riffles and flatwaters was categorized as gravel with small cobbles and sand.

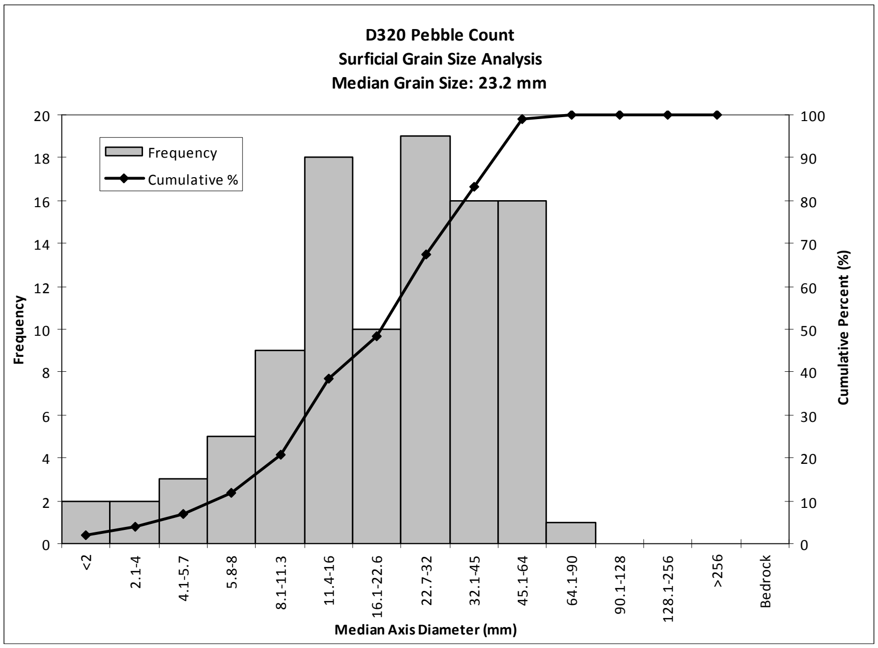


Figure 11: Grain size distribution for riffle downstream of the unnamed tributary, downstream from Westside Road (habitat unit #320).

Side-Channels

Of the three side channels in Reach 2, two were pool dominated, and the third consisted mainly of flatwater habitat. Each side channel was narrow (average 7 feet) and long (113 feet long on average). Substrate was gravel with sand and small cobble.

Alcoves

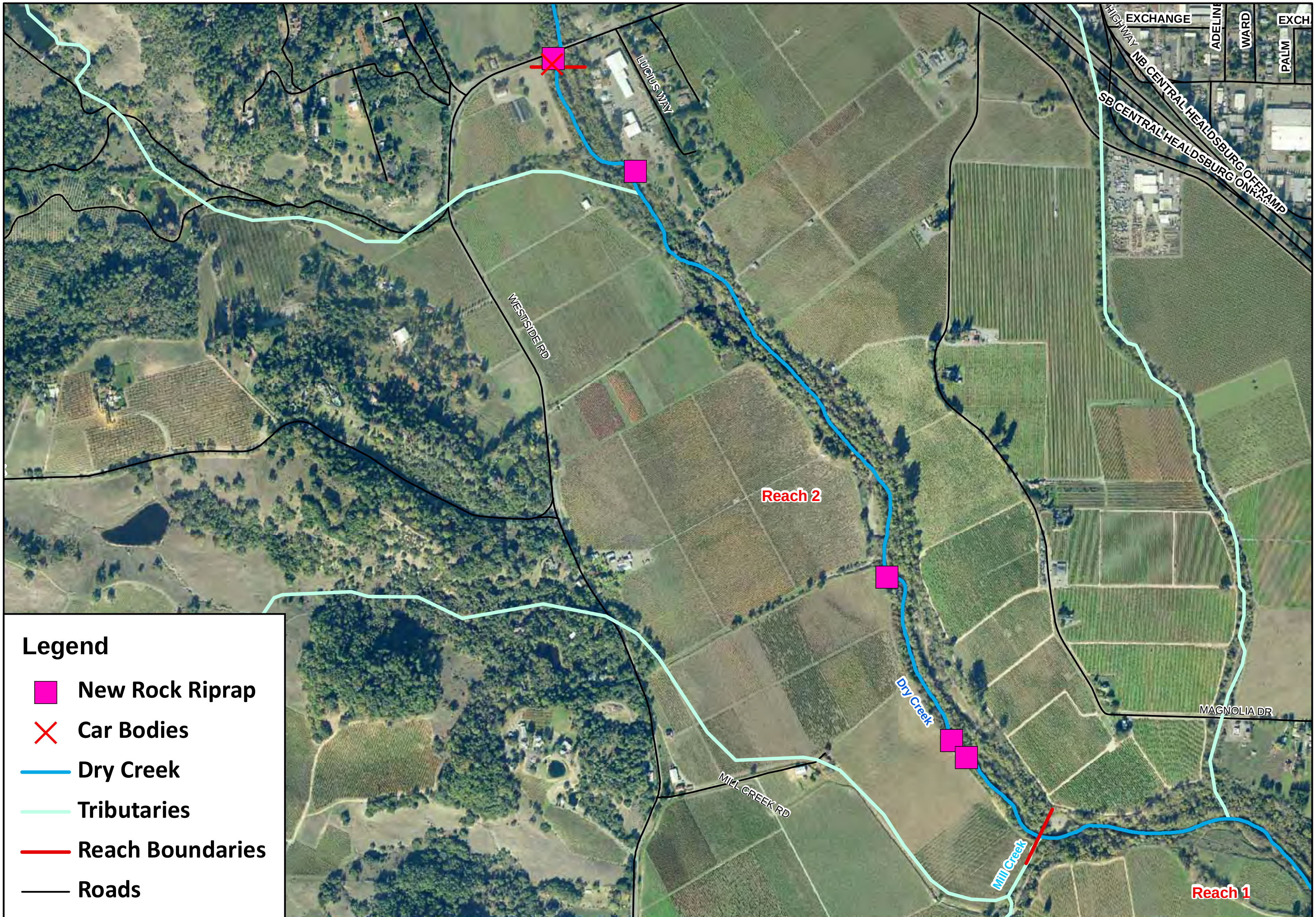
All six alcoves in Reach 2 were narrow (average width 11 feet), and most ranged from 40 to 90 feet long, with one exception. Near the unnamed tributary junction at river mile 1.9, one alcove was 250 long and followed the incised floodplain wall upstream. Substrate in the alcoves was mostly fine sediment, with sand and gravels.

Instream Cover & Woody Debris

Most instream cover in Reach 2 was provided by terrestrial vegetation interacting with the water or within 6" of the water surface, and secondarily by small woody debris. In the alcoves, abundant aquatic vegetation provided additional cover. More abundant and larger woody debris was found in scour pools (Table 2). The highest cover and shelter ratings were found in narrow side-channels, with thick overhanging vegetation and abundant small woody debris. All alcoves provided edge habitat, with an edge frequency of about 40% in other habitat types.

Table 2: Instream woody debris, cover, and edge habitat frequency for Reach 2.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	90.1	55.8	12.9	158.7	29%	87	50%
Scour Pools	93.5	46.7		140.2	27%	62	33%
Riffles	125.1	55.6	27.8	208.4	17%	48	40%
Flatwaters	96.2	45.0	7.2	148.4	27%	71	17%
Side Channels	248.5	46.6	15.5	310.6	77%	204	67%
Alcoves	138.2	49.3		187.5	61%	174	100%
	mainstem wood pieces/mile			141.9			



N W E S

0 750 1,500 Feet

DRY CREEK
Reach 2 Feature Map

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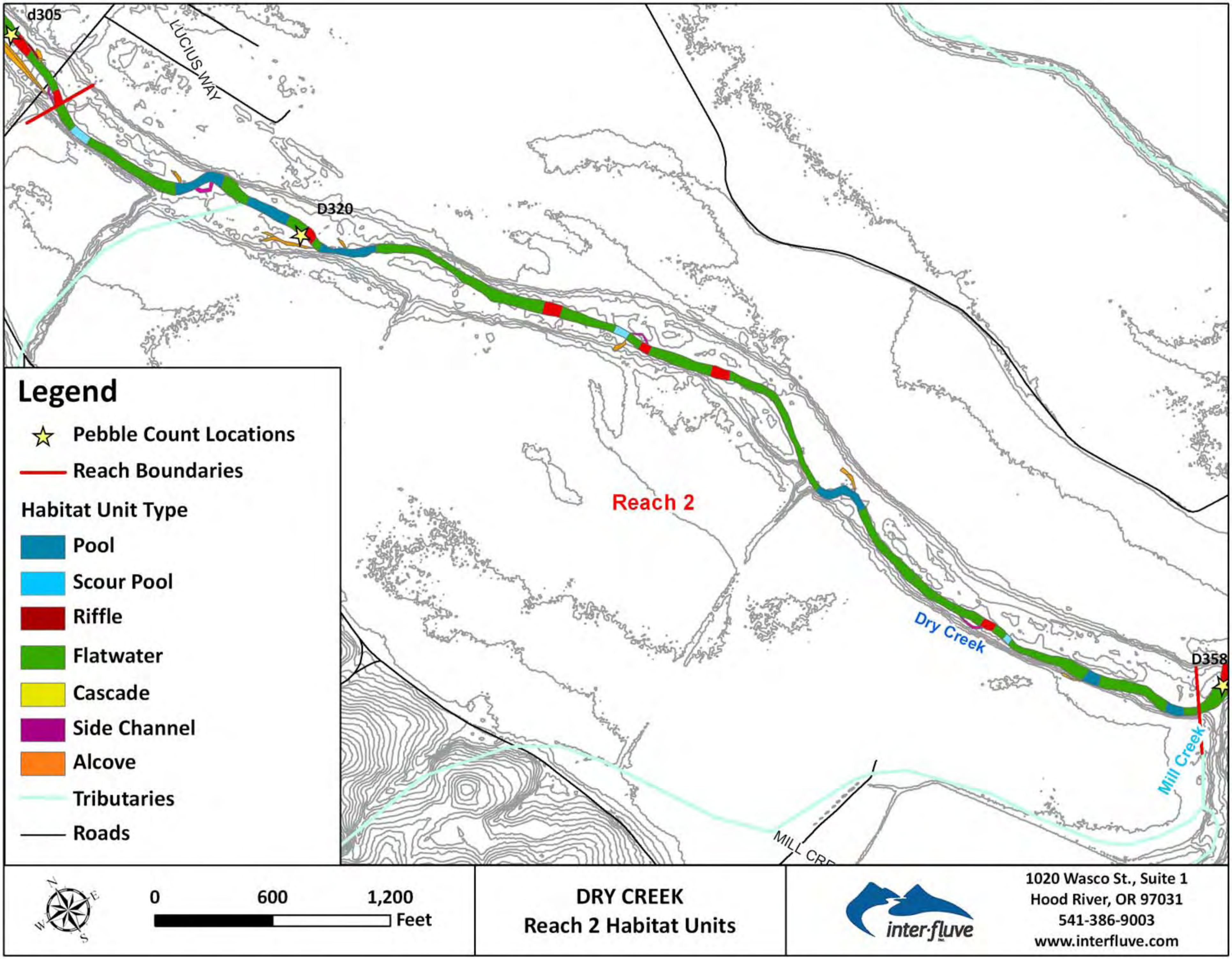

DRY CREEK
Reach 2 Habitat Units

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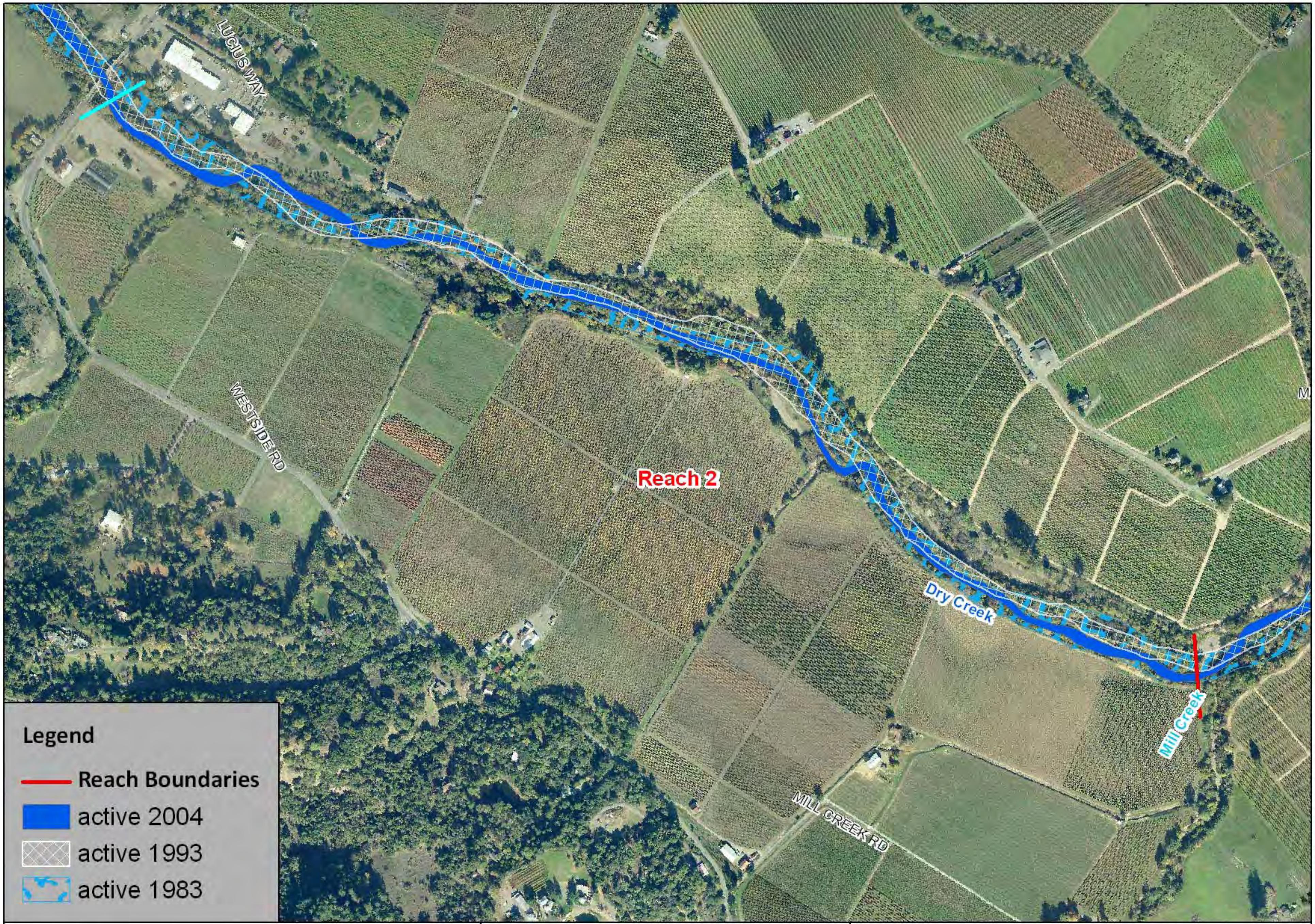

N E S W

0 600 1,200 Feet

DRY CREEK
Reach 2 - Channel Position Map

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REACH 3 (RM 2.0 to RM 3.0) **Active Incised Floodplain, from the Westside Bridge to a fault lineament downstream of the gradient sills**

Reach 3 was less confined than Reach 2, and contains eight side channels, six of which are over 100 feet long. Abundant alcoves and side-channels may provide substantial channel and habitat complexity, and may serve as templates for off-channel habitat design and construction in other areas. One intermittent tributary enters at river mile 3.0 on the right[2] bank (unmapped). Stream stabilization efforts using I-beams and chainlink fence have failed at river mile 2.95. The Dry Creek screw trap is located at river mile 2.0, under the Westside Road bridge at the downstream end of the reach. A mapped levee runs along the right bank for 1300 feet in at the upper end of Reach 3, but the stream has meandered away from it, and it was not noted during the survey.

The upstream reach boundary is at the approximate downstream influence of the three grade control structures in Reach 4 and is where the southeast/northwest trending lineament intersects Dry Creek. Upstream of this point the lineament is located approximately along Dry Creek to river mile 5.35. It is unlikely that the lineament impacts the current processes shaping the channel and riparian corridor, but the historic location of the channel may have been influenced by the location of the lineament.

Figure 12: (upper left) Westside Road bridge and screw trap, (upper right) mouth of intermittent stream, (lower left) failed I-beam and chainlink bank armor, and (lower right) side channel pool.

[2] In the individual reach summaries, right and left bank designation defined as looking downstream.

The channel in this reach is active and has been migrating frequently since the dam was constructed. The current channel is slightly less sinuous than during the 1980s and 1990s, but the older channels are now productive side channels flowing through dense riparian vegetation. This is the case particularly downstream of river mile 2.5 where a side channel that is up to 75% of the width of the main channel splits and meanders along the left terrace edge. This channel maintains pools of varying depths and flatwaters and has substantial quantities of large and small woody debris. An alcove along the right bank extends from the Westside Road Bridge upstream to about River Mile 2.05. This is a long, narrow channel, but there is no upstream inlet. At high flows, this alcove likely becomes reconnected to the main channel at the upstream end.

Degradation has likely not occurred in Reach 3 since the dam was built and there may be some aggradation. There are extensive gravel bar deposits and some alders were observed to be slightly buried or closer to the water surface. During flood flows, bedload may be transported and deposited in large volumes, leading to the higher degree of channel change and lateral instability in this reach.

Figure 13: (left) a typical pool in Reach 3, (right) one of the three riffles in Reach 3.

Habitat Classification

Reach 3 is comprised of 61% flatwater habitat, 17% is mainstem pool (0% scour pool), and 22% riffle by relative frequency. Only 6% of the 1.0 mile length of Reach 3 is riffle habitat by length. Nearly 70% of the wetted channels are composed of flatwaters and pools and almost 25% are side channels and alcoves. It was noted that flatwaters often contained very short pool units and visa versa. There are four riffles ranging in lengths from 70 to 110 ft. The average channel wetted width in the single-thread portions of the channel is about 48 ft. The active channel and flood prone widths are 82 and 110 ft respectively; these widths would

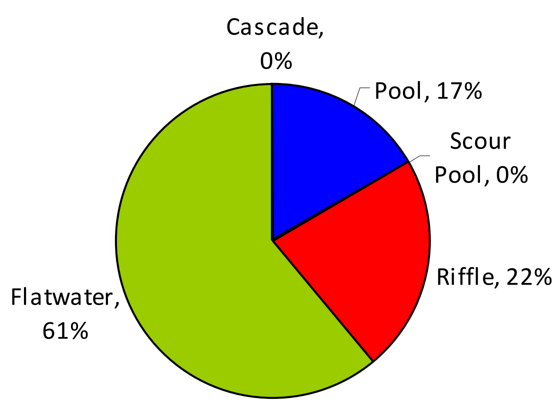


Figure 14: Proportion of Habitat Types by Relative Frequency in Reach 3

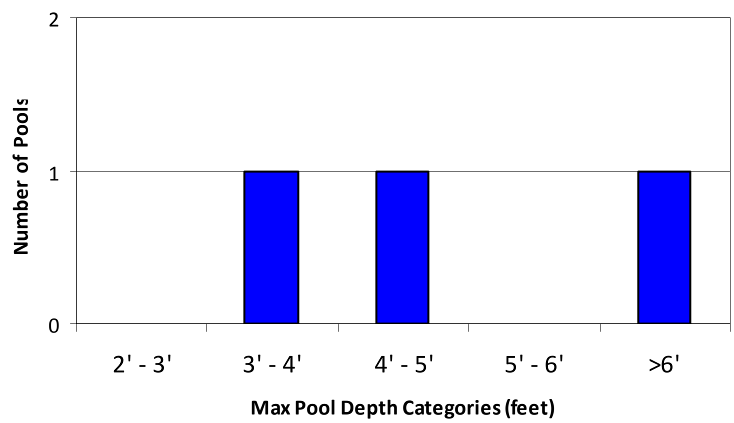
be greater in the multi-thread portions of the channel. The average active channel depth was 1.7 feet.

Reach 3 resembles plane-bed morphology based on long flatwater units and few riffles (Montgomery and Buffington, 1997). The entrenchment ratio was 1.35 and the average active channel width:depth ratio was 48. The incised nature of the floodplain caused this reach to resemble an "F4" type channel (Rosgen, 1996).

Pools

There were a total of three pools in Reach 3, with an average maximum depth of 4.6 feet (st.dev. 1.3). All three pools were greater than 3 feet deep (Figure 15). The average residual pool depth was 2.4 feet for main channel pools. The average pool crest depth was 1.3 feet. Observed substrates in pools were gravel with sand.

Figure 15: Maximum Pool Depths in Reach 3.

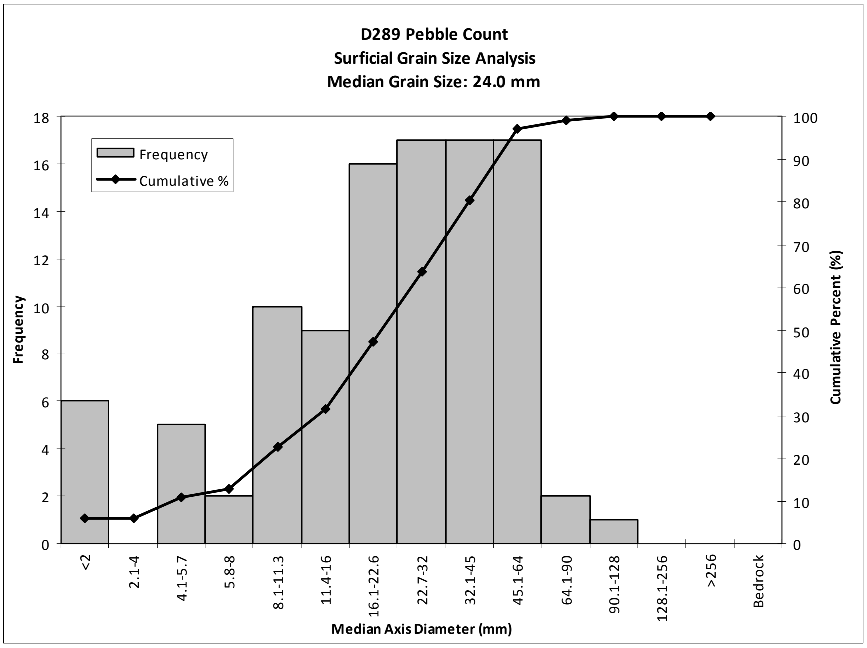


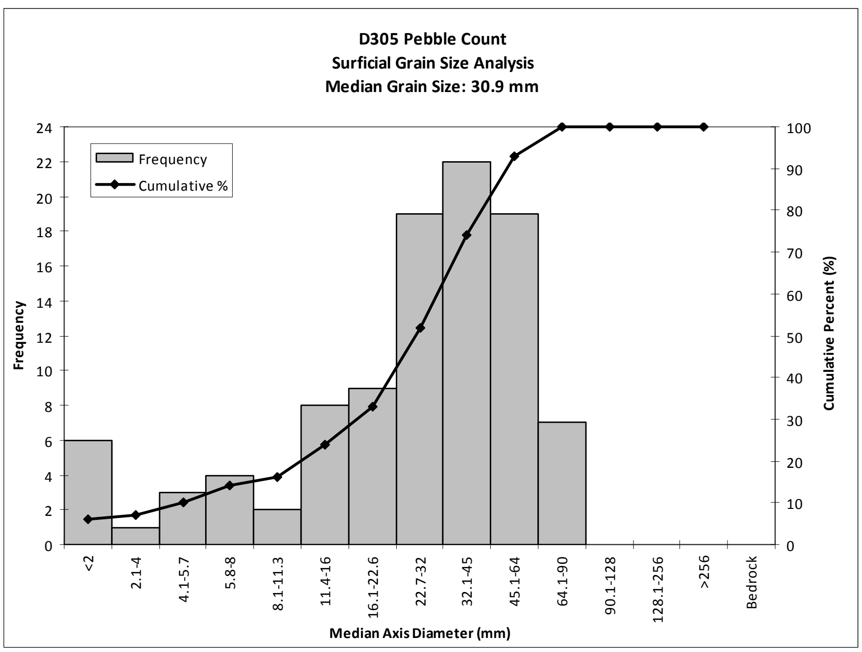
Riffles & Flatwaters

Average riffle depth was 1.1 feet (st.dev. 0.2), and the average flatwater depth was 1.4 feet (stdev 0.2). The bed material in reach 3 ranges from sand to small cobbles; flatwaters are primarily composed of gravel and sand and the riffles are composed of gravel and small cobbles.

Two pebble counts were conducted in riffles in Reach 3 (D305 and D289). One was the first riffle upstream of the Westside Road bridge, the second was about half-way through the reach. The median grain sizes of the two riffles in this reach were coarse gravel at 24 and 31 mm (Figure 16). 85% of the sediments were within desirable spawning gravel sizes (11.4mm to 128mm), and 42% within desirable coho/steelhead rearing sediment sizes (32mm to 128mm). 6% of the samples were fine sediment or sand (<2mm).

Figure 16: Grain size distribution for riffles in the middle of reach 3 (habitat unit #289) and just upstream of the Westside Road bridge (habitat unit #305).





Side-Channels

In the eight side channels, most of the substrate was fine sediment and sand, with some gravel. Seven out of the eight side channels were pool-dominated, with one flatwater-dominated. Maximum depths in pool-dominated side-channels averaged 2.9 feet, with only one over three feet deep. The flatwater-dominated side channel was 0.8 feet deep on average. There was one long side-channel on left side that extends for a few hundred feet with pools and flatwaters, woody debris and other cover. This side-channel is deep

(~3.5') and wide (~30') and abuts the terrace wall. A smaller side channel and alcove on the channel right side provides additional habitat.

Figure 17: (top row) side-channel habitat units, (bottom row) alcoves in Reach 3.

Alcoves

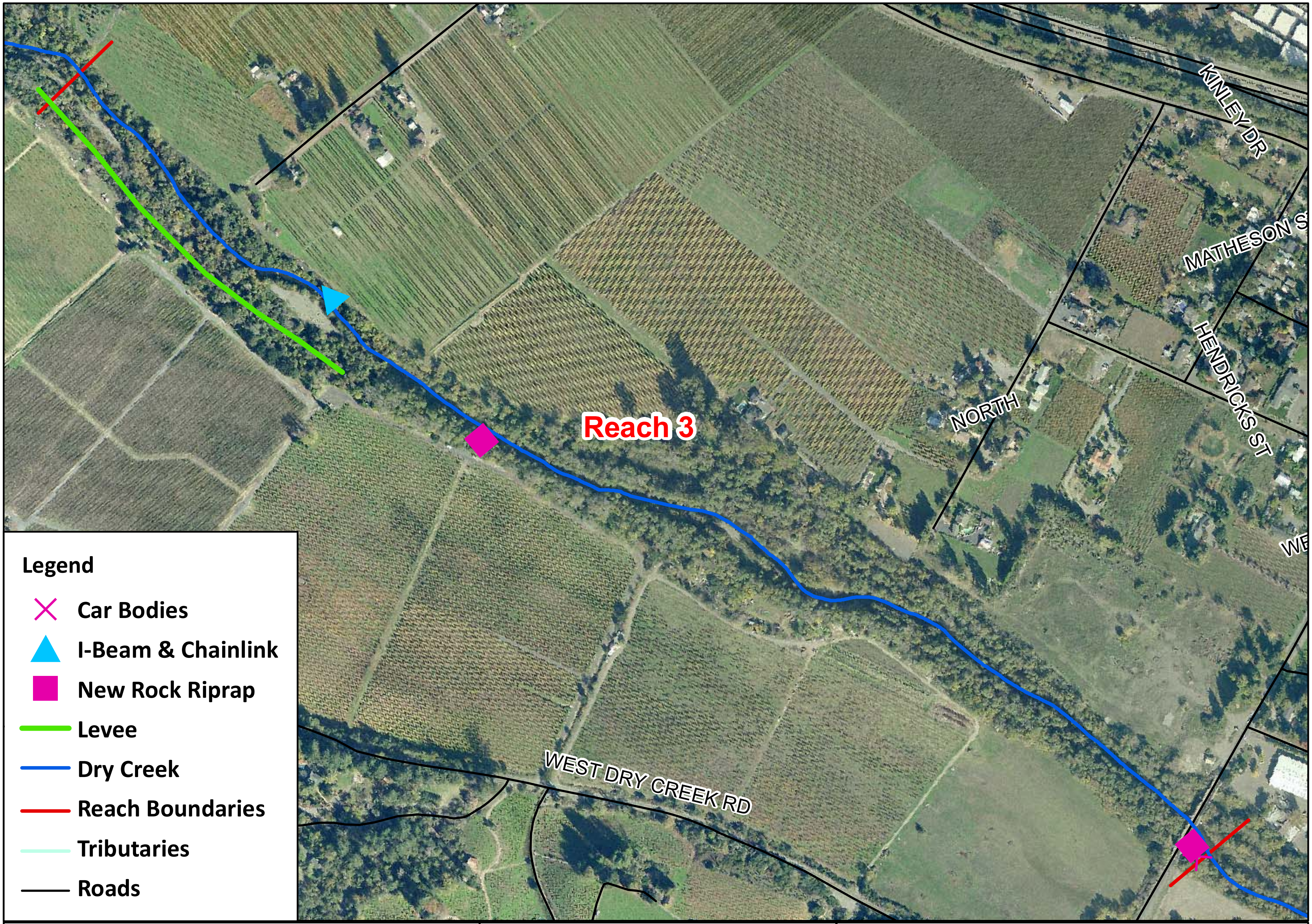
There were four alcoves in Reach 3. Substrate in alcoves is mainly fine sediments and sand, with some gravel. The average maximum depth of alcoves was 1.4 feet, with only one over three feet deep. There were several longer alcoves, including a 1500 foot alcove that flows along the base of a right bank terrace into a small side channel just downstream from the Westside Road bridge. A second very long alcove could not be fully investigated because we did not have landowner permission to access the area.

Instream Cover & Woody Debris

A total of 166 pieces of wood per mile were counted, with most pieces found in flatwaters and side channels (Table 3). While scour pools contained less small and medium sized wood than most other habitat types, the majority of large (>20" diameter) wood was observed in scour pools. Trees and shrubs interacting with the water provided the majority of cover in all habitat types, except for alcoves, where aquatic vegetation provided abundant cover. Additional cover was provided by small woody debris, root masses in riffles, aquatic vegetation in flatwaters and side channels, and large wood and boulders in scour pools. Edge habitat occurred in 18 out of 30 habitat units, primarily along the channel margins in flatwaters, and in side-channels, and alcoves.

Table 3: Instream woody debris, cover, and edge habitat frequency for Reach 3.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	120.0	23.2	11.6	154.8	27%	71	0%
Riffles	78.8	31.5	15.8	126.1	7%	14	25%
Flatwaters	118.5	38.6	15.7	172.8	30%	89	64%
Side Channels	76.6	39.6	26.4	142.7	63%	188	75%
Alcoves	74.6	8.6	14.3	97.6	84%	251	100%
	mainstem wood pieces/mile			165.4			



0 400 800 Feet

DRY CREEK
Reach 3 Features

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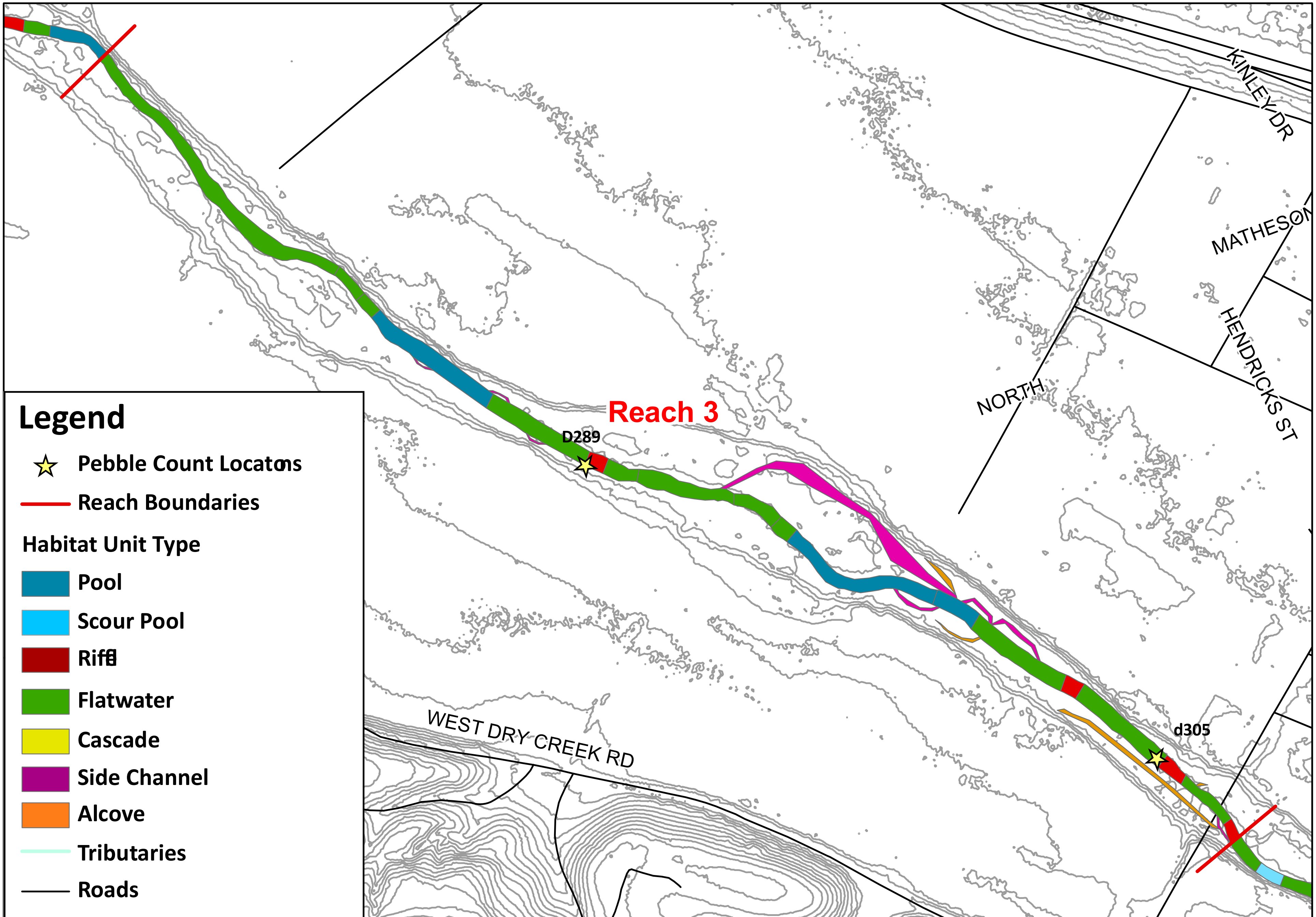

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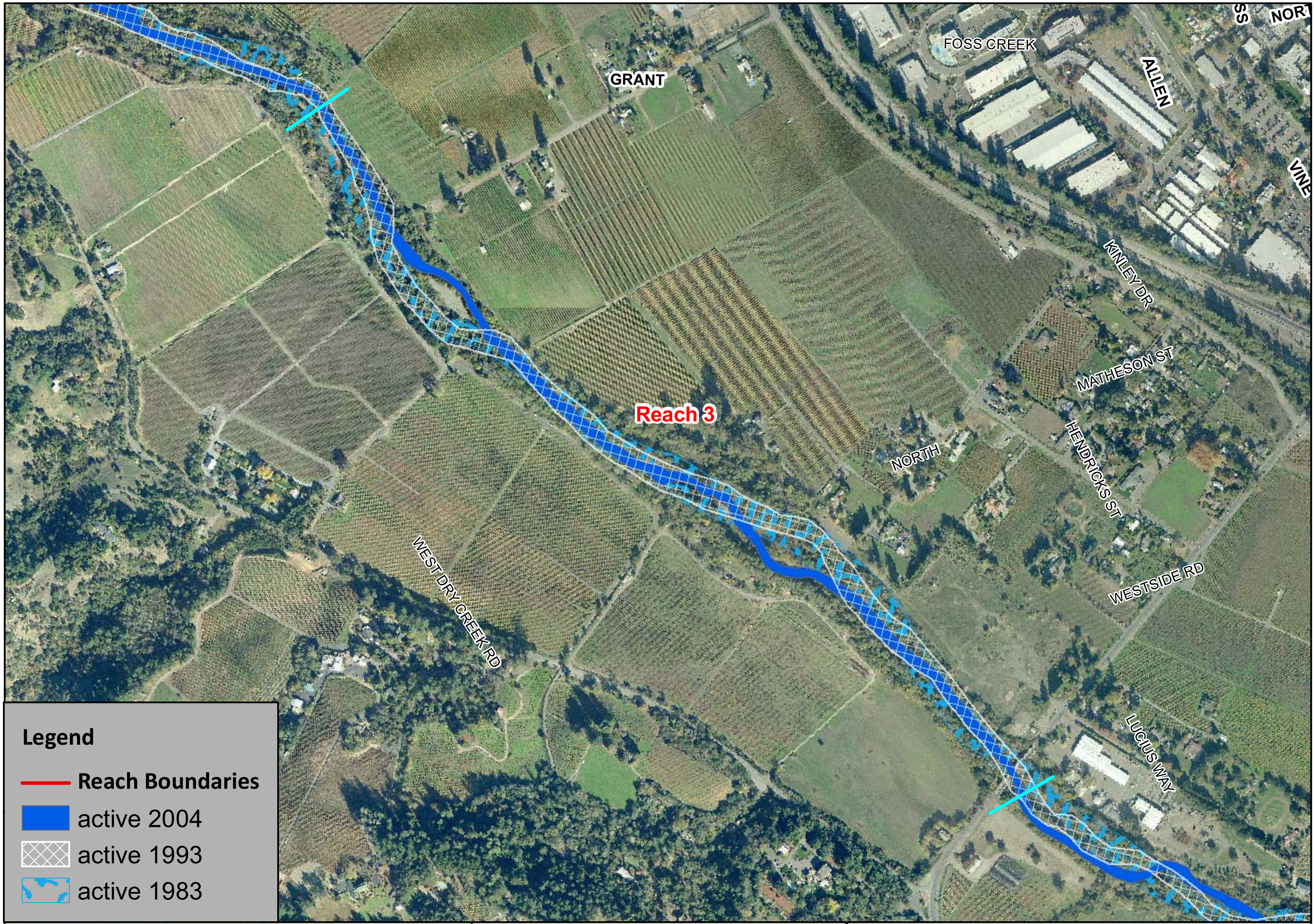

N E S W

0 500 1,000 Feet

DRY CREEK
Reach 3 - Channel Position Map

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REACH 4 (RM 3.0 to RM 4.1) **Three Constructed Gradient Sills with a fault running alongside, to the top of the upper backwatered pool**

Three gradient sills were constructed in 1983 by the ACOE to slow migrating nick points and associated channel incision in lower Dry Creek. This reach is vertically stable due to the check dams. The backwatered pools created by each sill extended several hundred feet upstream, forming a pool-dominated reach. The upper sill (RM 3.8) consisted of a cascade down two sets of boulder falls, 2’ and 1’ in height. The middle sill (RM 3.5) was 200’ long, 10’ wide, and 3’ in height. The lower sill (RM 3.3) was 100’ long, 10’ wide, and 1 foot tall. Each sill has a fish ladder to provide passage through the short cascades. Rock riprap covers than right bank between the upper and middle sill, and short sections of boulder riprap cover both banks upstream and downstream of each sill. An unnamed tributary enters Dry Creek just downstream of the lower sill at river mile 3.25.

Through Reach 4, the channel has become less sinuous since the dam was built, though minor channel migration has continued. Three side channels and eight alcoves were identified in this reach, and these are located primarily along previous channel paths.

Figure 18: (upper left) lower sill, (upper right) upper sill,
(lower left) ladder on middle sill, (lower right) middle sill.

Habitat Classification

This reach is primarily composed of flatwaters (50%) pools (25%) backwatered behind check dams, and riffles (20%) at and just downstream of the dams. Four riffles were identified ranging in length from 50 to 80 ft and comprise 6% of the 1.1 mile mainstem length for the reach on a length basis. At each sill, a short cascade of water pours over the structure.

The channel in this reach has steep banks as the average wetted width and active channel widths are the same at 52 ft. The active channel depth was 2.7 feet. The average flood prone width is more than double at 112 ft. The floodplain in Reach 4 is approximately 3 to 4 ft above the bed and adjacent terraces are 10 to 15 ft above the channel bed.

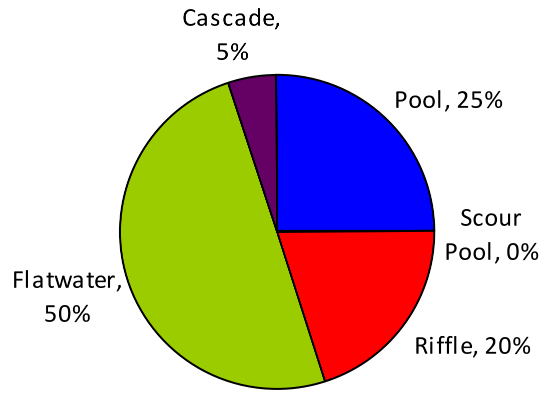
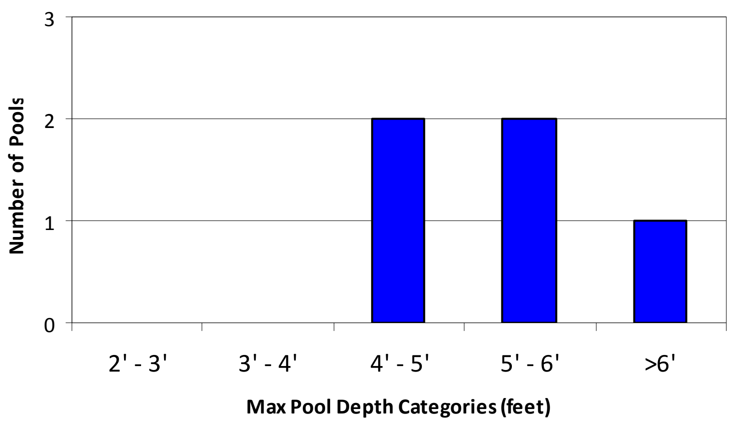


Figure 19: Proportion of Habitat Types by Relative Frequency in Reach 4

Pools

All five pools in Reach 4 were greater than 3 feet deep (Figure 20). The average maximum pool depth was 5.3 feet (st.dev. 0.6). The average residual pool depth was 3.8 feet, and the average pool tail crest depth was 1.6 feet. Substrate observed in pools was gravel with sand.

Figure 20: Maximum Pool Depths in Reach 4.



Riffles, Flatwaters & Cascades

In Reach 4, the average depth of riffles was 1.2 feet, 1.3 feet in flatwaters, and 0.9 feet in cascades. The bed material in Reach 4 ranges from sand to small cobbles, but is primarily composed of coarse to very coarse gravel. Gravel and some sand make up the majority of the channel bed in the pools and flatwaters and the riffles are composed primarily of gravel with a few small cobbles. In cascades, most of the substrate was boulders with large cobbles. The dimensions of the riffle downstream of the upper check dam, where the pebble count was conducted (D256), partly resembled a flatwater. The median grain size of the riffle below the most upstream check dam was 31 mm, coarse gravel (Figure 21). The frequency of fine sediment was 1%. 89% percent of the surface substrate was within ideal spawning sizes for coho and steelhead (11.4 to 128 mm), and 49% was within ideal juvenile rearing clast sizes (32 to 128 mm).

Figure 21: Grain size distribution for riffle below the most upstream check dam (habitat unit #256).

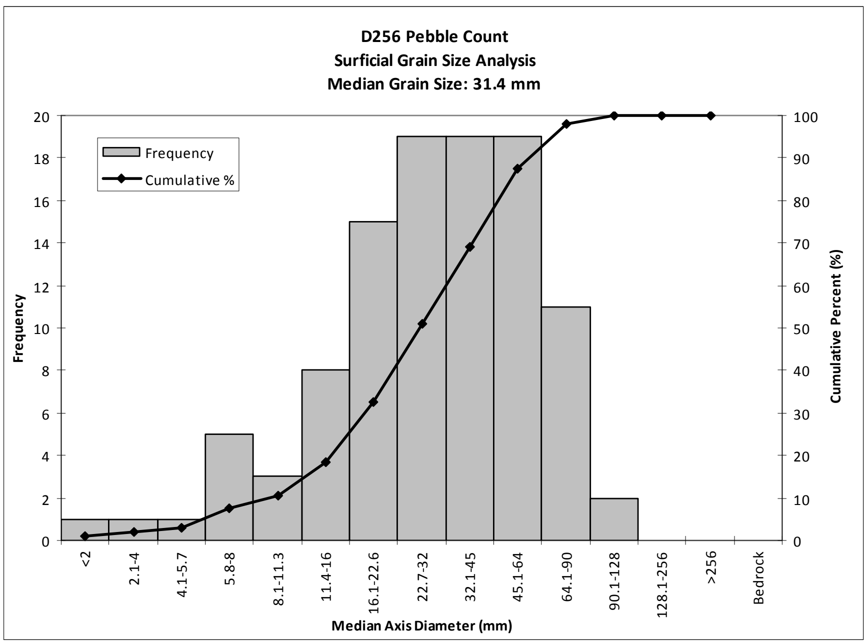


Figure 22: (upper left) long pool above upper sill, (upper right) alcove off upper sill, (lower left) side-channel habitat, (lower right) aquatic vegetation in alcove near middle sill.

Side-Channels

In Reach 4, three side channels were observed. Two of the side-channels were on the right side between the upper and middle sills, each with a pool in the middle and riffles and their entrances and exits. Their average depths were 0.5 and 0.7 feet. The third size-channel occurred where the creek split around an island downstream of the middle sill. The left channel, which was primarily flatwater habitat, was slightly smaller than the main channel to the right, with an average depth of 1.5. Substrates observed in side channels were classified as gravel with small cobbles and sand.

Alcoves

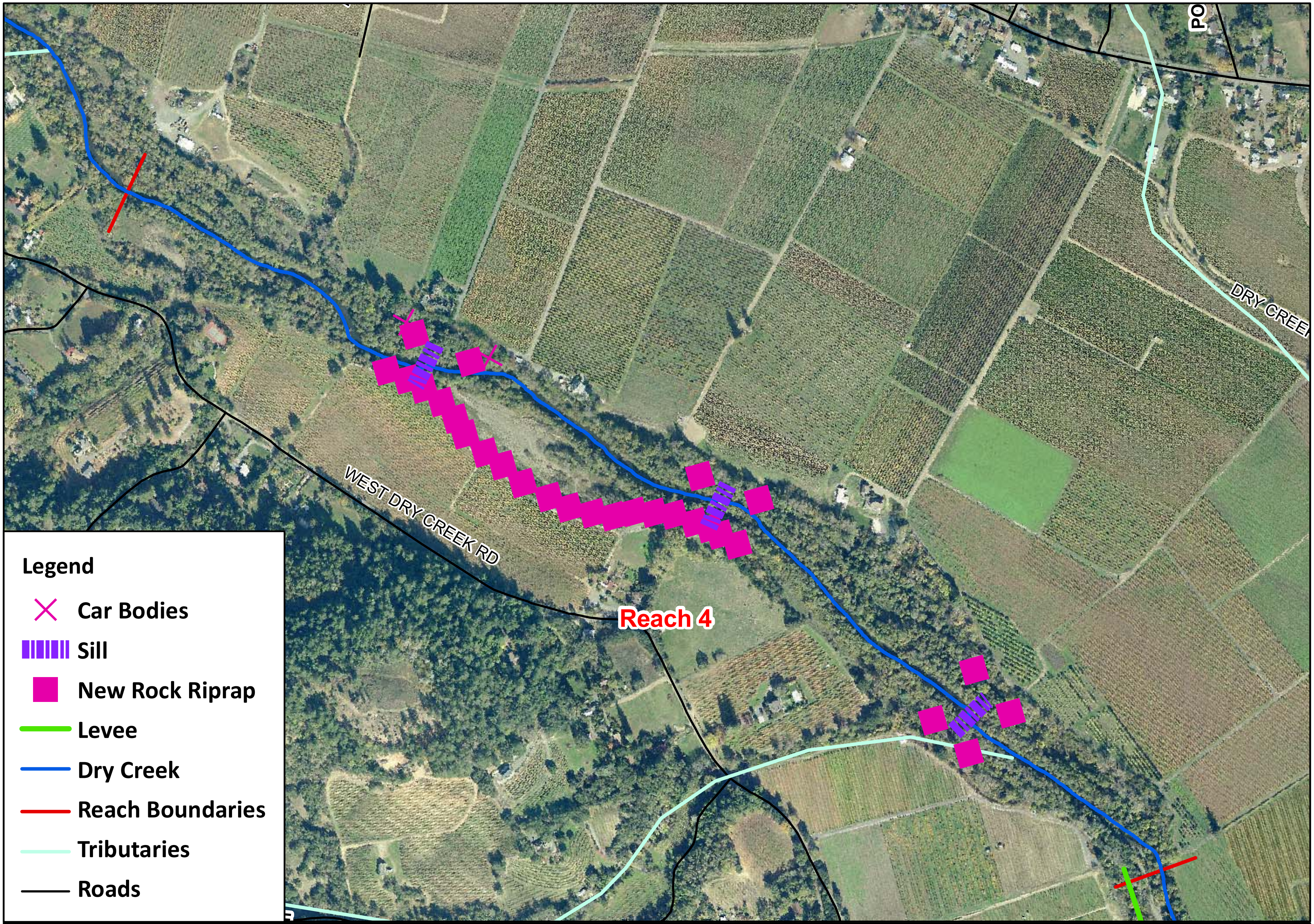
There were eight alcoves in Reach 4. Several were associated with the areas around the sills. There were two alcove pools on the right side of channel near the middle sill, with one upstream and the other downstream of the structure. The average maximum depth of the alcoves was 1.7 (st.dev. 0.9), with only one over three feet deep. Substrate in the alcoves was fine sediment and gravels with sand.

Instream Cover & Woody Debris

Overall, Reach 4 contained 185 pieces of wood per mile, with the greatest densities in pools, riffles, and side channels. Eight of the fifteen large pieces of wood were found in pools. The cascade and alcove habitats had more instream shelter and cover than ,riffles, and flatwaters. The side-channels in Reach 4 offered lower than ideal instream cover. Cover was provided in pools by terrestrial vegetation and small woody debris. In riffles, most cover was provided by woody debris, and secondarily by root masses and overhanging vegetation. In flatwaters, overhanging vegetation and root masses provided cover, along with some small woody debris. In cascades, cover was provided by boulders, with some overhanging terrestrial vegetation. Cover in alcoves was mainly provided by aquatic vegetation, with root masses, terrestrial vegetation, and some small woody debris. In side-channels the limited cover was mainly provided by small woody debris and root masses. Edge habitat was present in 5 pools, 5 flatwaters, and the majority of side-channels and alcoves.

Table 4: Instream woody debris, cover, and edge habitat frequency for Reach 4.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	145.3	66.6	10.6	222.5	38%	114	60%
Riffles	168.8	61.4	15.3	245.6	12%	26	0%
Flatwaters	88.8	15.7	7.8	112.3	16%	37	70%
Cascade	0	0	0	0.0	50%	100	0%
Side Channels	196.1	90.5	30.2	316.8	12%	23	67%
Alcoves	138.8	36.2	12.1	187.1	43%	101	75%
	mainstem wood pieces/mile			184.9			



0 500 1,000 Feet

DRY CREEK
Reach 4 Features

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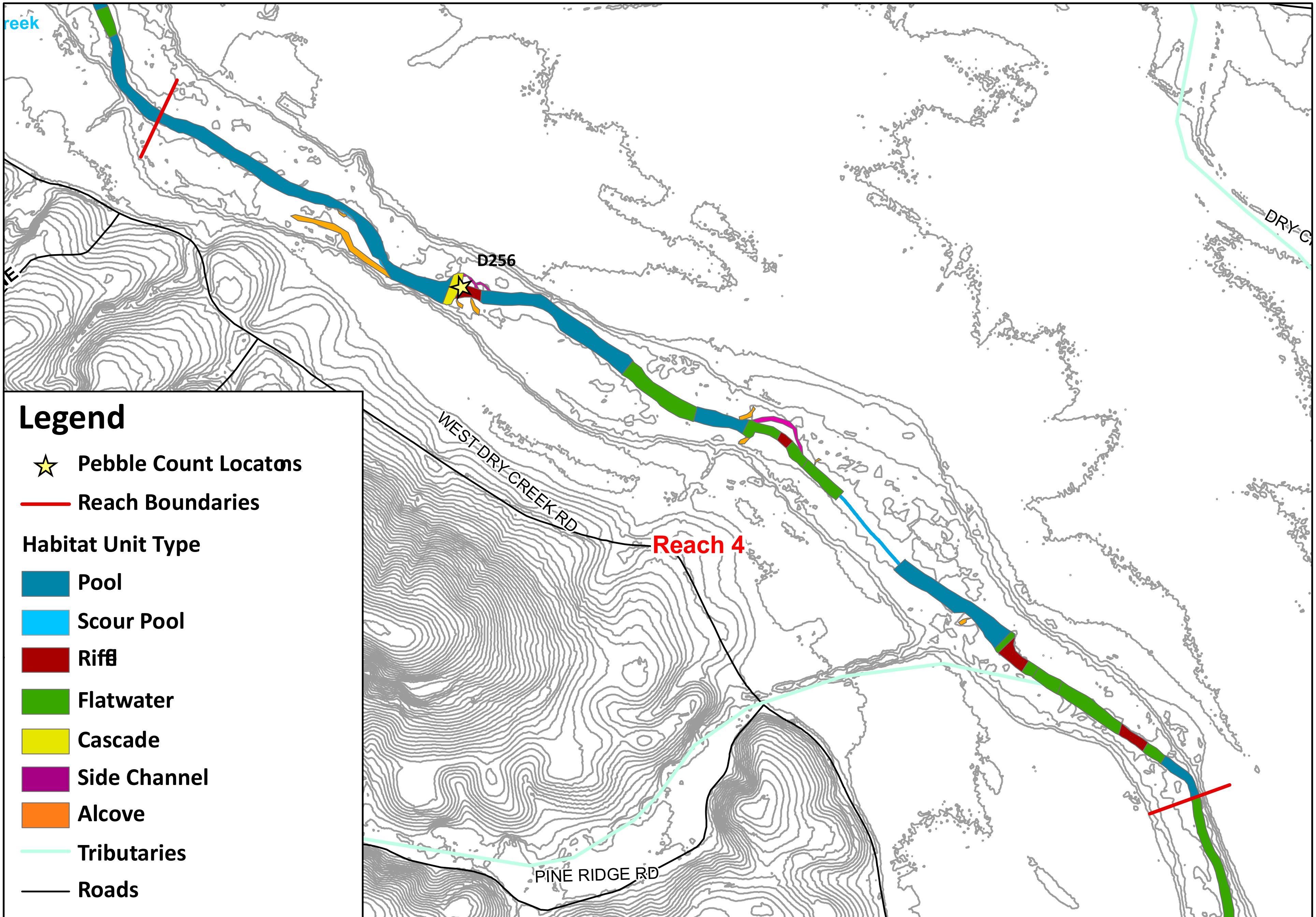

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Reach 4 Habitat Units

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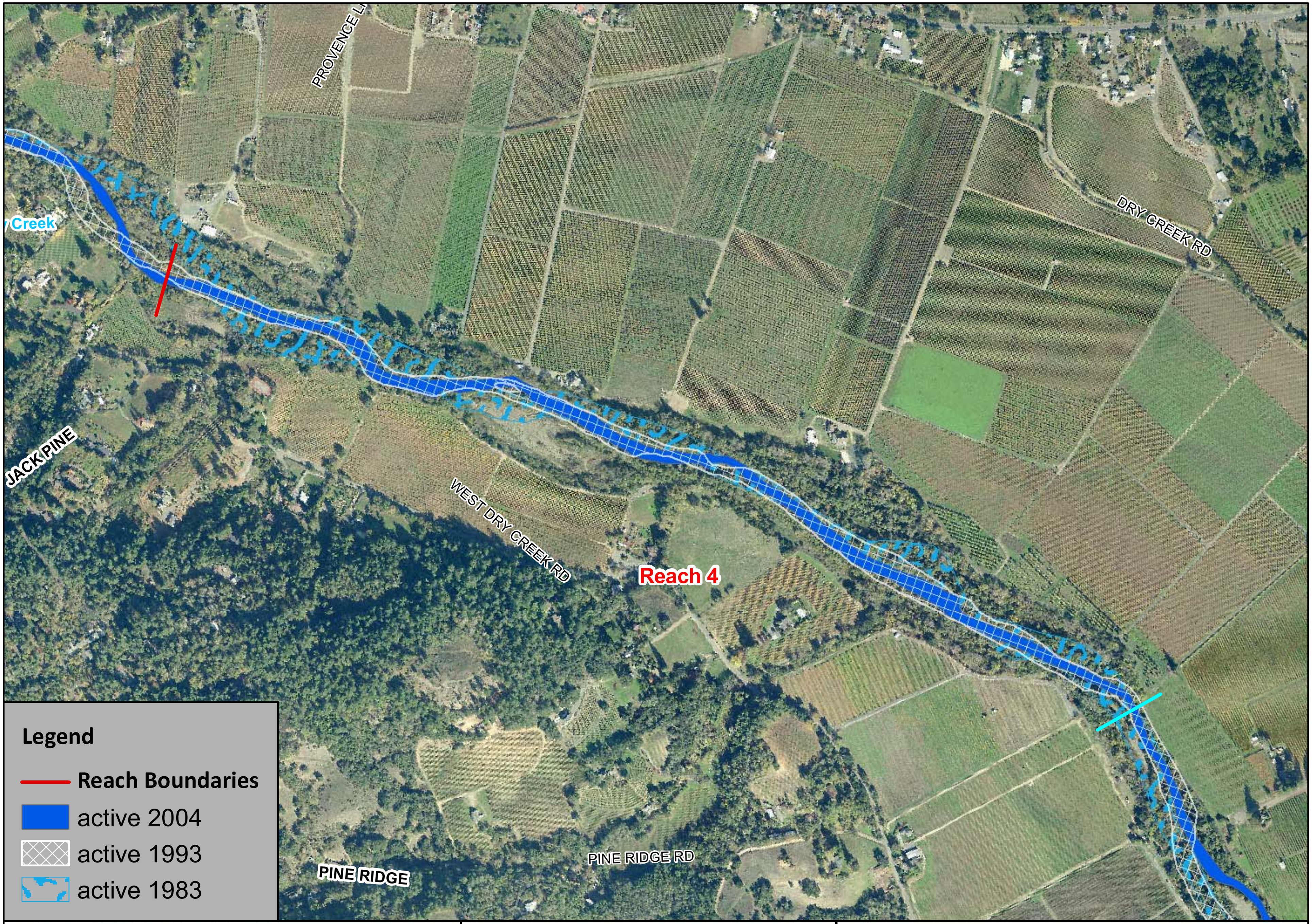

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DRY CREEK
Reach 4 - Channel Positon M p

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REACH 5 (RM 4.1 to RM 5.4) **Kelley Creek and Hidden Concrete Slabs, upstream of the sill-influenced pool to the end of the adjacent fault lineament**

A fault lineament runs along most of Reach 5, which is a single-thread channel extending upstream from the upper check dam pool to river mile 5.4, just upstream of where the channel diverges from the lineament. It is a fairly straight reach composed of long pools, with two tributary junctions. Kelley Creek enters Reach 5 at on the right[3] bank at river mile 4.3 in the lower end of the reach. Upstream from the Kelley Creek junction, an unnamed tributary enters Dry Creek on the left bank at river mile 4.6. The mouth of Kelley Creek is covered in fine sands with small gravels (Figure 23). The unnamed tributary is steep and dry, except for mouth. 20 feet up the unnamed creek channel from its confluence, a 3 foot nick point was observed. The riparian zone in this reach is narrow, especially upstream of the two tributaries.

Figure 23: (left) mouth of Kelley Creek, (right) mouth of unnamed tributary.

The channel has narrowed since the earliest aerial photographs in 1942, but there has been little channel migration upstream from the unnamed tributary at approximately river mile 4.6. The 10 to 15-ft terraces relatively close to the channel banks limit the degree of channel migration. Also limiting channel migration are the bank stabilization projects that have been implemented, particularly the concrete slabs lining both banks in the upper half of this reach. Even with these channel modifications, bank and terrace erosion does occur as was observed at river mile 4.55 where the channel meanders east.

Downstream from this unnamed tributary junction at river mile 4.6, the influx of water and bed load from the unnamed tributary on the left bank and Kelley Creek on the right bank has likely resulted in the frequent channel changes that have occurred in the last three decades.

[3] In the individual reach summaries, right and left bank designation defined as looking downstream.

Habitat Classification

Reach 5 is primarily composed of flatwaters (58%) and pools (25%) with a few riffles (16%) by relative frequency, Figure 24). Riffles represent only 6% of this 1.3 mile-long reach on a length basis. The wetted width at the time of the survey was 48 ft. There are five riffles ranging in length from 45 to 90 ft.

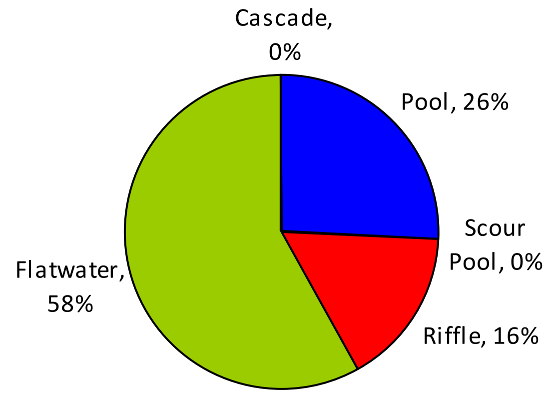


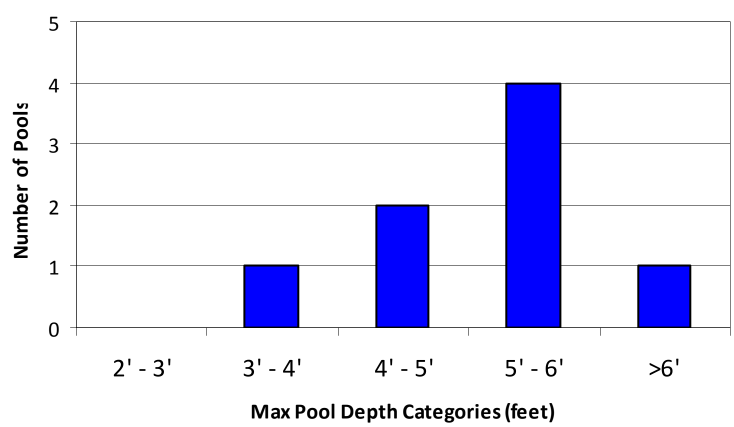
Figure 24: Proportion of Habitat Types by Relative Frequency in Reach 5

Reach 5 is typified by plane-bed morphology with long flatwaters and an entrenched floodplain (Montgomery and Buffington, 1997). The average active channel width was 69.0 feet, the active channel depth 1.8 feet, and the average floodprone with was 86.5 feet. With a active channel width:depth ratio of 39 and an entrenchment ratio of 1.25, Reach 5 resembles an “F4” channel type (Rosgen 1996).

Pools

There were 8 pools in Reach 5 with an average maximum depth of 4.9 feet (stdev 0.9). All pools in Reach 5 were greater than 3 feet deep (Figure 25). The average residual pool depth was 3.4 ft, with an average pool crest depth of 1.5 ft. Substrate in pools was gravel with sand.

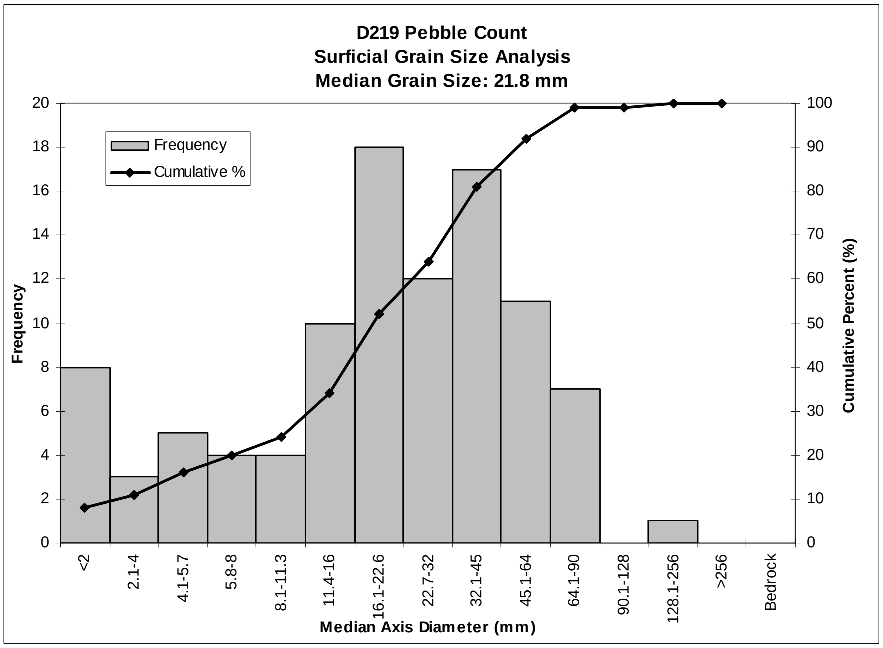
Figure 25: Maximum Pool Depths for Reach 5.

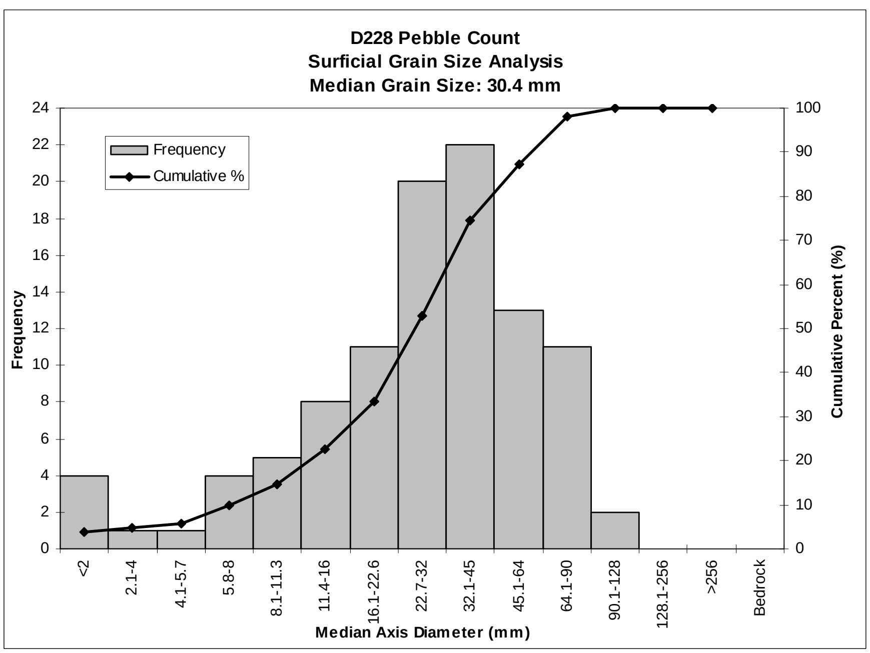


Riffles & Flatwaters

The average depth of riffles in Reach 5 was 1.0 feet, and the average depth of flatwaters was 1.5 feet. The bed material in this reach is primarily gravel with some sand in the pools and small cobbles in the flatwaters and riffles. Two pebble counts were conducted in riffles within Reach 5, both upstream of Kelley Creek. The riffles are primarily composed of coarse to very coarse gravel with median grain sizes of 22 and 30 mm (Figure 26). 4% and 8% of the substrate was sand/fine sediment (<2mm). 80% was coho and steelhead spawning gravel (11.4 to 128mm), and 42% was ideal juvenile rearing size (32 to 128 mm).

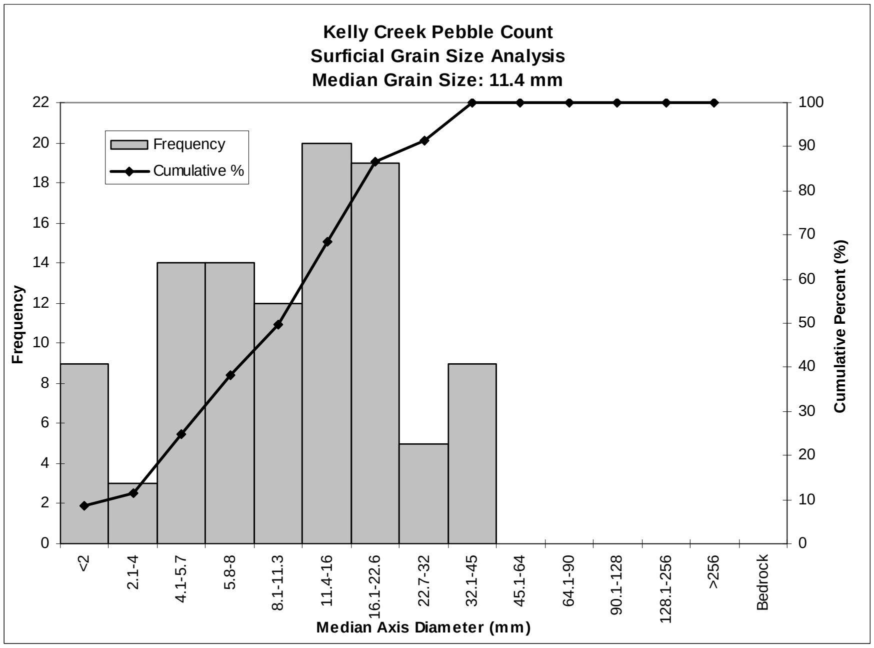
Figure 26: Grain size distribution of two riffles in the stable section of reach 5 upstream of both tributaries (habitat units #219 and 228).





The bed material in Kelley Creek is primarily fine to medium gravel but ranges from sand to very coarse gravel. The median grain size near the mouth of Kelley Creek is 11 mm, medium gravel (Figure 27). The smaller grain sizes being discharged by Kelley Creek are likely transported readily during higher flows on Dry Creek.

Figure 27: Grain size distribution for the channel bed of Kelley Creek near its confluence with Dry Creek.



Side-Channels

There was one short, riffle-dominated side channel in Reach 5. It was 60 feet long, 12 feet wide, with an average of 0.5 feet deep. Observed substrate was gravel with small cobble.

Figure 28: (left) riffle habitat unit, (right) long, deep pool with woody debris.

Alcoves

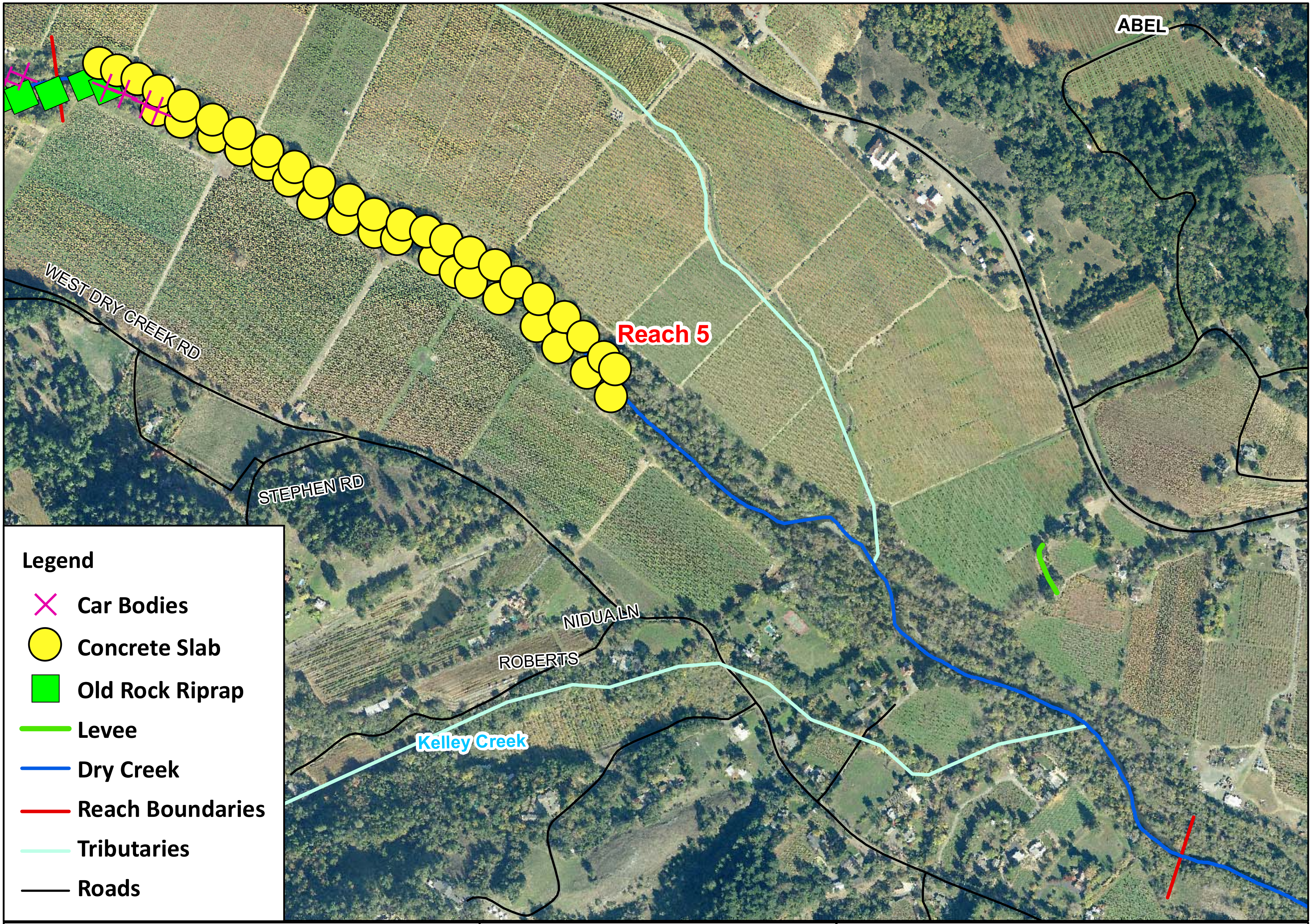
There are two medium-sized alcoves in Reach 5, one was 45 by 5 feet and 0.5 feet deep, and the other was 60 by 10 feet and 1.5 feet deep. Observed substrate was fine sediment with gravels.

Instream Cover & Woody Debris

In Reach 5, there were an average of 234 pieces per mile of wood in the mainstem channel (Table 5). Overall, pools contained the highest densities of wood pieces, followed by side channels and alcoves. Out of 20 large wood pieces (>20" diameter) counted, sixteen were found in mainstem pools. Cover was provided by terrestrial vegetation and small woody debris, with some root mass cover in riffles and flatwaters, and some cover in alcoves provided by aquatic vegetation. Edge habitat was observed in four flatwaters and six pools, and in the side-channel and alcoves.

Table 5: Instream woody debris, cover, and edge habitat frequency for Reach 5.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	224.8	40.1	26.8	267.1	22%	60	50%
Riffles	103.0	44.1	0.0	147.1	16%	36	0%
Flatwaters	166.3	35.3	12.6	214.2	26%	69	33%
Side Channels	264.0			264.0	20%	40	100%
Alcoves	150.9	50.3		201.1	55%	165	100%
	mainstem pieces/mile			233.9			



0 500 1,000 Feet

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Reach 5 Features

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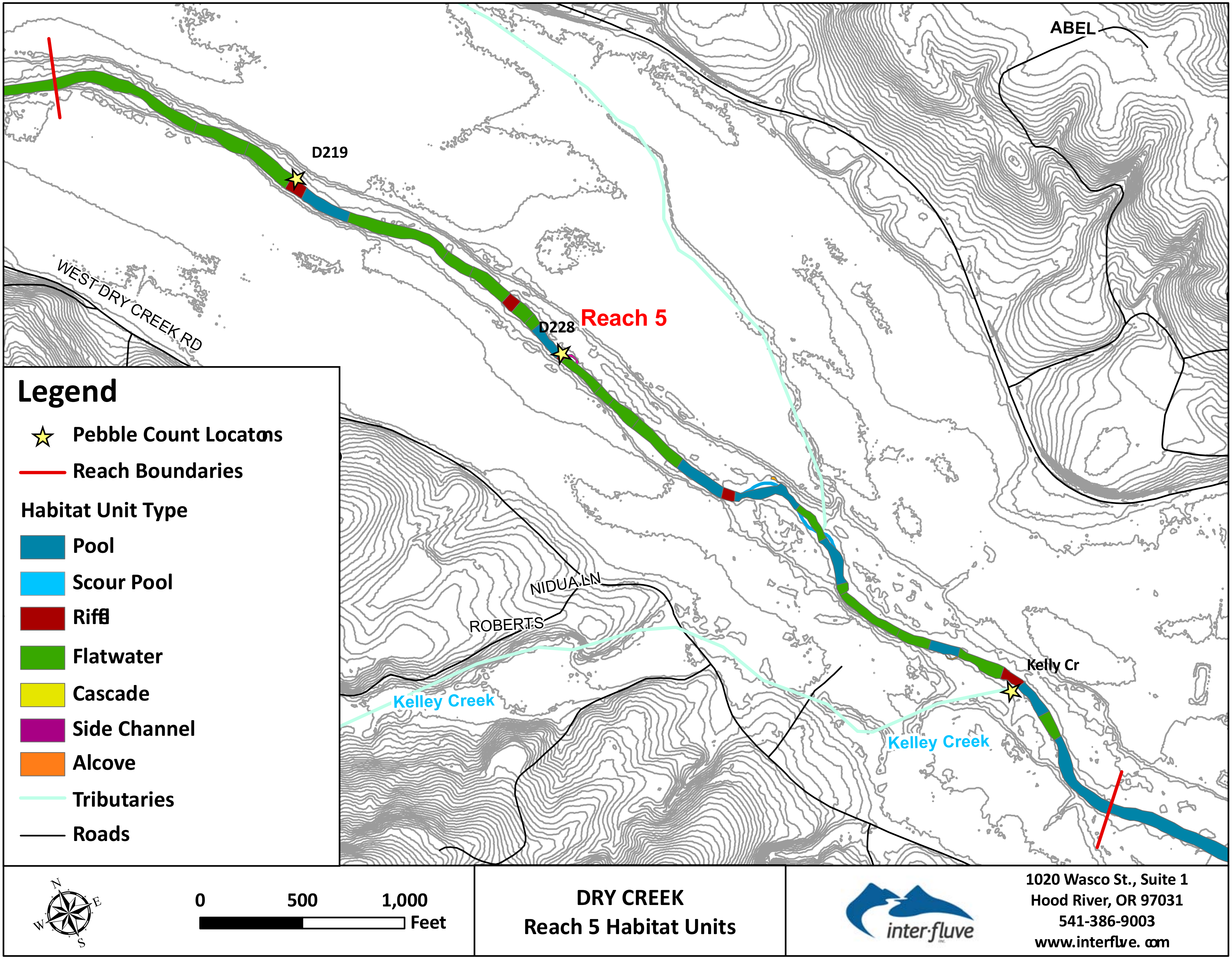

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Reach 5 Habitat Units

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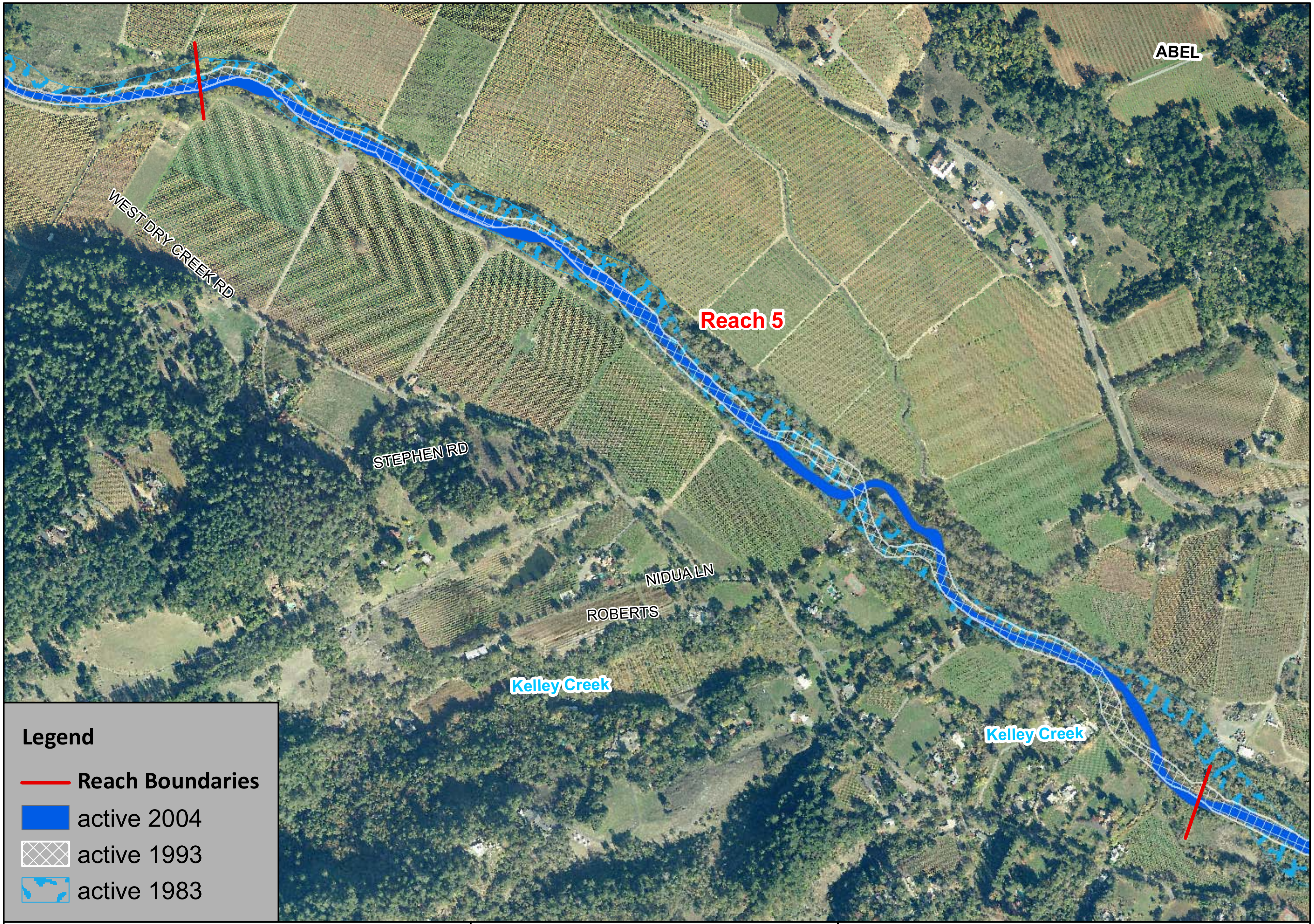

0 500 1,000 Feet

DRY CREEK
Reach 5 - Channel Positon Map

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REACH 6 (RM 5.4 to RM 6.2) **Moderately confined from the end of fault influence to the first bedrock outcrop**

Reach 6 is a single-thread channel that has narrowed over time but has not experienced substantial amounts of channel change. It extends upstream from reach 5 to river mile 6.2, about 500 ft downstream from the confluence of Crane Creek on the right[4] bank. Access to the floodplain was restricted through much of this reach due to landowner concerns, so information regarding this reach is limited. No tributaries flow into Dry Creek in this reach.

A PIT tag antenna was located in the middle of the reach at the time of the survey (Figure 29). Car bodies and riprap were observed for 500 feet along the streambanks at the downstream end of the reach. The upstream end of this reach terminates at the first visible expression of bedrock in the channel.

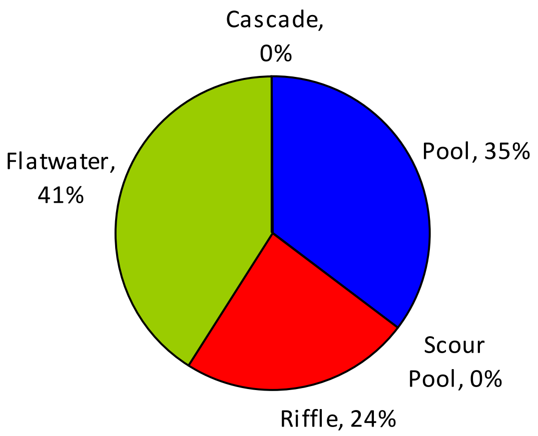
Figure 29: (left) adult fish monitoring station, (right) scour pool.

Habitat Classification

By relative frequency, Reach 6 is composed of 35 % pools, 41% flatwaters, and 24% riffles (Figure 30). Riffles range in length from 60 to 120 ft and account for 12% of the main channel on a length basis. The average wetted width at the time of the survey was 49 ft.

It was plane-bed morphology with an low gradient, with four of the seven pools longer than 300 feet long. Due to concerns over landowner permissions, no active channel or floodprone measurements were made.

Figure 30: Proportion of Habitat Types by Relative Frequency in Reach 6

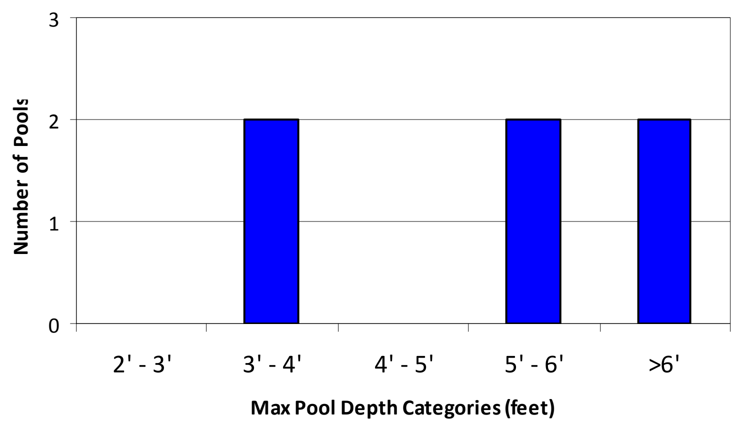


[4] In the individual reach summaries, right and left bank designation defined as looking downstream.

Pools

The average maximum pool depth was 5.5 (stdev. 1.8), and average residual pool depth was 4 feet. All of the six pools were greater than 3 feet deep (Figure 31). Substrate in pools was gravel with sand and some small cobble.

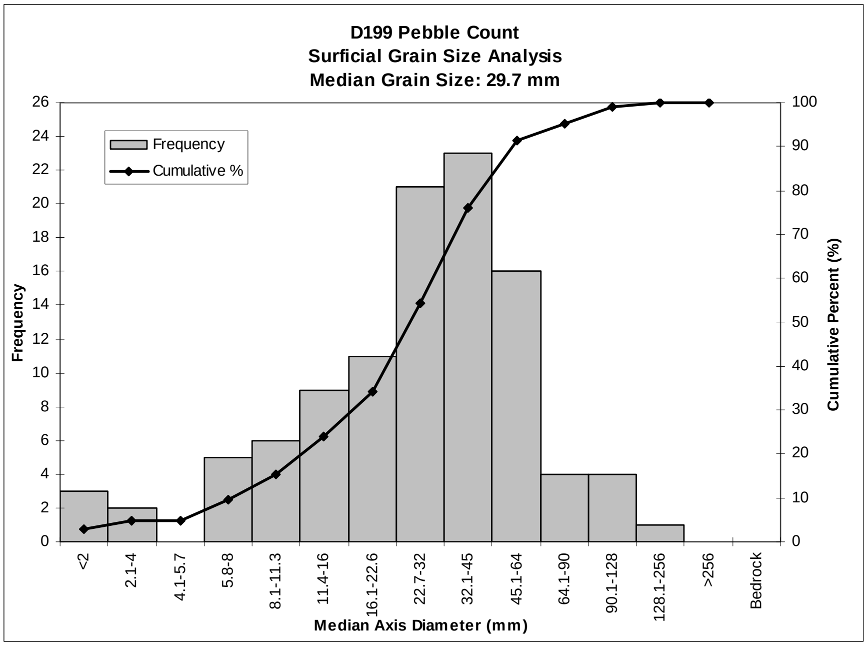
Figure 31: Maximum Pool Depths in Reach 6.



Riffles & Flatwaters

The average depth of riffles was 0.9, and the average depth of flatwaters was 1.5. Bed material in Reach 6 is primarily gravel with some sand in the pools and small cobbles in the flatwaters and riffles. The bed material in the riffle at the upstream extent of the reach ranges from sand to large cobbles but is primarily coarse to very coarse gravel. The median grain size is 30 mm, coarse gravel (Figure 32). The majority of samples fell within the very coarse gravel and coarse gravel size categories. 84% of the substrate was within desirable size classes for coho/steelhead spawning (11.4 to 128mm), and 45% fell within desirable sizes for juvenile rearing (32 to 128mm). 3% of the samples were fine sediment and sand (<2mm).

Figure 32: Grain size distribution for riffle about 500 ft downstream from Crane Creek (habitat unit #199).



Side-Channels & Alcoves

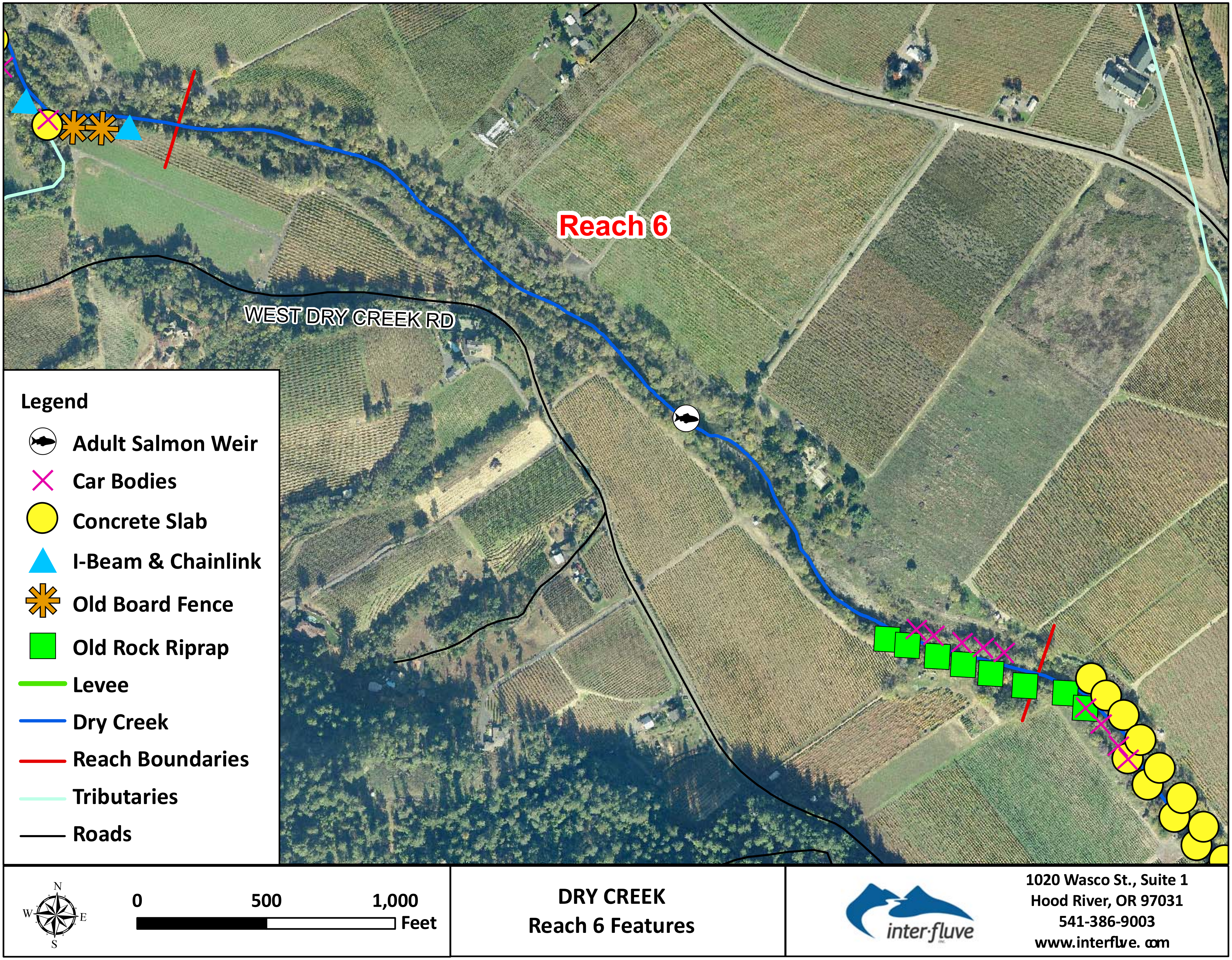
There were no side-channels or alcoves observed in Reach 6.

Instream Cover & Woody Debris

There were 196 pieces of wood per mile in Reach 6 (Table 6). The highest density of wood was found in pools, and 8 out of the 14 large wood pieces (>20” diameter) in Reach 6 were also found in pools. Most of the cover was provided by terrestrial vegetation and small woody debris, with some cover provided by large woody debris and root masses. Edge habitat was present in two pools and three flatwaters.

Table 6: Instream woody debris, cover, and edge habitat frequency for Reach 6.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	123.1	25.5	17.0	165.5	35%	98	33%
Riffles	72.8	10.4	20.8	103.9	16%	31	0%
Flatwaters	204.8	72.8	22.8	300.4	17%	47	43%
	mainstem pieces/mile			195.6			



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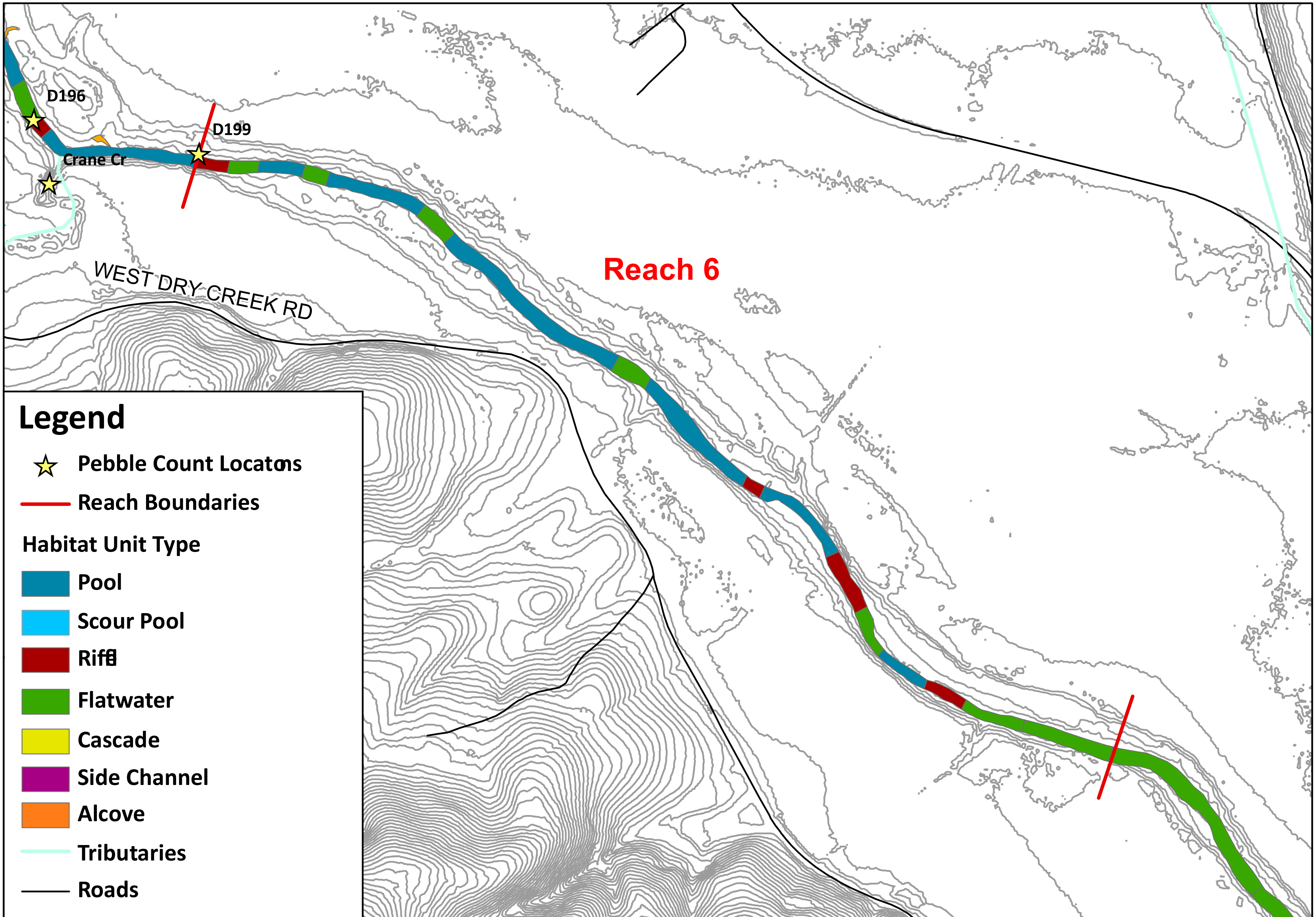

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REACH 7 (RM 6.2 to RM 7.5) **Crane Creek to Grape Creek, from the beginning of Bedrock Outcrops to the end of Bedrock Outcrops**

Reach 7 extends upstream from below Crane Creek to about 1000 ft upstream of Grape Creek at river mile 7.5. Two important tributaries, Grape Creek and Crane Creek, enter Reach 7 at river miles 7.2 and 6.3, respectively. Crane Creek is a steep, deeply incised tributary with exposed bedrock at its mouth and compacted sands and gravel on its steep banks. A mapped, unnamed tributary enters Dry Creek at river mile 6.6, but was not noted in the survey. A valley landmark, Lambert Bridge, crosses Dry Creek at river mile 6.6.

Multiple bedrock outcrops are visible along the channel bed in this reach and the reach boundaries were located to encompass all of these outcrops. Though the channel has narrowed as it has incised through this reach, there have been only minor amounts of channel migration since the 1940s. The channel is more sinuous than downstream, but the riparian corridor is narrow, and there is little room for substantial channel migration. Although the riparian corridor is narrow through this reach there is some room for habitat enhancement upstream from Crane Creek and downstream from Grape Creek where minor channel changes have occurred historically.

Figure 33: (upper left) cascade under Lambert Bridge, (upper right) mouth of Crane Creek, (lower left) bedrock outcrop, (lower right) riffle where Grape Creek enters Dry Creek.

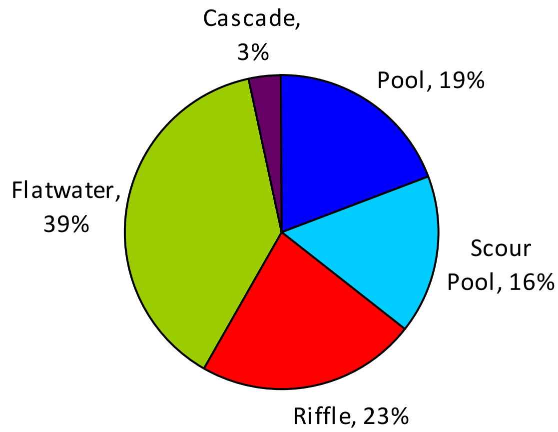
Substantial incision has occurred through this reach, but the bedrock outcrops have limited further degradation. The most apparent bedrock outcrop is the bedrock cascade under the Lambert Bridge, but there are also outcrops at river mile 6.4 between the unnamed tributary and Crane Creek, at the mouth of Grape Creek and upstream of Grape Creek. These occasional bedrock extrusions provide cover for fish, influence pool formation, and control stream gradient. Despite the bedrock outcrops, the dominant substrate is gravel, followed by sand.

Bank stabilization efforts in Reach 7 include boulder riprap, old cars on the banks, concrete slabs, I-beam and chain link fence, and old board fence protecting banks just downstream of Crane Creek on the right bank. At river mile 7.0, eight large boulders have been placed in a triangle formation in the center of a cobble-gravel flatwater. The cascade under Lambert Bridge is made up of bedrock, boulders, and chunks of concrete, with an approximate 2' drop. An 8'-high eroding streambank is exposed along outer bend of at river mile 6.4.

Figure 34: (upper left) Failed I-beam and chainlink fence stabilization efforts, (upper right) car bodies in the banks, (lower left) erosion along an outside bend, (lower right) a triangular boulder cluster in Dry Creek.

Habitat Classification

Figure 35: Proportion of Habitat Types by Relative Frequency in Reach 7



Reach 7 contains 35% pool habitat, 39% flatwater, 23% riffle, and 3% cascade (under Lambert Bridge) by relative frequency (Figure 35). Riffles represent only 10% of the 1.3 miles of main channel on a length basis. There are a few side channels and alcoves, one cascade and seven riffles ranging in length from 50 to 60 ft.

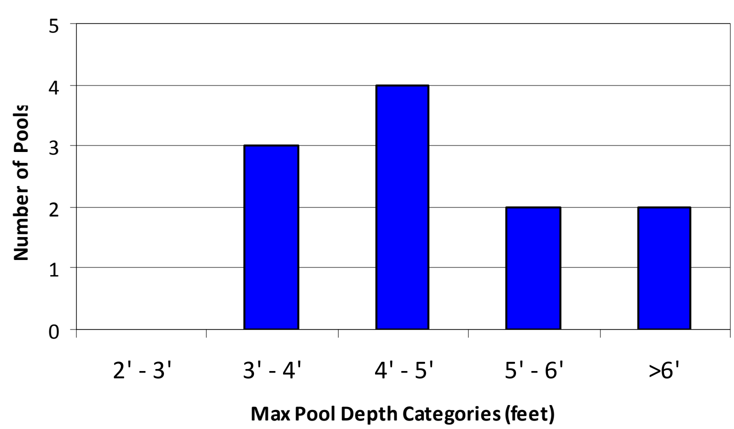
The average wetted width during the survey was 48 ft and the active channel and flood prone widths are 58.5 and 81 ft respectively. The average active channel depth was 2.5 ft. Adjacent terraces are about 10 ft above the channel bed.

Reach 7 is an F-type channel, due to its entrenched floodplain and a moderate-to-high width:depth ratio. However, in some segments of Reach 7, erosion, avulsion, and deposition are evidenced by a number of high quality alcoves, side-channels, and gravel bars and by creative bank stabilization efforts using I-beams, old cars, and boulder riprap.

Pools

The average maximum mainstem pool depth in Reach 7 was 5.4 feet (st.dev. 1.3), and the average maximum scour pool depth was 4.1 feet (st.dev. 0.4). Within Reach 7, a number of deep scour pools are associated with woody debris. All 11 pools are greater than 3 feet deep (Figure 36). Several of the pools include flatwaters shorter than a wetted channel width. In some areas, the water pools in the bedrock. The average residual pool depth was 3.5 ft., and the average pool crest depth was 1.4 ft. Ocular estimates of substrate identified gravel with sand covering the streambed in pools.

Figure 36: Maximum Pool Depths in Reach 7.

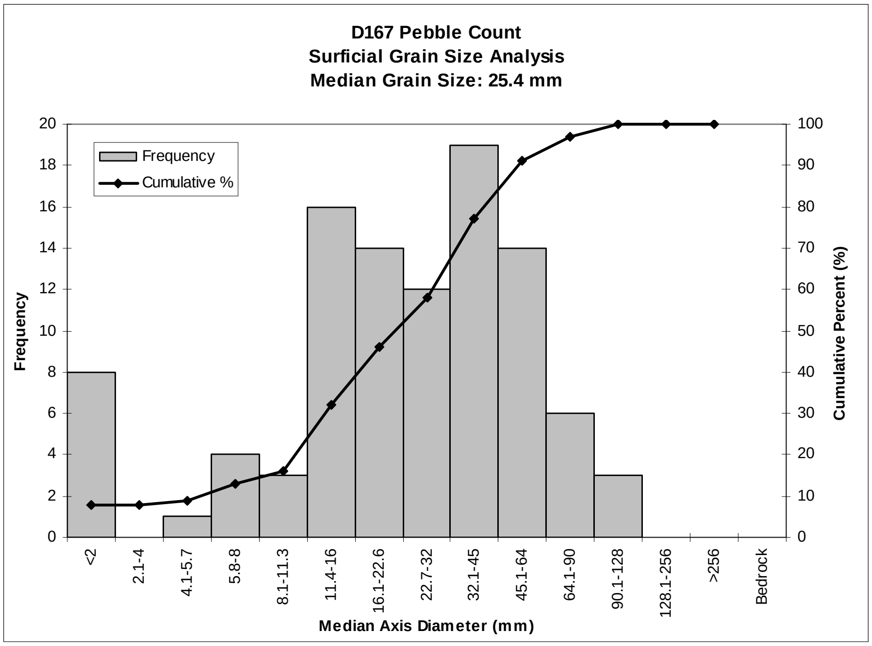


Riffles, Flatwaters & Cascade

The average depth is 1.0 feet for riffles, and 1.4 feet for flatwaters. The bed material through reach 7 is primarily gravel with some sand in the flatwaters and pools and small cobbles in the riffles. Riffles are primarily composed of coarse to very coarse gravels with material ranging from sand to small cobbles. Bedrock composed most of the bed material in the cascade and was identified in a few other locations through the reach. The single cascade under Lambert Bridge was bedrock-based, with boulders.

Pebble counts were conducted in four riffles in Reach 7, as well as in the mouths of Grape Creek and Crane Creek. The median grain size of four sampled riffles ranged from 16 to 30 mm (Figure 37). Most samples were medium gravels through very coarse gravels. 80% of all samples were within desirable coho/steelhead spawning sediment sizes, and 36% was within juvenile rearing size classes. 5% of the samples were fine sediments or sand (<2mm). A thick biomat of algae was observed to cover the gravel-sand substrate in several flatwaters.

Figure 37: Grain size distribution for four riffles between Grape Creek and Crane Creek.



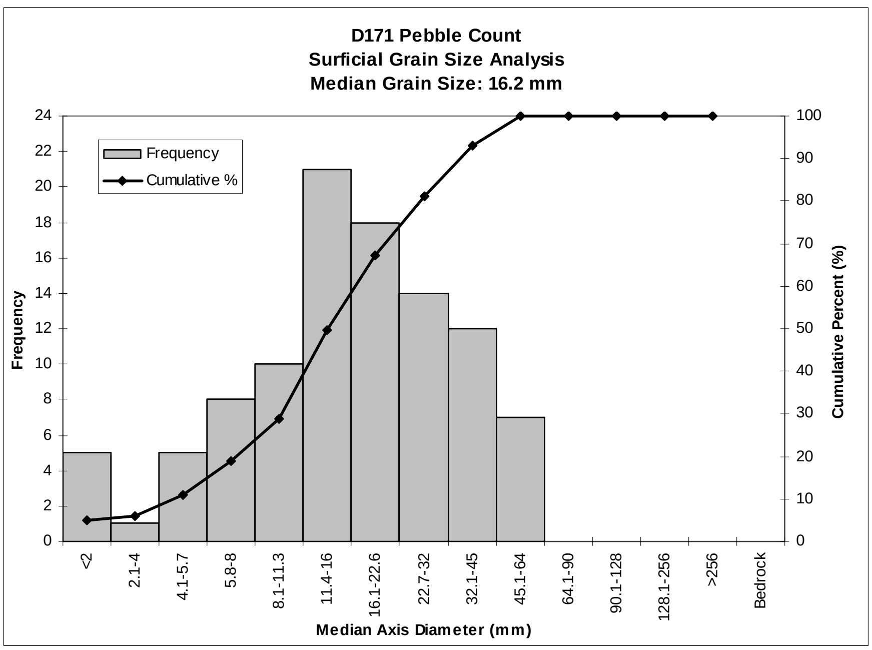
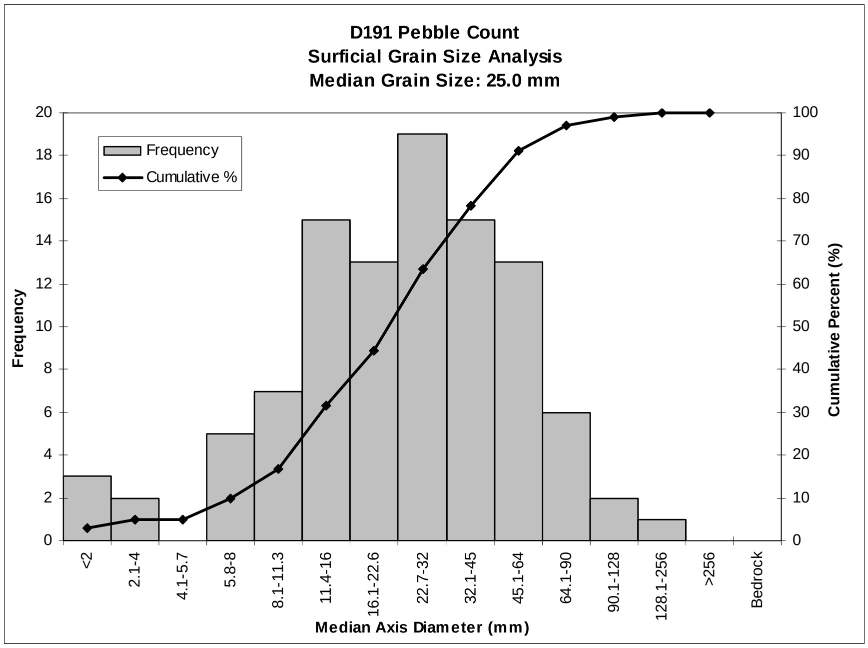
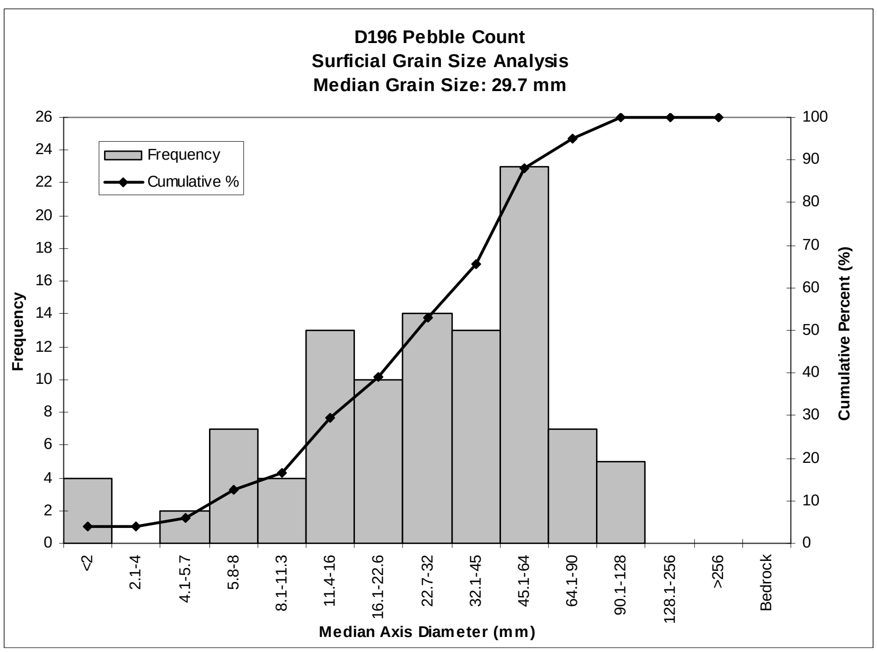


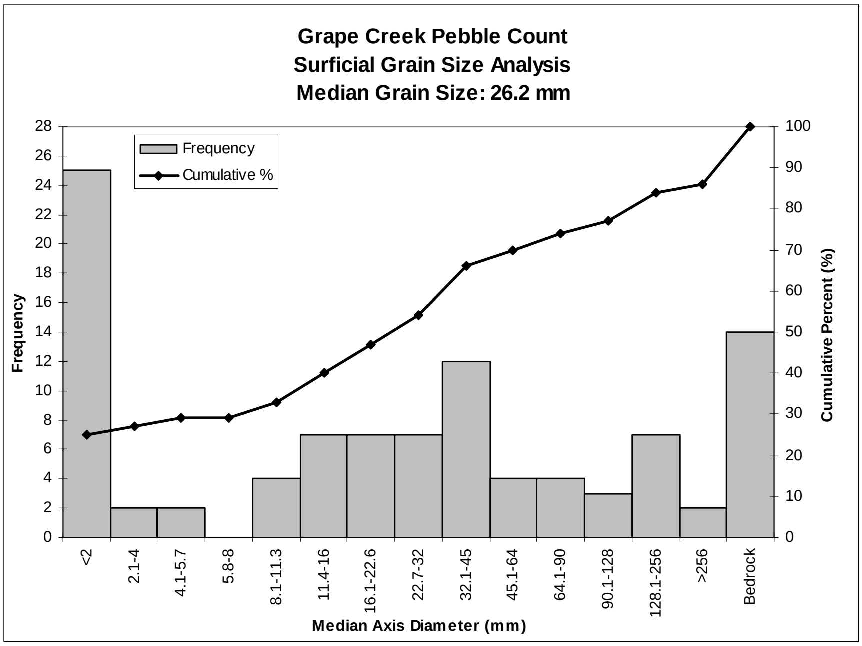
Figure 37, continued: Grain size distribution for four riffles between Grape Creek and Crane Creek.

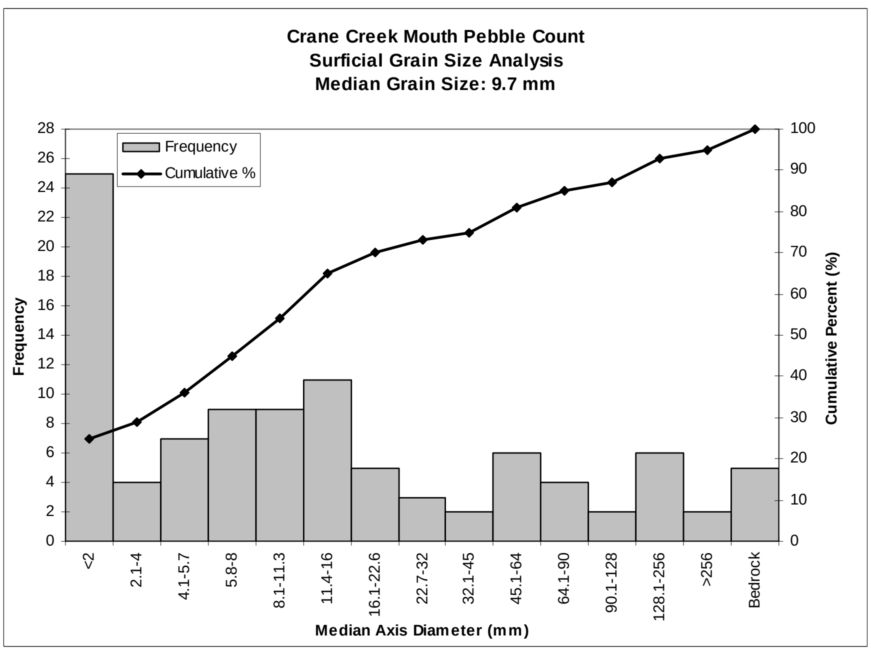




The bed material in Grape Creek is variable, ranging from sand to small boulders and bedrock. Though the median grain size is coarse gravel (26 mm), 25% of the material is sand and 14% is bedrock. The bed material in Crane Creek is similar to that in Grape Creek with 25% being sand and no other size class composing more than 9% of the material. The median grain size of Crane Creek is medium gravel (10 mm) (Figure 38).

Figure 38: Grain size distribution for the channel beds of Grape Creek and Crane Creek near their confluences with Dry Creek.





Side-Channels

Of the three side-channels in Reach 7, two were flatwater dominated and the third was riffle-dominated. The average side-channel depth was 0.8 feet. One of the flatwater-dominated side channels was 530 feet long (Figure 39), and 20 feet wide. This side-channel contained pools and riffles, as well as longer flatwater sections, with gravel with small cobble substrate. The other two side channels were shorter (30 feet and 70 feet long), with bedrock and gravel substrate with sand. The area where Grape Creek enters was very complex, with a long alcove along the left valley wall that serves as a side channel in higher flows.

Figure 39: (left) wood associated with a scour pool, (right) side channel D183.

Alcoves

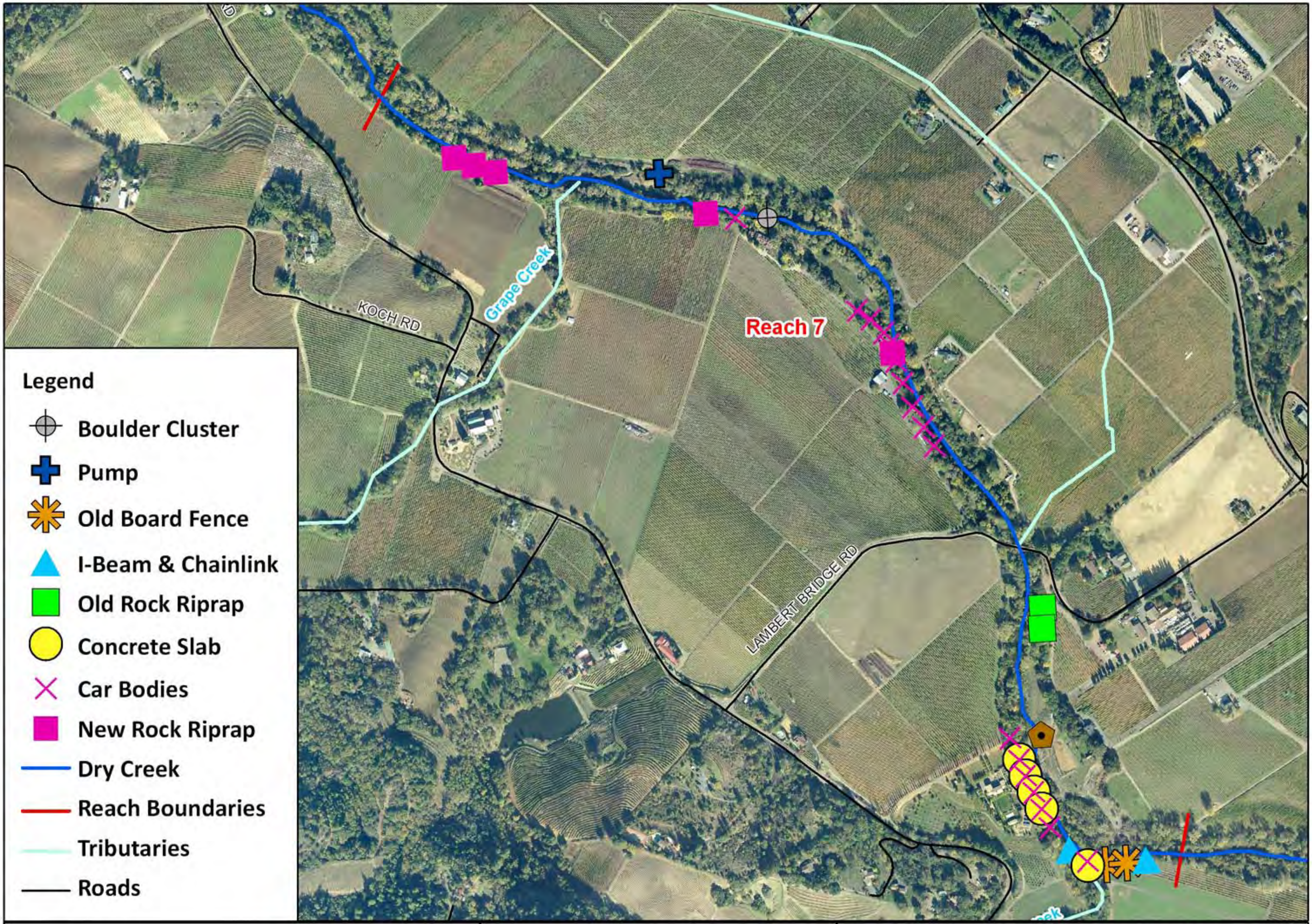
There are eight alcoves in Reach 7. The average maximum depth was 2.0 feet (st.dev. 1.0). Just downstream of Grape Creek, a long 400 foot alcove/canal was dug out and cleaned on the left bank, with an irrigation pump up on the left bank terrace. Substrate in the alcoves was gravel with sand, small cobble, and fine sediments. An additional 25'-long alcove, which was about 5' wide, was observed on the left bank of a scour pool at the head of the reach, but was deemed too small to count as a habitat unit.

Instream Cover & Woody Debris

There are a total of 287 pieces of wood in Reach 7, with 193 pieces per mile in the mainstem (Table 7). The highest densities of wood were found in pools and riffles, followed by flatwaters, then side-channels and alcoves. 5 out of the 8 large wood pieces (>20" diameter) were found in pools. Cover was provided by overhanging vegetation, terrestrial vegetation growing in the water, and small woody debris, and also by boulders, bedrock, and root masses. Edge habitat was present in 44% of the habitat units.

Table 7: Instream woody debris, cover, and edge habitat frequency for Reach 7.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	162.5	47.9	3.4	213.8	41%	117	50%
Scour Pools	165.6	44.9	10.4	220.9	22%	67	40%
Riffles	129.3	38.0	15.2	182.6	22%	49	29%
Flatwaters	103.0	21.3	0.0	124.4	17%	41	33%
Cascades	0.0	0.0	0.0	0.0	95%	285	100%
Side-Channels	120.9	24.2	0.0	145.1	40%	80	33%
Alcoves	126.7	10.6	5.3	142.6	39%	87	75%
	mainstem pieces/mile			190.5			



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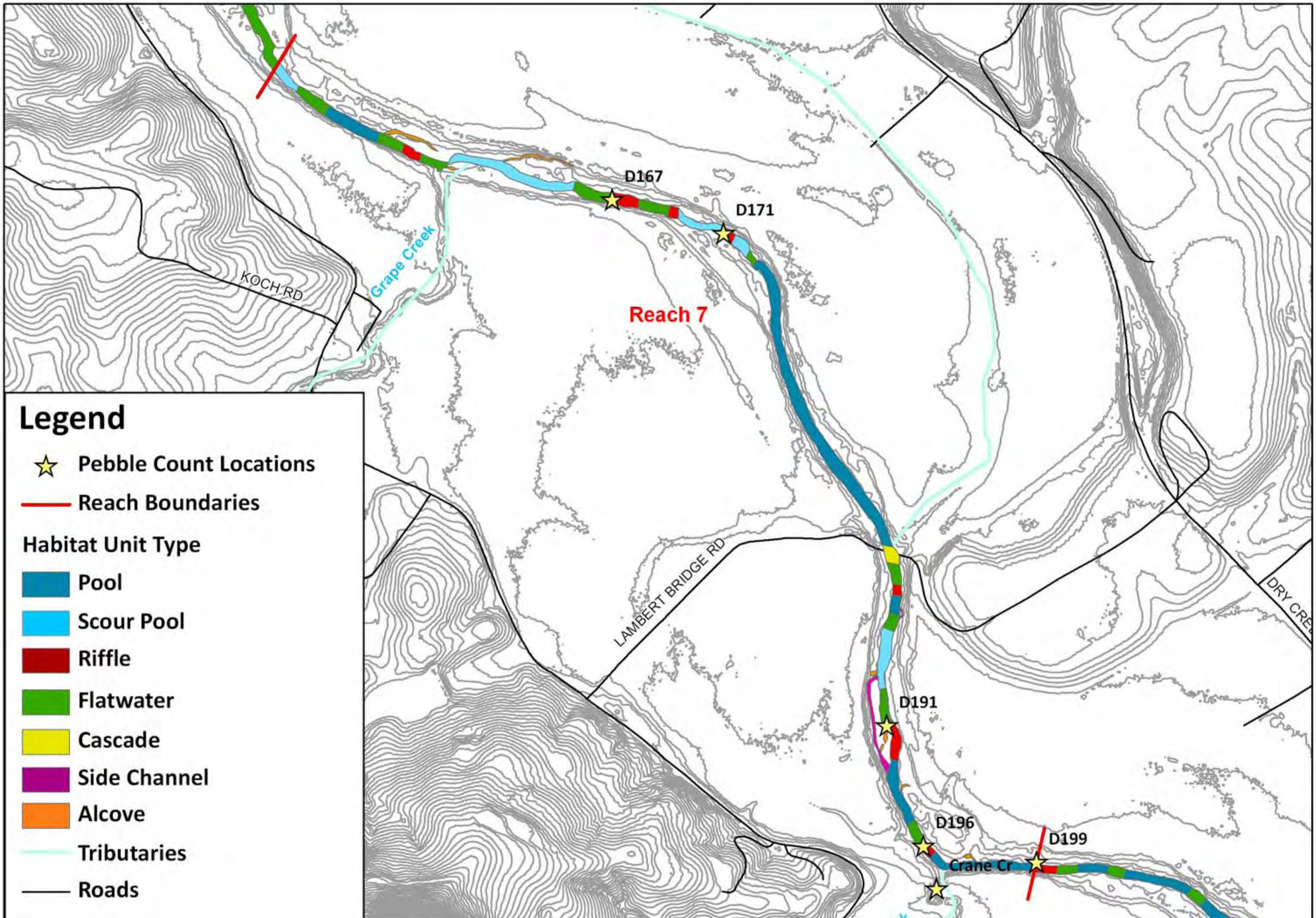

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Reach 7 - Channel Position Map

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REACH 8 (RM 7.5 to RM 9.0) **Moderately Confined with Bank Stabilization Features**

Nearly all of the various types of bank stabilization techniques applied in Dry Creek are present throughout Reach 8 (Figure 40). Approximately 2500 feet of banks are armored with large boulder riprap, some of it including car parts intermingled with the boulders and riprap. An old truckbed is used to stabilize one streambank at river mile 8.8, and a mix of metal pipes, logs, and rocks have been used to shore up another bank at river mile 7.9. Board fence lined 750 feet of the right[5] bank at river mile 8.5. A dry, unnamed tributary enters on the left bank at river mile 8.9.

Reach 8 is a single-thread channel extending 1.5 miles upstream from Grape Creek to river mile 9. The upstream reach boundary location is about 1700 ft downstream from the alignment of the lineament and the channel planform. The channel has incised and narrowed since the 1940s, but the general planform and channel location has remained similar for about half of the reach. Near the upstream reach boundary and the unnamed tributary, as well as between the downstream reach boundary and river mile 8.2, there has been moderate channel migration and changes in planform since the 1940s. Since the dam was built, however, the planform and location of the channel have remained relatively stable. The areas with different channel locations prior to the dam construction have a slightly wider riparian area and the old channels may provide opportunities for habitat enhancement.

Figure 40: Bank stabilization features. (upper left) Board Fence, (upper right) boulder riprap with car parts, (lower left) a truck bed, (lower right) metal poles with logs and rocks.

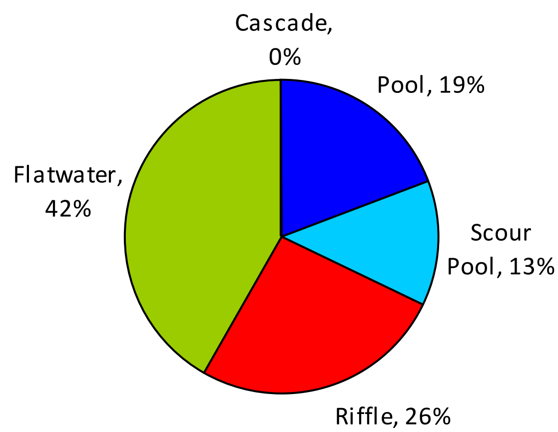
[5] In the individual reach summaries, right and left bank designation defined as looking downstream.

Habitat Classification

The channel in this reach is composed of pools (32%), and flatwaters (42%) and also contains 26% riffles on a frequency basis(Figure 41). The 8 riffles range in length from 50 to 100 ft and account for 11% of mainstem reach on a length basis. The average channel widths are similar to reach 7: The wetted width was 46 ft, the active channel width is 58.5 ft and the flood prone width is 70.5 ft. The average active channel depth in the riffles was 2.4 ft. The adjacent terraces are up to 15 ft above the channel bed.

The total length of Reach 8 was 1.5 miles. Reach 8 resembled an F4-type channel due to its low entrenchment ratio (1.2) and high active channel width:depth ratio (24).

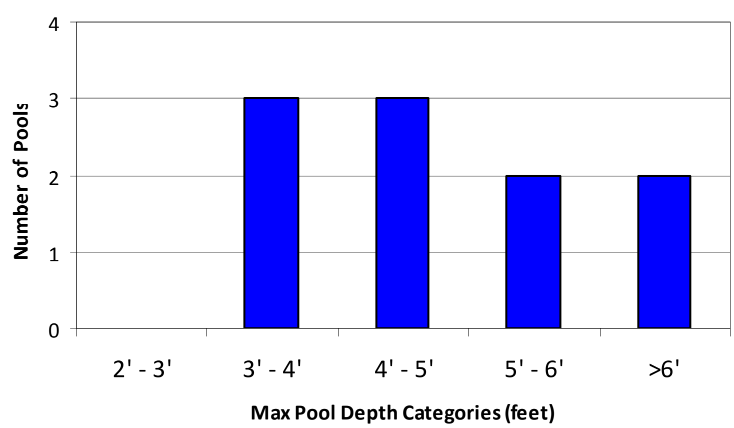
Figure 41: Proportion of Habitat Types by Relative Frequency in Reach 8



Pools

There were ten pools in Reach 8, four of which were identified as scour pools. All ten pools had maximum depths greater than 3 feet, with an average maximum pool depth of 4.7 feet (Figure 42). The average residual pool depth was 3.4 ft, and the average pool crest depth was 1.4 ft. Most substrate in pools was gravel with sand and small cobble, with several pools dominated by sand, and one with boulder substrate due to boulder riprap dropped into the channel.

Figure 42: Maximum Pool Depths in Reach 8.

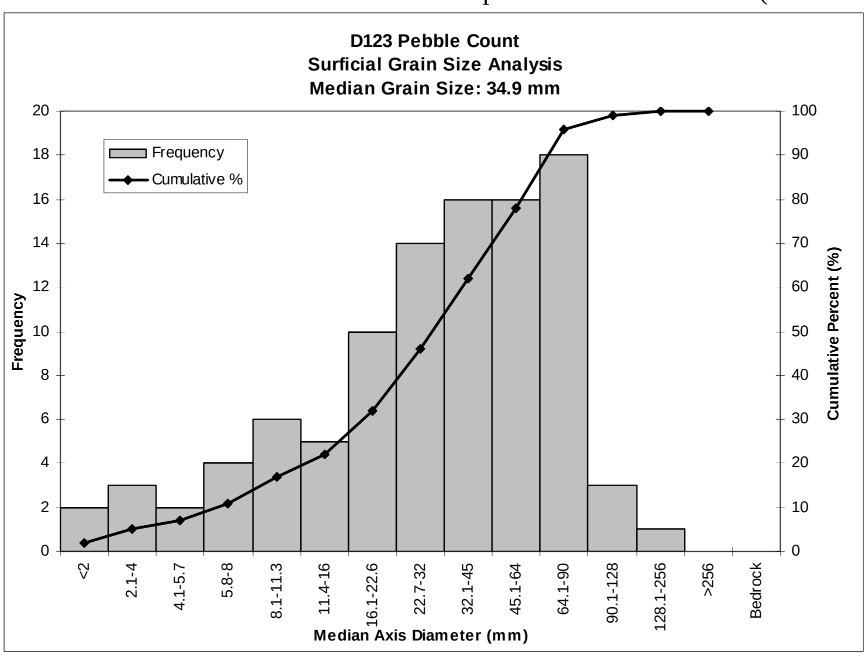


Riffles & Flatwaters

There were 8 riffles and 9 flatwaters in Reach 8. The average riffle depth was 1.0 feet and the average flatwater depth was 1.4 feet. The substrate in riffles was gravel with small cobble, and in flatwaters it was gravel with small cobble and sand. A pebble count was conducted in the in a riffle at the upstream extent of the reach (Figure 43). Bed material ranges from sand to large cobbles but is primarily composed of coarse to very coarse gravel. The median grain size of this riffle was 35 mm or coarse gravel (Figure 44). 82% of the sediment sampled was with the ideal coho/steelhead spawning sizes (11.4mm to 128mm), and 52% was within coho rearing sediment sizes (32mm to 128mm). 2% of the sediments were fine or sand (<2 mm).

Figure 43: (left) conducting a pebble count in a riffle, (right) pool habitat in Reach 8.

Figure 44: Grain size distribution for the riffle at the upstream extent of reach 8 (habitat unit #123).



Side-Channels

No side channels were observed in Reach 8.

Alcoves

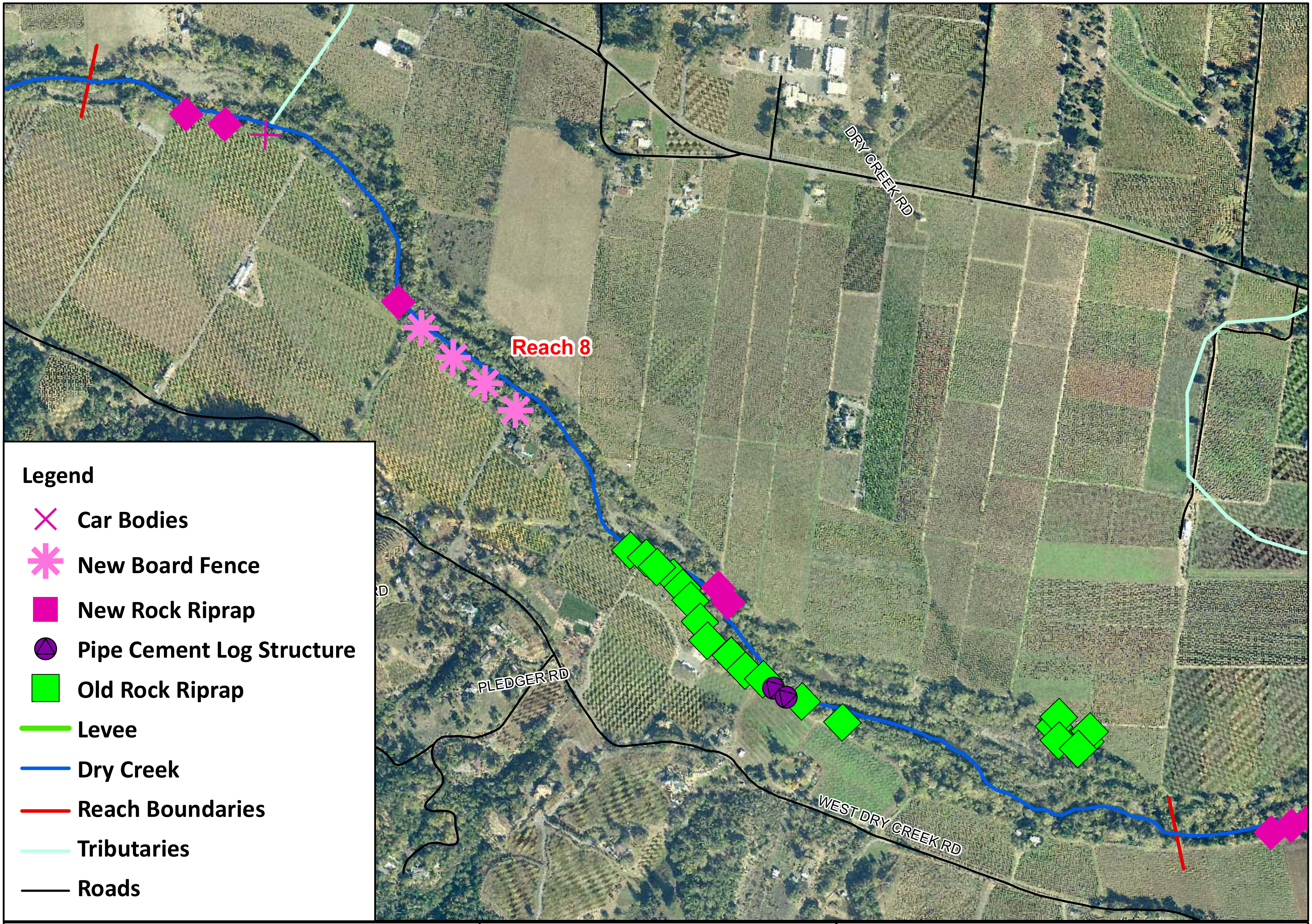
One alcove was measured in Reach 8. It was 15 feet wide, 110 feet long, with a maximum depth of 2 feet. Substrate in the alcove was gravel with fine sediment.

Instream Cover & Woody Debris

194 pieces of wood per mile were counted in Reach 8. Six out of the 8 pieces of large wood (>20" diameter) were found in pools, the other two were in a riffle. The highest densities of wood were in pools and the alcove, most of the wood falling into the small (6 to 12" diameter) category. The lowest cover and complexity was found in flatwaters, with only 13% cover and a complexity rating of 30. In Reach 8, the majority of instream cover was provided by terrestrial vegetation and small woody debris, with root masses providing limited cover in riffles and flatwaters. Boulders provided some additional cover in several pools, where bank stabilization boulders had tumbled into the channel. In addition, only a third of flatwaters contained edge habitat, whereas edge habitat was identified in most mainstem pools and in the alcove.

Table 8: Instream woody debris, cover, and edge habitat frequency for Reach 8.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	158.5	36.7	7.7	203.0	22%	66	67%
Scour Pools	212.9	61.3	6.5	280.6	17%	50	50%
Riffles	134.0			134.0	18%	46	38%
Flatwaters	113.9	27.9	4.3	146.1	16%	40	38%
Alcove	480.0	192.0		672.0	30%	90	100%
	mainstem pieces/mile			193.6			



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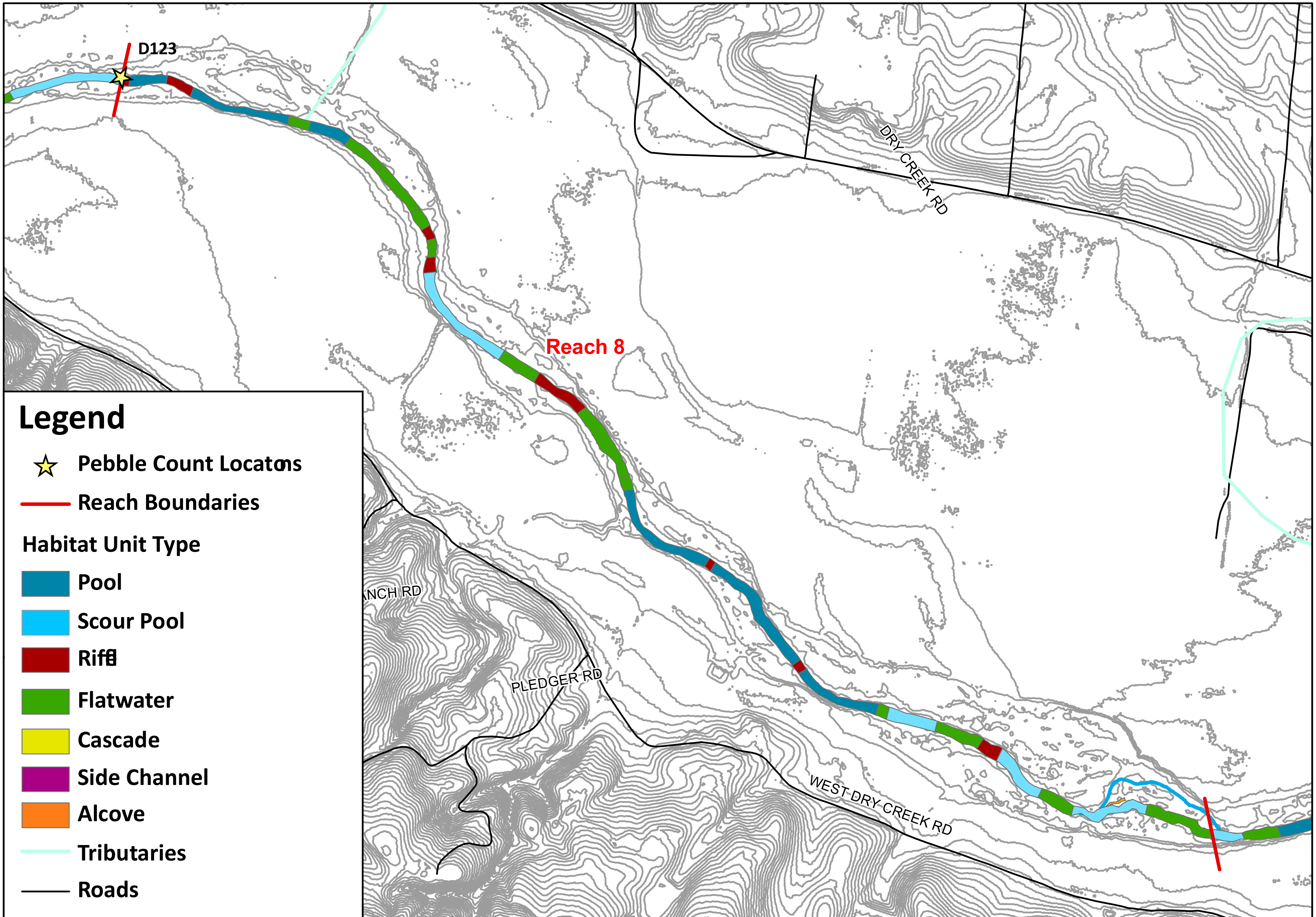

0 700 1,400 Feet

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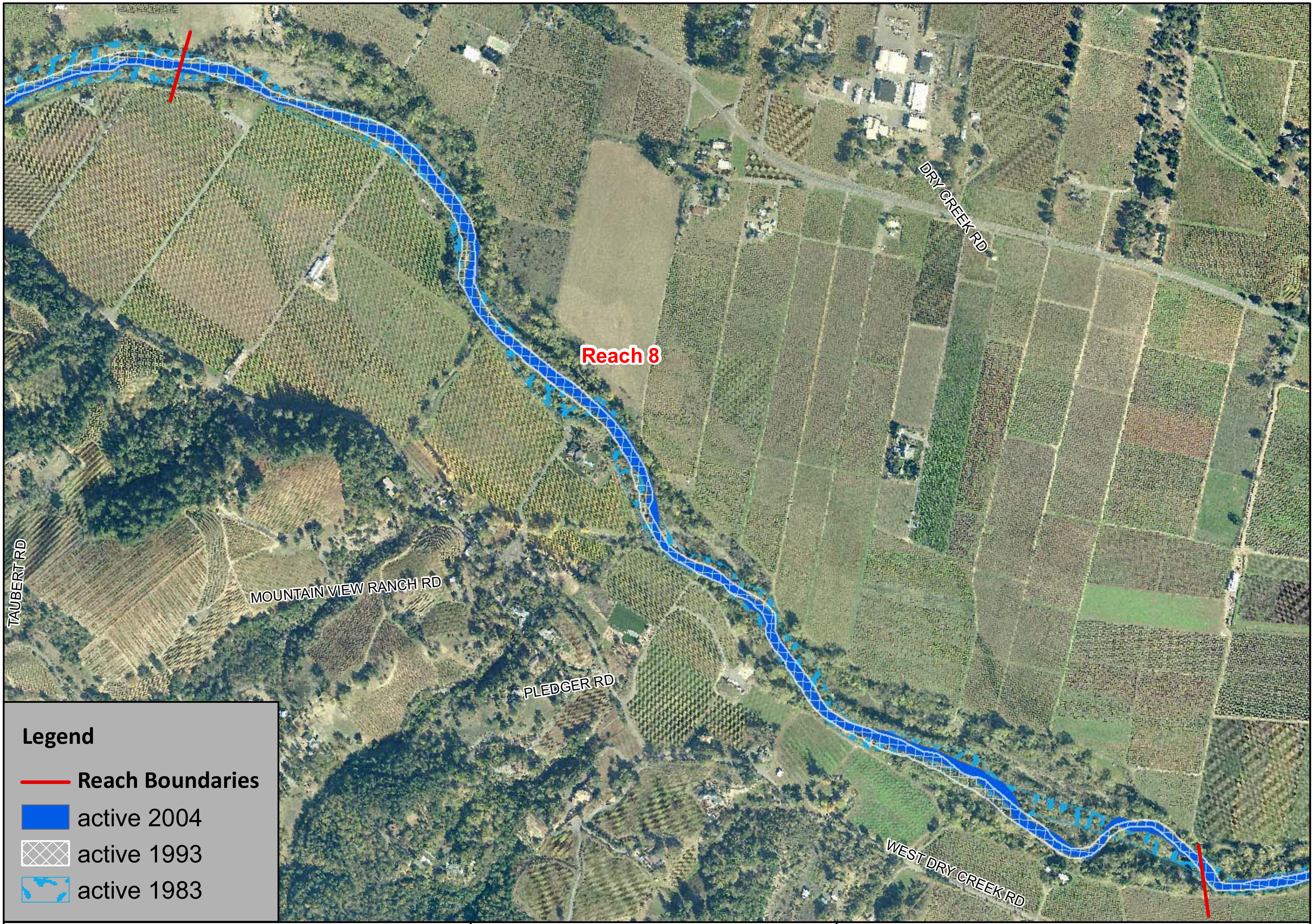

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DRY CREEK
Reach 8 - Channel Positon Map

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8 Appendix A – Detailed Reach Summaries

REACH 9 (RM 9.0 to RM 9.8) **Confined along a fault lineament, elevated former channels**

Reach 9 is a single-thread channel extending upstream to the lower extent of a long stretch of new rock riprap bank stabilization on the right[6] bank. The upper reach boundary is also about 800 feet downstream of where the west lineament diverges from the channel. The Dry Creek channel flows along, or close to, this lineament for about half of the length of Reach 9. There is little sinuosity in this reach and there has been little channel change since the 1940s, other than channel narrowing resulting from channel incision. In some areas, the older and wider channel bed provides opportunities for habitat enhancement. These older channel beds are elevated a few feet above the current channel bed and are often separated from the current channel by alder 'fences' (Figure 45), but habitat could be created with some excavation.

Notable features include a pipe that runs under the creek at river mile 9.4, where the first bedrock was observed as part of the active streambank. A culvert appears to drain directly to the creek at river mile 9.75. Otter scat was also observed in this reach full of crawdad exoskeletons. A former channel ran along the left bank for more than 500 feet. It was protected by a well-vegetated straight berm. The former channel is a long, mostly dry side-channel with one wet alcove. It is filled with alluvial gravel substrate and includes an old rope swing hanging above the dry former channel. Trees grow along the berm in a very straight line. Lastly, a thick layer of algae was observed growing on the substrate of several of the flatwaters and pool tail-outs (e.g. river mile 9.6, in a flatwater).

[6] In the individual reach summaries, right and left bank designation defined as looking downstream.

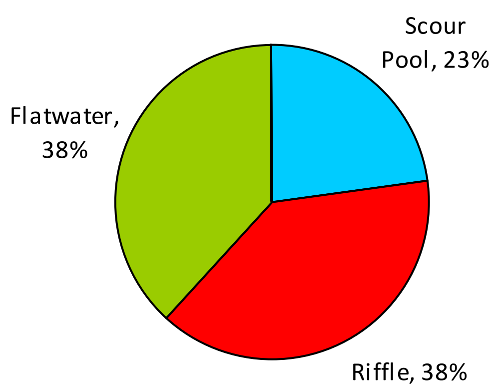
Figure 45: (upper row) pool habitat with riprap bank protection, (lower left) alcove habitat, (lower right) former channel along left bank, protected by a long, straight berm vegetated by even-aged alders.

Habitat Classification

Reach 9 is comprised of 23% pool habitat, 38% flatwater habitat, and 38% riffle habitat by relative frequency (Figure 46). Of the 1.0 mile long reach, there are four riffles that are 65 to 200 ft long representing 15% of the reach on a length basis. The average wetted channel width was 46.0 (st.dev. 9.4).

The average active channel width was 54.0 feet, the active channel depth was 2.6 feet, and the average floodprone width was 93.0 feet. The reach resembled an F4 channel type, with an entrenchment ratio of 1.7 and a active channel width:depth ratio of 22.

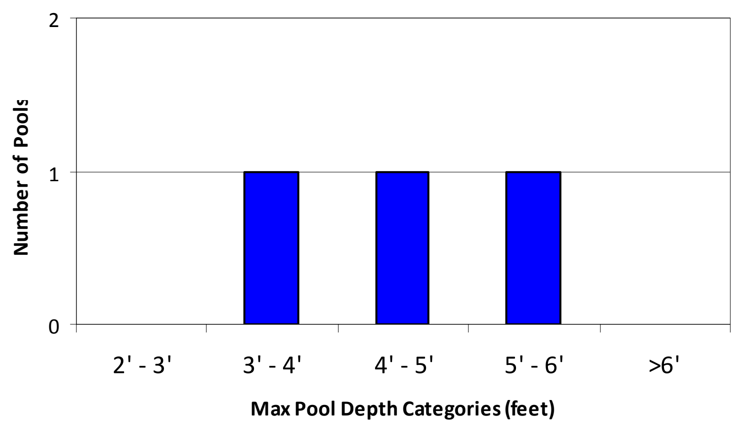
Figure 46: Proportion of Habitat Types by Relative Frequency in Reach 9



Pools

There were three scour pools in Reach 9, one of which contained two very short riffles and a small flatwater section that were shorter than the average wetted width of the channel, and were therefore not classified as separate units. The average maximum pool depth was 4.2 feet, average residual depth of 3 feet, with all of the pools greater than 3 feet deep (Figure 47). Substrate in pools was sand with gravel.

Figure 47: Maximum Pool Depths in Reach 9

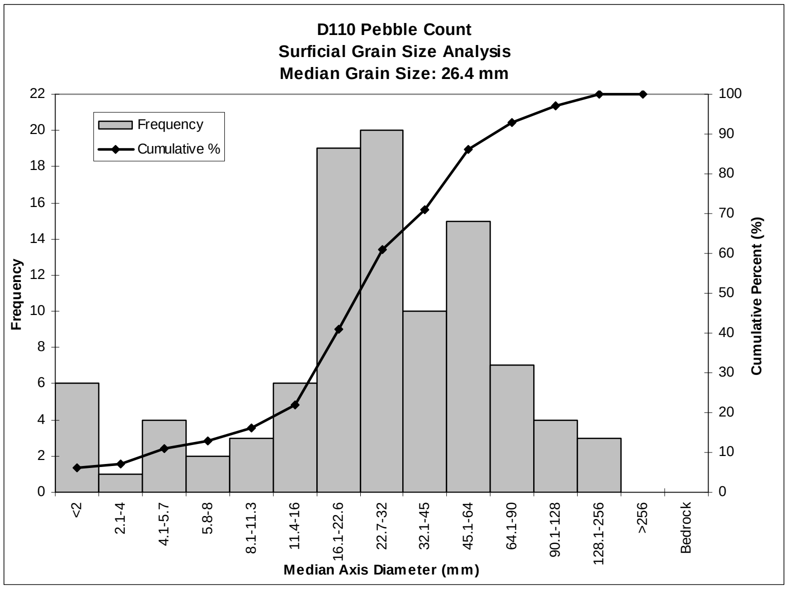


Riffles & Flatwaters

There were five riffles and five flatwaters in Reach 9. The average riffle depth was 0.9 feet, and the average flatwater depth was 1.5 feet. Substrate in riffles was gravel and small cobble, and in flatwaters it was gravel with small cobble and sand. One pebble count was conducted in a riffle near the upstream end of the reach.

The bed material in the riffle near the upstream extent of the reach ranges from sand to large cobbles but is primarily composed of coarse to very coarse gravel with a median grain size of 26 mm (Figure 48). The majority of the sediment fell within the coarse to very coarse gravel category. 81% of the sediment sampled was within desirable size classes for coho spawning (11.4 to 128mm), and 36% was within the desirable size classes for juvenile rearing (32 to 128 mm). 6% of the samples were fine sediments or sand.

Figure 48: Grain size distribution for a riffle near the upstream extent of reach 9 (habitat unit #110).



Side-Channels

No side channels were observed in Reach 9.

Alcoves

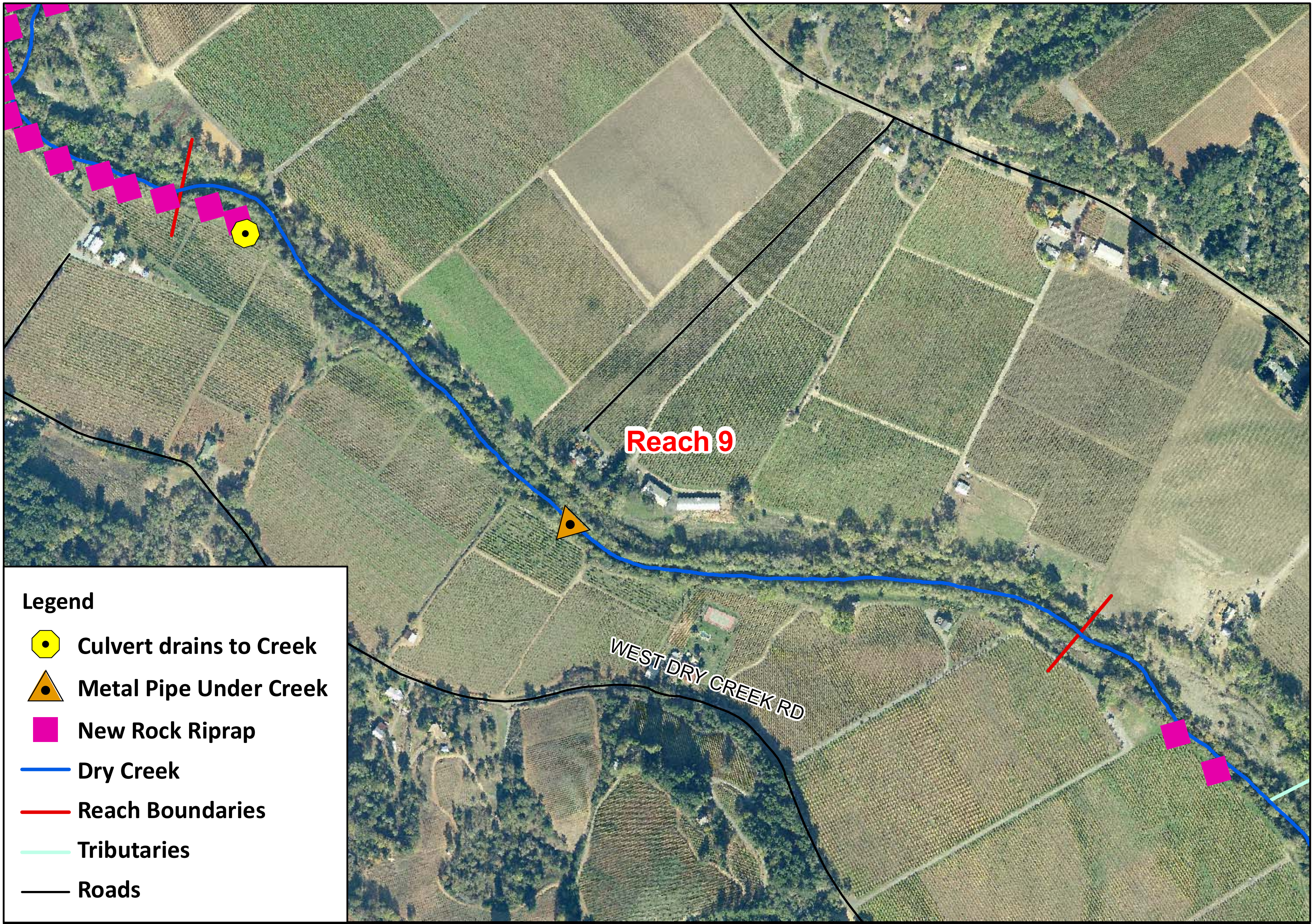
One alcove was measured in Reach 9. It was 53 feet long, 12 feet wide, with a maximum depth of 1.5 feet. Substrate was fine sediment with sand.

Instream Cover & Woody Debris

There were 193 pieces of wood per mile counted in Reach 9 (Table 9). A total of 155 pieces were counted. Of the 9 pieces of large wood (>20" diameter), 8 were counted in pools. The highest density of instream wood was in the mainstem pool, followed by scour pools and riffles. Although cover was provided by terrestrial vegetation and small woody debris in all habitat types, with some additional cover provided by root masses in riffles and flatwaters, and by riprap boulders in one pool. Only the alcove had abundant aquatic vegetation and high percent cover and shelter ratings. Edge habitat was only present in 4 out of a total of 13 habitat units.

Table 9: Instream woody debris, cover, and edge habitat frequency for Reach 9.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Scour Pools	159.8	33.5	12.9	206.3	28%	85	33%
Riffles	161.5	34.0	8.5	204.1	18%	55	20%
Flatwaters	143.3	17.1	10.2	170.5	16%	47	40%
Alcove	99.6	0.0	0.0	99.6	90%	270	0%
	mainstem pieces/mile			192.8			



N E S W

0 500 1,000 Feet

DRY CREEK
Reach 9 Features

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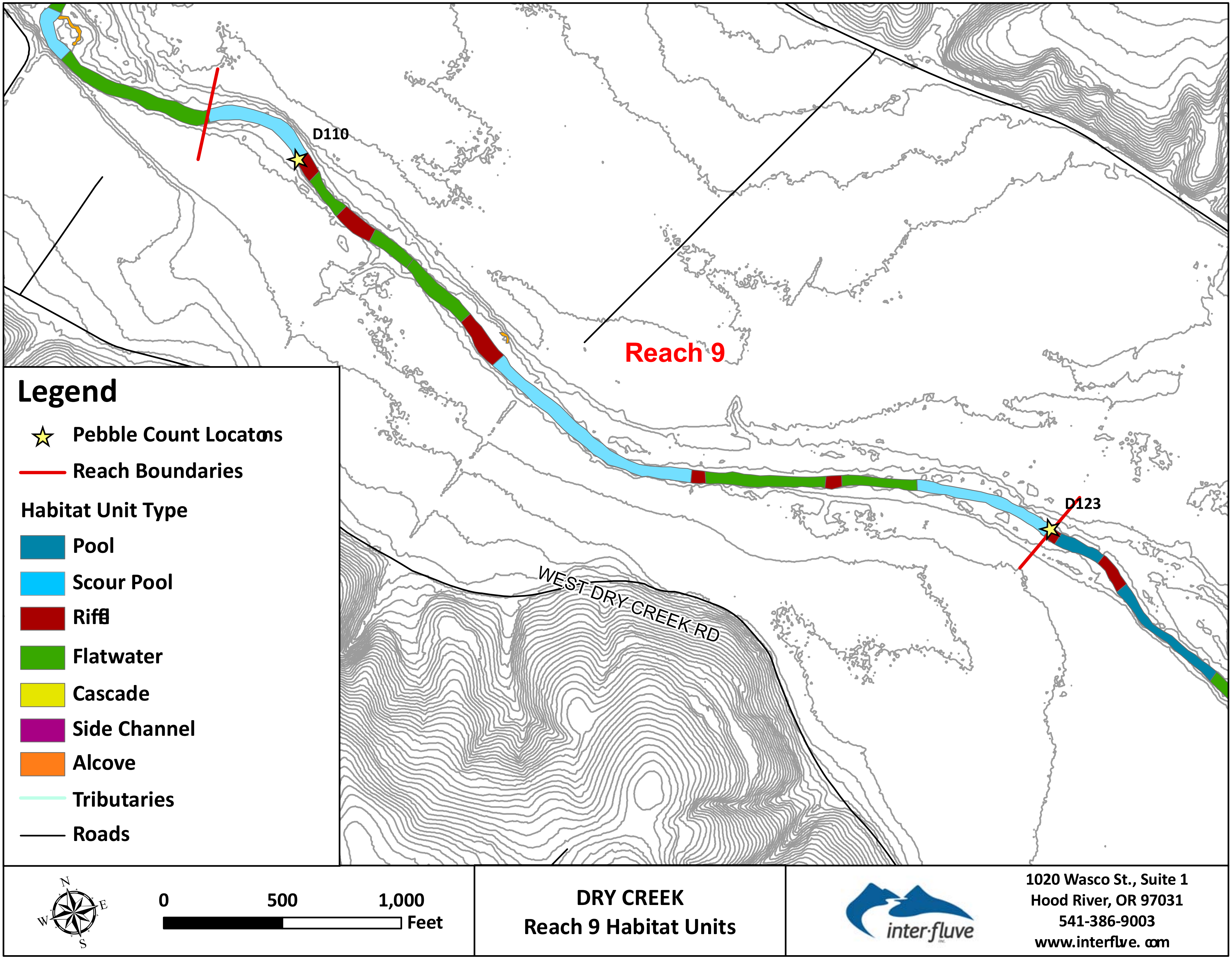

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Reach 9 Habitat Units

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N E S W

0 500 1,000 Feet

DRY CREEK
Reach 9 - Channel Positon Map

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REACH 10 (RM 9.8 to RM 10.3) **Bank stabilization structures, with native sourced boulders**

This reach contains significant length of stabilized streambank. From the start of Reach 10 at river mile 9.8, boulder riprap lines the right[7] bank for 0.3 miles upstream. At river mile 10.1, the tall, eroding left bank is covered with dead grapevines (Figure 49). The right bank at this site has a wide floodplain. Last, at river mile 10.3, I-beam and chainlink fence stabilization structures have been built along the left bank for 250 feet.

Reach 10 is a single-thread channel that extends upstream to where the east lineament intersects Dry Creek about 150 ft downstream of the inflow from an unnamed tributary. This reach is short but contains one large meander bend. Since the dam was built, the channel has narrowed substantially and the meander bend has migrated or avulsed to the opposite side of the riparian corridor. Despite channel modifications that have been built to try to stop bank erosion, the meander bend has continued to migrate southward in the last 25 years.

Figure 49: (upper row) vegetated islands in the middle of a riffle, recruiting small woody debris and creating a small scour pool, (lower left) native green boulder, (lower right) dead grapevine dump to stabilize the bank.

The channel change that has occurred has resulted in a large elevated bar on the right bank that is about 400 ft wide and 500 ft long as well as off-channel pools and backwater channels. The off-channel pools and backwater channels are fed by hyporheic flows and

[7] In the individual reach summaries, right and left bank designation defined as looking downstream.

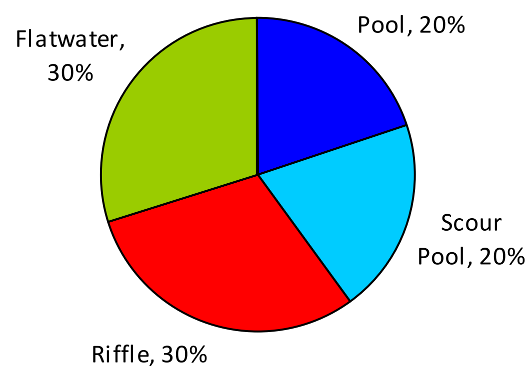
contain numerous salmonids. These areas may provide good analogs for enhancing habitat elsewhere. The large bar provides significant space for enhancing habitat, though this may require a large amount of excavation as the old channels are 6 to 7 ft above the bed.

Also in Reach 10, large, possibly native sourced boulders were observed in the stream, lime-green rocks w/white veins, 3'x3' boulders in substrate at river mile 10.2.

Habitat Classification

The channel in this reach was composed of 30% flatwaters, 20% pools, 20% scour pools, and 30% riffles by relative frequency (Figure 50). There were three riffles in the reach ranging from 70 to 150 ft in length representing only 12% of the reach on a length basis. The average wetted width during the survey was similar to reach 9 (48 ft), but the active channel was wider (78 ft) and the flood prone width was narrower (87 ft). The average active channel depth was 2.4 ft. The total mainstem length of Reach 10 is 0.6 miles.

Figure 50: Proportion of Habitat Types by Relative Frequency in Reach 10

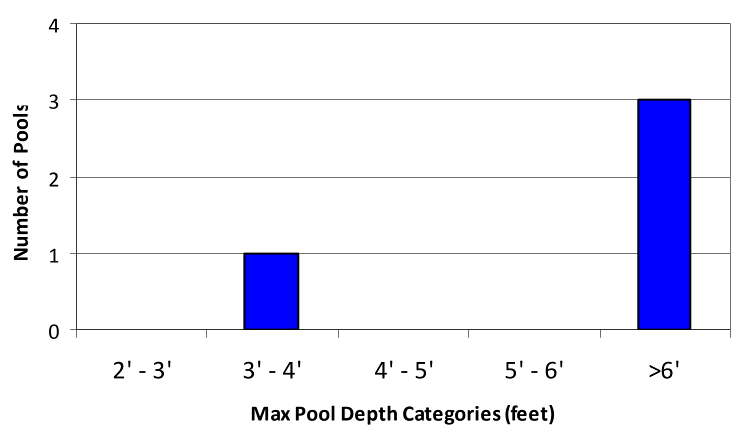


With a low entrenchment ratio (1.1) and a high active channel width:depth ratio (32), the reach resembles an F4-type channel, plane-bed reach with ample flatwater habitat and deep pools.

Pools

There are four pools in Reach 10, two of which are scour pools. All of the pools have a maximum depth of greater than 3 feet, with average maximum depth of 6.3 feet and average residual depth of 5 feet (Figure 51). Substrate in pools is gravel with sand, and some small cobble.

Figure 51: Maximum Pool Depths in Reach 10.



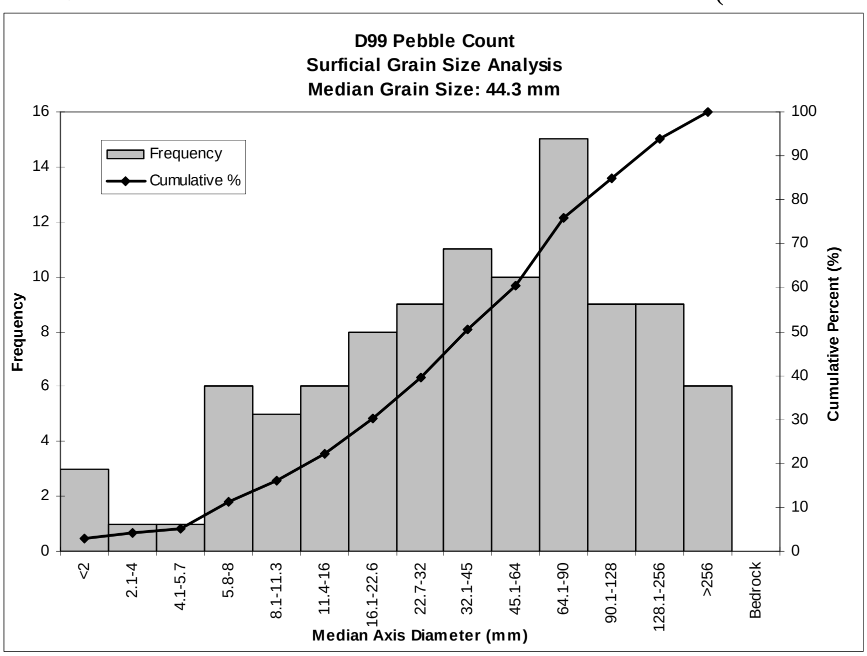
Riffles & Flatwaters

Three riffles and three flatwaters were in Reach 10. The average riffle depth was 1.1, while the average flatwater depth was 1.9 feet. Substrate in riffles was small cobble, with gravel and some large cobble. In flatwaters substrate was gravel with small cobble and sand. Algal mats grow on the substrate in some flatwaters.

The bed material in a riffle in the middle of the reach ranges from sand to small boulders but is primarily composed of very coarse gravel and small cobble. In this riffle, there were two mid-channel bar/islands with living willows and alders that have recruited a small woody debris jam. One island has formed a 15'x20' scour pool within the riffle. The median grain size for this riffle is very coarse gravel at 44 mm (Figure 52). 69% of the sediments were within ideal spawning sizes, and 45% were within ideal juvenile rearing sizes. 3% were fine sediment or sand. This riffle had a higher proportion of large cobbles and small boulders than any other.

Bed material may not be transported through this reach as easily as further downstream. The bed material in this reach is generally larger than downstream and there is evidence of aggradation: the bases of alders near the channel are buried by gravels and cobbles. The ability of the reach to transport bed material will need to be determined before attempting habitat enhancement.

Figure 52: Grain size distribution for a riffle in the middle of reach 10 (habitat unit #99).



Side-Channels

One riffle-dominated side channel in Reach 10 was measured, with a length of 70 feet, a width of 7 feet, and an average depth of 0.3 feet (Figure 53). Substrate was gravel, with small cobble.

Figure 53: (left) side channel, (right) alcove habitat.

Alcoves

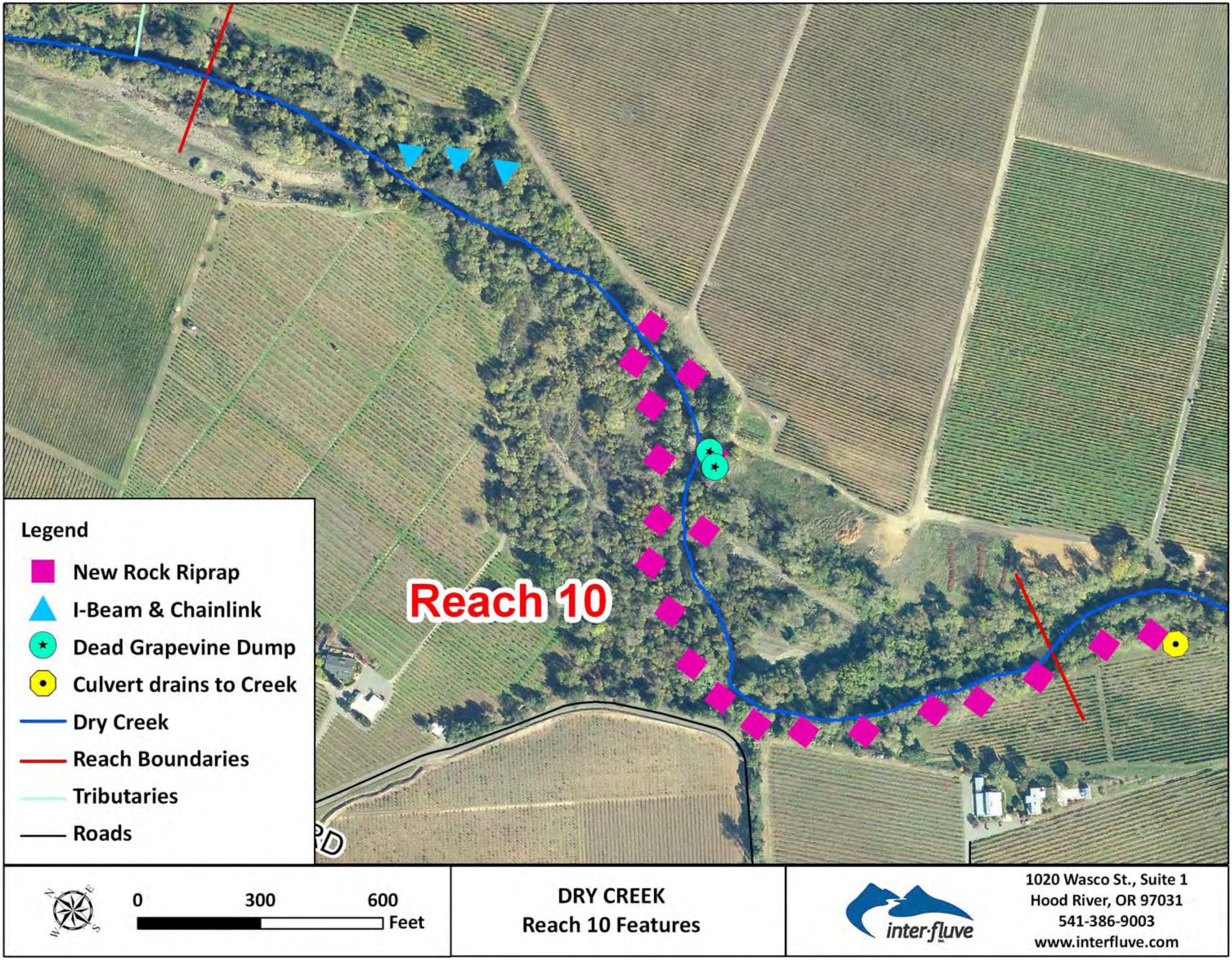
Three alcoves were observed in Reach 10. Water temperature measured in one alcove was 60° F, while Dry Creek water was 56° F. Several juvenile salmonids were seen in this alcove. Another alcove was 350 feet long, and resembled a side channel with no outlet. The water temperature in this series of small pools was also 60° F. Many small fish, frogs, and lizards were observed. This long alcove may serve as a template for enhancement or construction of additional alcoves. The average maximum depth of the alcoves was 2.6 feet, with substrate consisting of sand, gravels, fine sediment, and some small cobble.

Instream Cover & Woody Debris

In Reach 10, there were 362 pieces of wood per mile. A total of 235 pieces of wood were counted, 209 of these in the mainstem (Table 10). The highest wood densities by length were in scour pools, riffles, alcoves, and pools. Out of nine large wood pieces (>20" diameter), 7 were in pools. Only side channels and alcoves had significant percent cover and shelter rating (>40% and >100, respectively). Cover was primarily provided by small woody debris and terrestrial vegetation, and by aquatic vegetation in alcoves. There were few units with edge habitat present in Reach 10, with only two out of the two mainstem habitat pools, and all of the three alcoves providing edge habitat.

Table 10: Instream woody debris, cover, and edge habitat frequency for Reach 10.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	229.0	60.6	13.5	303.1	28%	83	100%
Scour Pools	355.7	125.5	34.9	516.1	33%	98	0%
Riffles	402.7	119.3	14.9	536.9	20%	60	0%
Flatwaters	201.1	41.1	4.6	246.9	22%	65	0%
Side-Channels				0.0	50%	100	0%
Alcoves	188.6	138.3		326.9	86%	258	100%
	mainstem pieces/mile			361.8			


Reach 10
Legend
New Rock Riprap
I-Beam & Chainlink
Dead Grapevine Dump
Culvert drains to Creek
Dry Creek
Reach Boundaries
Tributaries
Roads
0
300
600
Feet
DRY CREEK
Reach 10 Features
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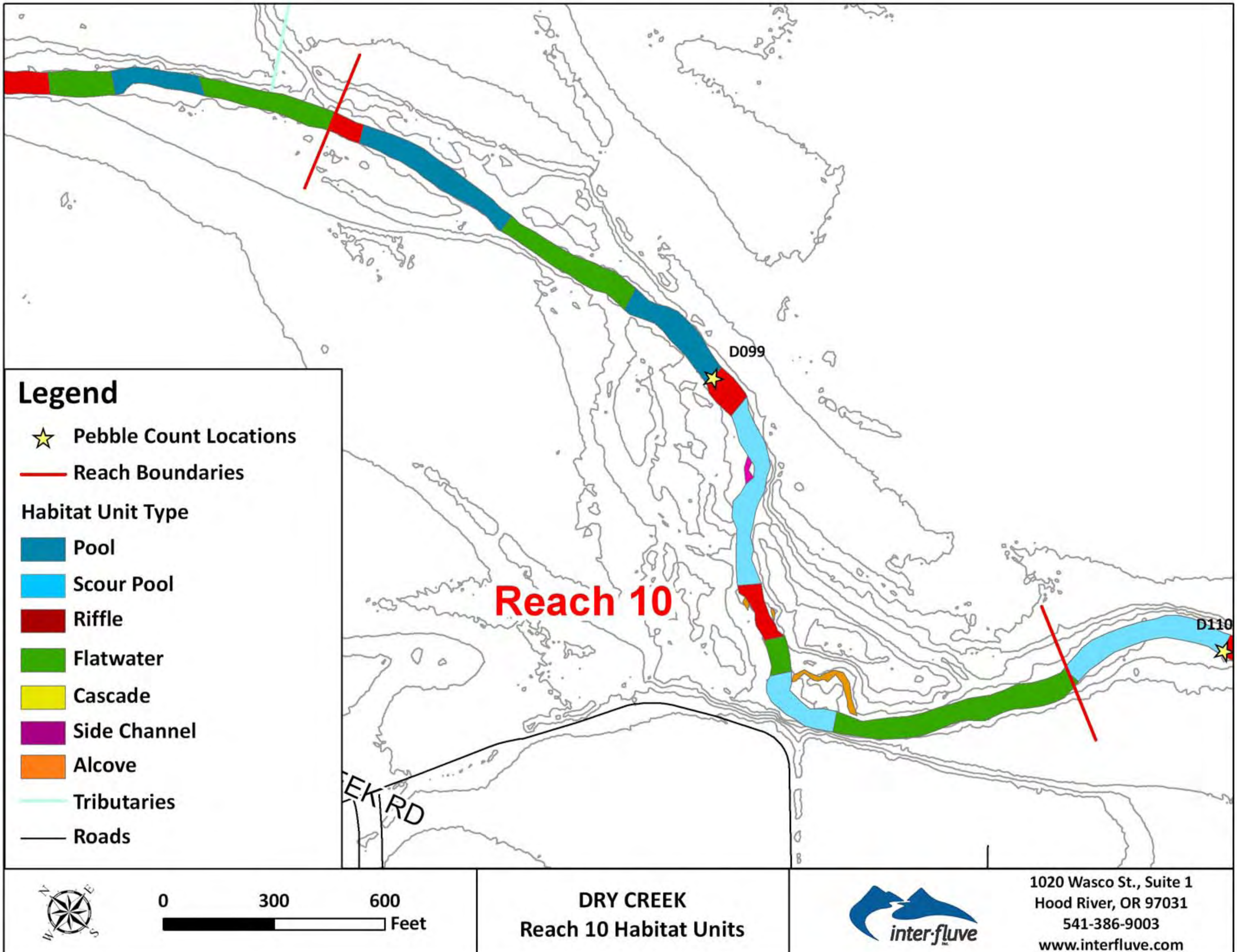

DRY CREEK
Reach 10 Habitat Units

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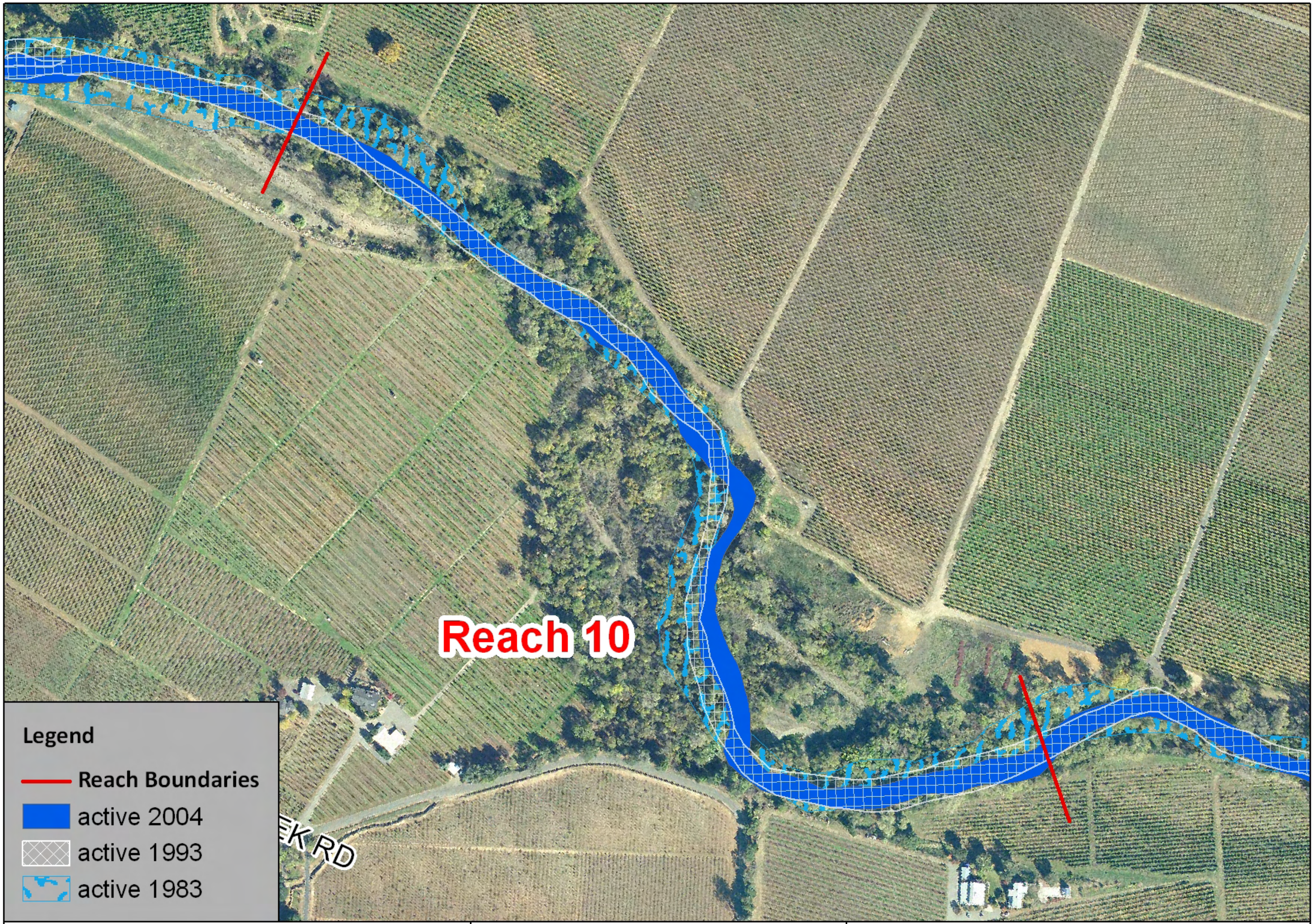

0 300 600 Feet

DRY CREEK
Reach 10 - Channel Position Map

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REACH 11 (RM 10.3 to RM 11.0) **Yoakim Bridge to Pena Creek**

Reach 11 contains several notable features (Figure 54). First, the upper boundary of Reach 11 is the confluence of Pena Creek with Dry Creek. The mouth of Pena Creek remains watered in the summertime, as serves as a 100 foot by 25 foot-wide alcove. The Pena Creek inlet was also hopping with hundreds of small frogs at the time of the survey. The Pena Creek watershed is the largest of the tributaries in the study area (22.3 mi^2) and contributes substantial quantities of flow and sediment to Dry Creek.

Reach 11 flows under Yoakim Bridge at river mile 10.7. A flow gage that operated in the past is located on Yoakim Bridge. Concrete and concrete chunks 200 feet downstream of the bridge along the left[8] bank and across the channel cause a small cascade in the mainstem. At river mile 10.45, an intermittent stream enters on the left bank of Dry Creek. A car body is partially buried in the left bank of this tributary, and vegetation has been cleared from all of the banks.

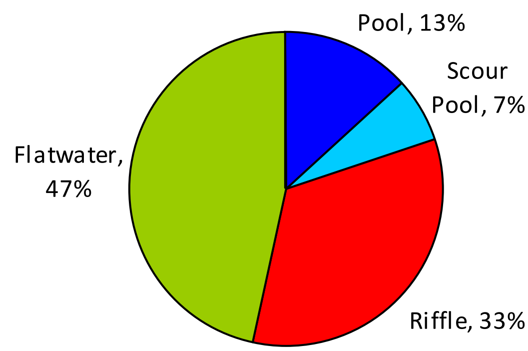
Figure 54: (upper left) A large gravel bar in Pena Creek 100 feet upstream from its confluence with Dry Creek, (upper right) an invasive grass (*Arundo donax*) grows on the right bank just downstream from Pena Creek, (lower left) small, intermittent stream with cleared banks, (lower right) Pebble count being conducted in a riffle in Reach 11.

[8] In the individual reach summaries, right and left bank designation defined as looking downstream.

The channel in reach 11 is single-thread with little sinuosity. Although the channel has narrowed, there has been little channel change since the 1940s except in the middle of the reach around Yoakim Bridge.

Habitat Classification

Figure 55: Proportion of Habitat Types by Relative Frequency in Reach 11



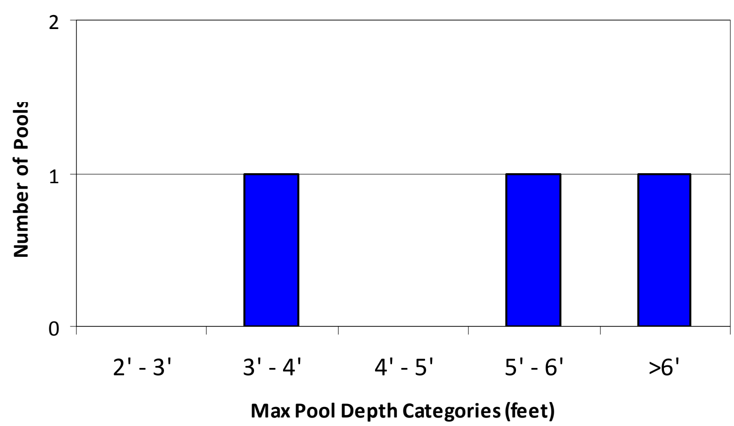
The channel in reach 11 is primarily composed of flatwaters (47%) and riffles (33%) but also contains a few pools and scour pools (20% combined), on a relative frequency basis (Figure 55). The five riffles in this reach ranging from 50 to 330 ft in length comprise 21% of the reach on a length basis. The channel geometry is similar to reach 10; the average wetted width during the survey was 47 ft. The average active channel depth in the riffles was 2.6 ft. The active channel and flood prone widths are narrower than in Reach 10 at 57 and 78 ft respectively. The total length of this reach is 0.7 miles.

The high active channel width:depth ratio of 22 and the low entrenchment ratio of 1.4 cause this channel to resemble an F4 channel type. The abundant flatwaters and deep pools resemble a plane-bed channel morphology.

Pools

There were three pools in Reach 11, one of which was a scour pool. All of the pools had a maximum depth of greater than 3 feet, with an average maximum depth of 5.1 feet (Figure 56). The average residual pool depth was 4.3 ft, and the average pool crest depth was 1.6 ft. Substrate in pools was gravel with sand, and some small cobble.

Figure 56: Maximum Pool Depths in Reach 11.

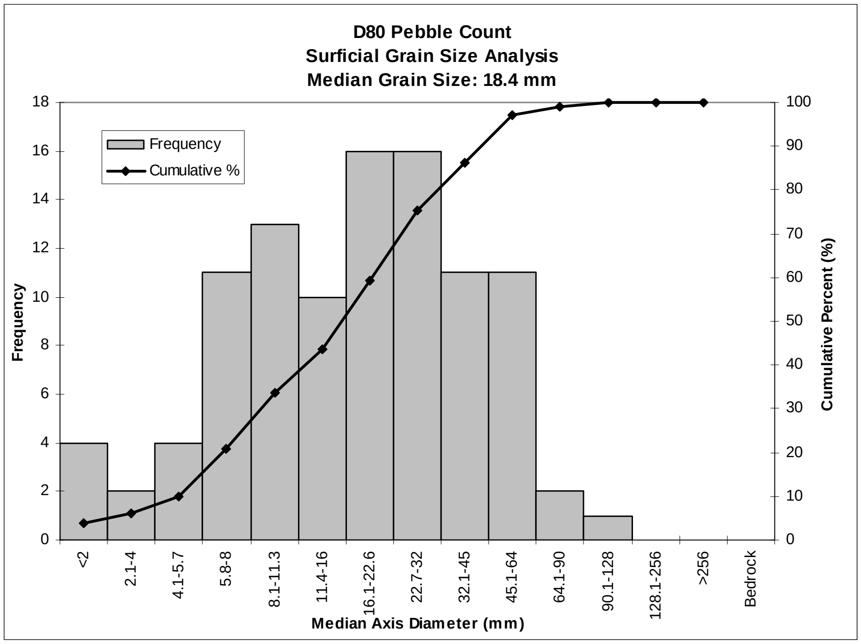


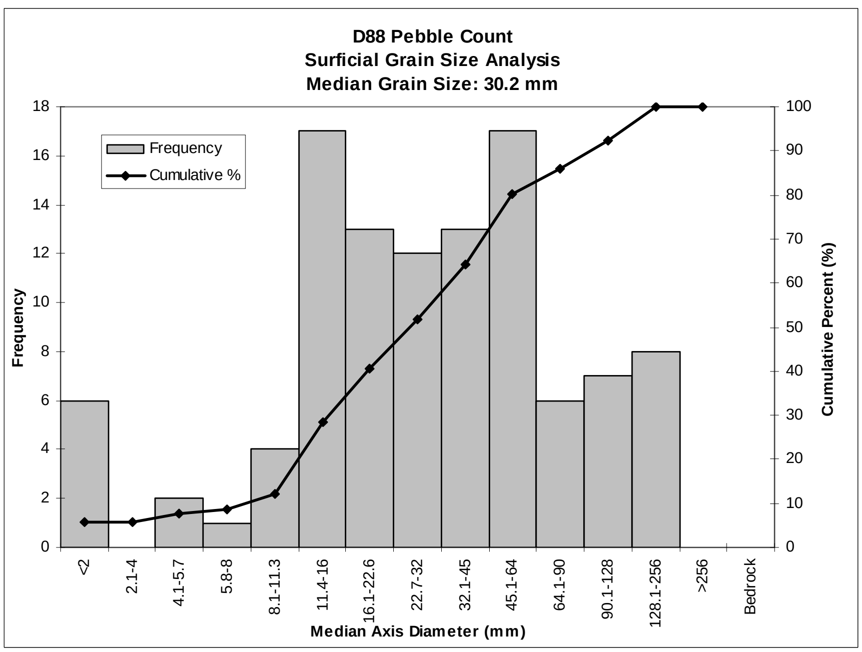
Riffles & Flatwaters

There were five riffles and six flatwaters in Reach 11. The flatwaters were extremely long, with two over 600 feet long, and another over 300 feet long. The average riffle depth was 1.0, and the average flatwater depth was 1.8 feet. Substrate in both riffles and flatwaters was predominantly gravel with small cobble.

The bed material in riffles downstream from Pena Creek and downstream from Yoakim Bridge ranges from sand to large cobbles but is primarily composed of coarse to very coarse gravel with median grain sizes of 18 and 30 mm respectively (Figure 57). 73% was within ideal spawning gravel sizes, 33% within ideal fry rearing size classes, and 5% of the samples were fine sediment or sand.

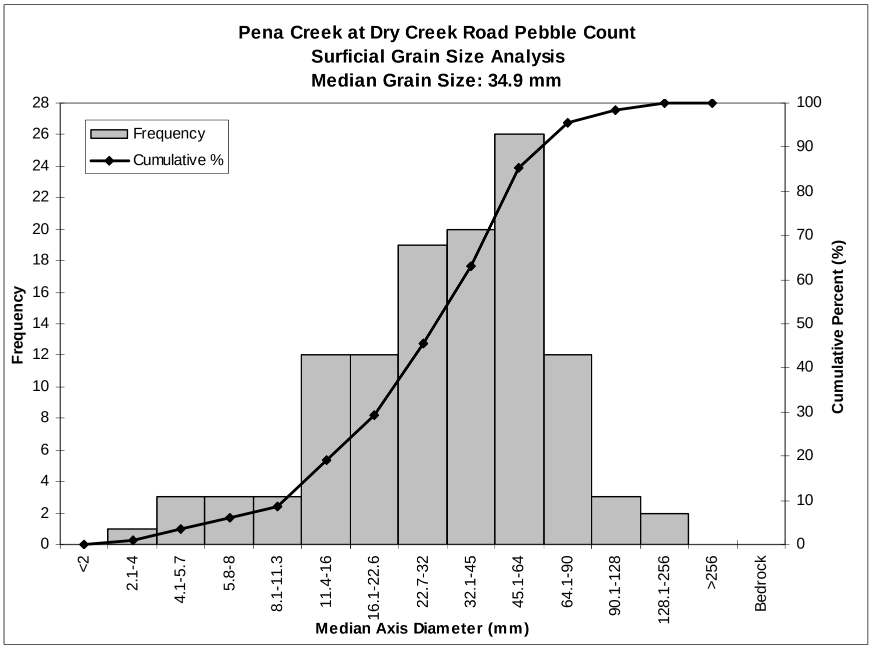
Figure 57: Grain size distribution for riffles downstream from Pena Creek (habitat unit #80) and downstream from Yoakim Bridge (habitat unit #88).

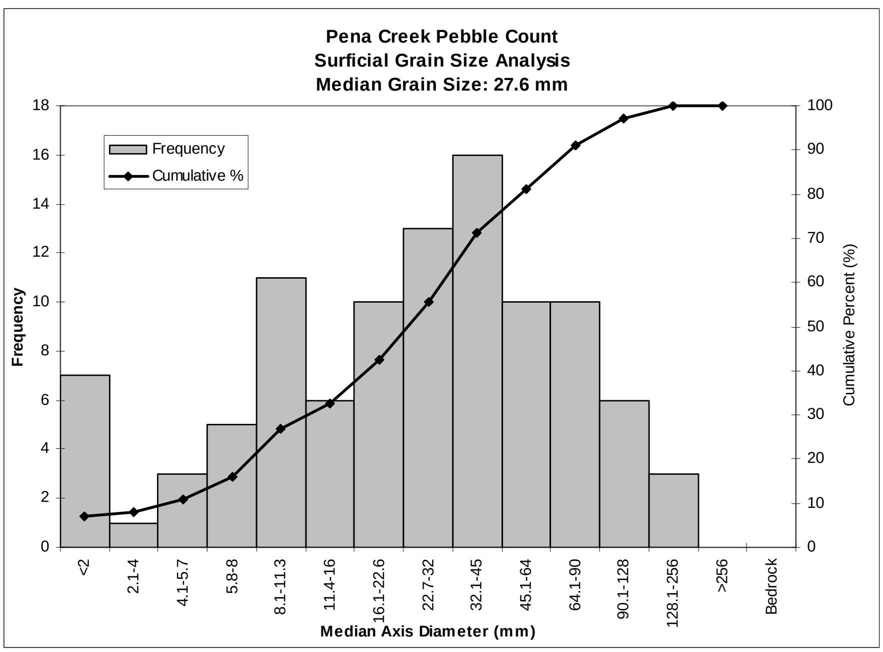




The bed material of Pena Creek was analyzed at the mouth and near the Dry Creek Road bridge about 1 mile upstream from the confluence with Dry Creek. At both locations, the Pena Creek bed material is primarily coarse to very coarse gravel. The median grain size decreases from 35 mm at the bridge to 28 mm near the mouth (Figure 58). This bed material is similar to the Dry Creek bed material downstream of Pena Creek.

Figure 58: Grain size distribution for Pena Creek at the Dry Creek Road bridge and near the confluence with Dry Creek.





Side-Channels

One, 100 foot long side channel was located on the left bank upstream from Yoakim Bridge. It was 25 feet wide, with an average depth of 1 foot. Substrate was gravel with small cobble.

Alcoves

The primary alcove in Reach 11 was the inlet at the mouth of Pena Creek. The maximum depth of this alcove was 2.3 feet. Substrate was gravel with fine sediment. Just downstream of Pena Creek, there were two very small alcoves that were less than a channel-width long. One was on the left bank in the flatwater, and another 10' long alcove was located on the right bank of the first riffle.

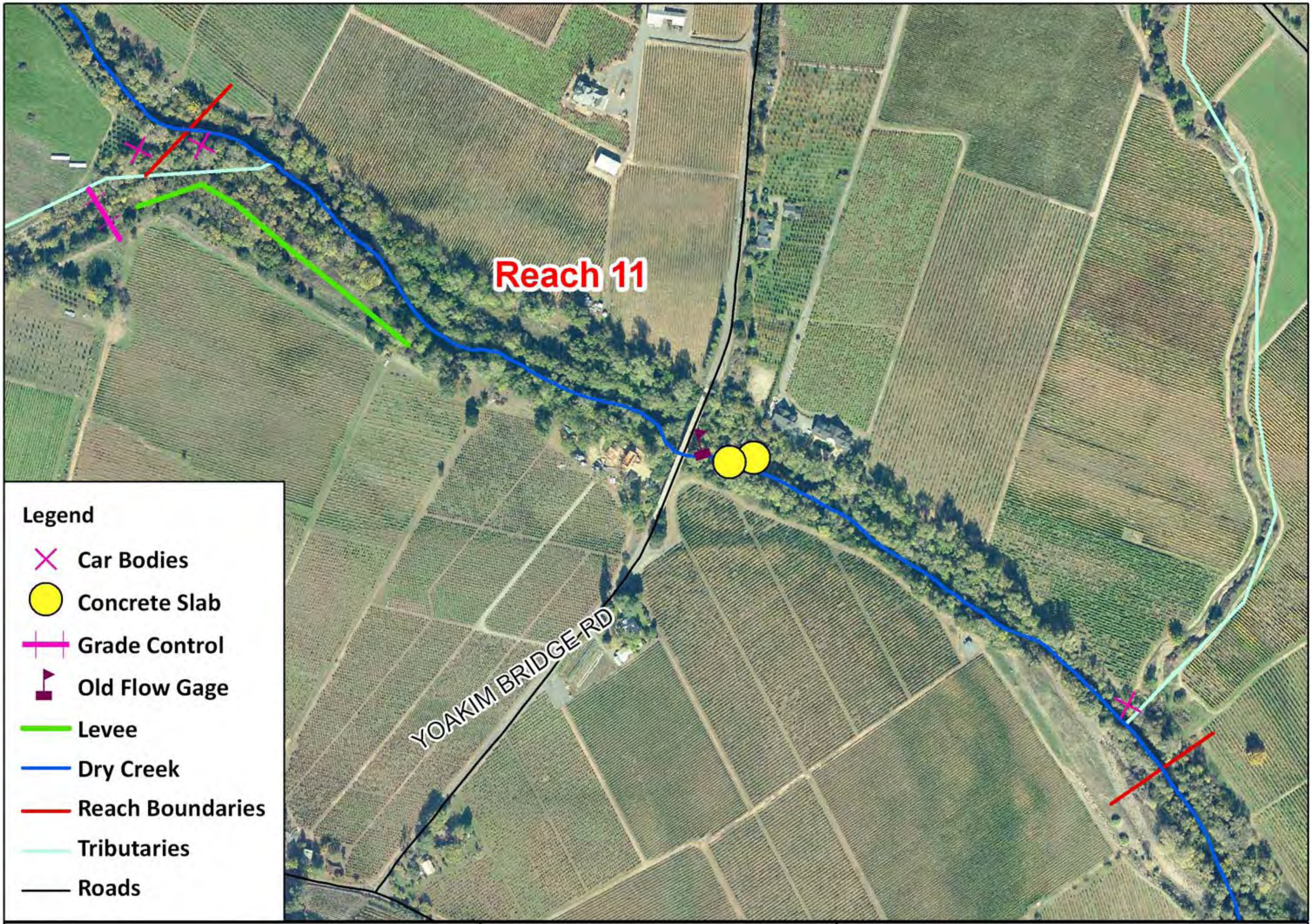
Figure 59: (left) glide habitat in Reach 11, (right) a deep pool with overhanging willows.

Instream Cover & Woody Debris

In Reach 11, there were 269 pieces of wood per mile. A total of 196 pieces of wood were counted, 47% of them in pools (Table 11). However, this number is likely an underestimate for these deeper pools, because woody debris could have been hidden under profuse willow thickets overhanging deeper, dark waters. Regardless, the highest density of wood was recorded in pools, although 6 out of the 12 large wood pieces (>20" diameter) were recorded in flatwaters. The highest levels of instream cover were also found in pools. Most of the cover was provided by woody debris and terrestrial vegetation, with some root masses. There was very little edge habitat in Reach 11, most of it associated with scour pools, and some present at the inlet of Pena Creek.

Table 11: Instream woody debris, cover, and edge habitat frequency for Reach 11.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	302.0	201.4	22.4	525.8	38%	113	0%
Scour Pools	330.0	132.0	0.0	462.0	20%	60	100%
Riffles	79.0	52.7	19.8	151.4	10%	29	0%
Flatwaters	183.7	52.5	15.3	251.4	19%	58	0%
Side-Channels	105.6			105.6	5%	15	0%
Alcoves	105.6			105.6	10%	20	100%
	mainstem pieces/mile			269.0			



0 400 800
Feet

DRY CREEK
Reach 11 Features

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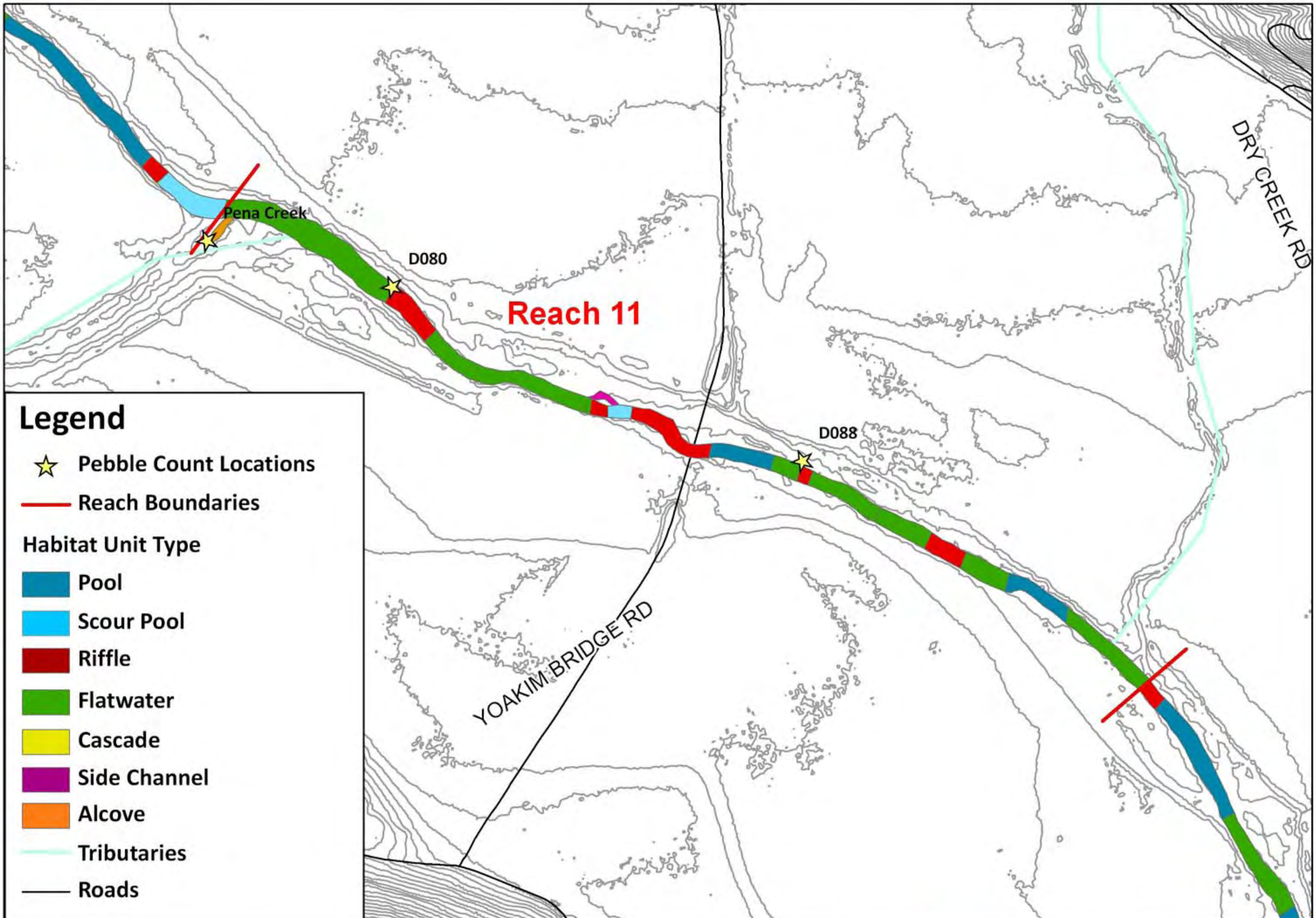

0 400 800 Feet

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Reach 11 Habitat Units

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0 400 800 Feet

DRY CREEK
Reach 11 - Channel Position Map

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REACH 12 (RM 11.0 to RM 11.7) **Pena Creek to Dutcher Creek**

Reach 12 is a single-thread channel extending from the Pena Creek confluence upstream to below the Dutcher Creek confluence. In addition to Dutcher and Pena creeks, an unnamed tributary flows into Dry Creek on the left[9] bank about half way through the reach at river mile 11.6. The active channel has narrowed substantially through the photo record, but there has been little lateral channel change since the dam was built, except for slight migrations immediately downstream from the unnamed tributary.

Figure 60: (upper left) pump in Dry Creek at river mile 11.75, (upper right) tributary at river mile 11.6, (lower left) straight bermed streambank along left bank, (lower right) gravel bar at river mile 11.75.

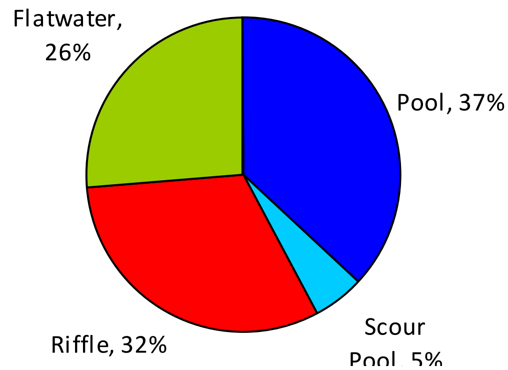
At river mile 11.65, a gravel bar forms along the left bank. Riprap bank stabilization covers the streambanks for about 800 feet throughout Reach 12. Riprap boulders have tumbled into the creek from these bank protection measures and provide some cover. A fault lineament runs along the left bank for the lower half of Reach 12.

[9] In the individual reach summaries, right and left bank designation defined as looking downstream.

Habitat Classification

By relative frequency, Reach 12 is primarily composed of pools (42%) but also contains riffles (32%) and flatwaters (26%, Figure 61). Side channels and alcoves represent 8% of the wetted channel area. There are six riffles that range in length from 50 to 230 ft and represent 19% of the mainstem on a length basis. The two riffles near the upstream reach boundary appear to have significant riprap materials as part of the substrate.

Figure 61: Proportion of Habitat Types by Relative Frequency in Reach 12

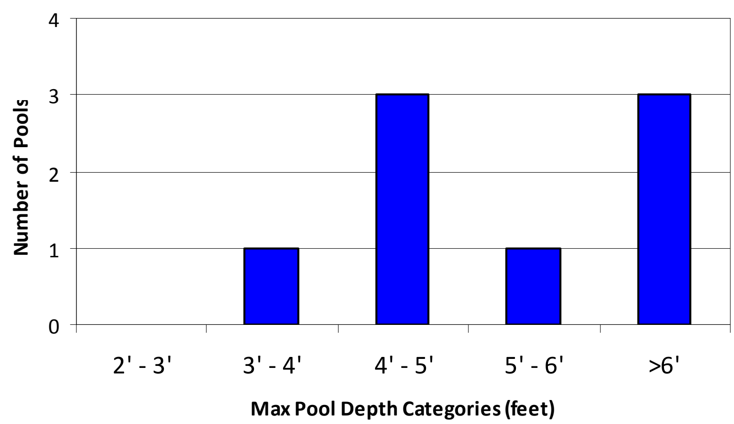


The average wetted channel width in Reach 12 was 46.0 feet, similar to Reach 11. The average active channel width was 54.0 feet, with an active channel depth of 2.6 feet, and a floodprone width of 93.0 feet. The entrenchment ratio was 1.7, and the active channel width:depth ratio was 21.

Pools

There were 8 pools in Reach 12, one of which was a scour pool. All of the pools had a maximum depth greater than 3 feet (Figure 62). Two pools had a maximum depth over 7 feet. The average maximum pool depth was 5.5 feet (stdev=2.0). The average residual depth was 3.9 ft., and the average pool crest depth was 1.5 ft. Substrate in pools was gravel with small cobble and sand, with a few boulders derived from riprap bank protection.

Figure 62: Maximum Pool Depths in Reach 12.

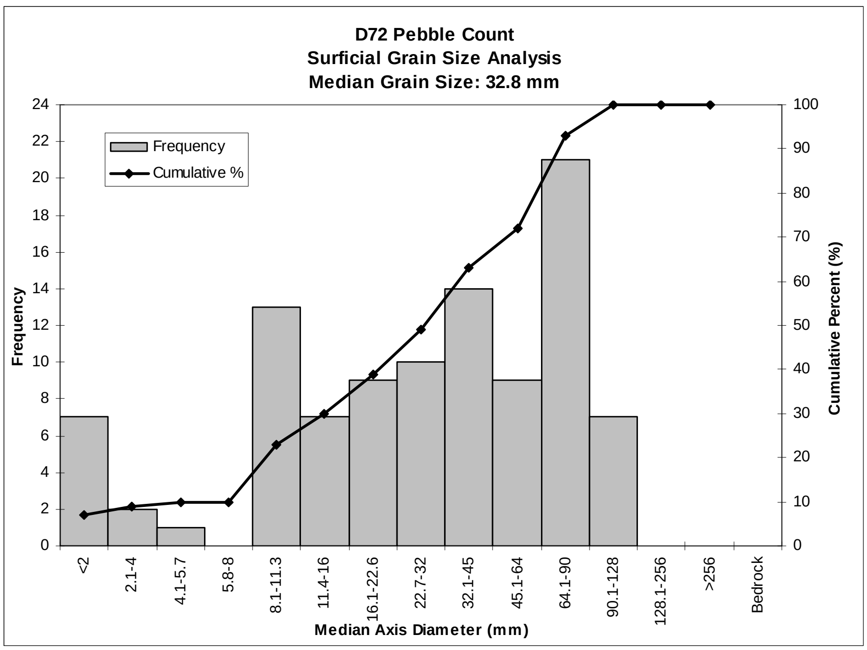


Riffles & Flatwaters

There were 6 riffles and 5 flatwaters in Reach 12. The average riffle depth was 1.4 feet, and the average flatwater depth was 2.0 feet. Substrate in riffles and flatwaters was gravel with small cobble, and some boulders associated with riprap banks.

The material in the riffle in the middle of the reach below the unnamed tributary ranges from sand to small cobbles with fairly even percentages of medium, coarse and very coarse gravel and small cobbles. The median grain size is coarse gravel at 33 mm. 77% were within ideal sizes for coho spawning (11.4 to 128mm), and 51% were within ideal sizes for juvenile rearing (32 to 128mm). 7% of the samples were fine sediments or sand.

Figure 63: Grain size distribution for a riffle in the middle of reach 12 downstream of an unnamed tributary (habitat unit #72).



Side-Channels

There were three side channels in Reach 12, two were pool dominated, and one was comprised of a single riffle. The side channel pools were 90 and 120 feet long, 12 and 32 feet wide, and 2.1 and 3.2 feet deep. Substrate in the pools was gravel with sand. The longer side channel pool resembled a straight canal, similar to the long alcove unit in this reach. The side channel riffle was 140 feet long, by 15 feet wide, with an average depth of 1.1 feet. Substrate in the side channel riffle was gravel with small cobble.

Alcoves

There was one alcove in Reach 12. It was 300 feet long, 25 feet wide, and had a maximum depth of 2.5 feet. Substrate was gravel with fine sediment. In addition, two small off-channel pools were observed on the left bank gravel bar that forms river mile 11.75. Each pool was 10 feet by 10 feet in area.

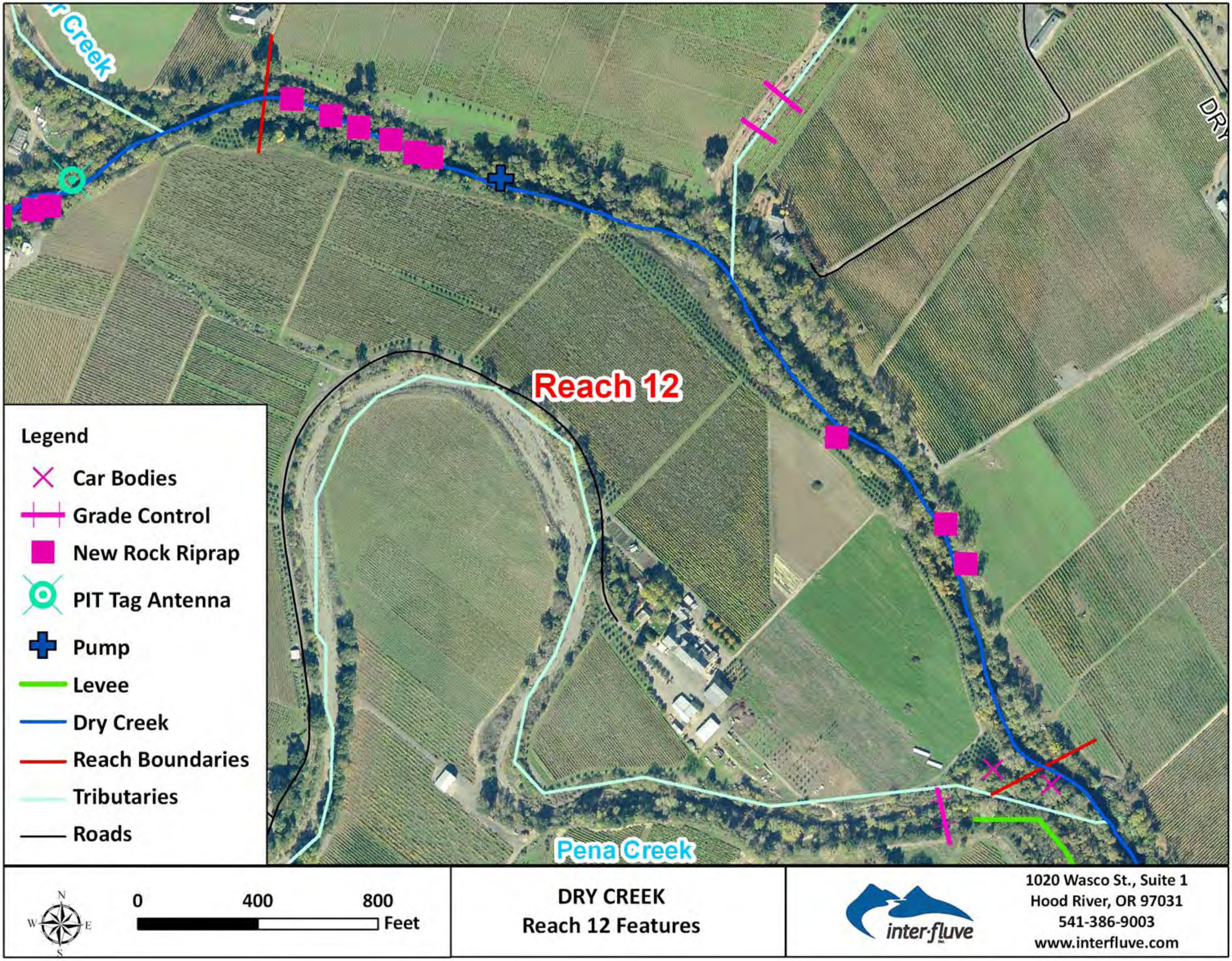
Instream Cover & Woody Debris

161 pieces of wood were categorized in Reach 12. Of these, 44% were in pools (Table 12). The highest densities of woody debris were found in side channels and in scour pools. Only three large pieces of wood were observed in Reach 12, one of which was in a side channel. Overall, cover was provided by overhanging vegetation and woody debris (Figure 64). Some cover was provided by boulders associated with bank stabilization measures, and boulders in riffles, root masses provided some limited instream cover. Edge habitat was associated with four out of the eight pools in Reach 12, and with a side channel and an alcove.


Figure 64: (left) green tunnel of riparian vegetation, (right) vegetation providing instream cover.

Table 12: Instream woody debris, cover, and edge habitat frequency for Reach 12.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	110.6	34.9	0.0	145.5	25%	68	57%
Scour Pools	142.2	121.8	0.0	264.0	25%	75	0%
Riffles	142.9	30.1	7.5	180.5	20%	53	0%
Flatwaters	170.1	34.0	5.7	209.8	28%	83	0%
Side-Channels	301.7	105.6	15.1	422.4	20%	60	33%
Alcoves	140.8	17.6	0.0	158.4	95%	285	100%
	mainstem pieces/mile			176.6			



DRY CREEK
Reach 12 Features

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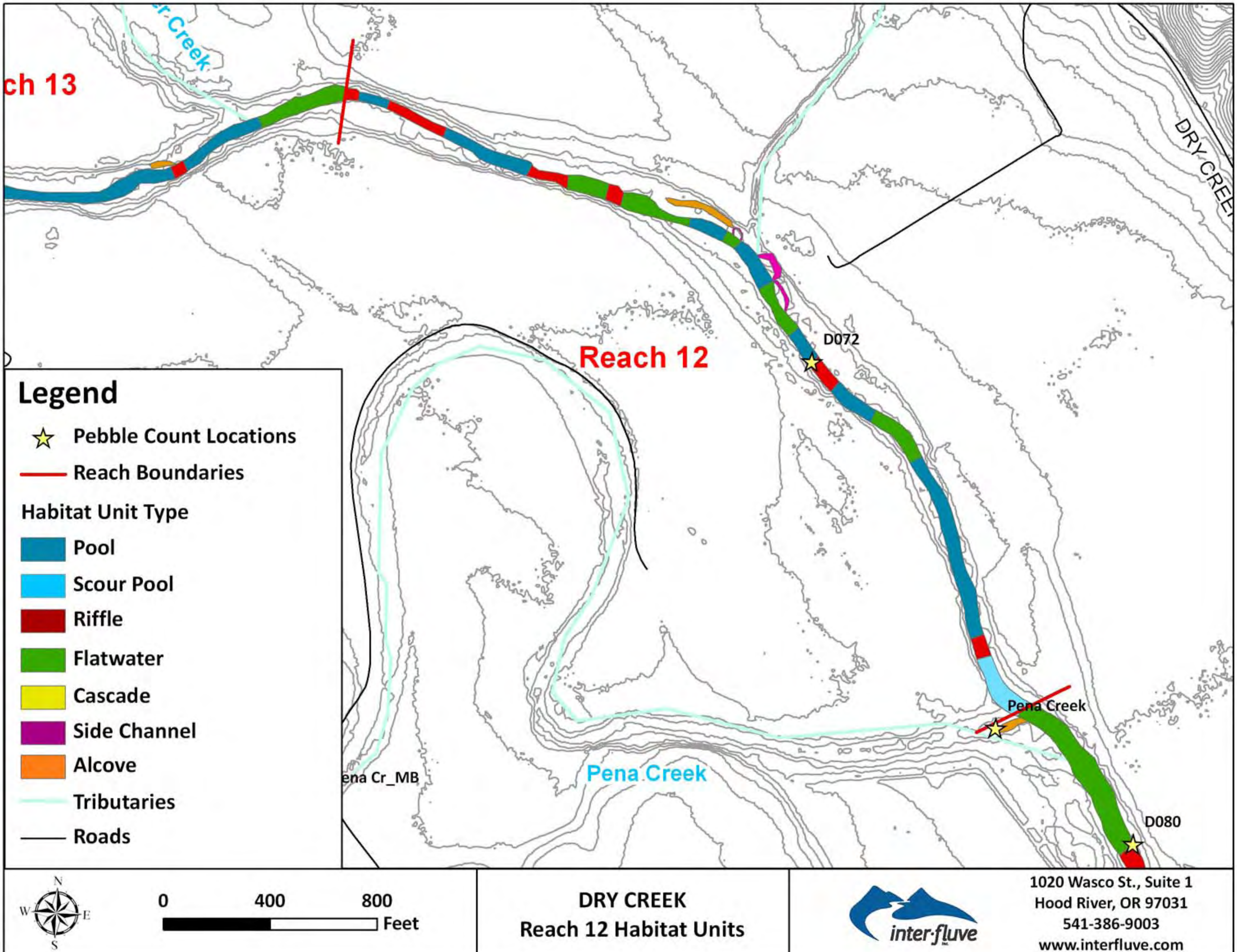

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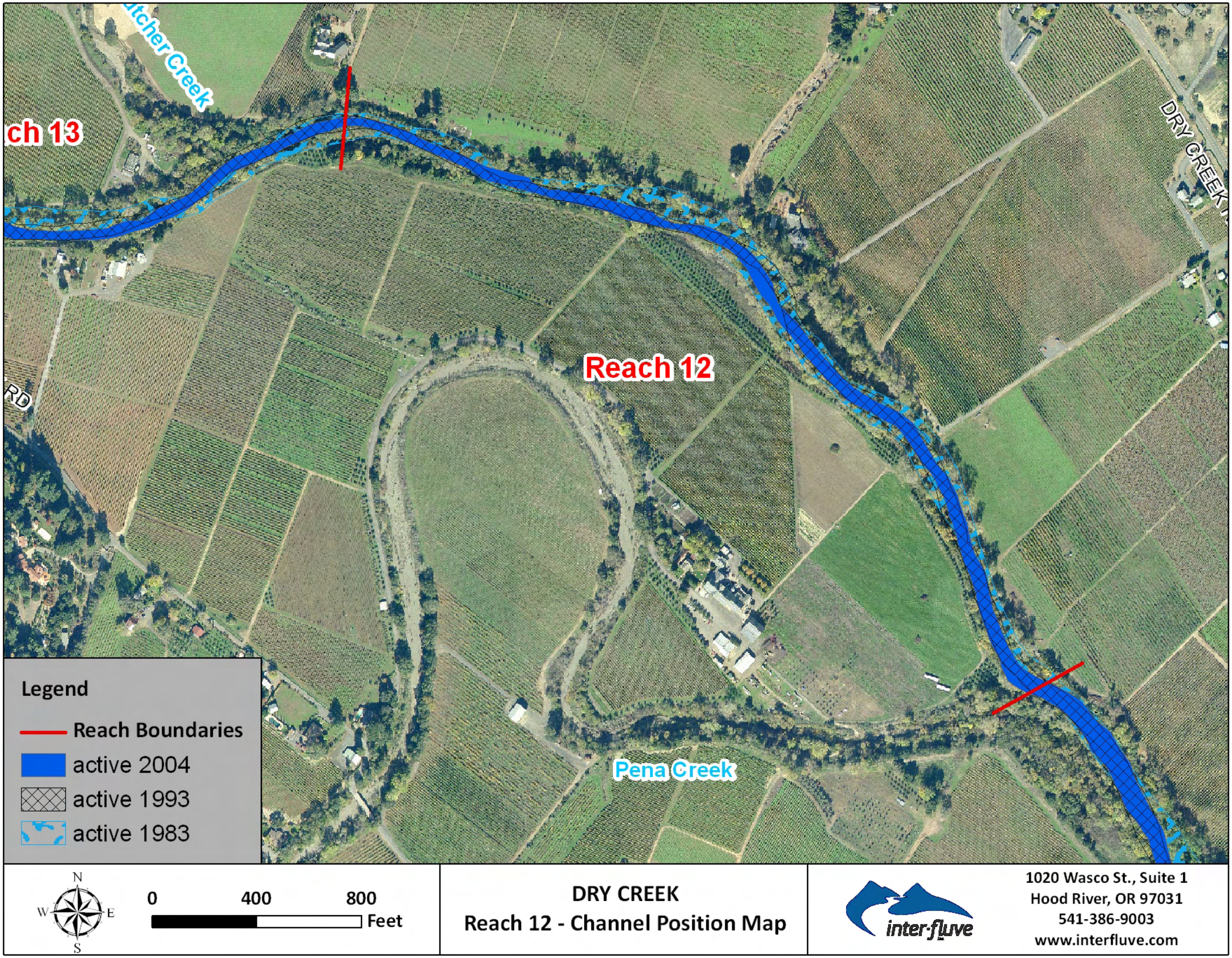

DRY CREEK
Reach 12 - Channel Position Map

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REACH 13 (RM 11.7 to RM 12.6**) Dutcher Creek to above Fall Creek**

Reach 13 extends from 0.05 miles below the Dutcher Creek tributary junction upstream to approximately river mile 12.6. Dutcher Creek enters Dry Creek on the left[10] bank at river mile 12, and Fall Creek flows into Dry Creek on the right bank at river mile 12.4. Upstream of Fall Creek, the channel planform and location has remained relatively stable since the dam was built. Downstream from Fall Creek slight channel migration since the dam was built has occurred. At the upstream extent of the reach, trees near previous channel boundaries are about 26 years old, the approximate date of dam construction. Trees close to the current channel are about 14 years old, indicating that narrowing and vegetation encroachment along the active channel margins has occurred.

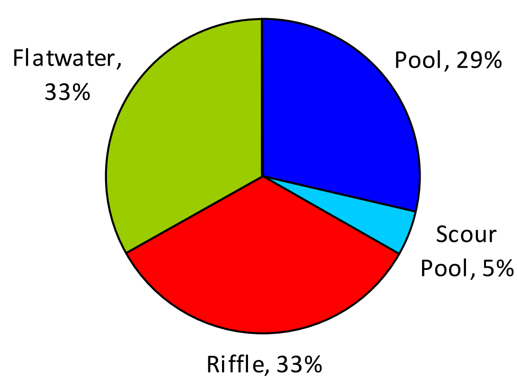
A pit tag recording station at river mile 12.05 creates a short riffle. A pump was observed on the left bank at river mile 12.1, with boulder riprap on the opposite bank along the pool unit. A short section of riprap armored the left bank at the top of the reach.

Figure 65: (left) Pump in Dry Creek, (right) Pit-tag antennae spans Dry Creek.

Habitat Classification

The channel in reach 13 alternates primarily between pools (34%) and flatwaters (33%) on a relative frequency basis (Figure 66). Seven riffles make up 33% of the reach by relative frequency, 21% of the channel on a length basis, and range from 40 to 400 ft in length. The channel banks are steep, so the average wetted and active channel widths are similar at slightly more than 40 ft wide. The flood prone width is 62 ft. The average active channel depth in the riffles is 2.3 ft. Terraces in reach 13 are approximately 10 ft above the channel bed.

Figure 66: Proportion of Habitat Types by Relative Frequency in Reach 13



Reach 13 resembles an F4 Rosgen channel type

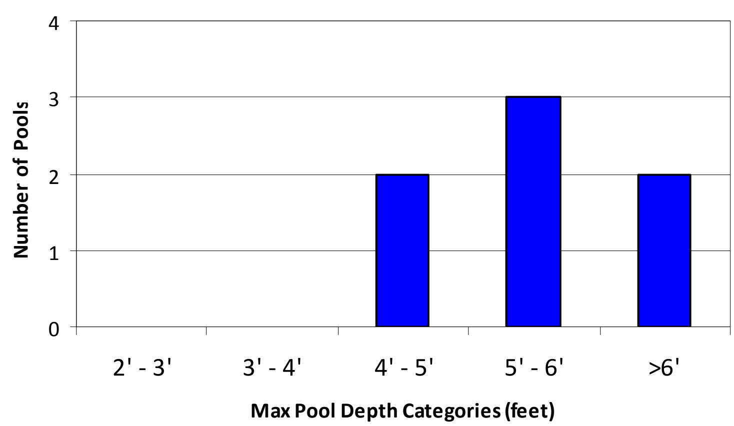
[10] In the individual reach summaries, right and left bank designation defined as looking downstream.

with an entrenchment ratio of 1.5 and a active channel width:depth ratio of 17.6. This reach has a plan-bed channel verging on pool-riffle morphology.

Pools

All of the eight pools measured in Reach 13 were greater than three feet deep (Figure 67). The average pool depth was 5.7 feet (stdev1.5). The average residual pool depth was 3.8 ft, and the average pool crest depth was 2.0 ft. Substrate in pools was gravel with cobbles and some sand.

Figure 67: Maximum Pool Depths in Reach 13.

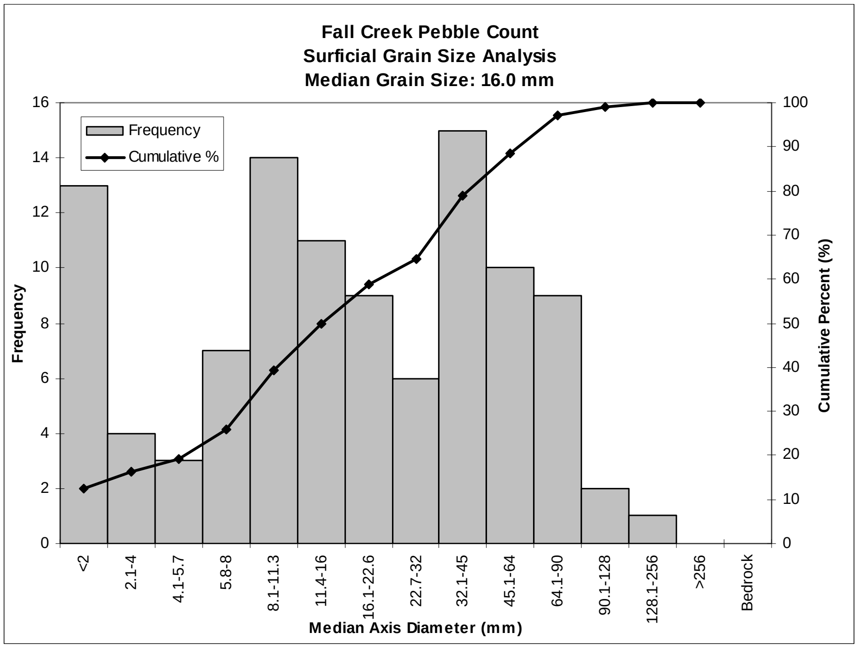


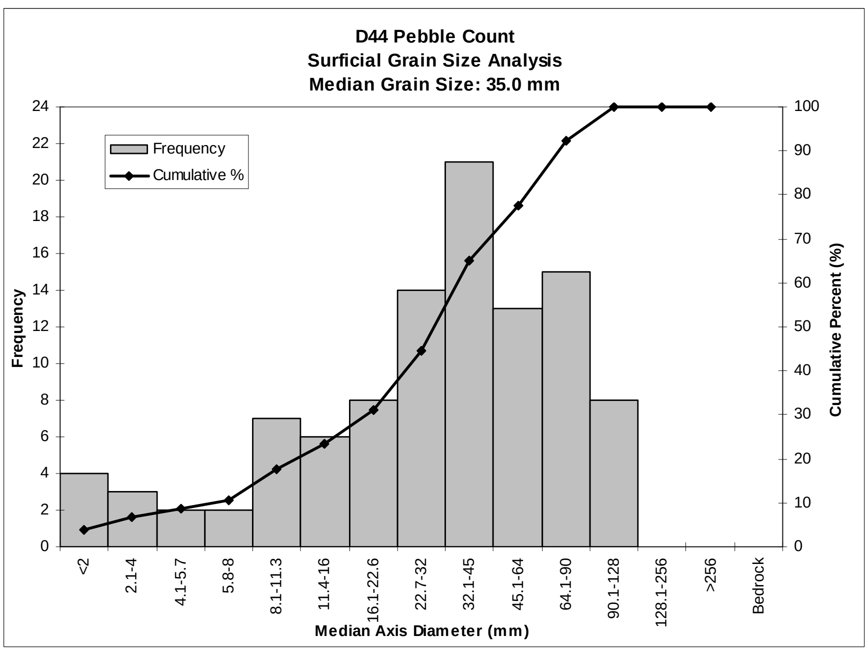
Riffles

Water depths in the riffles and flatwaters were 1.2 ft and 2.2 ft respectively during the survey. The bed material in reach 13 is primarily gravel with some small and large cobbles throughout the reach. Material in the riffle immediately downstream from the Fall Creek confluence ranges from sand to small cobbles but is primarily composed of coarse gravel to small cobble. The median grain size for this riffle is 35 mm (Figure 68). 83% of the sediments are within ideal spawning sizes, and 55% are within ideal fry rearing sizes. 4% of the samples were fine sediments or sand.

The bed material of Fall Creek is smaller (median grain size of 16 mm) than that found in Dry Creek.

Figure 68: Grain size distribution for the channel bed of Fall Creek and for a riffle on Dry Creek downstream of the Fall Creek inflow (habitat unit #44).





Side-Channels
No side channels were observed in Reach 13.

Alcoves
Three alcoves in Reach 13 measured 60, 80, and 90 feet long, 10, 18, and 12 feet wide, with maximum depths of 2.4, 2.5, and 1.6 feet. Substrate in the alcoves was fine sediment, sand, and gravel.

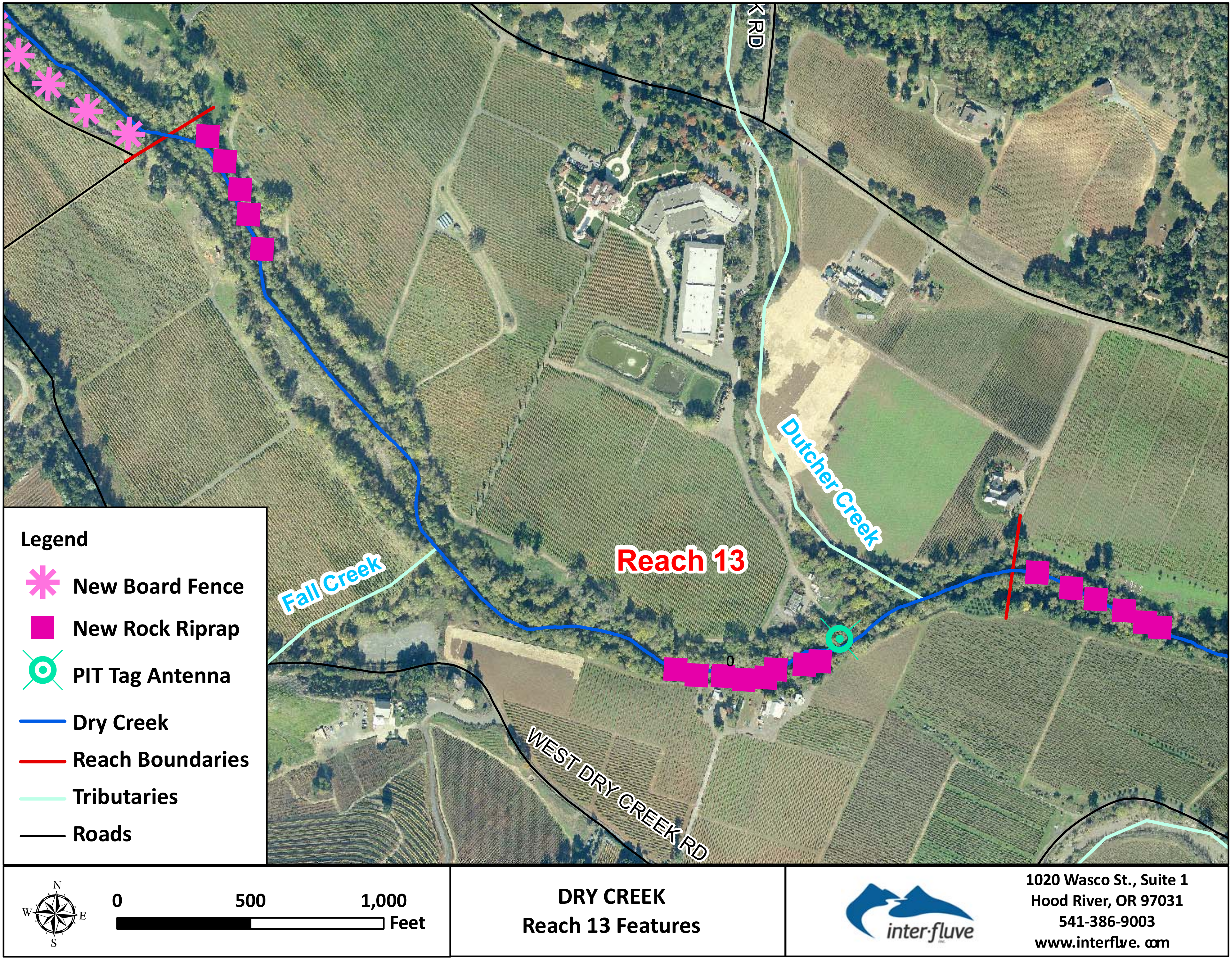
Instream Cover & Woody Debris

Overall, wood density in this reach of Dry Creek was 160 pieces per mile. A total of 141 pieces were counted, with 86 counted in pools. The highest densities of wood were in pools and alcoves. Of the six large pieces >20" diameter, three were located in pools. Instream cover was mainly provided by terrestrial vegetation and small woody debris, with some root mass cover provided in riffles. Aquatic vegetation with small woody debris provided abundant cover in alcoves (Figure 69). Edge habitat was observed in four pools, a riffle, a flatwater, and two alcoves.

Figure 69: Alcoves in Reach 13 with abundant cover provided by aquatic vegetation.

Table 13: Instream woody debris, cover, and edge habitat frequency for Reach 13.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	124.7	41.6	5.9	172.2	26%	78	50%
Scour Pools	303.0	86.6	21.6	411.1	35%	105	100%
Riffles	88.1	11.7	0.0	99.8	8%	17	14%
Flatwaters	91.7	40.4	7.3	139.4	22%	60	14%
Alcoves	91.8	91.8	23.0	206.6	87%	260	67%
	mainstem pieces/mile			159.9			



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Reach 13 Features

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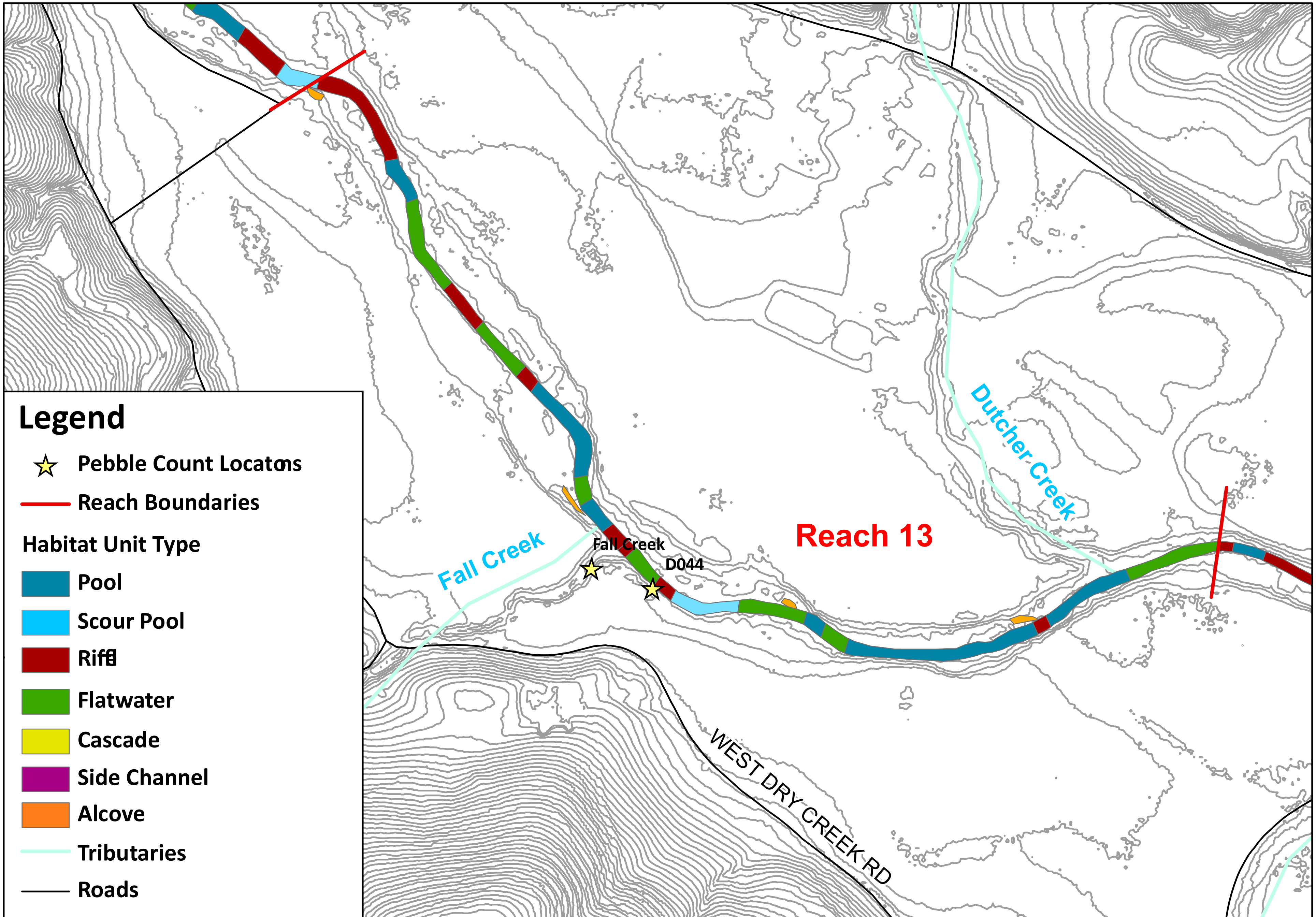

N W E S

0 400 800 Feet

DRY CREEK
Reach 13 Habitat Units

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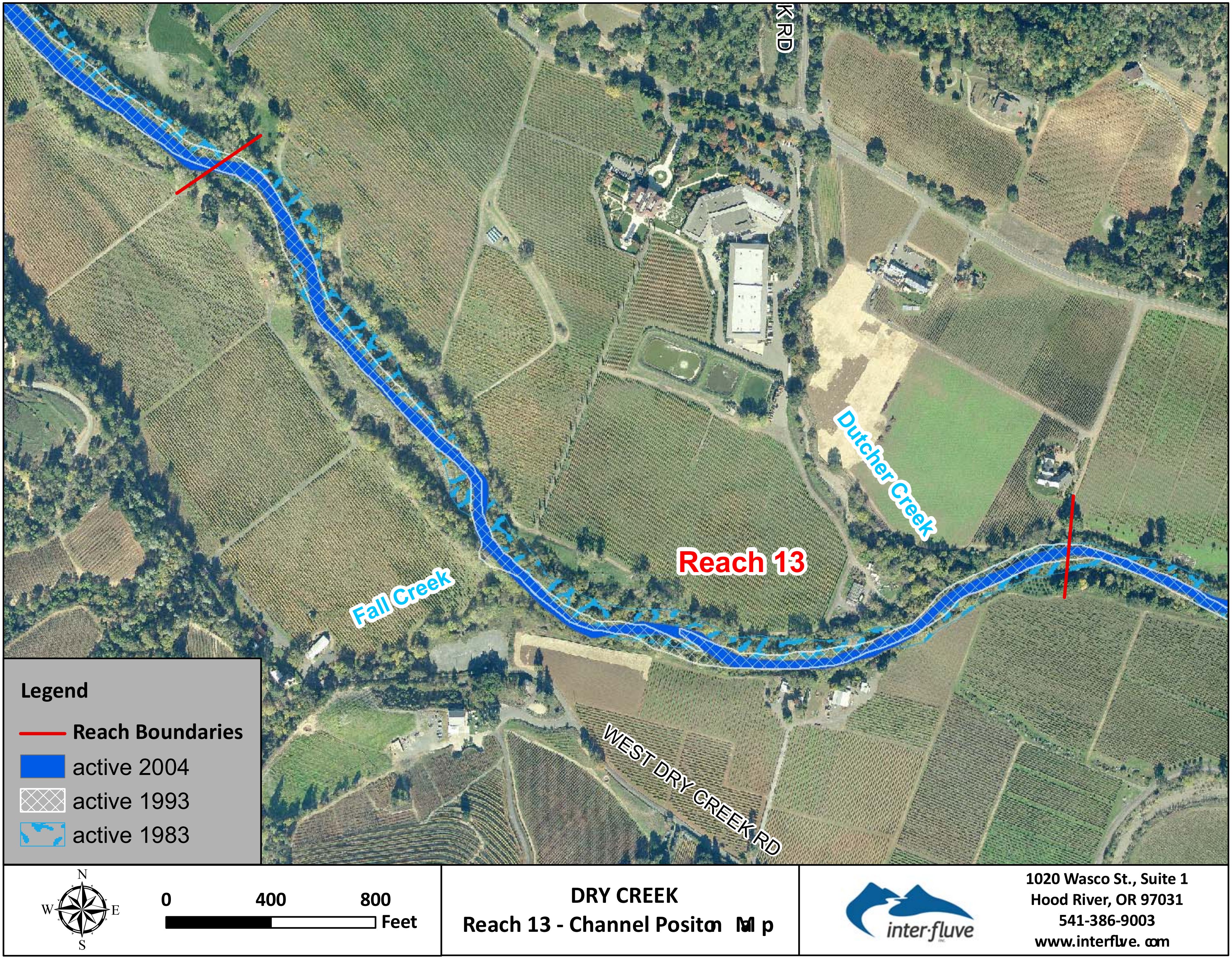

DRY CREEK

Reach 13 - Channel Positon Map

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REACH 14 (RM 12.6 to RM 13.3) **Schoolhouse Creek**

Reach 14 is a single-thread channel extending upstream to the Schoolhouse Creek confluence. The channel is slightly less entrenched than reach 13 and has migrated laterally slightly prior to, and since, dam construction. The air photo record suggests that the channel has generally narrowed over time as incision occurred.

Board fence bank protection was constructed along the lower 500 feet of the right[11] bank of Reach 14. Riprap boulder bank armor was installed along the banks near the upstream end of the reach for about 1,200 feet. Some litter was observed in Reach 14, including a ¾" black pipe on the left bank that disappears into the floodplain forest at river mile 12.9, and tires in the center of a flatwater at river mile 13.3 at the top of the reach.

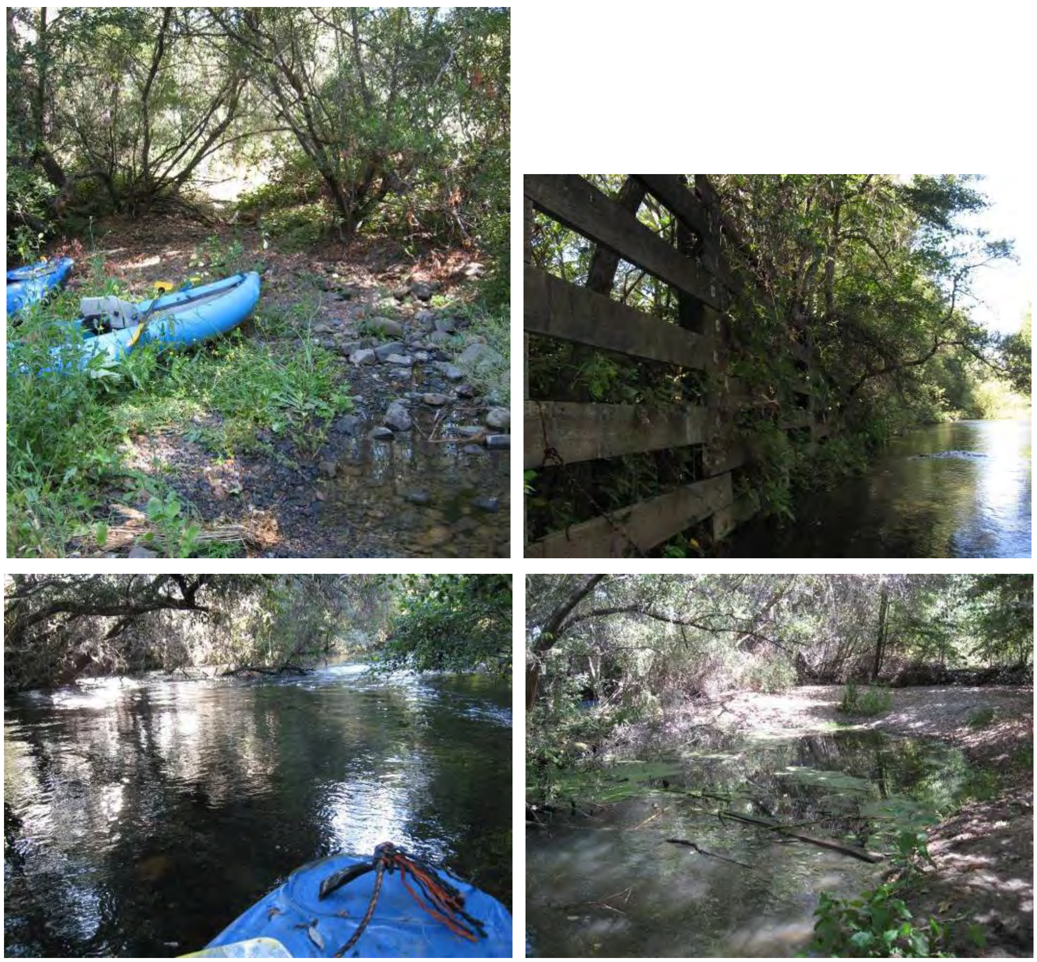


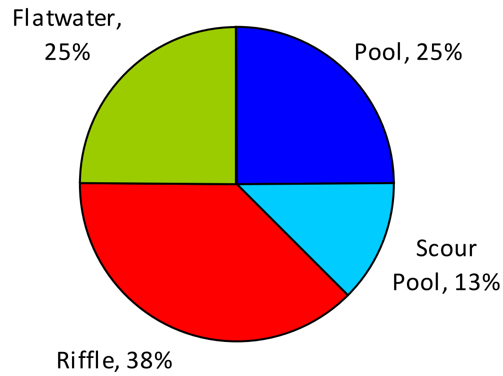
Figure 70: (upper left) mouth of Schoolhouse Creek, (upper right) board fence along the right bank, (lower left) deep pools with interacting live tree cover, (lower right) alcove habitat with aquatic vegetation.

[11] In the individual reach summaries, right and left bank designation defined as looking downstream.

Habitat Classification

The channel in reach 14 alternates between pools (38%), riffles (38%) and flatwaters (25%) on a relative frequency basis (Figure 71). There are nine riffles throughout the reach ranging in length from 50 to 300 ft making up 32% of the total reach on a length basis. The channel is wider than in the more confined reach 13, with an average wetted width of 48 ft during the survey and active channel and flood prone widths of 65 and 139 ft respectively. The average active channel depth of the riffles was 2.6 ft.

Figure 71: Proportion of Habitat Types by Relative Frequency in Reach 14

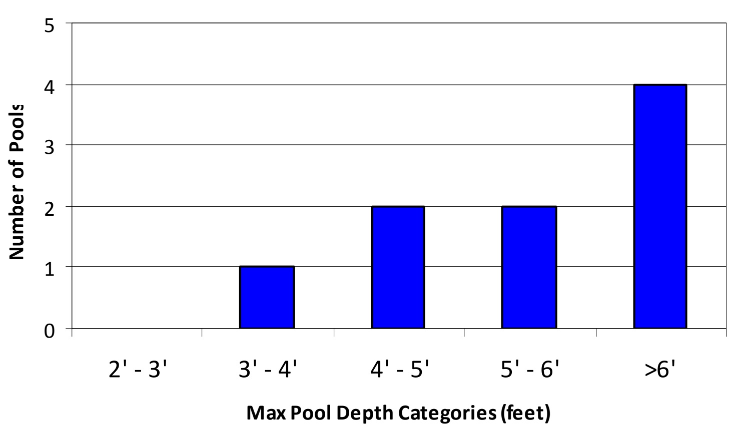


This portion of channel resembles an F4 Rosgen channel type, with a active channel width:depth ratio of 25 and an entrenchment ratio of 2.1. The reach has characteristics of both plane-bed and pool riffle morphology.

Pools

There were 9 pools in Reach 14, 3 of these were scour pools. All of the pools had a maximum depth greater than 3 feet, eith average maximum pool depth of 5.7 feet (Figure 72). The average residual pool depth was 4.4 feet, and the average pool crest depth was 1.4 ft. Substrate in the pools consisted of gravel with sand, with some small cobble.

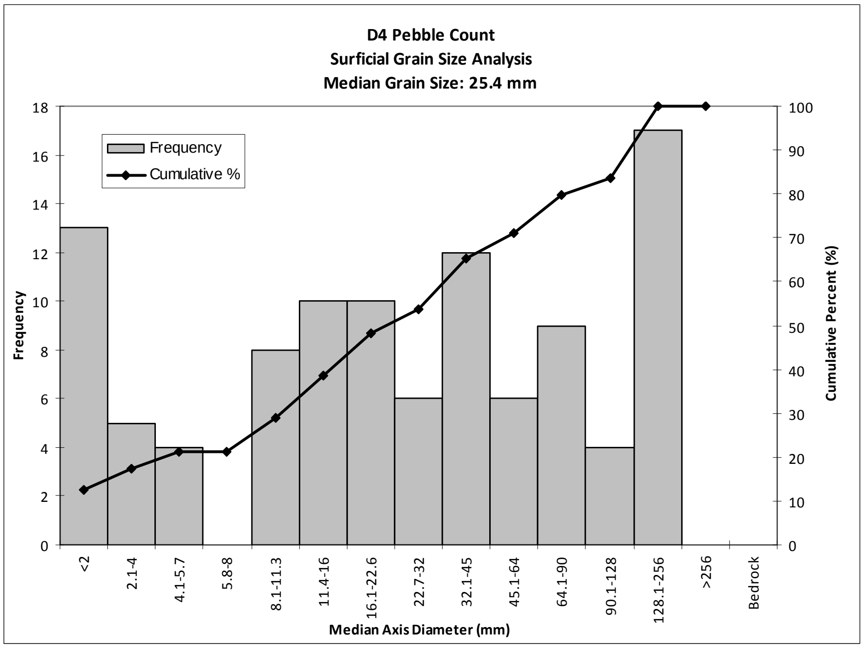
Figure 72: Maximum Pools Depths in Reach 14.

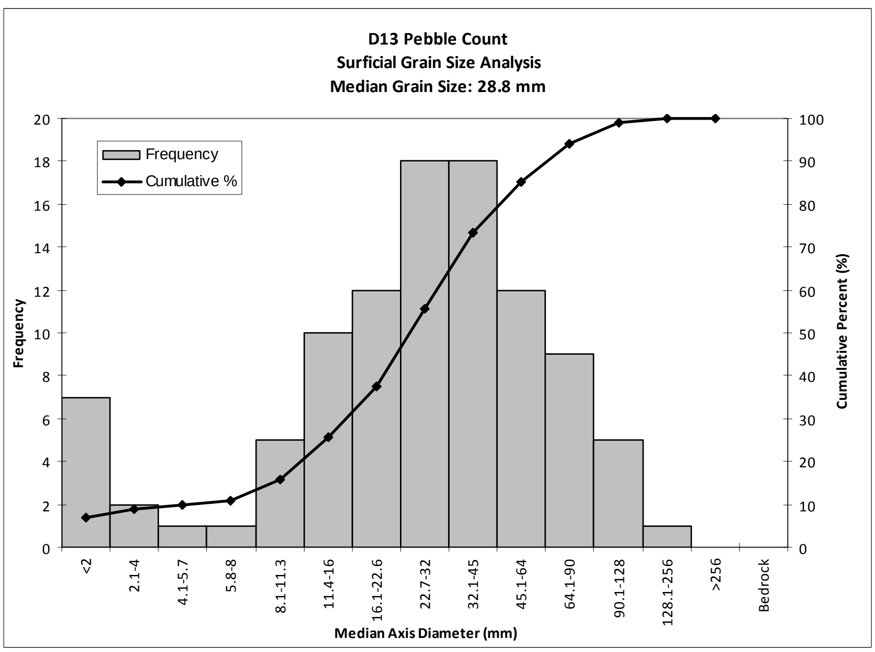


Riffles & Flatwaters

There were 9 riffles and 6 flatwaters in Reach 14. The average riffle depth was 1.1 feet, and the average flatwater depth was 2.3 feet. Substrate in riffles and flatwaters was gravel and small cobble. The bed material of two riffles were sampled, one at the upstream extent of the reach and the second approximately 0.25 miles downstream. The upstream riffle was primarily composed of medium to very coarse gravel with a median grain size of 25 mm. The downstream riffle was primarily composed of coarse to very coarse gravel with a median grain size of 29 mm.

Figure 73: Grain size distribution for two riffles in reach 14 (habitat units #4 and #13).





Side-Channels

One side channel, dominated by flatwater habitat, was observed in Reach 14. Dimensions were 118 feet long, by 15 feet wide, and an average of 1.1 feet deep. Substrate was gravel with sand.

Alcoves

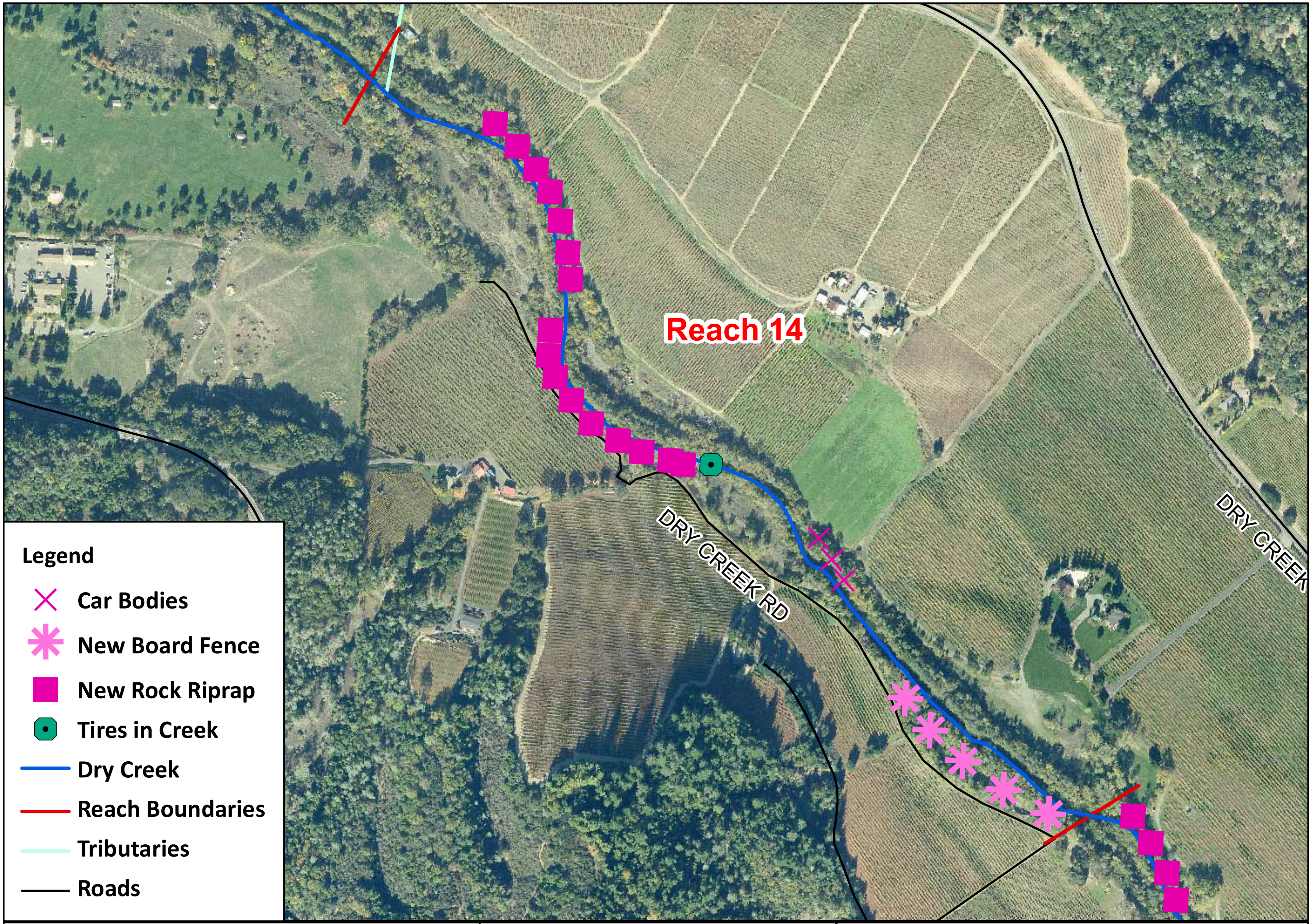
Three alcoves were measured in Reach 14. The alcoves were 58 and 38 feet long, 20 and 25 feet wide, with maximum depths of 1.5 and 5.4 feet. Substrate in the alcoves was fine sediment, with gravel and sand.

Instream Cover & Woody Debris

121 pieces of wood per mile were counted in Reach 14, with a total of 93 pieces counted in the reach (Table 14). There were no large pieces of wood observed, and 53 of the pieces were counted in pools. The highest densities of wood were found in pools and alcoves. Very low instream cover was present in Reach 14, provided by terrestrial vegetation and small woody debris, and less so by root masses and aquatic vegetation. Edge habitat was observed in one pool, three flatwaters, and the side channel.

Table 14: Instream woody debris, cover, and edge habitat frequency for Reach 14.

	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	135.7	72.4		208.1	23%	66	17%
Scour Pools	57.4	23.0		80.3	20%	47	0%
Riffles	62.8	16.7		79.6	20%	50	0%
Flatwaters	54.1	27.0		81.1	18%	50	50%
Side-Channels					30%	90	100%
Alcoves	110.0	55.0		165.0	28%	69	0%
	mainstem pieces/mile			117.0			



N W E S

0 500 1,000 Feet

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Reach 13 Features

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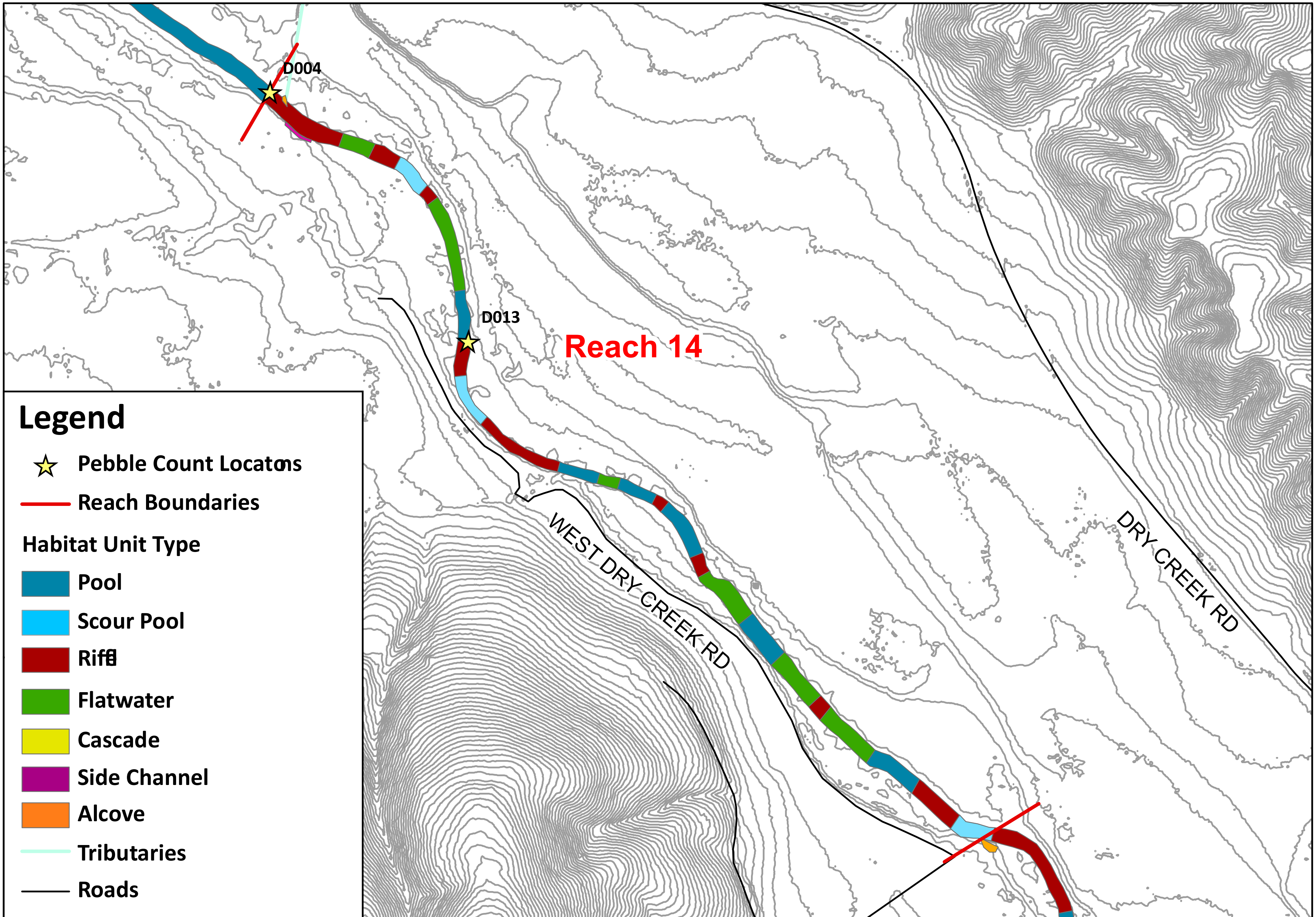

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Reach 14 Habitat Units

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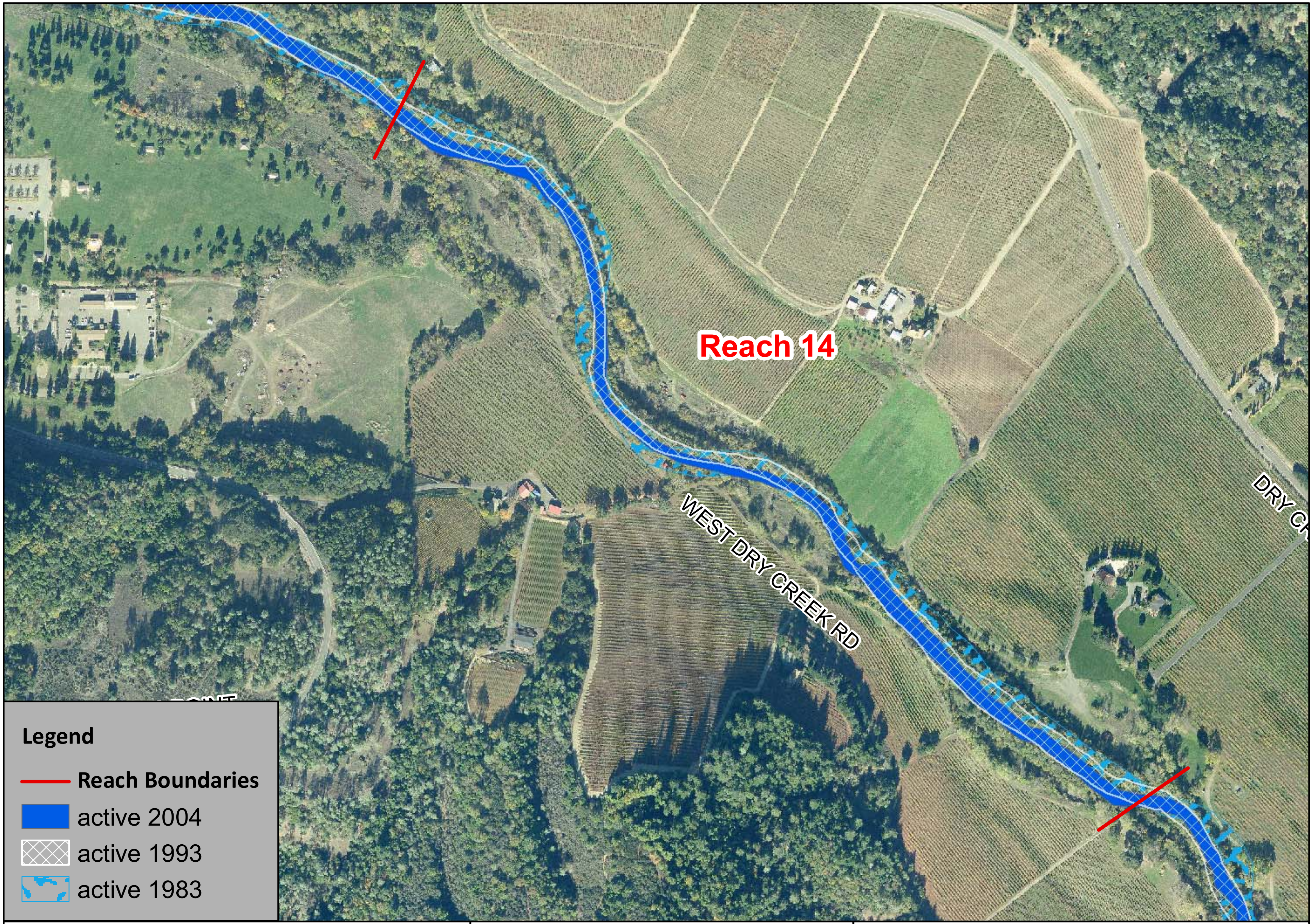

0 400 800 Feet

DRY CREEK
Reach 14 - Channel Positon Map

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REACH 15 (RM 13.3 to RM 13.6) **Schoolhouse Creek to Bord Bridge**

Reach 15 is a single-thread channel extending upstream from Schoolhouse Creek to the Bord Bridge. The channel here has a very low sinuosity and has experienced little channel change within the air photo record except for narrowing over time. The riparian corridor is narrow.

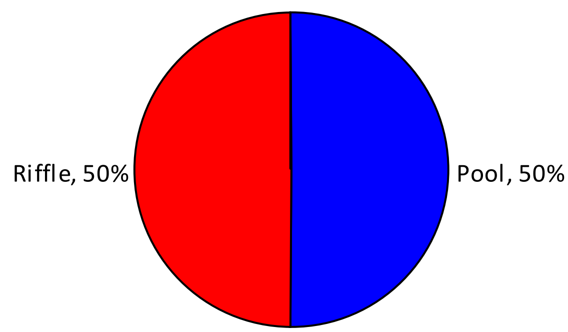
At the Bord Bridge, a boulder revetment associated with the bridge armors the right[12] bank. Higher on this bank, there is evidence of an older wood revetment. The high canopy cover in this reach is provided by California bay, willow, alder, and cottonwood. Himalayan blackberries and other exotics were present on both banks, but overstory vegetation dominates. An old board fence with metal mesh and cable covers part of the right bank along a pool unit. In general the banks were steeper on the right, and with a more gradual floodplain on the left bank.

Figure 74: (upper left) the riffle under Bord Bridge, (upper right) canopy cover, (lower left) deep, slow pool unit downstream, , (lower right) the long pool.

[12] In the individual reach summaries, right and left bank designation defined as looking downstream.

Habitat Classification

Figure 75: Proportion of Habitat Types by Relative Frequency in Reach 15



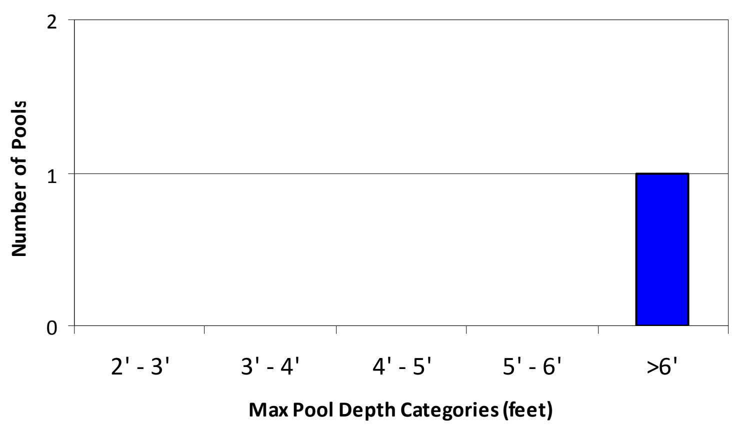
Reach 15 consists of a 48 foot long riffle and an extremely long, 1630 foot pool (Figure 75). This is the first stream channel habitat downstream of the dam outlet influence. The wetted channel width of the riffle was 23.0 feet, and the wetted width of the long pool was 55.0 feet.

Channel dimensions were measured at the riffle under the Bord Bridge. The active channel width was 45.0 feet, the average active channel depth was 2.9 feet, and the floodprone width with 126.0 feet. This riffle resembles a C4 channel type due to its moderate entrenchment ratio of 2.8 and its moderate width:depth ratio of 15.

Pool

The single, very long pool in Reach 15 had a maximum depth of 7.0 feet. The residual depth was 4.5 feet, with a pool crest depth of 2.5 feet. Substrate in this pool was gravel with small cobble.

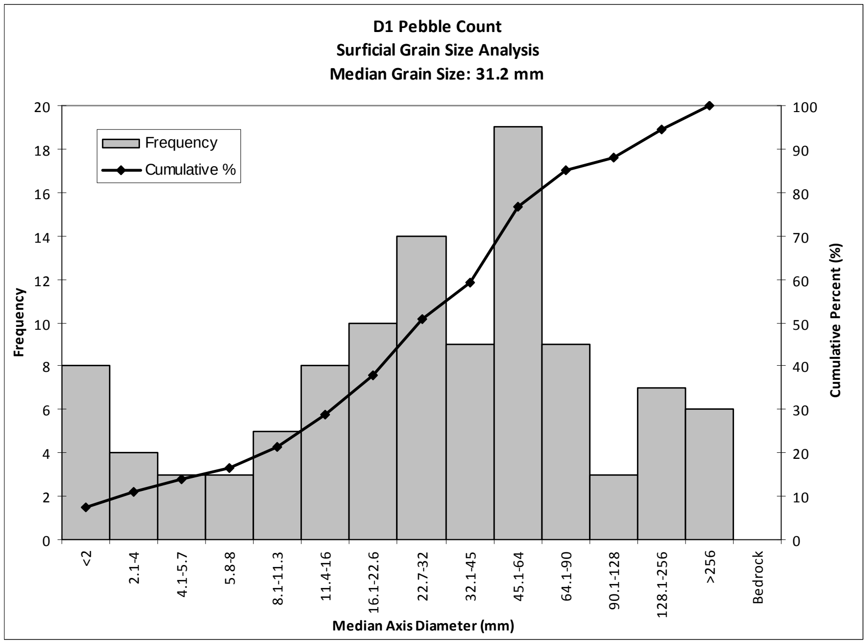
Figure 76: Maximum Pool Depth in Reach 15.



Riffle

The short, 48 foot long riffle had an average depth of 1.0 foot. The bed material is primarily gravel with some small cobbles. The material in the riffle is primarily coarse to very coarse gravel but ranges from sand to small boulders. The median grain size for this riffle is 31 mm (Figure 77). 67% was within ideal spawning sizes for coho and steelhead (11.4 to 128mm), and 37% was within ideal juvenile rearing sediment sizes (32mm to 128mm). 7% of the samples were sand or fine sediments.

Figure 77: Grain size distribution for the riffle below Bord Bridge in reach 15 (habitat unit #1).



Side-Channels

No side channels were observed in Reach 15.

Alcoves

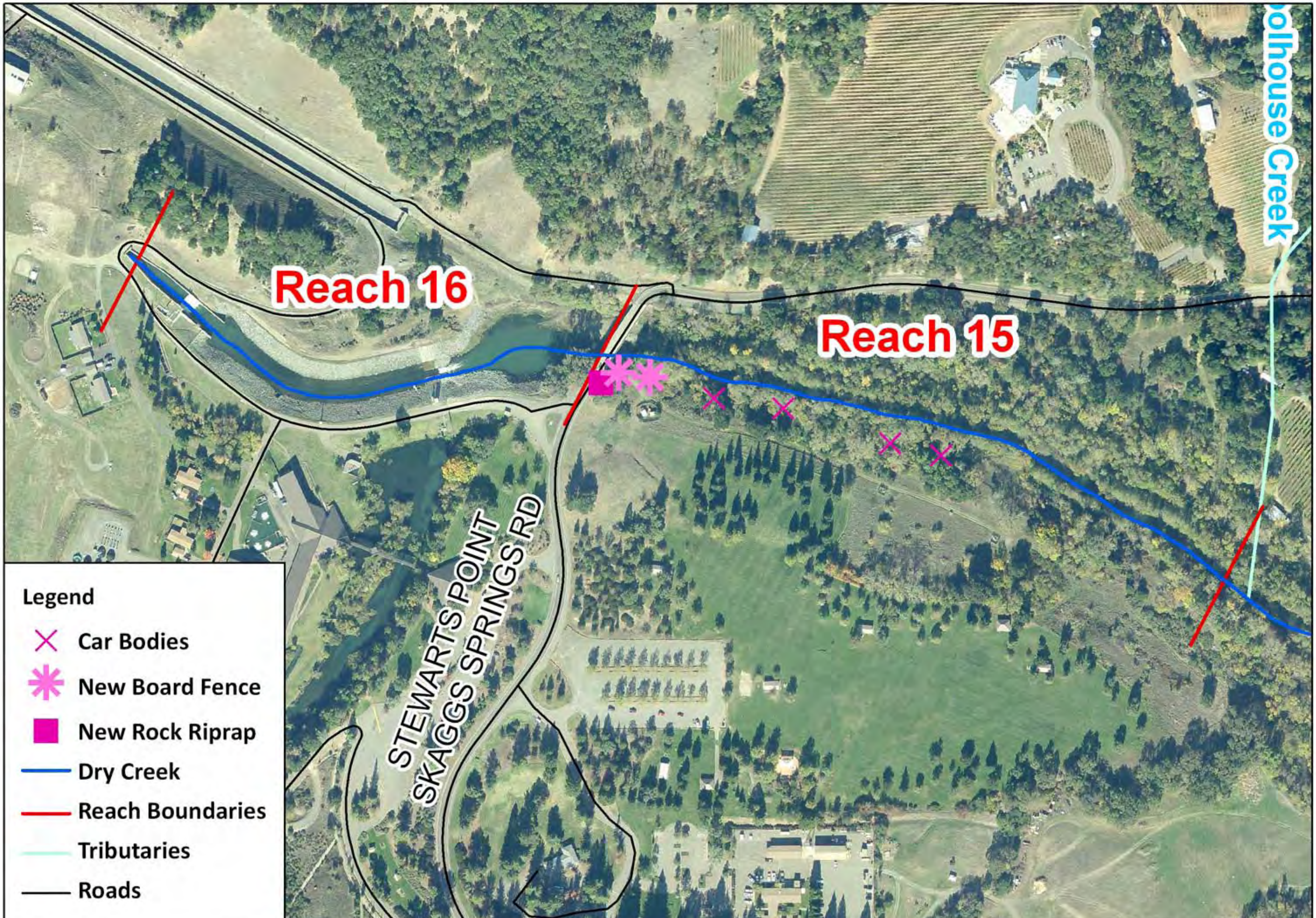
One alcove was observed in Reach 15. It was 45 feet long and 27 feet wide, with a maximum depth of 3.0 feet. Substrate in the alcove was fine sediment with sand.

Instream Cover & Woody Debris

There were 63 pieces of wood per mile in Reach 15. A total of 20 pieces of wood were counted, with no large pieces of wood observed (Table 15). 19 of the 20 pieces were found in the long pool, but the density of wood pieces in the riffle was much higher. Cover was provided in the pool by terrestrial vegetation, with additional cover provided by aquatic vegetation. In the riffle, a modicum of cover was provided by terrestrial vegetation and boulders associated with the bridge riprap bank armoring. In the alcove, cover was provided by aquatic vegetation with some overhanging vegetation. Edge habitat was observed only along the margins of the riffle in Reach 15.

Table 15: Instream woody debris, cover, and edge habitat frequency for Reach 15.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pool	38.9	22.7	0.0	61.5	30%	90	0%
Riffle	110.0	0	0	110.0	7%	7	100%
Alcove	0	0	0	0	80%	240	0%
	mainstem pieces/mile			62.9			



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Reach 15 Features

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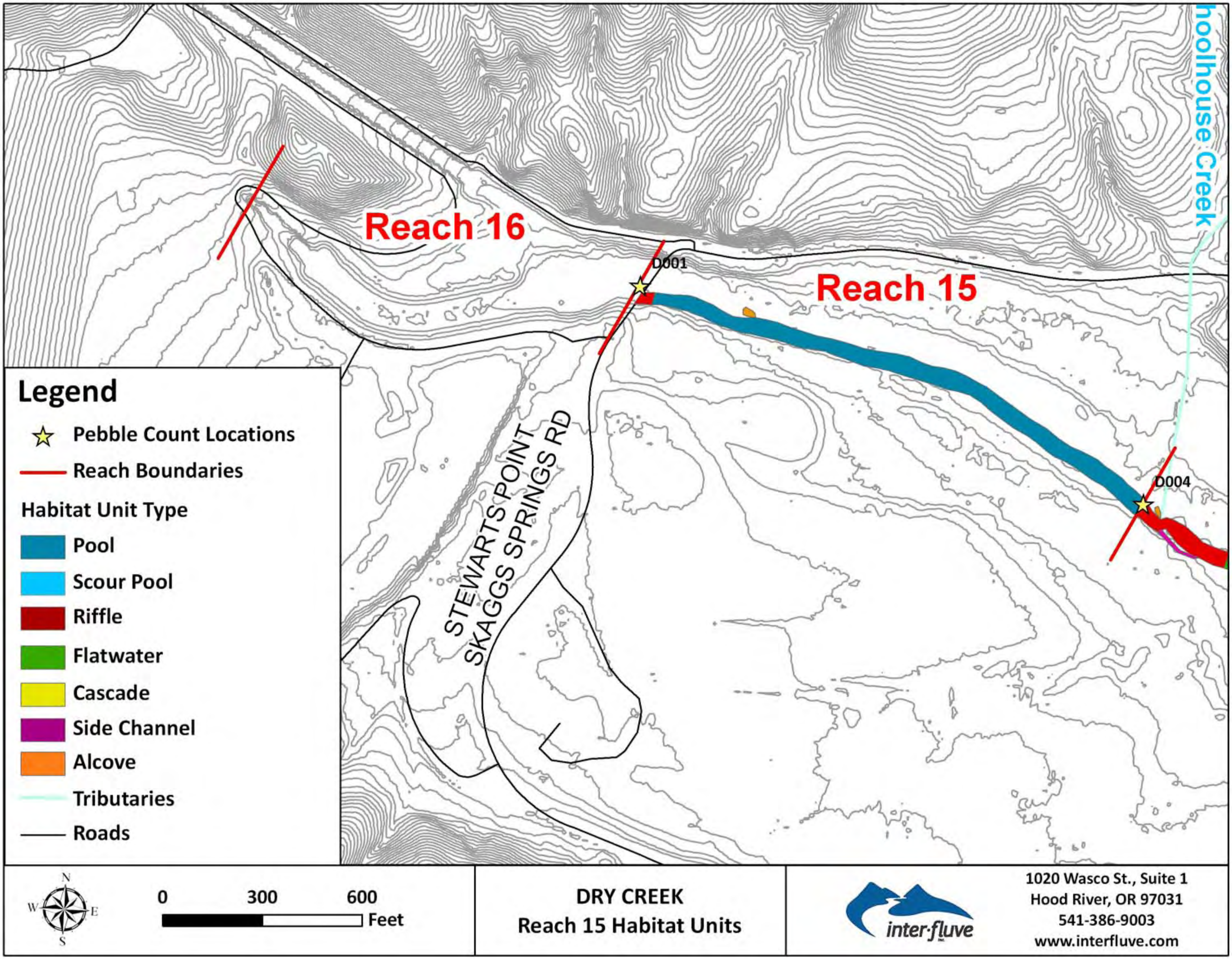

DRY CREEK
Reach 15 Habitat Units

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N W E S

0 300 600 Feet

DRY CREEK
Reach 15 - Channel Position Map

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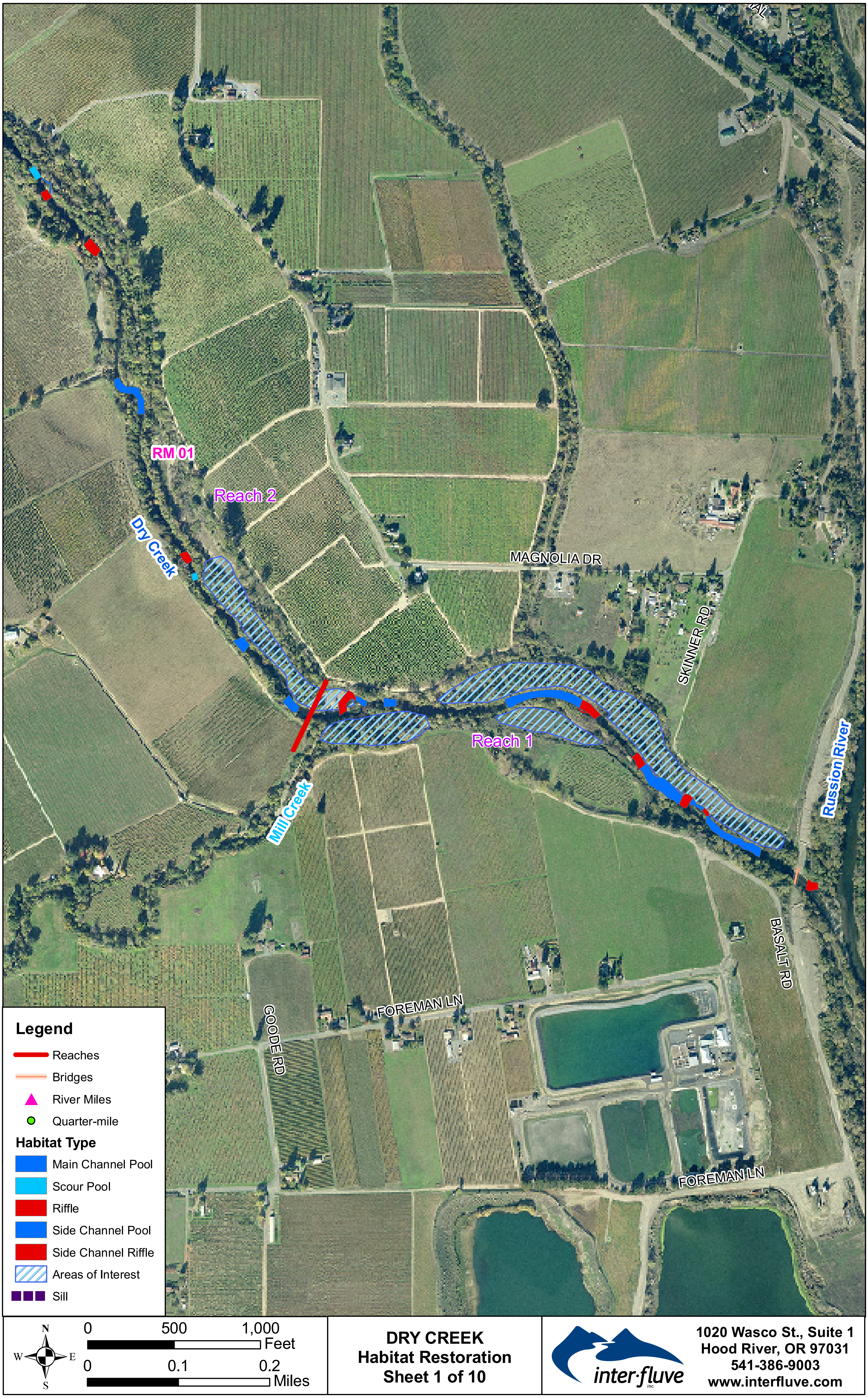
REACH 16 (RM 13.6 to RM 13.9) **Bord Bridge to dam spillway pool**

Reach 16 extends upstream from Bord Bridge to a flow measuring flume immediately below Warm Springs Dam. From the outlet of the dam, water flows through a constructed channel and over two drop structures before spilling into a deep pool (>12 feet deep) immediately upstream of the Bord bridge. Boulder revetments cover both banks within this constructed channel.

Figure 78: (left) looking upstream at the deep pool downstream of the measuring flume structure, (right) preparing to launch from the measuring flume structure.

9 APPENDIX B – PRELIMINARY ENHANCEMENT OPPORTUNITIES FIGURES



DRY CREEK
Habitat Restoration
Sheet 1 of 10

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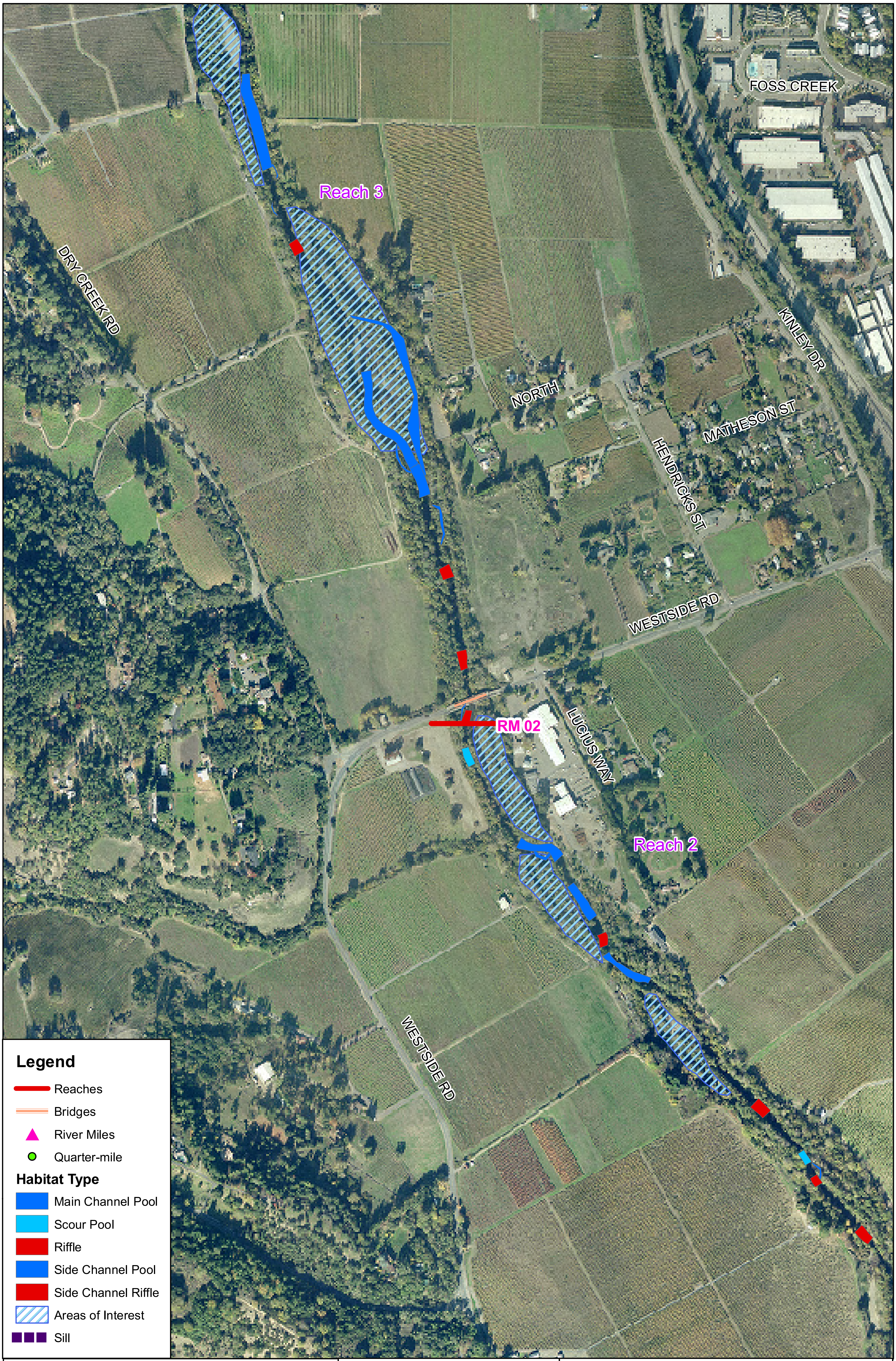

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Habitat Restoration
Sheet 2 of 10

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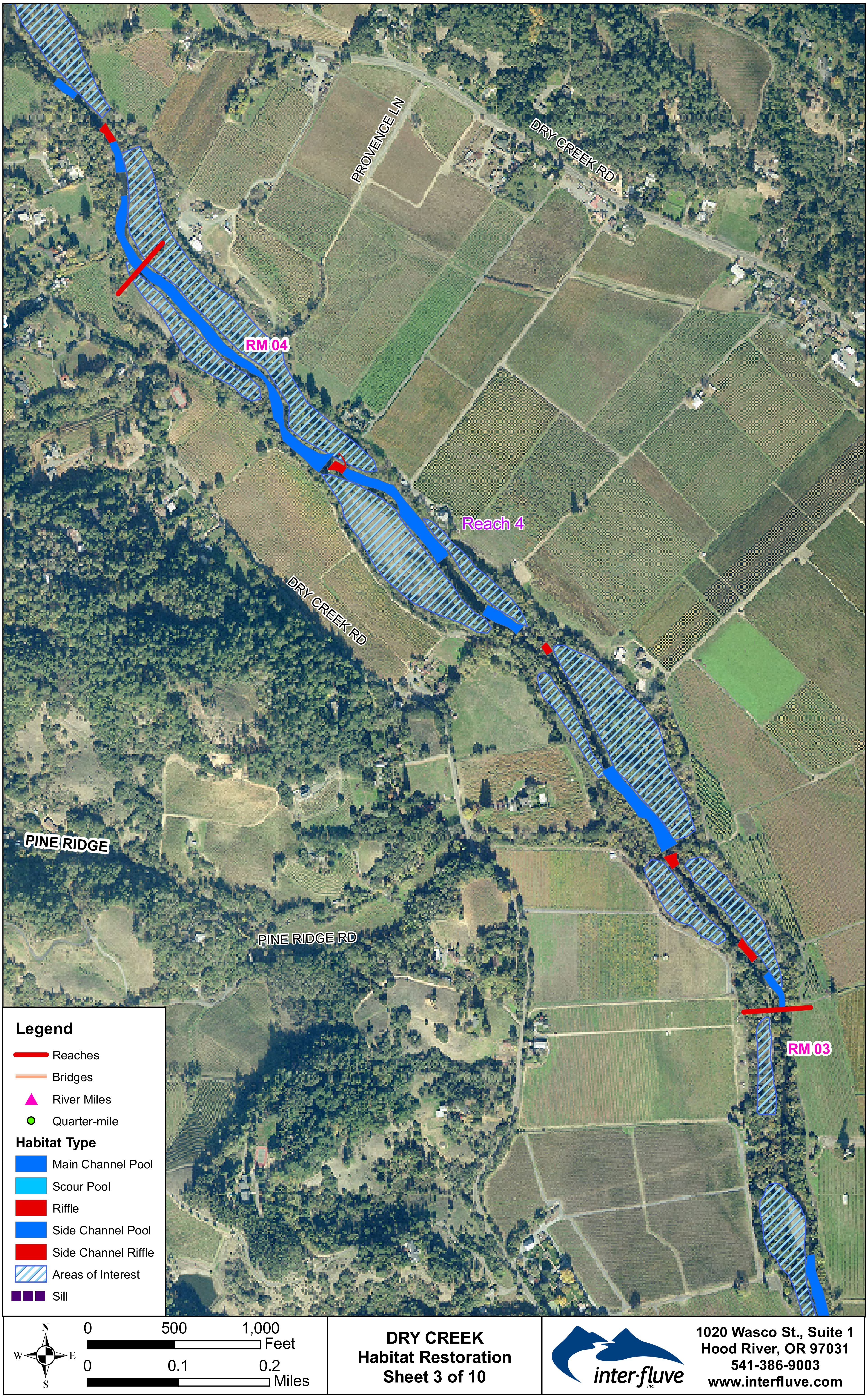

DRY CREEK
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Sheet 3 of 10

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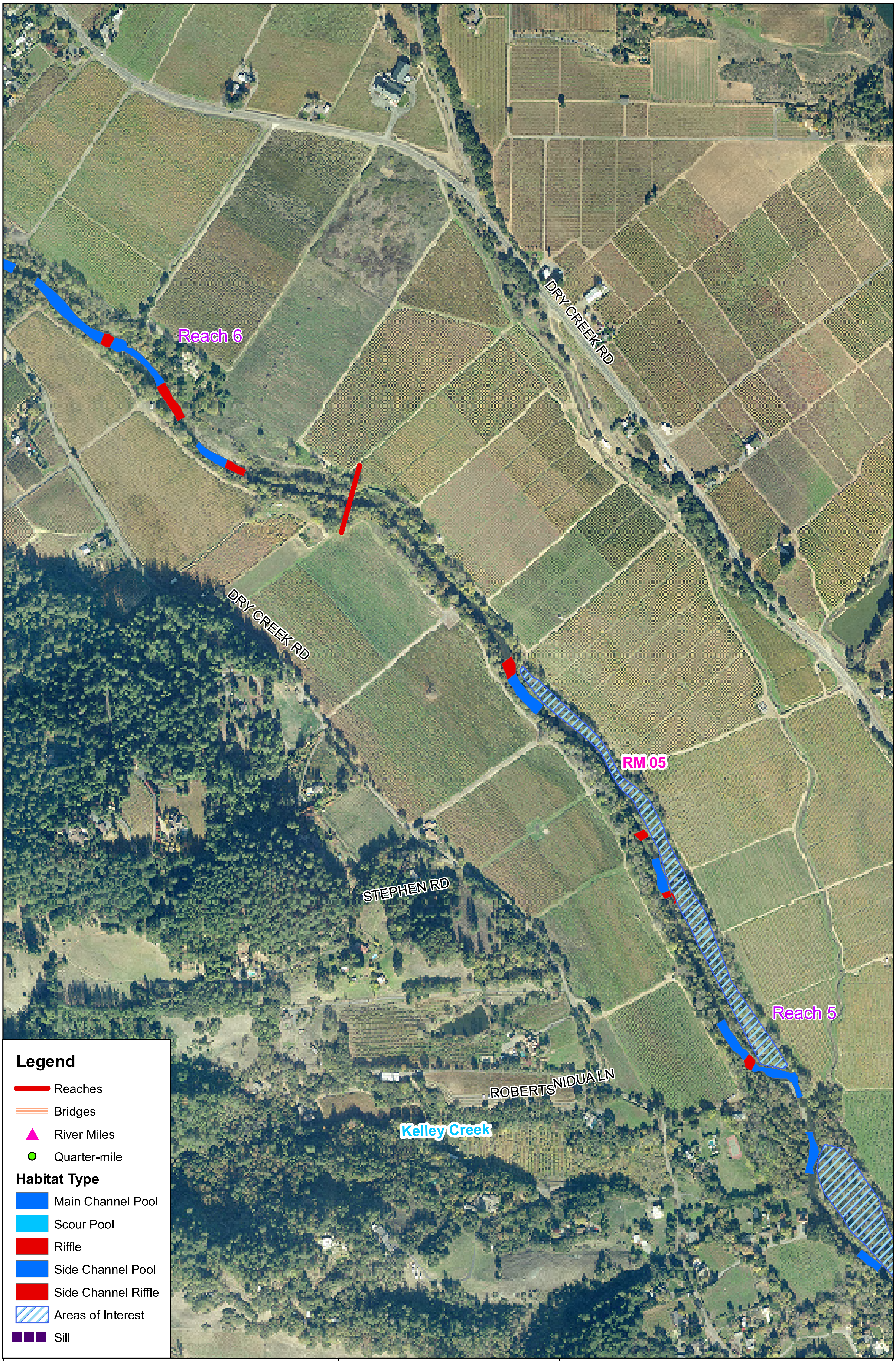

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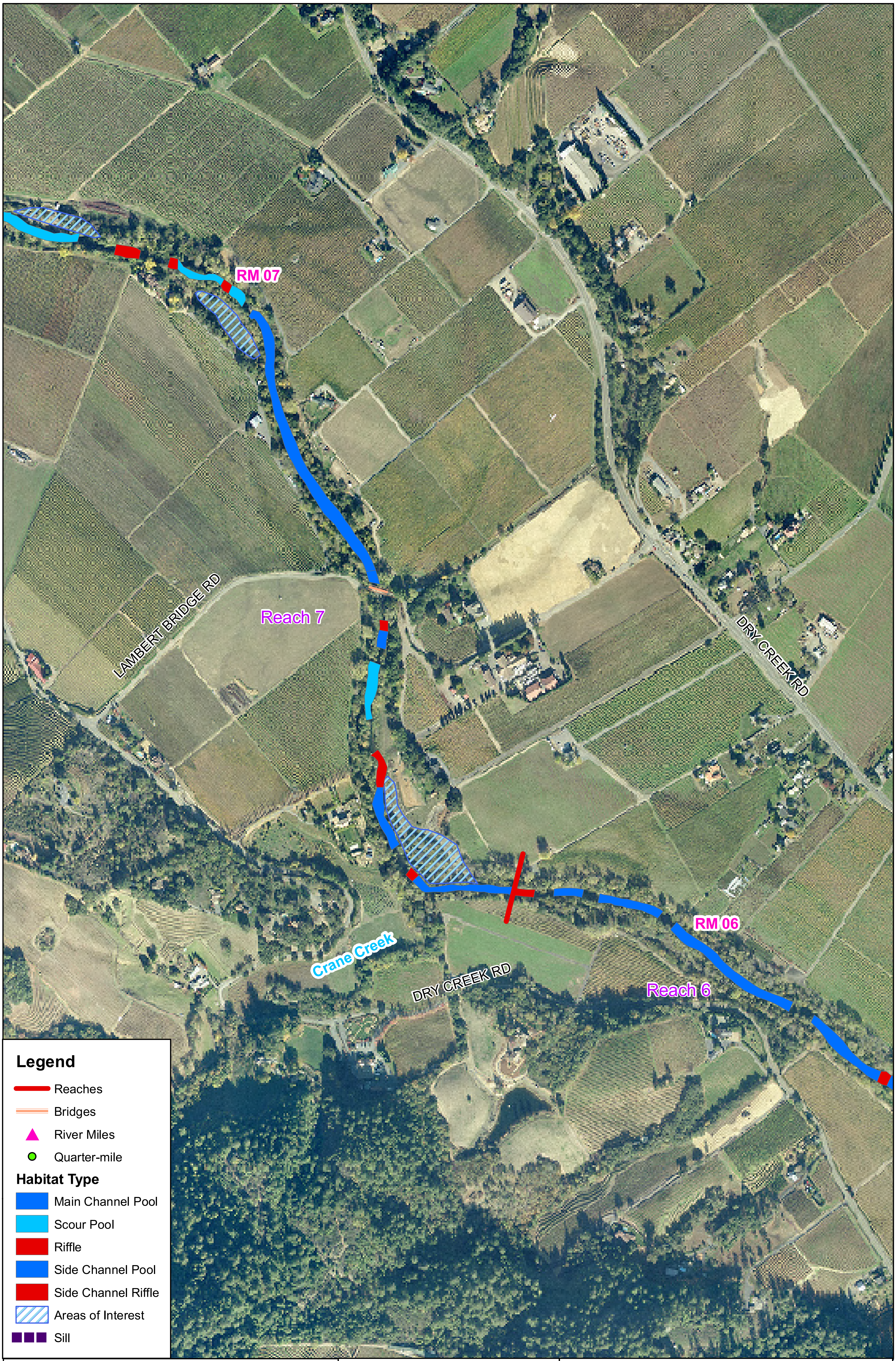

N W E S

0 500 1,000 Feet

0 0.1 0.2 Miles

DRY CREEK
Habitat Restoration
Sheet 5 of 10

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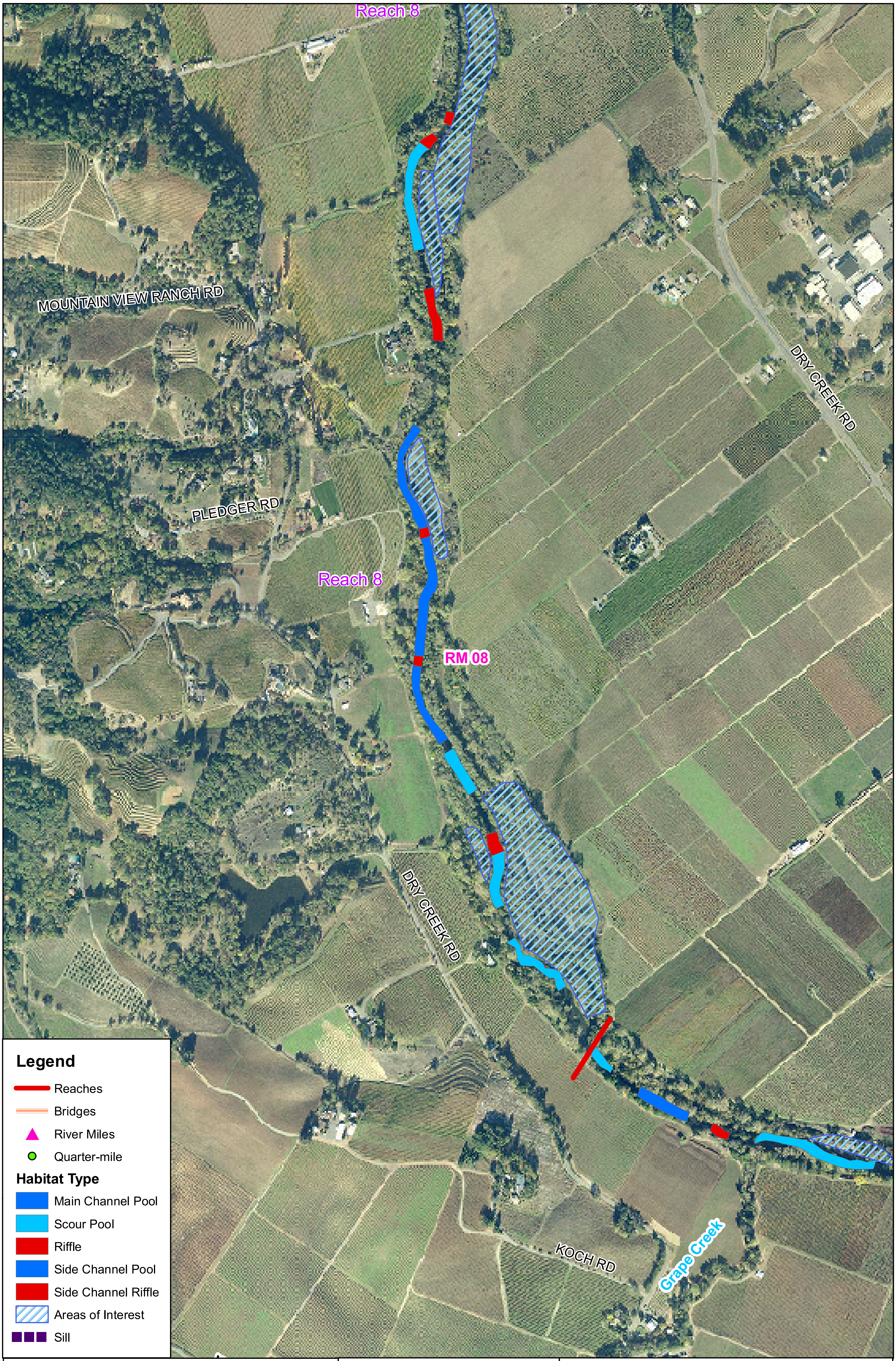

N W E S

0 500 1,000 Feet

0 0.1 0.2 Miles

DRY CREEK
Habitat Restoration
Sheet 6 of 10

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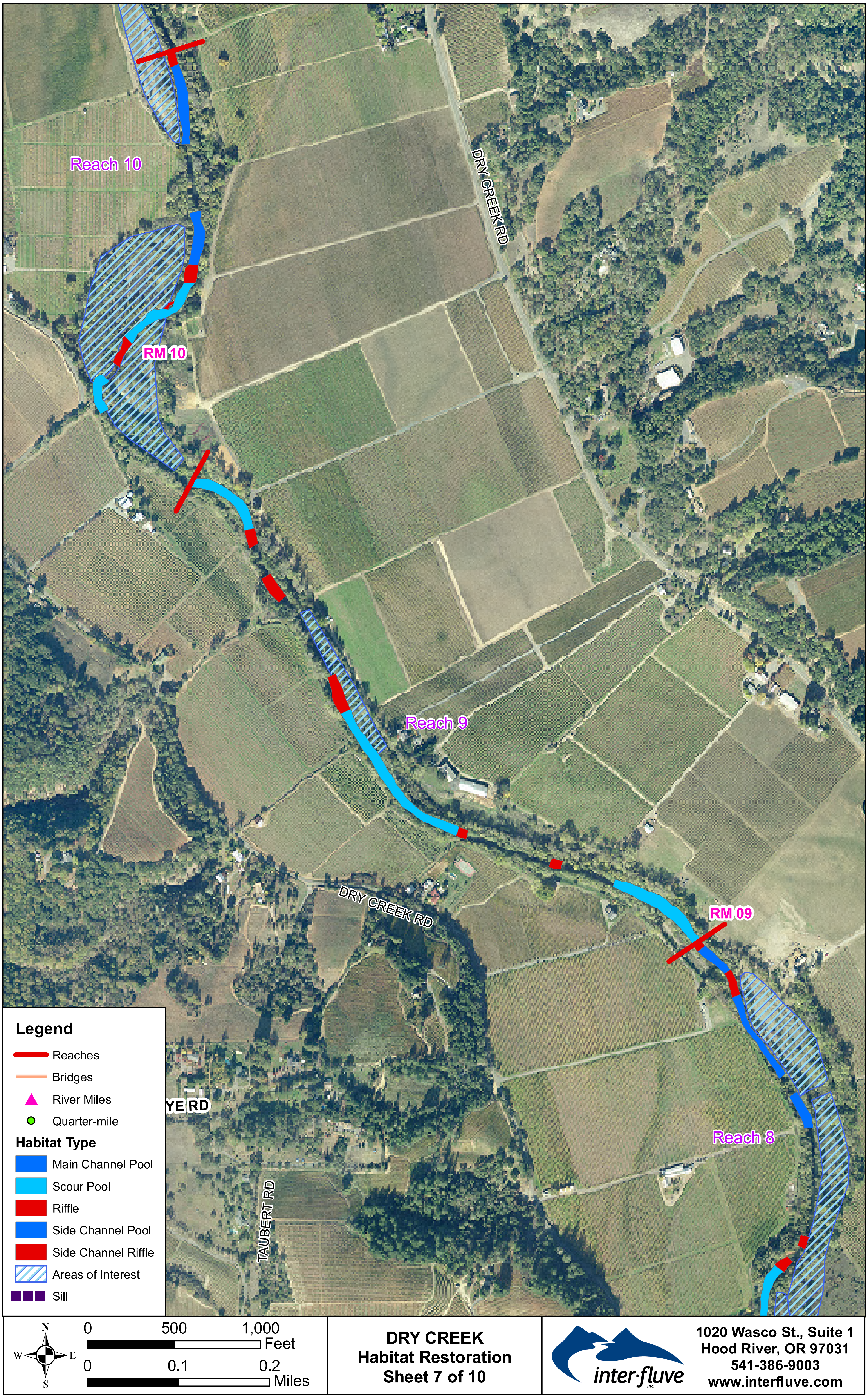

DRY CREEK
Habitat Restoration
Sheet 7 of 10

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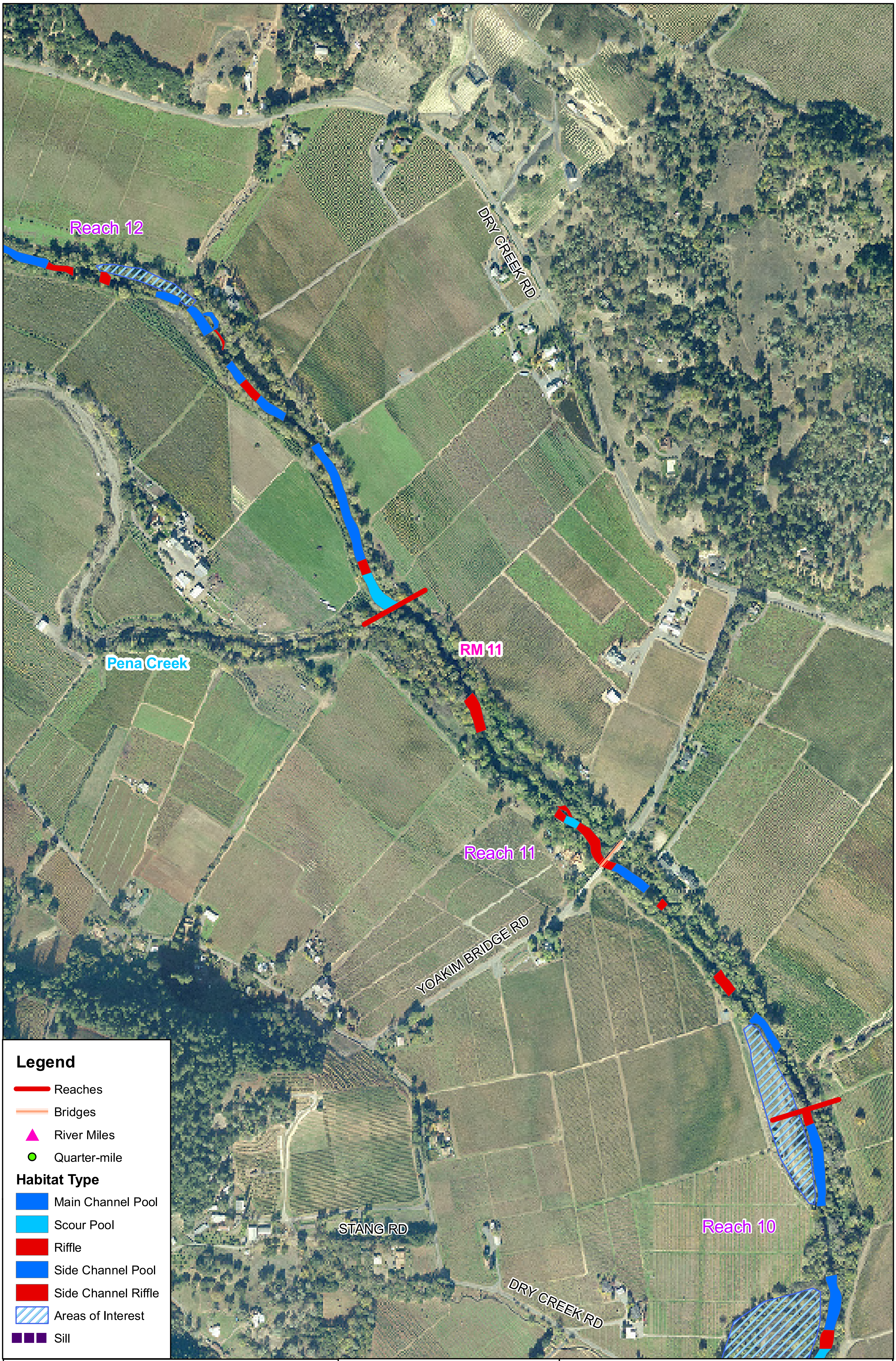

N W E S

0 500 1,000 Feet

0 0.1 0.2 Miles

DRY CREEK
Habitat Restoration
Sheet 8 of 10

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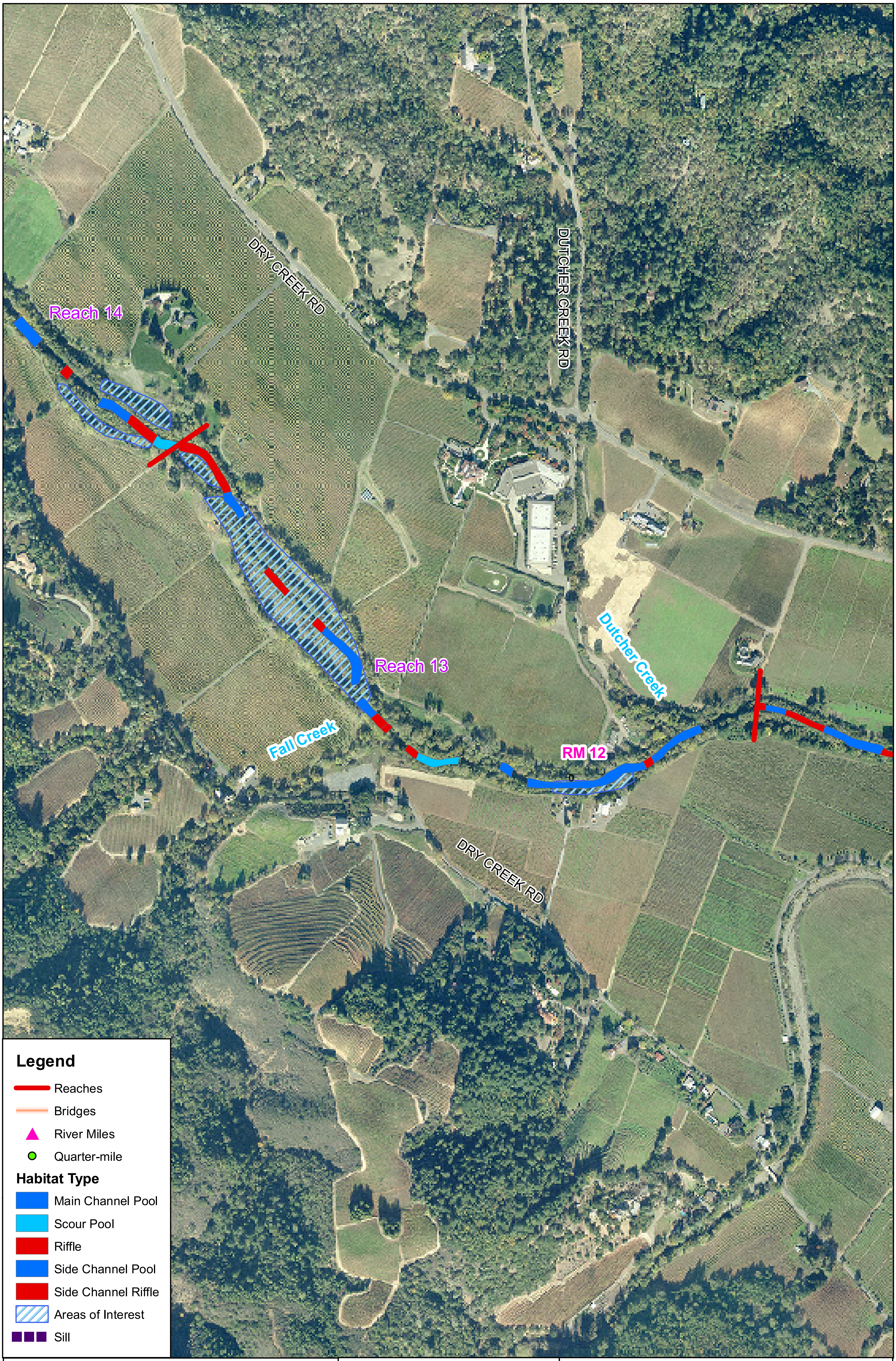

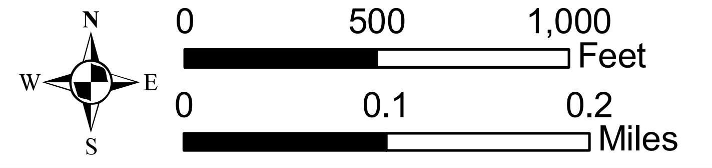

DRY CREEK
Habitat Restoration
Sheet 9 of 10

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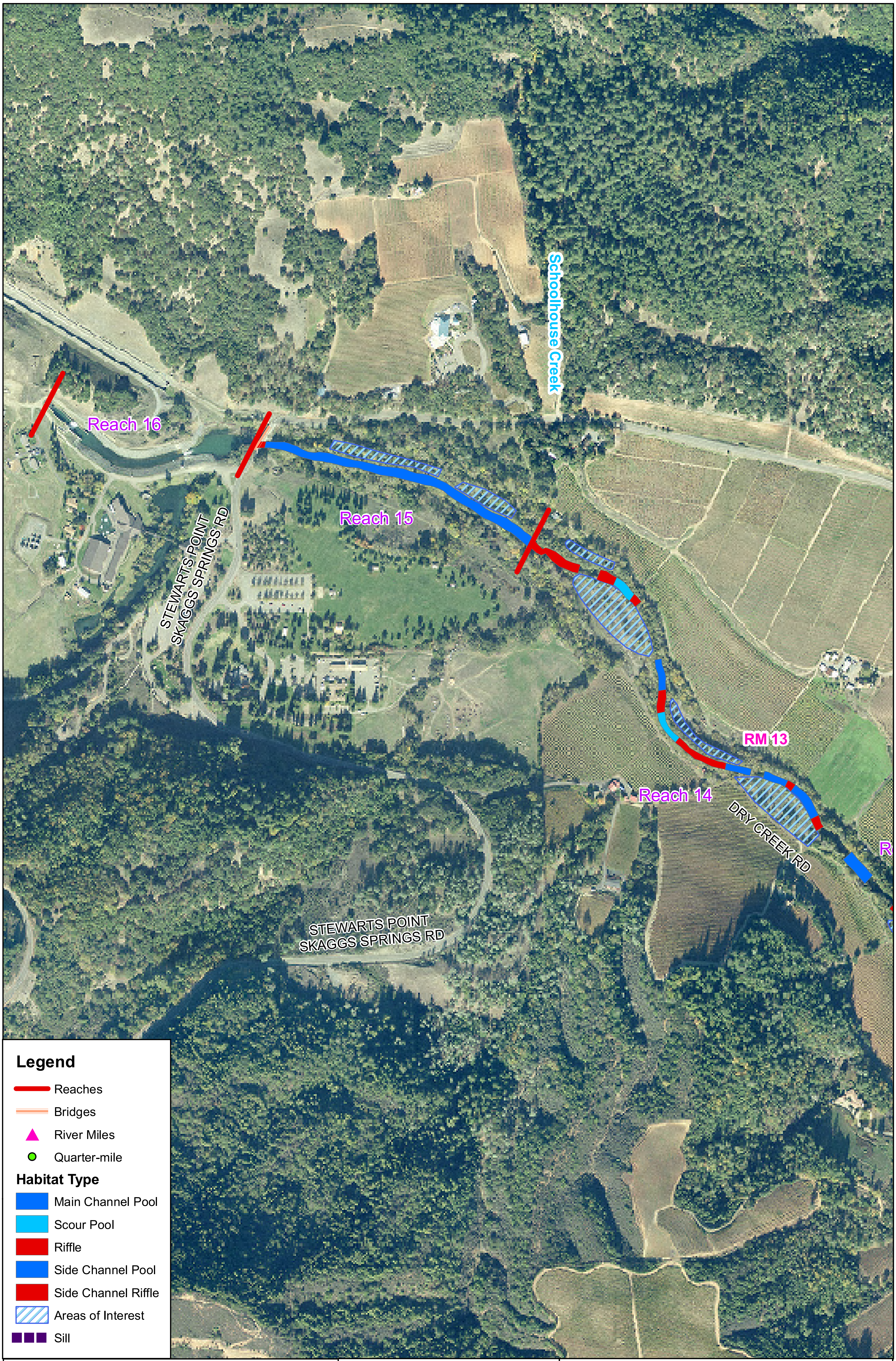

DRY CREEK
Habitat Restoration
Sheet 10 of 10

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10 APPENDIX C - HABITAT SURVEY DATA SHEETS

FISHERY HABITAT INVENTORY DATA

STREAM Dry Creek

OBSERVOR(S) RJ & NN

DATE 8/26/2009

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
1	15	1	R	D01	48	23		2	*				1			7	TV	Bo	1	G	SC	33			45	2.8	2.8	3.2	126	Y
2	15	2	P	D02	1630	55	7	2.5		2	4		10	3		3000%	TV	AV	3	G	SC	57								N
3	15	3	A	D03	45	27	3									8000%	AV	TV	3	F	S	52								
4	14	1	R	D04	312	55		1.7					1			15	TV	SWD	2	SC	G				88	3.4	2.4	2.1	113	Y
5	14	2	A	D05	38	20	1.5						2			5	TV	SWD	2	F	G									
6	14	3	SC/F	D06	108	15		1.1	*							30	TV	AV	3	G	S									
7	14	4	F	D07	114	43		2	*				3			20	TV	SWD	3	SC	S	42								
8	14	5	R	D08	100	38		1.5			1		4			35	SWD	TV	3	SC	G									
9	14	6	SP	D09	132	40	5.8	1					3	1		25	TV	SWD	3	SC	G	33								
10	14	7	R	D10	50	38		1.2								20	TV	RM	3	G	SC									
11	14	8	F	D11	332	44		3.5		1	1		1			20	TV	SWD	3	G	S									
12	14	9	P	D12	180	50	7	1.5			1		4			15	TV	SWD	3	G	S									
13	14	1	R	D13	126	53		1		3				1		10	TV	SWD	2	G	SC	43			54	2	2.6	3.6	180	Y
14	14	2	SP	D14	185	38	6	1.3		1						15	TV	RM	2	G	S	38								
15	14	3	R	D15	315	40		0.9					1			10	TV	RM	2	G	SC									
16	14	4	P	D16	145	43	5.5	2			1			1		15	TV	SWD	2	G	SC									
17	14	5	F	D17	80	45		2		1	1		2			15	SWD	TV	3	G	SC									
18	14	6	P	D18	132	48	3.5	1.1		1			2			15	TV	RM	3	G	S									
19	14	7	R	D19	50	38		1					2	1		30	SWD	TV	3	G	SC									
20	14	8	P	D20	206	60	8	1.2		5	2		5	6		30	SWD	TV	3	G	S									
21	14	9	R	D21	60	50		0.7					1			20	TV	SWD	2	G	SC	49			53	2	2.7	2.9	124	N
22	14	10	F	D22	231	60		2	*	1	1		1	3		20	TV	SWD	3	G	SC	65								
23	14	11	P	D23	180	60	4	1.3	*	1	2		7	2		40	TV	AV	3	G	S									
24	14	12	F	D24	197	57		2.2	*				2			20	TV	SWD	3	G	SC									
25	14	13	R	D25	60	53		1					1			30	SWD	TV	3	SC	G									
26	14	14	F	D26	218	48		2								10	TV	RM	2	SC	G									

Habitat Unit Types

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types

RM
SWD
LWD Root Mass
TV <12" Woody Debris
AV >12" Woody Debris
BC Terrestrial Vegetation
BO Aquatic Vegetation
BD Bubble Curtain
UC Boulders
Bedrock Ledge
Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
stable 12" undercut bank w/ rootmass
single RW lacking complexity
branches in/near water
limited submersed veg fish cover
bubble curtain

3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

Substrate

F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC small cobble, 64mm<D<128mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

FISHERY HABITAT INVENTORY DATA

inter-fluve, inc.

STREAM Dry Creek

OBSERVOR(S) RJ & NN

DATE 8/26/2009

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
27	14	15	P	D27	192	53	7.2	1.4		3	1		2			25	TV	AV	3	G	SC									
28	14	16	R	D28	188	50		0.9		2				1		7	SWD	TV	3	G	SC									
29	14	17	SP	D29	143	50	4.4	1.2		1				1		20	TV	AV	2	G	S	45								
30	14	18	A	D30	58	25	5.4				1					50	AV	SWD	3	F	S									
31	13	19	R	D31	405	39		1.6		4						5	Bo	RM	2	SC	G									
32	13	20	P	D32	159	43	4.4	2		2	1		2	1		20	TV	SWD	3	G	SC									
33	13	21	F	D33	336	40		2.2								15	TV	RM	2	G	SC									
34	13	22	R	D34	180	40		1.1					1			10	TV	RM	2	SC	LC	40								
35	13	23	F	D35	218	45		2.5					1			5	TV	RM	2	SC	LC									
36	13	24	R	D36	65	40		1.7		1			1			10	TV	RM	2	SC	G									
37	13	25	P	D37	394	43	5	1.9		2	1		5	3	1	20	SWD	TV	3	SC	LC									
38	13	26	F	D38	70	45		2.1			1		1	2	1	20	SWD	TV	3	SC	LC									
39	13	27	P	D39	139	38	5.3	1.3								35	LWD	SWD	3	G	SC									
40	13	28	A	D40	90	12	1.6		*	2	2					80	AV	SWD	3	S	G									
41	13	29	R	D41	84	45		0.7	*				1			5	RM	TV	2	G	SC									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes
S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types
RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
AV Aquatic Vegetation
BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
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limited submersed veg fish cover
bubble curtain

3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC gravel, 2mm<D<64mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE 1 of ____

FISHERY HABITAT INVENTORY DATA

inter-fluve, inc.

STREAM **Dry Creek**

OBSERVOR(S) **RJ & NN** DATE 8/27/2009

Stream Discharge ____

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
42	13	1	R	D42	40	37		0.9		2			3			8	SWD	TV	3	G	SC									
43	13	2	F	D43	136	46	3	1.4		2	1		4	2		20	SWD	TV	3	G	SC	50	49	49						
44	13	3	R	D44	70	36		1.2			1		1			10	TV	SWD	3	G	SC	39	37	38	41	2.1	1.9	3	62	Y
45	13	4	SP	D45	244	35	5.7	2.1	*	8	3		6	1	1	35	SWD	TV	3	G	S									
46	13	5	F	D46	239	38		3		3	1		4	2		30	TV	SWD	3	G	SC									
47	13	6	A	D47	60	10	2.4			1				1	1	100	AV	TV	3	F	S									
48	13	7	P	D48	77	50	4	1.5	*	1			1	1		25	TV	SWD	3	G	S	58	53	45						
49	13	8	F	D49	100	55		1.8					2	1		35	TV	SWD	3	G	S									
50	13	9	P	D50	681	50	8	2	*	12	3	1	2	1		30	TV	SWD	3	SC	G									
51	13	10	R	D51	55	33		1.2		1				1		5	TV	SWD	2	G	SC									
52	13	11	A	D52	80	18	2.5		*	1				1		80	AV	TV	3	G	F									
53	13	12	P	D53	328	55	7.5	3	*	7	2		8	1		25	TV	SWD	3	S	G									
54	13	13	F	D54	340	60		2.4	*	2		1	6	1		30	SWD	TV	3	G	SC									
55	12	14	R	D55	50	58		1.8					3			20	TV	SWD	2	SC	G	54	53	56	60	3.1	3.3	2.7	130	N
56	12	15	P	D56	114	35	4.5	2.3		3			1	1		40	BO	RM	3	B	S	35	37	40	ely hp-rap from along LB					
57	12	16	R	D57	235	42		2.5		4	1					60	BO	RM	3	B	SC									
58	12	17	P	D58	350	45	7.8	1.2	*	3						30	TV	AV	3	S	SC									
59	12	18	R	D59	153	45		1.3		1	1		1			10	RM	SWD	3	G	SC									
60	12	19	F	D60	153	60	4	2.5		4	1		3			25	TS	AV	3	G	SC									
61	12	20	R	D61	54	53		1.1		1			1			10	TV	SWD	2	G	SC									
62	12	21	F	D62	277	35		2		4	1		3	1		20	SWD	TV	3	G	SC									
63	12	22	P	D63	141	40	6.5	1.5		5	2		2	2		25	TV	SWD	3	G	SC									
64	12	23	F	D64	59	35		1.6		3	1	1				38	SWD	TV	3	G	SC	27	28	29						
65	12	24	A	D65	300	25	2.5		*	5	1		3			95	AV	TV	3	G	F									
66	12	25	SC/F	D66	90	12	2.1	0.9		3				2		40	SWD	TV	3	G	S									

Habitat Unit Types

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S	>6" but <12"
M	>12" by <20"
L	>20"

CDFD Shelter Types

RM	Root Mass
SWD	<12" Woody Debris
LWD	>12" Woody Debris
TV	Terrestrial Vegetation
AV	Aquatic Vegetation
BC	Bubble Curtain
BO	Boulders
BD	Bedrock Ledge
UC	Undercut Bank

limited submersed veg fish cover
bubble curtain

Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

Substrate

F	fines, D<0.0625 mm
S	sand, 0.0625mm<D<2mm
G	gravel, 2mm<D<64mm
SC	small cobble, 64mm<D<128mm
LC	large cobble, 128mm<D<256mm
B	boulders, 256 mm<D
W	bedrock

PAGE 2 of ______

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **RJ & NN** DATE 8/27/2009

Stream Discharge ____________

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
67	12	1	P	D67	187	43	4	1.5					1			20	TV	SDW	3	G	SC									
68	12	2	F	D68	205	28		1.8		9	2		2			35	TV	SDW	3	G	SC	29	27	27						
69	12	3	SC/P	D69	120	32	3.2	0.8	*	8	2	1	1	3		15	SWD	AV	3	G	S									
70	12	4	SC/R	D70	140	15		1.1		5			3			5	SWD	RM	3	G	SC									
71	12	5	P	D71	129	43	3.5	1.2	*	2			1			5	TV	SDW	2	G	SC									
72	12	6	R	D72	130	44		1		3			1			5	SWD	RM	3	G	SC	46	38	40	48	1.7	2.3	2.2	56	Y
73	12	7	P	D73	183	50	4.5	1.9	*				2			5	TV	SDW	2	G	S									
74	12	8	F	D74	237	45		2		2						20	TV	SDW	3	G	SC									
75	12	9	P	D75	710	57	7.2	1.1	*	9	5		9	2		50	TV	SDW	3	G	S	70	68	65						
76	12	10	R	D76	80	56		0.8		2	2	1	2			15	SWD	TV	3	G	SC									
77	12	11	SP	D77	260	60	5.8	1.6			4		7	2		25	TV	SDW	3	G	SC									
78	11	1	F	D78	670	46		1.3		8	4	2	3			20	TV	SDW	3	G	SC	47	49	65						
79	11	2	A	D79	100	25	2.3		*	2						10	TV	SDW	2	G	F									
80	11	3	R	D80	216	63		0.6		2	4	2	3	1		10	SWD	TV	3	G	SC	65	67	77	68	2.3	2	3.2	74	Y
81	11	4	F	D81	637	55	5.8	1.5		17	4	2	5	1	1	15	TV	SDW	3	G	G									
82	11	5	R	D82	60	45		1								10				G	SC									
83	11	6	SC/R	D83	100	25		1		1			1			5	TV	RM	3	G	SC									
84	11	7	SP	D84	80	40	3.1	1	*	5	2					20	SWD	TV	3	G	S									
85	11	8	R	D85	335	55		1.1		2	1		1	1		10	TV	SDW	3	SC	G									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes
S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types
RM
SWD Root Mass
LWD <12" Woody Debris
TV >12" Woody Debris
AV Terrestrial Vegetation
BC Aquatic Vegetation
BO Bubble Curtain
BD Boulders
UC Bedrock Ledge
Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

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bubble curtain

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3 LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
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extensive submersed veg fish cover

F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC gravel, 2mm<D<64mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

FISHERY HABITAT INVENTORY DATA

inter-fluve, inc.

STREAM **Dry Creek**

OBSERVOR(S) **RJ & NN** DATE 8/28/2009

Stream Discharge ____

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
				STA	Length	Avg Wet	Pool	Avg D	Edge	DEAD			ALIVE			%	1	2	Complex.	1	2	Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	bgn		Width (O)	Max D	/PTC	Present	S	M	L	S	M	L	Cover			Code			1	2	3	Width	1	2	3	FPW	(Y/N)
86	11	1	P	D86	226	43	5.2	1.7		12	7	2	3	2		35	SWD	TV	3	G	SC	35	35	35						
87	11	2	F	D87	95	38		1.7		2			2			20	SWD	TV	3	G	SC									
88	11	3	R	D88	50	40	4.2	1		1		1		1		8	SWD	TV	3	G	SC	41	41	42	45	2.4	2.6	3	82	Y
89	11	4	F	D89	269	45	2.5	1		20	5	1	8	4		25	SWD	LWD	3	G	S									
90	11	5	F	D90	202	40		2.3		3	3	1				20	TV	SWD	3	G	SC									
91	11	6	R	D91	141	43		1.5		2			1			10	TV	SWD	3	G	SC									
92	11	7	F	D92	175	47		2.6		4	2		2	1		30	TV	RM	3	G	SC	45	45	50						
93	11	1	P	D93	246	48	7	2		6			6	9		40	SWD	TV	3	S	G	43	44	43						
94	11	2	F	D94	367	50		2		9			1			5	TV	SWD	3	G	SC									
95	10	3	R	D95	86	48		1.3		6	1		1			15	SWD	TV	3	G	SC									
96	10	4	P	D96	467	45	3.4	1.1	*	9	2		6	2	1	25	TV	SWD	3	G	S									
97	10	5	F	D97	390	50		2.1		12	1		3			15	TV	SWD	3	G	S									
98	10	6	P	D98	317	52	8.4	1.4	*	15	3	1	4	2		30	TV	SWD	3	S	G									
99	10	7	R	D99	108	70		0.7		15	4		2	1		25	SWD	TV	3	LC	SC	71	60	69	78	2	2.5	2.8	87	Y
100	10	8	SP	D100	531	55	7	1.4		38	12	5	3	1		30	SWD	LWD	3	G	SC	48	54	52						
101	10	9	SC/R	D101	70	7		0.3								50	TV		2	G	SC									
102	10	10	R	D102	160	32		1.4		2	2		1		1	20	TV	SWD	3	SC	G									
103	10	11	A	D103	35	15	2.3		*	1	2					90	AV	TV	3	SC	S									
104	10	12	A	D104	35	20	3.2		*	1						98	AV	RM	3	F	G									
105	10	13	F	D105	98	40				5	2		3	3		30	TV	SWD	3	G	SC									
106	10	14	SP	D106	226	44	6.5	1.6		9	5		1			35	SWD	TV	3	G	S									
107	10	15	A	D107	350	15	2.3		*	10	8		3	1		70	AV	TV	3	G	S									
108	10	16	F	D108	667	40		1.6		19	3	1	2			20	SWD	TV	3	G	SC	42	45	41						

Habitat Unit Types

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types

RM
SWD Root Mass
LWD <12" Woody Debris
TV >12" Woody Debris
AV Terrestrial Vegetation
BC Aquatic Vegetation
BO Bubble Curtain
BD Boulders
UC Bedrock Ledge
Undercut Bank

Instream Shelter Complexity

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
stable 12" undercut bank w/ rootmass
single RW lacking complexity
branches in/near water
limited submersed veg fish cover
bubble curtain

3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

Substrate

F fines, D<0.0625 mm
S gravel, 2mm<D<64mm
G gravel, 2mm<D<64mm
SC small cobble, 64mm<D<128mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE 2 of

FISHERY HABITAT INVENTORY DATA

inter-fluve, inc.

STREAM **Dry Creek**

OBSERVOR(S) **RJ & NN** DATE 8/28/2009

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	DEAD S	DEAD M	DEAD L	ALIVE S	ALIVE M	ALIVE L	% Cover	1	2	Complex. Code	1	2	Wet Width (M) 1	Wet Width (M) 2	Wet Width (M) 3	Riffle BF Width	Riffle BF Avg Depth 1	Riffle BF Avg Depth 2	Riffle BF Avg Depth 3	Riffle FPW	Peb Ct (Y/N)
109	9	1	SP	D109	469	40	3.4	0.9	*	17	5		2			30	SWD	BO	3	G	S	52	55	45						Y
110	9	2	R	D110	104	56		1.1		1			2			10	TV	SWD	3	G	SC	50	51	49	57	2.3	2.6	3.4	95	
111	9	3	F	D111	191	50	2.6	1.3		3	1	1	1		1	15	TV	SWD	3	S	G									
112	9	4	R	D112	168	53		1.1	*	7	3	1	2			25	SWD	TV	3	G	SC									
113	9	5	F	D113	200	54	2.6	1.6		18	1	1				20	SWD	TV	3	S	G									
114	9	6	F	D114	330	49		1.5		7	1		1	1		20	TV	SWD	3	G	SC									
115	9	7	R	D115	**224**	45		1			1					7	TV	RM	3	SC	G									
116	9	8	SP	D116	984	45	4.2	1.5		25	1	1	2	1	1	25	TV	SWD	3	S	G	49	51	59						
117	9	9	A	D117	53	12	1.5			1						90	AV	SWD	3	F	S									
118	9	10	R	D118	60	55		0.7		1			1			20	TV	SWD	3	SC	G									
119	9	11	F	D119	504	63		1.5	*	4			2			8	TV	RM	3	G	S									
120	9	12	R	D120	65	57		0.7		4			1			30	TV	SWD	3	SC	G									
121	9	13	F	D121	323	46		1.5	*	5	1		1			15	TV	SWD	3	S	G									
122	9	14	SP	D122	595	51	5	1.3		8	4	2	8	2	1	30	TV	SWD	3	S	G									
123	8	1	R	D123	50	40		1		3						10	SWD	RM	3	G	SC	42	41	41	64	3.8	2.4	1.4	77	Y
124	8	2	P	D124	200	45	4	1.5	*	7						8	TV	SWD	3	G	S	51	50	52						
125	8	3	R	D125	149	33		1.2	*							25	TV		2	G	SC									
126	8	4	P	D126	547	40	7	1.2		16	2	1	5	1	1	50	BO	TV	3	S	G									
127	8	5	F	D127	121	38		1.5		3						20	TV	SWD	3	G	SC									
128	8	6	P	D128	220	40	3.5	1.5		1				2		15	TV	SWD	3	G	S									
129	8	7	F	D129	160	41		1.5								3	TV	TV	1	G	S									
130	8	8	F	D130	67	44	3	1.4	*	6			1			20	SWD	TV	3	G	S									
131	8	9	F	D131	295	47		1.2		3		1	2			20	TV	SWD	3	G	SC	58	57	55						
132	8	10	F	D132	105	55	2.2	1.2	*	2	1					15	TV	SWD	3	G	S									
133	8	11	R	D133	72	45		1.1		6			1			20	TV	SWD	3	G	SC									
134	8	12	F	D134	95	48	2.1	1.5		3						25	TV	SWD	3	G	SC									
135	8	13	R	D135	85	38		0.8	*							50	TV		3	G	SC									
136	8	14	SP	D136	612	45	5	1.1		19	3	1	7	2	1	17	SWD	TV	3	G	S									

Habitat Unit Types

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types

RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
AV Aquatic Vegetation
BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

Instream Shelter Complexity

0 No Shelter

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bare undercut bank / bedrock ledge
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bubble curtain

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3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

Substrate

F fines, D<0.0625 mm
S gravel, 2mm<D<64mm
G gravel, 2mm<D<64mm
SC small cobble, 64mm<D<128mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **RJ, NN, JM**

DATE 8/28/09 & 8/29/09

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
137	8	15	F	D137	223	55		1.4	*	5	1					10	SWD	RM	3	G	SC									
138	8	16	R	D138	298	50		0.8		5						8	TV	RM	3	G	SC									
139	8	17	F	D139	424	48	2.7	1.3		12	3		3	1		28	TV	SWD	3	G	SC	58	50	53						
140	8	18	F	D140	77	49		1.3		4		1				25	TV	SWD	3	G	SC									
141	8	19	P	D141	616	45	4.2	1.4	*	9	3	1	6	3		18	TV	SWD	3	G	SC									
142	8	20	R	D142	53	49		1.1		4			1			20	SWD	TV	3	G	SC	49	48	49	53	3	2.2	1.8	64	N
143	8	21	P	D143	678	50	5.5	1.5	*	18	2	1	7	4		23	SWD	TV	3	S	G	57	48	48						
144	8	22	R	D144	60	45		0.9	*	1			1			8	TV	SWD	2	G	SC									
145	8	23	P	D145	470	53	3.6	1.4	*	7	1		6	1		18	SWD	BO	3	G	B									
146	8	24	F	D146	52	35		1.6			1					5	TV	RM	1	G	SC									
147	8	25	SP	D147	277	58	3.8	1.3	*	8	3			1		15	TV	SWD	3	G	S									
148	8	26	F	D148	253	58		1.2	*	3						12	TV	SWD	2	G	SC									
149	8	27	R	D149	100	35		1.1								5	TV	RM	1	G	SC									
150	8	28	SP	D150	323	48	6.8	1.3		15	3		1	2		20	SWD	RM	3	G	S	37	44	42						
151	8	29	F	D151	196	50		1.6		2						18	TV	SWD	2	G	S									
152	8	30	SP	D152	425	48	4	1.3	*	15	4		1	1		15	SWD	TV	3	G	SC									
153	8	31	A	D153	110	15	2		*	7	2		3	2		30	SWD	TV	3	G	G									
154	8	32	F	D154	389	45		1.6	*	4	6					8	TV	SWD	2	G	SC									
155	7	33	SP	D155	80	48	4.5	1.4	*	6	2		1			40	SWD	RM	3	G	S									
156	7	34	F	D156	202	58		1.9	*	5	1		2			20	SWD	BO	3	G	SC	44	64	49						
157	7	35	P	D157	313	45	5	1.6	*	6		1	1	1		40	BD	SWD	3	G	W									
158	7	36	F	D158	148	45		1.1	*	3						15	BO	SWD	3	G	S									
159	7	37	A	D159	320	15	2.1		*	4	1		4			35	TV	SWD	3	S	F									
160	7	38	R	D160	108	40		1		3					1	5	RM	TV	2	G	SC									
161	7	39	F	D161	107	40	2.7	1.1			1					3	RM	SWD	2	G	SC									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S	>6" but <12"
M	>12" by <20"
L	>20"

CDFD Shelter Types

RM	Root Mass
SWD	<12" Woody Debris
LWD	>12" Woody Debris
TV	Terrestrial Vegetation
AV	Aquatic Vegetation
BC	Bubble Curtain
BO	Boulders
BD	Bedrock Ledge
UC	Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
stable 12" undercut bank w/ rootmass
single RW lacking complexity
branches in/near water
limited submersed veg fish cover
bubble curtain

3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

F	fines, D<0.0625 mm
S	sand, 0.0625mm<D<2mm
G	gravel, 2mm<D<64mm
SC	gravel, 2mm<D<64mm
LC	large cobble, 128mm<D<256mm
B	boulders, 256 mm<D
W	bedrock

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FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **RJ, NN, JM**

DATE 8/29/2009

Stream Discharge ______

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	DEAD S	DEAD M	DEAD L	ALIVE S	ALIVE M	ALIVE L	% Cover	1	2	Complex. Code	1	2	Wet Width (M) 1	Wet Width (M) 2	Wet Width (M) 3	Riffle BF Width	Riffle BF Avg Depth 1	Riffle BF Avg Depth 2	Riffle BF Avg Depth 3	Riffle FPW	Peb Ct (Y/N)
162	7	1	F	D162	50	30		1.2								2	RW	TV	1	G	SC	30	42	38						
163	7	2	SP	D163	721	33	4	1.3		12			5	4		25	TV	SWD	3	S	G									
164	7	3	A	D164	30	12	2.5		*	2						5	RM	TV	2	G	S									
165	7	4	A	D165	400	5	1		*							10	TV		1	G	S									
166	7	5	F	D166	222	55		1		4			3			10	TV	SWD	3	G	S	59	63	54						
167	7	6	R	D167	145	63		1.1	*	8	3		4			15	SWD	TV	3	G	SC	66	59	57	77	1.9	2.8	2.5	82	Y
168	7	7	F	D168	171	54		1.3					1			15	TV	RM	3	G	S									
169	7	8	R	D169	50	57		0.8			1					8	TV	RM	2	G	SC									
170	7	9	SP	D170	283	40	3.8	0.8	*	5	1	3	1	3		12	TV	SWD	3	G	S									
171	7	1	R	D171	55	48		1.1	*	2	1					23	TV	SWD	3	G	SC	52	52	50	62	3.8	2.7	3.7	84	Y
172	7	2	SP	D172	116	49	3.8	1.3		2	2		1	1		20	TV	SWD	3	G	S									
173	7	3	F	D173	64	42		1.4	*	3	2		1	1		15	TV	SWD	3	G	S									
174	7	4	P	D174	1654	60	4.3	1.3	*	28	7	1	24	8		20	TV	SWD	3	G	S	61	60	63						
175	7	5	P	D175	80	50	3.9	1.3	*	1						90	BD	BO	3	G	S									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types

RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
AV Aquatic Vegetation
BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

0 No Shelter

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bare undercut bank / bedrock ledge
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F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC gravel, 2mm<D<64mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM Dry Creek

OBSERVOR(S) NN & JM

DATE 8/29/09 & 8/30/09

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	DEAD S	DEAD M	DEAD L	ALIVE S	ALIVE M	ALIVE L	% Cover	1	2	Complex. Code	1	2	Wet Width (M) 1	Wet Width (M) 2	Wet Width (M) 3	Riffle BF Width	Riffle BF Avg Depth 1	Riffle BF Avg Depth 2	Riffle BF Avg Depth 3	Riffle FPW	Peb Ct (Y/N)
176	7	1	C	D176	75	55		1.1	*							95	BD	BO	3	W	B									
177	7	2	F	D177	100	55	2.9	1.5		1			1			15	RM	SWD	2	G	SC									
178	7	3	R	D178	60	45		1								90	BD	BO	3	W	B									
179	7	4	P	D179	99	50	6	1.5					1			50	BO	BD	2	B	S	54	55	53						
180	7	5	F	D180	100	40		1.6								5	RM		1	G	SC									
181	7	6	SC/F	D181	75	10		0.9	*	2	1					50	BD	SWD	2	W	S									
182	7	7	SP	D182	330	55	4.5	1.4		8			7			15	TV	SWD	3	G	SC									
183	7	8	A	D183	40	20	3.4	0.9		2						70	TV	SWD	2	G	SC									
184	7	9	SC/F	D184	550	23		0.8		10	2		3			30	TV	SWD	2	G	SC									
187	7	12	A	D187	40	18	2.7	0.7	*				1			40	TV	BO	2	G	SC									
188	7	13	SC/R	D188	30	35		0.6								40	TV		2	G	S									
189	7	14	F	D189	60	40		2		1			1			60	BD	TV	3	W	G									
190	7	15	F	D190	110	50	2.7	1.6	*	1			1			30	BD	TV	3	G	W	51	44	48						
191	7	16	R	D191	216	30		0.9		2						5	TV	SWD	1	G	SC	28	35	39	32	2.1	2.4	2.3	84	Y
192	7	17	A	D192	50	12	0.4		*	2						30	TV	SWD	2	G	SC									
193	7	1	P	D193	361	55	5.9	2		12	3		3	2		25	TV	SWD	3	G	SC	53	46	58						
194	7	2	A	D194	60	8	0.9		*	2		1				80	TV	SWD	3	F	G									
195	7	3	F	D195	152	48		1.5		1	1					12	TV	SWD	2	G	SC									
196	7	4	R	D196	60	45		1		1					1	5	TV	LWD	2	G	SC	53	53	49	63	2	1.7	2.3	74	Y
197	7	5	P	D197	580	55	7.4	1.2		10	4		9	3		22	TV	SWD	3	G	S									
198	7	6	A	D198	60	15	2.7			6			1	1		40	TV	SWD	3	G	S									
199	6	7	R	D199	100	50		0.8		6	1					20	TV	SWD	3	G	SC									Y
200	6	8	F	D200	100	52		2	*	1						30	TV	SWD	2	G	SC									
201	6	9	P	D201	194	50	8	1.4		9			4		1	45	TV	SWD	3	G	S									
202	6	10	F	D202	80	35		2.2	*	1						5	TV	RM	2	G	SC									
203	6	11	P	D203	373	55	5.8	1.8		13	2		3	2	3	45	TV	SWD	3	S	G	51	55	58						

Habitat Unit Types
P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
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LWD Size Classes
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SWD <12" Woody Debris
LWD >12" Woody Debris
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0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
stable 12" undercut bank w/ rootmass
single RW lacking complexity
branches in/near water
limited submersed veg fish cover
bubble curtain

3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

Substrate
F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC small cobble, 64mm<D<128mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM Dry Creek

OBSERVOR(S) NN & JM

DATE 8/30/2009

Stream Discharge ____________

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
204	6	14	F	D204	100	50		1.4		16	2	2	2	3	3	12	LWD	TV	3	G	SC									
205	6	15	P	D205	810	50	3.3	1.2	*	5		1	5	2	1	18	TV	SWD	3	G	S									
206	6	16	F	D206	100	55		1		7	3			2		10	TV	SWD	3	G	SC									
207	6	17	P	D207	541	52	3.8	1.5	*	9	3	1	4	2	1	30	LWD	TV	3	G	S									
208	6	18	R	D208	60	48		0.9								2	TV		1	G	SC									
209	6	19	P	D209	372	50	5.6	1.2		2						30	TV	SWD	2	G	SC	42	42	50						
210	6	20	R	D210	228	45		1.1		1		1				30	TV	SWD	2	G	SC									
211	6	21	F	D211	167	45		1.5	*	4			5			30	TV	SWD	3	G	SC									
212	6	22	P	D212	198	48	6.7	1.9		1			3	1		40	TV	SWD	3	S	G									
213	6	23	R	D213	120	45		0.7							1	10	TV	RM	2	G	SC									
214	6	24	F	D214	270	48	2.9	1.6					3			18	TV	RM	3	G	SC									
215	6	25	F	D215	343	48		1.5		2	3		4	3		15	TV	SWD	3	G	S									
216	5	1	F	D216	753	50	3.2	1.6	*	18	2	3	10	3	2	35	TV	SWD	3	G	S	51	56	60						
217	5	2	F	D217	275	55		1.6			1		2			30	TV	SWD	3	G	SC									
218	5	3	F	D218	269	50	2.6	1.6		2	1		4			30	TV	SWD	2	G	S									
219	5	4	R	D219	90	52		1		1						12	TV	SWD	3	G	SC	64	63	57	73	1.8	1.9	2	88	Y
220	5	5	P	D220	247	55	6.2	1.5	*	10	2	2	3		1	20	TV	SWD	3	G	S									
221	5	6	F	D221	526	52		1.6	*	15	5		2	2		18	TV	SWD	3	G	SC									
222	5	7	F	D222	148	55	3	1.7		4			1	1		30	SWD	TV	3	G	S									
223	5	8	F	D223	223	55		1.4		17	2	1	2			25	SWD	RM	3	G	S									
224	5	9	R	D224	50	35		1		2						15	TV	SWD	2	G	SC									
225	5	10	F	D225	80	35	3	1.6		4	1		1			20	SWD	TV	3	G	SC	35	33	33						
226	5	11	F	D226	50	35		1.6		1	1					5	SWD	TV	1	G	SC									
227	5	12	P	D227	195	40	4	1.4		3	1		2			10	TV	SWD	2	G	S									

Habitat Unit Types

P - Main Channel Pool

SP - Scour Pool

A - Alcove/Backwater/SideChannel Pool

SC/Type - Side Channel with Unit Type

R - Riffle

F - Flatwater (Glide/Run)

C - Cascade

LWD Size Classes

S >6" but <12"

M >12" by <20"

L >20"

CDFD Shelter Types

RM Root Mass

SWD <12" Woody Debris

LWD >12" Woody Debris

TV Terrestrial Vegetation

AV Aquatic Vegetation

BC Bubble Curtain

BO Boulders

BD Bedrock Ledge

UC Undercut Bank

Instream Shelter Complexity

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LC large cobble, 128mm<D<256mm

B boulders, 256 mm<D

W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **NN & JM** DATE 8/30/2009 & 8/31/

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	DEAD S	DEAD M	DEAD L	ALIVE S	ALIVE M	ALIVE L	% Cover	1	2	Complex. Code	1	2	Wet Width (M) 1	Wet Width (M) 2	Wet Width (M) 3	Riffle BF Width	Riffle BF Avg Depth 1	Riffle BF Avg Depth 2	Riffle BF Avg Depth 3	Riffle FPW	Peb Ct (Y/N)
228	5	1	R	D228	45	40		1.2		2			1	1		40	SWD	TV	3											Y
229	5	2	SC/R	D229	60	12		0.5	*	1			2			20	TV	SWD	2	G	SC									
230	5	3	F	D230	209	47	3.5	1.6	*	3			6			40	TV	SWD	3	G	S	52	46	46						
231	5	4	F	D231	88	48		1.5		2	1	1				35	TV	SWD	3	G	S									
232	5	5	F	D232	161	50	2.3	1.5		3				1		40	TV	SWD	2	G	S									
233	5	6	F	D233	292	53		1.5		6	1	2				25	TV	SWD	3	G	SC									
234	5	7	P	D234	255	45	4	1.7	*	2	1		4			20	TV	SWD	3	G	S									
235	5	8	R	D235	60	38		1			1					5	TV	SWD	1	G	SC	37	48	33	65	1.3	1.3	2.4	85	
236	5	9	P	D236	260	40	5.4	1.6		13	1	1	4	2	1	40	SWD	TV	3	G	S									
237	5	10	A	D237	45	5	0.5		*	1	1		2			70	AV	SWD	3	F										
238	5	11	F	D238	203	35		1.7		1						15	TV	SWD	2	G	SC	37	42	33						
239	5	12	P	D239	241	52	3.8	1.5		7	1	1	3			20	TV	SWD	3	G	S									
240	5	13	F	D240	48	50		1.1	*							20	TV		2	G	SC									
241	5	14	F	D241	331	55	2.7	1.8		13	3	1	1	2		35	TV	SWD	3	G	S									
242	5	15	F	D242	167	55		1.5	*	1	1		1			30	TV	SWD	2	G	S									
243	5	16	P	D243	148	58	5.5	1.4					7			20	TV	SWD	3	G	S	56	57	57						
244	5	17	A	D244	60	10	1.5		*							40	TV			G	F									
245	5	18	F	D245	233	65		1.5	*	4			3			25	TV	SWD	3	G	S									
246	5	19	R	D246	114	48		0.9		1				1		10	TV	RM	2	G	SC									
247	5	20	P	D247	183	50	5	1.6	*	3			2	1		20	TV	SWD	2	G	S									
248	5	21	F	D248	135	48		0.9		4			1			15	TV	SWD	3	G	S									
249	5	22	P	D249	444	55	5.2	1.1	*	15	3	2	6	3	2	25	TV	SWD	3	G	S									
250	4	1	P	D250	1618	60	6.2	1.6	*	39	18	1	11	11	2	25	TV	SWD	3	G	S	58	64	67						
251	4	2	A	D251	45	5		1.2	*	2			1			50	TV	RM	3	F	G									
252	4	3	A	D252	500	35	3		*	10	3	2		3		25	SWD	AV	3	F	S									
253	4	4	C	D253	30	120		0.9								50	BO	TV	2	B	SC									
254	4	5	A	D254	30	18	2		*							3	RM	TV	1	G	S									
255	4	6	A	D255	60	20	2.1		*	1						3	RM	SWD	1	G	S									

Habitat Unit Types

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types

RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
AV Aquatic Vegetation
BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

Instream Shelter Complexity

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

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bubble curtain w/ LWD/boulders
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extensive submersed veg fish cover

Substrate

F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC small cobble, 64mm<D<128mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **NN & JM** DATE 8/31/2009

Stream Discharge ______

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
256	4	7	R	D256	80	30		1.5		2				1		3	SWD	RM	2	G	SC									Y
257	4	8	SC/R	D257	40	12		0.5	*	4			1			15	SWD	RM	2	G	SC									
258	4	9	SC/F	D258	60	12		0.7	*	1				1		5	RM	SWD	1	G	S									
259	4	10	P	D259	805	65	5.5	1.7		13	3	2	4	3		30	TV	SWD	3	S	G									
260	4	11	F	D260	378	60		1.1	*	2			4			10	TV	AV	2	S	G									
261	4	12	P	D261	239	58	5.2	1.7	*	12	2		2	2		35	TV	SWD	3	G	S									
262	4	13	F	D262	172	30		1.4		1			1	1		5	RM	SWD	1	G	SC									
263	4	14	A	D263	100	30	2.8			2			1			30	AV	TV	3	F	S									
264	4	15	A	D264	50	25	1.5									70	AV	TV	2	F	S									
265	4	16	SC/F	D265	250	30		1.5		5	2	2	2	3		15	TV	SWD	3	G	SC									
266	4	17	R	D266	50	30		1.2		1	1	1	1	1		10	SWD	TV	2	G	SC									
267	4	18	F	D267	80	40		1.7	*	2						8	TV	SWD	2	G	S									
268	4	19	F	D268	249	58	2.5	1.1	*	4			2		1	25	TV	SWD	3	G	S	44	65	64						
269	4	20	A	D269	40	6	0.5		*	2						90	AV	TV	3	F	G									
270	4	21	F	D270	417	60		1.2	*	3	1		1	2		30	TV	SWD	3	G	S									
271	4	22	P	D271	588	53	4.8	1.7	*	4			7	1	1	40	TV	SWD	3	G	S									
272	4	23	A	D272	50	8	0.8		*				4			70	TV	SWD	3	G	S									
273	4	24	F	D273	40	60		0.9	*						1	10	RM	TV	2	G	S									
274	4	25	R	D274	70	40		1		2			1			8	RM	SWD	2	G	S	45	42	49	52	3.1	2.6	2.5	112	
275	4	26	F	D275	60	43		1.3								5	RM	TV	1	G	S									
276	4	27	F	D276	188	52	2.9	1.4	*	1			4			12	TV	SWD	3	G	S									
277	4	28	F	D277	337	55		1.4	*	3			3	1		18	TV	SWD	3	G	S	68	53	40						
278	4	29	R	D278	144	43		1		1	1		3			25	TV	SWD	3	G	SC									
279	4	30	F	D279	101	40		1.3		1			2	1	1	40	TV	SWD	3	G	S									
280	4	31	P	D280	238	40	4.6	1.5		3	1	1	1	3		60	TV	SWD	3	G	S									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

<u>LWD Size Classes</u>
S >6" but <12"
M >12" by <20"
L >20"

<u>CDFD Shelter Types</u>
RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
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BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

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LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **JM & NN**

DATE 8/31/2009

Stream Discharge ____________

SAMP #	UNIT Rch.	UNIT No.	UNIT Type	DIMENSIONS STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	WOOD DEAD S	DEAD M	DEAD L	ALIVE S	ALIVE M	ALIVE L	SHELTER % Cover	1	2	Complex. Code	SUBSTRATE 1	2	Nth UNIT MEASURES Wet Width (M) 1	2	3	Riffle BF Width	Riffle BF Avg Depth 1	2	3	Riffle FPW	Peb Ct (Y/N)
281	3	1	F	D281	1244	40		1.6	*	4	1	1	7	3		40	TV	SWD	3	G	S	47	37	39						
282	3	2	F	D282	133	40	3.3	1.4					2	1		30	TV	SWD	3	G	S									
283	3	3	F	D283	91	38		1.4	*	2			3			28	TV	SWD	3	G	S									
284	3	4	P	D284	554	50	4	1.5		2	1		6	2	1	40	TV	SWD	3	G	S									
285	3	5	SC/P	D285	70	15	0.8		*				2	1		70	TV	SWD	3	F	S									
286	3	6	F	D286	434	53		1.4	*	3	1		8	3	4	35	TV	SWD	3	G	S									
287	3	7	SC/P	D287	100	25	2.9		*	1	1		1	2	1	80	AV	TV	3	F	S									
288	3	8	SC/P	D288	80		1.9				1		2			25	TV	SWD	3	S	G									
289	3	9	R	D289	80	55		0.9	*	2						10	TV	RM	2	G	SC	79	56	44	86	2.2	2	1.6	95	Y
290	3	10	F	D290	132	48	3.3	1.5		1			1	1	1	10	TV	LWD	3	G	S									
291	3	11	F	D291	128	50		1	*	4			1	1		40	TV	SWD	3	G	S	56	42	39						
292	3	12	F	D292	384	48	2.6	1.5		1						50	TV	SWD	3	G	S									
293	3	13	F	D293	81	55		1.2	*				1			35	TV	AV	3	G	S									
294	3	14	P	D294	625	45	6.1	1		7	1		5		1	15	TV	SWD	2	G	S									
295	3	1	P	D295	185	60	3.7	1.4		6	2	1	5			25	SWD	TV	3	G	S									
296	3	2	SC/P	D296	150	10	0.8		*			2		1	1	70	TV	SWD	3	S	F									
297	3	3	SC/P	D297	1073	35	2.5		*	3	2	1	2	3	4	90	AV	LWD	3	F	S									
298	3	4	A	D298	100	12	0.8		*	3	1		1			80	AV	TV	3	F	S									
299	3	5	SC/F	D299	165	18		0.8	*	6	3		2	1	1	45	SWD	TV	3	G	S									
300	3	6	F	D300	418	50		1.1	*	29	5	1	8	6	2	30	SWD	LWD	3	G	S									
301	3	7	SC/P	D301	250	22	3.6			6			3			25	SWD	TV	3	F	S									
302	3	8	A	D302	200	10	1.3		*	1						95	AV	TV	3	F	S									
303	3	9	R	D303	75	48		1.3			1					2	SWD		1	G	SC									
304	3	10	F	D304	412	58		1.7	*	8	1	1		4		15	TV	SWD	3	G	S	68	68	67						
305	3	11	R	D305	110	48		1.1		2	1	1	1			8	RM	SWD	3	G	SC	45	48	44	78	1	1.6	1.9	125	Y
306	3	12	F	D306	240	38	3.1	1.7				1				12	TV	BO	3	G	S									
307	3	13	A	D307	40	8	0.3		*	3			4			70	TV	SWD	3	F	G									
																SWD														

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LC large cobble, 128mm<D<256mm
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PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **JM & NN** DATE 9/1/2009 REACH 2: Small pools in glides & small glides in pools

Stream Discharge ____________

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	DEAD S	DEAD M	DEAD L	ALIVE S	ALIVE M	ALIVE L	% Cover	1	2	Complex. Code	1	2	Wet Width (M) 1	Wet Width (M) 2	Wet Width (M) 3	Riffle BF Width	Riffle BF Avg Depth 1	Riffle BF Avg Depth 2	Riffle BF Avg Depth 3	Riffle FPW	Peb Ct (Y/N)
308	3	1	R	D308	70	35		1.2						1		7	TV	SWD	2	G	SC									
309	2	2	F	D309	138	53		1.4		1			1			13	TV	SWD	3	G	SC									
310	3	3	A	D310	1500	15	3.2		*	13	2	5	1			90	AV	TV	3	F	S									
311	3	4	SC/P	D311	110	6	0.9		*	1						95	TV	AV	3	S	F									
312	2	5	SP	D312	106	52	3.8	1.5	*	2	1		1			20	TV	SWD	3	G	S									
313	2	6	F	D313	514	45		1.8		4	3		7	2		30	TV	SWD	3	G	S	39	39	40						
314	2	7	P	D314	260	55	3.5	1.4					2	2		33	TV	SWD	3	G	S									
315	2	8	A	D315	60	12	2.6		*	1			2			20	TV	AV	3	F	S									
316	2	9	SC/P	D316	90	10	3.2			10	2		4	1	1	90	SWD	AV	3	G	S									
317	2	10	F	D317	163	48		1.6	*	1						8	TV	SWD	2	G	SC	52	45	41						
318	2	11	P	D318	230	48	3.9	1.4	*	2			5	1		35	TV	SWD	3	G	S									
319	2	12	F	D319	101	45		1.3						1		25	TV	SWD	2	G	S									
320	2	13	R	D320	70	42		1.2	*							8	TV		2	G	SC	43	46	44	72	0.8	2.1	1.8	190	Y
321	2	14	F	D321	50	45		1.7					2			15	TV	SWD	2	G	S									
322	2	15	A	D322	250	12	0.8		*	6	4			1		98	AV	SWD	3	F	S									
323	2	16	P	D323	297	28	3.6	1.5		2	1		1			45	TV	SWD	3	G	S									
324	2	17	A	D324	45	8	0.8		*	1						25	TV	SWD	2	F	G									
325	2	18	F	D325	924	40		1.7		15	6		10	9	1	45	SWD	TV	3	G	SC									
326	2	19	R	D326	90	45		0.8		2	1		2	1		25	SWD	TV	3	G	SC									
327	2	20	F	D327	290	45		1.6		1						12	TV	SWD	2	G	SC									
328	2	21	SP	D328	80	55	4.1	1.4								10	RM	TV	2	G	S									
329	2	22	F	D329	80	50		1.2		1			1			12	TV	SWD	2	G	S	58	55	56						
330	2	23	A	D330	50	12	3.5		*	1						70	TV	SWD	3	F	S									
331	2	24	R	D331	60	50		0.5		1			1		1	10	TV	SWD	3	G	S									
332	2	25	SC/P	D332	100	4		0.3	*							80	TV		2	G	SC									
333	2	26	F	D333	328	45		1.2		1			1		1	23	TV	SWD	3	G	SC									
334	2	27	R	D334	90	45		1		1			1	1		12	TV	SWD	3	G	SC									
335	2	28	F	D335	149	45		1.6					1			20	TV	SWD	2	G	SC									
336	2	29	F	D336	60	40	3.3	1.5	*		1					50	LWD	TV	3	G	S									
337	2	30	F	D337	82	45		0.9	*	2			2	2	1	15	TV	RM	3	G	S	45	51	51						
338	2	31	F	D338	127	35	2.4	1.3		4	1					40	TV	SWD	3	G	S									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes
S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types
RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
AV Aquatic Vegetation
BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock led
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
stable 12" undercut bank w/ rootmass
single RW lacking complexity
branches in/near water
limited submersed veg fish cover
bubble curtain

Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC gravel, 2mm<D<64mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

PAGE ______ of ______

FISHERY HABITAT INVENTORY DATA

inter-fluve, inc.

STREAM **Dry Creek**

OBSERVOR(S) **JM & NN** DATE 9/1/2009

Stream Discharge

SAMP #	UNIT			DIMENSIONS						WOOD						SHELTER				SUBSTRATE		Nth UNIT MEASURES								
										DEAD			ALIVE									Wet Width (M)			Riffle BF	Riffle BF Avg Depth			Riffle	Peb Ct
	Rch.	No.	Type	STA bgn	Length	Avg Wet Width (O)	Pool Max D	Avg D /PTC	Edge Present	S	M	L	S	M	L	% Cover	1	2	Complex. Code	1	2	1	2	3	Width	1	2	3	FPW	(Y/N)
339	2	32	F	D339	368	45		1		1			3	1	1	25	TV	SWD	3	G	SC									
340	2	33	P	D340	280	40	5.8	1.9	*	6	5	3		4		25	TV	LWD	3	G	S									
341	2	34	A	D341	90	12	1.7		*	2			1			85	AV	TV	3	F	G									
342	2	35	F	D342	260	45		1.3		2	2		1	3		35	TV	LWD	3	G	SC									
343	2	36	F	D343	187	45	3.2	1.6		2	3		2	2		35	TV	LWD	3	G	S	40	41	43						
344	2	37	F	D344	147	42		1.5					2			32	TV	SWD	3	G	S									
345	2	38	F	D345	100	45	2.3	1.8		1				1	1	25	TV	SWD	3	G	S									
346	2	39	F	D346	175	50		1.6		2	1	1	3			28	TV	SWD	3	G	S									
347	2	40	R	D347	70	50		1.1	*				1	1	1	30	TV	SWD	3	G	S	58	64	43	64	1.6	2	1.9	90	N
348	2	41	SC/F	D348	150	6		0.5	*	1			1			60	TV	SWD	3	G	S									
349	2	42	F	D349	60	38		1.3								30	TV	RM	2	G	S									
350	2	43	SP	D350	40	40	5.4	1.5					1	1		50	LWD	TV	2	G	S									
351	2	44	F	D351	433	50		1.4	*				5	3		40	TV	BO	3	G	S	56	58	50						
352	2	45	P	D352	70	45	5	1.2		3						15	SWD	TV	3	G	S									
353	2	46	A	D353	40	12	2.3		*							70	AV	TV	3	S	F									
354	2	47	F	D354	373	48		1.6		5	3		10		1	35	TV	SWD	3	G	S									
355	2	48	P	D355	94	52	4	1.7	*							20	BO	TV	3	G	S									
356	2	49	F	D356	50	50		1.8								20	TV	BO	2	G	S									

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes

S	>6" but <12"
M	>12" by <20"
L	>20"

CDFD Shelter Types

RM	Root Mass
SWD	<12" Woody Debris
LWD	>12" Woody Debris
TV	Terrestrial Vegetation
AV	Aquatic Vegetation
BC	Bubble Curtain
BO	Boulders
BD	Bedrock Ledge
UC	Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

2 1 to 2 pieces LWD associated with SWD
> 6 boulders / 50 feet
stable 12" undercut bank w/ rootmass
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branches in/near water
limited submersed veg fish cover
bubble curtain

3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

F	fines, D<0.0625 mm
S	sand, 0.0625mm<D<2mm
G	gravel, 2mm<D<64mm
SC	gravel, 2mm<D<64mm
LC	large cobble, 128mm<D<256mm
B	boulders, 256 mm<D
W	bedrock

PAGE ____ of ____

FISHERY HABITAT INVENTORY DATA

STREAM **Dry Creek**

OBSERVOR(S) **JM & NN** DATE 9/1/2009

Stream Discharge ________

SAMP #	UNIT Rch.	UNIT No.	UNIT Type	DIMENSIONS STA bgn	DIMENSIONS Length	DIMENSIONS Avg Wet Width (O)	DIMENSIONS Pool Max D	DIMENSIONS Avg D /PTC	DIMENSIONS Edge Present	WOOD DEAD S	WOOD DEAD M	WOOD DEAD L	WOOD ALIVE S	WOOD ALIVE M	WOOD ALIVE L	SHELTER % Cover	SHELTER 1	SHELTER 2	SHELTER Complex. Code	SUBSTRATE 1	SUBSTRATE 2	Nth UNIT MEASURES Wet Width (M) 1	Wet Width (M) 2	Wet Width (M) 3	Riffle BF Width	Riffle BF Avg Depth 1	Riffle BF Avg Depth 2	Riffle BF Avg Depth 3	Riffle FPW	Peb Ct (Y/N)
357	1	1	F	D357	190.5	40	3.5	1.6								10	TV		1	G	SC									
358	1	2	R	D358	141	45		1								2	TV		1	G	SC	39	38	52	43	2.9	2.1	1.4	145	Y
359	1	3	P	D359	70	45	4	1.2					1			40	TV	SWD	2	G	S									
360	1	4	F	D360	111	50		1	*					1	2	20	TV	SWD	3	G	S									
361	1	5	A	D361	60	7	1.2		*	1						60	TV	AV	3	F	G									
362	1	6	P	D362	76	48	3.5	1.1					2	1	1	30	TV	SWD	2	G	S									
363	1	7	A	D363	70	8	0.8		*	2						80	TV	AV	3	F	G									
364	1	8	F	D364	648	65		1.3	*	5		1	4	2		35	TV	SWD	3	G	S	56	64	52						
365	1	9	P	D365	459	55	3.5	1.3		12	1		4	1		28	TV	SWD	3	G	S									
366	1	10	R	D366	125	58		1								15	TV	RM	2	G	S									
367	1	11	SC/R	D367	60	17		0.3	*							1	TV		1	G	S									
368	1	12	F	D368	106	50		1.5	*							15	TV	RM	2	G	S									
369	1	13	F	D369	203	50	2.8	1.7								15	TV	RM	2	G	S	45	48	49						
370	1	14	R	D370	83	42		0.9		1	1					15	TV	AV	3	G	SC									
371	1	15	P	D371	304	55	5.4	1.3	*	5	3					18	TV	SWD	3	G	S									
372	1	16	R	D372	60	38		1.1								1	TV		1	G	SC									
373	1	17	SC/F	D373	110	15		0.9	*				1			40	TV	SWD	2	G	S									
374	1	18	SC/R	D374	40	18		0.6	*							2	TV		1	G	SC									
375	1	19	P	D375	86	25	4.1	1.2								25	TV	RM	2	G	S									
376	1	20	R	D376	45	20		1.5			1					5	TV	LWD	2	G	SC									
377	1	21	P	D377	395	55	3.3	1.3	*	1		3	1	3		12	RM	SWD	3	G	S	62	52	54						
378	1	22	F	D378	331	55		1.3					1			18	TV	SWD	2	G	S									
379	1	23	A	D379	50	8	0.2		*							55	TV	AV	3	G	F									
380	1	24	R	D380	70	35		1.2								10	BC		1	G	SC	41	45	32	82	1.8	2.3	2	130	N
381	1	25	F	D381	105	35		1.3							1	5	TV	LWD	2	G	SC									
382	1	26	A	D382	40	8	1.6					1				50	AV	RM	3	G	S									
383	MOUTH OF DRY CREEK																													

P - Main Channel Pool
SP - Scour Pool
A - Alcove/Backwater/SideChannel Pool
SC/Type - Side Channel with Unit Type
R - Riffle
F - Flatwater (Glide/Run)
C - Cascade

LWD Size Classes
S >6" but <12"
M >12" by <20"
L >20"

CDFD Shelter Types
RM Root Mass
SWD <12" Woody Debris
LWD >12" Woody Debris
TV Terrestrial Vegetation
AV Aquatic Vegetation
BC Bubble Curtain
BO Boulders
BD Bedrock Ledge
UC Undercut Bank

0 No Shelter

1 1 to 5 boulders
bare undercut bank / bedrock ledge
single piece large wood (LWD

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3 Combination of cover types (at least two)
LWD/boulders/rootwads
3 or more LWD w? SWD
3 or more boulders w/ LWD/SWD
bubble curtain w/ LWD/boulders
stable > 12" undercut bank w/ rootmass/LWD
extensive submersed veg fish cover

F fines, D<0.0625 mm
S sand, 0.0625mm<D<2mm
G gravel, 2mm<D<64mm
SC gravel, 2mm<D<64mm
LC large cobble, 128mm<D<256mm
B boulders, 256 mm<D
W bedrock

12 APPENDIX D - PEBBLE COUNT DATA SHEETS

Location (Stream, Reach, Description)

Sediment Grain Size Analysis

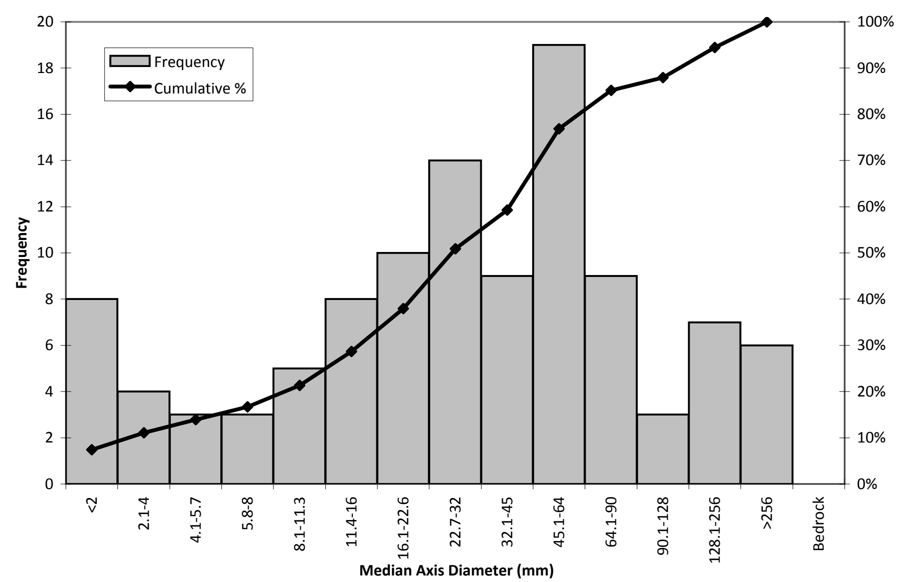
Dry	Stream	**8/26/2009**	Date
15	Reach	N. Nelson & G. Johnston	Personnel
	Location		Latitude
1	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	8	7.4%
Very Fine Gravel	2.1-4	4	11.1%
Fine Gravel	4.1-5.7	3	13.9%
Fine Gravel	5.8-8	3	16.7%
Medium Gravel	8.1-11.3	5	21.3%
Medium Gravel	11.4-16	8	28.7%
Coarse Gravel	16.1-22.6	10	38.0%
Coarse Gravel	22.7-32	14	50.9%
Very Coarse Gravel	32.1-45	9	59.3%
Very Coarse Gravel	45.1-64	19	76.9%
Small Cobble	64.1-90	9	85.2%
Small Cobble	90.1-128	3	88.0%
Large Cobble	128.1-256	7	94.4%
Small Boulders	>256	6	100.0%
Bedrock	Bedrock	0	100.0%
	Total	108	

D1 Pebble Count Surficial Grain Size Analysis



Location (Stream, Reach, Description)

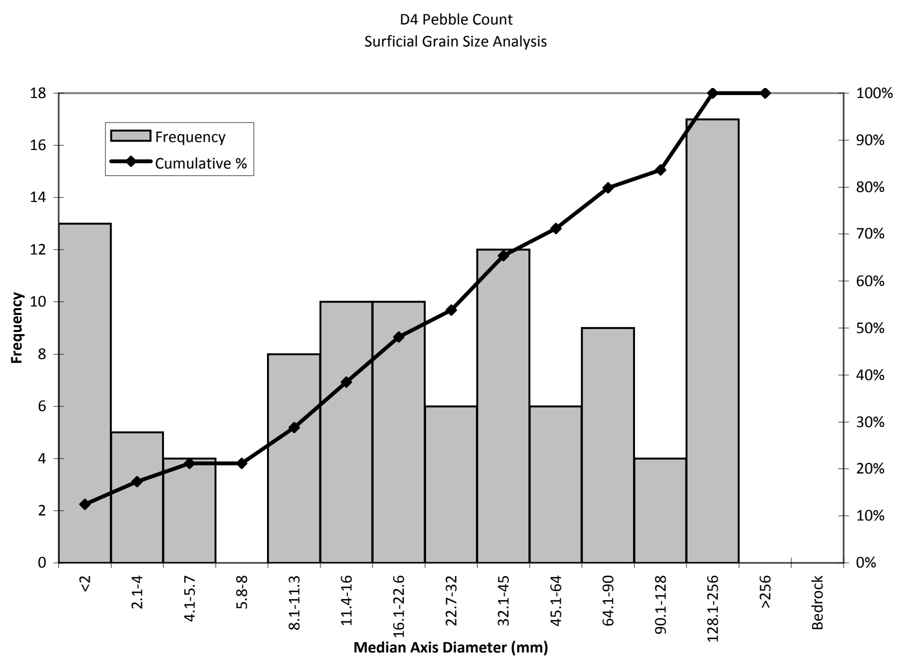
Sediment Grain Size Analysis

Dry	Stream	**8/26/2009**	Date
14	Reach	N. Nelson & G. Johnston	Personnel
	Location		Latitude
4	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Riffle at the top of Reach 20 below Schoolhouse Trib.

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	13	12.5%
Very Fine Gravel	2.1-4	5	17.3%
Fine Gravel	4.1-5.7	4	21.2%
Fine Gravel	5.8-8	0	21.2%
Medium Gravel	8.1-11.3	8	28.8%
Medium Gravel	11.4-16	10	38.5%
Coarse Gravel	16.1-22.6	10	48.1%
Coarse Gravel	22.7-32	6	53.8%
Very Coarse Gravel	32.1-45	12	65.4%
Very Coarse Gravel	45.1-64	6	71.2%
Small Cobble	64.1-90	9	79.8%
Small Cobble	90.1-128	4	83.7%
Large Cobble	128.1-256	17	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	104	



Location (Stream, Reach, Description)

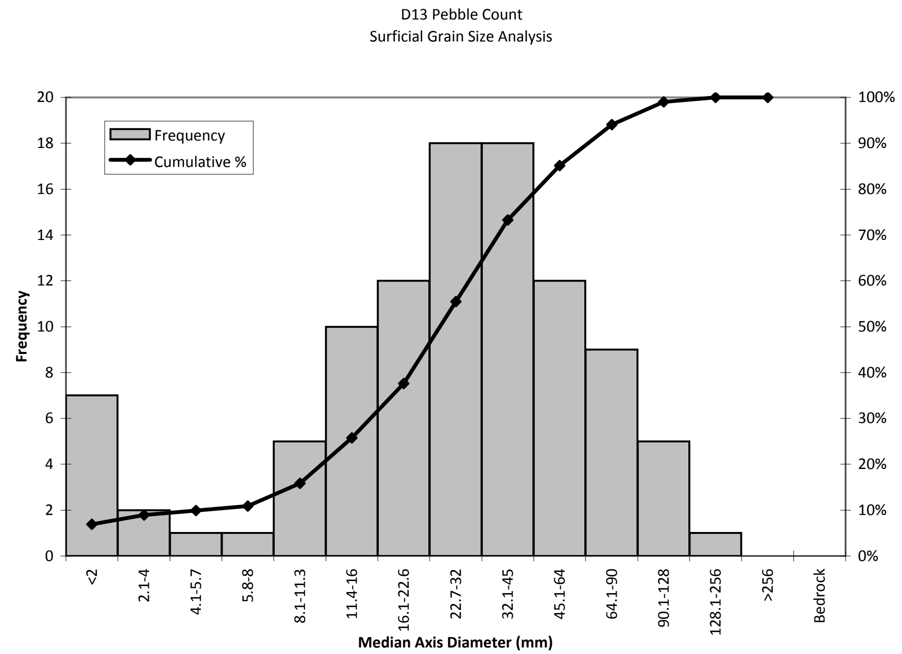
Sediment Grain Size Analysis

Dry	Stream	**8/26/2009**	Date
14	Reach	N. Nelson & G. Johnston	Personnel
	Location		Latitude
13	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	7	6.9%
Very Fine Gravel	2.1-4	2	8.9%
Fine Gravel	4.1-5.7	1	9.9%
Fine Gravel	5.8-8	1	10.9%
Medium Gravel	8.1-11.3	5	15.8%
Medium Gravel	11.4-16	10	25.7%
Coarse Gravel	16.1-22.6	12	37.6%
Coarse Gravel	22.7-32	18	55.4%
Very Coarse Gravel	32.1-45	18	73.3%
Very Coarse Gravel	45.1-64	12	85.1%
Small Cobble	64.1-90	9	94.1%
Small Cobble	90.1-128	5	99.0%
Large Cobble	128.1-256	1	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	



Location (Stream, Reach, Description)

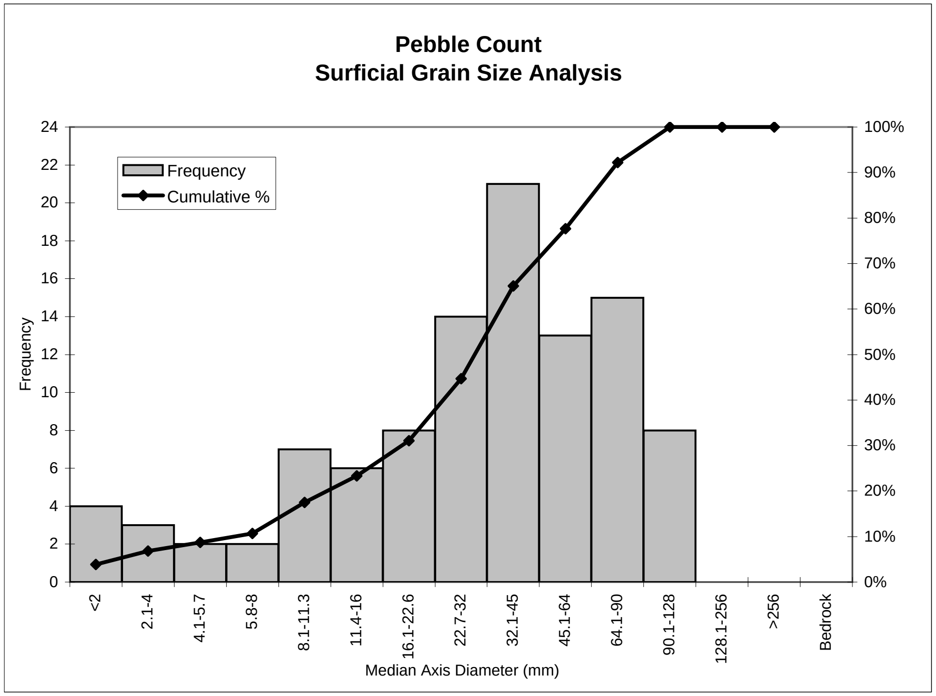
Sediment Grain Size Analysis

Dry	Stream	**8/27/2009**	Date
13	Reach		Personnel
	Location		Latitude
D44	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Riffle in R18 just d/s of whre Fall Ck enters Dry Ck at GPS # D44

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	4	3.9%
Very Fine Gravel	2.1-4	3	6.8%
Fine Gravel	4.1-5.7	2	8.7%
Fine Gravel	5.8-8	2	10.7%
Medium Gravel	8.1-11.3	7	17.5%
Medium Gravel	11.4-16	6	23.3%
Coarse Gravel	16.1-22.6	8	31.1%
Coarse Gravel	22.7-32	14	44.7%
Very Coarse Gravel	32.1-45	21	65.0%
Very Coarse Gravel	45.1-64	13	77.7%
Small Cobble	64.1-90	15	92.2%
Small Cobble	90.1-128	8	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	103	



Location (Stream, Reach, Description)

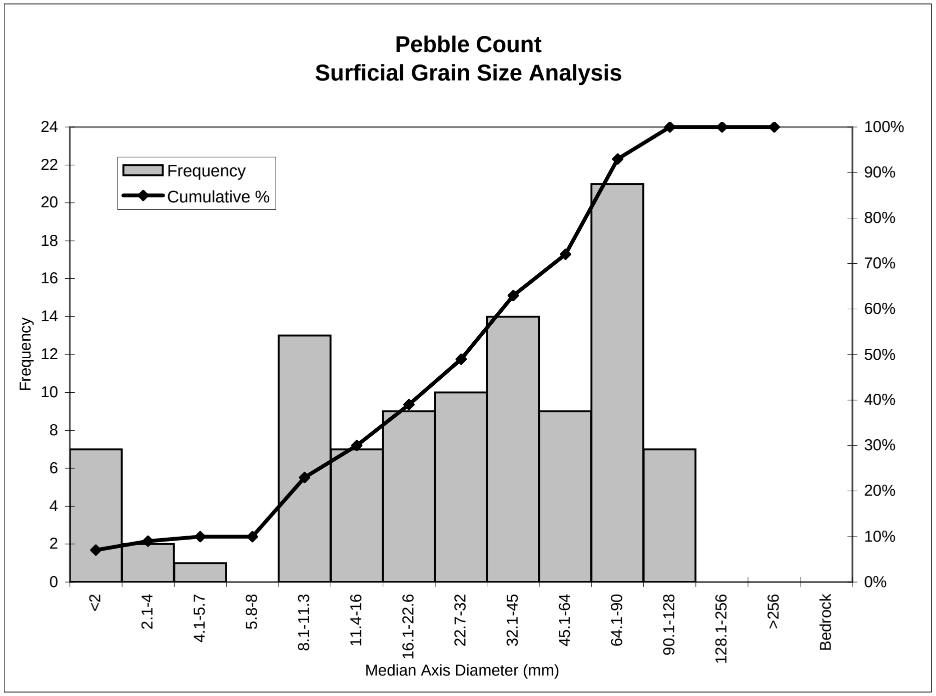
Sediment Grain Size Analysis

Dry	Stream	**8/27/2009**	Date
12	Reach		Personnel
	Location		Latitude
D72	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Dry Creek at D72 in Reach 17 u/s of Pena Ck.

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	7	7.0%
Very Fine Gravel	2.1-4	2	9.0%
Fine Gravel	4.1-5.7	1	10.0%
Fine Gravel	5.8-8	0	10.0%
Medium Gravel	8.1-11.3	13	23.0%
Medium Gravel	11.4-16	7	30.0%
Coarse Gravel	16.1-22.6	9	39.0%
Coarse Gravel	22.7-32	10	49.0%
Very Coarse Gravel	32.1-45	14	63.0%
Very Coarse Gravel	45.1-64	9	72.0%
Small Cobble	64.1-90	21	93.0%
Small Cobble	90.1-128	7	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	100	



Location (Stream, Reach, Description)

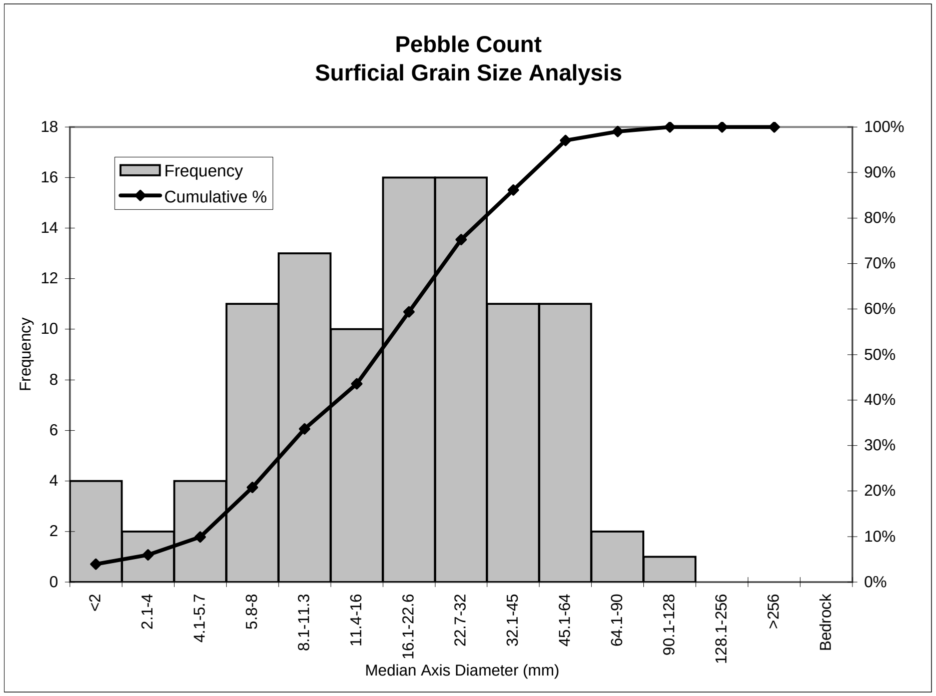
Sediment Grain Size Analysis

Dry	Stream	**8/27/2009**	Date
111	Reach		Personnel
	Location		Latitude
D80	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Dry Creek, Reach 16, D80 Riffle d/s of Pena Ck.

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	4	4.0%
Very Fine Gravel	2.1-4	2	5.9%
Fine Gravel	4.1-5.7	4	9.9%
Fine Gravel	5.8-8	11	20.8%
Medium Gravel	8.1-11.3	13	33.7%
Medium Gravel	11.4-16	10	43.6%
Coarse Gravel	16.1-22.6	16	59.4%
Coarse Gravel	22.7-32	16	75.2%
Very Coarse Gravel	32.1-45	11	86.1%
Very Coarse Gravel	45.1-64	11	97.0%
Small Cobble	64.1-90	2	99.0%
Small Cobble	90.1-128	1	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	



Location (Stream, Reach, Description)

inter-fluve, inc.

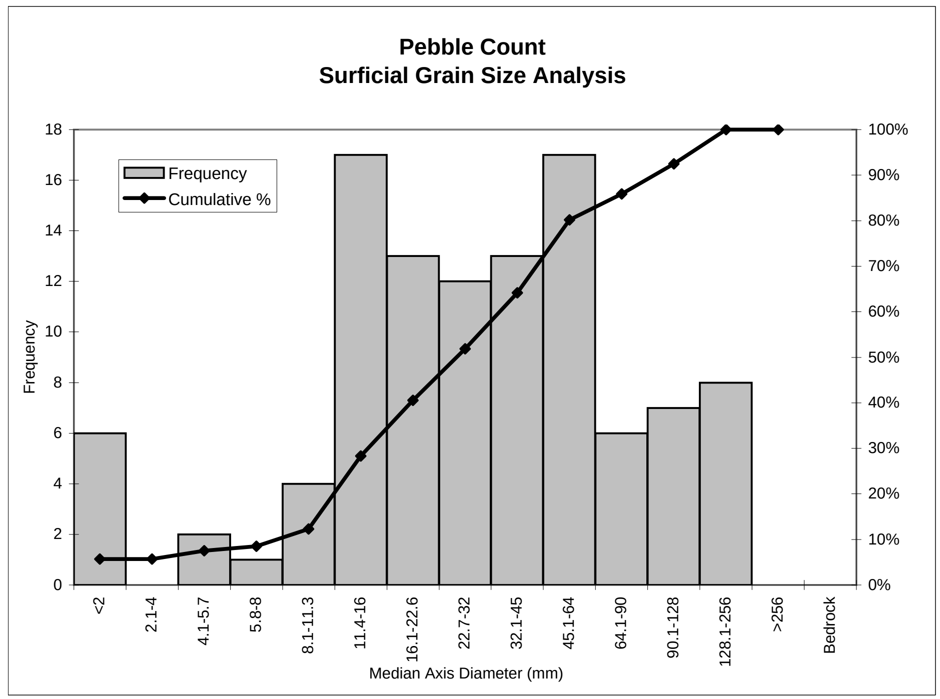
Sediment Grain Size Analysis

Dry	Stream	**8/28/2009**	Date
11	Reach		Personnel
	Location		Latitude
D88	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	6	5.7%
Very Fine Gravel	2.1-4	0	5.7%
Fine Gravel	4.1-5.7	2	7.5%
Fine Gravel	5.8-8	1	8.5%
Medium Gravel	8.1-11.3	4	12.3%
Medium Gravel	11.4-16	17	28.3%
Coarse Gravel	16.1-22.6	13	40.6%
Coarse Gravel	22.7-32	12	51.9%
Very Coarse Gravel	32.1-45	13	64.2%
Very Coarse Gravel	45.1-64	17	80.2%
Small Cobble	64.1-90	6	85.8%
Small Cobble	90.1-128	7	92.5%
Large Cobble	128.1-256	8	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	106	



Location (Stream, Reach, Description)

inter-fluve, inc.

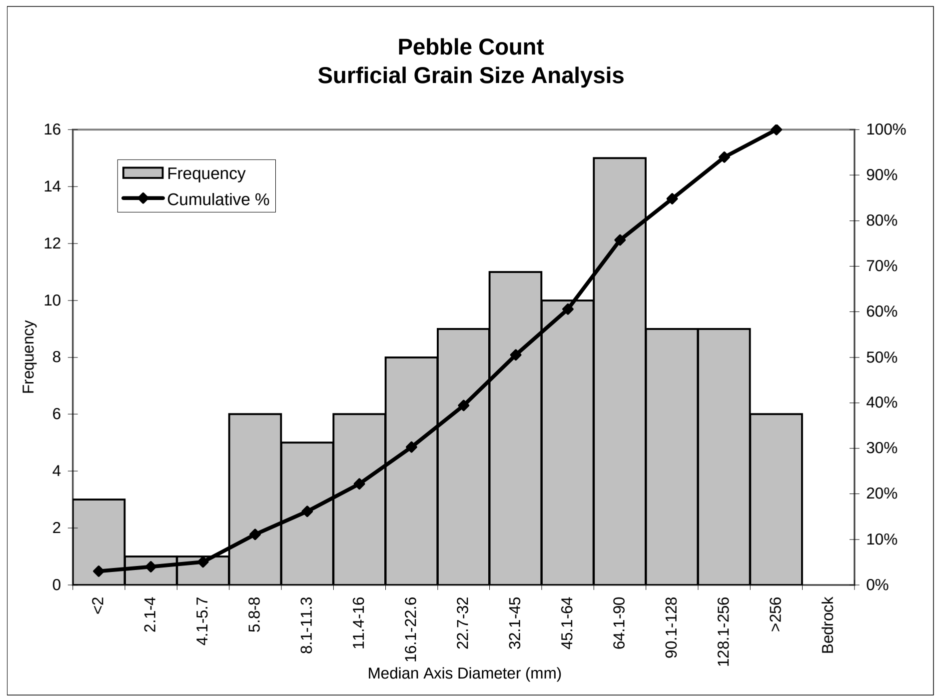
Sediment Grain Size Analysis

Dry	Stream	**8/29/2009**	Date
10	Reach		Personnel
	Location		Latitude
D99	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
w/ small mid-channel bars

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	3	3.0%
Very Fine Gravel	2.1-4	1	4.0%
Fine Gravel	4.1-5.7	1	5.1%
Fine Gravel	5.8-8	6	11.1%
Medium Gravel	8.1-11.3	5	16.2%
Medium Gravel	11.4-16	6	22.2%
Coarse Gravel	16.1-22.6	8	30.3%
Coarse Gravel	22.7-32	9	39.4%
Very Coarse Gravel	32.1-45	11	50.5%
Very Coarse Gravel	45.1-64	10	60.6%
Small Cobble	64.1-90	15	75.8%
Small Cobble	90.1-128	9	84.8%
Large Cobble	128.1-256	9	93.9%
Small Boulders	>256	6	100.0%
Bedrock	Bedrock	0	100.0%
	Total	99	



Location (Stream, Reach, Description)

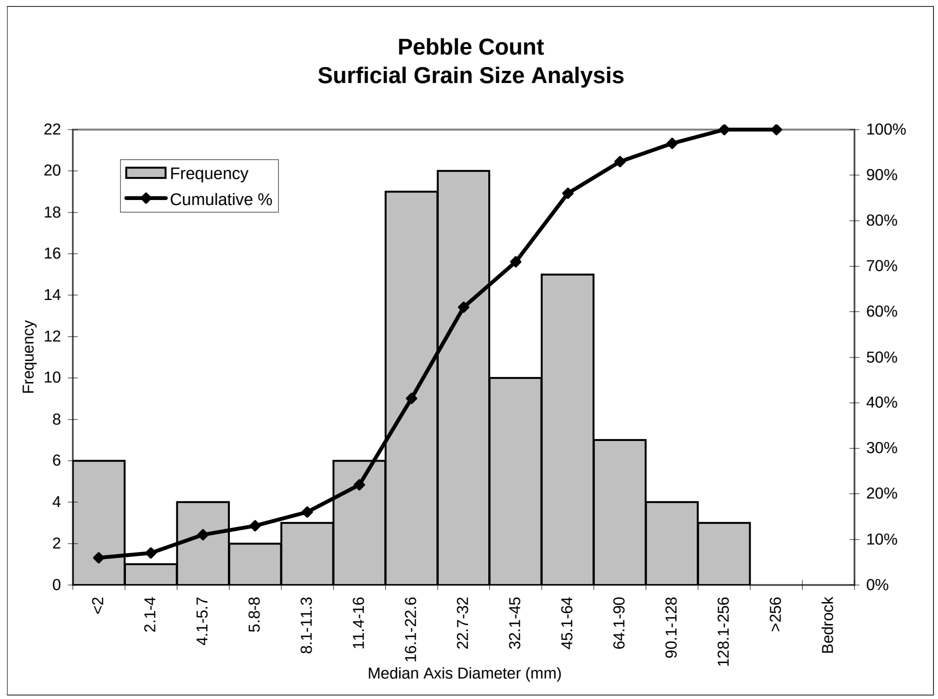
Sediment Grain Size Analysis

Dry	Stream	**8/28/2009**	Date
9	Reach		Personnel
	Location		Latitude
D110	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	6	6.0%
Very Fine Gravel	2.1-4	1	7.0%
Fine Gravel	4.1-5.7	4	11.0%
Fine Gravel	5.8-8	2	13.0%
Medium Gravel	8.1-11.3	3	16.0%
Medium Gravel	11.4-16	6	22.0%
Coarse Gravel	16.1-22.6	19	41.0%
Coarse Gravel	22.7-32	20	61.0%
Very Coarse Gravel	32.1-45	10	71.0%
Very Coarse Gravel	45.1-64	15	86.0%
Small Cobble	64.1-90	7	93.0%
Small Cobble	90.1-128	4	97.0%
Large Cobble	128.1-256	3	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	100	



Location (Stream, Reach, Description)

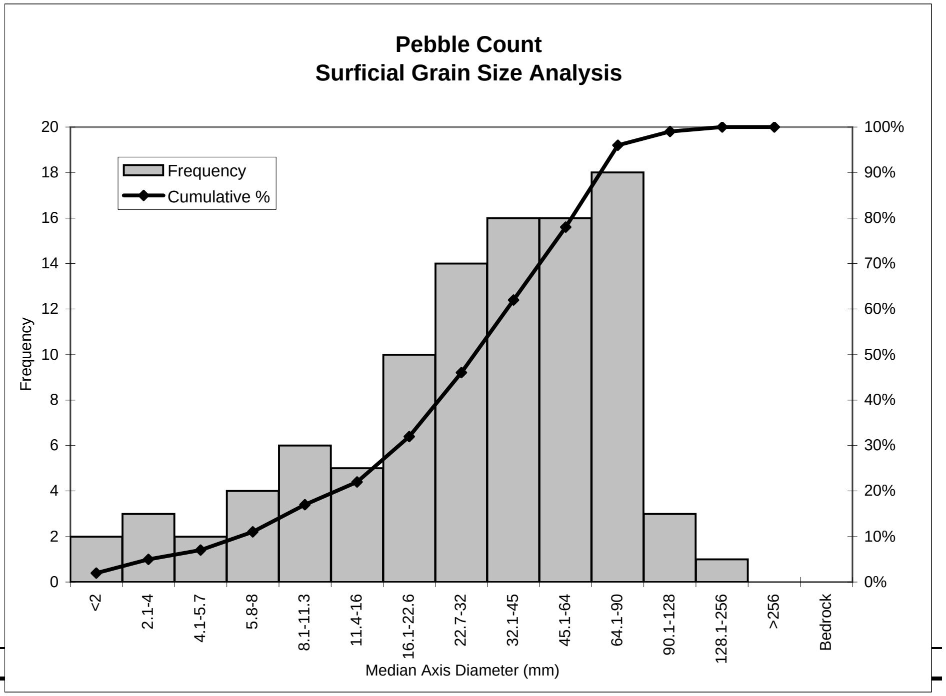
Sediment Grain Size Analysis

Dry	Stream	**8/28/2009**	Date
8	Reach		Personnel
	Location		Latitude
D123	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	2	2.0%
Very Fine Gravel	2.1-4	3	5.0%
Fine Gravel	4.1-5.7	2	7.0%
Fine Gravel	5.8-8	4	11.0%
Medium Gravel	8.1-11.3	6	17.0%
Medium Gravel	11.4-16	5	22.0%
Coarse Gravel	16.1-22.6	10	32.0%
Coarse Gravel	22.7-32	14	46.0%
Very Coarse Gravel	32.1-45	16	62.0%
Very Coarse Gravel	45.1-64	16	78.0%
Small Cobble	64.1-90	18	96.0%
Small Cobble	90.1-128	3	99.0%
Large Cobble	128.1-256	1	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	100	



Location (Stream, Reach, Description)

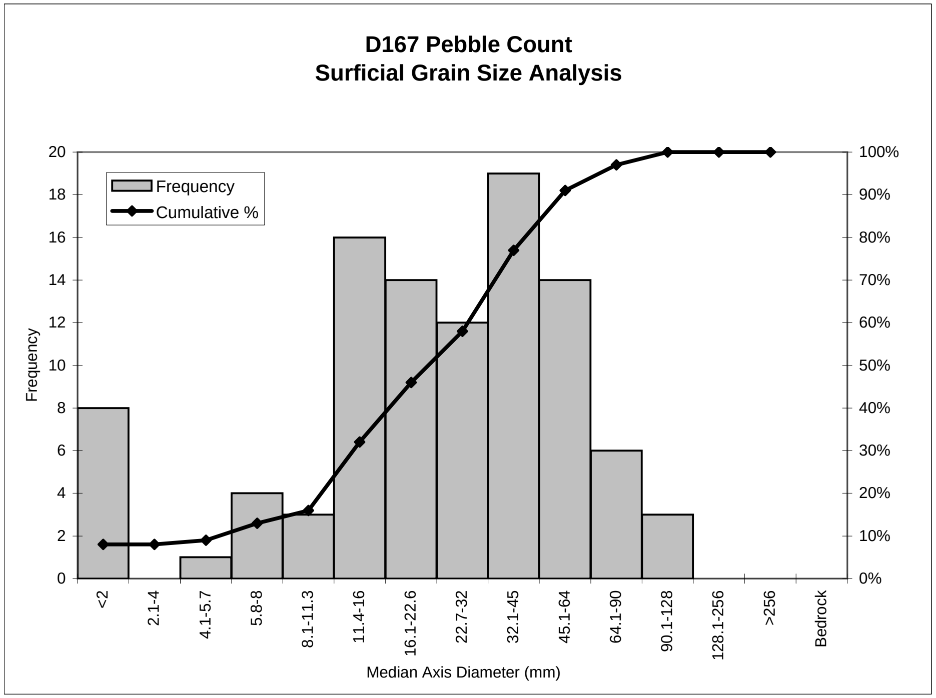
Sediment Grain Size Analysis

Dry	Stream	**8/29/2009**	Date
7	Reach		Personnel
	Location		Latitude
167	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	8	8.0%
Very Fine Gravel	2.1-4	0	8.0%
Fine Gravel	4.1-5.7	1	9.0%
Fine Gravel	5.8-8	4	13.0%
Medium Gravel	8.1-11.3	3	16.0%
Medium Gravel	11.4-16	16	32.0%
Coarse Gravel	16.1-22.6	14	46.0%
Coarse Gravel	22.7-32	12	58.0%
Very Coarse Gravel	32.1-45	19	77.0%
Very Coarse Gravel	45.1-64	14	91.0%
Small Cobble	64.1-90	6	97.0%
Small Cobble	90.1-128	3	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	100	



Location (Stream, Reach, Description)

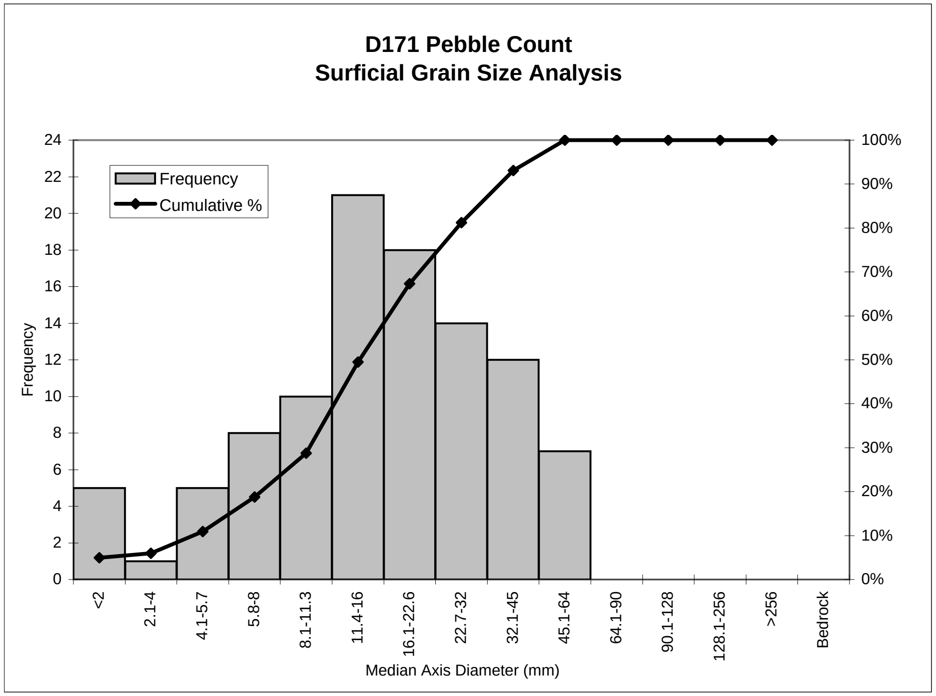
Sediment Grain Size Analysis

Dry	Stream	**8/29/2009**	Date
7 7	Reach		Personnel
	Location		Latitude
171	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	5	5.0%
Very Fine Gravel	2.1-4	1	5.9%
Fine Gravel	4.1-5.7	5	10.9%
Fine Gravel	5.8-8	8	18.8%
Medium Gravel	8.1-11.3	10	28.7%
Medium Gravel	11.4-16	21	49.5%
Coarse Gravel	16.1-22.6	18	67.3%
Coarse Gravel	22.7-32	14	81.2%
Very Coarse Gravel	32.1-45	12	93.1%
Very Coarse Gravel	45.1-64	7	100.0%
Small Cobble	64.1-90	0	100.0%
Small Cobble	90.1-128	0	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	



Location (Stream, Reach, Description)

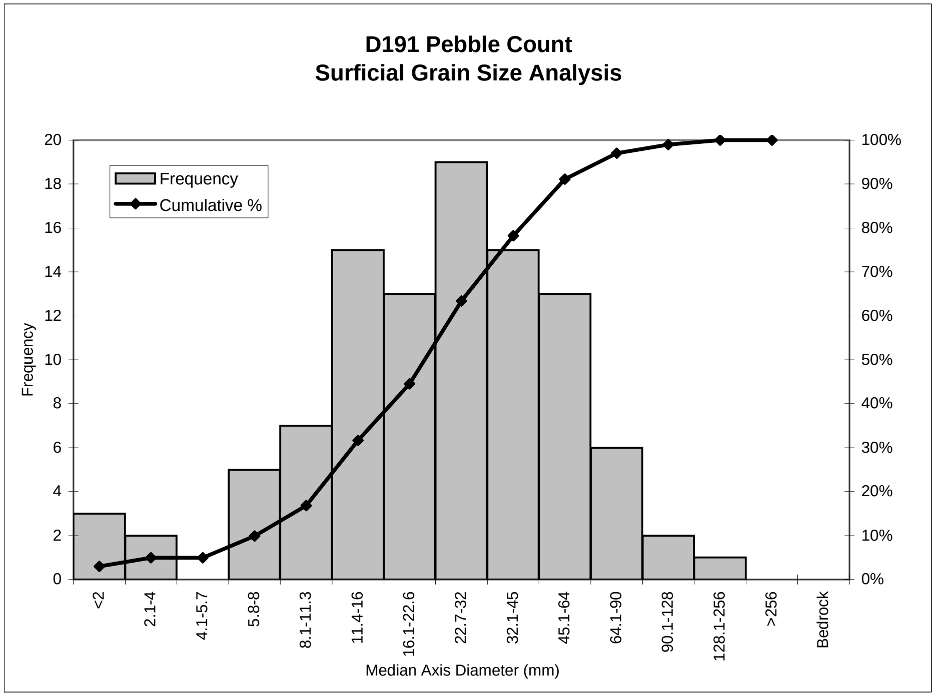
Sediment Grain Size Analysis

Dry	Stream		Date
7	Reach		Personnel
	Location		Latitude
191	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	3	3.0%
Very Fine Gravel	2.1-4	2	5.0%
Fine Gravel	4.1-5.7	0	5.0%
Fine Gravel	5.8-8	5	9.9%
Medium Gravel	8.1-11.3	7	16.8%
Medium Gravel	11.4-16	15	31.7%
Coarse Gravel	16.1-22.6	13	44.6%
Coarse Gravel	22.7-32	19	63.4%
Very Coarse Gravel	32.1-45	15	78.2%
Very Coarse Gravel	45.1-64	13	91.1%
Small Cobble	64.1-90	6	97.0%
Small Cobble	90.1-128	2	99.0%
Large Cobble	128.1-256	1	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	



Location (Stream, Reach, Description)

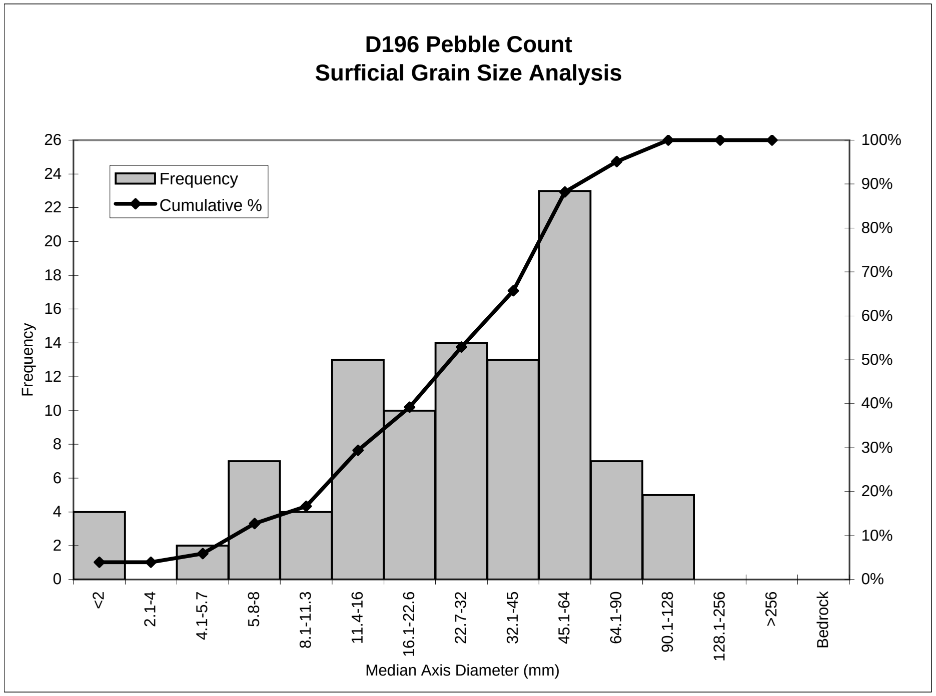
Sediment Grain Size Analysis

Dry	Stream	**8/30/2009**	Date
7	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
D196	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	4	3.9%
Very Fine Gravel	2.1-4	0	3.9%
Fine Gravel	4.1-5.7	2	5.9%
Fine Gravel	5.8-8	7	12.7%
Medium Gravel	8.1-11.3	4	16.7%
Medium Gravel	11.4-16	13	29.4%
Coarse Gravel	16.1-22.6	10	39.2%
Coarse Gravel	22.7-32	14	52.9%
Very Coarse Gravel	32.1-45	13	65.7%
Very Coarse Gravel	45.1-64	23	88.2%
Small Cobble	64.1-90	7	95.1%
Small Cobble	90.1-128	5	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	102	



Location (Stream, Reach, Description)

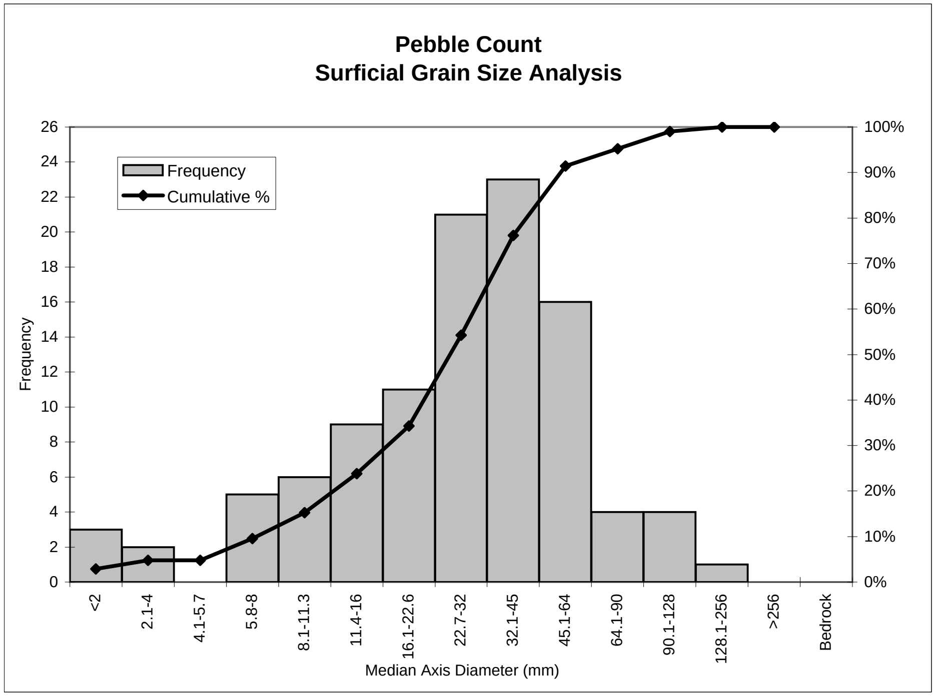
Sediment Grain Size Analysis

Dry	Stream	**8/31/2009**	Date
6	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
199	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Riffle D/S of Crane Creek

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	3	2.9%
Very Fine Gravel	2.1-4	2	4.8%
Fine Gravel	4.1-5.7	0	4.8%
Fine Gravel	5.8-8	5	9.5%
Medium Gravel	8.1-11.3	6	15.2%
Medium Gravel	11.4-16	9	23.8%
Coarse Gravel	16.1-22.6	11	34.3%
Coarse Gravel	22.7-32	21	54.3%
Very Coarse Gravel	32.1-45	23	76.2%
Very Coarse Gravel	45.1-64	16	91.4%
Small Cobble	64.1-90	4	95.2%
Small Cobble	90.1-128	4	99.0%
Large Cobble	128.1-256	1	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	105	



Location (Stream, Reach, Description)

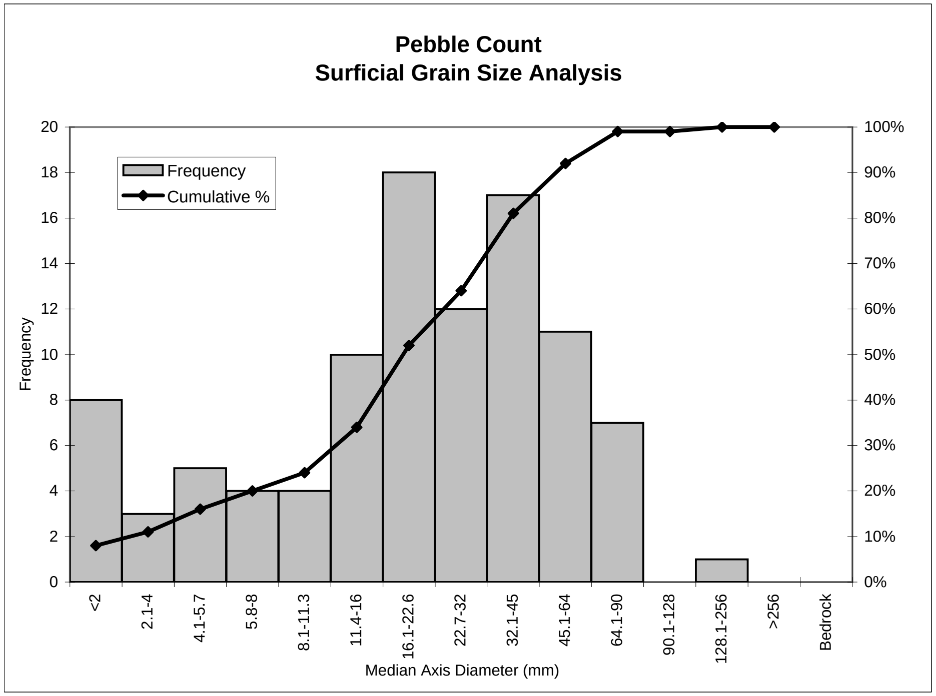
Sediment Grain Size Analysis

Dry	Stream	**8/30/2009**	Date
5	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
D219	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	8	8.0%
Very Fine Gravel	2.1-4	3	11.0%
Fine Gravel	4.1-5.7	5	16.0%
Fine Gravel	5.8-8	4	20.0%
Medium Gravel	8.1-11.3	4	24.0%
Medium Gravel	11.4-16	10	34.0%
Coarse Gravel	16.1-22.6	18	52.0%
Coarse Gravel	22.7-32	12	64.0%
Very Coarse Gravel	32.1-45	17	81.0%
Very Coarse Gravel	45.1-64	11	92.0%
Small Cobble	64.1-90	7	99.0%
Small Cobble	90.1-128	0	99.0%
Large Cobble	128.1-256	1	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	100	



Location (Stream, Reach, Description)

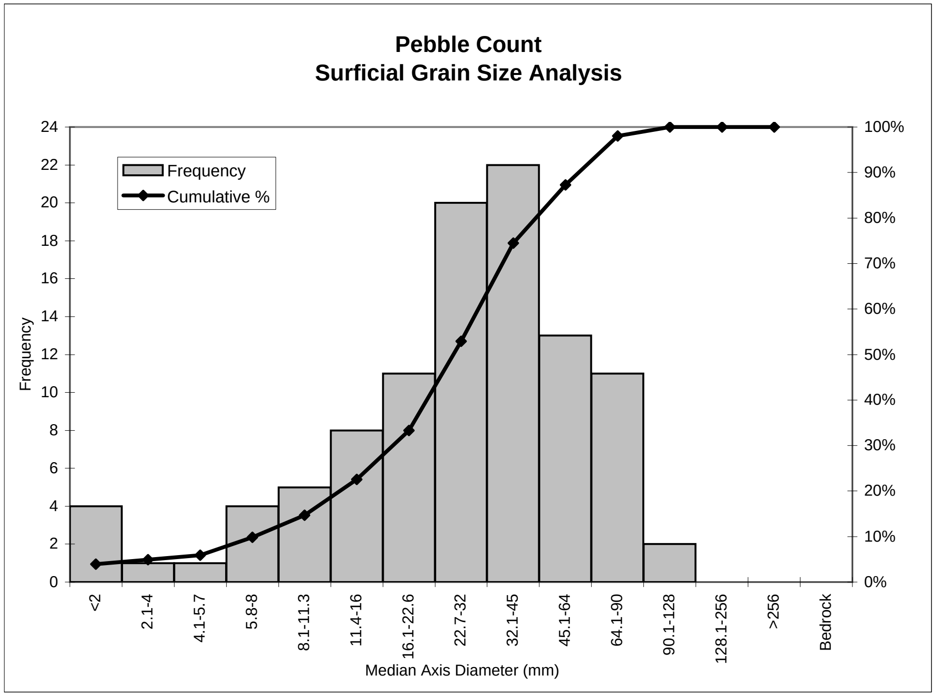
Sediment Grain Size Analysis

Dry	Stream	**8/30/2009**	Date
5	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
D228	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	4	3.9%
Very Fine Gravel	2.1-4	1	4.9%
Fine Gravel	4.1-5.7	1	5.9%
Fine Gravel	5.8-8	4	9.8%
Medium Gravel	8.1-11.3	5	14.7%
Medium Gravel	11.4-16	8	22.5%
Coarse Gravel	16.1-22.6	11	33.3%
Coarse Gravel	22.7-32	20	52.9%
Very Coarse Gravel	32.1-45	22	74.5%
Very Coarse Gravel	45.1-64	13	87.3%
Small Cobble	64.1-90	11	98.0%
Small Cobble	90.1-128	2	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	102	



Location (Stream, Reach, Description)

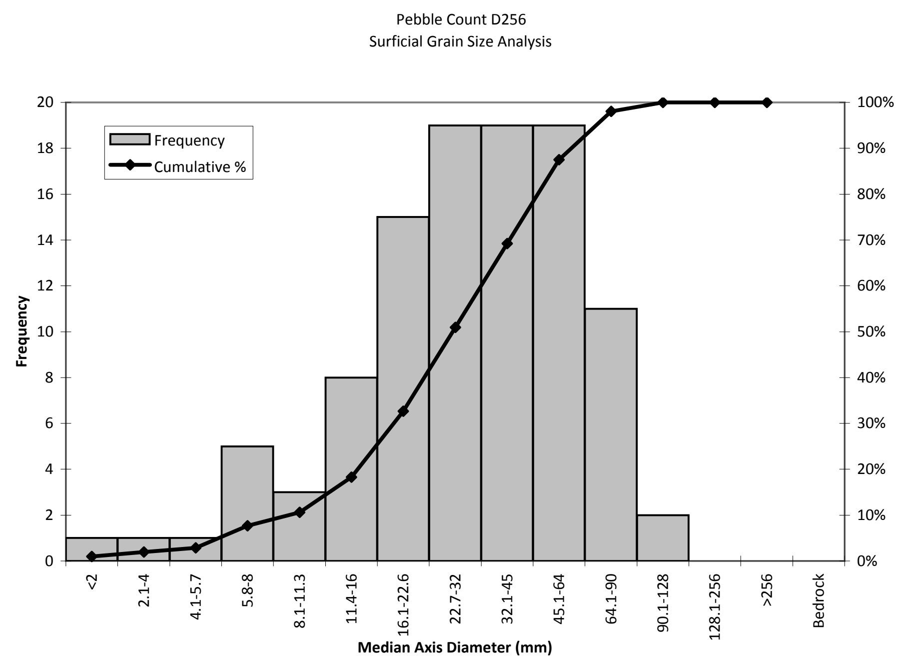
Sediment Grain Size Analysis

Dry	Stream	Dry Creek	**8/31/2009**	Date
4	Reach	5	N. Nelson & J. Mullen	Personnel
	Location			Latitude
256	Identifier / Unit			Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)			Northing
Surficial	Sample Type: Armor Layer or Subarmor			Easting
	Approximate Depth of Flow at Thalweg (ft)			Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	1	1.0%
Very Fine Gravel	2.1-4	1	1.9%
Fine Gravel	4.1-5.7	1	2.9%
Fine Gravel	5.8-8	5	7.7%
Medium Gravel	8.1-11.3	3	10.6%
Medium Gravel	11.4-16	8	18.3%
Coarse Gravel	16.1-22.6	15	32.7%
Coarse Gravel	22.7-32	19	51.0%
Very Coarse Gravel	32.1-45	19	69.2%
Very Coarse Gravel	45.1-64	19	87.5%
Small Cobble	64.1-90	11	98.1%
Small Cobble	90.1-128	2	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	104	



Location (Stream, Reach, Description)

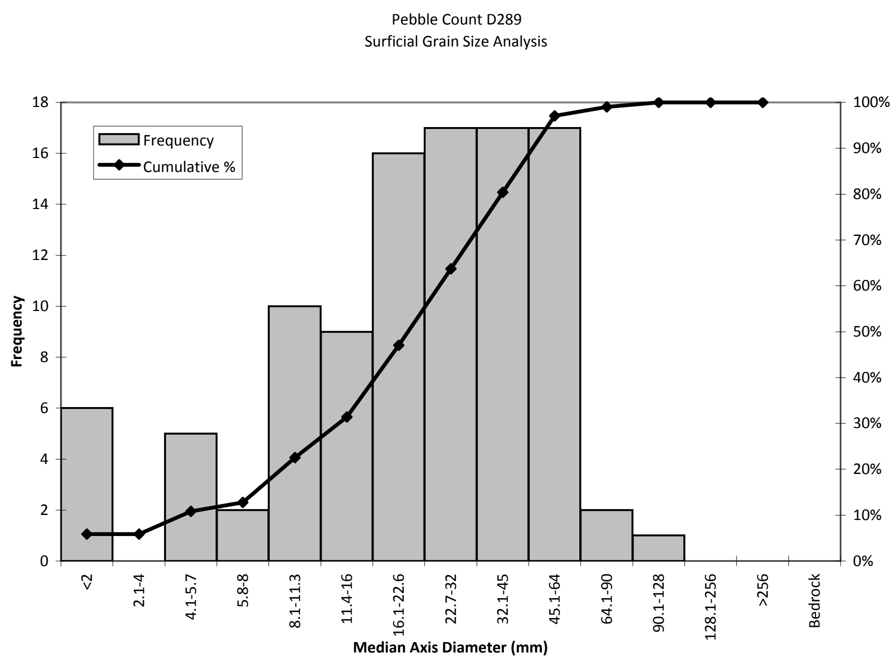
Sediment Grain Size Analysis

Dry	Stream	**8/31/2009**	Date
3	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
D289	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	6	5.9%
Very Fine Gravel	2.1-4	0	5.9%
Fine Gravel	4.1-5.7	5	10.8%
Fine Gravel	5.8-8	2	12.7%
Medium Gravel	8.1-11.3	10	22.5%
Medium Gravel	11.4-16	9	31.4%
Coarse Gravel	16.1-22.6	16	47.1%
Coarse Gravel	22.7-32	17	63.7%
Very Coarse Gravel	32.1-45	17	80.4%
Very Coarse Gravel	45.1-64	17	97.1%
Small Cobble	64.1-90	2	99.0%
Small Cobble	90.1-128	1	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	102	



Location (Stream, Reach, Description)

inter-fluve, inc.

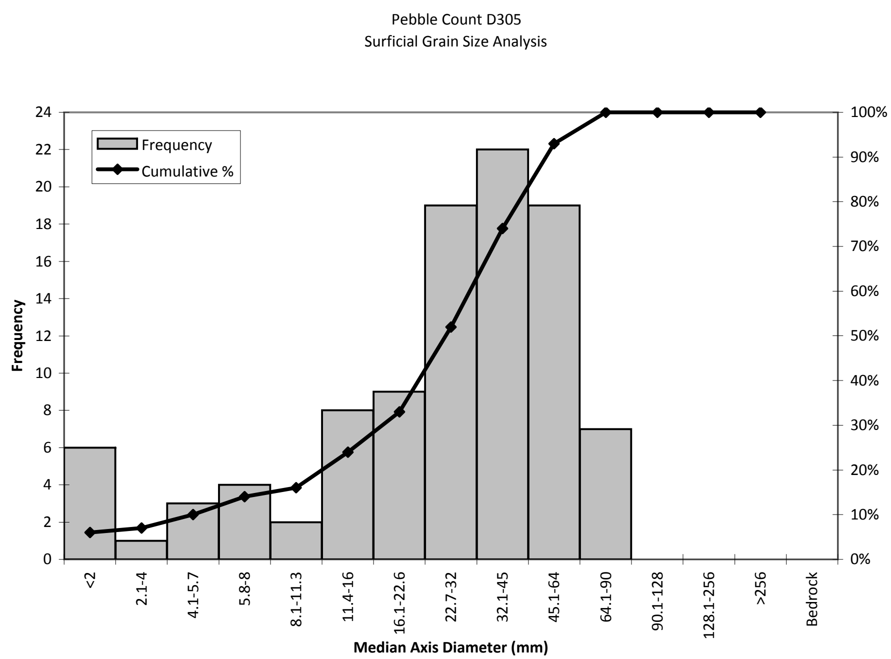
Sediment Grain Size Analysis

Dry	Stream	**9/1/2009**	Date
3	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
D305	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	6	6.0%
Very Fine Gravel	2.1-4	1	7.0%
Fine Gravel	4.1-5.7	3	10.0%
Fine Gravel	5.8-8	4	14.0%
Medium Gravel	8.1-11.3	2	16.0%
Medium Gravel	11.4-16	8	24.0%
Coarse Gravel	16.1-22.6	9	33.0%
Coarse Gravel	22.7-32	19	52.0%
Very Coarse Gravel	32.1-45	22	74.0%
Very Coarse Gravel	45.1-64	19	93.0%
Small Cobble	64.1-90	7	100.0%
Small Cobble	90.1-128	0	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	100	



Location (Stream, Reach, Description)

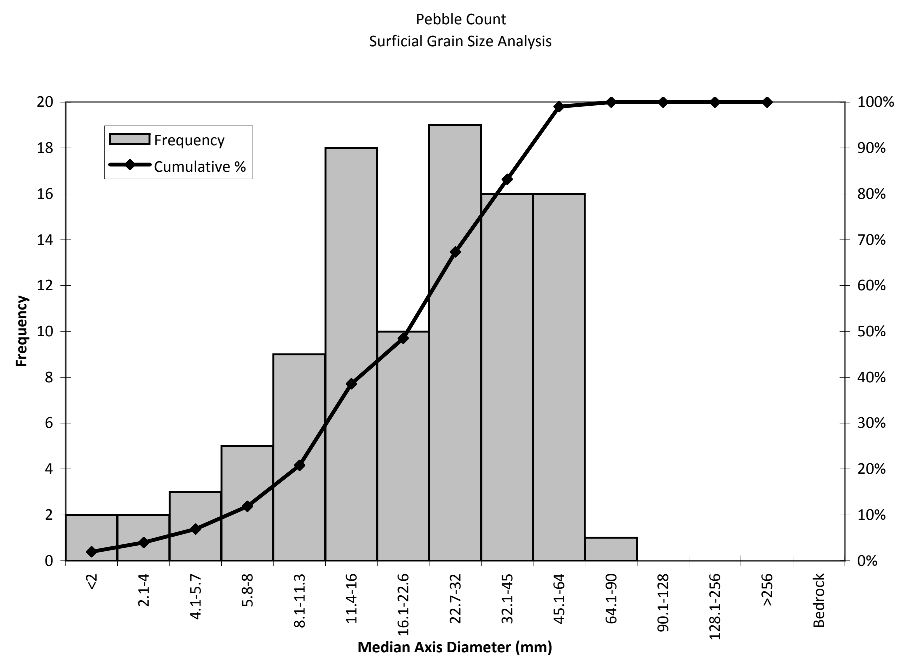
Sediment Grain Size Analysis

Dry	Stream	**9/1/2009**	Date
2	Reach	N. Nelson	Personnel
	Location		Latitude
320	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	2	2.0%
Very Fine Gravel	2.1-4	2	4.0%
Fine Gravel	4.1-5.7	3	6.9%
Fine Gravel	5.8-8	5	11.9%
Medium Gravel	8.1-11.3	9	20.8%
Medium Gravel	11.4-16	18	38.6%
Coarse Gravel	16.1-22.6	10	48.5%
Coarse Gravel	22.7-32	19	67.3%
Very Coarse Gravel	32.1-45	16	83.2%
Very Coarse Gravel	45.1-64	16	99.0%
Small Cobble	64.1-90	1	100.0%
Small Cobble	90.1-128	0	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	



Location (Stream, Reach, Description)

Sediment Grain Size Analysis

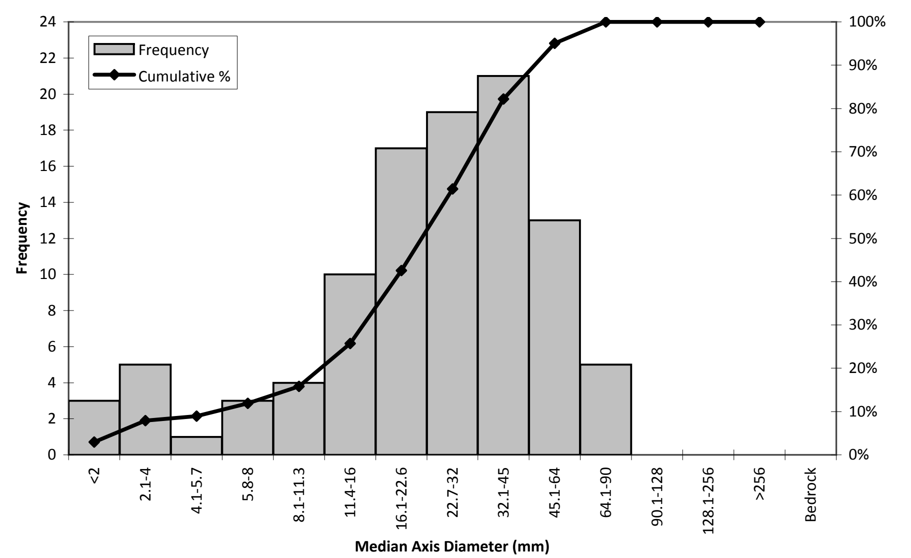
Dry	Stream	**9/1/2009**	Date
1	Reach	N. Nelson	Personnel
	Location		Latitude
358	Identifier / Unit		Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
Surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Riffle below Mill Creek

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	3	3.0%
Very Fine Gravel	2.1-4	5	7.9%
Fine Gravel	4.1-5.7	1	8.9%
Fine Gravel	5.8-8	3	11.9%
Medium Gravel	8.1-11.3	4	15.8%
Medium Gravel	11.4-16	10	25.7%
Coarse Gravel	16.1-22.6	17	42.6%
Coarse Gravel	22.7-32	19	61.4%
Very Coarse Gravel	32.1-45	21	82.2%
Very Coarse Gravel	45.1-64	13	95.0%
Small Cobble	64.1-90	5	100.0%
Small Cobble	90.1-128	0	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	

D358 Pebble Count
Surficial Grain Size Analysis



Location (Stream, Reach, Description)

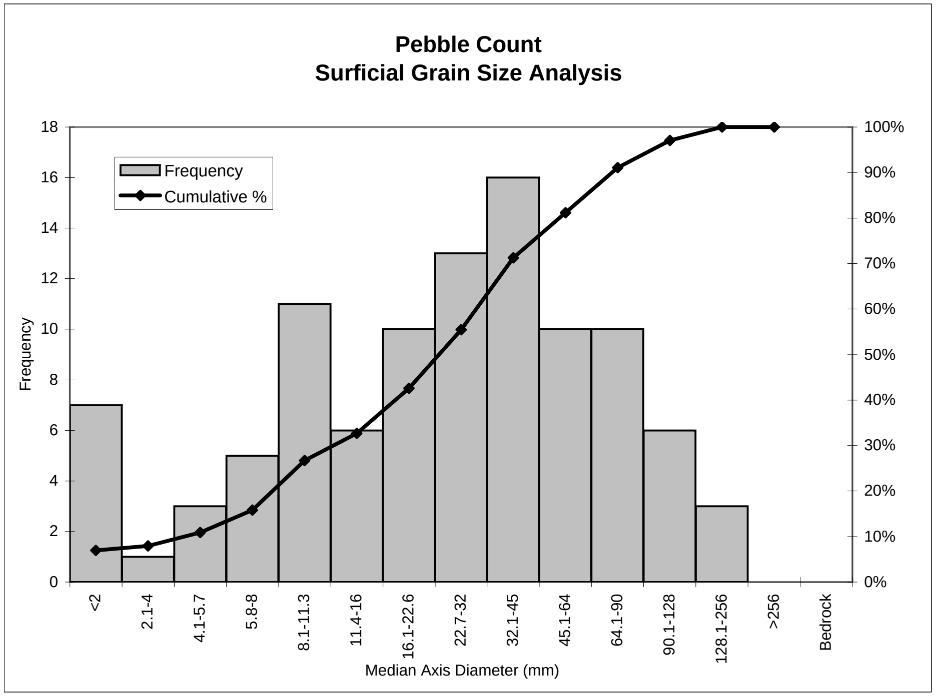
Sediment Grain Size Analysis

Pena	Stream	**8/27/2009**	Date
	Reach	Brunfelt	Personnel
	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Trib to Dry Creek that enters at reach break between R17 and R16 at D78

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	7	6.9%
Very Fine Gravel	2.1-4	1	7.9%
Fine Gravel	4.1-5.7	3	10.9%
Fine Gravel	5.8-8	5	15.8%
Medium Gravel	8.1-11.3	11	26.7%
Medium Gravel	11.4-16	6	32.7%
Coarse Gravel	16.1-22.6	10	42.6%
Coarse Gravel	22.7-32	13	55.4%
Very Coarse Gravel	32.1-45	16	71.3%
Very Coarse Gravel	45.1-64	10	81.2%
Small Cobble	64.1-90	10	91.1%
Small Cobble	90.1-128	6	97.0%
Large Cobble	128.1-256	3	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	101	



Location (Stream, Reach, Description)

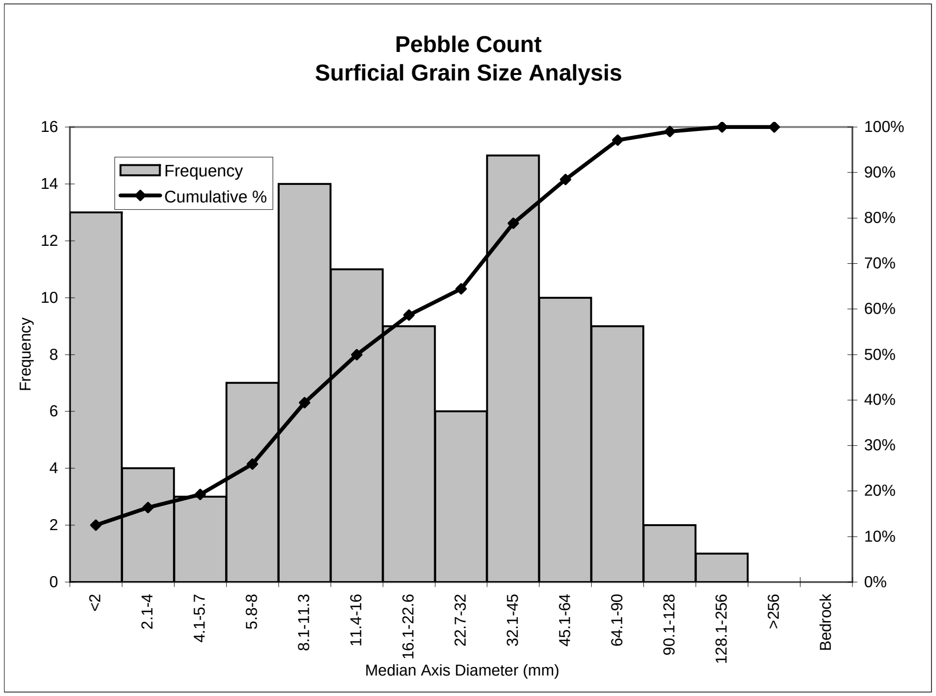
Sediment Grain Size Analysis

Fall	Stream	**8/27/2009**	Date
	Reach	Brunfelt	Personnel
	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Tributary to Dry Creek enters at GPS D42 at the v/s end of R18

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	13	12.5%
Very Fine Gravel	2.1-4	4	16.3%
Fine Gravel	4.1-5.7	3	19.2%
Fine Gravel	5.8-8	7	26.0%
Medium Gravel	8.1-11.3	14	39.4%
Medium Gravel	11.4-16	11	50.0%
Coarse Gravel	16.1-22.6	9	58.7%
Coarse Gravel	22.7-32	6	64.4%
Very Coarse Gravel	32.1-45	15	78.8%
Very Coarse Gravel	45.1-64	10	88.5%
Small Cobble	64.1-90	9	97.1%
Small Cobble	90.1-128	2	99.0%
Large Cobble	128.1-256	1	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	104	



Location (Stream, Reach, Description)

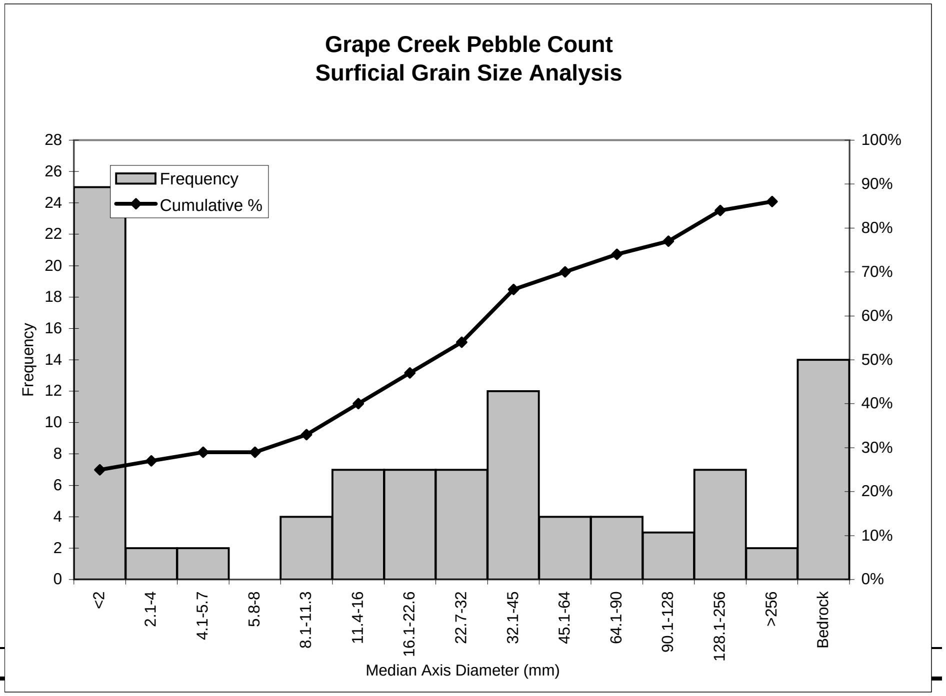
Sediment Grain Size Analysis

Grape	Stream	**8/29/2009**	Date
	Reach	Brunfelt	Personnel
	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	25	25.0%
Very Fine Gravel	2.1-4	2	27.0%
Fine Gravel	4.1-5.7	2	29.0%
Fine Gravel	5.8-8	0	29.0%
Medium Gravel	8.1-11.3	4	33.0%
Medium Gravel	11.4-16	7	40.0%
Coarse Gravel	16.1-22.6	7	47.0%
Coarse Gravel	22.7-32	7	54.0%
Very Coarse Gravel	32.1-45	12	66.0%
Very Coarse Gravel	45.1-64	4	70.0%
Small Cobble	64.1-90	4	74.0%
Small Cobble	90.1-128	3	77.0%
Large Cobble	128.1-256	7	84.0%
Small Boulders	>256	2	86.0%
Bedrock	Bedrock	14	100.0%
	Total	100	



Location (Stream, Reach, Description)

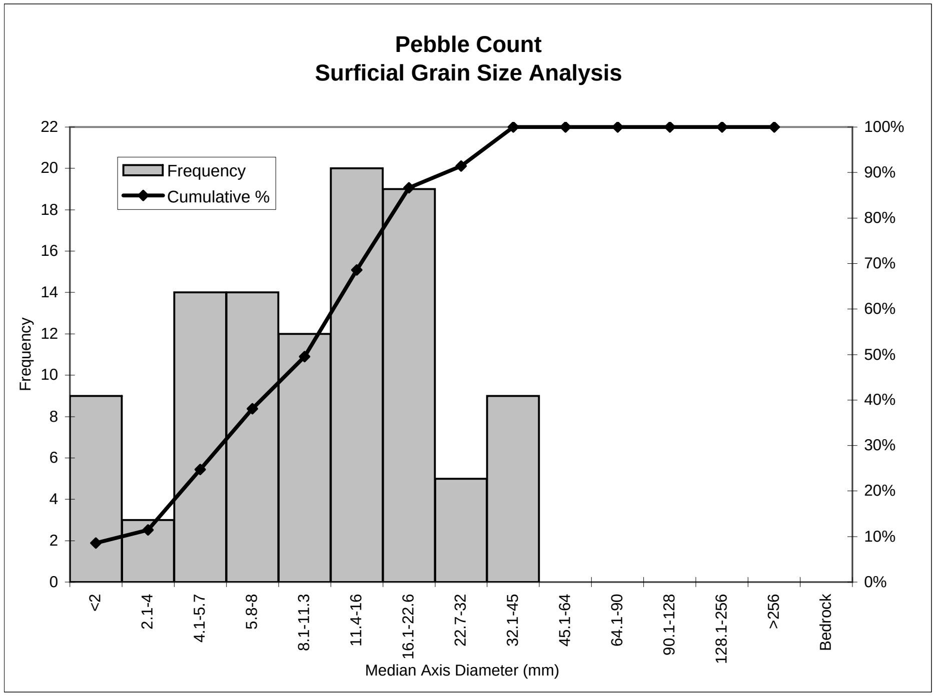
Sediment Grain Size Analysis

Kelly	Stream	**8/30/2009**	Date
	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Kelly Creek is in the middle of unit #242

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	9	8.6%
Very Fine Gravel	2.1-4	3	11.4%
Fine Gravel	4.1-5.7	14	24.8%
Fine Gravel	5.8-8	14	38.1%
Medium Gravel	8.1-11.3	12	49.5%
Medium Gravel	11.4-16	20	68.6%
Coarse Gravel	16.1-22.6	19	86.7%
Coarse Gravel	22.7-32	5	91.4%
Very Coarse Gravel	32.1-45	9	100.0%
Very Coarse Gravel	45.1-64	0	100.0%
Small Cobble	64.1-90	0	100.0%
Small Cobble	90.1-128	0	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	105	



Location (Stream, Reach, Description)

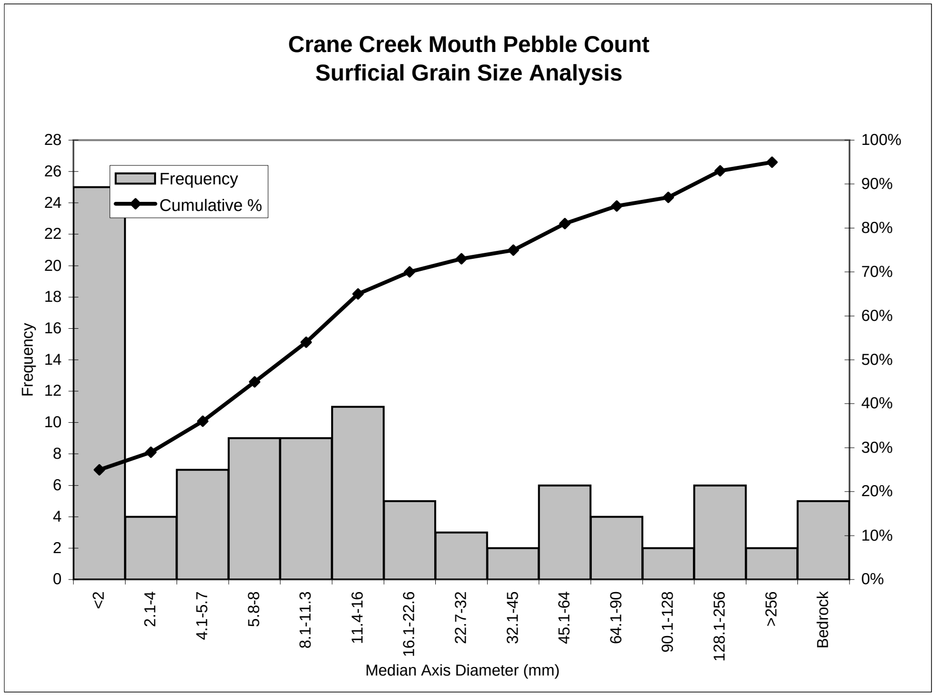
Sediment Grain Size Analysis

Crane	Stream	**8/31/2009**	Date
	Reach	N. Nelson & J. Mullen	Personnel
	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	25	25.0%
Very Fine Gravel	2.1-4	4	29.0%
Fine Gravel	4.1-5.7	7	36.0%
Fine Gravel	5.8-8	9	45.0%
Medium Gravel	8.1-11.3	9	54.0%
Medium Gravel	11.4-16	11	65.0%
Coarse Gravel	16.1-22.6	5	70.0%
Coarse Gravel	22.7-32	3	73.0%
Very Coarse Gravel	32.1-45	2	75.0%
Very Coarse Gravel	45.1-64	6	81.0%
Small Cobble	64.1-90	4	85.0%
Small Cobble	90.1-128	2	87.0%
Large Cobble	128.1-256	6	93.0%
Small Boulders	>256	2	95.0%
Bedrock	Bedrock	5	100.0%
	Total	100	



Location (Stream, Reach, Description)

inter-fluve, inc.

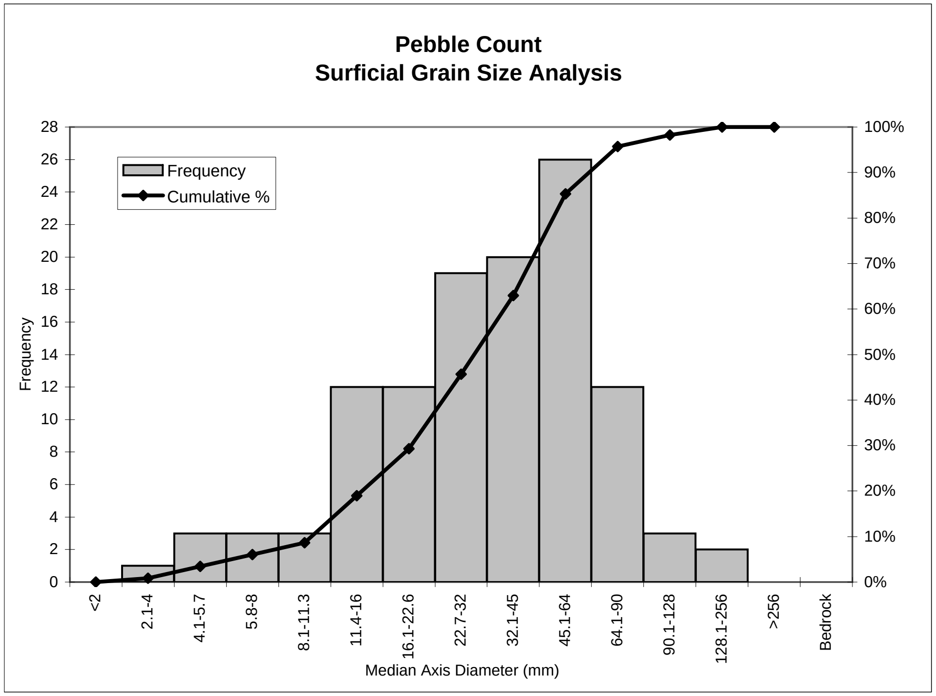
Sediment Grain Size Analysis

Pena Ck	Stream	**8/31/2009**	Date
	Reach	N. Nelson & J. Mullen	Personnel
near bridge	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Pebble count taken under and upstream ~ 60 feet
Very simiar size distrubution to what sampled all the way down below Mill C
Mill Creek, little larger w/ some 128 mm. due to slope?

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	0	.0%
Very Fine Gravel	2.1-4	1	.9%
Fine Gravel	4.1-5.7	3	3.4%
Fine Gravel	5.8-8	3	6.0%
Medium Gravel	8.1-11.3	3	8.6%
Medium Gravel	11.4-16	12	19.0%
Coarse Gravel	16.1-22.6	12	29.3%
Coarse Gravel	22.7-32	19	45.7%
Very Coarse Gravel	32.1-45	20	62.9%
Very Coarse Gravel	45.1-64	26	85.3%
Small Cobble	64.1-90	12	95.7%
Small Cobble	90.1-128	3	98.3%
Large Cobble	128.1-256	2	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	116	



Location (Stream, Reach, Description)

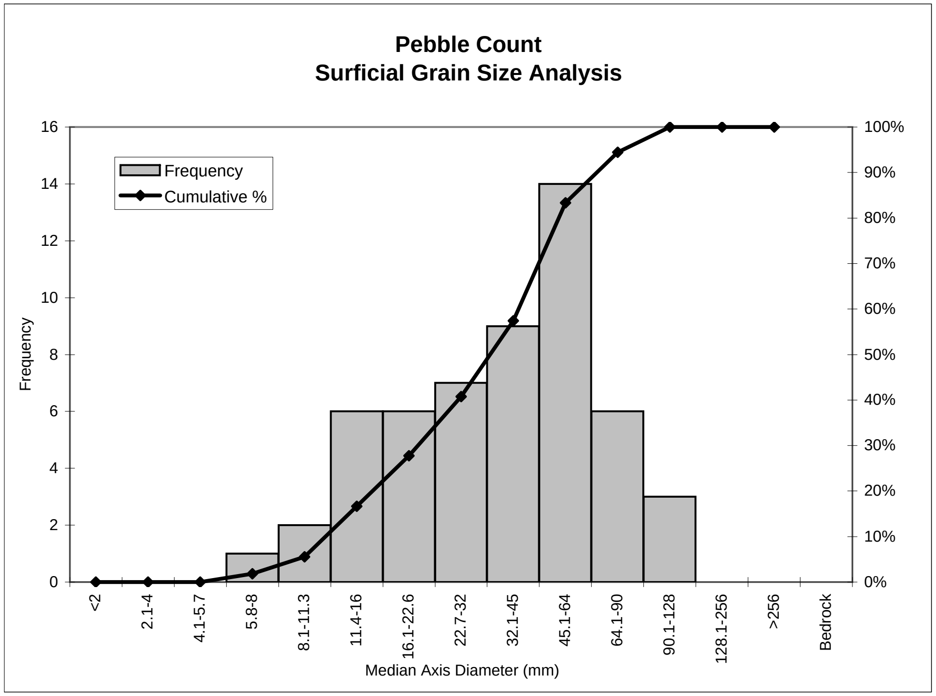
Sediment Grain Size Analysis

Dry Creek	Stream	**8/28/2009**	Date
	Reach	Brunfelt	Personnel
Dp 28	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
In yellow book, no Reach number.
Pool filled with Pea Gravel

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	0	.0%
Very Fine Gravel	2.1-4	0	.0%
Fine Gravel	4.1-5.7	0	.0%
Fine Gravel	5.8-8	1	1.9%
Medium Gravel	8.1-11.3	2	5.6%
Medium Gravel	11.4-16	6	16.7%
Coarse Gravel	16.1-22.6	6	27.8%
Coarse Gravel	22.7-32	7	40.7%
Very Coarse Gravel	32.1-45	9	57.4%
Very Coarse Gravel	45.1-64	14	83.3%
Small Cobble	64.1-90	6	94.4%
Small Cobble	90.1-128	3	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	54	



Location (Stream, Reach, Description)

Sediment Grain Size Analysis

Dry Creek	Stream	**8/28/2009**	Date
1	Reach	Brunfelt	Personnel
below Mill Creek	Location		Latitude
	Identifier / Unit		Longitude
	Longitudinal Description (Pool, Riffle, Bend, Crossing)		Northing
surficial	Sample Type: Armor Layer or Subarmor		Easting
	Approximate Depth of Flow at Thalweg (ft)		Waypoint

Notes:
Below Mill Creek

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	0	.0%
Very Fine Gravel	2.1-4	1	.9%
Fine Gravel	4.1-5.7	0	.9%
Fine Gravel	5.8-8	0	.9%
Medium Gravel	8.1-11.3	3	3.7%
Medium Gravel	11.4-16	6	9.3%
Coarse Gravel	16.1-22.6	11	19.6%
Coarse Gravel	22.7-32	19	37.4%
Very Coarse Gravel	32.1-45	27	62.6%
Very Coarse Gravel	45.1-64	24	85.0%
Small Cobble	64.1-90	13	97.2%
Small Cobble	90.1-128	3	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	107