Lower Kalama River
Off-Channel Habitat Assessment

Final Report
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Prepared for:

Lower Columbia Fish Enhancement Group
Vancouver, Washington

Lower Columbia Fish Recovery Board
Longview, Washington

Prepared by:

Waterfall Engineering, LLC
Patrick D. Powers, P.E.
Olympia, Washington

ECOLUTION
Marnie Tyler, Ph. D.
Olympia, Washington

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Donna (Hale) Bighouse	WDFW
Bryce Glaser	WDFW
Bernadette Graham-Hudson	LCFRB
Julius Ledgett	Landowner
Hal Mahnke	LCFEG
Nello Picinich	LCFEG
Patrick Powers	Waterfall Engineering
Marnie Tyler	Ecolution
Chris Wegemann	WDFW
Steve West	WDFW
Mark Wilson	Port of Kalama
Rick Yahrmarkt	LCFEG, Kalama Landowner

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EXECUTIVE SUMMARY

The Lower Kalama River Off-Channel Habitat Assessment was initiated to identify and prioritize potential salmonid habitat restoration projects in the lower reaches of the subbasin. Conceptual engineering designs and preliminary cost estimates were developed for top ranking projects. This habitat assessment was restricted to the lower 2.5 miles of the Kalama River. The lower portion of the Kalama mainstem has been heavily channelized, thus greatly reducing the abundance of off-channel habitat in the subbasin, particularly chum spawning and coho overwintering habitat (LCFRB 2004). This habitat assessment primarily focused on off-channel habitat creation and restoration, but also considered fish passage barriers, floodplain connectivity, bank stability, and riparian enhancement projects. These projects will benefit populations of adult chum and coho salmon as well as juvenile coho, steelhead, Chinook and cutthroat trout.

This habitat assessment builds upon the foundation of work incorporated into the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (hereafter referred to as the Recovery Plan, LCFRB 2004), the subsequent Habitat Work Schedule developed by the Lower Columbia Fish Recovery Board (LCFRB, 2008), and the Watershed Assessment Project (R2 2004) commissioned by the LCFRB. The Ecosystems Diagnosis and Treatment (EDT) and Integrated Watershed Assessment (IWA) models were prominent tools used in the development of the Salmon Recovery Plan, and in the prioritization of potential restoration projects. Simply put, the EDT Reach Analysis identifies the most important reaches affecting fish populations; the EDT Habitat Factor Analysis identifies which habitat factors are most limiting to fish populations within each reach. IWA identifies watershed processes impacting fish populations across the subbasin and rates the severity of impact for three watershed processes (riparian conditions, hydrology, and sediments).

To select potential projects in the Lower Kalama River, a work group was convened, with representation from the Lower Columbia Fish Enhancement Group, LCFRB, the Washington Department of Fish and Wildlife (WDFW), individual landowners, the Port of Kalama, and technical consultants. Work group members evaluated aerial photographs and remotely sensed data and participated in field reconnaissance by boat and land. Along the 2.5 RM study area, twelve potential projects were identified. Additional field investigations were conducted for the most promising projects, providing critical information for assessing project viability and developing construction designs. Field studies included collection of topographical, surface and groundwater water flow, and channel geomorphology data.

Potential projects were prioritized following a scoring approach developed by the LCFRB Technical Advisory Committee. The work group participated in the ranking process. One project was selected for engineering designs developed at a 30% completion level (KRL 2.5, Ledgett Ground Water Channel). Conceptual engineering design and cost estimates were developed for three additional projects (KRR 2.2, Port of Kalama Groundwater Channel System; KRR 0.7, WDFW Tidal and Groundwater Channel; and SC 0.5, Spencer Creek Riparian Restoration and Large Woody Debris). Engineering designs followed accepted practices promoted by WDFW and drew upon consultant experience from 48 similar projects within Washington State.

1. INTRODUCTION

1.1 Goals and Objectives

The Lower Columbia Fish Enhancement Group (LCFEG) initiated the Lower Kalama Off-Channel Habitat Assessment to identify and prioritize restoration opportunities in the lower 2.5 miles of the Kalama mainstem and tributaries. The ultimate objectives of this effort were to develop conceptual engineering designs and cost estimates for top ranking projects, focusing on off-channel habitat opportunities. Restoration projects were identified that could directly address primary limiting factors and priority measures and actions identified within the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (hereafter referred to as the Recovery Plan, LCFRB 2004). LCFEG intends to include select projects in future Salmon Recovery Funding Board (SRFB) funding requests; the project list will also be available for other entities to consider for possible restoration and mitigation activities. Species to benefit from this work include adult chum and coho salmon as well as juvenile coho, steelhead, Chinook and cutthroat trout. It is also hoped that the fine-scale data collected as a part of this project will inform and enhance future iterations of the LCFRB's 6-Year Habitat Work Schedule and Lead Entity Habitat Strategy (HWS).

1.2 Approach

This study initially targeted a single reach within the subbasin: Kalama 2. This is a Tier 1 reach which was identified as the top ranking reach in the HWS at the time the study was initiated. An individual property was identified based on landowner willingness and site suitability[1]. Proposed activities were aimed at creating off-channel habitat, and improving riparian condition and floodplain connectivity. A work group was convened to incorporate stakeholder input and technical expertise. The work group included representation from the LCFEG, the Lower Columbia Fish Recovery Board (LCFRB), the Washington Department of Fish and Wildlife (WDFW), individual landowners, the Port of Kalama, and technical consultants. The work group met at key junctures of the study to provide input on scope, objectives, restoration opportunities, and project prioritization and ranking. Per the suggestions of the work group, the scope was extended beyond the initial property to include the lower 2.5 miles of the Kalama River mainstem and Spencer Creek, and the number of projects for which designs were developed was increased.

The study builds upon previous efforts to identify and prioritize restoration opportunities in the subbasin, including the Recovery Plan (LCFRB 2004), HWS (LCFRB 2008), the Kalama, Washougal, and Lewis River Habitat Assessments (hereafter referred to as the Watershed Assessment Project, R2 2004), and similar project development and prioritization efforts in the Cowlitz subbasin (Tetra Tech 2007) and Woodward Creek (Tetra Tech and Anchor 2007). The study also includes new field investigations and monitoring of hydrologic conditions, including an inventory of potential restoration project sites and data collection essential for determining project feasibility.

[1] The reach has subsequently been split into Kalama 2A and Kalama 2B, with the identified property in reach Kalama 2A. Kalama 2A is identified as the second ranked reach in the 2008 update of the HWS.

2. LOWER KALAMA RIVER SUBBASIN DESCRIPTION

2.1 Subbasin Description

The Kalama River falls within the 205 square mile Kalama River subbasin (Figure 1) and is one of eleven major subbasins comprising the Washington side of the Lower Columbia Basin. The River originates on the southwest slopes of Mount St. Helens and enters the Columbia River at river mile (RM) 73.1. The Kalama River subbasin was historically populated with thousands of fall Chinook, winter steelhead, chum, and coho, however their numbers have fallen drastically. Chinook, chum, steelhead and coho are listed as threatened under the Endangered Species Act (ESA). Unless specifically referenced to another source, the information presented throughout Section 2.1 is derived from the Recovery Plan (LCFRB 2004).

Figure 1. The Kalama River Subbasin and its relationship to the Lower Columbia Basin. Reproduced from the Recovery Plan (LCFRB 2004)

Based on criteria established by the Technical Recovery Team convened by NOAA, the Kalama Subbasin was identified as one of the most important subbasins for salmon recovery within Washington Cascade subbasins. To meet regional recovery objectives, Kalama River Chinook and steelhead will need to be restored to a high level of viability; coho and chum will need to be restored to medium and low levels of viability respectively.

The vast majority (96%) of the subbasin is managed for commercial timber production, however the lower portion of the subbasin has been heavily impacted by residential and industrial development, highway and road construction, agriculture and water withdrawals, gravel mining and other land use activities. Impacts from land use have resulted in channelization, degradation of riparian conditions, and loss of wetlands, side channels, oxbows, and meander scars. Most of the floodplain has been disconnected from the river and riparian conditions have been degraded (Wade 2000).   The ultimate result has been the loss of salmonid spawning and rearing habitat. Without concerted efforts to reverse these trends, these losses can be expected to continue.

2.1.1 Study Area

The Kalama River mainstem has roughly 35 miles of anadromous fish distribution. The focus of the current assessment is on the lower 2.5 miles of the river and its tributaries (Figure 2), which includes the second ranked reach identified within the 2008 HWS. The gradient in this part of the basin is low and the entire area considered is influenced by tidal fluctuations to varying degrees. Land ownership within the study area is predominately private residential, but also includes industrial properties and lands owned by the Port of Kalama, and a small area owned by WDFW.

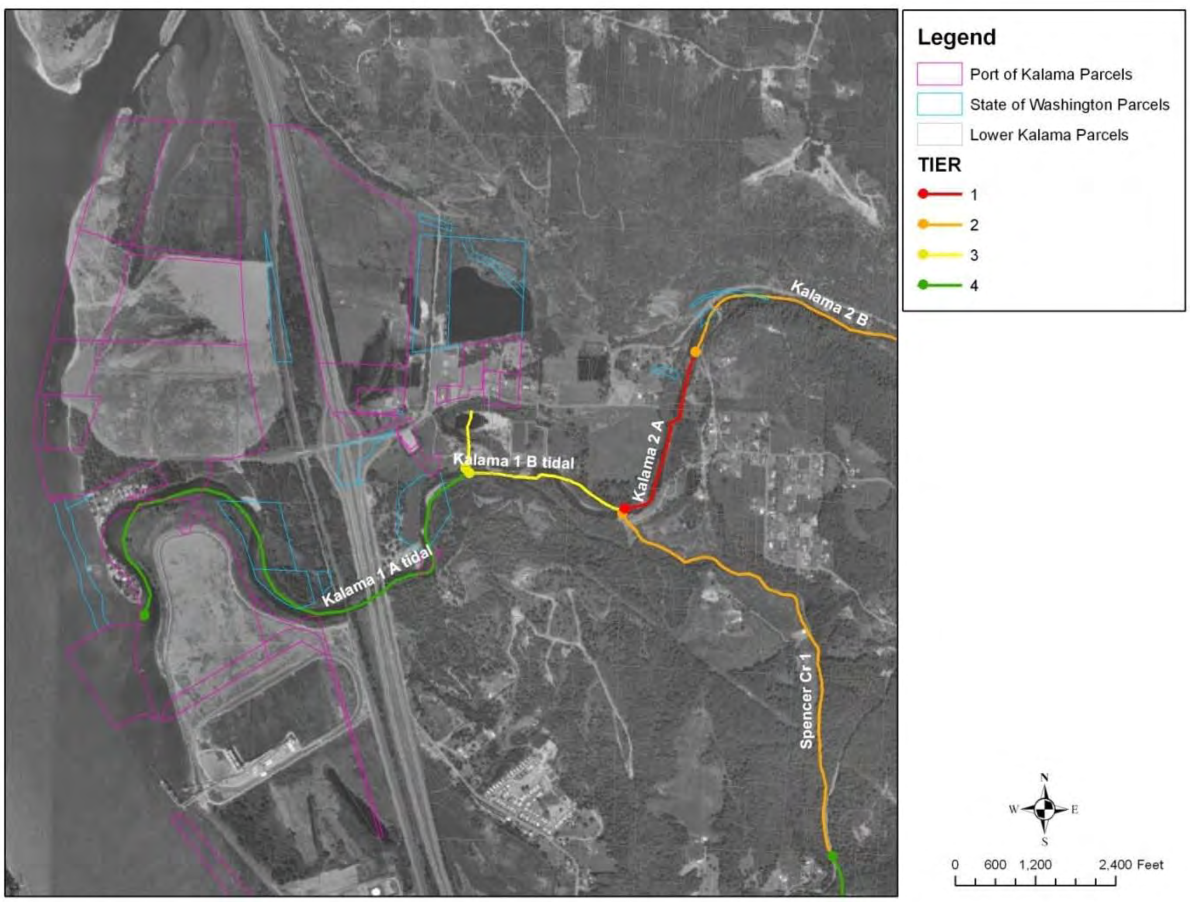

Figure 2. Lower Kalama River study area.

2.1.1 Geology

In the Watershed Assessment Project, R2 and MBI (2004) summarized geologic data presented in Washington Department of Natural Resource's *Geologic Map of Washington – Southwest Quadrant* (Walsh et al., 1987). R2 and MBI (2004, page 2-30) provides the following description of the geology and geomorphology of the subbasin:

> *"The Kalama River basin geology is relatively uniform compared to the nearby Lewis and Washougal River basins. The upper Kalama River flows through volcaniclastic deposits of pyroclastic flows, lahars, and debris avalanches, from its headwaters downstream to below Bush Creek near river mile (RM) 30 (Walsh et al. 1987). These deposits produce fine sediments that are typically composed of fine to medium size grains. There are isolated lahar areas distributed as patches throughout the middle Kalama River section, containing mixtures of cobble and boulders supported by a matrix of sand or mud. Between RM 30 and Marietta Falls near RM 6), the mainstem flows through fine grained igneous, Lower Oligocene to upper Eocene andesite flows. Most of the tributaries to the Kalama River entering below upper Kalama Falls also flow through the same fine grained igneous andesite flow material as the middle mainstem river (Walsh et al. 1987; Foster 1983). Below Marietta Falls, the Kalama River flows through predominantly alluvial deposits containing sand and gravel."*

The data collected by R2 for the Watershed Assessment Project suggest that EDT-modeled embeddedness values were underestimated throughout the basin. For a more thorough evaluation of substrate, sedimentation patterns and spawning suitability, the reader is referred to the Watershed Assessment Project itself (R2 2004).

2.1.2 Climate and Precipitation

The study area has a maritime climate with cool, wet winters and warm, dry summers. Mean annual precipitation is 68 inches at the Kalama Falls Hatchery, which is located within 3 miles of the study area. River flows are also influenced by precipitation in the upper reaches of the basin, which may exceed 120 inches. The bulk of the precipitation falls between October and March (LCFRB 2004).

2.1.3 Hydrology and Hydraulics

Daily exceedence flow duration curves for the Kalama River were developed by the Department of Ecology for an Instream Flow Incremental Methodology (IFIM) assessment (Caldwell, 1999). Values from the graph are shown in (Table 1). The 90 and 10 percent are recommended design flow ranges for the development of off-channel habitat. The 50 percent flow is included to show average conditions. Juvenile salmon typically migrate into and egress from off-channel areas during changes in stream flow and temperature. For the Kalama River this change occurs in the fall to winter period (October to December) and in the spring to summer period (May to July). Using these months to define the migration timing for juveniles, the design flows would range from 250 to 4000 cubic feet per second (cfs). Fish still may use off-channel habitat above and below these flows, but on a much smaller scale relative to the overall population.

Table 1. Kalama River flow exceedance values. Data from 1946 to 1983 USGS Gage 14223500 at RM 4.2

Month	Flow Exceedance (cfs)		
	90%	**50%**	**10%**
Oct	*200*	*300*	*1000*
Nov	*250*	*600*	*1800*
Dec	*600*	*1800*	*4000*
Jan	*1000*	*1800*	*3000*
Feb	*700*	*1800*	*4000*
Mar	*900*	*1700*	*3000*
Apr	*700*	*1600*	*2500*
May	*700*	*1200*	*2000*
Jun	*450*	*700*	*1200*
July	*300*	*450*	*700*
Aug	*230*	*300*	*450*
Sep	*200*	*280*	*450*

Kalama River peaks flows are available from a historical USGS gaging station (Kalama River Near Kalama 14223000; online at http://waterdata.usgs.gov/wa/nwis/), for 31 years from 1912 to 1947. USGS flood frequency analysis software PeakFq (available online at http://water.usgs.gov/software/PeakFQ/) yields the following peak flows and return periods.

8200 cfs	2-Year Flood
15000 cfs	10-Year Flood (Note: FEMA Flood Study used 16500 cfs)
20000 cfs	20-Year Flood
30000 cfs	100-Year Flood (Note: FEMA Flood Study used 25050 cfs)

For project longevity in terms of maintaining the project as designed it is recommended using the 20-year peak flood event. For risk assessment and potential liability to the Public, the 100-year peak flood flow event should be evaluated.

Tidal elevations at the mouth of the Kalama River vary from 6 to 14 feet. The actual point of tidal impact will vary from RM 1.0 at low flow, to 1.6 at high flow. Tidal impact (in terms of channel morphology) extends further upstream to around RM 2. Figure 3, shows the steeper water surface gradient just downstream from RM 2.

Groundwater has been studied extensively in the Lower Kalama (CH2MHill, 2002). Sediment in the Lower Kalama study area consists of recent Columbia River and Kalama River alluvial deposits overlying volcanic and sedimentary bedrock deposited during the building of the Cascade Mountains. Identified projects for off-channel enhancement are located within this alluvial delta of the Kalama River. The thickness of this sediment layer varies from 90 to 325 feet. In the lower portions of the study area the groundwater is tidally influenced. There were no data presented on groundwater elevations or flow directions in the CH2M Hill draft report. At the upper end of the project study reach, several wells exist (City of Kalama and Ledgett) on the left bank of the river. Groundwater pump tests performed showed a direct connection to the

Kalama River. In the lower portions of the study area, the groundwater corresponds directly to Columbia River levels.

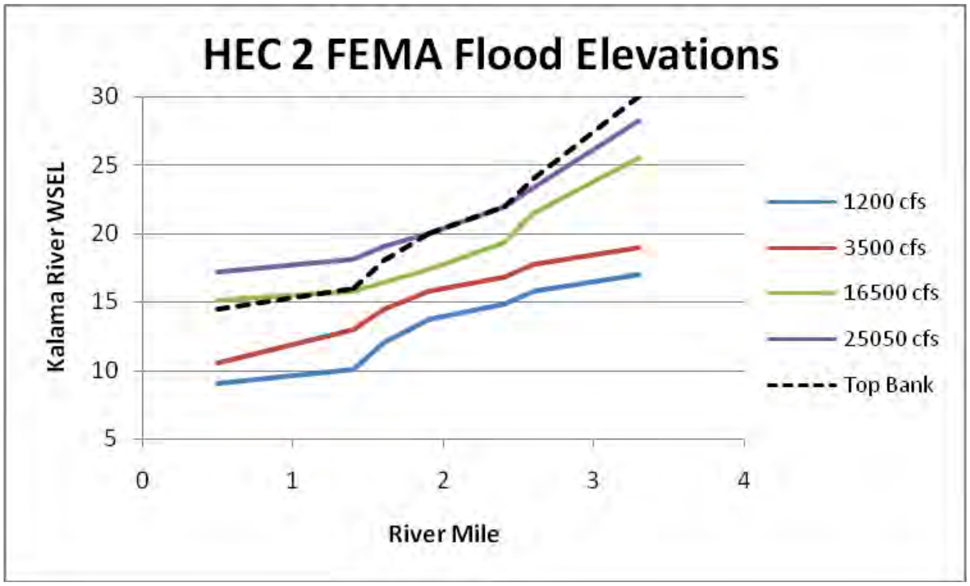

Figure 3. Water surface profile in the Lower Kalama River at various flood flows. Note: The top bank elevation above RM 2.0 appears to be near the 100-year flood line. This would indicate an incised channel through this reach and a loss of side channel connectivity. Although, observations of flooding have shown at RM 2.0 that floods above the 5 year event overtop the bank.

2.1.4 Vegetation and Land Use

Historically, this landscape was dominated by late seral coniferous forests. Dominant overstory species likely included western hemlock interspersed with Douglas-fir and western redcedar. Understory species were diverse plant associations of such species as salal, Oregon grape, vine maple, dogwood, huckleberry, salmonberry, and thimbleberry among others (Franklin and Dyrness 1988). Natural disturbance in the form of wind, fire, river meanders, insect and disease, resulted in a mosaic of patches of early and mid-seral forest interspersed within the late seral matrix. Riparian and floodplain areas were likely a mix of deciduous trees (e.g. black cottonwood, red alder, bigleaf maple), shrubs (predominately willows), emergent wetlands and grasses, and coniferous forests (predominately western redcedar and western hemlock).

Patterns of land use and development in the study area have greatly affected upland and riparian vegetation. Most of the watershed, including riparian areas, was logged between the late 1960s and early 1980s, resulting in a prevalence of early and mid-seral stages in forested areas of the subbasin (Lewis County GIS 1999, as cited in Wade 2000). R2 and MBI (2004) summarized riparian large woody debris (LWD) recruitment potential and stream shading levels. Overall, LWD recruitment potential is poor throughout the subbasin, however it is identified as high or moderate for three of the five reaches included in this study, as noted in the reach descriptions below. Riparian shade criteria however, are off target for all reaches (R2 and MBI 2004). Existing size classes are relatively small, with only 5% of riparian stands in size classes >20” diameter (for the subbasin overall). Riparian stands are ineffective in providing adequate shade and stream temperatures for salmonids and were labeled as 'impaired'. Disturbance in the riparian area is largely due to urban development and roads (R2 and MBI 2004). Non-native species such as Himalayan blackberry, Scot's broom and reed canary grass are present and increasing in extent in disturbed areas.

2.1.5 Fish Distribution

The focal species in the Kalama Subbasin include six salmonid species, all of which have been federally listed as threatened: fall Chinook, spring Chinook, chum, coho, summer steelhead, and winter steelhead (LCFRB 2004). Other species of interest in the Kalama River watersheds include coastal cutthroat trout and Pacific lamprey. There is a significant hatchery component in the subbasin for all focal species except chum. Additionally, many out-of-basin stocks may rely on estuarine habitat within the Kalama Subbasin for rearing, refuge and migration.

Current viability of focal populations is quite low, however recovery goals for these populations are generally high, due to the importance of these populations to recovery of the species within their Evolutionarily Significant Units (Table 2). All six of these species are present in the lower 2.5 miles of the Kalama River mainstem. Coho and chum are documented in both of the Spencer Creek reaches included in this analysis, and steelhead are also present in the downstream reach, Spencer Creek 1 (LCFRB 2008). The 2004 Watershed Assessment Project (R2 and MBI) indicates that coho spawning is documented or presumed in the mainstem Kalama below lower Kalama Falls and in Spencer Creek. Steelhead spawning is widely distributed across the subbasin and is documented in the lower Kalama mainstem and nearly all tributaries surveyed in the R2 report (Spencer Creek was not surveyed). Chinook spawning primarily occurs in the Kalama mainstem upstream from the study area. Chum historically have spawned at the upper end of the study area (beginning at RM 2.4) (R2 and MBI 2004).

Table 2. Current and recovery goal viability rating and population status for species in the study area (LCFRB 2004).

Species	Current Viability Rating	Recovery Goal Viability Rating	Recovery Scenario Population Importance
Fall Chinook	Low+	High	Primary
Spring Chinook	Very low	High	Primary
Chum	Very low	Low	Contributing
Coho	Low	Medium	Contributing
Summer Steelhead	Low+	High	Primary
Winter Steelhead	Medium+	High	Primary

2.2 Reach Descriptions

Reaches used within this report and throughout the project mirror those used in EDT analyses included within the HWS (Table 3). EDT Habitat Factor Analysis identifies key habitat quantity and habitat diversity as important habitat attributes for restoration across all species and reaches in the study area. Additionally, sediment load is moderately important for coho, chum, winter steelhead in some reaches, flow and harassment have moderate importance in Kalama 2A for chum; predation is moderately important in Kalama 1A and 1B tidal for coho and winter steelhead.

The HWS (LCFRB 2008) identifies the same multi-species project benefits for all reaches in the study area. Four of the five reaches have a high benefit, the fifth reach, Spencer Creek 2, also identifies these project benefits, but gives a moderate rating:

- stream channel habitat structure and bank stability,
- off-channel and side-channel habitat,
- floodplain function and channel migration processes,
- riparian conditions and functions,
- instream flows, and
- watershed conditions and hillslope processes.

Table 3. Reach description summary.

Reach	Description	Starting RM	Ending RM	Tier
Kalama 1 A tidal	Mouth to Right Bank (RB) Tributary 1	0.00	1.75	4
Kalama 1 B tidal	Kalama RB Tributary 1 to Spencer Creek	1.75	2.22	3
Spencer Creek 1	Mouth to Spencer Ck Rd. Culvert	0.00	1.80[2]	2
Spencer Creek 2	Spencer Ck Rd culvert to end of salmonid distribution	1.80[2]	2.00	4
Kalama 2A	Spencer Creek to confined canyon	2.22	2.75	1

2.2.1 Kalama 1A Tidal

Kalama 1A Tidal and 1B Tidal were lumped together as Kalama 1 tidal in the initial EDT analysis of the 2004 Recovery Plan. While Kalama 1 tidal was identified as a Tier 3 reach, Kalama 1A Tidal was classified as a Tier 4 in the 2008 HWS. This reach extends from the mouth of the Kalama River at the confluence with the Columbia River up to an unnamed tributary on the right bank at RM 1.75.

Tidal influence extends throughout this reach, affecting channel and floodplain morphology. The channel is of low gradient (<1%) and is geomorphically unconfined, however armored banks or levees constrain this reach on both sides. Habitat in this reach is entirely deep glide with a lot of sand, except at the mouth, where some large cobbles and gravels are found. With very little usable spawning habitat, the reach is useful as a transportation corridor for upstream migrating adults, and for acclimatization for outmigrating juveniles. LWD recruitment is identified as poor (R2 and MBI 2004).

As a Tier 4, this reach has low priority overall for restoration of multiple species of salmonids in the subbasin. The reach potential is moderate for coho, and low for steelhead, Chinook and chum (LCFRB 2008). Restoration opportunities within this reach include addressing passage issues at the mouth of the river (Figure 4), habitat enhancement of several tidal channels on Port of Kalama property (Figure 5), and creating a connection between the reach and possible groundwater channels on WDFW property at RM 0.7, and a groundwater channel at RM 1.4.

[2] The location of the mouth of Spencer Creek is incorrect in the 2008 HWS and thus the starting and ending RM listed here is different than that in the HWS.

Deposition of sediment at the mouth of the river has been thought to create an upstream passage obstruction for migrating salmonids, particularly during low tide, and to increase avian predation of outmigrating smolts (LCFRB 2004). The Kalama River channel is confined and transports sediment until connection with the Columbia River. It is possible that the quantity of deposition has been affected by the construction and ongoing operations of the Federal Columbia River Power System, and eroding banks of the lower river and midbasin tributaries (R2 and MBI 2004). Fisher and Associates, documented the use of several hundred ESA-listed juvenile salmon (fry and alevins) in this reach in a constructed off-channel area on Port of Kalama Property.

Figure 4. Reach Kalama 1A Tidal: deposition at mouth of Kalama River

Figure 5. Reach Kalama 1A: tidal channels on Port of Kalama property

2.2.2 Kalama 1B Tidal

Kalama 1A Tidal and 1B Tidal were lumped together as Kalama 1 Tidal in the initial EDT analysis included in the 2004 Recovery Plan. This reach extends from the unnamed right bank tributary at RM 1.75 up to the mouth of Spencer Creek (Kalama Mainstem RM 2.2). This reach is also influenced by tidal fluctuations, but to a lesser degree than Kalama 1A Tidal. The reach is flanked by a gently sloping alluvial terrace covered with predominately deciduous forest (Figure). LWD recruitment potential is high for this reach (R2 and MBI 2004).

Figure 6. Kalama 1B tidal

This is a Tier 3 reach; the reach potential is low for all six species found in the study area (LCFRB 2008). The reach is unconstrained by levees and dikes and offers some of the only off-channel habitat found in the lower basin: a large backwater/tributary confluence at the upper end of the reach, between RM 1.9 and 2.2. Habitat in this reach is entirely deep glide, with a lot of sand. With very little usable spawning habitat, it is useful as a transportation corridor for upstream migrating adults, and for acclimatization for outmigrating juveniles (R2 and MBI 2004).

2.2.3 Spencer Creek 1

This reach extends from the mouth of Spencer Creek (Kalama River mainstem RM 2.2) to Spencer Creek RM 1.8[3]. This is a very narrow, low-gradient, partially shaded channel (Figure 7). It flows through the Kalama River floodplain, which is comprised largely of sand and silt in the upper 8-10 feet near the mouth of Spencer Creek (R2 and MBI 2004). In the vicinity of the confluence with the Kalama mainstem there are several small excavated pits which have year-round groundwater. Beaver activity in the area regularly results in Spencer Creek forming several braided channels through the Kalama River floodplain. The creek's banks alternate between open grassy stretches and deciduous shrubs and trees (alder and cottonwood); reed canary grass and Himalayan blackberry are established in the area. LWD recruitment is poor (R2 and MBI 2004).

Spencer Creek 1 has a high reach potential for coho, and low potential for chum, and winter and summer steelhead (LCFRB 2008). The reach is heavily embedded, probably due to the low gradient and lack of stream velocity and sediment transport capacity (R2 and MBI 2004). Based on field reconnaissance, the best spawning habitat of this reach is located above the Kalama River floodplain, at the base of a rising, heavily vegetated slope (near the 40 foot contour on the contour on the Kalama 1:24,000 topographic map.

Figure 7. Mouth of Spencer Creek.

[3] The location of the mouth of Spencer Creek is incorrect in the 2008 HWS and thus the distance listed here is different than that in the HWS

The 2008 HWS assigns a high reach potential for coho to this Tier 2 reach, and gives a low rating for chum and winter and summer steelhead (Chinook are not present). The Watershed Assessment Project (R2 and MBI 2004) noted that reducing sediment levels would be a critical component of improving spawning conditions within the reach. Achieving this goal would require long-term, extensive sediment abatement efforts (R2 and MBI 2004).

2.2.4 Spencer Creek 2

This Tier 4 reach extends from Spencer Creek RM 1.8 to RM 2.0, the end of known salmonid distribution. This is a very narrow, shaded channel with gradient generally greater than 3%. Heavy riparian vegetation of mixed deciduous/conifer composition flanks the channel; LWD recruitment is identified as high (R2 and MBI 2004). The 2008 HWS assigns this reach a low species potential for coho and chum, the only species present.

2.2.5 Kalama 2A

Reach Kalama 2A is a Tier 1 reach extending from RM 2.2 to 2.75. The channel is confined on the right bank by rock vanes and riprap but unconfined on the left bank. Gradient ranges from 0.5-1%. The pool-riffle habitat complex has a substrate dominated by cobbles and gravel with a low level of fines, making spawning conditions favorable (R2 and MBI 2004). At the time this study was initiated, it was identified as the highest priority reach in the 2007 HWS; in the 2008 HWS, it is recognized as the second priority reach. This reach was identified in the Recovery Plan as having the greatest potential benefit to overall population abundance, productivity, and diversity. LWD recruitment is identified as moderate for this reach (R2 and MBI 2004).

Reach potential is high for fall Chinook and chum, and low for the other four species present in the study area (LCFRB 2008). The Recovery Plan (LCFRB 2004) specifically includes this reach in its top priority measure aimed at preservation of stream corridor structure and function. The 2004 Watershed Assessment Project (R2 and MBI) identifies riparian planting and addition of large wood as ideal restoration opportunities for this reach. Field reconnaissance also identified opportunities for removal of a natural gas pipeline (Figure 8) and rip rap (Figure 9).

Figure 8. Natural gas pipeline on Kalama 2A

Figure 9. Rip rap along banks of Kalama 2A

3. METHODS: IDENTIFYING POTENTIAL RESTORATION SITES

Much work has already been done to identify and prioritize restoration and recovery opportunities within the Kalama Subbasin. These previous efforts, combined with initiative from landowners interested in salmon recovery, have shaped the original scope of this habitat assessment. This assessment builds upon these prior efforts and provides additional detail necessary to implement recovery actions.

3.1 Previous Efforts

The primary previous efforts upon which this work builds, include the Recovery Plan (LCFRB 2004), the associated Habitat Work Schedule (LCFRB 2008), and the Watershed Assessment Project (R2 2004).

3.1.1 The Recovery Plan

Development of the Recovery Plan was an intensive collaborative effort which spanned several years, integrated technical expertise and analytical approaches across disciplines, and synthesized the best available technical information relevant to salmon recovery. In the interest of brevity and clarity, the depth and complexity of information presented in the Recovery Plan has been greatly simplified here. For a more complete understanding of the process and priorities identified in the Recovery Plan, the reader is encouraged to consult several chapters of the Recovery Plan, all of which are referenced here as LCFRB 2004, including the Regional Plan (Volume I), Kalama Subbasin Chapter (Volume II, Chapter F) and the assessment analyses of EDT and IWA (Appendix E, Chapters 6 and 4 respectively).

A number of analyses were used to identify priority actions and habitat measures in the Recovery Plan, essentially following a three-step process to identify the 1) priority geographic areas; 2) limiting factors; and 3) land-use threats for multiple species. Priority areas and limiting factors were determined based on technical assessments and models, primarily EDT and IWA. Selection of priority areas was also shaped by the relative importance of subbasin focal fish populations in the overall regional recovery objectives. Regional recovery objectives were identified through a collaborative stakeholder process and ultimately based on the recovery criteria outlined by the NOAA Fisheries-convened Technical Recovery Team. Land-use threats were identified based on a compilation of information, including the Washington Conservation Commission Limiting Factors Analyses, IWA, the State 303(d) list, air photo analysis, the Barrier Assessment, expert opinion, or documented cause-effect relationships between stream conditions and land-uses (LCFRB 2004).

3.1.1.1 EDT

The EDT model was an important analysis tool employed in the development of the Recovery Plan. EDT was used to draw linkages between reach-level habitat attributes and fish population performance, thus aiding in identifying which species and which life stages would most likely benefit from restoration and protection actions in specific reaches. EDT is a mechanistic model developed by Mobrand Biometrics, Inc. (MBI) that evaluates 46 reach-level habitat attributes to evaluate survival across all potential life history trajectories, and calculates four population performance parameters (population productivity, capacity, equilibrium abundance, and diversity; LCFRB 2004). The EDT model is one of several tools used to assess fish population performance and fish / habitat interactions in the Recovery Plan. Specifically, the model was used to estimate fish population performance based on characteristics of physical habitat. EDT targeted geographic areas and reach-specific habitat attributes that have been identified as the most limiting for salmonid populations (LCFRB 2004).

Two key EDT analyses are foundational elements of the Recovery Plan: reach analysis, and habitat factor analysis. Reach analysis prioritizes reaches by identifying which reaches are likely to significantly affect fish populations. Habitat factor analysis identifies habitat attributes in each reach that may be modified to produce an effect in that reach. Simply put, reach analysis identifies which reaches are most important for focal populations, and habitat factor analysis identifies habitat parameters most important within a given reach. All EDT analyses employ a comparison between the current (patient) and historical (template) habitat conditions, and also typically model Properly Functioning Condition (PFC) scenarios. Within the Kalama Subbasin, 103 reaches were identified and analyzed within EDT, including the 5 reaches that are a part of this assessment.

EDT reach analysis ranks reaches based on preservation value and restoration potential. Preservation and restoration priorities are in turn based on abundance, productivity, and life-history diversity for each species in each reach. The output of this analysis is the "ladder", or "tornado" diagrams which identify the most important reaches for each species and identify the relative value of preservation and restoration in that reach. One aspect of the analysis that is important to recognize is that each reach is analyzed independently for restoration and degradation. If a downstream reach is severely degraded or impassable, upstream reaches may show no restoration value, even if a strong potential for restoration exists (LCFRB 2004). While this is an important consideration in decisions regarding project selection and sequencing in general, it should not affect this assessment, because all reaches included in this study are very low in the subbasin, and none are severely degraded or impassable.

EDT habitat factor analysis, or limiting factors analysis, identifies the habitat conditions that are limiting for each life stage of each species within a subbasin. The resulting "habitat impact attribute" charts describe habitat parameters limiting populations across all life stages (LCFRB 2004). The charts include a list of reaches for each species, prioritized for the relative importance to the species. Within this prioritized list of reaches, the habitat attributes most limiting in each reach for each species are identified, and the degree to which the habitat factor is limiting (high, medium, low, or indirect) is displayed. This diagram is often commonly referred to as the "consumer report" diagram, however MBI distinguishes the consumer report diagrams as the more detailed version of this analysis, which evaluates habitat parameters that are limiting for each life stage (these more detailed diagrams are called the "individual consumer reports" in the LCFRB 2008).

3.1.1.2 IWA

The Integrated Watershed Assessment (IWA) identifies watershed processes impacting focal fish populations. It is a GIS-based screening tool that aids in identification and prioritization of actions to address watershed impairments at the subwatershed scale (3,000-12,000 acres, LCFRB 2004). The condition of three key watershed processes are evaluated (riparian conditions, sediment supply, and hydrology (runoff)), using landscape conditions as model inputs (i.e. road density, impervious surfaces, vegetation, soil erodability, and topography). The level of impairment of sediment and hydrology is determined at the local scale (i.e. within subwatersheds, not including upstream drainage area) and watershed scale (i.e. integrating the entire drainage area upstream of each subwatershed).

The entire Kalama River Subbasin was divided into 18 subwatersheds. The tidally influenced Kalama mainstem and tributaries in the lower 2.5 miles of the river all fall within the same IWA subwatershed, identified as subwatershed 40501 in the analysis. This subwatershed is rated as impaired for hydrology at both the local and watershed scales, and is rated moderately impaired for riparian condition and sediment at both the local and watershed scales.

Hydrologic conditions are predicted to be impaired over the next 20 years, due to intense development pressures locally, and current and historic land use practices in upper reaches of the subbasin. Sedimentation is predicted to gradually improve in the lower reaches, due to improved conditions and practices in upper reaches of the subbasin, however this could be offset if development activities in the lower subbasin outstrip predicted levels. Riparian condition is expected to continue to degrade in the lower reaches over the next 20 years, due to the channelization of the river and discontinuous floodplain (LCFRB 2008). The high road densities in the riparian areas of these reaches have resulted in channelization of these reaches disconnected from the floodplain, which exacerbates the already impaired hydrologic conditions.

3.1.2 2008 Habitat Work Schedule

The HWS (LCFRB 2008) is an implementation tool for the Recovery Plan. It is updated as needed (which thus far has been annually) to reflect new information and analyses, and modification to population targets, and priority measures and actions. The HWS provides several tools for ranking projects, including the key priorities identified for the subbasin, the population priorities and viability goals, and summaries of the IWA and EDT analyses. Much of this information is synthesized within the Reach Priorities and Potential Restoration Activities Table, which is a component of the HWS.

The 2008 HWS does not reveal any modifications to population performance targets, however some changes were made since the 2007 HWS in the limiting factors by life stage, and in reach description and tier designations. New EDT analyses were conducted in 2007, largely because full EDT analyses had not been previously conducted for Lower Columbia River coho, which were not listed at the time the original Recovery Plan was finalized. New EDT analyses were conducted over the revised reaches at that time.

3.1.3 Summary of Limiting Factors and Priority Actions

The Recovery Plan broadly describes the most significant limiting factors affecting the Kalama Subbasin: habitat connectivity, habitat diversity, riparian function, floodplain function, stream flow, and substrate and sediment (LCFRB 2004). The predominant threats in the lower 2.5 miles of the Kalama River are agricultural and rural development, and forest practices (LCFRB 2004). The HWS (LCFRB 2008) identifies the most current understanding of the primary limiting factors by life stage (Table 4).

Table 4. Summary of Primary Limiting Factors for the Life Stages of Focal Salmonid, as derived from Habitat Factor Analysis (reproduced from LCFRB 2008)

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
Kalama Fall Chinook				
most critical	Egg incubation	sediment	channel stability	temperature, harassment
second	Prespawning holding	key habitat, habitat diversity	temperature, harassment, predation, flow	
third	Fry colonization	habitat diversity	channel stability, flow, predation, sediment, key habitat	
Kalama Spring Chinook				
most critical	Egg incubation	sediment	channel stability	
second	Prespawning holding	key habitat	habitat diversity, flow	
third	Spawning	habitat diversity	temperature	
Kalama Chum				
most critical	Egg incubation	channel stability, sediment	temperature	flow
second	Prespawning holding	flow	habitat diversity, temperature	pathogens, harassment, key habitat
third	Fry colonization	habitat diversity, sediment	flow	food
Kalama Coho				
most critical	0-age winter rearing	habitat diversity	key habitat, flow	channel stability
second	Egg incubation	channel stability, sediment		
third	0-age summer rearing	habitat diversity	key habitat, competition (hatchery)	channel stability, predation, pathogens, temperature
Kalama Summer Steelhead				
most critical	Egg incubation	sediment	channel stability	
second	0,1-age winter rearing	flow, habitat diversity	channel stability	
third	0-age summer rearing	habitat diversity	flow, competition (hatchery)	
Kalama Winter Steelhead				
most critical	Egg incubation	sediment	channel stability, temperature	
second	0,1-age winter rearing	flow, habitat diversity	channel stability, sediment	
third	0-age summer rearing	habitat diversity	flow, competition (hatchery), predation, pathogens	

The Recovery Plan also lists key priorities, priority measures and habitat actions designed to provide guidance on essential steps to recover focal species. The key priorities identified in the HWS (2008) reflect the most immediate needs for multi-species recovery in the subbasin and provide overarching goals for recovery efforts:

1. Manage forest lands to restore watershed processes;
2. Manage growth and development to protect watershed processes and habitat conditions;
3. Restore passage at culverts and other artificial barriers;
4. Align hatchery priorities with conservation objectives;
5. Manage fishery impacts so they do not impede progress toward recovery; and
6. Reduce out-of-subbasin impacts so that the benefits of in-basin actions can be realized.

Prioritized measures, or habitat measures, while still broad, are more specific descriptions of steps necessary for recovery in the subbasin. Prioritized measures are derived from the EDT and IWA analyses and based solely on biological and physical conditions. The HWS (LCFRB 2008) identifies the following prioritized measures for the Kalama Subbasin in rank order:

1. Protect stream corridor structure and function;
2. Protect hillslope processes;
3. Restore degraded hillslope processes on forest, agriculture, and developed lands;
4. Restore riparian conditions throughout the basin;
5. Restore access to habitat blocked by artificial barriers;
6. Restore floodplain function and channel migration processes in the mainstem and major tributaries;
7. Restore channel structure and stability;
8. Provide for adequate instream flows during critical periods;
9. Restore degraded water quality; and
10. Create/restore off-channel and side-channel habitat.

Habitat actions are also considered essential to salmonid recovery however they take into account existing conservation and recovery programs and not just biophysical parameters. The habitat actions are derived from the prioritized measures and provide still greater specificity. Sixteen habitat actions are included in the Recovery Plan which identify the prioritized measure addressed, the responsible party, spatial extent of the target area, the expected biophysical response, and the certainty of the outcome.

3.1.4 LCFRB Watershed Assessment Project, Phase 2

Phase 2 of the LCFRB Watershed Assessment Project was conducted by R2 and S.P. Cramer and Associates and was aimed at collecting field data on stream habitat conditions, riparian conditions, sediment sources, and hydromodifications within priority reaches of the Lower Columbia Subbasin (R2 2004). This information was intended to aid in identification and prioritization of recovery projects and to verify EDT and IWA model results.

R2 and MBI (2004, p. 2-41) identified the following habitat limitations over the entire subbasin:

- "*The area where natural geomorphic processes can occur has been reduced by approximately 84 percent in the lower 10 miles of the Kalama River.*
- *Forest cover represented only 10 percent of the current generalized floodplain area, and forests consisted of sparse to medium stocked stands of mixed forest.*
- *Within the lower 10 miles of river, the current length of channel margins was estimated to be reduced by 5 percent from pre-settlement conditions, due to the loss of two major side channels.*
- *Sixty-six percent of the total bank length in the lowermost 10 miles has been armored or bordered by levees.*
- *The Kalama River has been fixed in place by levees and armored banks. As a result depositional sediments formerly distributed across a wide area north and south of the river have been concentrated at the mouth of the river.*

- *The overall LW recruitment potential of riparian stands in the Kalama basin is relatively poor due to small size of riparian trees and human encroachment in the riparian zone.*
- *Riparian disturbance ranged from 36 to 60 percent of the habitats surveyed. The greatest frequency of disturbance types included urbanization and roads.*
- *Substrates required for salmonid spawning and incubation appears to be limited in the Kalama Basin. Embeddedness ratings were high in the lower river and several mainstem tributaries.*
- *The culvert at Kalama River Road in Summers Creek appears to be a fish passage barrier."*

Phase 2 of the Watershed Assessment also presented a prioritized list of protection/restoration opportunities across the subbasin, some of which were also identified in the current assessment of the lower 2.5 miles of the river.

3.2 Current Assessment

Fine-scale knowledge is necessary to identify specific restoration opportunities on the ground, assess feasibility, prioritize potential projects and develop engineering designs. To that end, field studies were undertaken in the lower 2.5 miles of the mainstem Kalama River and associated tributaries. In order to prioritize and select the best projects for implementation, the work group was involved and the project scoring methodology developed by the LCFRB was followed. The most promising projects were identified for groundwater and surface water monitoring and analysis. Projects were reevaluated after monitoring data were obtained, and the top scoring projects were selected for development of conceptual engineering designs.

Fine-scale data collection associated with this project included topographical, surface and groundwater water flow, and channel geomorphology data. Fish use observed during data collection efforts was also documented. Prioritization of projects followed the scoring approach developed by the LCFRB Technical Advisory Committee (TAC). Conceptual designs developed for top ranking projects followed accepted practices promoted by WDFW and drew upon consultant experience from 48 similar projects within Washington State.

This project follows basic principles of ecosystem restoration put forth by NRC (1992) and Roni et al. (2002) and summarized in the HWS (LCFRB 2008):

1. Protect existing functional habitats and the processes that sustain them;
2. Allow no further degradation of habitat or supporting processes;
3. Reconnect isolated habitat;
4. Restore watershed processes and ecosystem function;
5. Restore habitat structure; and Create new habitat where it is not recoverable.

Given that the objectives and funds of this project are not aimed at land purchase for preservation, this project emphasizes restoration of degraded habitats and processes and creation of new habitat, specifically off-channel habitat. In seeking to identify suitable sites for restoration activities, potential projects were sought that will work with natural processes and be self-sustaining and or restore a lost habitat floodplain function. Targeted sites should be maintained by natural processes, or are remediating natural processes that were curtailed by human development and modification. For example, the presence of groundwater is critical for the success of off-channel habitat creation projects. In addition to the physical parameters necessary to evaluate project feasibility, the project site must also meet logistical viability, such as landowner willingness and project expense.

3.2.1 Field Reconnaissance

Prior to actual fieldwork, initial assessment involved examination of aerial photographs and USGS quadrangle maps, looking for geologic conditions that would lend themselves to hyporheic upwelling, multiple river channels, oxbows, wall-base channels, abandoned gravel pits, and areas of shallow groundwater. Field surveys sought to identify groundwater sources, gravel river banks (which suggest porous floodplains), flood swales, elevation changes that could provide head for flow, levees and roads that disconnect the floodplain, and existing side channels.

Initial reconnaissance of potential restoration sites was conducted by a river float in August 2007 followed by an October 2007 walking field visit to areas identified as having potential on the float or from aerial photos. Reconnaissance efforts were aimed at identifying restoration opportunities and constraints. The area floated stretched from RM 2.8, just below the fish trap and extended down to the shallow delta at the mouth of the Kalama River. Work group members participated in the reconnaissance, including biologists, engineers, and geomorphologists from the LCFEG, Waterfall Engineering, LCFRB, WDFW, and private landowners. The reach descriptions provided in Section 2.2 are based on this reconnaissance effort and subsequent surveying on the ground. A memo to the work group summarizing the October field visit is included in Appendix C.

3.2.2 Potential Project List

Based on review of the Recovery Plan (LCFRB 2004), field reconnaissance described in section 3.2.1, and aerial photos, an initial project list was developed. The list was modified to incorporate comments from work group members and monitoring data, resulting in the Potential Project List (Table 5). Project vicinity maps and locations on aerial photos are shown in Appendix A. Restoration type refers to the multi-species project benefits categories identified in the LCFRB's HWS (2008) and used in the LCFRB project scoring methodology.

Projects were not selected based solely on their rank order, but on a combination of factors. The two projects with the highest rank score were included. However two of the projects, KRR 0.7 and SC 0.5, were not among the top four projects. A large reason for the inclusion of both of these projects was strong landowner support. In the case of SC 0.5, the project is in close proximity to the top-ranked project being developed at the 30% level, and the land is owned by the same individual. In the case of KRR 0.7, Phase 1 has already been funded and is slated for implementation in 2009. Finally, greater uncertainty is associated with some of the other, higher ranking projects which may be due to uncertain landowner support, or a lack of field data to assess project viability.

Table 5. Potential Project List.

Project RM[4]	Restoration Type	Description and Notes
KRL 0.0	Access to blocked habitat	Address low water fish passage concerns at the river mouth's tidal flat.
KRL 0.1	Off-channel/side-channel habitat	Extend and enhance tidal and backwater channels on Port of Kalama property. The Port has documented juvenile salmonid usage in these channels. Four years of quarterly monitoring data are available, including water levels, vegetation, salmonid usage, and presence of freshwater clams. Amphibian usage has also been observed.
KRR 0.7	Off-channel/side-channel habitat	Enhance and Create off-channel habitat on WDFW land upstream of the boat ramp. Water source will be tidal and groundwater. There is a potential for Chum spawning in the upper portions of this channel.
KRL 1.4	Off-channel/side-channel habitat	Excavate groundwater fed channel along base of bluff. Elevation change present here, providing head for groundwater flow. Possibly suitable for chum salmon spawning.
KRR1.8	Off-channel/side-channel habitat	An active side channel was observed during field reconnaissance, but additional data collection would be necessary to evaluate potential for off-channel habitat enhancement.
SC 0.5	Riparian restoration	Restore riparian conditions along Spencer Creek, at the base of steep slope with seeps. Remove noxious weeds, plant native species with good shade potential, and add LWD. This area currently serves as juvenile salmonid refuge, but lacks wood.
SC 1.8	Access to blocked habitat	Replace culvert at county road.
KRR 2.1	Off-channel/side-channel habitat.	Excavate off-channel habitat on Port of Kalama and private property. Water source would be groundwater. Landowner willingness is unknown.
KRR 2.2	Off-channel/side-channel habitat	Excavate off-channel habitat on Port of Kalama property. Water source would be groundwater and surface water from tributary in the winter months.

[4] KR refers to Kalama River (an additional L or R denotes the left or right bank); SC refers to Spencer Creek. Enumeration of RM traditionally begins from the river's mouth and increases as one goes upstream. However, notation of right and left bank refers to the bank one would see it as looking or floating downstream.

KRL 2.2	Stream channel habitat structure and bank stability.	Remove unused Olympic Gas Pipeline and add LWD on Port of Kalama property. LWD would include 3-4 small engineered logjams. Pipeline is visible at low flows and affects channel morphology
KRR 2.4	Stream channel habitat structure and bank stability.	Remove riprap and excavate to reconnect active side channel. Removing riprap could require mitigation with existing homes and properties downstream. The riprap was placed in the 1970s as an agricultural initiative.
KRL 2.5	Off-channel/side-channel habitat	Excavate off-channel habitat on private property. Water source would be groundwater. Landowner Julius Ledgett is willing and participating in work group. Old city pump house in vicinity was built 30 years ago and could possibly supplement GW channel, however could also contribute to sedimentation. Pump tests were completed on this site and confirmed presence of groundwater (see Appendix D). The city has done some prior studies on GW response to river levels for the Ranney well system.

3.2.3 Monitoring Surface and Groundwater at Potential Project Sites

Understanding the interaction between groundwater and surface water is important to the assessment and development of off-channel habitat. This section summarizes the results of the groundwater, surface water and water temperature data which were collected from October 10, 2007 to November 11, 2008. A total of 17 different monitoring sites were established along the lower 2.8 miles of the Kalama River to track surface water elevations, groundwater elevations and water temperature. The water elevation and temperature data are presented in Appendix B; groundwater pump tests results are in Appendix D.

The Stream Habitat Restoration Guidelines (Saldi-Caromile 2004) identify data collection needs for various types of off-channel habitat, from wall-based rearing areas for juvenile Coho to percolation-fed channels for adult chum salmon spawning. Groundwater and surface water were monitored in the vicinity of the most promising restoration opportunities. The type of data collected can be grouped into the following categories:

- Water flow (Kalama River, Spencer Creek, other surface runoff channels)
- Water elevation (River, Creek, Pond, Groundwater)
- Water temperature (Surface and groundwater)
- Groundwater flow potential (as measured from pump tests)
- Local rainfall amounts

Data were collected over a range of hydrologic conditions to understand the interaction and potential benefit to different life stages of salmonids. For each location a bench mark was established and related to the overall survey based on NGVD datum supplied by the Port of Kalama. Water levels were measured to the nearest tenths of a foot. Because the data were collected over a short period of time (less than two years), local weather conditions were also monitored to provide for some comparison to a normal condition (rainfall).

3.2.3.1 Monitoring Results: Water Elevation Data

The monitoring data (Appendix B) provide important information for developing concepts for off-channel design and can be used for the development of any future off channel projects in the Lower Kalama River. Once a site survey has been completed, the elevations can be compared to the river, pond, and groundwater elevations to determine a specific design elevation for that site.

The water elevations of the Kalama River relative to the flow in the river, is one useful component of this monitoring; six monitoring stations were established along the banks of the river. Some of the monitoring stations placed along the river reveal little influence of tidal fluctuations, whereas other stations have significant tidal influences at certain times of the year. In areas perennially outside of tidal influence, the water surface elevation shows a tight correlation with river flow. Areas within the tidal influence show much greater variation in water surface elevation relative to flow. In these areas, the fluctuation in water surface elevation is apparent twice daily when the Columbia River is low, but fluctuation is greatly reduced in the late spring and early summer when the Columbia River is high. In the tidal areas, the backwater provides good opportunities for fish to access off-channel habitat. When the Columbia River is high there is good access and when the river is low the tidal action provides access. The tidal action also provides groundwater recharge which could provide good spawning habitat for chum salmon if low swales were excavated and gravel added. For projects within RM 2.0 to RM 2.5, the Kalama River water surface varies from elevation 12 to 16 feet, at the recommended project design flows of 250 and 4000 cfs.

Groundwater elevations are also important in evaluating potential project viability and in developing concepts for off-channel habitat projects. Groundwater elevations were collected at two existing wells and at four excavated test pits (Appendix D). Groundwater pump tests conducted in isolated test pits revealed that groundwater elevations in the study area vary 2.5 to 3 feet between winter and summer. An exception is the tidally-influenced area near the mouth of the Kalama River (RM 0.7). In this area, groundwater elevation may vary as much as 6 feet due to backwater from the Columbia River and tidal fluctuations. Outside of the area if tidal influence, groundwater elevations are at the highest in January and at the lowest in August and September. In tidal areas (RM 0.0 to RM 1.6), groundwater elevations are highest in late May and early June. Development of off-channel projects should be excavated to a level which corresponds to the late spring or low summer flow levels to ensure year round flow (unless juvenile overwintering is a specific project goal). Collected data suggest that the high groundwater elevations found in the vicinity of Project KRR 2.5 provide a good opportunity for creating off-channel habitat.

Six monitoring stations were established to evaluate the water surface elevation of ponds. This information was then compared to groundwater elevations to identify the degree to which the ponds are recharged by groundwater or surface water. Most of the ponds have a surface water connection which gives them a higher water elevation in winter relative to groundwater. The pond located near the Bonneville Power Administration (BPA) transfer station had a water elevation that varied by seven feet over the 1-year monitoring period. There doesn't appear to be any surface connection to this pond, so it is likely that the local groundwater charges the system. Kress Lake levels are similar to this pond, but it is fed by a surface water stream in the winter months. In contrast to the BPA pond, a pond on the Ledgett property only varied 3 feet over the monitoring period.

3.2.3.2 Monitoring Results: Water Temperature Data

Water temperatures are critical to the growth and survival of juvenile salmon. Ideal rearing temperatures for juvenile coho range from 54 to 57° F. Growth often stops at 68° F and temperatures in excess of 77° F are lethal.

A common trend in low lying western Washington rivers is cool water temperatures in the winter, a gradual warming in the spring and warming water temperatures in the summer. This is true for the Kalama River. Data collected at Lower Kalama monitoring stations shows water temperature in the winter is all within the 40° to 45° F range for most of the monitoring sites. The Kalama River and groundwater sources remain low, between 45 to 50° F in May, while the Columbia River and large open ponds warm to 70 to 75°F. In spring, groundwater sources tend to be 3 to 5° warmer than the Kalama River. Towards the end of the summer this trend reverses and the Kalama River is 3 to 4° warmer than the groundwater. Water temperatures in the Kalama River for the monitoring period never got over 58°F, which is ideal for juvenile coho growth and rearing.

In the open ponds, the temperatures ranged from 40 to 45° in the winter to over 70° in the summer, with one exception: one pond on the Ledgett property remained cooler in May and June. The intent of collecting these data was to explore the options of connecting existing open ponds to the Kalama River so fish have access. For a successful project, the connection needs to intercept groundwater and be constructed in a manner such that riparian vegetation can shade the open water. The project objective would be to lower the pond level, initiate groundwater flow and therefore reduce the water temperatures.

3.2.3.3 Monitoring Results: Groundwater Pump Tests

Groundwater pump tests were completed at two of the monitoring sites over a two day period from April 3rd to 4th, 2008, to assess groundwater elevation, flow potential, substrate and water quality (Appendix D). The Kalama River flow was 1100 cfs. Water quality samples for dissolved oxygen and dissolved iron, were collected at three sites.

The drawdown index is one parameter measured in a pump test that is useful for evaluating project viability and design options. The drawdown index is a measure of the rate of drawdown compared to the recharge rate. In general a drawdown index of 1.0 or higher is very good, 1.0 to 0.5 is good and below 0.5 typically means there is a lack of groundwater flow potential to create a high quality spawning habitat. Sites where the drawdown index is less than 0.5 are typically developed as off-channel rearing habitats, due to the lack of flow which is often needed to attract adult fish for spawning.

A test pit was conducted at the location for the critical water supply to the proposed Ledgett Groundwater Channel. The pump test results are marginal in terms of creating a formal groundwater-fed spawning channel. It is recommended this site be developed mainly as a groundwater-fed, off-channel rearing area with the potential for adult spawning. Adult spawning would require an expensive import of spawning gravel. Detailed results for both pump tests are included in Appendix D.

3.2.4 Prioritizing Potential Restoration Projects

A scoring spreadsheet was developed to aid in evaluating projects' benefits to fish, certainty of success and ultimately to prioritize the project list. The scoring spreadsheet provides structure to the ranking process, minimizes personal bias of individuals scoring the projects, and documents the process. The LCFRB TAC scoring spreadsheet was used as a starting point, as adapted by Tetra Tech for a habitat restoration siting and design assessment project in the Lower Cowlitz River (Tetra Tech 2007). The scoring spreadsheet draws heavily on the data within the Subbasin Reach Priorities and Potential Restoration Activities Table within the HWS (LCFRB 2008). This table integrates information from EDT and IWA analyses and identifies the greatest restoration priorities across multiple species within each reach. One modification was made to the TAC/Tetra Tech scoring spreadsheet, per guidance from LCFRB: the Reach/Population Rating was elevated for reaches providing estuary rearing and migration benefits to stocks spawning in other subbasins. For example a Tier 4 reach with estuary benefits would be elevated from a Low to a Moderate Reach/Population Rating. All tidally influenced reaches were considered to offer estuary benefits. The estuary management action addressed by the project is noted in the Comments column of the spreadsheet. Management actions and threats are identified within the *Columbia River Estuary Recovery Plan Module* (LCREP 2007).

The scoring approach used by the LCFRB TAC equally weights the benefits to fish and the certainty of success. While many information gaps do exist relative to the recovery needs for these species, the benefits to fish score is more objective, incorporating physical data collected in the field from spawner surveys, smolt traps, habitat surveys, catch counts, as well as modeled data and predicted future population conditions. These parameters and their significance are described in great detail in the HWS and the Recovery Plan and include:

- Stream reach (and tier ranking);
- Importance of the reach to the population;
- Importance of the population to overall recovery of the species in the ESU;
- Number of listed salmonid species present,
- Restoration activity type (e.g. recovery measure) which determines the value of that activity in contributing to multi-species benefits in that reach;
- Area of habitat a restored by the project; and
- Anticipated effectiveness of the project in achieving restoration goals.

Per LCFRB Evaluation Criteria, the Lower Kalama Subbasin projects were initially grouped by their Benefit to Fish Rating (largely driven by the reach's tier rating) and then ranked within these groups by their Benefit to Fish score (Table 6). The complete scoring spreadsheet and ranked list are included in Appendix E.

Table 6. Ranked project list based on benefits to fish.

Project		Overall Benefit to Fish		Certainty	RANK
ID	**Description**	**Rating**	**Score**	**Rating**	
KRL 2.5	Ledgett Groundwater Channel	H	47.00	H	**1**
KRR 2.2	Port of Kalama Groundwater Channel	H	43.40	H	**2**
KRR 2.1	GW Channel System (private)	H	42.80	M	**3**
KRR 2.4	Riprap Removal/Floodplain Reconnection	H	29.00	H	**4**
KRL 2.2	Pipeline Removal and LWD	H	29.00	M	**5**
KRR 0.7	WDFW Tidal and Groundwater Channels	M	33.40	H	**6**
KRL 0.0	Low Water Fish Passage	M	32.00	L	**7**
KRL 1.4	Groundwater Channel	M	29.80	M	**8**
KRR 1.8	Active Side Channel	M	23.96	L	**9**
KRL 0.1	Port Tidal and Backwater Channels	M	23.95	M	**10**
SC 0.5	Spencer Creek Riparian and LWD	M	17.44	M	**11**
SC 1.8	Fish Passage Culvert	L	7.90	H	**12**

The certainty rating aims to ascertain the degree to which a project will achieve stated goals and incorporates more subjective factors, such as "reasonable" cost, degree of community support, qualifications of sponsor, etc. Certainty factors are extremely important in weighing alternative projects, however it is difficult to develop a meaningful assessment of certainty before projects are more thoroughly scoped. Within this assessment, certainty scores are therefore qualitative (high, medium, low) and primarily address the project's ability to meet the stated goal based on technical considerations and landowner support where known; additional information on the factors affecting the certainty score are included within the scoring spreadsheet. It is important to note that the certainty rating may be low simply because information is lacking. This relative ranking should only be considered within the context of other projects in the Lower Kalama assessment. Other certainty parameters considered by the TAC include:

- Appropriateness of technical approach;
  - Project addresses causes of degraded habitat, not symptoms;
  - Approach is tried and proven;
  - Qualifications and experience of sponsor;
  - Monitoring and maintenance is included;
- Landowner willingness and community support;
- Coordination with other habitat restoration projects within the watershed;
  - Addresses priority processes and limiting factors identified in the LCFRB;
  - Project is logically sequenced with existing and planned efforts;
- Degree of uncertainty and constraints;
  - Including technical, legal, policy, funding, and permitting considerations;
- Estimated preliminary costs.

The initial scores for benefits to fish and certainty were developed by representatives from Waterfall Engineering, Ecolution, and LCFEG, with input on use of the scoring spreadsheet from LCFRB. These preliminary scores were presented to the work group with an explanation of the assumptions made about each project when scoring. The work group provided additional feedback on the scoring process. Assumptions and considerations affecting scoring for each project are included in the scoring spreadsheet (Appendix E).

4. CONCEPTUAL DESIGNS AND PRELIMINARY COST ESTIMATES

One project was selected for development of engineering designs to a 30%-completion level:

- KRL 2.5, Ledgett Groundwater Channel.

Three projects were selected for a more simplified “conceptual design”:

- KRR 2.2, Port of Kalama Groundwater Channel;
- KRR 0.7, WDFW Tidal and Groundwater Channel; and
- SC 0.5, Spencer Creek Riparian Restoration and Large Woody Debris.

Designs and costs for these projects are included in Appendix G. Engineering designs followed accepted practices for the development of off channel habitat. From 1991 to 1999 WDFW designed and constructed over 70 off channel restoration projects in the Skagit, Stillaguamish, Hoh, Clearwater and Bogachiel River Basins. Some of this work and other design guidance can be found in Saldi-Caromile (2004), Slaney and Zaldokas (1997) and Powers (1993).

Conceptual level costs were developed for each of the four projects. Costs were developed from two sources: RSMeans (2006) and experience by the designer. RSMeans is a common manual used for estimating heavy construction, but many of the items, such as cubic yards of material excavated to create a groundwater channel or construction of large woody debris, are not covered in the manual. Total project costs were developed assuming a typical public works construction project. Obviously, with many stream restoration projects cost efficiencies can be found by using volunteer works groups, donated materials, etc. Specific assumptions underlying the cost estimates are noted within the estimates. Quantities were estimated from site surveys, measurements from CAD drawings and scaling from 2006 aerial photography and LiDAR files. These costs should be used for planning and budgeting purposes only, and should be revised as the designs become more complete, prior to construction contracting.

4.1 30% Design

4.1.1 Ledgett Groundwater Channel, KRL2.5

This project utilizes existing ponds and swales within the project site in combination with groundwater sources to create 10,400 square meters of year round rearing habitat with a potential for some spawning habitat. The channel length would be 2500 feet, with Pond 1 expanded to create an additional 2 acres of off channel rearing habitat (Appendix G, Section 1.0). In addition, the project will supply groundwater to existing downstream rearing habitats at the mouth of Spencer Creek. The project excavation amounts and depth were determined from the extensive groundwater monitoring (see Appendix B).

The key to this project is a connection to the groundwater sources identified from the monitoring near the upper end of the project (Test Pit 1 and Well Monitoring Station 2). Two layouts are presented to achieve this. The final layout needs to be decided with the landowner. Layout 2 creates more pond habitat and would be isolated more from overbank flooding. Layout 2 requires more excavation and some spoils will likely need to be removed from the site.

The project construction cost is estimated at $528,000. The project could be broken down in phases to reduce the overall cost. The first phase should include a connection to the groundwater sources. A constant groundwater source (that increases as the river stage increases) will create a sediment wedge near the channel outlet and keep fine sediment from moving upstream into the project area.

4.2 Conceptual Designs

4.2.1 KRR 2.2, Port of Kalama Groundwater Channel

This project (Appendix G, Section 2.0) is broken down into three phases because of the cost and floodplain issues to be resolved.

Phase 1 is fairly straight forward and would extend and deepen an existing swale along the right bank floodplain. The length would be 500 ft with an estimated construction cost of $104,000 and would create 650 square meters of off channel rearing habitat. It would also provide flow through the summer into an existing active side channel which goes dry. Test Pit 3 is located within this swale.

Phase 2 would extend the channel across the open field owned by the Port of Kalama to a location up to the Kalama River Road. Phase 2 would create an additional 1100 square meters of off channel habitat. The estimated construction cost is $364,000. Long-term channel viability and flooding need to be resolved at this location. Currently flood waters from upstream overtop the right bank and flow overland crossing into the proposed channel area. It is recommended that a floodway remain open for this water and that the alignment be revised based on a floodway analysis and project future use of the Port of Kalama field area. This overland flow impacts landowners upstream.

Phase 3 will add an additional 1400 square meters of habitat with a construction cost of $530,000 (the higher cost is due to the culvert installation under the Kalama River Road).

This project is located in the right bank floodplain of the Kalama River. Only the lower portion is within the 100 year floodplain (see Appendix G, Section 2.0, Sheet 2 of 3-Site Plan). The design proposes to excavate (in three phases) a 3700 foot long groundwater fed channel. The first Phase would be 500 feet long. The channel would outlet into an existing active side channel of the Kalama River on the right bank at RM 2.2. The upper end would be the end of an existing swale. Phase 2 would extend from Phase 1, to just downstream of the Kalama River Road (Test Pit 2 location). Phase 3 would be implemented after one season of flow and temperature monitoring of Phase 1 and 2, and would require excavation or boring of a culvert under the Kalama River Road. The channel would then extend to connect with the pond near the BPA substation and extend further upstream to connect a portion of the surface fed stream. A flow splitter would be required to maintain a portion of the flow to Kress Lake. The stream only flows in the winter and would provide pulses of clean water to the entire channel for fish attraction. The channel width would vary from 8 to 10 feet. Excavation depth varies from 7 to 11 feet. The excavation depth was determined based on groundwater monitoring. The channel slope is 0.13%, and the depth will be controlled by installing a series of plank weirs. Spawning gravel may be added in some sections. Phase 1 excavation is 4000 cubic yards, Phase 2 is 18,000 cubic yards and Phase 3 is 14,000 cubic yards. Material from the excavation will either be spoiled on site or hauled to an appropriate spoil location. Spoiling material on site in strategic locations may provide some additional flood protection. Once excavated the channel cross section will consist of a 1:1 slope rock toe 3 feet high (to protect groundwater source), and slopes cut back 2:1 and revegetated with a mixture of riparian plants and trees.

4.2.2 KRR 0.7, WDFW Tidal and Groundwater Channel

The project will create 2400 square meters of off channel habitat and the estimated construction cost is $350,000 (Appendix G, Section 3.0).

Located at RM 0.7, this project will create off channel habitat by excavating within the existing right bank floodplain existing low points and swales (see attached drawings). Two phases are proposed. Phase 1 is an extension of an existing side channel which has documented fish use and groundwater flow, and Phase 2 would allow fish to access a larger portion of the floodplain by cutting a channel through the WDFW access road (either open cut or culvert). Groundwater, substrate and water quality tests were done in support on this project (Appendix D). The Phase 1 project length is 800 feet with a cut depth of 2 to 4 feet. Pools will be excavated within the channel and LWD placed for habitat structure. There will be some rock lining of the channel and some spawning gravel placement. The channel width will vary from 6 to 10 feet. Total excavation for Phase 1 is 3500 cubic yards. Phase 1 has already been funded by the SRFB and is slated for implementation. Phase 2 is 2300 feet long and has a potential to provide spawning for chum salmon. The upper ends of this phase (where groundwater has been documented) will be over excavated and backfilled with spawning gravel. Phase 2 excavation is 9000 cubic yards. The water level in both channels will be controlled by tidal changes from the Columbia River, and by high Columbia River water levels in the late spring and early summer months.

4.2.3 SC 0.5, Spencer Creek Riparian Restoration and Large Woody Debris

The project will restore 4.6 acres of riparian habitat and 800 square meters of spawning and rearing habitat for an estimated construction cost of $78,000 (Appendix G, Section 4.0).

Spencer Creek enters the Kalama River at RM 1.8 on the left bank. Upstream 0.5 miles Spencer Creek flows through an open field. The channel is void of any habitat features, LWD and is dominated by reed canary grass. This area has been identified by water level and temperature monitoring as a viable location for rearing and potential spawning. This project proposes to restore 4.3 acres of pasture land to a forest canopy dominated by firs and cedars. In combination with the riparian planting, five rearing pools will be excavated and LWD installed for habitat. Immediately upstream of each pool, large wood will be installed to prevent channel incision.

4.3 Summary of Preliminary Cost Estimates

Table 7 summarizes the preliminary cost estimates across all four projects for which conceptual designs were generated. Most of the projects have phased approaches; costs are detailed in Appendix G.

Table 7. Summary of Preliminary Costs for Selected Projects

Project ID	*Description*	*Preliminary Construction Cost Estimate*
KRL 2.5	Ledgett GW Channel	$634,000 to $777,000
KRR 2.2	Port of Kalama GW Channel System (3 Phases)	$1,200,000
KRR 0.7	WDFW Tidal and Groundwater Channel (2 Phases)	$350,000
SC 0.5	Spencer Creek Riparian and LWD	$78,000

5. CONCLUSIONS AND RECOMMENDATIONS

This assessment of potential restoration projects identified the majority of off-channel habitat restoration opportunities within the lower 2.5 miles of the Lower Kalama River and ranked these projects in order of priority. While off-channel habitat creation was the focus of this assessment, fish passage barriers, floodplain connectivity, and bank stability projects were also considered. Engineering conceptual designs and preliminary costs estimates were developed for top ranked projects. Because this assessment evaluated only a portion of the subbasin, additional high priority projects may also exist in higher reaches of the subbasin.

Currently, engineering designs have been developed at a 30% design level for one project (Groundwater Channel, KRL 2.5). This project is the best candidate for immediate implementation: field monitoring has verified sufficient groundwater for a successful project, and the project has some landowner support.

The remaining projects with engineering designs have only been developed conceptually, meaning that the designs are not as complete. Further consideration should be given to these projects to adequately assess implementation costs, certainty and relative priority once these projects have been scoped more thoroughly. Of these, the Tidal and Groundwater Channel project on WDFW ownership (KRR 0.7) is a strong candidate for implementation. Field monitoring has confirmed adequate groundwater for a successful project and strong owner and local support exist for the project to move forward. Project SC 0.5 (Spencer Creek Riparian Restoration and LWD) is in close proximity to the mainstem KRL 2.5 project referenced above. It lies on the same property as the KRL 2.5 project and also has the some landowner support, and it would be a good pair to the Project KRL 2.5. Phase 1 of Project KRR 2.2, Ground Water Channel on Port of Kalama property is also a strong candidate for implementation and could be pursued in partnership with the Port. Flooding from the Kalama River upstream has been identified as a critical issue which needs to be understood before Phase 2 of this project can be implemented.

Remaining projects on the list for which engineering concepts have not been designed may still be attractive projects, however they would require further investigation, which might include additional field reconnaissance, monitoring, landowner contact, and other measures to ascertain factors contributing to a high certainty of success and costs that are reasonable for the benefit.

Project KRR2.1 appears to have good opportunities, and should be further investigated. In some of these cases, the current certainty rating is low, simply because information is lacking to determine the likelihood of success, or degree of landowner interest.

These projects address habitat diversity, habitat connectivity, riparian function, and floodplain function, all of which have been identified as limiting factors in the subbasin. This will result in improved pre-spawning holding, spawning, fry colonization, 0-age summer rearing , and 0, 1-age winter rearing. Implementation of these projects will add critical salmon habitat vital for recovery of the local populations of winter and summer steelhead, spring and fall Chinook, coho and chum, and will also contribute to stocks from other subbasins that utilize the estuary habitat of the Kalama Subbasin for rearing and refuge.

6. REFERENCES

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APPENDIX A. PROJECT VICINITY MAP AND AERIAL LOCATIONS

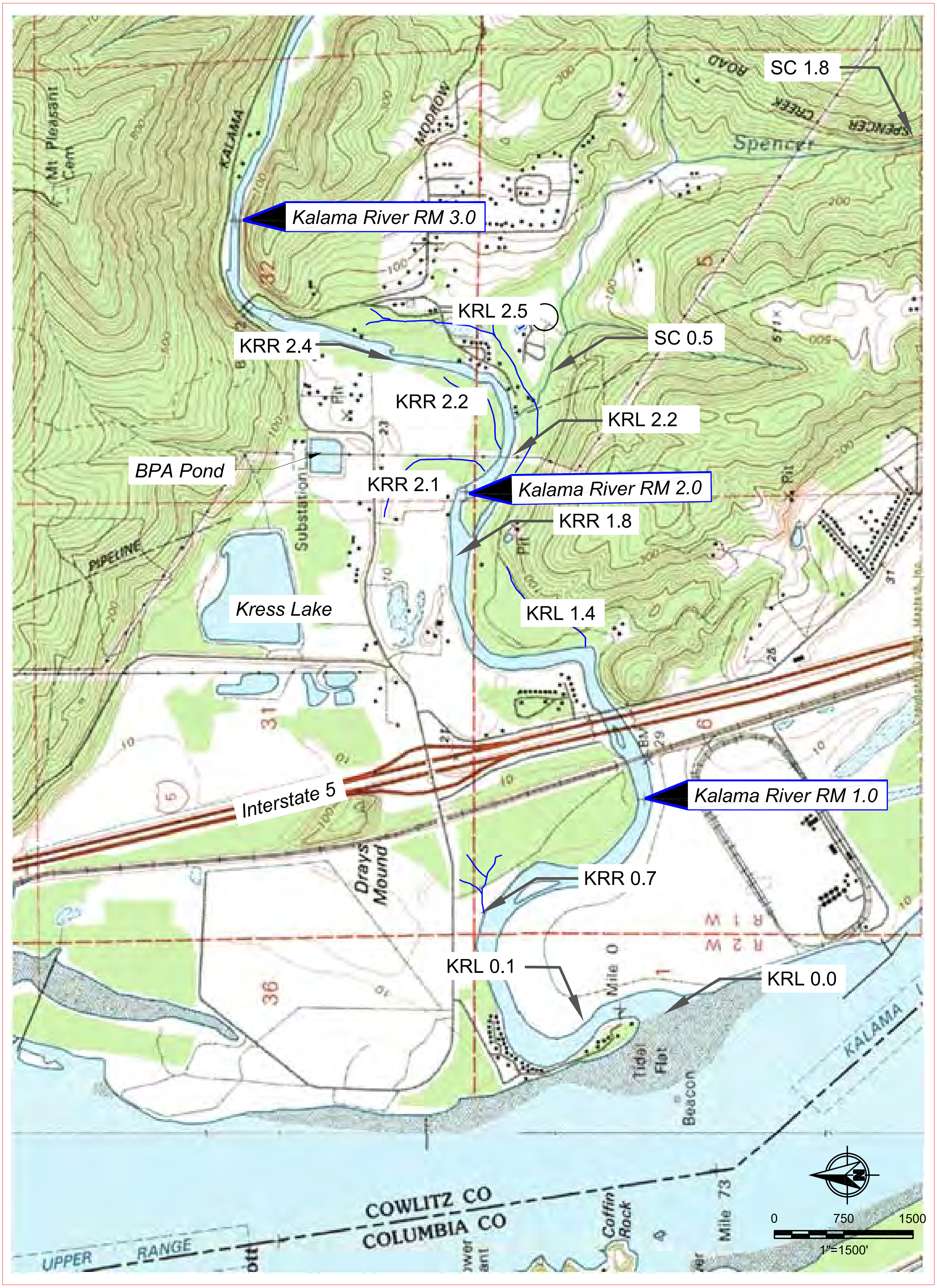


Figure A-1: Lower Kalama Off Channel Habitat Design - Project Map

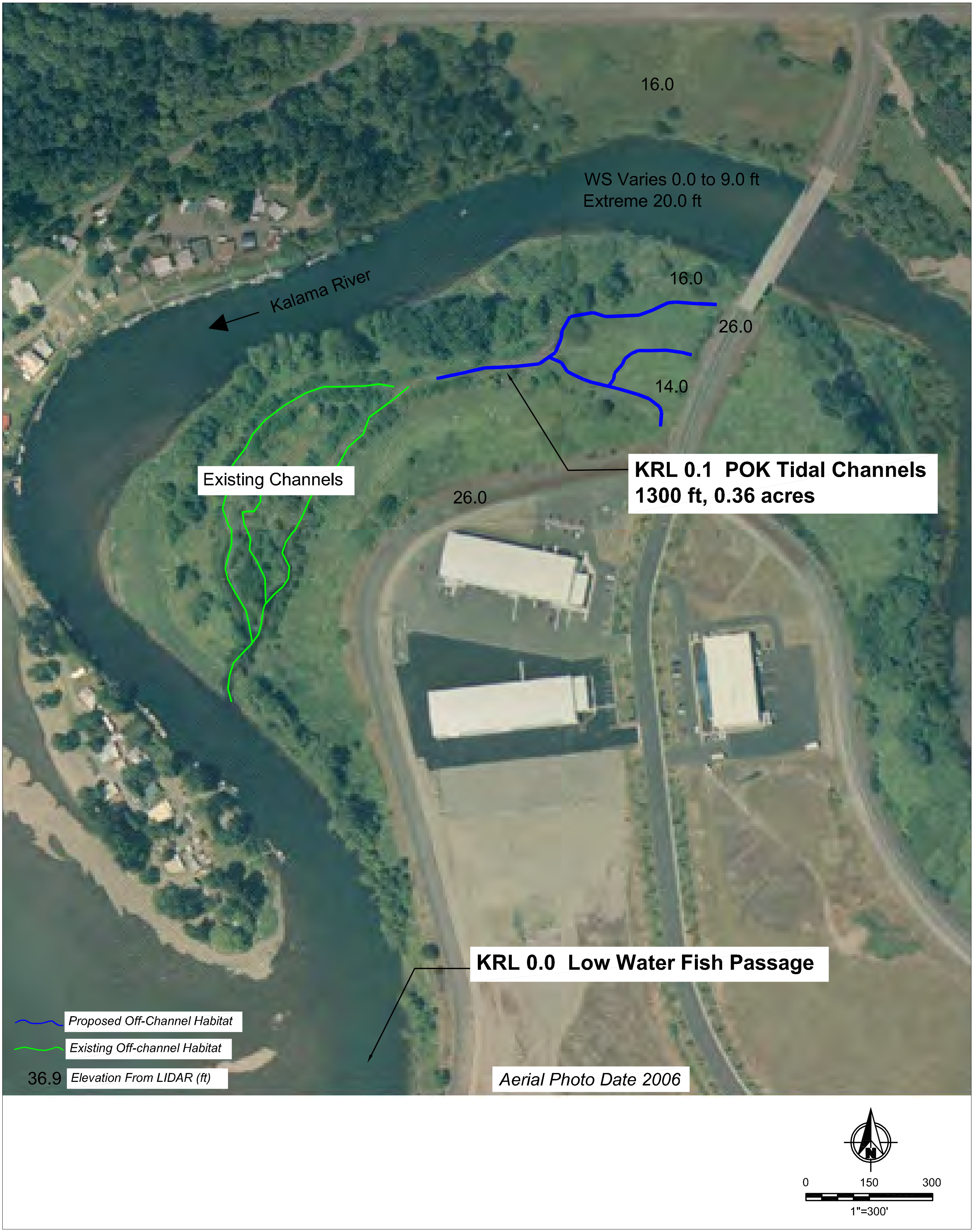


Figure A-2: KRL 0.0 and KRL 0.1

Figure A3 - KRR 0.7

Figure A4 - KRL1.4

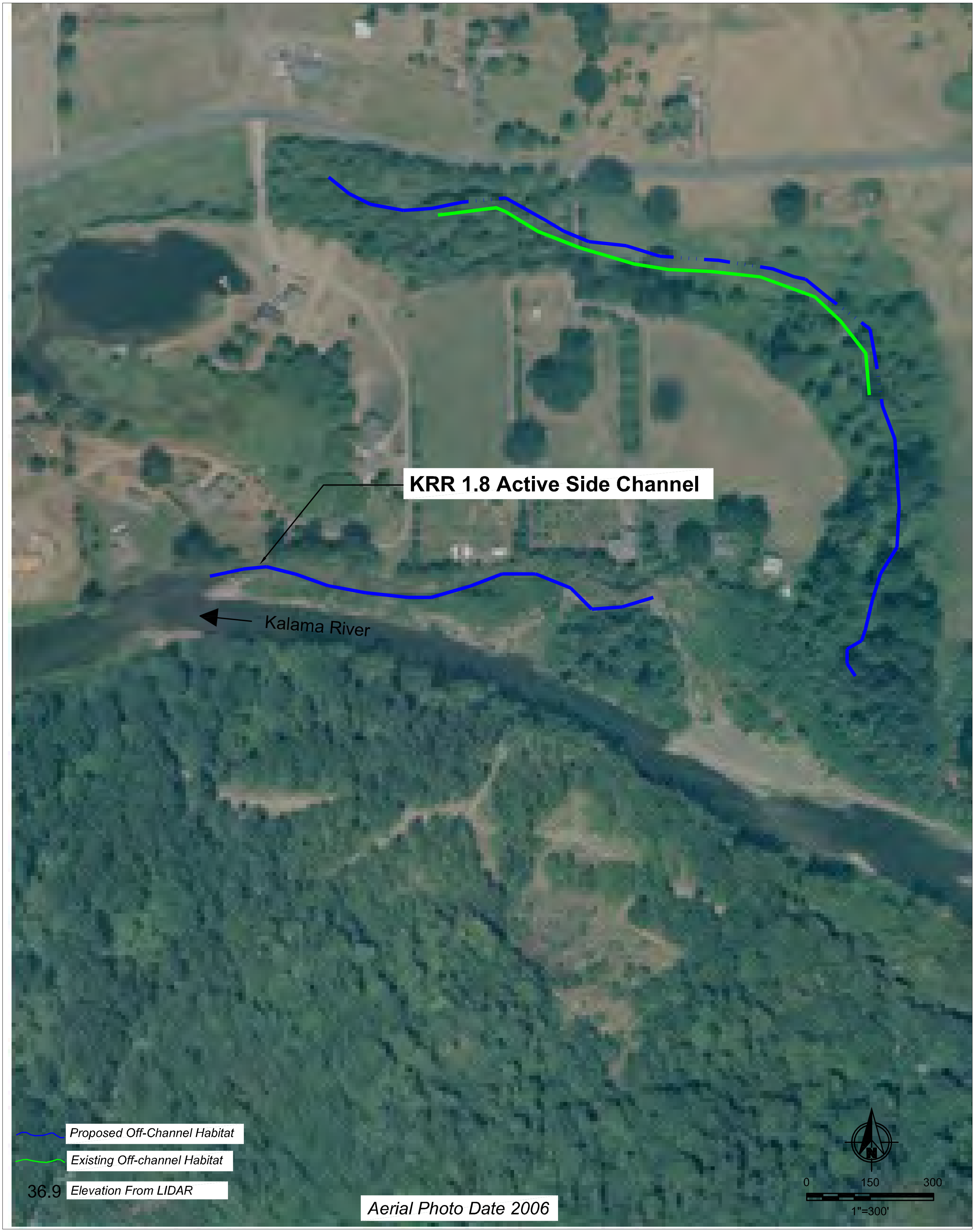


Figure A5 - KRR 1.8

Figure A6 - KRL 2.2

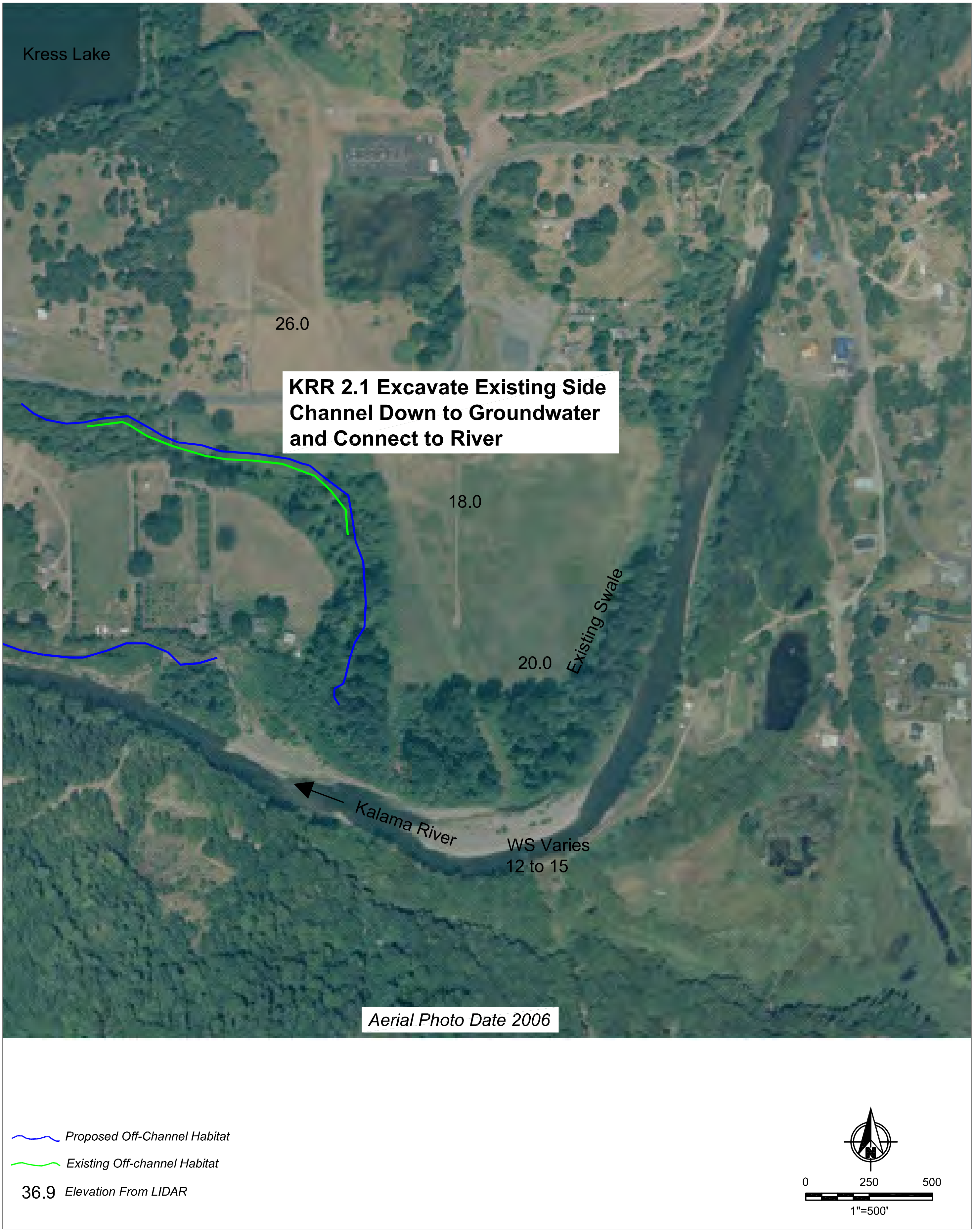


Figure A7 - KRR 2.1

Figure A8 - KRR 2.4

APPENDIX B. WATER LEVEL AND TEMPERATURE DATA

This appendix summarizes monitoring station locations, data collection and analyses for water elevations and temperature across the study area. Monitoring of all stations occurred for only twelve months, so a comparison to hydrologic factors controlling the data over a longer time period is needed. Tables B1 and B2 show a comparison of rainfall and stream flow data for the monitoring period (2007 to 2008) relative to historical data. The nearest rainfall gage was at the Kalama Falls Hatchery which is located 6 miles east of the project site. As discussed in Section 2.1.3, the USGS gage on the East Fork Lewis was used to correlate stream flows. The following observations can be made relative to the data collection period:

- The total precipitation for the monitoring period was 71.6 inches, or 86% of normal. Normal (100%) is the average precipitation for the same time period, based on 41 years of collected data at the station.
- December rainfall was 161% of normal values for that month.
- May, June, July and September precipitation was below normal, with the one exception of August being above normal.
- Stream flows overall for the monitoring period were normal. May and June 2008 flows were nearly 200% of normal. September and October flows were below normal.

These comparisons can be used when looking at the data to make adjustments in results. For example; the groundwater levels in Well Monitoring Station 2 (WMS2) and Test Pit 1 (TP1) remained very high in May and June and dropped rapidly by several feet in September and October. Water levels in WMS2 and TP1 are controlled by the Kalama River and the average monthly flows in the river was way above normal in May and June and below normal in September and October. One could extrapolate the data collected for this time period and conclude the sudden drop is not normal.

	Oct 2007	Nov	Dec	Jan 2008	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Totals
2007 - 2008	6.0	6.0	17.4	10.4	7.3	8.5	4.5	1.7	0.0	0.4	2.6	0.4	3.0	3.5	**71.6**
41-Yr Ave	5.4	9.9	10.8	9.6	7.6	7.3	5.5	3.8	2.6	1.0	1.6	2.9	5.4	9.9	**83.3**
% Normal	111%	60%	161%	108%	95%	116%	82%	44%	0%	40%	160%	13%	56%	35%	**86%**

Table B1. Monthly precipitation for the period of data collection compared to the 41-year average at Coop Station 454084, Kalama Falls Hatchery, Kalama, Washington. Percent normal row numbers indicate the monthly precipitation compared to normal. 100% = normal.

	Oct 2007	Nov	Dec	Jan 2008	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Totals
2007-2008	336	564	1590	1189	1077	1195	898	1029	712	159	93	59	131	**336**
79 Yr Ave	338	1080	1460	1400	1270	1110	909	584	344	143	83	111	338	**338**
% Normal	99%	52%	109%	85%	85%	108%	99%	176%	207%	111%	112%	53%	39%	**99%**

Table B2. Monthly flows for the East Fork Lewis River for the period of data collection compared to the 79 year average. Percent normal row numbers indicate the average monthly flows compared to normal. 100% = normal.

1.0 Monitoring Stations

The following are detailed descriptions of the monitoring stations. They are described in four categories (River, Creek, Pond and groundwater Well). In some instances the water level in ponds (if isolated from surface flow) will be similar to groundwater.

Monitoring stations were associated with a location and bench mark for elevation control. Water elevation was recorded by measuring the vertical distance from the bench mark to the water surface. River flows at monitoring stations were either measured with a flow meter (or correlated to another river with an active stream gage). The Kalama River flows were correlated to the East Fork Lewis River (http://waterdata.usgs.gov/nwis/uv?14222500) as is described in the Hydrology and Hydraulics Section (2.1.3). Flows for Spencer Creek were measured on site. Additional information on the data collection at each site can be found in subsequent sections of this appendix: Monitoring Site Locations Map (Section 2.0), Flow and Water Elevation Data (Section 3.0), and Temperature Data (Section 4.0).

1.1 Kalama River

Six River Monitoring Stations (RMS) were established:

- **RMS1.** Located on the right bank of the river (RM 1.4) near the edge of the WDFW parking area for the boat launch. A bench mark was established (elevation 14.5 feet) from a level loop survey from Point # 116 along the highway. This river water level is controlled by Columbia River and tidal elevations.

- **RMS2.** This site is on the left bank of the river just upstream of the Interstate 5 bridge and near the mouth of a potential side channel. A bench mark elevation has not been established.

- **RMS3.** Located on the left bank of the river (RM 1.8) and the mouth of Spencer Creek. A bench mark was never established at this location. This river water level is used as the far downstream control point. There are two or three beaver dams above this point on Spencer Creek so the low flow water control will likely vary over time.

- **RMS4.** Located on the left bank at RM 2.2 near the pipeline alignment. The bench mark is #113, a plastic cap on rebar. This river water level is used as a downstream control point for any projects developed along the left bank floodplain and Spencer Creek. A stage discharge rating curve is important at this location in order to assess the backwater effect on potential projects.

- **RSW5.** A random spot along the left bank, directly adjacent to pond monitoring station LP3 at RM 2.4. Only spot measurements were taken and were used to track river water surface.

- **RMS6.** Located just downstream of the City of Kalama Water Supply Plant on the left bank RM 2.5. The bench mark is a wood stake (elevation 24.3 feet). River water surface elevation and temperature were measured here. This is the furthest upstream monitoring station and is being used as the critical water level control feature for the development of off channel habitat within the left bank floodplain (Ledgett property).

1.2 Spencer Creek
Three Creek Monitoring Stations (CMS) were established:

- **CMS1.** Located adjacent to RMS4 and BM#113, this is the Spencer Creek water level within the reach with beaver dams. Water elevation and temperature were measured here. All the water from Spencer Creek has converged back together at this point before flowing back into the Kalama River.

- **CMS2.** Located adjacent to bench mark Steel Pin 4, this is the water level upstream of a small culvert which receives drainage from LP3 and LP2, which are fed by up-slope surface water connections in the winter. Water level and temperature were recorded.

- **CMS3.** This monitoring station is located along Spencer Creek where springs coming off the hillside have been observed. Water level and temperature were recorded.

1.3 Ponds
Two Pond Monitoring Stations (PMS) were established outside of the Ledgett property, and four were established on the Ledgett property:

- **PMS1 (Kress Lake).** Located near Kress Lake and Port BM # 106 (elevation 20.91 feet) in the parking lot for Kress Lake access. Water levels and temperatures for the lake were recorded. *Note: It is not anticipated that Kress Lake will be connected for habitat restoration, but the water levels will be assessed to determine floodplain response which will help in the development of the other sites.*

- **PMS2 (BPA Pond).** Located near the north shore of the BPA Pond. An orange stake (bench mark was established, elevation 17.6 feet). Water level and temperature for the pond were recorded. The intent with monitoring this location is to understand the hydraulic connection between the Kalama River, groundwater and surface water drainage, and possibly reconnect a large area for off-channel habitat on the right bank floodplain of the Kalama River.

- **LP1 – LP4 (Ledgett Ponds 1 through 4).** Located on the Ledgett Property, these ponds were excavated at one time for fish culture purposes. Water level and temperature were recorded. During the summer, the water level is controlled by groundwater (likely from the Kalama River), but during the winter the stage of the pond increases from upland surface water flow.

1.4 Wells and Test Pit Standpipes
There were two existing (informal) wells or standpipes on site which were surveyed and tied into the overall project datum as Well Monitoring Stations (WMS):

- **WMS1.** This well is located 75 feet from LP1. The well is a steel tube installed by the LCFEG during some pond excavation and groundwater monitoring in 2005. Water level and temperature were recorded.

- **WMS2.** This well is located 80 feet from the rivers water edge near RMS6. The well is a 6 foot diameter culvert on end. It was installed by the landowner, Mr. Ledgett. Water level and temperature were recorded.

In addition to the two existing wells, four test pits (TP) were excavated (see Appendix D). A plastic vertical standpipe with cap was installed before backfilling each excavated pit. The top of the standpipe was tied into the vertical survey datum. See Appendix D for detailed pump test results. Collected data across all monitoring stations are depicted in Figures B1-B8.

1.5 Interpretation of the Data
Figure B1 shows the data collected for the Kalama River water elevations relative to flow. A trend line is shown for RMS6 and RMS1. RMS6 is above the tidal influence and shows a very tight correlation. RMS1 is in the tidal area and the correlation fluctuates on a twice daily basis when the Columbia River is low, but in the late spring and early summer when the Columbia River is high the tidal fluctuations are greatly reduced. These data are useful in developing concepts for off-channel design. In the tidal areas, the backwater provides good opportunities for fish to access off channel habitat. When the Columbia River is high there is good access and when the river is low the tidal action provides access. The tidal action also provides groundwater recharge which could provide good spawning habitat for chum salmon if low swales were excavated and gravel added.

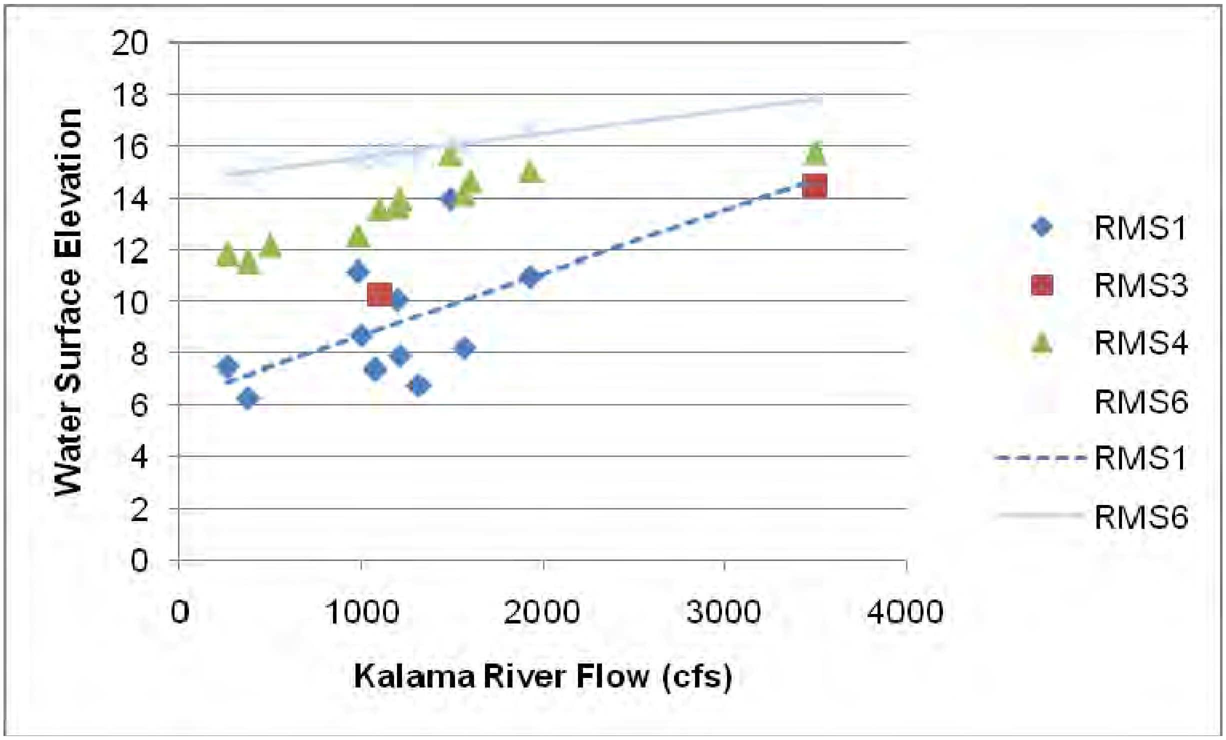


Figure B1. Kalama River water surface elevations versus flow at selected Monitoring Stations. Trendline shown fo the most upstream station (RMS6) and the furthest downstream station (RMS1).

Groundwater elevations (Figure B2) in isolated test pits vary 2.5 to 3 feet from the winter to summer. The exception is TP4 (RM 0.7), which varies as much as 6 feet due to backwater from the Columbia River and tidal fluctuations. Groundwater elevations are at the highest in January and at the lowest in August and September. In tidal areas (RM 1.6 to RM 0.0), groundwater elevations are highest in late May and early June. Development of off channel projects should be excavated to a level which corresponds to the late spring or low summer flow levels to ensure year round flow (unless juvenile overwintering is a specific project goal).

The groundwater elevations in WMS1 (left side of the Kalama Floodplain) are 3 to 3.5 feet higher than groundwater elevations from TP3 (right side of the Kalama River floodplain). These two monitoring stations are adjacent to each other at the same River location. TP3 is much closer to the river. Groundwater elevations in WMS1 are also higher than in TP1. TP1 is near the City of Kalama Raney Well. It appears the high groundwater levels in WMS1 provide a good opportunity for creating off channel habitat.

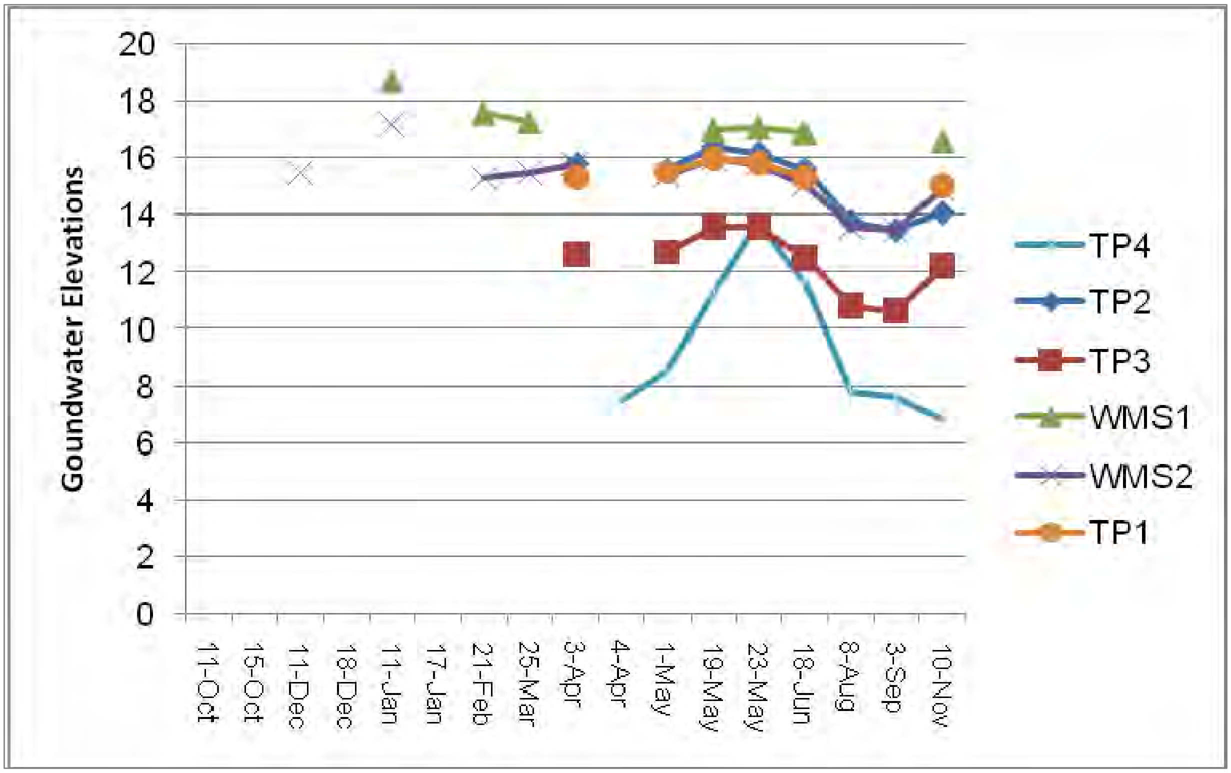


Figure B2. Groundwater elevations at selected well monitoring stations (WMS) and test pits (TP), which are not subjected to rainfall or surface water flow. Dates are October 11, 2007 to November 10, 2008.

Water elevations in ponds (Figure B3) vary drastically when compared to groundwater levels. The BPA Pond (or PMS2) had a water elevation fluctuation of seven feet. There doesn't appear to be any surface connection to this pond, but likely the local groundwater charges the system. Kress Lake (RMS1) levels are similar to the BPA Pond but it is fed by a surface water stream in the winter months. Ledgett Pond 1 (LP1) only varied 3 feet over the monitoring period.

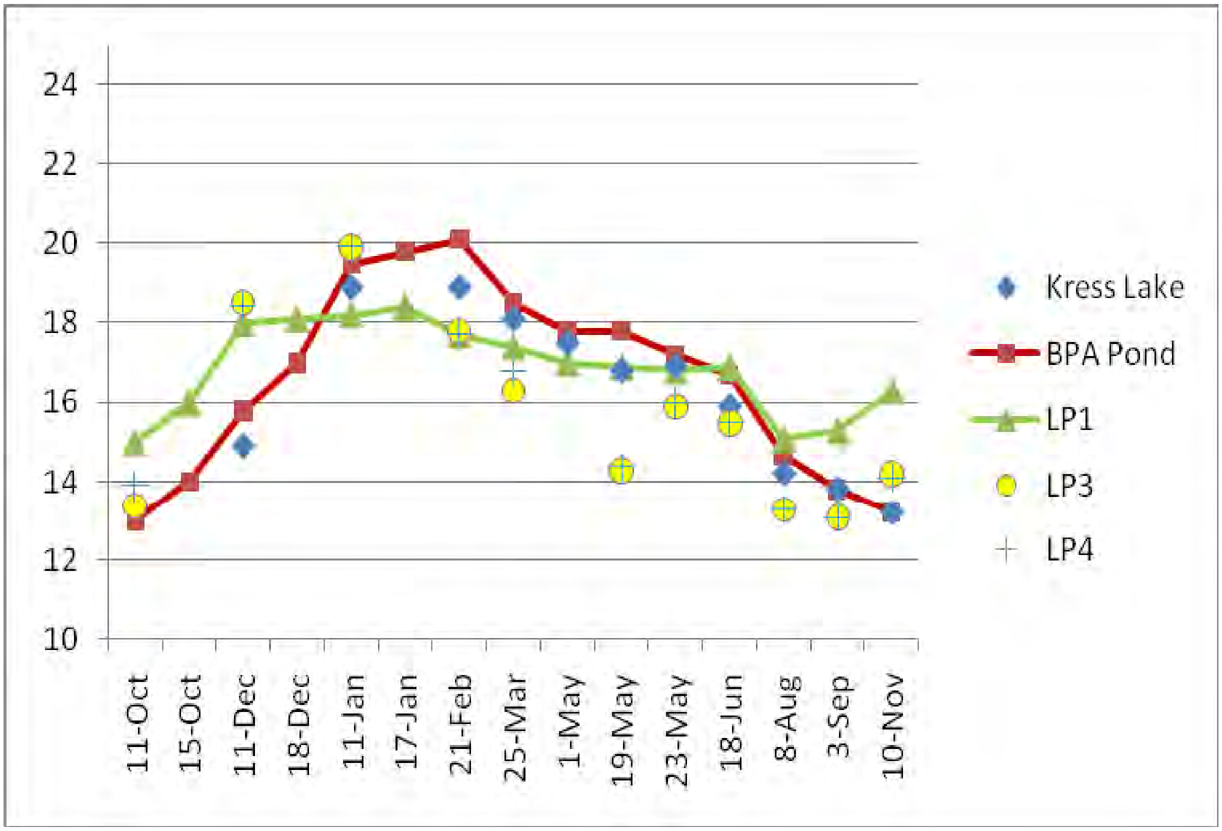


Figure B3. Pond water surface elevations for dates October 11, 2007 to November 10, 2008. Pond water elevation differs from groundwater in that most of the ponds have a surface water connection which creates a high water elevation in the winter. The two solid lines connecting points represent the BPA Pond (PMS2) and the Lower Pond on the Ledgett Property (LP1).

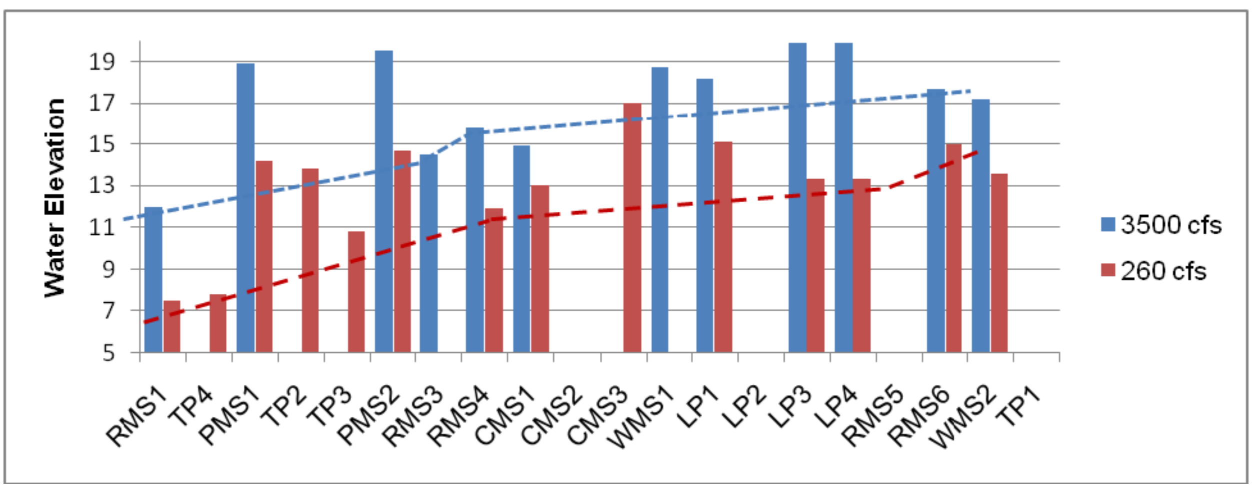


Figure B4. Water elevations for selected dates and river flows. The 3500 cfs flow occurred on January 11, 2008, and the 260 cfs flow occurred on August 8, 2008. The dashed lines are approximate and represent the Kalama River water surface profiles adjacent to the monitoring site. Note the nearly 6-foot differential in water level at LP3 and LP4. The proposed project design elevation for these two ponds is 14.0 feet.

The water temperature data is plotted graphically in Figures B5 through B8). Figure B5 is a plot of all the data within the project area (15 monitoring sites); Figure B6 is a plot for just the surface fed streams (Columbia River, Kalama River and Spencer Creek). Figure B7 is a plot of temperature data for the six pond monitoring sites and Figure B8 is a plot of the six groundwater sites. The following are trends and observations from analysis of the data:

- For the Lower Kalama, the data collected shows water temperature in the winter is all within the 40° to 45° F range for most of the monitoring sites. In May there is a large shift in temperature in the Columbia River and large open ponds warm to 70 to 75°F, however the Kalama River and groundwater sources remain low within the 45 to 50° F range. Groundwater sources tend to be 3 to 5° warmer than the Kalama River. Towards the end of the summer this trend reverses and the Kalama River is 3 to 4° warmer than the groundwater.

- Water temperatures in the Kalama River for the monitoring period never got over 58°F, which is ideal for juvenile coho growth and rearing.

- For the open ponds, the temperatures ranged from 40 to 45° in the winter to over 70° in the summer. The exception is LP1 which remained cooler in May and June. The intent of collecting theses data was to explore the options of connecting existing open ponds to the Kalama River so fish have access. For a successful project, the connection needs to intercept groundwater and be constructed in a manner so riparian vegetation can shade the open water. The project objective would be to lower the pond level, initiate groundwater flow and therefore reduce the water temperatures.

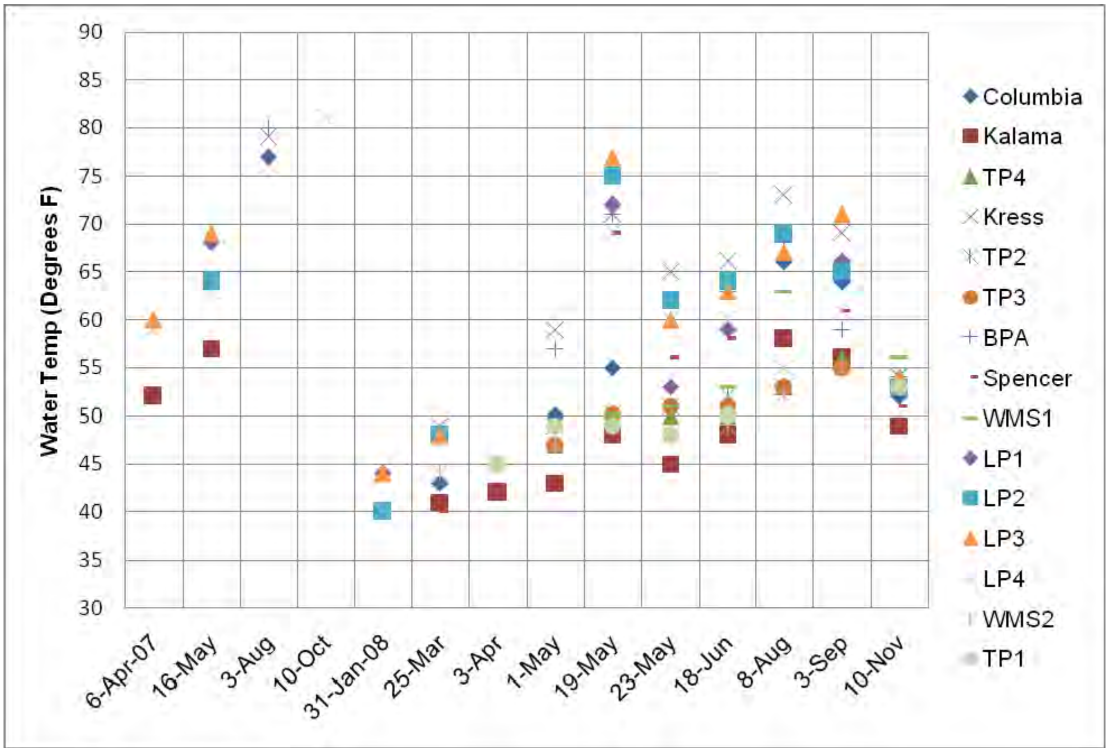


Figure B5. Water temperature data for selected monitoring stations from April 2007 to November 2008. Monitoring sites denoted in legend (top to bottom) generally represents the downstream to upstream direction (i.e. TP1 is the most upstream test pit monitoring station).

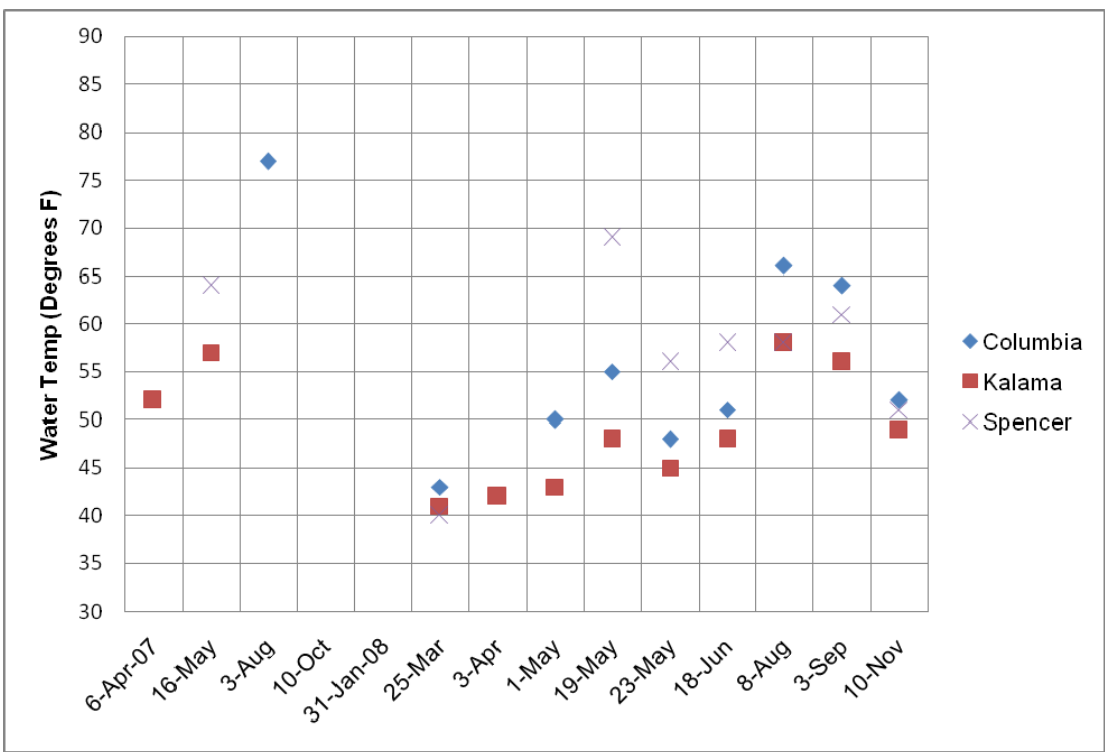


Figure B6. Water temperature data for the Columbia and Kalama Rivers and Spencer Creek. The Spencer Creek measurement is CMS3.

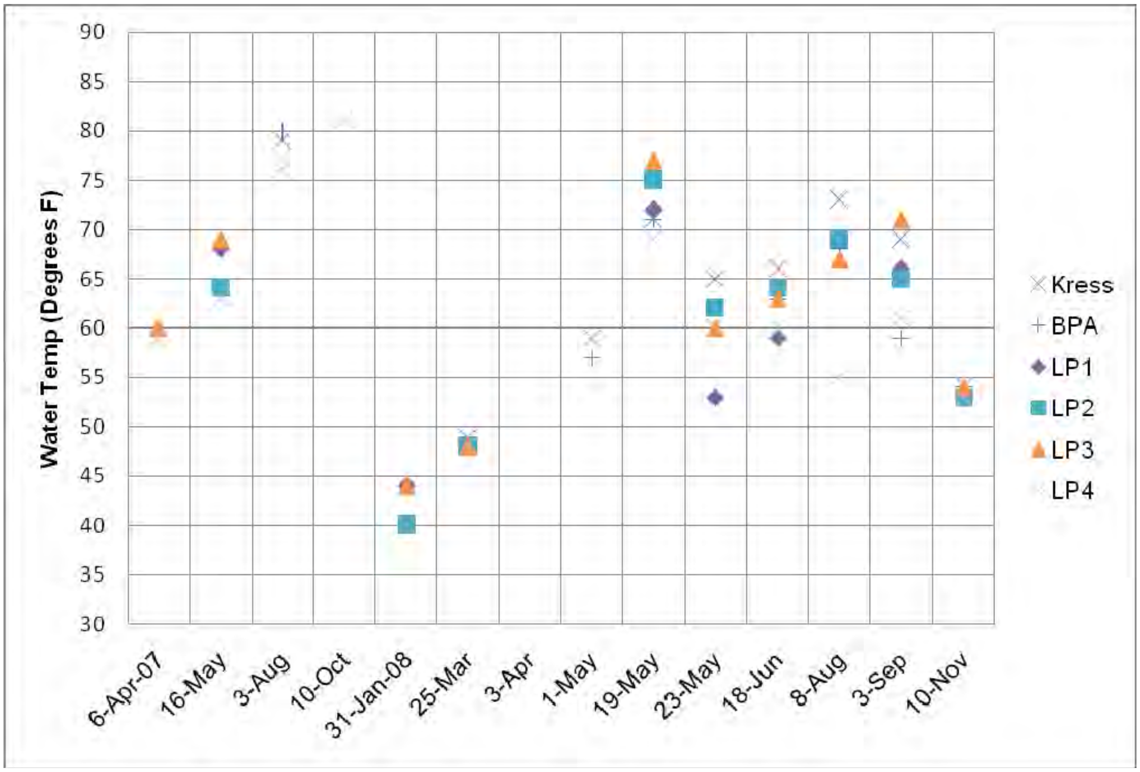


Figure B7. Water temperature data for the Pond Monitoring Stations.

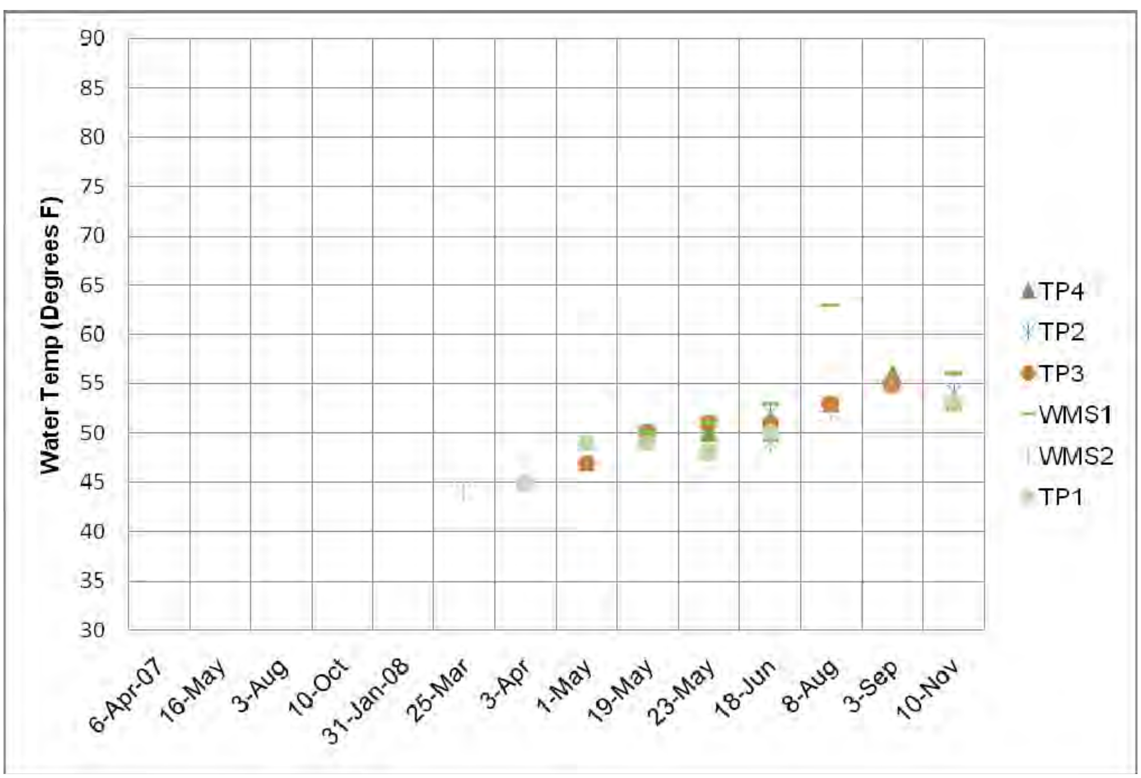


Figure B8. Water temperature data for the groundwater well monitoring stations and test pits.

2.0 Monitoring Site Locations Maps

The monitoring site locations are depicted for the study area overall (Figure B9) and an enlargement of the Ledgett property (Figure B10).

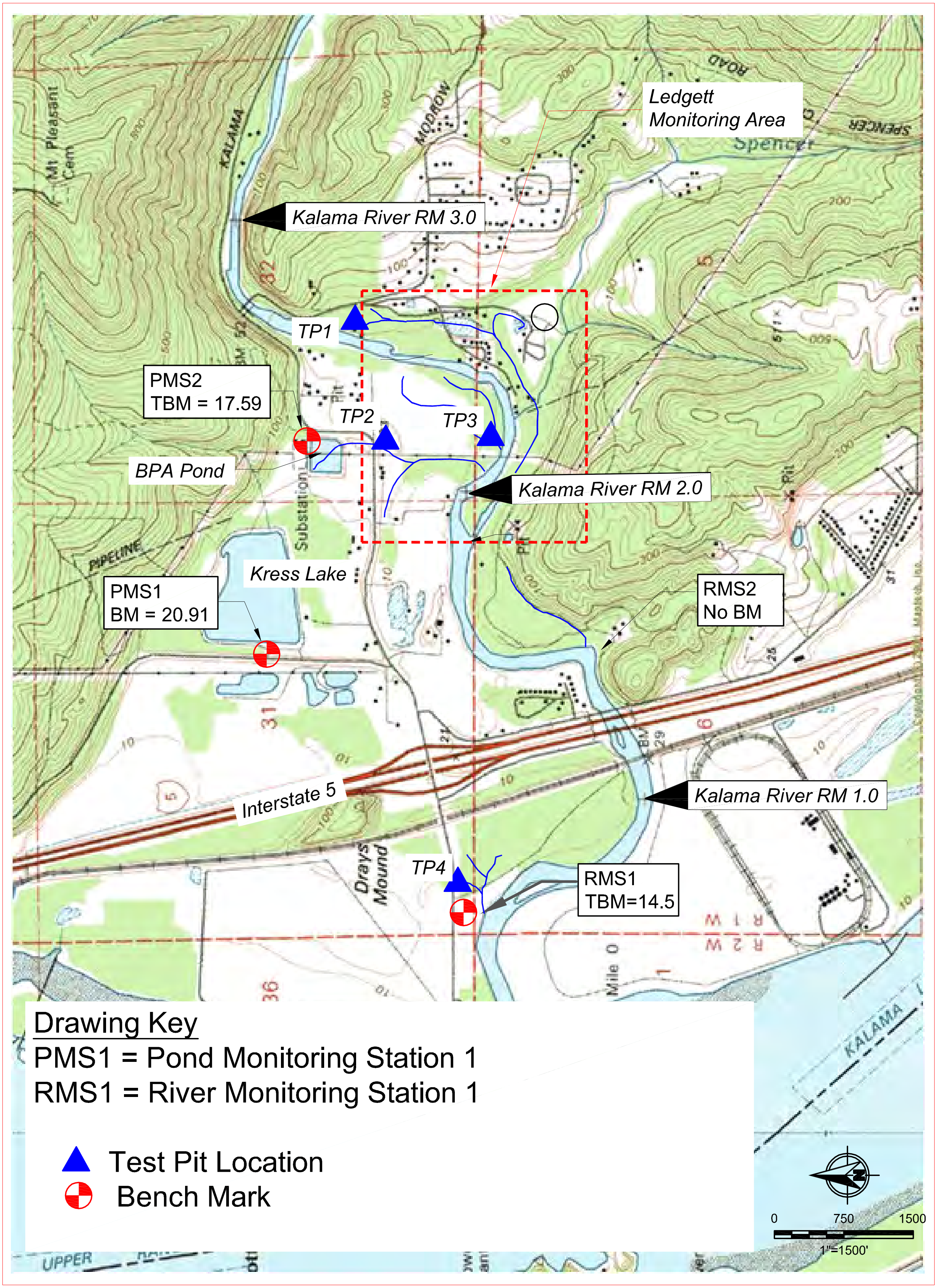
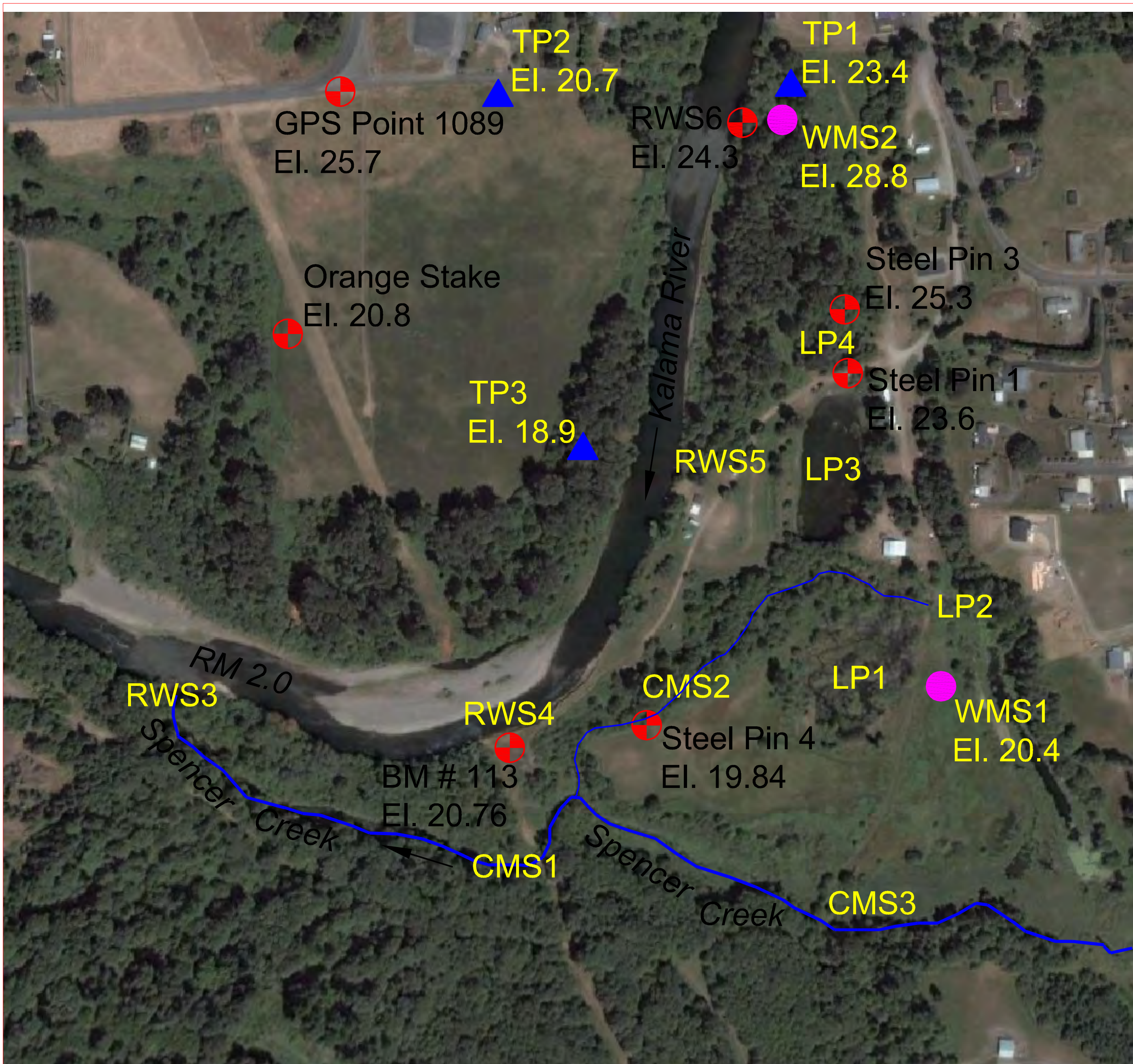


Figure B9 - Lower Kalama Monitoring Sites - Overall



Drawing Key
RMS1 = River Monitoring Station 1
CMS2 = Creek Monitoring Station 2
LP1 = Ledgett Pond 1

WMSX = Well Monitoring Station
Test Pit Location
Bench Mark

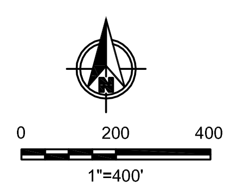


Figure B10 - Lower Kalama Monitoring Locations - Ledgett Area

3.0 Flow and Water Elevation Data

The columns of each table for the data collected generally start in the downstream reaches and move upstream (left to right in the table). The first three columns denote who collected the data, date and time. As you move from left to right, the next five columns are river and stream flow and or stage data (values are in cfs or ft). The next 20 columns contain the data pertaining to each monitoring site. The rows of the table are in order from top to bottom for the date collected. There are some gaps in the data. For example; data collection started in October of 2007, but the Test Pits were not excavated until April 2008.

Kalama River Off Channel Habitat Design - Water Flow and Elevation Data

Water Surface Elevations - For Monitoring Site Locations, see Appendix B, Section 2.0

By	Date	Time	E.Fk. Lewis Flow	Kalama Flow	Columbia River Gage Longview	St. Helens	Spencer Cr Flow	RMS1 WDFW	TP4	PMS1 Kress	TP2	TP3	PMS2 BPA	RMS3 Spencer	RMS4 BM #113	CMS1 TBM1	CMS2 Steel Pin 4	CMS3 Steel Rail	WMS1 Well Case	LP1 Well Case	LP2	LP3 Steel Pin 1	LP4 Steel Pin 1	RMS5 HWM	RMS6 Water Plant	WMS2 Ledgett	TP1 Ledgett
	BM Elev							14.5	14.9	20.91	20.7	18.9	17.59		20.76	20.0	19.84	22.31	20.4	20.4		23.6	23.6		24.3	28.84	23.4
	Notes		*15*	*cfs*	*13*	*14*	*cfs*	*1*		*2*	*17*	*18*	*3*		*4*	*5*	*6*	*7*	*8*			*9*		*10*	*11*	*12*	*16*
	10/11/2007			500			1								12.2							13.4	13.9	12.2	15.2		
	10/15/2007													9.4													
	12/11/2007			1100			5			14.9			15.8	10.3	13.6	13.1				18	19.5	18.5	18.4		15.7	15.5	
	12/18/2007			1000	6.5			8.7																	15.5		
	1/11/2008			3500			18			18.9			19.5	14.5	15.8	14.9			18.7	18.2		19.9	19.9		17.7	17.2	
	1/17/2008			1600											14.7	13.9				18.4							
	2/21/2008	2:24 PM		1200	6			10.1		18.9			20.1		13.7	13.6			17.6	17.7		17.8	17.7		15.8	15.3	
		4:18 PM			9																						
N	3/25/2008	9:30 AM	1060	1564	4.2	3.5		8.2		18.1			18.5		14.2		15.8	17	17.3	17.4		16.3	16.8		16	15.5	
N,P	4/3/2008	9:00 AM	680	1112							15.8	12.6	18.6												15.6	15.8	15.3
		3:00 PM																							15.5	15.3	15.6
N,P	4/4/2008	10:50 AM			2.8	3.1		6.4	7.5																		
		12:40 PM	650	1077	5.6	3.5		7.4																			
P	5/1/2008	11:00 AM	850	1315	5.3	5.3		6.8	8.5	17.5	15.6	12.7	17.8												15.7	15.4	15.5
N	5/19/2008	12:00 PM	1370	1933	10.0	10.7		11.0	11.3	16.8	16.4	13.6	17.8		15.1			16.8	17.0	16.9		14.3	14.4		16.6	16.0	16.0
N	5/23/2008	12:00 PM	996	1488	11.4	13.0		14.0	13.8	16.9	16.2	13.6	17.2		15.8		16.1	17.0	17.1	16.8		15.9	16.0		16.2	15.8	15.8
Nello	6/18/2008	8:35 AM	570	981	8.7	9		11.2	11.6	15.9	15.6	12.5	16.7		12.6		15.3	17.2	16.9	16.9		15.5	15.5		15.6	15.1	15.3
N,P	8/8/2008	9:00 AM	70	260	4.2	3.65		7.5	7.8	14.2	13.8	10.8	14.7		11.9	13		17	dry	15.1		13.3	13.3		15	13.6	14 dry
N	9/3/2008	10:00 AM	62	377	2.74	1.82		6.3	7.6	13.8	13.5	10.6	13.8		11.6			17.1	dry	15.3		13.1	13.1		14.7	13.5	13.7 dry
N	11/10/2008	10:15 AM	766	1215	5.47	4.59		7.9	6.8	13.2	14.1	12.2	13.2		14			17.3	16.6	16.3		14.2	14.1		16.1	14.9	15

Notes:

1 TBM is Orange Stake on RB River at Upstream End of Parking Area next to Concrete Block
2 BM is PK Nail in Parking Lot Near Outhouse and North Entrane Road
3 TBM is Orange Stake along the North East Bank Near Building
4 BM is Plastic Cap on Rebar along Pipeline 30 feet back from Kalama River LB
5 Located in Spencer Creek Along Pipeline Alignment, WS controlled by Beaver Dams
6 BM is Steel Pin along LB of Creek where spur road crosses into field
7 BM yet to be set, but WSEL is near culvert/road
8 BM is top of square tube with cap removed adjacent to LP1
9 Steel Pin on North Edge of Road between LP3 and LP4
10 Area where high water marks have been measured from debris on fence posts
11 TBM is wood stake on RB River just DS Kalama PUD Treatment Plant
12 TBM is top of Lid on Ledgett Well (Vertical CMP)
13 Longview http://ahps2.wrh.noaa.gov/ahps2/hydrograph.php?wfo=pqr&gage=lopw1&view=1,1,1,1,1,1&toggles=10,7,8,2,9,15,6&type=0
14 St. Helens http://ahps2.wrh.noaa.gov/ahps2/hydrograph.php?wfo=pqr&gage=shno3&view=1,1,1,1,1,1&toggles=10,7,8,2,9,15,6&type=0
15 E. Fk. Lewis http://waterdata.usgs.gov/nwis/uv?14222500
16 BM is rim of 4" white PVC pipe on Ledgett Property
17 BM is rim of 4" white PVC pipe
18 BM is rim of 4" white PVC pipe

Notes: (See Figure 3.2)

RMS6 River Monitoring Station 6 Just DS of Kalama Plant
RMS5 River 1/2 way between 6 and 4 where the river floods overbank
RMS4 River under Pipeline
RMS3 River Monitoring Station 3 at the Mouth Spencer Creek
RMS2 Just U/S I5 on LB No data Collected
RMS1 WDFW Parking Area
WMS2 Ledgetts Ranney Well
WMS1 LCFEG Well Steel Tube
LP4 Ledgett Most Upstream Pond
LP3 Ledgett Pond Next to House
LP2 Ledgett Pond US Road Crossing
LP1 Ledgett Pond Out in Field
CMS3 S. Br. Spencer at Crossing with 4 foot culvert
CMS2 N. Br. Spencer at Crossing with small culvert
CMS1 Lower Section of Spencer Creek
PMS1 Kress Lake

PMS2 BPA Pond

4.0 Temperature Data

The columns of each table for the data collected generally start in the downstream reaches and move upstream (left to right in the table). The first three columns denote who collected the data, date and time. As you move from left to right, the next five columns are river and stream flow and or stage data (values are in cfs or ft). The next 20 columns contain the data pertaining to each monitoring site. The rows of the table are in order from top to bottom for the date collected. There are some gaps in the data. For example; data collection started in October of 2007, but the Test Pits were not excavated until April 2008.

Kalama River Off Channel Habitat Design - Temperature Data

Water Temperature -- For Monitoring Site Locations, see Appendix B, Section 2.0

Date	Time	E. Fk. Lewis Flow	Kalama Flow	Columbia River Gage Longview	St. Helens	Spencer Cr Flow	Columbia River	RMS1 WDFW	TP4	PMS1 Kress	TP2	TP3	PMS2 BPA	RMS3 Spencer	RMS4 BM #113	CMS1	CMS2 Steel Pin 4	CMS3 Steel Rail	WMS1 Well Case	LP1	LP2	LP3 Steel Pin 1	LP4	RMS5 HWM	RMS6 Water Plant	WMS2 Ledgett	TP1	Air
BM Elev								14.5	14.9	20.91	20.7	18.9	17.59		20.76		19.84	22.31	20.4			23.6			24.3	28.84		
Notes		*15*	*cfs*	*13*	*14*	*cfs*		*1*		*2*	*17*	*18*	*3*		*4*	*5*	*6*	*7*	*8*			*9*		*10*	*11*	*12*		
4/6/2007																						60	59		52			
5/16/2007																59	59	64		68	64	69	63		57			
8/3/2007	1:30 PM		200				77	69		79			80										76					
10/10/2007																58							81					
10/11/2007			500			1																						
10/15/2007																												
12/11/2007			1100			5																						
12/18/2007			1000	6.5				46																	43			
1/11/2008			3500			18																						
1/17/2008			1600												38													
1/31/2008																				44	40	44	40					45
2/21/2008	2:24 PM		1200	6																								
	4:18 PM			9																								
3/25/2008	9:30 AM	1060	1564	4.2	3.5		43	41		49			48			43	43	40		48	48	48	48		41	44		
4/3/2008	9:00 AM	680	1112																						42	45	45	
	3:00 PM										48	46													43		48	
4/4/2008	10:50 AM			2.8	3.1			45																				
	12:40 PM	650	1077	5.6	3.5																							
5/1/2008	11:00 AM	850	1315	5.3	5.3		50	44	47	59	49	47	57												43	47	49	47
5/19/2008	12:00 PM	1370	1933	10.0	10.7		55	48	50	71	50	50	71			68	58	69	50	72	75	77	69		48	49	49	
5/23/2008	12:00 PM	996	1488	11.4	13.0		48	48	50	65	51	51	62			56	51	56	51	53	62	60	60		45	48	48	60
6/18/2008	8:35 AM	570	981	8.7	9		51	48	50	66	52	51	63			58	47	58	53	59	64	63	60		48	49	50	58
8/8/2008	9:00 AM	70	260	4.2	3.65		66	59	53	73	53	53	68			63		58	63		69	67	55		58	52	dry	60
9/3/2008	10:00 AM	62	377	2.74	1.82		64	54	56	69	55	55	59			58		61	dry	66	65	71	61		56	55	dry	62
11/10/2008	10:15 AM	766	1215	5.47	4.59		52	48	53	54	54	53	54			51		51	56	53	53	54	53		49	53	53	50

Notes:

1 TBM is Orange Stake on RB River at Upstream End of Parking Area next to Concrete Block
2 BM is PK Nail in Parking Lot Near Outhouse and North Entrane Road
3 TBM is Orange Stake along the North East Bank Near Building
4 BM is Plastic Cap on Rebar along Pipeline 30 feet back from Kalama River LB
5 Located in Spencer Creek Along Pipeline Alignment, WS controlled by Beaver Dams
6 BM is Steel Pin along LB of Creek where spur road crosses into field
7 BM yet to be set, but WSEL is near culvert/road
8 BM is top of square tube with cap removed adjacent to LP1
9 Steel Pin on North Edge of Road between LP3 and LP4
10 Area where high water marks have been measured from debris on fence posts
11 TBM is wood stake on RB River just DS Kalama PUD Treatment Plant
12 TBM is top of Lid on Ledgett Well (Vertical CMP)
13 Longview http://ahps2.wrh.noaa.gov/ahps2/hydrograph.php?wfo=pqr&gage=lopw1&view=1,1,1,1,1,1&toggles=10,7,8,2,9,15,6&type=0
14 St. Helens http://ahps2.wrh.noaa.gov/ahps2/hydrograph.php?wfo=pqr&gage=shno3&view=1,1,1,1,1,1&toggles=10,7,8,2,9,15,6&type=0
15 E. Fk. Lewis http://waterdata.usgs.gov/nwis/uv?14222500

Notes: (See Figure 3.2)

RMS6 River Monitoring Station 6 Just DS of Kalama Plant
RMS5 River 1/2 way between 6 and 4 where the river floods overbank
RMS4 River under Pipeline
RMS3 River Monitoring Station 3 at the Mouth Spencer Creek
RMS2 Just U/S I5 on LB No data Collected
RMS1 WDFW Parking Area
WMS2 Ledgetts Ranney Well
WMS1 LCFEG Well Steel Tube
LP4 Ledgett Most Upstream Pond
LP3 Ledgett Pond Next to House
LP2 Ledgett Pond US Road Crossing
LP1 Ledgett Pond Out in Field
CMS3 Spencer Creek - Upstream of culvert near alluvial fan
CMS2 N. Br. Spencer at Crossing with small culvert
CMS1 Lower Section of Spencer Creek
PMS1 Kress Lake
PMS2 BPA Pond

APPENDIX C. RIVER FLOAT AND FIELD RECONNAISSANCE

Field Reconnaissance Summary
Lower Kalama Off-Channel Habitat Design
October 11, 2007
P.D. Powers

This memo provides summary notes and recommendations from a field reconnaissance of potential off-channel habitat in the Lower Kalama River. The reconnaissance was conducted by Pat Powers, Waterfall Engineering, Nello Picinich, Lower Columbia Fish Enhancement Group and Donna Hale Bighouse and Steve West from the Washington State Department of Fish and Wildlife. The objective for the day was to visit three off channel areas, walk through the sites and identify potential off channel restoration opportunities.

The river flow was 300 cfs. Low tide (1.3 feet) was at 1:02 pm. High tide was 8.5 feet at 4:59 pm. Note: the mean tide is 4.5.

<u>Project KRR0.7 – WDFW Tidal and Groundwater Channels</u>
The floodplain in this reach of river encompasses 45 acres, and is isolated from roads on all four sides. We parked at the boat ramp, walked upstream back and forth through the floodplain looking for low swales, disconnected wetlands, etc. Two potential restoration opportunities were identified. The first is a low swale which is connected to the Kalama River. The lower end appears to be tidal and had some flow. The swale runs to the west side of the access road. The second is a low elevation area within a stand of large cottonwood trees which could potentially be excavated and reconnected to the river or side channel. Data collection needed to further identify the restoration options include:

1. Level survey of the surrounding ground and swales relative to tidal elevations.

2. Exploration for groundwater and substrate with backhoe and installation of standpipes to monitor water levels relative to river flows, tides and seasonal groundwater changes.

   Note: The water level on the other side of the West Kalama River road was surveyed by the Port in March of 2007. These measurements would help to determine the feasibility and type of off channel habitat (i.e. backwater channels versus groundwater fed).

<u>Project KRL1.4 – Kalama River Left RM 1.4 – Groundwater Channel</u>
This site is located on the left bank floodplain across the river from Camp Kalama near river mile 1.4. This area along the left bank floodplain is 20 acres in size. We parked above the gate and walked through the landowner’s property to his house. We then had a brief discussion with the landowner and proceeded to hike upstream through the floodplain, weaving back and forth through very brushy areas between the river and high wall which delineates the channel migration zone on the left valley wall. One potential groundwater channel site was found along the toe of the hillside (wall based channel). The channel would be about 1000 feet long. The upper end of the floodplain terminates at a bedrock outcropping and quickly gains elevation.

Question: Is the landowner open to restoration work on this property?

Data collection needs to further identify restoration potential include:

1. Survey of the Kalama River water surface elevations and ground elevation in the swale at the upstream and downstream end.
2. Exploration for groundwater and substrate with backhoe and installation of standpipes to monitor groundwater levels relative to river flows, tides and seasonal groundwater changes.
3. Perform groundwater pump tests to evaluate the potential for flow and chum spawning.

<u>Project KRL0.1 – Kalama River Left RM 0.1 – Tidal/Backwater Channels</u>
This site consists of excavated tidal channels near the left bank, river mile 0.1 on the Port of Kalama Property. These channels function as backwater/refuge habitat at medium to high tide and when the Columbia River and/or Kalama River are high. The channels provide low velocity refuge areas with some shallow margins and several isolated pieces of large woody debris (LWD). The riparian area could be improved by removing reed canary grass and planting native trees and shrubs. The depth and width of the channels will be controlled in the long term by sediment from the Kalama River and tidal flushing action from high to low tide. The opportunities for additional restoration could be extension of the existing channels and/or addition of LWD. Data collection needs to further identify restoration potential include:

1. Ground topographic survey to determine the potential for extending channels.
2. Gage river and tidal levels to determine design water surface elevations.

Photo Documentation of Lower Kalama River

August 28, 2007

Float from WDFW Trap at RM 2.8 to Mouth

River Flow = 220 cfs

Columbia River Tidal Elevation (Varied 1.6 to 2.7)

Photo Points 1 through 6.

Photo points 6 and 7.

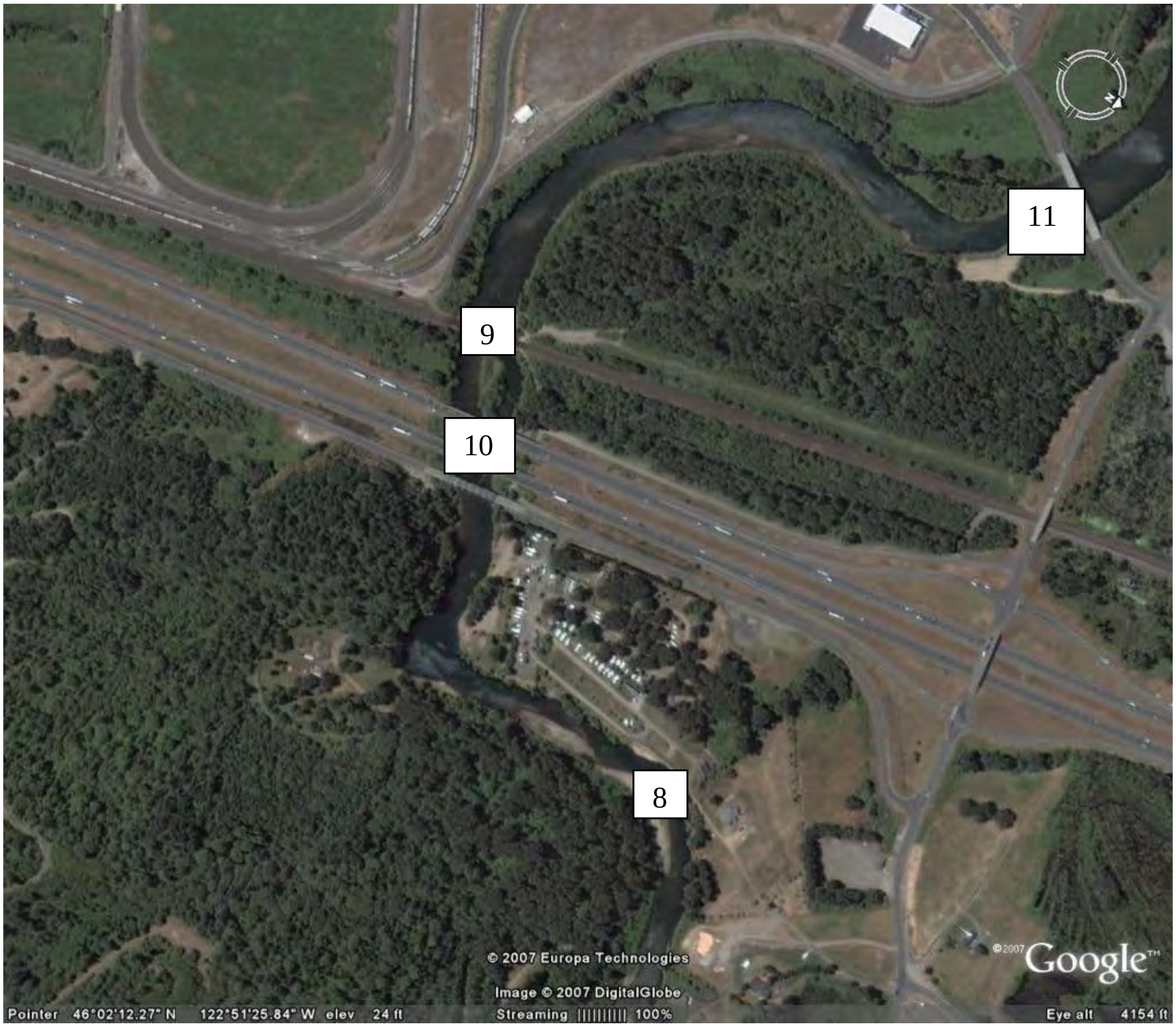


Photo Points 8 to 11.

Photo Points 12 to 15.

Photo 1 – View Upstream of WDFW Fish Trap Kalama River Mile 2.8.

Photo 2 – View downstream from WDFW fish Trap.

Photo 3 – View downstream RM 2.7. Note right bank is lined with riprap. This is the new Port Property. View further downstream is Ledgett's property on the left bank.

Photo 4 – View downstream of eroding bank on Ledgett's property. Immediately to left is a small LWD cluster.

Photo 5 - Abandoned Gas line.

Photo 6 - Riffle above Spencer Creek. Spencer Creek outlet in on the left bank. The bar on the left bank has aggraded over the last winter floods and the low flow channel has cut down through the middle of the bar and is actively head cutting upstream.

Photo 7 - Mouth of Spencer Creek.

Photo 8 - Right bank at Camp Kalama.

Photo 9 – View downstream under RR Bridge. There is a lot of LWD submerged on the left bank and along the left bank of the channel downstream. Fishing access is along the right bank.

Photo 10 – Upstream view I5 Bridge.

Photo 11 – WDFW boat ramp on the right bank just upstream of new bridge.

Photo 12 – Narrow piece of road near peninsula. Water depth was 17 feet.

Photo 13 – Mouth of Kalama River view upstream. Stumps to left in alignment with white house, actual location of channel 10 to 12 years ago.

Photo 14 – Tip of peninsula at mouth of River. Tide = 2.6.

Photo 15 – Mouth of Kalama River, shallowest point. Depth = 0.8 ft at a tide of 2.6.

APPENDIX D. GROUNDWATER PUMP TESTS

Groundwater pump tests were conducted at four test pits in 2008 to evaluate the presence of groundwater at potential project sites. At each site, soil and water samples were collected and analyzed. In this appendix, the four sites are described, and the results and analytical reports are presented.

1.0 Test Pit Descriptions

Test Pit 1

Test Pit 1 was located on the left bank of the Kalama River at RM 2.5 (Ledgett Property). The ground elevation was 23.7 feet. The excavation proceeded to a depth of 10 feet (Figures D1 and D2). The upper 4 feet consisted of fine grained silts and sand, from 4 to 6 feet there was a transition to gravel and below 6 feet river alluvium. The digging below 6 feet was very hard, as the material was compacted. Water was encountered at elevation 15.2 feet (7 feet below the ground surface). A groundwater pump test was conducted. Test results for the pump test, soil samples and water quality measurements are shown in Table D1 and Figure D7.

Figure D1. Test Pit 1 Excavation

Figure D2. Test Pit 1 Soils

Test Pit 2

Test Pit 2 was dug out in a low point of the open pasture owned by the Port of Kalama (Figure D3). The ground elevation was 19.6. The water level was 15.8. Excavation proceeded down to an approximate elevation of 13.6 feet (6 feet deep). Below elevation 15 feet, the excavated soil walls were collapsing, and it would have been very difficult to stabilize the slopes without a major excavation. Soil tests within this area indicate a much lower percentage of gravel compared to Test Pit 1.

Figure D3. Test Pit 2 Excavation

Test Pit 3

Test Pit 3 was dug within an existing swale on the right bank of the Kalama River downstream from Test Pit 1. The ground elevation was 15.0 feet and static water surface was at 12.6 feet. The first three feet of excavation were very wet sandy loam. When the excavator bucket removed water from the pit, the groundwater recharge appeared to have a high iron content; the cobble removed were covered with iron rich sediment. This condition was confirmed by the water quality tests with a 35 part per million (ppm) iron reading. Similar to Test Pit 2, the soil walls were collapsing and it would have been very difficult to stabilize the slopes without a major excavation so a pump test was not completed.

Figure D4. Test Pit 3 Excavation Area

Test Pit 4

Test Pit 4 was dug within land owned by WDFW on the right bank floodplain at RM 0.4. The ground elevation was 12.5 feet, and the groundwater elevation was 7.5 feet. The excavation proceeded to a depth of 6.5 feet. There was no gravel, but a very consistent sand material after 2 to 3 feet of sandy loam was removed. A pump test was conducted at this site. Pumping started at a static water surface of 7.5 feet. The water level was pumped down 1.1 feet at a rate of 97 gallons per minute (gpm) over a time of 4 minutes. The drawdown rate, or the rate at which the water elevation dropped, exceeded the pumping rate and the hole was pumped dry. The adjacent water elevation in the Kalama River during pumping was 7.0 feet. This reach of the river is tidal with water elevations varying from 6 to 10 feet of elevation. Drawdown curve and results are shown in Table D1, and Figure D7.

Figure D5. Test Pit 4 Excavation

Figure D6. Test Pit 4 Bottom of Hole

2.0 Results

The two parameters used to assess the flow potential are the drawdown index and the apparent velocity. The drawdown index is the pump rate divided by the drawdown rate. It is a measurement of how much water will flow into the hole relative to the rate water is going out. The apparent velocity is the inflow rate divided by the cross-sectional area of the hole contributing flow, at the point at which the pump rate is equal to the inflow rate (i.e. the water level has stabilized). Powers (1990) has published values for these two parameters on an empirical basis relative to the success of over 10 groundwater channels constructed in Washington State.

For the Lower Kalama River sites the low drawdown index, and the very slow recharge rates tends to indicate a low potential for the development of adult salmon spawning channels. The exception may be the area around Test Pit 4, as this is tidal and adult access could be provided at higher tides. Spawning gravel would have to be imported. The high quality groundwater and substrate does provide excellent opportunities for creation of year round off channel rearing for juvenile salmonids.

The drawdown and recharge curves of Figure D7 show that the test holes were drawn down very fast and took much longer to recharge. The soil was very compacted at Test Pit 1. Conditions for summer and fall (low flow periods) need to be monitored to check for water elevations. These low flow elevations need to be correlated to the surveyed project datum. Figure D8, shows the water levels for all the monitoring areas within the Lower Kalama and Columbia River.

	Sediment Classification (%)			Water Quality			Drawdown			Recharge				
	Gravel	Sand	Silt, Clay	DO (ppm)	Fe (ppm)	Pump Rate (gpm)	Depth (ft)	Rate (gpm)	Time (min)	Depth (ft)	Rate (gpm)	Time (min)	Drawdown Index	Apparent Velocity (fpm)
TP1	79	20	1	4.1	9.7	60	1.5	70	7.8	1.5	32	17	0.46	NA
TP2	56	25	19			-	-	-	-	-	-	-	-	-
TP3	-	-	-	2.8	35	-	-	-	-	-	-	-	-	-
TP4	11	85	4	2.3	0.2	97	1.1	128	3.9	1.1	17	29	0.13	NA

Table D1. Lower Kalama River Groundwater Test Results for Test Pit 1 (TP1), Test Pit 2 (TP2), Test Pit 3 (TP3), and Test Pit 4 (TP4).

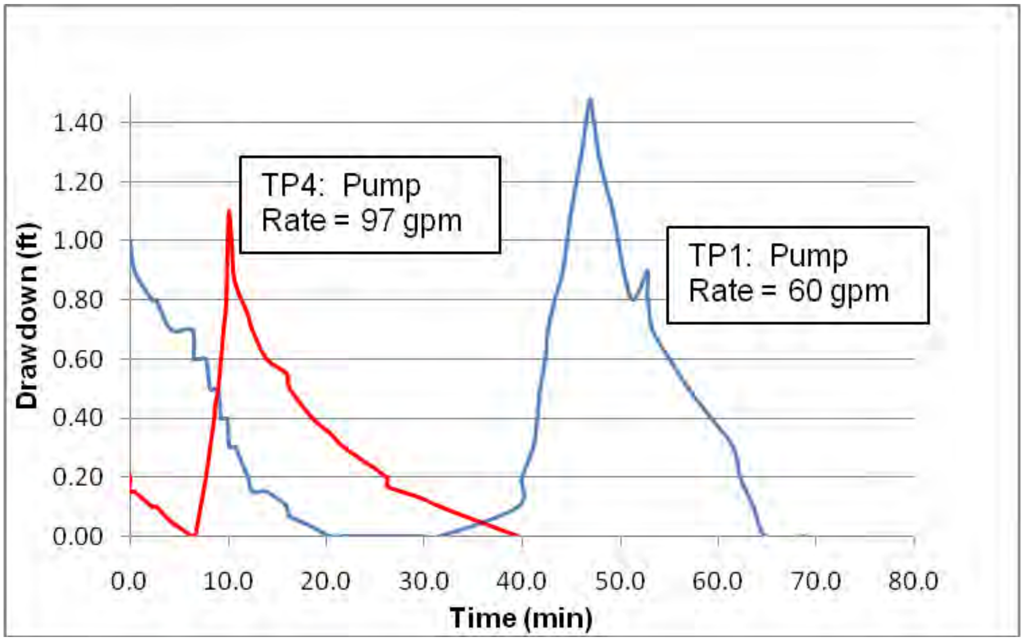


Figure D7. Lower Kalama River Test Pit 1 (TP1) and Test Pit 4 (TP4) drawdown and recharge curves superimposed to a common start time.

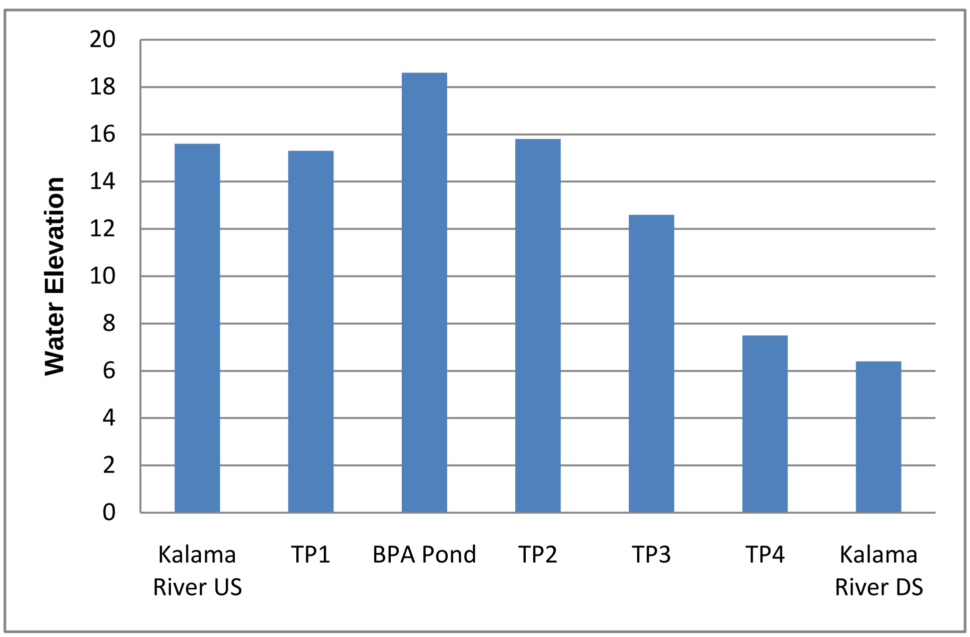
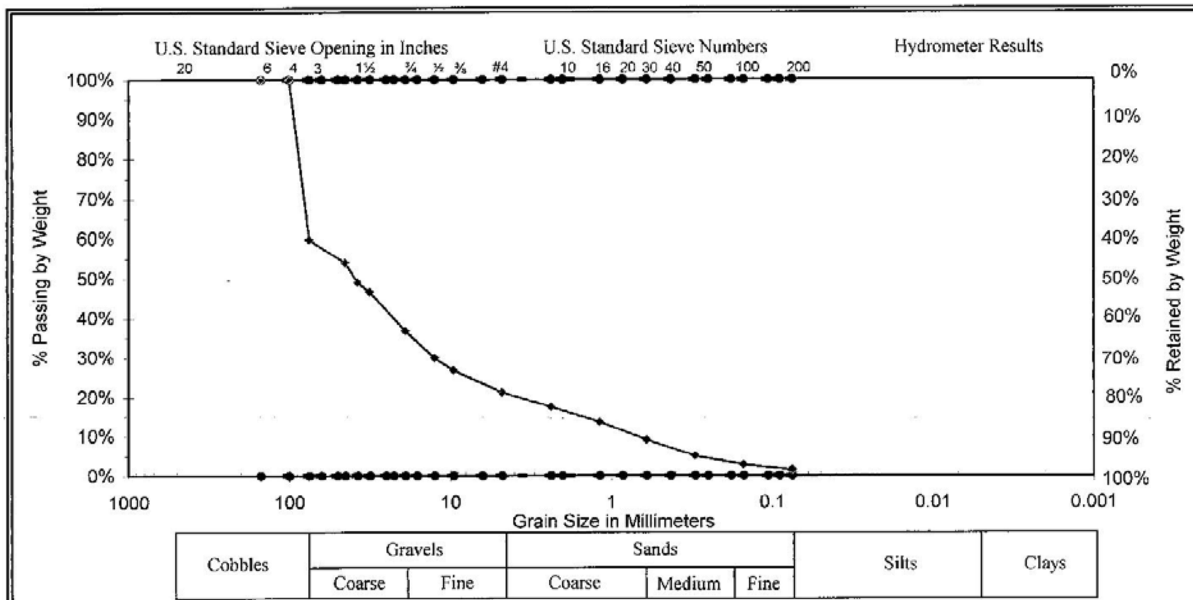


Figure D8. April 3 and 4, 2008 water surface elevations during the test pit period. Datum is Port Survey datum.

3.0 Soil Samples

Soil samples were analyzed by Geotechnical Testing Laboratory of Olympia Washington, in April of 2008. The analysis report follows.

GEOTECHNICAL TESTING LABORATORY



Date : 04/07/08	D_{10} = 0.74	**Classification**	% Gravel
Sample #: 450	D_{30} = 12.79	**GW, Well-graded Gravel with Sand**	78.94%
Sample ID: Gravel with Sand	D_{60} = 75.29	**Specifications**	% Sand
Source: TP-1	C_C = 2.94	**No Specs**	19.65%
Project: Lower Kalama	C_U = 102.06	% Moisture: #DIV/0!	% Silt & Clay
Client: Waterfall Engineers	Liquid Limit= 0.00	Dust Ratio=	1.42%
ASTM#: C-136	Plastic Limit= 0.00	Fineness Modulus	Sample Meets Specs
Depth: NA	Plasticity Index= 0.00	7.60	**NA**

Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00	100.0%	100.0%		
3.00"	75.00	59.5%	59.5%		
2.50"	63.00		57.2%		
2.00"	50.00		54.8%		
1.75"	45.00	53.8%	53.8%		
1.50"	37.50	48.9%	48.9%		
1.25"	31.50	46.5%	46.5%		
1.00"	25.00		41.3%		
7/8"	22.40		39.3%		
3/4"	19.00	36.6%	36.6%		
5/8"	16.00		33.4%		
1/2"	12.50	29.7%	29.7%		
3/8"	9.50	26.6%	26.6%		
1/4"	6.30		22.9%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	21.1%	21.1%		
#8	2.360	17.4%	17.4%		
#10	2.000		16.2%		
#16	1.180	13.5%	13.5%		
#20	0.850		10.9%		
#30	0.600	8.9%	8.9%		
#40	0.425		6.5%		
#50	0.300	4.8%	4.8%		
#60	0.250		4.1%		
#80	0.180		3.1%		
#100	0.150	2.7%	2.7%		
#140	0.106		1.9%		
#170	0.090		1.7%		
#200	0.075	1.4%	1.4%		
#270	0.053				

Reported by: ____________

Reviewed by: ____________

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Phone #: (360) 754-4612 Fax #: (360) 754-4848

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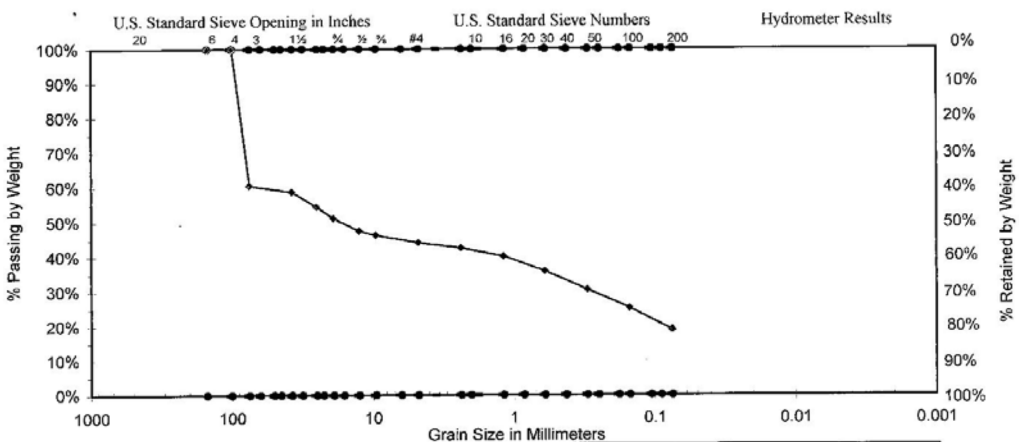

Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date : 04/07/08	D_{10} = 0.04	**Classification**	% Gravel
Sample #: 451	D_{30} = 0.29	GM, Silty Gravel with Sand	55.93%
Sample ID: Silty Gravel with Sand	D_{60} = 63.60	**Specifications**	% Sand
Source: TP-2	C_C = 0.03	No Specs	25.22%
Project: Lower Kalama	C_U = 1598.37	% Moisture: 7.4%	% Silt & Clay
Client: Waterfall Engineers	Liquid Limit= 0.00	Dust Ratio=	18.85%
ASTM#: C-136	Plastic Limit= 0.00	Fineness Modulus	Sample Meets Specs
Depth: NA	Plasticity Index= 0.00	5.65	**NA**

Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00	100.0%	100.0%		
3.00"	75.00	60.5%	60.5%		
2.50"	63.00		60.0%		
2.00"	50.00		59.4%		
1.75"	45.00		59.1%		
1.50"	37.50	58.8%	58.8%		
1.25"	31.50		56.7%		
1.00"	25.00	54.4%	54.4%		
7/8"	22.40		52.9%		
3/4"	19.00	51.1%	51.1%		
5/8"	16.00		49.4%		
1/2"	12.50	47.4%	47.4%		
3/8"	9.50	46.2%	46.2%		
1/4"	6.30		44.8%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	44.1%	44.1%		
#8	2.360	42.5%	42.5%		
#10	2.000		41.8%		
#16	1.180	40.0%	40.0%		
#20	0.850		37.7%		
#30	0.600	35.9%	35.9%		
#40	0.425		32.7%		
#50	0.300	30.5%	30.5%		
#60	0.250		28.7%		
#80	0.180		26.2%		
#100	0.150	25.1%	25.1%		
#140	0.106		21.4%		
#170	0.090		20.1%		
#200	0.075	18.8%	18.8%		
#270	0.053				

Reported by: Z

Reviewed by: JW

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Phone #: (360) 754-4612 Fax #: (360) 754-4848

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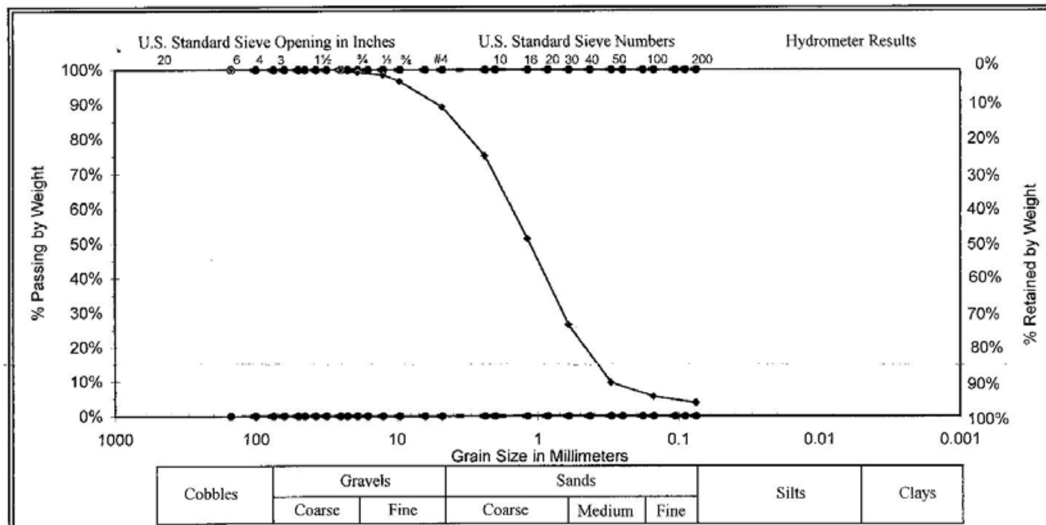

Date : 04/07/08	D_{10} = 0.31	**Classification**	% Gravel
Sample #: 452	D_{30} = 0.69	SP. Poorly graded Sand	10.82%
Sample ID: Sand	D_{60} = 1.61	**Specifications**	% Sand
Source: TP-4	C_C = 0.95	No Specs	85.37%
Project: Lower Kalama	C_U = 5.25	% Moisture: 15.2%	% Silt & Clay
Client: Waterfall Engineers	Liquid Limit= 0.00	Dust Ratio=	3.82%
ASTM#: C-136	Plastic Limit= 0.00	Fineness Modulus	Sample Meets Specs
Depth: NA	Plasticity Index= 0.00	3.47	NA

Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		99.7%		
3/4"	19.00	99.2%	99.2%		
5/8"	16.00		98.9%		
1/2"	12.50	98.4%	98.4%		
3/8"	9.50	96.6%	96.6%		
1/4"	6.30		91.6%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	89.2%	89.2%		
#8	2.360	75.1%	75.1%		
#10	2.000		67.8%		
#16	1.180	51.2%	51.2%		
#20	0.850		37.0%		
#30	0.600	26.3%	26.3%		
#40	0.425		16.6%		
#50	0.300	9.6%	9.6%		
#60	0.250		8.3%		
#80	0.180		6.4%		
#100	0.150	5.7%	5.7%		
#140	0.106		4.6%		
#170	0.090		4.2%		
#200	0.075	3.8%	3.8%		
#270	0.053				

Reported by: B

Reviewed by: JM

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Phone #: (360) 754-4612 Fax #: (360) 754-4848

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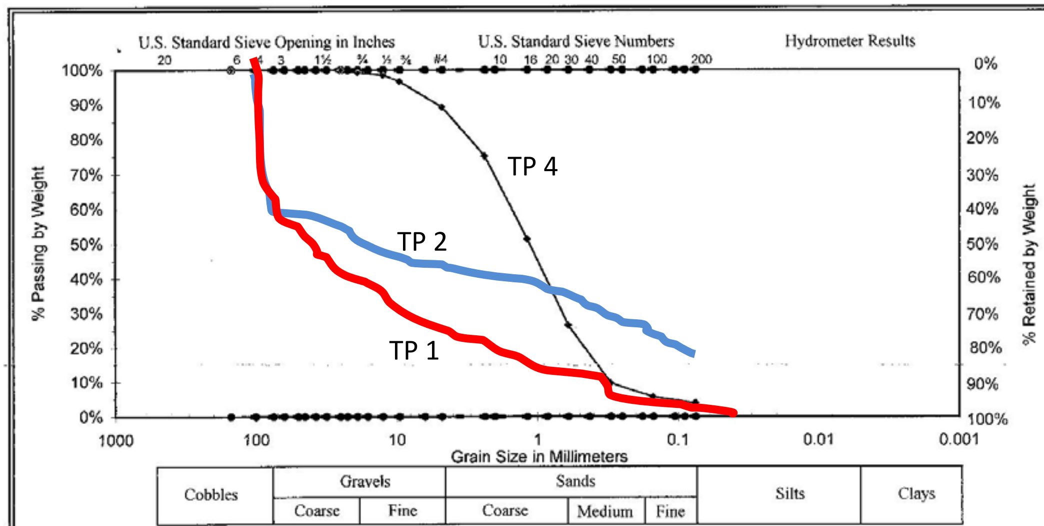


Date :	04/07/08	D_{10} = 0.31	**Classification**		% Gravel
Sample #:	452	D_{30} = 0.69	**SP. Poorly graded Sand**		10.82%
Sample ID:	Sand	D_{60} = 1.61	**Specifications**		% Sand
Source:	TP-4	C_C = 0.95	No Specs		85.37%
Project:	Lower Kalama	C_U = 5.25	% Moisture: 15.2%		% Silt & Clay
Client:	Waterfall Engineers	Liquid Limit= 0.00	Dust Ratio=		3.82%
ASTM#:	C-136	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth:	NA	Plasticity Index= 0.00	3.47		NA

Coarse Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		99.7%		
3/4"	19.00	99.2%	99.2%		
5/8"	16.00		98.9%		
1/2"	12.50	98.4%	98.4%		
3/8"	9.50	96.6%	96.6%		
1/4"	6.30		91.6%		

Fines Section

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	89.2%	89.2%		
#8	2.360	75.1%	75.1%		
#10	2.000		67.8%		
#16	1.180	51.2%	51.2%		
#20	0.850		37.0%		
#30	0.600	26.3%	26.3%		
#40	0.425		16.6%		
#50	0.300	9.6%	9.6%		
#60	0.250		8.3%		
#80	0.180		6.4%		
#100	0.150	5.7%	5.7%		
#140	0.106		4.6%		
#170	0.090		4.2%		
#200	0.075	3.8%	3.8%		
#270	0.053				

Reported by: TB

Reviewed by: JM

10011 Blomberg St. SW, Olympia, WA 98512
Phone #: (360) 754-4612 Fax #: (360) 754-4848

4.0 Water Samples

Water samples were analyzed by Columbia Analytical Services Inc., in April of 2008. The analytical report follows.

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client :	Waterfall Engineering	**Service Request :**	K0802848
Project Name :	Lower Kalama Off Channel Design	**Date Collected :**	04/03/08
Project No. :	NA	**Date Received :**	04/03/08
Matrix :	Water	**Date Extracted :**	04/08/08

Dissolved Metals

Sample Name :	TP1 Ledge H (4/3)	**Units :**	ug/L (ppb)
Lab Code :	K0802848-002	**Basis :**	NA

Analyte	**Analysis Method**	**MRL**	**Date Analyzed**	**Sample Result**	**Result Notes**
Iron	6010B	20	04/16/08	9770	

Comments:

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client :	Waterfall Engineering	**Service Request :**	K0802848
Project Name :	Lower Kalama Off Channel Design	**Date Collected :**	04/03/08
Project No. :	NA	**Date Received :**	04/03/08
Matrix :	Water	**Date Extracted :**	04/08/08

Dissolved Metals

Sample Name :	TP4 (4/3)	**Units :**	ug/L (ppb)
Lab Code :	K0802848-003	**Basis :**	NA

Analyte	Analysis Method	MRL	Date Analyzed	Sample Result	Result Notes
Iron	6010B	20	04/16/08	187	

Comments:

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client :	Waterfall Engineering	**Service Request :**	K0802848
Project Name :	Lower Kalama Off Channel Design	**Date Collected :**	04/03/08
Project No. :	NA	**Date Received :**	04/03/08
Matrix :	Water	**Date Extracted :**	04/08/08

Total Metals

Sample Name :	TP3 (4/3)	**Units :**	ug/L (ppb)
Lab Code :	K0802848-004	**Basis :**	NA

Analyte	Analysis Method	MRL	Date Analyzed	Sample Result	Result Notes
Iron	6010B	20	04/16/08	35400	

Comments:

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client :	Waterfall Engineering	**Service Request :**	K0802848
Project Name :	Lower Kalama Off Channel Design	**Date Collected :**	NA
Project No. :	NA	**Date Received :**	NA
Matrix :	Water	**Date Extracted :**	04/08/08

Total Metals

Sample Name :	Method Blank	**Units :**	ug/L (ppb)
Lab Code :	K0802848-MB	**Basis :**	NA

Analyte	Analysis Method	MRL	Date Analyzed	Sample Result	Result Notes
Iron	6010B	20	04/16/08	ND	

Comments:

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client :	Waterfall Engineering	**Service Request :**	K0802848
Project Name :	Lower Kalama Off Channel Design	**Date Collected :**	04/02,03/08
Project Number :	NA	**Date Received :**	04/02,03/08
Sample Matrix :	WATER		

Oxygen, Dissolved

Analysis Method : SM 4500-O G
Test Notes :

Units : mg/L
Basis : NA

Sample Name	Lab Code	MRL	Dilution Factor	Date/Time Analyzed	Result	Result Notes
TP1 Ledge H (4/2)	K0802848-001	-	1	04/02/08 17:30	4.11	
TP4 (4/3)	K0802848-003	-	1	04/03/08 17:00	2.31	
TP3 (4/3)	K0802848-004	-	1	04/03/08 17:00	2.81	

SM Standard Methods for the Examination of Water and Wastewater, 20th Ed., 1998.

APPENDIX E. SCORING SPREADSHEET

Project				SPP Presence and Reach Potential						Population/Reach		Pro/Access/Rest	PAR		Restoration		Access			Overall BTF		Certainty	
No.	ID	Description	Affected Reaches	Tier	SPP	Pop Class	Pop Score	SRP	SRP Score	Rating	Score	Project Type/ Multi-SPP Benefits	Rating	Score	Habitat Units	Effectiv Factor	Quant Factor	Qual Factor	Passage Factor	Rating	Score	Rating	Assumptions/Notes
1	KRL0.0	Low Water Fish Passage	Kalama 1 A tidal	4	WIST	P	3	L	1		4	Access to blocked habitats					10.0	10.0	0.1				Building log jams or piling and excavate channel to increase depth for passage.
					SUST	P	3	L	1		4												High uncertainty in achieving goals; treatment options to increase depth would likely be short
					FACH	P	3	L	1		4												term due to natural deposition area just downstream of constricted area and incised floodplain.
					SPCH	P	3	L	1		4												Passage improvement is L, access is blocked for juveniles intermittently on a seasonal basis and is not blocked in all years.
					COHO	C	2	L	1		3												Habitat quantity is H; assumes all upstream mainstem reaches in subbasin are affected.
					CHUM	C	2	L	1		3												Habitat quality is H; the average of upstream Kalama mainstem tier ratings is 3.64.
					OUT	P		M															Population/Reach Rating is elevated from L to M, because of benefit to out-of-basin stocks
										M	22		M	10.00						M	32.00	L	
2	KRL0.1	Port Tidal and Backwater Channels	Kalama 1 A tidal	4	WIST	P	3	L	1		4	Off channel/side channel habitat			1	0.65							Extend and enhance existing tidal channels
					SUST	P	3	L	1		4												Can't ID Habitat Units (HUs) until project better defined.; default value of 1 assigned
					FACH	P	3	L	1		4												EF of .65 is due to tidal influence
					SPCH	P	3	L	1		4												Certainty score based on documentation of existing fish use
					COHO	C	2	L	1		3												Estuary benefit to out-of-basin stocks addresses estuary management action CRE-10
					CHUM	C	2	L	1		3												Population/Reach Rating is elevated from L to M, because of benefit to out-of-basin stocks
					OUT	P		M															
										M	22		H	1.95						M	23.95	M	
3	KRR0.7	WDFW Tidal and Groundwater Channels	Kalama 1 A tidal	4	WIST	P	3	L	1		4	Off channel/side channel habitat			4.75	0.8							T4 reach, but affects T1 and T2 reaches upstream, benefiting WIST and SUST, COHO and
					SUST	P	3	L	1		4												CHUM
					FACH	P	3	L	1		4												Road on site that if flooded would be opened up; currently a dike there
					SPCH	P	3	L	1		4												Effectiveness = 0.8, because of tidal influence
					COHO	C	2	L	1		3												Certainty high due to both groundwater and tidal exchange and documented fish use.
					CHUM	C	2	L	1		3												Should add area opened up by flooding road onto HU for the Off-Channel Habitat HU.
					OUT	P		M															Estuary benefit to out-of-basin stocks addresses estuary management action CRE-10
										M	22		H	11.40						M	33.40	H	Population/Reach Rating is elevated from L to M, because of benefit to out-of-basin stocks
4	KRL1.4	Groundwater Channel	Kalama 1 A tidal	4	WIST	P	3	L	1		4	Off channel/side channel habitat			2.6	1							Certainty would be high, except that data are needed on groundwater and substrate .
					SUST	P	3	L	1		4												Estuary benefit to out-of-basin stocks addresses estuary management action CRE-10
					FACH	P	3	L	1		4												Population/Reach Rating is elevated from L to M, because of benefit to out-of-basin stocks
					SPCH	P	3	L	1		4												
					COHO	C	2	L	1		3												
					CHUM	C	2	L	1		3												
					OUT	P		M															
										M	22		H	7.80						M	29.80	M	
5	KRR1.8	Active Side Channel	Kalama 1 B tidal	3	WIST	P	3	L	1		4	Off channel/side channel habitat			0.4	0.8							Needs additional field data
					SUST	P	3	L	1		4												Assume this is the break between reach Kalama 1a and 1b tidal
					FACH	P	3	L	1		4												Off channel hab with wood in it, no GW benefits
					SPCH	P	3	L	1		4												Assume 200' for HU
					COHO	C	2	M	2		4												EF =0.8 because has potential for stranding fish
					CHUM	C	2	L	1		3												Certainty score based on lack of floodplain connection and incised channel
					OUT	P		M															Estuary benefit to out-of-basin stocks addresses estuary management action CRE-10 and CRE-9
										M	23		H	0.96						M	23.96	L	Population/Reach Rating is elevated from L to M, because of benefit to out-of-basin stocks
6	SC0.5	Spencer Creek Riparian and LWD	Spencer Creek 1	2	WIST	P	3	L	1		4	Riparian restoration			0.6	0.8							Assume 300' for HU
					SUST	P	3	L	1		4												EF=.8 because of uncertainty on summer water temps
					COHO	C	2	H	3		5												Certainty score M due to low flows in the summer; project would primarily provide fall,
					CHUM	C	2	L	1		3												winter and spring habitat
										M	16		H	1.44						M	17.44	M	
7	SC1.8	Fish Passage Culvert	Spencer Creek 2	4	COHO	C	2	L	1		3	Access to blocked habitats					1.0	2.0	1.0				6-yr plan identifies this as mile 1.34, perhaps because mouth of Spencer Ck incorrectly
					CHUM	C	2	L	1		3												identified in 6-year plan. We believe it should actually be 1.8
																							HU: If culvert is really at 1.8 (not 1.34), then length is really 0.2
																							Passage improvement will be H, Habitat Qual is L
										L	6		M	1.90						L	7.90	H	Certainty H because fish passage standards would be met

Project No.	Project ID	Description	Affected Reaches	Tier	SPP	Pop Class	Pop Score	SRP	SRP Score	Population/Reach Rating	Population/Reach Score	Pro/Access/Rest Project Type/ Multi-SPP Benefits	PAR Rating	PAR Score	Restoration Habitat Units	Restoration Effectiv Factor	Access Quant Factor	Access Qual Factor	Access Passage Factor	Overall BTF Rating	Overall BTF Score	Certainty Rating	Assumptions/Notes
8	KRR2.1	GW Channel System	Kalama 2 A	1	WIST	P	3	L	1		4	Off channel/side channel habitat			7	0.8							This project is entirely on private land and abuts Project KRR 2.2 on POK ownership.
		private ownership			SUST	P	3	L	1		4												EF 0.8 because don't know where it would enter creek
					FACH	P	3	H	3		6												HU = 3500'
					SPCH	P	3	L	1		4												Certainty M because landowner has not yet been contacted, however significant off channel
					COHO	C	2	L	1		3												areas identified; with landowner willingness certainty would increase.
					CHUM	C	2	H	3		5												
										H	26		H	16.80						H	42.80	M	
9	KRR2.2	Port of Kalama GW	Kalama 2 A	1	WIST	P	3	L	1		4	Off channel/side channel habitat			5.8	1							This project is completely on POK land and abuts Project KRR2.1.
		Channel System			SUST	P	3	L	1		4												EF = 0.75 because there is more uncertainty about keeping acceptable temperatures with an
					FACH	P	3	H	3		6												open field and lack of shading.
					SPCH	P	3	L	1		4												HU = 2900'
					COHO	C	2	L	1		3												Certainty score based on verified groundwater supply and connection to surface flow.
					CHUM	C	2	H	3		5												
										H	26		H	17.40						H	43.40	H	
10	KRL2.2	Pipeline Removal and LWD	Kalama 2 A	1	WIST	P	3	L	1		4	Stream channel hab. Structure and bank s			1	1							HU = 500'
					SUST	P	3	L	1		4												May be contingent on rip rap removal on opposite bank
					FACH	P	3	H	3		6												Concerns regarding public safety: river floaters
					SPCH	P	3	L	1		4												Certainty score based on restoring floodplain function
					COHO	C	2	L	1		3												
					CHUM	C	2	H	3		5												
										H	26		H	3.00						H	29.00	M	
11	KRR2.4	Riprap Removal/Floodplain	Kalama 2 A	1	WIST	P	3	L	1		4	Stream channel hab. Structure and bank s			1	1							Needs additional field data
		Reconnection--Port of Kalama			SUST	P	3	L	1		4												Certainty score based on restoration of floodplain processes.
					FACH	P	3	H	3		6												
					SPCH	P	3	L	1		4												
					COHO	C	2	L	1		3												
					CHUM	C	2	H	3		5												
										H	26		H	3.00						H	29.00	H	
12	KRL2.5	Ledgett Groundwater Channel	Kalama 2 A	1	WIST	P	3	L	1		4	Off channel/side channel habitat			7	1							Certainty score based on confirmed presence of groundwater which will supply all the
					SUST	P	3	L	1		4												habitat downstream
					FACH	P	3	H	3		6												
					SPCH	P	3	L	1		4												
					COHO	C	2	L	1		3												
					CHUM	C	2	H	3		5												
										H	26		H	21.00						H	47.00	H	

APPENDIX F. MEETING SUMMARIES

November 16, 2007 Meeting Summary

Attendee	Affiliation
Julius Ledgett	Landowner
Mark Wilson	Port of Kalama
Donna (Hale) Bighouse	WDFW
Patrick Powers	Waterfall Engineering
Marnie Tyler	Ecolution
Bernadette Graham Hudson	LCFRB
Hal Mahnke	LCFEG
Nello Picinich	LCFEG
Rich Yahrmarkt	LCFEG & Kalama Landowner

Pat Powers (Consultant Hired by LCFEG) opened the meeting by reviewing status of the project to date and provided an overview of the project kick-off meeting on April 18, 2007. Pat also introduced Marnie Tyler of Ecolution who will be assisting Waterfall Engineering with the project.

Project Review

Pat reviewed the project goals and objectives, which are, in short, to develop a list of viable projects, prioritize them, and prepare 30% engineering design for the top few projects. The role of this stakeholder group will be to make recommendations in this process.

Because the SRFB proposal only referenced property owned by Julius Ledgett, the group focused on the Julius Ledgett lands initially, but subsequently expressed interest in expanding the scope of the areas considered. The LCFEG is surveying the Ledgett property and has reviewed prior surveys of the property. Information has already been collected on Lake Kress, and two ponds on the Ledgett property. Over the winter of 2007-2008, during high water levels, the team will be collecting additional data and surveying potential project areas to obtain data necessary for the engineering design. We will also be installing piezometers. The additional data will enhance our ability to describe groundwater linkages between surface water bodies and strengthen our understanding of which potential projects have the greatest likelihood of success. Based on HEC2 data from Mark Wilson, which shows 100-year flood data throughout the Lower Kalama area, Pat plotted the outline and extent of the 100 year flood. Pat presented this information, as well as information on the water temperature and water surface elevations over the project area.

Potential Restoration Project List

Pat presented the first iteration of the list of potential restoration projects, which was developed from a float of the river by several stakeholder members and follow-up ground reconnaissance. The October 11 Field Reconnaissance Summary provides a brief description of several of the sites. At the November meeting, the group briefly discussed each project on the list and identified its location on aerial photography. The following table incorporates group discussion related to each potential project site at the 11/16 meeting. The nomenclature is as follows:

KR = Kalama River; the L or R following identifies which bank when looking downstream. The number identifies the river mile, from the mouth of the river. SC refers to Spencer Creek, a tributary to the Kalama River. Therefore, KRL0.0 refers to river mile 0.0 of the Kalama River, on the left bank as floating downstream.

Project #	**Name**	**11/16 Discussion**
KRL 0.0	Low Water Fish Passage	• Tidal flat at mouth.
KRL 0.1	Port Tidal and Backwater Channels	• Port has documented juvenile salmonid usage in these channels. • Mark Wilson has 4 years of quarterly monitoring data for these areas, including water levels, vegetation, salmonid usage, and presence of freshwater clams • Amphibian usage has also been observed in this area.
KRR 0.7	WDFW Tidal and Possible Groundwater Channels	• Need additional water level monitoring data to evaluate off-channel opportunities on WDFW lands. • Need further discussion on whether or not to consider Tier 4 reaches, even if Tier 1 reaches would benefit from the project elsewhere. • Should consider alternative funding sources for lower Tier reaches, if it can be demonstrated that there is a benefit to fish. • Long-term data are needed to revise tier rankings.
KRL 1.4	Groundwater Channel	• Wall-based channel • Possible chum channel • Elevation change present here, providing head for groundwater flow.
KRR 1.8	Active Side Channel	• Observed but not explored further.
SC 0.5	S. Branch Side channel rearing	• This area currently serves as juvenile salmonid refuge, but lacks wood. • A pump test here would further identify groundwater connectivity and flow.

SC 1.0	Fish Passage Culvert	• This culvert is actually passable and will be removed from the project list.
SC 1.8	Fish Passage Culvert	
KRR 2.2	GW Channel System	
KRL 2.2	Pipeline removal and LWD	• Pipeline is visible at low flows and affects channel morphology • LWD to include 3-4 small logjams
KRR 2.4	Riprap removal/floodplain reconnection	• Riprap was placed in 1970 as agricultural initiative. • Removing riprap could require mitigation with existing homes and properties downstream.

Ultimately, the most successful projects will be identified based on biological and logistical factors. On the biological side, groundwater sources, the species and life stages affected, proximity to existing suitable habitat, tier ranking, priority level within the 6-Year Habitat Work Schedule, and other factors may all be taken into account. Logistical considerations, including landowner willingness, structural complexity, and cost effectiveness are also important factors. Several landowners still need to be contacted to gauge their support of restoration activities on their property. We will use a matrix incorporating these factors to aid in evaluating and ranking the potential projects and will review this approach at the March meeting.

Project Timeline

The overall aim in 2008 is to prepare one to two projects to 30% engineering design in order to apply for SRFB funding. A 30% design completed by May 2008 could be submitted as a pre-proposal in the next grant round. Funding would be available in January 2009 if approved. Construction could then begin, within approved work windows. There is some risk in moving forward with projects and not having the final report done. SRFB in the past has often wanted sponsors to wait until the assessment is complete. Any project proposed need to be clean, and not dependent upon additional assessment.

Additional projects could be taken to a 30% design level if the projects are less complex. For example, it would be realistic to take one complex project, or two or three straight forward projects to this design level in 2008. However, it is unlikely the SRFB would approve funding for more than one project in the same area in the next grant round. Additional designs could be used in subsequent grant rounds. It is not cost-effective to develop designs beyond the 30% level until funding is approved.

Next Steps

- Link potential restoration projects with the 6-Year Habitat Work Schedule, which supplements the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan;
- Identify fish species and life stages benefiting from each project;
- Contact landowners to gauge willingness to participate;
- Develop a matrix to evaluate biological and logistical success factors for each potential project site.

Individual Tasks

- Donna will check HPA requirements for the Olympic Pipeline.

March 20, 2008 Meeting Summary

Attendee	Affiliation
Bryce Glaser	WDFW
Bernadette Graham-Hudson	LCFRB
Hal Mahnke	LCFEG
Nello Picinich	LCFEG
Patrick Powers	Waterfall Engineering
Marnie Tyler	Ecolution
Chris Wegemann	WDFW
Steve West	WDFW
Mark Wilson	Port of Kalama
Rick Yahrmarkt	LCFEG, Kalama Landowner

Nello Picinich opened the meeting by asking Pat Powers to provide a status report on the project, and to review developments on each potential project site discussed at the November 16, 2007 meeting.

Project Status
The project is progressing on schedule. Data have been collected for evaluating potential sites and developing design plans. Additionally a matrix has been developed that links each project site with the LCFRB 6-Year Habitat Work Schedule and provides the basis for ranking the projects.

Data Collection & Monitoring
Pat has collected several background documents and data sources describing past conditions or work in the area that will inform the study and will be referenced in the report:

- Updated 6-Year Habitat Work Schedule (LCFRB, 2008)
- Habitat Assessment Report (R2 and Mobrand, 2004)
- Groundwater Report prepared for Washington Department of Ecology (CH2M Hill, 2002)
- Groundwater Report (Port of Kalama)
- Ecology Instream Flow Report
- HEC 2 Flood Study
- Aerial Photos
- LIDAR

Both of the groundwater reports (Port of Kalama and the CH2M Hill groundwater logs) document high potential of groundwater flow in this area and this is also supported by field data. We have actively been collecting field data on water surface elevations and temperature. Pat shared a graphic of water surface elevations at all data points collected that depicts relative differences of these key locations at the same point in time. Data were collected October through February, so information is available on both low and high flows. It is most important now is to see how this changes between now and September as we continue to monitor these sites. Pat emphasized that if there are additional projects to be considered, it is critical that they be identified right away for data collection and ranking among other potential projects to occur. No projects were identified. Mark Wilson did present some ideas about the area south of the Kalama River Road on a private drive which has water flowing in the winter. Chris noted that DOE takes flow data from Modrow Bridge several times per month and have been doing so for the past eight years. It is believed this data may be available on the Internet. It was also noted that the river is tidally influenced up to river mile 1.3 to 1.4.

Potential Restoration Project List: Update and Discussion
As the group moved into discussion of the potential projects Nello Picinich explained that the LCFEG is still openly considering all of these projects; no final selections have been made and that stakeholder input is needed for all of them. Bernadette added that the initial funding award had targeted the Ledgett property, but that the stakeholder group had seen the value of also looking at the lower two miles of the Kalama River to identify potential off-channel habitat opportunities. Pat indicated that creation of any instream habitat will follow WDFW protocols, which draw from empirical project data across Washington and British Columbia for evaluating the sufficiency of groundwater. Before any digging, location of utility lines would be identified. Pat displayed aerial photos of each potential project site and reviewed key elements of the Projects; group discussion included the following:

KRL 0.0 Low Water Fish Passage. Several options were discussed to address low water fish passage including: debris bunkers or LWD to maintain scour; continual dredging of a thalweg; re-meandering the mouth to project downstream into the Columbia River; and a bridge. It was agreed to by the group that all potential options should be listed but not pursued at this point in time.

KRL 0.1 Port Tidal and Backwater Channels. The proposed extension of tidal channels would add 1300 feet, or 0.36 acres, of habitat. Existing data indicates salmonids do use the tidal channels.

KRR 0.7 WDFW Tidal and Possible Groundwater Channels. Collected data strongly suggests the presence of groundwater flow: a three-degree temperature difference exists between the mainstem and the channels feeding into the mainstem. Creating additional habitat here would involve extending tidal channels upstream and into low areas, connecting swales that are currently disconnected from floodplain. The road currently acts as a low level dike and prevents some level of floodwater from reaching this area. A culvert could be installed or the road decommissioned to allow fish access to the created channels. This area is within the floodplain, however the road provides a certain level of protection from flooding (another argument for retaining the road and creating access by use of a culvert). Field reconnaissance and LIDAR suggest that there are low spots that would naturally drain the area during floods. If additional water entered the area by extending the tidal channels, it is possible that sufficient flows could exist to scour a distinct channel.

Mark suggested that the iron content could be too high for fish and the water quality poor. Water quality analysis (dissolved oxygen and iron) will be sampled to confirm site suitability.

KRL 1.4 Groundwater Channel. This project would add 1300 feet, or 0.3 acres of habitat. Higher elevations protect this area from frequent flooding. This area has not been surveyed with engineering equipment, however the potential for groundwater is high, based on river gradient and LIDAR data.

KRR 1.8 Active Side Channel. This site needs additional scoping before possible projects could be identified.

SC 0.5 S. Branch Side Channel Rearing. The concept here is to create rearing ponds adjacent to Spencer Creek. Cold water seeps and gravel may make for summer refuge area.

SC 0.7 Flow Splitter. This would take part of Spencer Creek and divert it to the ponds on Julius Ledgett's property. This concept would need to be explored further before this could be considered a viable project. The lack of certainty about what would be involved in the project will cause it to rank low in project scoring exercises.

SC 1.8 Fish Passage Culvert. A barrier culvert would be replaced on the Spencer Creek Road (County culvert). This is not the culvert closest to the mouth of Spencer Creek, which is passable.

KRR 2.1 Groundwater Channel System. This project was previously considered to be a part of KRR 2.2, but was separated due to different ownership. Based on high points and low points identified on LIDAR, groundwater would be channeled into an existing open side channel. A good groundwater source is key for the success of this project and KRR 2.2; a groundwater pump test is currently scheduled for the first week of April to confirm such a source.
Mark Wilson pointed out that the alignment depicted on the aerial photo would not be acceptable to the Port because it bisects the Port property at nearly its center. Pat suggested that a different alignment could be developed and the two agreed to work on this outside of the stakeholder group.

KRR 2.2 Groundwater Channel System. This project continues project KRR 2.1, but on private ownership. Landowner support needs to be secured before this could be Evaluated any further.

KRL 2.2 Pipeline Removal and Engineered Logjams. The pipeline would be removed across the channel and floodplain for about 500 ft on either bank. Engineered logjams would provide habitat and have a secondary benefit for bank stability. Information is needed from the pipeline's HPA permit before this can be developed further. Donna Bighouse is planning to follow up on the HPA status.

KRR 2.4 Riprap Removal & Floodplain Reconnection. Would remove riprap and provide riparian vegetation. Mark suggested that heavy erosion could be a problem if riprap was completely removed. He suggested possibly softening the bank, but scour has historically taken a lot of soil. The previous owner lost 10 acres of property before hardening the bank. Chris Wegeman thought that removing the riprap could work if a channel were created and an outlet created for the water. Further site review is needed to identify the certainty of success and fish benefit.

KRL 2.5 Ledgett Side Groundwater Channel. This area was the initial focus of the project as funded by the SRFB. Channels would be excavated to connect ponds to initial fingers of channels where groundwater flow potential is very high. The expectation is that there would be sufficient flows to connect to the Kalama River. The upper portion of this project area would be groundwater fed, the lower portion surface fed. Ponds would be deepened to make them more fish friendly, but the most important aspect for success of the project is in the upper areas, and the groundwater-fed finger channels. The ponds are currently disconnected from groundwater in the summer and the pond temperatures get high. Through excavation, and connection to groundwater, they would have more constant flow, water level, and temperature. Additionally planned riparian planting and subsequent shading would improve temperatures. Salmonids are currently not present in the ponds. Chris Wegeman added that sticklebacks may be present. If the Flow Splitter project were also undertaken (SC 0.7), additional water from Spencer Creek would be added to the ponds.

Enough surveying has been conducted at this site for 30% design work to be completed if this project were selected by the stakeholder group. Pump tests are planned in the upper portion of the project. Before the design can move forward the LCFEG and Consultants need to meet to flush out design details.

Ranking Potential Projects

Marnie Tyler presented a preliminary approach to scoring projects and requested feedback from the group. She distributed a written summary of the project scoring approach, which adopts the same approach and scoring calculations used by the LCFRB Technical Advisory Committee. The data incorporated into the scoring matrix are drawn directly from the 6-Year Habitat Work Schedule.

As a starting point for generating scores, Marnie used a spreadsheet provided by LCFRB that was used in scoring projects in the Cowlitz assessment. This approach equally weights the benefits to fish (Benefits) and the certainty of success (Certainty). The initial Benefits and Certainty scores were developed by representatives from LCFEG, Waterfall Engineering, and Ecolution, with input on use of the scoring spreadsheet from LCFRB. The initial scoring approach included one modification to the spreadsheet intended to more precisely anticipate benefits to individual species and life history phases. Additionally, the project score without this modification was also retained within the scoring spreadsheet. Marnie distributed the resulting matrix that lists the projects in rank order.

Marnie requested feedback on the approach in general, the value of the modifications to the spreadsheet, and in particular, the Certainty component of the scoring. Pat requested direction from the group on which projects he should begin to develop 30% conceptual designs. Bernadette Hudson noted that the top four projects (by both scoring approaches) were distinctly higher than the projects below them and deferred to LCFEG, Waterfall Engineering and Ecolution to make the final call on which projects would be moved forward among those four. Bryce Glaser asked if a focal species had been identified for each project, or if multiple species were being considered. He added that WDFW is interested in reintroducing chum in the Lower Kalama because they are known to have been present historically, and the agency would have added interest in Kalama projects that were aimed at chum. Nello responded that because the Recovery Plan lists a low viability goal for chum, identifying chum as a project focal species is not effective in securing SRFB funds. However, Bernadette added that if chum were reintroduced, then scoring algorithms would be reconsidered by LCFRB, even for T4 reaches, because the Recovery Plan emphasizes linkages between existing recovery actions.

Pat explained that projects would be designed somewhat differently for different species and life phases, however a water source is critical for all projects. Any projects that include groundwater channel in the description have a high potential for chum use. After 10 years of designing and implementing these projects while at WDFW, Pat has found that these projects have been more effective when designed for multiple species. Pat recommends starting with a multi-species approach in targeting sites, but then modifying the design to target individual species where appropriate.

Project Timeline

At the last meeting, the group determined that it would be desirable to develop 30% designs for one project by May 2008, for pre-proposal submittal in the next SRFB grant round, despite concerns mentioned at that meeting about this approach. SRFB in the past has often wanted sponsors to wait until the assessment is complete. After further consideration, Nello determined that we should wait until the report is finished and not develop any projects for SRFB funding This year.

Nello asked Pat if it were possible to develop a 30% design for one project (KRL 2.5), and a simplified "conceptual design" for five others: KRR 0.7, KRR 2.1, KRR 2.2, SC0.5, and KRL 2.2. The consultants agreed to consider this request and respond at the next work group meeting.

Next Steps

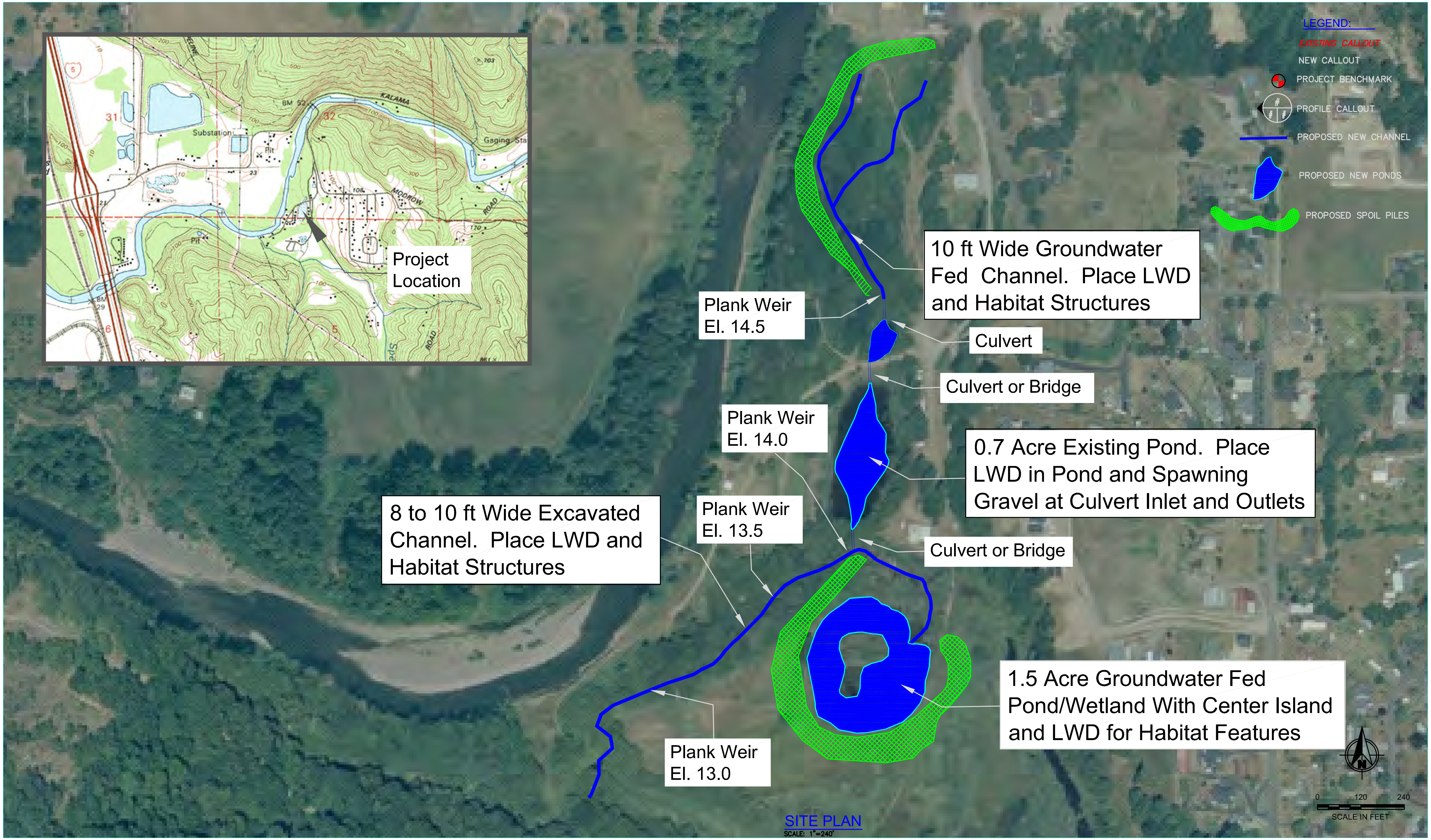
- April pump tests at two locations;
- Ongoing monitoring of water surface elevations and temperature;
- Site review of projects KRR 1.8 and 2.4, to firm up design concept;
- Develop draft report;
- Schedule next work group meeting for late summer.

Individual Tasks

- Donna will check HPA requirements for the Olympic Pipeline
- Nello will contact the County to discuss any possible actions they have planned for the Spencer Creek culvert
- Nello will contact the private landowner to assess supportiveness of project KRR 2.1

APPENDIX G. CONCEPTUAL DESIGN DRAWINGS AND COST ESTIMATES

1.0 Ledgett Groundwater Channel



Lower Kalama Off Channel Habitat Design

30% DESIGN NOT FOR CONSTRUCTION

REVISIONS

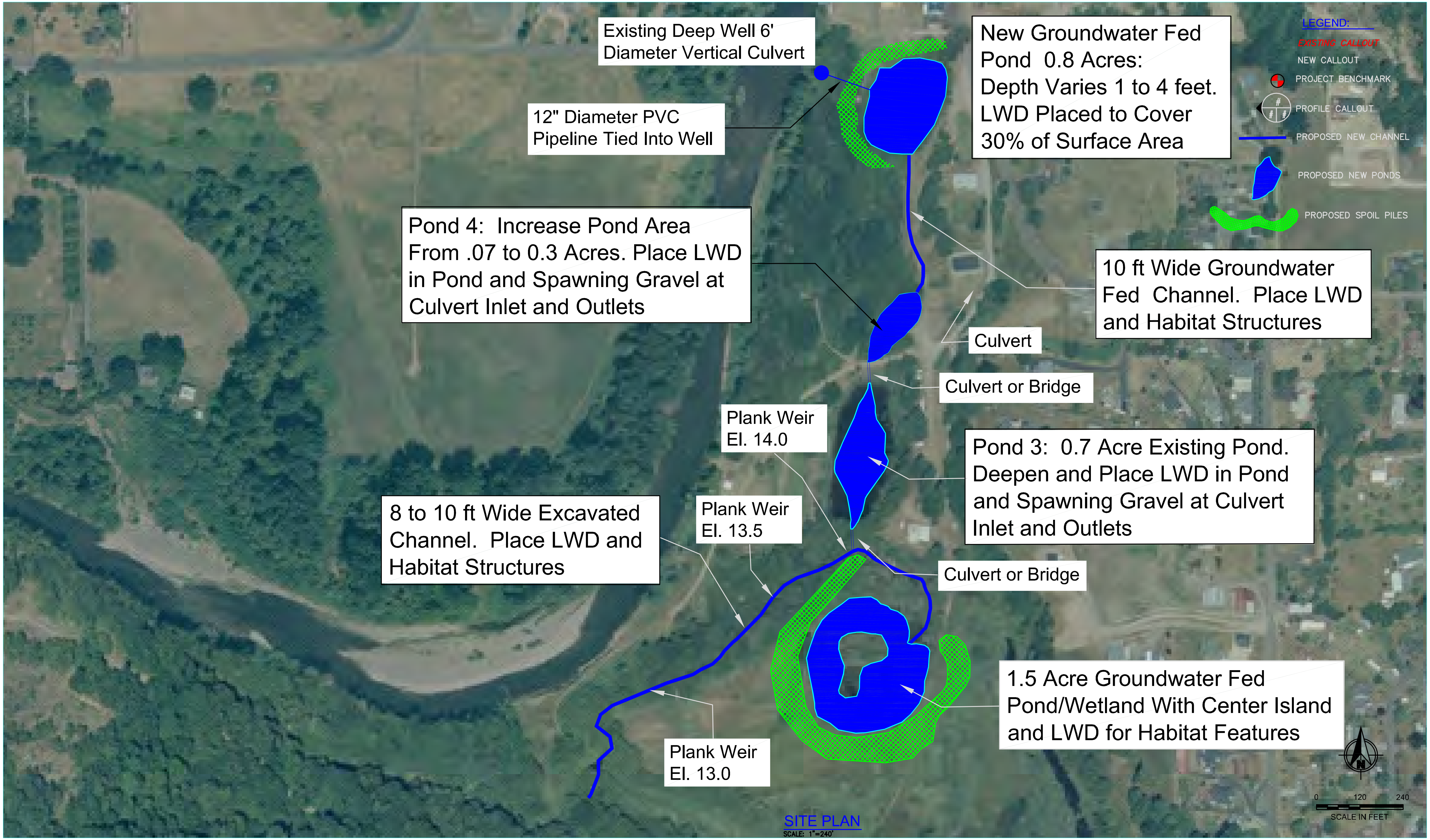
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Dimensions Drafting and Design
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 12/01/2008

KRL2.5 Ledgett Groundwater Channel

Main Project Features on Aerial Layout 1

SHEET NO. 1 OF 5



Lower Kalama Off Channel Habitat Design

30% DESIGN NOT FOR CONSTRUCTION

REVISIONS

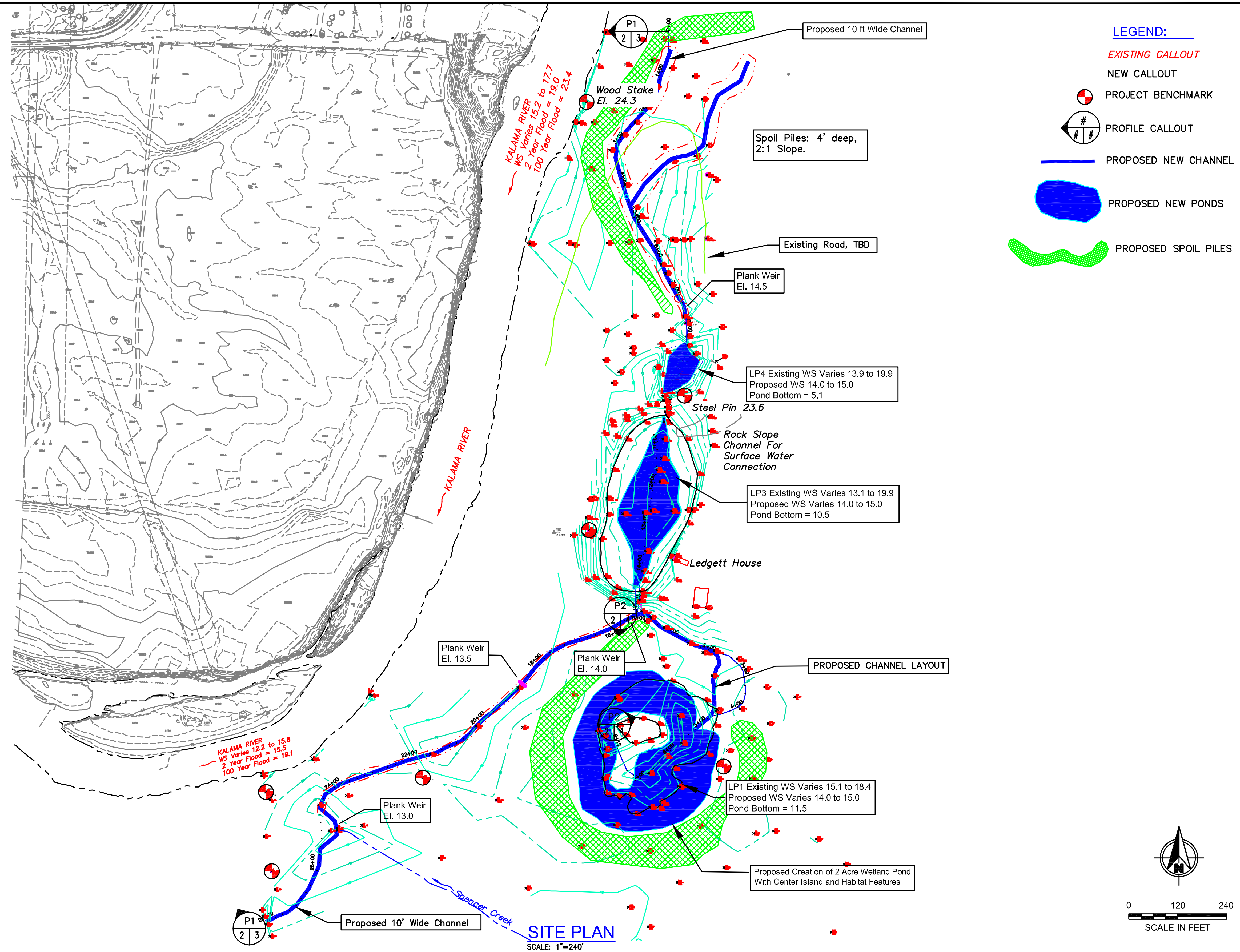
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Dimensions Drafting and Design
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 12/01/2008

KRL2.5 Ledgett Groundwater Channel

Main Project Features on Aerial Layout 2

SHEET NO. 2 OF 5



Lower Kalama Off Channel Habitat Design

30% DESIGN NOT FOR CONSTRUCTION

REVISIONS

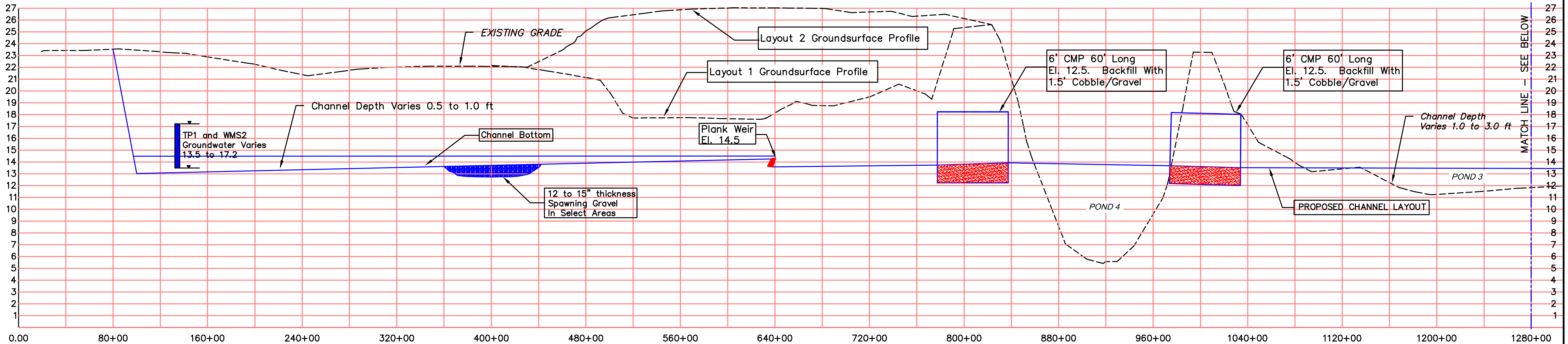
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Dimensions Drafting and Design
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 12/01/2008

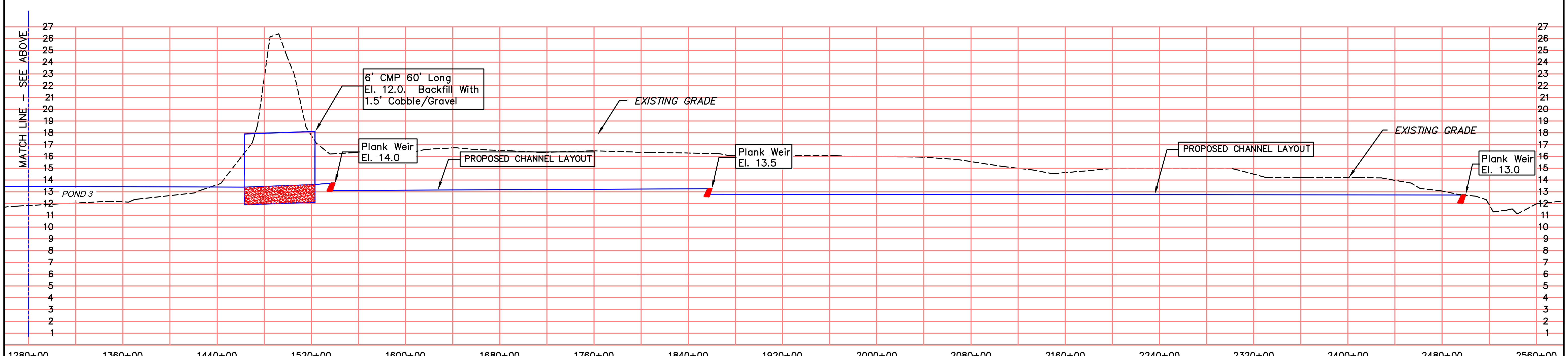
KRL2.5 Ledgett Groundwater Channel

SITE PLAN
Layout 1

SHEET NO. 3 OF 5



P1 2 3 CHANNEL PROFILE
SCALE: 1"=80' HORIZONTAL – 1"=8' VERTICAL



P1 2 3 CHANNEL PROFILE - CONTINUED
SCALE: 1"=80' HORIZONTAL – 1"=8' VERTICAL

Lower Kalama Off Channel Habitat Design

30% DESIGN NOT FOR CONSTRUCTION

REVISIONS

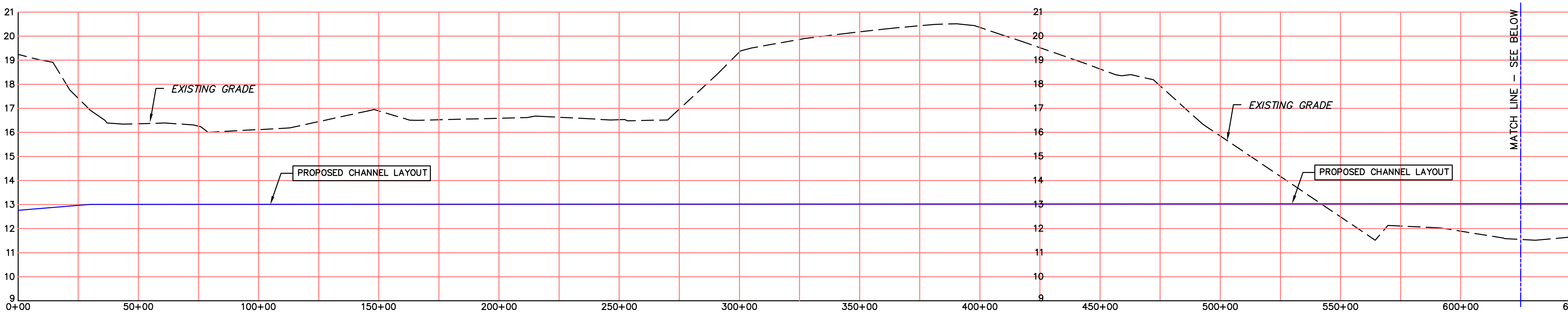
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Dimensions Drafting and Design
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 08/03/2008

KRL2.5 Ledgett Groundwater Channel

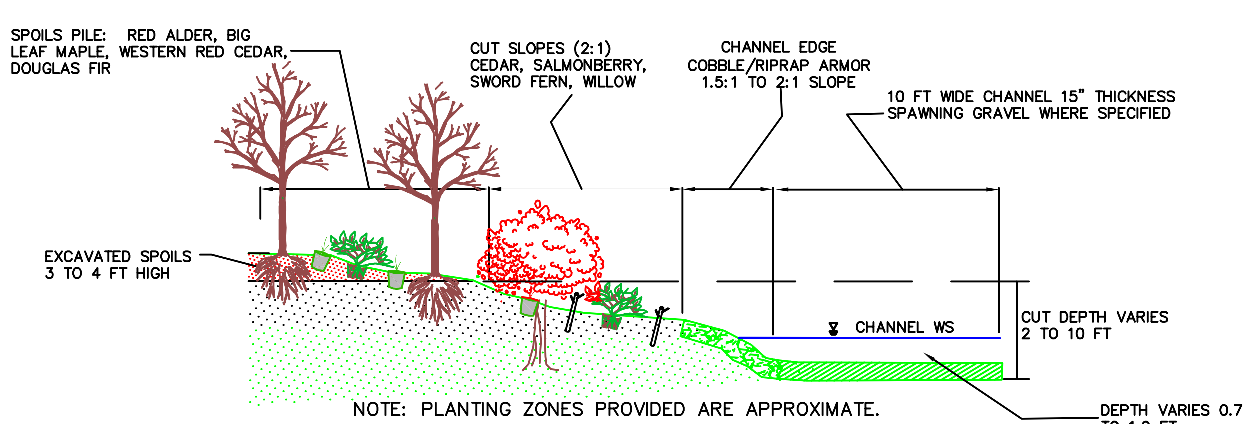
CHANNEL PROFILE

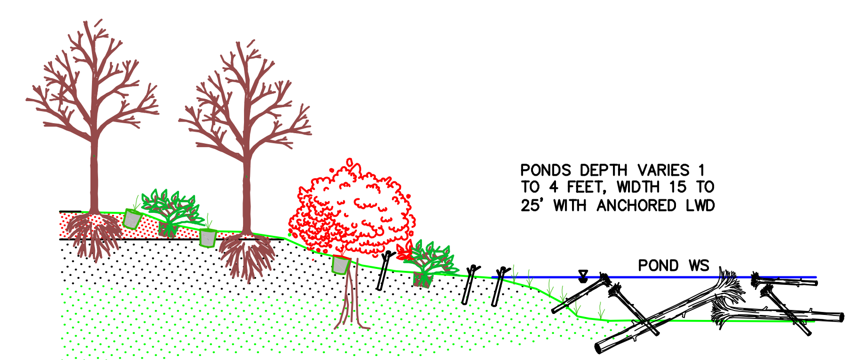
SHEET NO. 4 OF 5



P2 2 4 CHANNEL PROFILE CONNECTION TO POND 1

SCALE: 1"=40' HORIZONTAL – 1" =4' VERTICAL





TYPICAL POND SECTION

NOT TO SCALE

REV	DATE	BY	APP'D	DESCRIPTION

REVISIONS

Lower Kalama Off Channel Habitat Design

30% DESIGN NOT FOR CONSTRUCTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Dimensions Drafting and Design
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 07/23/2008

KRL2.5 Ledgett Groundwater Channel

PROFILE AND TYPICAL SECTIONS

SHEET NO. 5 OF 5

Ledgett Groundwater Channel - Layout 1

Date: February 22, 2009

Design Level: 30%

Project Description: Construct 800 ft of groundwater fed channel, 2 acre pond with LWD

Description	Unit	Qty	Cost	Amount	Sub Total	*Comments*
Channels and Ponds					**$306,800**	
Mobilization	L.S.	1	$40,000.00	$40,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$4,000.00	$4,000		*Pumps*
Utilities	L.S.	1	$2,000.00	$2,000		*Assumes some relocation and replacment*
Pond 3 and 4 Channel Excavation	C.Y.	7000	$12.00	$84,000		
Disposal	C.Y.	5000	$6.00	$30,000		*Spoil on site*
Pond 1 Channel Excavation	C.Y.	4000	$12.00	$48,000		
Disposal	C.Y.	4000	$6.00	$24,000		*Spoil on site*
Large Woody Debris	L.S.	1	$20,000.00	$20,000		
Spawning Gravel	C.Y.	320	$65.00	$20,800		
Plank Weirs	ea.	4	$2,000.00	$8,000		
Toe Protection Rock	C.Y.	400	$65.00	$26,000		
Culverts					**$119,675**	
Excavation	C.Y.	1200	$12.00	$14,400		
Disposal	C.Y.	1200	$6.00	$7,200		
Dispose of Culverts	ea.	3	$300.00	$900		
Bedding	L.S.	50	$60.00	$3,000		
72" Culvert	ft	180	$105.00	$18,900		
Install Culvert	ea.	3	$1,000.00	$3,000		
Gravel Backfill	C.Y.	35	$65.00	$2,275		
Riparian Plantings	acre	3	$10,000.00	$30,000		
Restoration						
Restoration	acre	4	$10,000.00	$40,000		
Sub Total					**$426,475**	
Contingency	15%				$63,971	
Sales Tax	7.7%				$37,800	
Construction Total					**$528,200**	
Admin and Engineering	20.0%				$105,600	
Project Total					**$633,800**	

Opinions of Probable Construction Cost

In providing opinions of probable construction cost, the Client understands that the Consultant (Waterfall Engineering, L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express of implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

Ledgett Groundwater Channel - Layout 2

Date: February 22, 2009

Design Level: 30%

Project Description: Construct 800 ft of groundwater fed channel, 2 acre pond with LWD, expand Pond 4 and 1 acre new pond

Description	Unit	Qty	Cost	Amount	Sub Total	*Comments*
Channels and Ponds					**$402,800**	
Mobilization	L.S.	1	$40,000.00	$40,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$4,000.00	$4,000		*Pumps*
Utilities	L.S.	1	$2,000.00	$2,000		*Assumes some relocation and replacment*
Pond and Channel Excavation	C.Y.	15000	$12.00	$180,000		
Disposal	C.Y.	5000	$6.00	$30,000		*Spoil on site*
Pond 1 Channel Excavation	C.Y.	4000	$12.00	$48,000		
Disposal	C.Y.	4000	$6.00	$24,000		*Spoil on site*
Large Woody Debris	L.S.	1	$20,000.00	$20,000		
Spawning Gravel	C.Y.	320	$65.00	$20,800		
Plank Weirs	ea.	4	$2,000.00	$8,000		
Toe Protection Rock	C.Y.	400	$65.00	$26,000		
Culverts					**$119,675**	
Excavation	C.Y.	1200	$12.00	$14,400		
Disposal	C.Y.	1200	$6.00	$7,200		
Dispose of Culverts	ea.	3	$300.00	$900		
Bedding	L.S.	50	$60.00	$3,000		
72" Culvert	ft	180	$105.00	$18,900		
Install Culvert	ea.	3	$1,000.00	$3,000		
Gravel Backfill	C.Y.	35	$65.00	$2,275		
Riparian Plantings	acre	3	$10,000.00	$30,000		
Restoration						
Restoration	acre	4	$10,000.00	$40,000		
Sub Total					**$522,475**	
Contingency	15%				$78,371	
Sales Tax	7.7%				$46,300	
Construction Total					**$647,100**	
Admin and Engineering	20.0%				$129,400	
Project Total					**$776,500**	

Opinions of Probable Construction Cost

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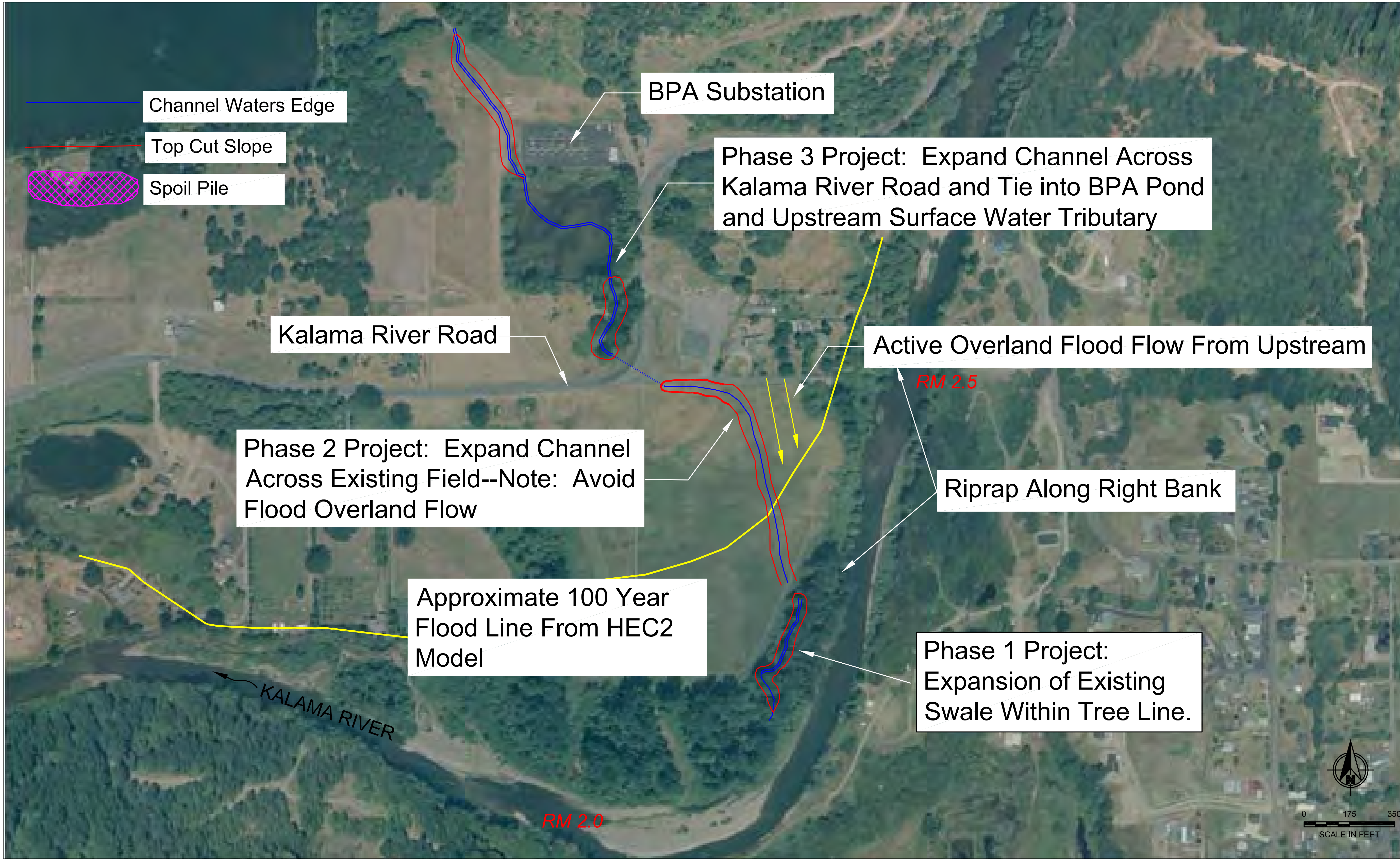
2.0 Port of Kalama Groundwater Channel



Lower Kalama Off Channel
Habitat Design

30% DESIGN
NOT FOR
CONSTRUCTION

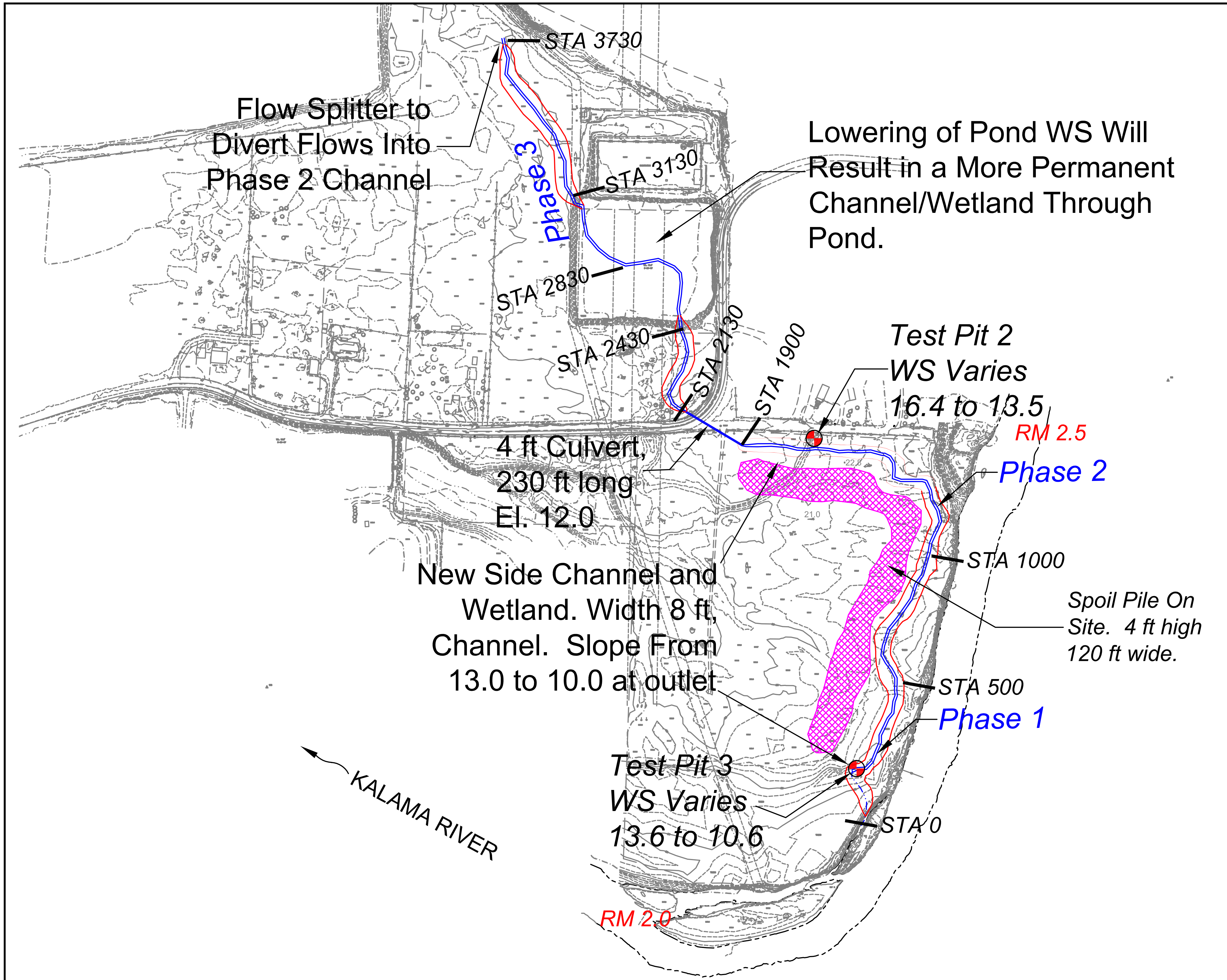
REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Waterfall Engineering
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 12/23/08

KRR 2.2 - Port of Kalama Groundwater Channel

2006 Aerial Photo

SHEET NO. 1 OF 3



LEGEND:

- Project Benchmark
- Channel Waters Edge
- Top Cut Slope
- Spoil Pile

Construction Notes:

1. Excavation: Phase 1: 3900 CY
   Phase 2: 18,000 CY
   Phase 3: 14,000 CY
2. Channel Slope: 0.13% (Ave)
3. Water Level and Depth Control With Plank Weirs (WDFW Standard Detail)
4. Cut Depth Varies 7 to 11 feet

Note: Channel Alignment From STA 600 to STA 1500 Will Experience Overland Flow From Flooding Upstream. Actual Channel Alignment Will Need to be moved to accomodate this.

N

0 175 350
SCALE IN FEET

SITE PLAN
SCALE: 1"=350'

Lower Kalama Off Channel Habitat Design

30% DESIGN NOT FOR CONSTRUCTION

REVISIONS

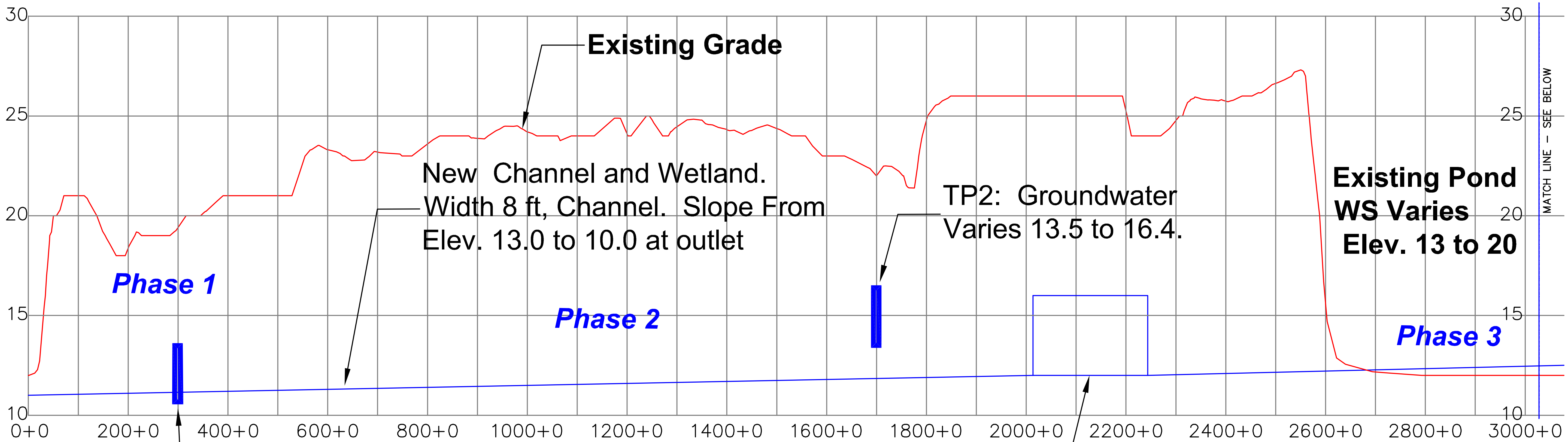
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Waterfall Engineering
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 12/23/08

KRR 2.2 - Port of Kalama Groundwater Channel

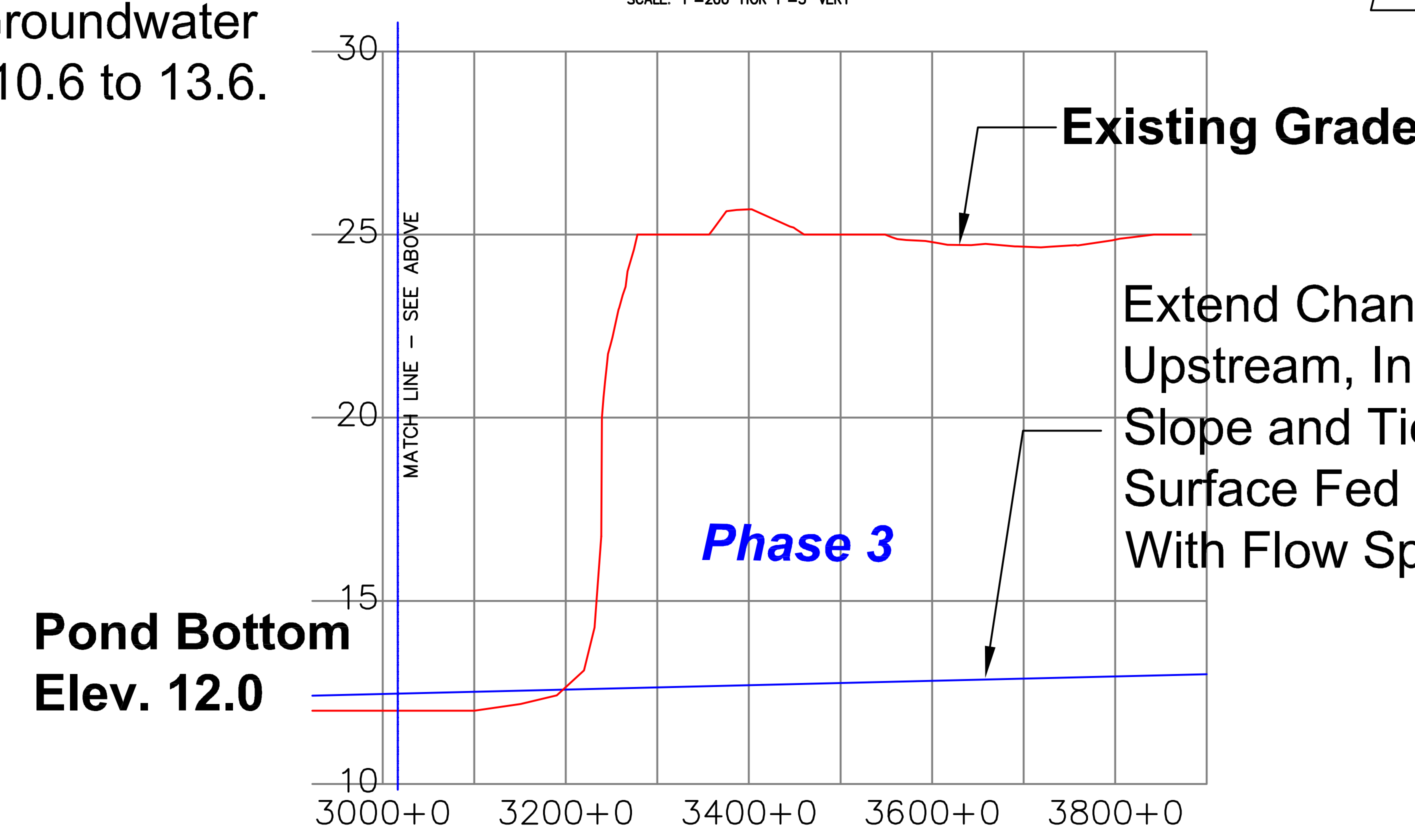
SITE PLAN

SHEET NO. 2 OF 3



CHANNEL PROFILE

SCALE: 1"=200' HOR 1"=5' VERT



CHANNEL PROFILE

SCALE: 1"=200' HOR 1"=5' VERT

0 100 200

SCALE IN FEET

Lower Kalama Off Channel
Habitat Design

30% DESIGN
NOT FOR
CONSTRUCTION

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY: Dimensions Drafting and Design
CHECKED BY: -
APPROVED BY: -
FILE: NOTED
DATE: 2/22/2009

KRR 2.2 - Port of Kalama Groundwater Channel

CHANNEL PROFILE

SHEET NO. 3 OF 3

Port of Kalama Groundwater Channel

Date: February 22, 2009
Stream: Kalama River
Design Level: Conceptual
Assumed Construction Time: 2011

Project Description: Construct 3700 feet of groundwater fed rearing channel and wetland habitat which will outlet into an existing active side channel on the right bank of the Kalama River.

Description	**Unit**	**Qty**	**Cost**	**Amount**	**Sub Total**	***Comments***
Phase 1: 500 Feet of Channel					**$104,392**	
Mobilization	L.S.	1	$9,000.00	$9,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$2,000.00	$2,000		*Pumps*
Excavation	C.Y.	4000	$12.00	$48,000		
Disposal	C.Y.	4000	$6.00	$24,000		*Spoil on site*
Utilities	L.S.	1	$1,000.00	$1,000		
Spawning Gravel	C.Y.	50	$65.00	$3,250		*Assumes 1/4 of Channel with added gravel*
Large Woody Debris	L.S.	1	$5,000.00	$5,000		
Plant Removal/Control	acre	0.5	$2,084.00	$1,042		*Assumes 30 wide riprarin strip each side*
Riparian Plant Installation	sq ft	22000	$0.05	$1,100		*planted with conifers*
Site maintenance	L.S.	1.5	$3,333.00	$5,000		
Restoration	ea.	1	$5,000.00	$5,000		
Phase 2: 1400 Feet of Channel					**$363,918**	
Mobilization	L.S.	1	$30,000.00	$30,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$2,000.00	$2,000		*Pumps*
Excavation	C.Y.	18000	$12.00	$216,000		
Disposal	C.Y.	18000	$4.00	$72,000		*Spoil on site*
Utilities	L.S.	1	$1,000.00	$1,000		
Spawning Gravel	C.Y.	200	$65.00	$13,000		*Assumes 1/4 of Channel with added gravel*
Large Woody Debris	L.S.	1	$5,000.00	$5,000		
Plank Weirs	ea.	5	$1,000.00	$5,000		*To provide depth and grade control*
Plant Removal/Control	acre	2.6	$2,084.00	$5,418		*Assumes 30 wide riprarin strip each side*
Riparian Plant Installation	sq ft	90000	$0.05	$4,500		*planted with conifers*
Site maintenance	L.S.	1.5	$3,333.00	$5,000		
Restoration	ea.	1	$5,000.00	$5,000		
Phase 2: 1600 Feet of Channel With Culvert and Flow Splitter					**$529,126**	
Mobilization	L.S.	1	$7,000.00	$7,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$1,500.00	$1,500		*Pumps*
Excavation	C.Y.	14000	$12.00	$168,000		
Disposal	C.Y.	14000	$4.00	$56,000		*Spoil on site*
Utilities	L.S.	1	$10,000.00	$10,000		*Assumes some relocation and replacment*
Streambed Gravel	C.Y.	50	$65.00	$3,250		
LWD	L.S.	1	$5,000.00	$5,000		
Gravel Placement	C.Y.	200	$30.00	$6,000		
Culvert	ft	230	$1,100.00	$253,000		
Plant Removal/Control	acre	2.2	$2,084.00	$4,585		*Assumes 30 wide riprarin strip each side*
Riparian Plant Installation	sq ft	95832	$0.05	$4,792		*planted with conifers*
Site maintenance	L.S.	1.5	$3,333.00	$5,000		
Restoration	ea.	1	$5,000.00	$5,000		
Sub Total					**$997,435**	
Contingency	15%				$149,615	
Sales Tax	7.7%				$88,300	
Construction Total					**$1,235,400**	
Admin and Engineering	20.0%				$247,100	
Project Total					**$1,482,500**	

Opinions of Probable Construction Cost

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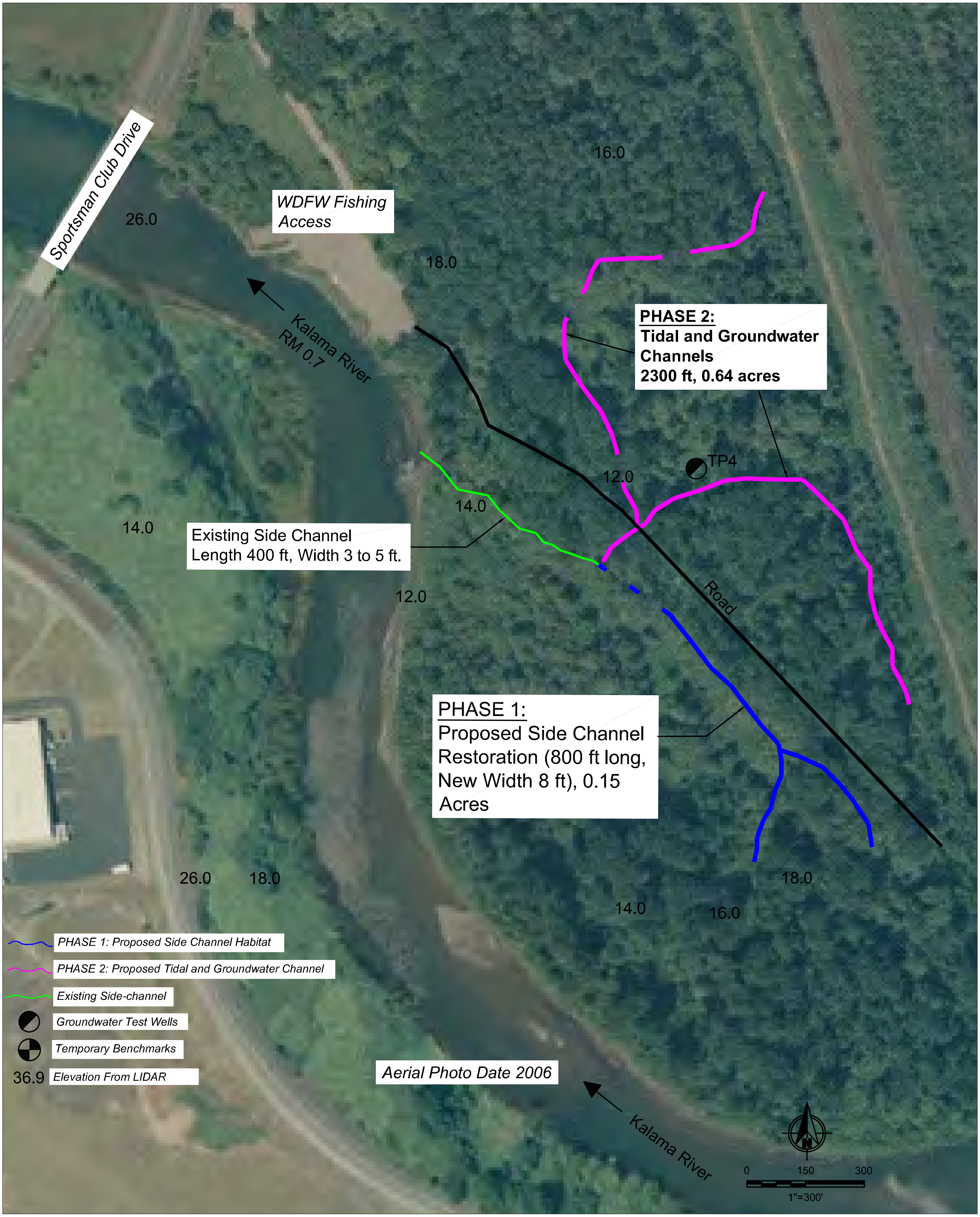
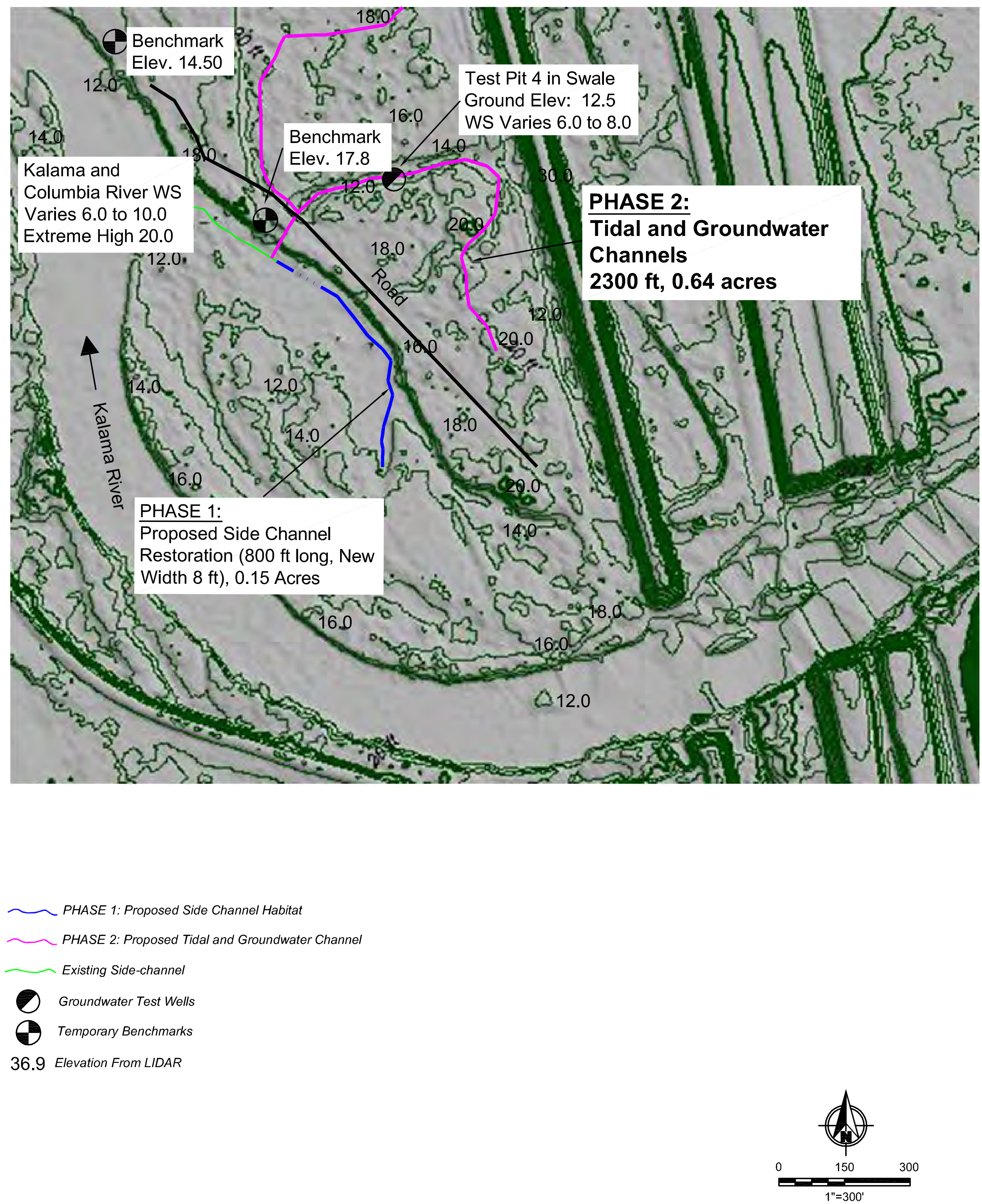
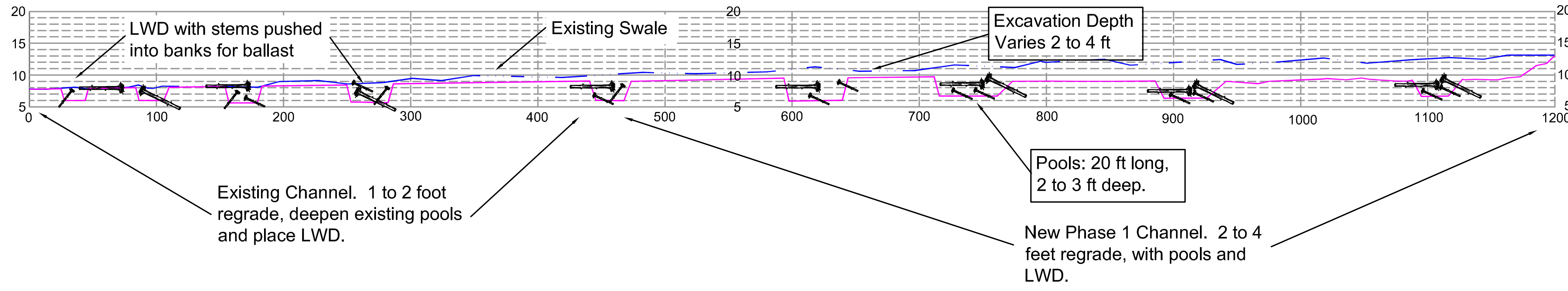
3.0 WDFW Tidal and Groundwater Channel



Sheet 1 of 3: KRR 0.7 - WDFW Tidal and Groundwater Channel - Aerial Photo



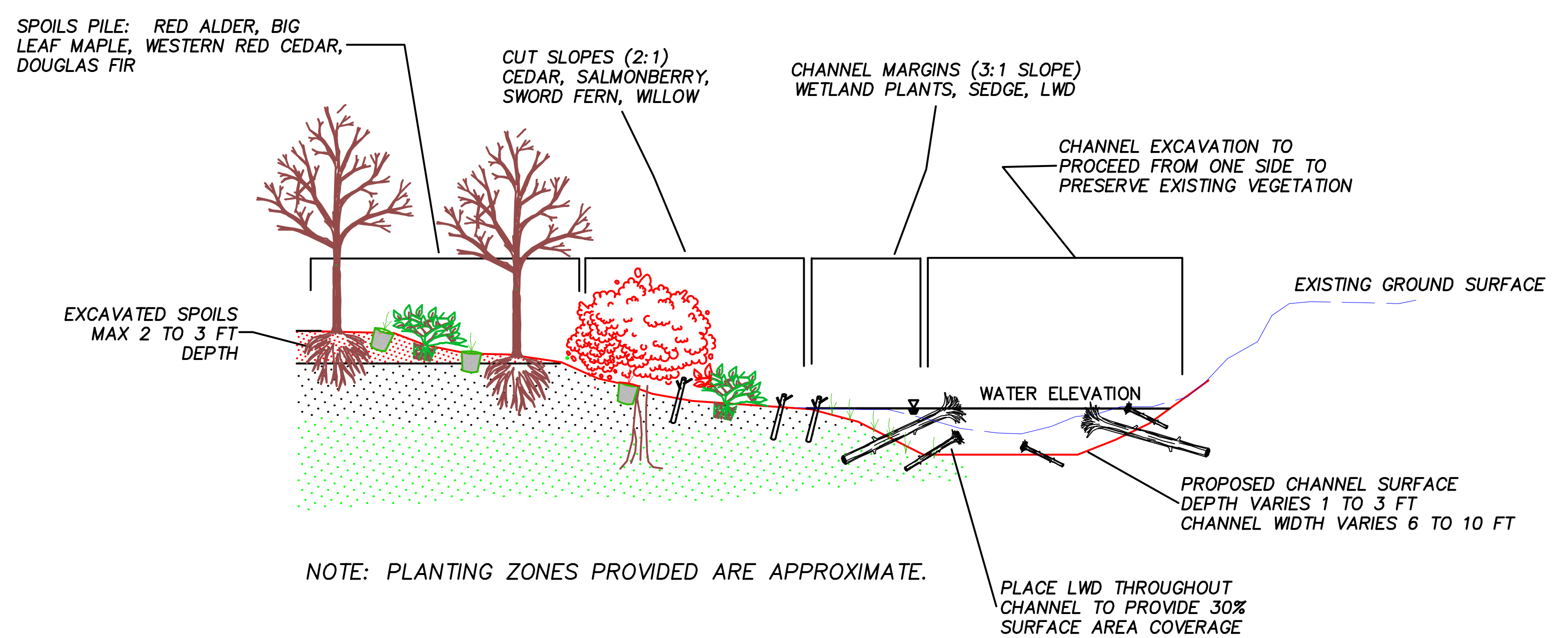
Sheet 2 of 3: KRR 0.7 - WDFW Tidal and Groundwater Channel - LiDAR Image and Contours



Proposed Channel Profile: PHASE 1

Vertical Scale 1" = 20 ft

Horizontal Scale 1" = 100 ft



NOTE: PLANTING ZONES PROVIDED ARE APPROXIMATE.

Typical Channel Section:

Not to Scale

KRR 0.7 - WDFW Tidal and Groundwater Channel

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: Waterfall Engineering
DRAWN BY:
CHECKED BY:
APPROVED BY:
FILE:
DATE: 12/23/08

Profile and Section

SHEET NO. 3 OF 3

WDFW Tidal and Groundwater Channel Cost Estimate

Date:	Jan-09
Design Level:	10%
By:	Waterfall Engineering

Project Description: 3100 ft of tidal and groundwater fed channels with ponds and LWD

Description	Unit	Qty	Cost	Amount	Sub Total	*Comments*
Phase 1					**$102,152**	
Mobilization	L.S.	1	$5,000.00	$5,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$1,000.00	$1,000		*Pumps*
Pond and Channel Excavation	C.Y.	3500	$12.00	$42,000		
Disposal	C.Y.	3500	$6.00	$21,000		*Spoil on site*
Large Woody Debris	L.S.	1	$5,000.00	$5,000		
Spawning Gravel	C.Y.	20	$65.00	$1,300		
Plank Weirs	ea.	4	$2,000.00	$8,000		
Toe Protection Rock	C.Y.	200	$65.00	$13,000		
Plant Removal/Control	acre	0.2	$2,084.00	$417		
Riparian Plant Installation	sq ft	8712	$0.05	$436		
Site maintenance	L.S.	1	$5,000.00	$5,000		
Phase 2					**$201,928**	
Mobilization	L.S.	1	$5,000.00	$5,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$2,000.00	$2,000		*Pumps*
Pond and Channel Excavation	C.Y.	9000	$12.00	$108,000		
Disposal	C.Y.	9000	$4.00	$36,000		*Spoil on site*
Large Woody Debris	L.S.	1	$8,000.00	$8,000		
Spawning Gravel	C.Y.	80	$65.00	$5,200		
Plank Weirs	ea.	2	$2,000.00	$4,000		
Toe Protection Rock	C.Y.	400	$65.00	$26,000		
Plant Removal/Control	acre	0.64	$2,084.00	$1,334		
Riparian Plant Installation	sq ft	27878.4	$0.05	$1,394		
Site maintenance	L.S.	1	$5,000.00	$5,000		
Sub Total					**$296,352**	
Contingency	10%				$29,635	
Sales Tax	7.7%				$25,100	
Construction Total					**$351,100**	
Admin and Engineering	20.0%				$70,200	
Project Total					**$421,300**	

Opinions of Probable Construction Cost

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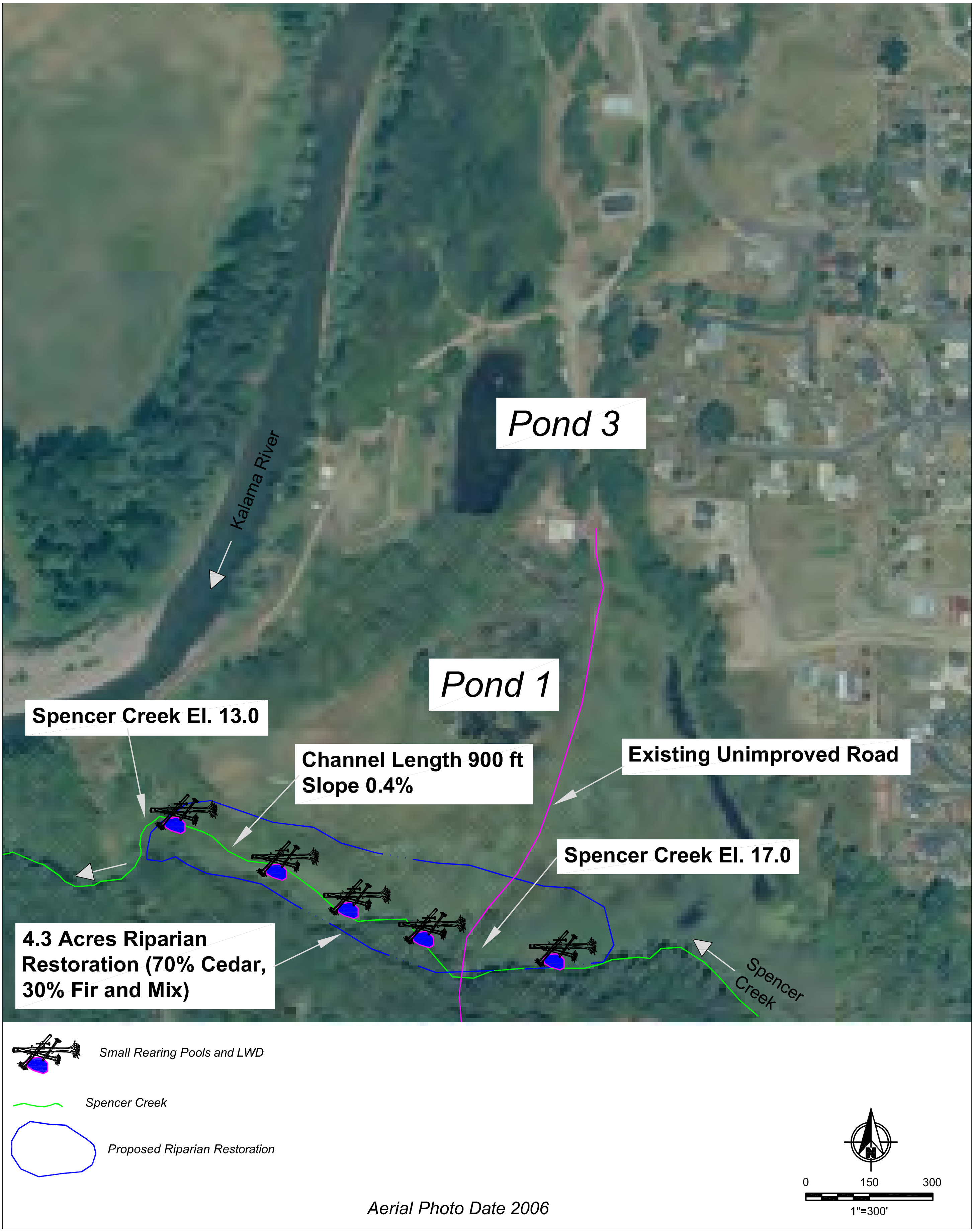
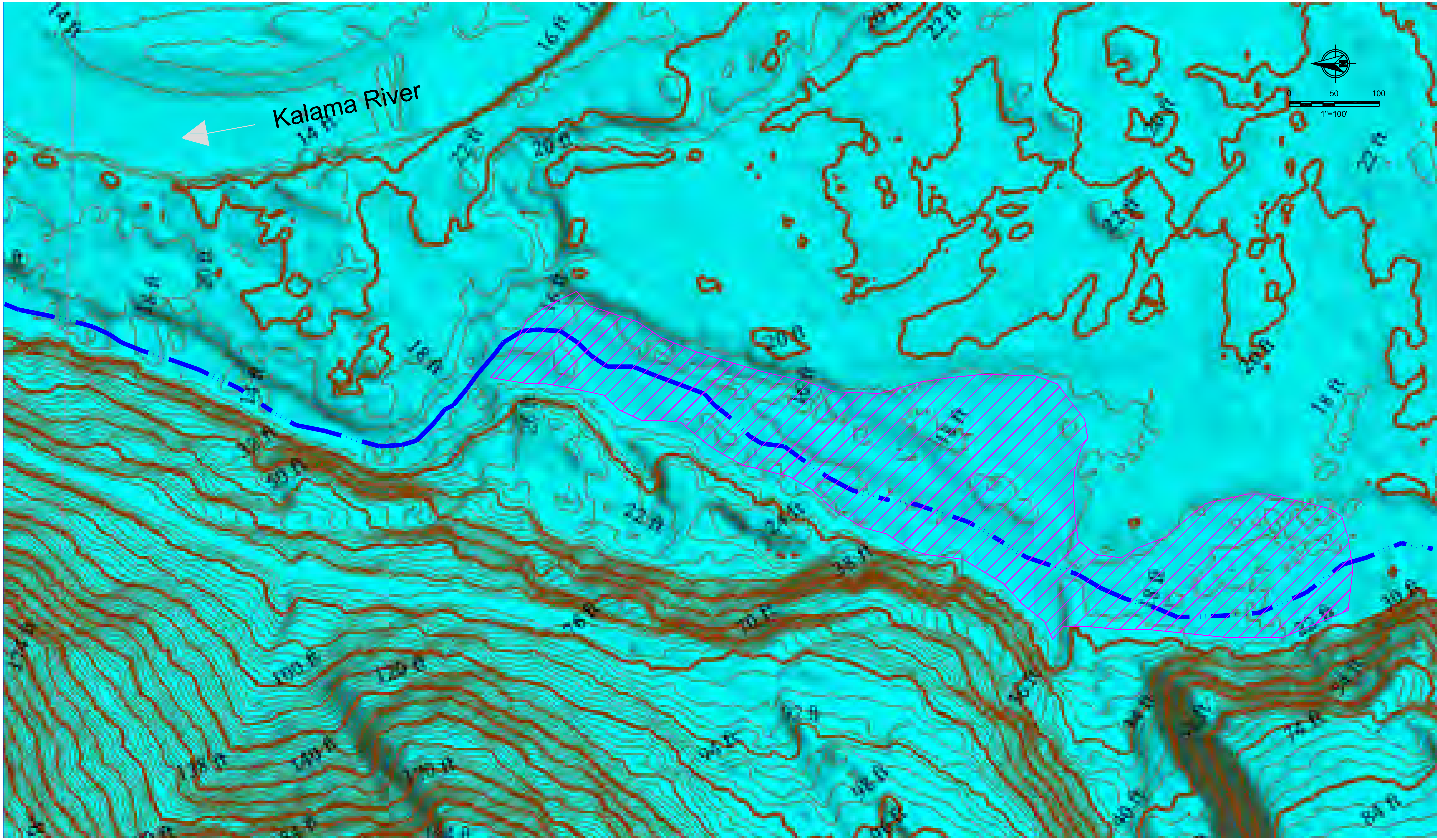
4.0 Spencer Creek Riparian and LWD



SC 0.5 Spencer Creek Riparian Restoration and LWD **Sheet 1 of 2**



SC0.5 - Spencer Creek Riparian Restoration and LWD	REVISIONS			
	REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: ______
DRAWN BY: ______
CHECKED BY: ______
APPROVED BY: ______
FILE: ______
DATE: ______

Lidar - PlanView

SHEET NO. 2 OF 2

Spencer Creek Riparian and LWD

Date: December 18, 2008
Design Level: 10%

Project Description: A 4.3 acre riparian restoration and LWD placement project.

Description	Unit	Qty	Cost	Amount	Sub Total	*Comments*
Channels and Ponds					**$65,355**	
Mobilization	L.S.	1	$5,000.00	$5,000		*Typically 10% of construction costs*
Water Management	L.S.	1	$500.00	$500		*Pumps*
Pond Excavation	C.Y.	150	$15.00	$2,250		
Disposal	C.Y.	150	$6.00	$900		*Spoil on site*
Large Woody Debris	ea.	5	$3,000.00	$15,000		
Spawning Gravel	C.Y.	40	$65.00	$2,600		
Plank Weirs	ea.	5	$1,500.00	$7,500		
Plant Removal/Control	acre	4.6	$2,084.00	$9,586		
Riparian Plant Installation	sq ft	200376	$0.05	$10,019		
Site maintenance	L.S.	1	$7,000.00	$7,000		
Restoration	ea.	1	$5,000.00	$5,000		
Sub Total					**$65,355**	
Contingency	10%				$6,536	
Sales Tax	7.7%				$5,500	
Construction Total					**$77,400**	
Admin and Engineering	20.0%				$15,500	
Project Total					**$92,900**	

Opinions of Probable Construction Cost

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