Abernathy and Germany Creeks Intensively Monitored Treatment Plan

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Executive Summary

The Mill, Abernathy, and Germany systems are important to salmon conservation and recovery, provide very real opportunities for significant habitat restoration, and are particularly well suited to fish and habitat monitoring and evaluation. ESA recovery objectives in the Columbia River coastal recovery strata cannot be achieved without significant improvement in the status of winter steelhead, coho salmon, chum salmon, and fall Chinook salmon populations that were once abundant in these streams. Chum and winter steelhead have primary populations in Germany and Abernathy Creeks. Coho and fall Chinook have contributing populations. The Lower Columbia Fish Recovery Board (LCFRB) initiated the development of this fish recovery implementation plan in order to direct funding of projects to recover these important populations.

The primary goal of these restoration projects is to improve in-stream, side-channel and floodplain habitat conditions. The guiding premise behind these projects is that restoration projects, and subsequent designs, must contribute to a larger watershed scale process-based framework. This approach builds on the idea that successful restoration projects start with an understanding of watershed scale physical processes and that these processes should facilitate the development of effective treatment strategies.

Field work for project identification focused in reaches that were the most important to fish recovery, according to the LCFRB's six-year Habitat Work Schedule (HWS; LCFRB 2008). The following HWS reaches were visited:

Abernathy Creek

- Abernathy 1-Abernathy 4: Confluence of Columbia River to Slide Creek (RM 0 to 3.08)
- Abernathy 5 & Abernathy 7: Technology Center to the Falls (RM 3.08 to RM 3.58)
- Abernathy 9- Abernathy 11: Erick Creek (RM 5.77) to RM 10.26
- Cameron 1: Confluence of Abernathy Creek to tributary 1231894462314 (RM 0 to 3.13)
- Weist 1: Confluence with Abernathy Creek to CHFA (RM 0 to 1.02)
- Sarah 1: Confluence with Abernathy Creek to the Forks (RM 0 to .42)
- Ordway 1: Confluence with Abernathy Creek to the Forks (RM 0 to .72)

Germany Creek

- Germany 2- Germany 6: Confluence of Columbia River to tributary 1231363462545 (RM .16 to 5.55)
- Germany 8: RM (7.02 to 7.15)
- Germany 10- Germany 13: (RM 8.29 to 8.59)

The limiting factors identified by the HWS include channel stability, habitat diversity, key habitat quality, sediment load, water temperature, and flow. This implementation plan defines

the specific types of restoration projects that address these limiting factors, where these projects should take place, and their relative priorities for project implementation.

Germany and Abernathy watersheds need corrective measures to 'force' changes between current habitat conditions and desired conditions that could support salmonids from the 0-3 year age class to returning spawners. In particular, channel morphology has been negatively impacted due to changes in the hydrology-sediment transport regime and through lack of LWD inputs of appropriate size and type (i.e. large conifers).

In terms of stream types and physical factors limiting fish recovery, Germany and Abernathy Creeks are characterized by 10 broad segments. The following descriptions summarize current conditions and the restoration actions prescribed in this plan:

Abernathy Creek

Abernathy 1-Abernathy 4: Confluence of Columbia River to Slide Creek (RM 0 to 3.08)

The tidal portion of Abernathy Creek (Abernathy 1, 2,) is depositional with sediment and limited LWD deposits. Two Engineered Log Jam projects are proposed to increase cover, scour, channel complexity, and rearing habitat for multiple Abernathy Creek and transient Columbia River migrants. The riparian condition is poor in the delta and there are many problems with invasive plant species. Riparian restoration projects are proposed that will increase shading, increase future habitat function, reduce predation, and reduce harassment from humans.

Upstream, Abernathy Creek transitions from a lower gradient (1%) unconfined system, with point bar formations (lower Abernathy 3), to a steeper confined bedrock canyon (middle part of Abernathy 3). There were active redds observed in the bedrock canyon. Upstream of the canyon, there is a depositional reach with channel gradients between 1-3% (Upper Abernathy 3 and Abernathy 4). The channel exhibits a plane-bed morphology with little pool habitat. In these reaches, there are restoration opportunities for LWD enhancement (ELJ structures), Riparian Enhancement, and Side Channel Enhancement. Eighty-four acres of riparian habitat has recently been restored along this section by the Cowlitz Conservation district. There are several areas where large LWD/ELJ structures should be used to facilitate sediment accumulation, force pool scouring and create localized backwater conditions in order to (re)connect side channels. These projects will increase rearing opportunities for coho and winter steelhead, and increase spawning habitat for Chinook and chum. Additionally, there are LWD enhancement opportunities on the side channels to increase habitat complexity and rearing opportunities for coho and winter steelhead.

Abernathy 5 & Abernathy 7: Technology Center to Weist Creek (RM 3.08 to 3.58)

This section of Abernathy Creek includes the USFWS hatchery and a natural bedrock formation which is >10 feet in height. This is a sediment transport reach that is largely bedrock in the upper portions transitioning to plane-bed morphology. Although both coho and steelhead pass over the natural bedrock formation, it may be a passage impediment during low flows. There are housing developments along the west bank. There are opportunities for limited LWD projects and riparian enhancement along both streambanks above the falls. Riparian enhancement would

help regulate stream temperature for Chinook spawning, improve long-term riparian function and therefore habitat diversity for Chinook, coho, and winter steelhead rearing. Minimizing fine sediment inputs from functioning riparian conditions will benefit Chinook, coho, and winter steelhead egg incubation. LWD enhancement will increase habitat diversity for Chinook fry colonization, coho rearing, winter steelhead rearing, and chum spawning.

Abernathy 9- Abernathy 11: Erick Creek to the end (RM 5.77 to 10.26)

This section represents a multitude of opportunities to improve instream, side channel and riparian zone habitat. This area contains more depositional areas than the previous downstream section. However, the majority of the main instream habitat has low diversity and a very low density of LWD. Although the riparian zone is good in terms of width and coverage, there are very few conifers in any age class. In addition, many of the side channels through this area are currently inaccessible and perched above the current main channel. Overall, 26 large ELJ structures are recommended in this section that would be designed to meet multiple objectives. The first objective is to raise the elevation of the active channel by aggrading cobble and gravel. The second objective is to enhance and maintain side-channel connections with the main channel. The third objective is to facilitate habitat diversity, pool formation, and sediment sorting. Meeting these objectives would enhance spawning and rearing opportunities for coho and winter steelhead. A large effort of LWD enhancement and conifer planting is also proposed for this section. The LWD enhancement would contribute to the objective of increasing habitat diversity, pool formation, and sediment sorting for coho and winter steelhead spawning and rearing. Planting conifers in the existing understory will contribute to future riparian function and LWD loading as the existing hardwoods reach the end of their life span.

In this section there is one very large wetland complex (1/2 to 3/4 mile) that has relict beaver ponds. This area is no longer connected to the main channel during normal flood events. This is an excellent opportunity to install 5-10 large ELJ structures to reactivate this wetland complex for coho rearing and to sustain main channel diversity for coho and winter steelhead spawning and rearing. There are several other opportunities to do LWD and side channel projects through this area.

Cameron 1: Confluence with Abernathy Creek to the Forks (RM 0 to .42)

Cameron Creek is a large tributary that enters Abernathy Creek at RM 0.56. Cameron 1 (tier 2) is a high gradient reach with very little sediment. Much of the lower portion of Cameron 1 was scoured to bedrock. Although the riparian zone was intact and mature, very little LWD was present in the channel. Older mature Spruce was present in the lower segment of the reach. Habitat complexity and sediment retention had occurred in the few areas where LWD was keyed into the channel. The high gradient, transport nature of Cameron 1 may make LWD rehabilitation a challenge, considering the large upper watershed and likely large stream power during flood flows. The confluence at Abernathy Creek is a depositional area. Projects in this reach include enhancing a side channel near the confluence with Abernathy Creek and increasing LWD densities. These projects would increase habitat complexity and benefit coho fry colonization and rearing, winter steelhead rearing, and chum salmon spawning habitat.

Weist 1: Confluence with Abernathy Creek to CHFA (RM 0 to 1.02)

Weist Creek joins Abernathy Creek at the downstream portion of Abernathy 8. The lower ½ mile of Weist 1 is a steep canyon section that is confined by the adjacent road and is incised to bedrock. Above the canyon is a broad valley with excellent meadow habitat. The creek meanders through a low gradient (<1%) unconfined area. The riparian buffer zone along this section has been severely degraded and the main channel lacks complexity. The single project proposed for this reach includes LWD enhancement and riparian enhancement in the meadow area that will increase habitat diversity for coho and winter steelhead rearing and help control fine sediments for winter steelhead egg incubation.

Sarah 1: Confluence with Abernathy Creek to the Forks (RM 0 to .42)

Sarah Creek is a small naturally confined stream that joins Abernathy Creek at the downstream end of Abernathy 10. Sarah 1 has a pool- riffle typology along much of the reach with some quality cobble/ gravel sediment. Towards the end of the reach, a side-channel and several hundred feet downstream were scoured to bedrock. This scoured segment is a transport reach with a 5+ ft bedrock waterfall at the terminal end. This waterfall may be a passage barrier for coho but is probably passable for steelhead. Downstream of the waterfall, cobble and gravel sediments were more abundant. One LWD enhancement project is proposed for this reach. This project would increase habitat diversity for coho in the scoured reach and improve passage over the waterfall.

Ordway 1: Confluence with Abernathy Creek to the Forks (RM 0 to .72)

Ordway Creek joins Abernathy Creek at the downstream end of Abernathy 11. Ordway Creek has a larger drainage area and more base flow than upper Abernathy Creek (i.e. upstream of confluence with Ordway Cr.). Ordway Creek also appeared to be contributing a significant amount of bedload to Abernathy Creek. Ordway 1 was relatively confined, but had a few narrow marshy benches that could serve as off-channel habitat. The mouth of Ordway 1, downstream of the bridge, is unconfined and complex with a high LWD density. One project in this reach is proposed to create a side channel in a marshy bench that contains significant seeps. This project would contribute to Coho juvenile rearing habitat.

Germany Creek

Germany 1- Germany 6: Confluence of Columbia River to tributary 1231363462545 (RM 5.55)

In the tidal portion of this segment (Germany 1 and 2), engineered log jam and riparian restoration projects are proposed. Multiple salmonid species use these reaches. The riparian restoration would regulate stream temperature for Chinook spawning, coho rearing, and steelhead rearing. The LWD jams and bank restoration would increase cover, scour, channel complexity and rearing habitat for multiple Germany Creek and transient Columbia River migrants. A bank protection project using biotechnical techniques is recommended to protect

Germany Creek Road from future erosion. Riparian enhancement between the Germany Creek road and Germany Creek could help reduce harassment and predation as well as provide shade. The Columbia Land Trust has already acquired 155 acres of riparian and floodplain habitat from the Columbia River confluence to approximately one mile upstream. In addition, the Columbia Land Trust has recently restored approximately 2.5 acres of off-channel salmonid rearing habitat by enhancing existing ponds located along the creek (vegetation planting and large woody debris placement) and providing access for salmonids from the main creek channel.

Upstream of the tidal area, the morphology transitions from a pool-riffle depositional reach to a steep confined bedrock canyon, to wide open valley, and finally back to another steep confined bedrock canyon. There are excellent opportunities for large ELJ structures and loading LWD through the lower portion to facilitate side channel rehabilitation. Side channel rehabilitation will increase habitat complexity, rearing opportunities, and winter refuge habitat for coho and winter steelhead. Above this lower portion, the channel complexity, floodplain connection, riparian buffers and channel sinuosity have been dramatically reduced. There is a discrete opportunity to reactivate one large relict wetland complex. In addition, there are several miles of river in which restoration projects could improve the riparian zone through plantings, and increase channel complexity through additions of LWD and/or channel relocation. Increasing channel complexity in the active channel would increase spawning habitat for chum and fry colonization for Chinook. There are many problems with invasive plant species throughout this area and there are opportunities for riparian restoration. Land ownership in this section is comprised of numerous landowners. Therefore, coordination among many landowners may be required for several projects identified in this section

Germany 8: RM 7.02 to 7.15

Germany 8 is a short reach between two tributaries in the mid-section of the Germany Creek watershed. The left bank is confined by a steep valley wall. The right bank is relatively unconfined and has the potential to contribute quality coho off-channel habitat. Restoration objectives in this reach are to increase LWD density to retain bedload, create hydraulic complexity, protect the left bank, and increase access to the unconfined right bank. Meeting these objectives would increase habitat diversity for fry colonization and juvenile rearing, and minimize the risk of increased fine sediment loading for egg incubation.

Germany 10- Germany 13: RM 8.29 to 10.45. Although Germany 11 and Germany 12 were not identified as priority reaches, but there were several redds observed by WDFW and restoration potential was considered good. This section has low main channel habitat complexity with a low density of LWD. Incision (vertical degradation) in the main channel has decreased hydrologic connection between the main channel, floodplains and side channels. Several side channels were found to be perched above the active channel. Restoration actions should consider adding LWD along these reaches through hand falling of existing trees within the riparian zone. Increased LWD density will promote gravel recruitment, sorting, create pools, and provide fish cover for coho and winter steelhead rearing. There are restoration opportunities to install 4 large ELJ structures to promote channel aggradation (accumulate sediments) and to reconnect relict side channels. Increased side channel habitat would benefit coho rearing. Bank stabilization projects at the upstream end of this section will help control mass wasting and therefore improve

egg incubation downstream for multiple species. There is also one culvert that needs to be replaced to improve fish passage.

Project Prioritization and Implementation

Sixty potential projects were identified in this plan. Projects were ranked based largely on an evaluation method developed by the LCFRB. This method considers the following factors in rating habitat projects:

- The species targeted by a project and their importance to recovery of the ESU;
- The estimated current and/or potential value of the targeted reach or project site to the performance of the targeted species;
- The species life history stages and associated limiting factors or habitat attributes targeted; and
- Anticipated improvement in the quality and quantity of habitat.

The ranked projects were divided into three two-year implementation phases of 20 projects each. The first phase, containing the 20 highest ranked projects, would produce the highest benefits to fish. Within each phase, projects were then grouped based on possible implementation efficiencies taking into consideration design interdependencies, geographic proximity, landownership, work sequencing, and similarities. Three 2-year implementation phases would meet the IMW objectives of producing a treatment effect within the timeframe of their study design.

The top twenty projects shown below were primarily associated with in-stream LWD enhancement and off/ side- channel enhancement. These projects address activation of historic side/ off channel habitat that is no longer accessible and forcing the main channel to a more complex condition.

EDT Reach	Project Name	Project Description	Group	EDT Tier	PAR Score	Total Benefit Score	Cost	Benefit/ Cost	Opportunity / Constraints Score
Abernathy 9	ABERNATHY 9G	Engineered Log Jams; LWD Enhancement (Wood from Riparian); Off/ Side Channel Enhancement (minor grading)	C	1	101	141	$500,485	9	high opportunity
Abernathy 2	ABERNATHY 2A	Engineered Log Jams	A	1	35	135	$260,640	16	high opportunity
Abernathy 9	ABERNATHY 9A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	D	1	77	117	$589,262	6	moderate
Abernathy 10	ABERNATHY 10B	Off/ Side Channel Enhancement; Engineered Log Jams; LWD Enhancement (Wood from Riparian)	C	1	62	112	$608,933	6	high opportunity
Abernathy 3	ABERNATHY 3C	Engineered Log Jams; LWD Enhancement (Imported Wood)	E	1	21	112	$138,959	26	high opportunity
Abernathy 5	ABERNATHY 5A	LWD Enhancement (Imported Wood)	D	1	20	106	$137,500	25	high opportunity
Germany 2	GERMANY 2A	Engineered Log Jams; Riparian Rehabilitation	B	1	15	106	$282,360	12	high opportunity
Germany 5	GERMANY 5D	Off/ Side Channel Enhancement; LWD Enhancement (Wood from Riparian); Engineered Log Jams	F	1	46	105	$897,149	4	Constraints
Abernathy 3	ABERNATHY 3A	LWD Enhancement (Imported Wood)	E	1	10	101	$125,000	26	moderate
Abernathy 3	ABERNATHY 3B	Engineered Log Jams	E	1	10	101	$130,320	25	high opportunity
Germany 5	GERMANY 5A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	D	1	39	98	$274,732	11	moderate
Germany 2	GERMANY 2C	Riparian Rehabilitation	B	1	6	97	$298,650	10	high opportunity
Germany 2	GERMANY 2B	Bank Stabilization/ Protection; LWD Enhancement (Imported Wood); Riparian Rehabilitation	B	1	3	94	$47,325	63	high opportunity
Germany 5	GERMANY 5B	LWD Enhancement (Imported Wood); Riparian Rehabilitation	F	1	34	93	$569,343	5	Constraints
Abernathy 9	ABERNATHY 9F	LWD Enhancement (Wood from Riparian); Engineered Log Jams	C	1	50	91	$221,659	13	high opportunity
Abernathy 1	ABERNATHY 1A	Engineered Log Jams	A	1	4	91	$80,000	36	high opportunity
Germany 5	GERMANY 5C	LWD Enhancement (Imported Wood)- main channel; LWD Enhancement (Imported Wood)- Side Channel; Riparian	F	1	19	78	$189,096	13	Constraints
Germany 5	GERMANY 5F	Off/ Side Channel Enhancement	F	1	13	72	$223,570	10	Constraints
Germany 6	GERMANY 6F	Off/ Side Channel Enhancement; Engineered Log Jams; Riparian Enhancement (underplanting)	F	1	26	67	$330,490	6	Constraints
Abernathy 10	ABERNATHY 10A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	D	1	16	66	$120,357	17	high opportunity

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1.0 Introduction

The Mill, Abernathy, and Germany systems are essential to salmon conservation and recovery, provide very real opportunities for significant habitat restoration, and are particularly well suited to fish and habitat monitoring and evaluation. ESA recovery objectives in the Columbia River coastal recovery strata cannot be achieved without significant improvement in the status of winter steelhead, coho salmon, chum salmon, and fall Chinook salmon populations that were once abundant in these streams. Chum and winter steelhead have primary populations in Germany and Abernathy Creeks. Coho and Fall Chinook have contributing populations. The Lower Columbia Fish Recovery Board (LCFRB) has initiated the development of this fish recovery implementation plan in order to direct funding of projects to recover these important populations.

This project is also related to the Intensively Monitored Watershed (IMW) project. The IMW project compares changes in salmon production among experimental treatment (restoration) and control (no restoration) watersheds. There are three IMW watershed complexes (Juan de Fuca, Hood Canal, and Lower Columbia) that differ in physical characteristics, land use patterns, climate and salmon relative abundance. Differences among watersheds and complexes also provide opportunities to address a range of factors that contribute to habitat degradation. The Lower Columbia IMW complex is composed of Germany, Abernathy, and Mill Creeks. Mill Creek is the control (no restoration). Germany and Abernathy Creeks will have restoration projects occurring in them in order to produce a treatment effect on biological response (i.e. fish recruitment).

The goal of the current project is to "complete a basin-wide treatment plan for Abernathy and Germany Creeks as part of the IMW experimental design." The following tasks have been completed to meet this end:

- Compiled existing data in order to determine factors limiting coho, steelhead, chum, and fall Chinook recovery and for possible reach/ site scale analysis.
- Developed qualitative field methods to identify causal factors at a site scale that confirmed landscape-scale limiting factors from the recovery plan.
- Identified project opportunities based on those site-scale causal factors.
- Developed methods for prioritization and implementation of project opportunities.
- Projects were prioritized based on the previously developed methods
- An implementation plan was developed based on the prioritization scores and opportunities for project efficiencies.

2.0 Watershed Descriptions

2.1 Topography and Geology (excerpt from LCFRB 2004)

The Mill/Abernathy/Germany Watershed is primarily a low elevation system, comprised primarily of volcanic (85%) and sedimentary and metamorphic rocks (13%). The majority of the

watersheds are comprised of low elevation, headwater and tributary subwatersheds; mostly in areas of low natural erodability (average rating is 11 on a scale of 0-126). Moderate sized, low elevation stream reaches drain both watersheds.

2.2 Climate and Precipitation (excerpt from LCFRB 2004)

The watersheds have a typical northwest maritime climate. Summers are dry and cool and winters are mild, wet, and cloudy. Most precipitation falls between October and March, with mean annual precipitation ranging from 45-118 inches with an average mean of 70-85 inches. Snowfall is light and transient owing to the relative low elevation and moderate temperatures. Less than 10% of the watershed area is within the rain-on-snow zone or higher (WDNR data).

2.3 Hydrology (excerpt from LCFRB 2004)

There has been a significant decrease in vegetative cover in the Mill/Abernathy/Germany Watershed, with potential impacts to runoff properties. Approximately 72% of the basin is either in early-seral stage forests, is cultivated land, or is developed land. Late-seral stage forests are virtually non-existent. High road densities are also a concern, with road densities greater than 5 miles/mi_2 throughout most of the basin. Forest and road conditions have potentially altered flow regimes. The Integrated Watershed Assessment (IWA) indicates that 11 or 14 subwatersheds in the watershed are 'impaired' with regards to runoff conditions; the remainder are 'moderately impaired'.

2.4 Land Use, Ownership, and Cover (excerpt from LCFRB 2004)

Forestry is the predominant land use in the Mill/Abernathy/Germany Watershed. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Nearly 0% of the forest cover is in late-seral stages. However, as the forest matures, watershed conditions are recovering. Agriculture and residential land use is located along lower alluvial stream segments of Mill, Abernathy, and Germany Creeks. The watershed is primarily in private ownership... The bulk of the private land is industrial forestland and road densities are high. The extent of the road network has important implications for watershed processes such as flow generation, sediment production, and contaminant transport. The State of Washington owns, and the Washington State Department of Natural Resources (DNR) manages the beds of all navigable waters within the subbasin.

2.5 Limiting Factors to Fish Recovery

Germany and Abernathy Creeks contain primary populations for chum and winter steelhead. Coho and Chinook have populations that are contributing to recovery of their respective ESUs. The LCFRB Fish and Wildlife Recovery Plan (Recovery Plan; 2004) has identified reach-scale factors limiting coho, steelhead, chum, and fall Chinook recovery in these creeks. A summary of these factors is presented in Appendix A and in section 4 of this report. The data sources used to define limiting factors in the recovery plan (LCFRB 2004) included the Ecosystem Diagnosis and Treatment (EDT) and the Integrated Watershed Assessment (IWA) models. One of the most important EDT model outputs are the "reach tiers" that indicate reach importance to fish

recovery. Figure 1 shows the reach tiers in Germany and Abernathy Creeks. The EDT model also predicts the factors most limiting to the recovery of specific species. Species-specific life history stage and limiting factors are presented in Appendix A. The Integrated Watershed Assessment (IWA) model predicts sub-watershed conditions based on conditions in that sub-watershed and in those upstream. IWA results are shown in Figure 2. Overall, the following primary habitat limiting factors identified in the Recovery Plan will be used to inform the restoration planning process.

- Channel stability
- Habitat diversity
- Key habitat quality
- Sediment load
- Water temperature
- Flow

Figure 1. Reach tiers in the Germany and Abernathy Creek watersheds. Tier 1 reaches are the most important for fish recovery, and higher order tiers are of less importance. Tier 0 reaches are undefined.

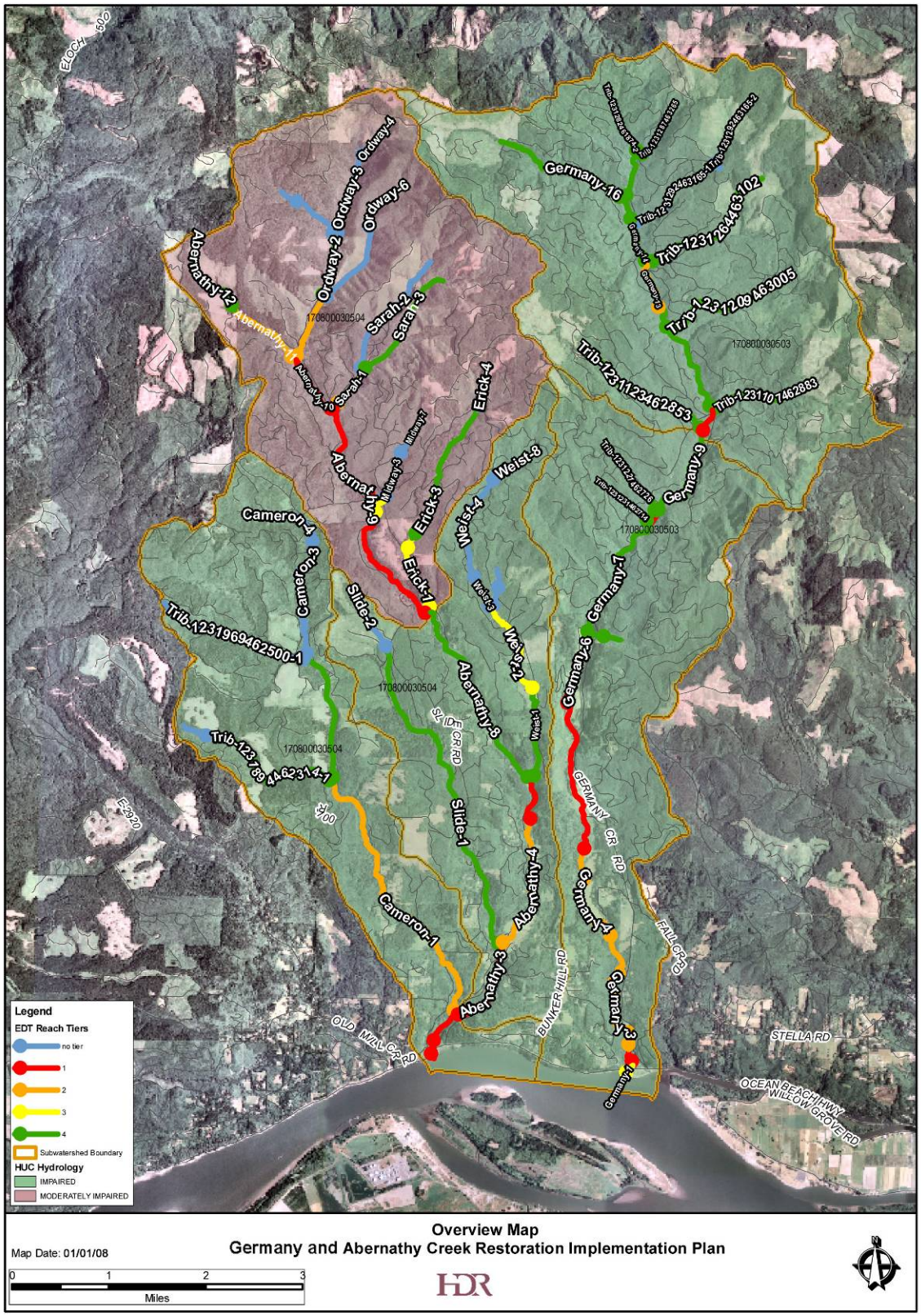
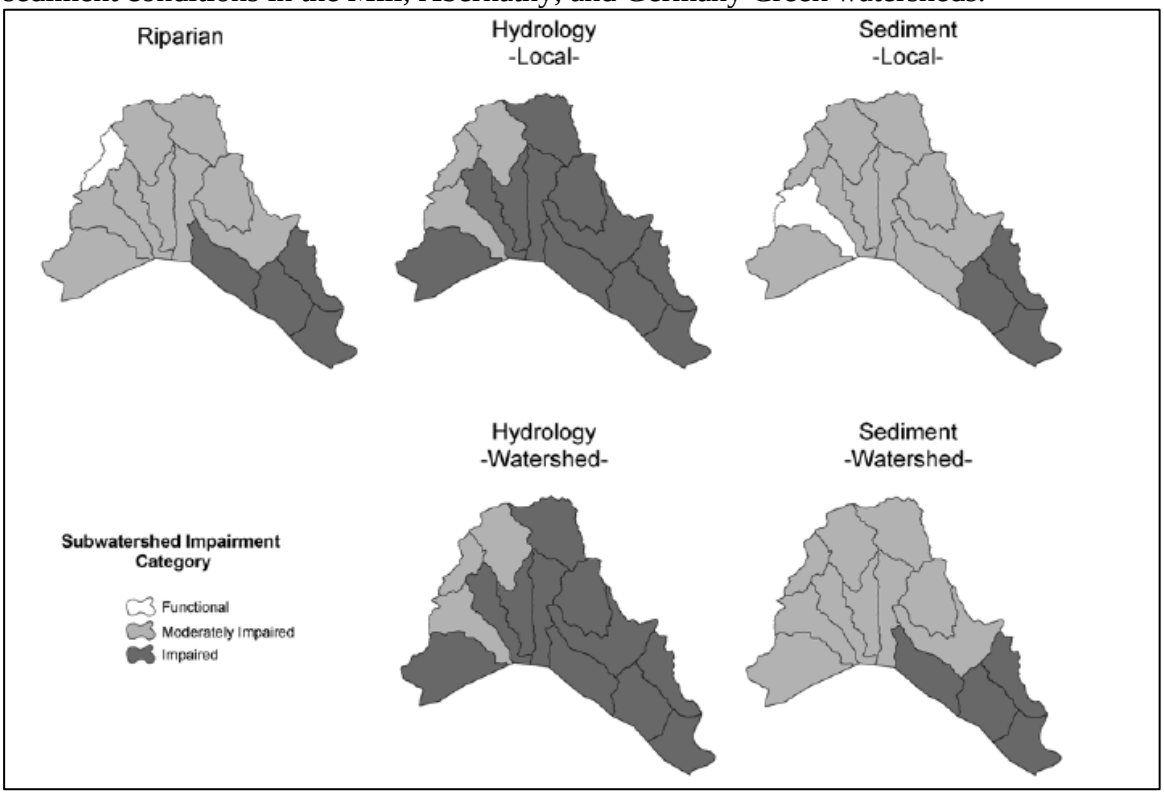


Figure 2. Integrated Watershed Assessment (IWA) modeling results on riparian, hydrology, and sediment conditions in the Mill, Abernathy, and Germany Creek watersheds.



3.0 Methods

3.1 Summary of Existing Data

3.1.1 Inventory of Existing Data

The following existing data about the Germany and Abernathy Creek watersheds were compiled to assist in development of project opportunities and an implementation schedule:

- EDT reach designations and tiering (LCFRB 2004)
- Limiting factors by fish species (LCFRB 2008)
- Watershed Process Limitations (LCFRB 2008)
- Reach description and project recommendations (Cowlitz County Conservation District)
- Fish passage barriers (WDFW)
- Parcel Taxlot Data (Cowlitz County)
- Fish distribution layer (IMW Program, WDFW)

- Spawning distribution (IMW Program, WDFW)
- Juvenile rearing distribution (IMW Program, WDFW)
- FEMA floodplain layer (WA Ecology)
- Aerial photography-NAIP imagery (WDFW)
- Road layer (WA DNR)
- Streamcourses (WA Ecology)
- Wetlands (National Wetlands Inventory)

3.1.2 Use of Data in Project Identification and Concept Designs

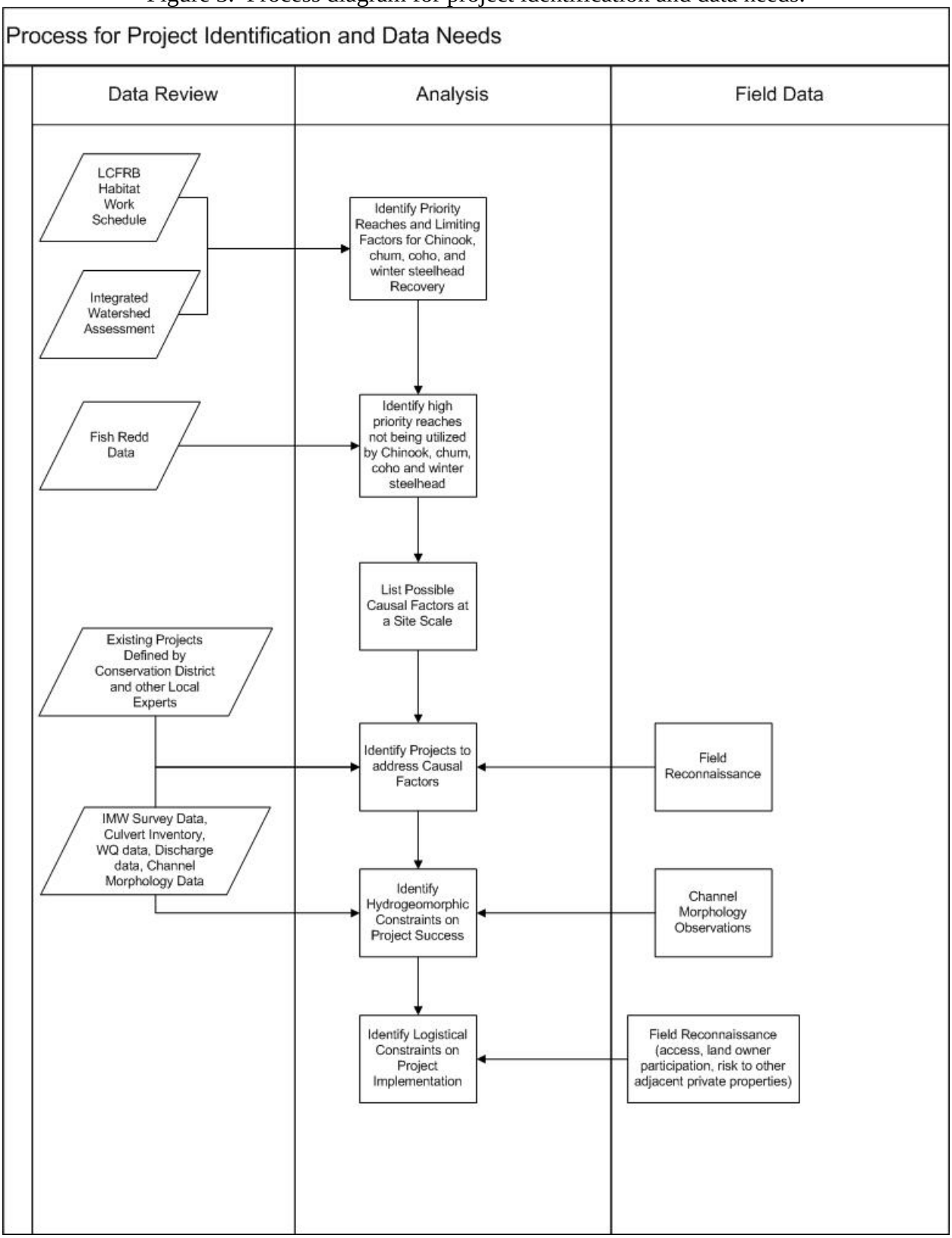
The data inventoried were used to complete the following tasks:

1) Identify priority reaches and factors limiting coho, steelhead, chum, and fall Chinook recovery
2) Identify projects that address these limiting factors
3) Identify hydro-geomorphic constraints on project implementation and success.

The use of existing and new field data is depicted in Figure 3. The limiting factors assessments (EDT, IWA) were used to focus attention in the field on degradation that would contribute to the factors limiting fish recovery. The reach tiers provided a way to prioritize field work, since the effort was limited to four days. The fish utilization and redd distribution data were used to either identify tier 1 reaches that were not being utilized by fish or higher tier reaches that were being utilized by fish. Some higher tier reaches that were being used by fish were visited in the field, whereas other high tier reaches were not visited due to time constraints. The qualitative reach descriptions and project recommendations were used in the field to focus attention on specific reaches or segments of reaches for specific impacts or project types. The IMW habitat survey data were also used to help shape our expectations for reach conditions. The LWD survey data were particularly helpful, since quantitative LWD counts were not possible in the scope of the current field effort.

During the current field effort, qualitative observations were made to justify the citing of potential projects. In addition, coarse stream morphology measurements were made to support the development of concept designs. IMW habitat survey data were also used to support development of concept designs.

Figure 3. Process diagram for project identification and data needs.



3.2 Methods to Identify and Prioritize Potential Habitat Restoration Projects

3.2.1 Desktop Analysis

Project identification started with a desktop analysis of recent digital orthophotos and other relevant spatial data. When identifying potential projects, reach tiers, limiting factors, wetlands, fish passage barriers, and other spatial data were considered along with previous recommendations from the Cowlitz County Conservation District. This desktop analysis helped focus field work on project opportunities in high priority reaches and on the primary life-stage limiting factors for the target fish species. Selection of project opportunities were also guided by the reach-level strategies and goals developed as part of the Recovery Plan and Habitat Work Schedule.

3.2.2 Reconnaissance Identification of Causal Factors and Potential Projects

The limiting factors identified by the EDT and IWA models were used to make observations at both the landscape and reach scale. The first objective for field work was to identify site-scale impacts (i.e., causal factors) that are contributing to those limiting factors and specific project types to remedy those impacts. Table 1 lists the causal factors that were observed in the field.

Table 1. Parameters observed for reconnaissance /project identification

Parameter
Channel confinement
Substrate size distribution
Riparian conditions
LWD size and distribution
Channel type

Observations of these causal factors were used to help evaluate conditions at a site scale and define project opportunities. A reconnaissance-level survey was completed in the tier 1 and 2 stream reaches to identify potential projects. The field teams categorized the causal factors based on guidance in Appendix B. Tier 3 and 4 streams were only visited if time allowed; however, reaches with major sediment inputs or passage barriers were visited since these impacts could potentially affect the tier 1 and 2 reaches. Reaches that are relatively inaccessible were only visited if time allowed and if the anticipated project types were feasible given the access constraints.

3.2.3 Project Types and Project Metrics

Each potential project was described with metrics that were descriptive of conditions in the field and would compliment the funding application process. Table 2 lists the project types and metrics that were measured or estimated in the field. These metrics are from the LCFRB pre-proposal guidelines.

Table 2. Project metrics measured during field reconnaissance.

Project Types and Metrics	Units
Fish Passage Improvement (e.g. Culvert Replacement)	
Outfall Drop	feet
Culvert Slope	%
Est. Distance of Usable Habitat Upstream	feet
In-Stream Habitat (e.g. LWD, ELJs)	
Length of Stream Treated	feet
Type of structure to be Placed	text
Number of Structures to be Placed	count
Off/ Side-Channel Enhancement	
Length of Channel Treated or Created	feet
Width of Channel Treated or Created	feet
Current Access into Side-Channel	text
Proposed Access into Side-Channel	text
Type of structure to be Placed	text
Number of Structures to be Placed	count
Floodplain Function/ Channel Migration (e.g. Levee Removal)	
Type of Proposed Enhancement	text
Length of Proposed Enhancement	feet
Width of Proposed Enhancement	feet
Riparian Enhancement/ Rehabilitation	
Length of Proposed Enhancement	feet
Width of Proposed Enhancement	feet
Left Bank, Right Bank, or Both Banks	text
Watershed Conditions/ Hillslope Processes	
Type of Proposed Treatement	text
# Acres to be Treated	acres
Bank Stabilization	
Length of Bank to be Treated	feet
Type of Proposed Treatment	text
Left Bank, Right Bank, or Both Banks	text
Protection (Acquistion/ Easement)	
# Acres to be Protected	acres
Stream Length Protected	feet

3.3 Project Cost

The project types in Table 3 were used to define cost. The unit costs were taken from Puget Sound Shared Strategy (2003) cost model. This cost model developed by the Evergreen Funding Consultants and was derived from interviewing many restoration professionals. For each project type, an array of unit cost ranges were developed based on variations of the most important factors driving cost. Each unit cost was escalated to 2008 dollars using the Seattle, WA construction cost index to account for inflation. Each cost estimate for Germany and Abernathy Creek project is based on assumptions that determined the most appropriate unit cost range. Based on those assumptions, a minimum, mean, and maximum cost was determined for each project type and metric. Since multiple project types were oftentimes prescribed for a given

location, multiple costs (min, mean, max) were summed to equal a total project cost. The cost model did not perform very well for small projects, because the linear nature of the cost per habitat unit does not account for fixed costs such as design, permitting, and equipment mobilization in small projects. In these cases, adjustments were made to projects whose costs were not consistent with professional experience in that project type.

Table 3. Variable Project Costs.

		Unit Cost		
Project Type	Units	Min	Max	Mean
Off/ Side Channel Enhancement	per acre	$76,020	$108,600	$92,310
LWD Enhancement (Wood from Riparian)	per acre	$10,860	$32,580	$21,720
LWD Enhancement (Imported Wood)	per mile	$21,720	$54,300	$38,010
Engineered Log Jams	per structure	$21,720	$43,440	$32,580
Riparian Enhancement (Underplanting)	per acre	$10,860	$38,010	$24,435
Riparian Rehabilitation	per acre	$48,870	$70,590	$59,730
Bank Stabilization/ Protection	per foot	$65	$109	$87
Culvert Replacement	per structure	$21,720	$43,440	$32,580
Bridge Removal	per structure	$16,290	$54,300	$35,295

The following assumptions were made for each project type in order to derive unit costs:

- Riparian Enhancement- Underplanting of conifers in existing riparian
  - No clearing required
  - Medium density planting (10 ft on center)
  - Difficult access, but minimal materials (bare root plants, no weed block)
  - Range is $10,860- $38,010 per acre
- Riparian Rehabilitation- No existing riparian
  - Clearing and management of invasive weeds required
  - High density planting (5 ft on center) of multiple species
  - Difficult access, weed block
  - Range is $48,870- $70,590 per acre
- Culvert Replacement
  - Road type is a forest road
  - Size of waterway is between 0- 10 feet wide
  - Range is $21,720 $43,440 per project
- LWD Enhancement (Wood from Riparian)
  - Materials can be fallen or cable-yarded into the stream from the adjacent riparian zone. (25- 36 inch diameter)
  - Transportation is near (0-7 miles)
  - Stream size is small (1- 100 cfs)
  - 100- 400 pieces per stream mile
  - Range is $10,860- $32,580 per stream mile

- LWD Enhancement (Imported Wood)
  - Imported large diameter materials (25- 36 inch diameter)
  - Transportation is near (0-7 miles)
  - Stream size is small (1- 100 cfs)
  - 100- 400 pieces per stream mile
  - Range is $21,720- $54,300 per stream mile
- Engineered Log Jams (ELJs)
  - Imported large diameter materials (25- 36 inch diameter)
  - Transportation is 7-20 miles away
  - Stream size is small (1- 100 cfs)
  - Range is $21,720- $43,440 per structure
- Bank Stabilization (biotechnical)
  - Stream size is small (1- 100 cfs)
  - Moderate excavation (re-grading, placement of logs/ stumps for protection, etc.)
  - Range is $65- $109 per lineal foot
- Off/ Side Channel Enhancement/ Creation
  - Energy of waterway is medium (2nd order trib with pool/ riffle morphology; or 3rd or 4th order mainstem rivers).
  - Moderate amount of earthmoving (50- 500 yards per acre)
  - Range is $76,020- $108,600 per acre

3.4 Prioritization Methods

The project prioritization strategy takes the list of preliminary project opportunities identified from the in-office and field evaluation efforts and scores them according to how well they meet a number of stream habitat restoration objectives. All projects submitted for scoring assume the project will meet the following criteria:

- The approach meets the goals and objectives of the Recovery Plan and Habitat Work Schedule
- The approach is technically appropriate,
- The project is coordinated with other habitat protection and restoration efforts in the watershed.

Project scoring results will help determine appropriate project sequencing and will be used to determine which projects are carried forward for conceptual designs. This prioritization method takes into account a similar suite of factors addressed by the LCFRB project evaluation criteria. Projects that rank high using this method would be expected to rank high in the LCFRB evaluation. Benefits can be generally defined as improvements in productivity, abundance, and/or distribution. Each project is assigned a benefit rating of high, medium, or low as well as a numerical score. The three categories included in the evaluation are:

- Fish benefits
- Cost benefits
- Constraints and opportunities

This prioritization method derives a project rating (high, med, or low) and a numerical score for each of the three categories based on scoring of elements within each category. Only those projects with ratings of high or medium for the fish benefit, cost, and constraints or opportunities will be considered for conceptual design. Projects with a low rating will remain on the potential project list and may be re-evaluated in the future.

3.4.1 Fish Benefits

Fish benefits can be generally defined as improvements in productivity, abundance, and/or distribution to at least one fish species. The key components of the benefits determination reflect the degree that a project targets priority populations, their limiting life stages and factors, and the importance of the reach to the population as described in the EDT analysis (LCFRB 2008; Appendix A).

The fish benefit score sums the following:

- Population/ Reach Score, and
- Preservation, Access, Restoration (PAR) Score

Population/ Reach Score: Population/Reach Scores reflect the degree that a project targets priority populations and reaches. A project also receives a Population/Reach rating (high, med, or low) based on the Tier of the targeted reach and the population score. A reach tier is a categorical variable that varies from 1-4 and is indicates the relative importance of a reach to fish recovery. Tier 1 reaches are the most important to fish recovery, and tier 4 reaches are the least important (Table 4; LCFRB 2008).

Table 4. Reach tier designation rules.

Designation Rule	
Reaches	Rule
Tier 1	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary population and/ or all high priority reaches for one or more contributing populations.
Tier 3	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.

Scores for both ratings are combined and result in a numerical score. That score is normalized to a scale of 1-100. Tier ratings are based on the following rules.

> **Reach Tier Designation Rules:** All Tier 1 (based on EDT) reaches receive a "high" rating. Tier 2 reaches receive a "medium" rating. Tier 3 and 4 reaches receive a "low" rating.

Population Score Rules: Each project received a Population/ Reach Score. This score reflects that reaches within a given Tier that is believed to be used by a number of populations of varying recovery classifications and that the targeted reach or reaches may be of varying importance to the populations. The population score reflects the importance of the populations present in the reach to regional recovery (i.e. primary, contributing, or stabilizing) and the importance of the reach to each population (high, medium, or low). The score is the cumulative total of the Population Classification (Primary = 3, Contributing = 2, Stabilizing =1) plus the Species Reach Potential (High=3, Medium=2, Low=1) for each population using the targeted reach or reaches.

Protection/Access/Restoration (PAR) Ratings and Scores: The PAR score reflects the type of restoration activity proposed and the effectiveness the project will have in providing a fish benefit. The PAR score is the sum of the individual protection, access, and/or restoration score. That score is normalized to a scale of 1-100.

Protection Rating: The protection benefit rating is based on the EDT preservation rating for the targeted reach or reaches using the following scale: EDT Reach Preservation Rating of >50% was classified as High, 25 to 49% was classified as Medium, and <25% was classified as Low. Reach EDT preservation ratings are found in the Recovery Plan (LCFRB 2004).

Access Rating: The access benefit rating is based on the quality of the habitat that would be made available if passage was provided and a passage improvement factor. The habitat quality is determined by averaging the upstream Tier reach ratings, where Tier 1=4 points, Tier 2=3 points, Tier 3=2 points, and Tier 4=1 points, where an average Tier score of 3 or greater is "high", 2 but less than 3 is "medium", and less than 2 is "low". The passage improvement factor is equal to 100% minus the current passability percentage by the project proponent, where a score of 60 to 100% is "high", 30 to 59% is "medium" and <30% is "low". The Access Score is the product of the passage improvement percentage times the Habitat Quality Factor times Habitat Quantity Factor (Table 5).

Table 5. Factors contributing to an Access Score.

Habitat Quantity	Quantity Factor	Habitat Quality	Quality Factor
5+ miles	10	High	10
2 to 4.9 miles	6	Medium	6
1 to 1.9 miles	4	Low	2
0.5 to 0.9 miles	2	Unknown	
<0.5 miles	1		

Restoration rating: The restoration rating is based on the EDT-derived "multiple species project benefits" ratings (LCFRB 2008; high, medium, low) for the reaches targeted by a project. The Restoration rating is the sum of the benefit scores for each category of project benefit covered by the project. The benefit score of each project benefit category is the product of the project benefit ratings (High=3, Medium=2, Low=1) times the number of habitat units, times an effectiveness factor. For each reach, the ratings for the restoration types covered by the project are averaged and rounded up to the next highest

rating. A habitat unit equals: (1) 500 feet on both sides of the stream or 1000 feet on one side of the stream for riparian, floodplain, and hillslope process project types; or (2) 500 feet of stream length for instream project types. The effectiveness factor reflects a percentage estimate of the extent to which the project would address the project type within the targeted habitat unit.

- Off channel & side channel habitat (.25, .50, .75, 1.0 points)
- Riparian conditions and functions (.25, .50, .75, 1.0 points)
- Stream channel habitat structure and bank stability (.25, .50, .75, 1.0 points)
- Stream channel bank stability/ fine sediment (.33, .66, 1.0)

Off channel & side channel habitat rule: is based on the degree to which the project provides for fish access, LWD cover, riparian cover, and pool habitat. Projects which provide all four receive a 1.0. Projects that provide 3 out of 4 receive a 0.75. Project that Projects that provide 2 out of 4 receive a 0.50. Projects that provide 1 out of 4 receive a 0.25.

Riparian conditions and functions rule: is based on the degree to which the project fully restores the riparian area (150 feet width both sides) to a historic condition with the most likely historic species composition. Projects that fully plant (150 feet width; both sides) in a deforested riparian zone receive a 1.0. Projects that plant less than 150 feet in a deforested riparian zone receive a 0.75 to 0.25 rating, depending on the width. Projects that plant conifer under a mature hardwood riparian receive a 0.25.

Stream channel habitat structure rule: is based on the degree to which the project fully restores channel complexity or structure and the type of structure the project uses. Projects that are expected to be effective at creating desired in-stream habitat would score higher than those that are less effective, considering the channel conditions, flows, and other constraints. Projects that achieve a LWD single piece and key piece density of >63 and >38 pieces, respectively, receive a rating of 1.0 (See Appendix B LWD criteria) (Montgomery et. al. 2003). Projects that achieve a LWD single piece and key piece density of 29- 63 and 26-38 pieces, respectively, receive a rating of 0.75. Projects that achieve a LWD single piece density of 29- 63, but a key piece density of <26 pieces receive a score of 0.50. Projects that will not achieve a LWD single piece and key piece density of 29 and 26 pieces, respectively, will receive a rating of 0.25.

Stream channel bank stability/ fine sediment rule: values the degree to which the project addresses the source vs. symptom, duration of results, and imminent risk. Projects which eliminate current fine sediment source inputs for longer than 20 years receive a high rating (1.0) those that provide for less receive either a 0.33 or 0.66 depending on whether they address only 1 or 2 of the elements described.

Total Benefit Score: The total benefit score is the sum of the standardized (1-100) population/ reach and the standardized (1-100) PAR scores. Therefore, the total benefit scores range could potentially range from 0- 200 points.

3.4.2 Cost Benefit

Each project was evaluated in terms of the benefit to fish per unit cost. For each project, the total benefit score was divided by the project cost. This value is the cost benefit score. The cost benefit scores were normalized to a 1- 100 point range.

3.4.3 Constraints and Opportunities

This rating assumes that public landowners will be more willing to host restoration on their land and agree to future protection. This rating also assumes that the need for more landowner agreements will increase the likelihood of project constraints. These assumptions are broad and will not hold true all of the time. However, since landowner outreach was not a part of this implementation plan, these general assumptions are used as a proxy for constraints.

4.0 Results

Over the course of four days, two teams observed habitat and physical conditions over much of the Tier 1 and 2 reaches in the Germany and Abernathy Creek watersheds, including many Abernathy Creek tributaries: Cameron Creek, Sarah Creek, Weist Creek, and Ordway Creek. The goals of these stream walks were to characterize physical conditions in the context of fish limiting factors, identify project opportunities and potential constraints, and to develop a better understanding of current channel conditions. Observations of current riverine conditions suggest that ecological processes, which are capable of supporting salmonid species and other aquatic life, have been impaired. However, opportunities exist to significantly improve habitat conditions and stream processes.

4.1 Observations of Stream Processes

4.1.1 Summary of Observed Watershed Conditions

Abernathy and Germany Creeks shared common characteristics, including a simple channel morphology, lack of available gravels for spawning, and lack of channel complexity and diversity. Both creeks have altered hydrology (i.e. increased peak and decreased low flows; LCFRB 2000). Our observations suggest that channel morphology has adjusted to this increase in peak flows, and velocity, by increasing the size of bed sediments, decreasing sinuosity and by degrading vertically. In general, what this points to is the fact that the historical hydrology-sediment transport process has been altered and this current regime has introduced morphological changes to the stream channel. These morphological changes have, in turn, impacted habitat forming processes. In both creeks, much of the historic floodplain is inaccessible; many side-channels are perched and only activated at very high flows. The inability of the creek to accommodate high flows horizontally results in more vertical degradation (i.e. a negative feedback loop). This suggests that corrective measures are needed to ‘force’ changes between channel morphology, the hydrology-sediment transport regime and habitat function in order to mimic natural disturbances (e.g. LWD recruitment) and to create self-sustaining long-term habitat benefits.

Riparian areas were generally adequate in terms of buffer width and cover. However, very few riparian areas had mature or understory conifer trees. The historic climax conifer and mixed-stand communities were largely absent. Recent LWD recruitment consisted mostly of alders, which are not historically dominant LWD constituent (e.g. large conifers). Mature coniferous trees play an important role in the riparian functions of bank stability and providing channel structure as LWD. They generally have stronger root systems than deciduous trees, thus providing increased bank stability, especially during major flood events. Coniferous trees also provide higher quality LWD since they are larger in diameter and decompose at a slower rate than deciduous LWD. Future recruitment of conifers into the active channel will be very low because of the paucity of conifers in the riparian zone. This suggests that underplanting the existing mature deciduous riparian zones with conifers will provide long-term benefits to the structure and function of these creeks.

4.1.2 Summary of Observed Channel Morphology

Preliminary analysis of field data collected on Germany and Abernathy Creeks suggests similarities in terms of impaired form and function between the two watersheds. The following is a summary of observed channel morphology conditions:

- Stream channels showed a lack of geomorphic diversity and complexity
- LWD frequency and size were poor
- Gravels were overall armored (e.g. lack of interstitial space and inability to be mobilized)
- Gravel sizes appeared bi-modal with a lack of well sorted conditions
- Stream channels are vertically unstable
- Stream channels lacked sinuosity and were confined
- Streambanks are frequently vertical with no defined floodplain
- Side-channels and adjacent floodplains appeared largely inaccessible, or perched, and therefore normal (2-5 year recurrence interval) peak flows may not be hydrolologically connected to main channel.

4.2 Reach Descriptions and Project Opportunities

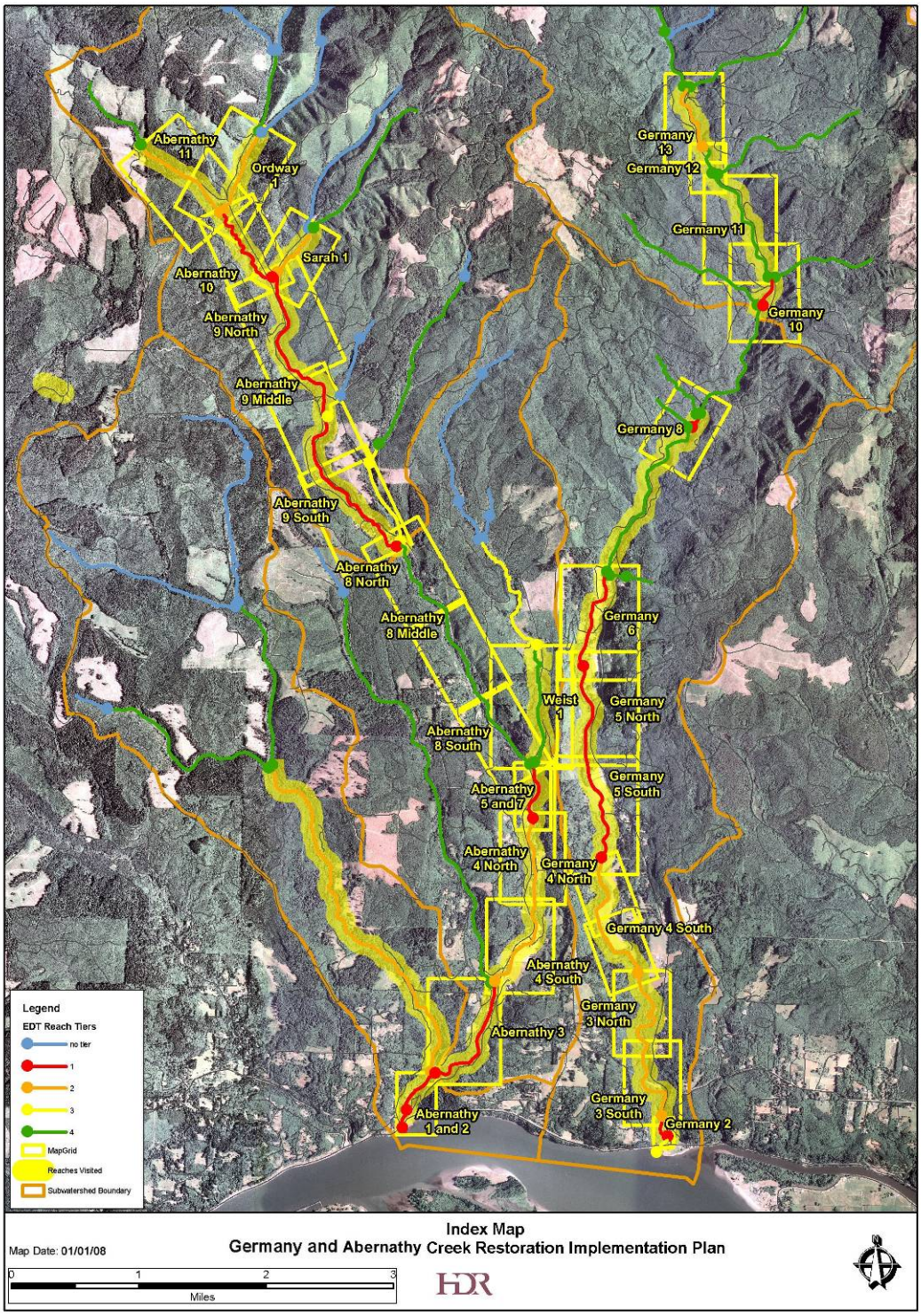
Project identification focused on recovering these stream processes in Germany and Abernathy Creeks. Within each reach, geomorphic controls and river channel conditions were noted (such as bedrock controls) in order to develop a greater understanding of local conditions and the limitations of future projects to achieve desired results. For instance, bedrock controlled areas with steeper gradients may not be a suitable environment to place large engineered LWD structures to increase and/or create salmonid habitat. Other important factors in identifying project opportunities included access to the site and whether or not the designs were sustainable. Each of the project types have expected outcomes and varying levels of construction, including engineering and non-engineering approaches. The following actions are considered to be critical in implementing each of the project types:

- Riparian preservation and enhancement can be implemented through buying land, encouraging easements, native plantings and seeding, and controlling invasive species
- LWD enhancement can be implemented using hand crews to fall timber and placement of different ELJ log structures and root wads
- Bank stabilization strategies can be developed using hard (rock) and soft (vegetation) engineering techniques used in concert with riparian enhancement.
- Side channel creation/restoration will be developed using strategic placement of ELJ structures in the main channel to redirect flows, placement of LWD structures in the side channel, and excavation at the confluence of the main channel and if necessary within the side channel
- Main channel enhancement to promote habitat diversity and improvements can be carried out using a combination of #2 and strategic boulder placements and channel narrowing
- Erosion repair can utilize stabilization techniques including revegetation and soft engineering concepts.

The following sections detail the projects identified in the field for the Germany and Abernathy Creek Implementation Plan. Figure 4 shows an index map the reaches visited in the field. Field work focused on tier 1 and tier 2 reaches. Some tier 3 and tier 4 reaches were visited when there was evidence of significant use by fish (i.e. redd counts). The rest of the reaches were not visited and although there may be additional project opportunities in those reaches, they were not evaluated as part of this implementation plan. Sixty projects are presented in this section. Ten projects were designed at the conceptual level and are presented in Appendix E. The following projects were selected for conceptual designs:

1. Abernathy 1A- lower drainage
2. Abernathy 2A- lower drainage
3. Abernathy 9A- mid/upper drainage
4. Abernathy 9F- mid/upper drainage
5. Abernathy 9G- mid/upper drainage
6. Abernathy 10A- mid/upper drainage
7. Abernathy 10B- mid/upper drainage
8. Germany 2A- lower drainage
9. Germany 2B- lower drainage
10. Germany 2C- lower drainage

Figure 4. An index map of stream reaches visited and described in section 4.2.



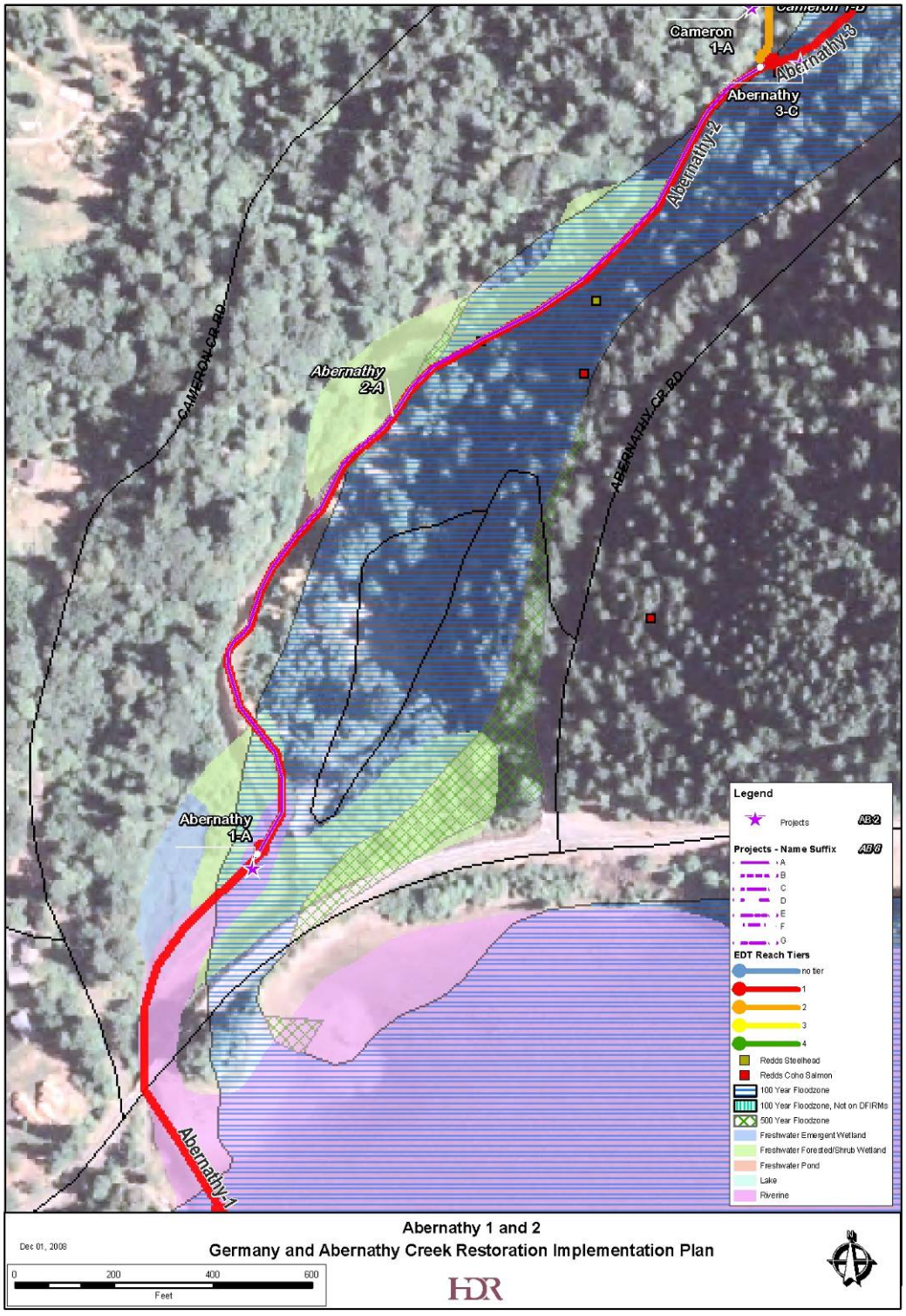
4.2.1 Abernathy 1 & 2

In Abernathy 2, there are several areas with large sediment accumulations and bar formations that are forcing the stream into adjacent areas. LWD jams were observed in several areas on the inside of meander bends. Local scouring and areas of channel complexity were observed. Abernathy Creek Road parallels a good portion of this reach, limiting riparian function and cover from predation. Abernathy 1 is the confluence of Abernathy Creek with the Columbia River. In this delta, vegetation is lacking and there appears to be a concerted effort to limit erosion through the use of rip-rap along both banks. Overall, this is a depositional reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 6. Two Engineered Log Jam projects are proposed in these reaches to increase cover, scour, channel complexity and rearing habitat for multiple Abernathy Creek and transient Columbia River migrants. Potential project locations are shown in Figure 5, followed by project descriptions.

Table 6. Abernathy 1 & 2 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Abernathy 1: mouth to slackwater (rm 0.16)	1	Chinook	C	M	Fry Colonization	0.9	Channel Stability
					Prespawn Migrant	0.1	Temperature
					0-Age Active Rearing	3	Habitat Diversity
		Coho	C	H	0-Age Inactive Rearing	26.9	Habitat Diversity
					0-Age Active Rearing	36.4	Habitat Diversity
					1-Age Active Rearing	9.3	Habitat Diversity
		Wsteelhead	P	L	0-Age Active Rearing	29.4	Habitat Diversity
					Fry Colonization	5.7	Habitat Diversity
					1-Age Active Rearing	20	Habitat Diversity
		Chum	P	H	Egg Incubation	44.5	Sediment Load
					Prespawn Holding	43.2	Habitat Diversity
					Spawning	8.4	Habitat Diversity
Abernathy 2: slackwater to Cameron Cr (rm 0.56)	1	Chinook	C	H	Egg Incubation	33.4	Sediment Load
					Spawning	8.1	Temperature
					Prespawn Holding	3.3	Key Habitat Quantity
		Coho	C	H	Egg Incubation	38	Sediment Load
					0-Age Active Rearing	21.1	Temperature
					0-Age Inactive Rearing	5.2	Key Habitat Quantity
		Wsteelhead	P	H	Egg Incubation	47.6	Sediment Load
					0-Age Active Rearing	22.6	Temperature
					1-Age Active Rearing	11.7	Temperature
		Chum	P	H	Egg Incubation	34.3	Sediment Load
					Prespawn Holding	10.8	Habitat Diversity
					Spawning	3.2	Habitat Diversity

Figure 5. Abernathy 1 & 2 project locations.



Abernathy 1-A

Abernathy Creek (Abernathy 1). This project would occur at the top of reach 1 and would improve an existing off channel (large alcove) habitat through the use of LWD inputs to activate the side channel. In general, this area lacks cover to shield juveniles from predation and warm water temperatures. This project should use ELJ structures to help divert the water, to raise the channel bed and to help with inundation the adjacent floodplain. The ELJ structures should provide juvenile rearing habitat at all water levels. A conceptual design of this project is provided in Appendix E, Figure E-1.

1. Type of Project
   - Engineered Log Jam (1 structure)
2. Potential Causal Factors
   - Lack of upstream LWD inputs
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

Abernathy 2-A

Abernathy Creek (Abernathy 2). Abernathy 2 could benefit from approximately 8 ELJs throughout the mainstem and side-channels to increase cover, scour, channel complexity and rearing habitat for downstream migrants and for Columbia River migrants (primarily juveniles but some adults as well) who use Abernathy as a stop over. The ELJs would need to be engineered to withstand the water elevation changes resulting from tidal influence (consider using pilings to anchor the jams). This is a tidally influenced area and is an important transitional area for many species. A conceptual design of this project is provided in Appendix E, Figure E-2.

1. Type of Project
   - Engineered Log Jams (8 structures)
   - Riparian Enhancement

- Plant with native species and treat invasive plant species

2. Potential Causal Factors
   - Lack of upstream LWD inputs
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

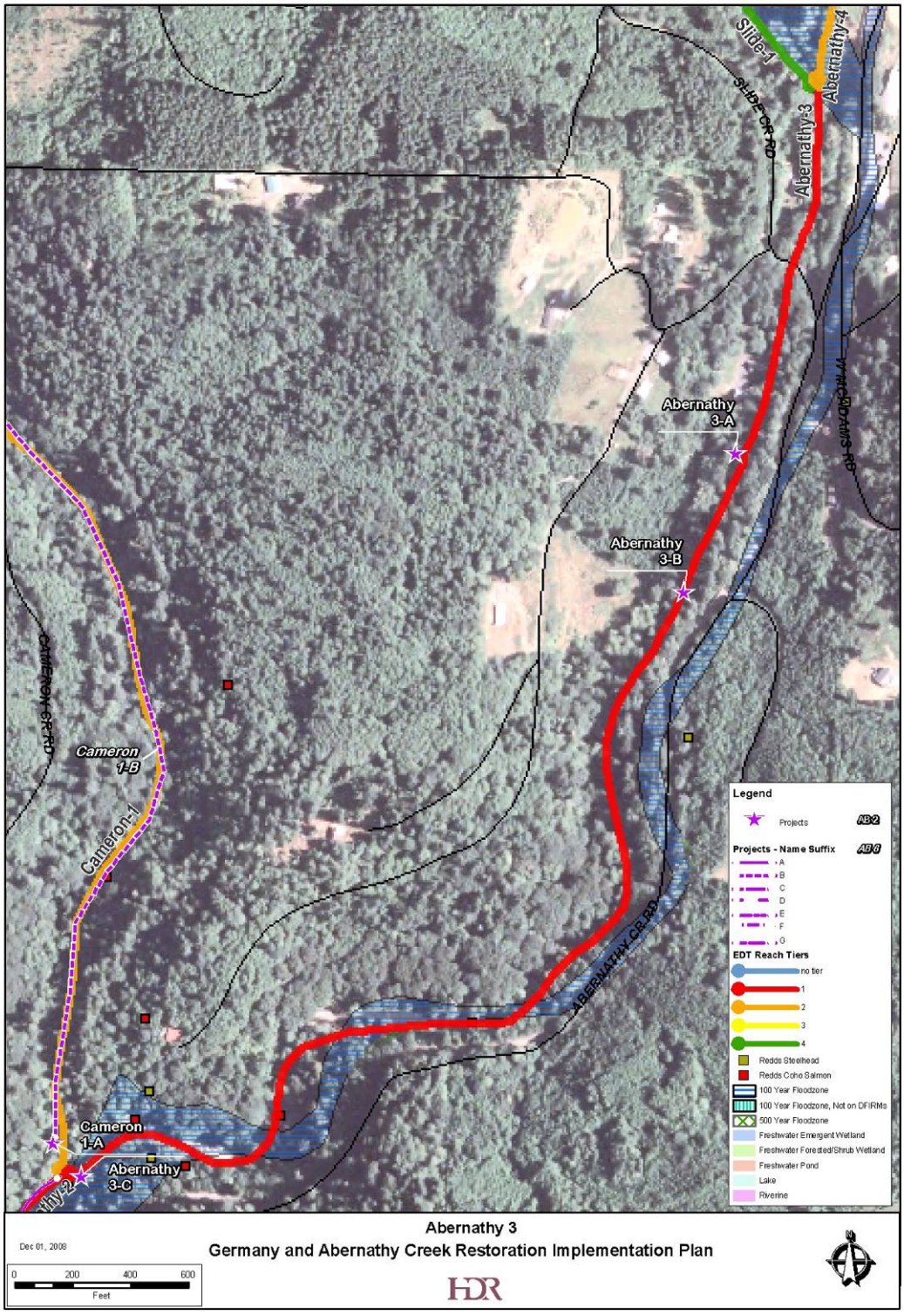
4.2.2 Abernathy 3

Abernathy 3 can be described in terms of 3 sections. The upper section is semi-confined and plane-bed in morphology. The middle section is a confined canyon with steeper bedrock controls. There were several redds observed in the canyon section. The lower section has lower gradient pool-riffle morphology with excellent floodplain access during average flood events. The lower reach appeared to be depositional with well-sorted gravel available to salmonids. Side-channels were also more accessible in this lower section. Abernathy 3 is remote and there are few access points. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 24. Two projects are proposed to improve key habitat quantity and diversity by adding LWD and Engineered Log Jams. These projects will benefit coho rearing habitat, Chinook fry colonization, and chum spawning habitat. A proposed side channel enhancement project in the lower reach will benefit coho and steelhead rearing habitat. Potential project locations are shown in Figure 6, followed by project descriptions.

Table 7. Abernathy 3 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Cameron Cr to Slide Cr	1	Chinook	C	H	Egg Incubation	32.9	Sediment Load
					Spawning	8.7	Temperature
					Fry Colonization	2.3	Key Habitat Quantity
		Coho	C	M	Egg Incubation	38.2	Sediment Load
					0-Age Active Rearing	24.8	Key Habitat Quantity
					0-Age Inactive Rearing	13	Key Habitat Quantity
		Wsteelhead	P	M	Egg Incubation	48.7	Sediment Load
					0-Age Active Rearing	22.9	Temperature
					1-Age Active Rearing	13.3	Temperature
		Chum	P	H	Egg Incubation	35.2	Channel Stability
					Prespawn Holding	14.9	Habitat Diversity
					Spawning	3.8	Habitat Diversity

Figure 6. Abernathy 3 project locations.



Abernathy 3-A

Abernathy Creek (Abernathy 3).This site represents an opportunity improve conditions within the main channel. The channel is confined and demonstrates both plane-bed and step-pool morphology which is bounded by bedrock controls. There are no LWD contributions and the riparian conditions are good on the left bank and poor on the right bank. Local habitat diversity and key habitat complexity is lacking and there is a lack of pools within the entire site.

1. Type of Project
   - Engineered Log Jams
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Access

Abernathy 3-B

Abernathy Creek (Abernathy 3).This project represents an opportunity to improve spawning gravels and channel complexity at a site that has existing redds. Currently, the channel bed is heavily armored (at the tail out of the pool), there is no LWD, and habitat diversity is lacking. This site has three consecutive pools which average more than 150 feet in length and the entire length of this site is greater then 1000 feet. LWD could provide channel complexity, assist with increasing local velocities and scour to break up the existing armor layer and fresh well sorted gravels. Up to 4 ELJ structures could be installed to assist with channel rehabilitation. This site is a prime steelhead spawning area.

1. Type of Project
   - Engineered Log Jams (up to 4 large structures)
2. Potential Causal Factors
   - Lack of upstream LWD inputs
   - Lack of sediment recruitment
   - Increased peak flows have increased sediment size and decreased sediment mobility
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
   - Unknown
4. Constraints
   - Access

Abernathy 3-C

Abernathy Creek (Abernathy 3).The location of this proposed project is at the confluence of Abernathy and Cameron Creek. Within this project site there are multiple opportunities to enhance current side channel refugia, to place LWD within the Abernathy main channel in order to increase habitat quantity and diversity, as well as to deflect flows into side channels to maintain hydrologic connection. This is a natural depositional area and structures within the channel could augment sediment deposition, encourage active channel migration, and assist with gravel deposition. There were LWD structures observed immediately downstream of this site.

1. Type of Project
   - Side Channel Enhancement
     - Install Engineered Log Jams (4 structures) to assist in diverting flow

- Increase LWD within side channel

2. Potential Causal Factors
   - Lack of upstream LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Access

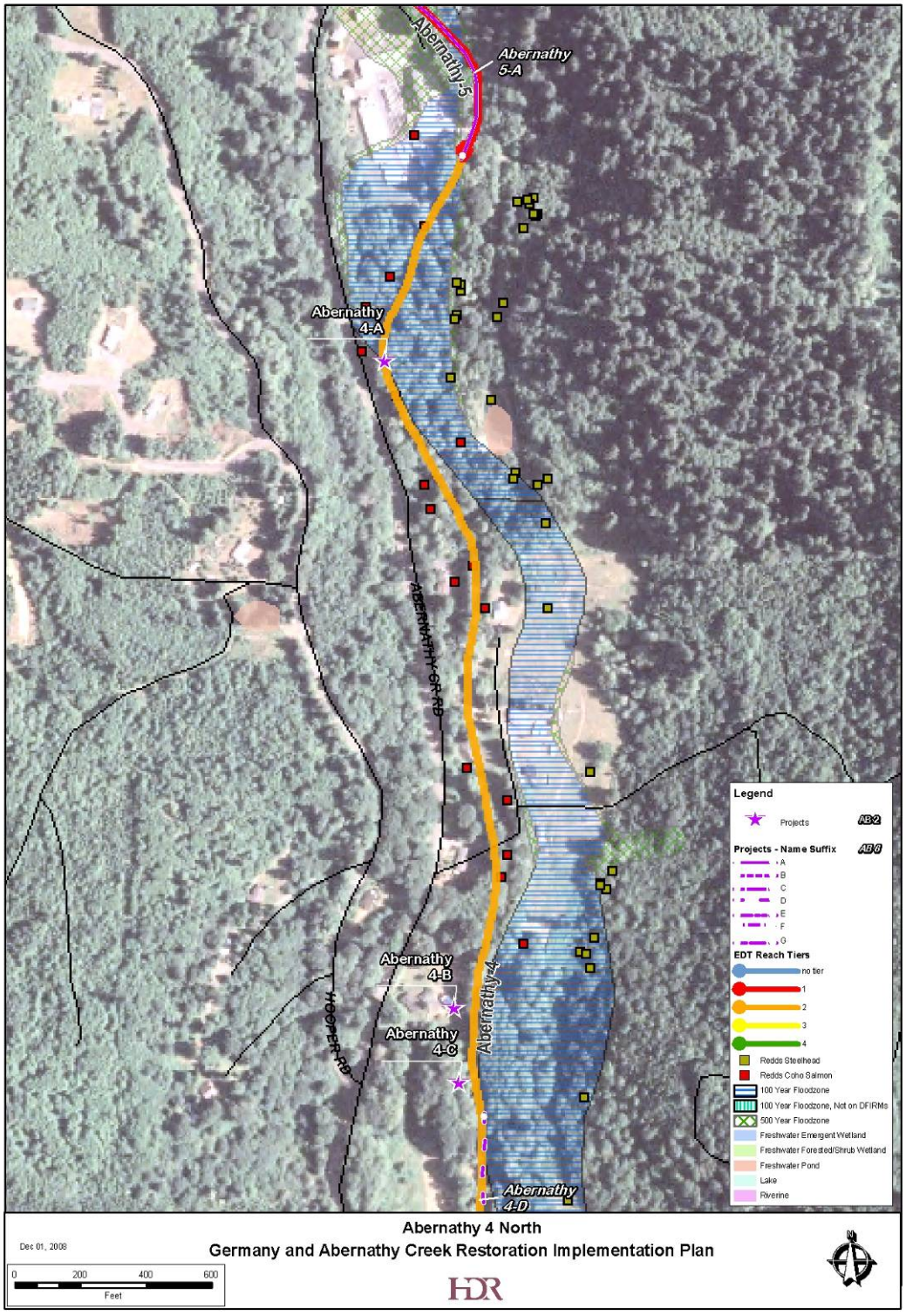
4.2.3 Abernathy 4

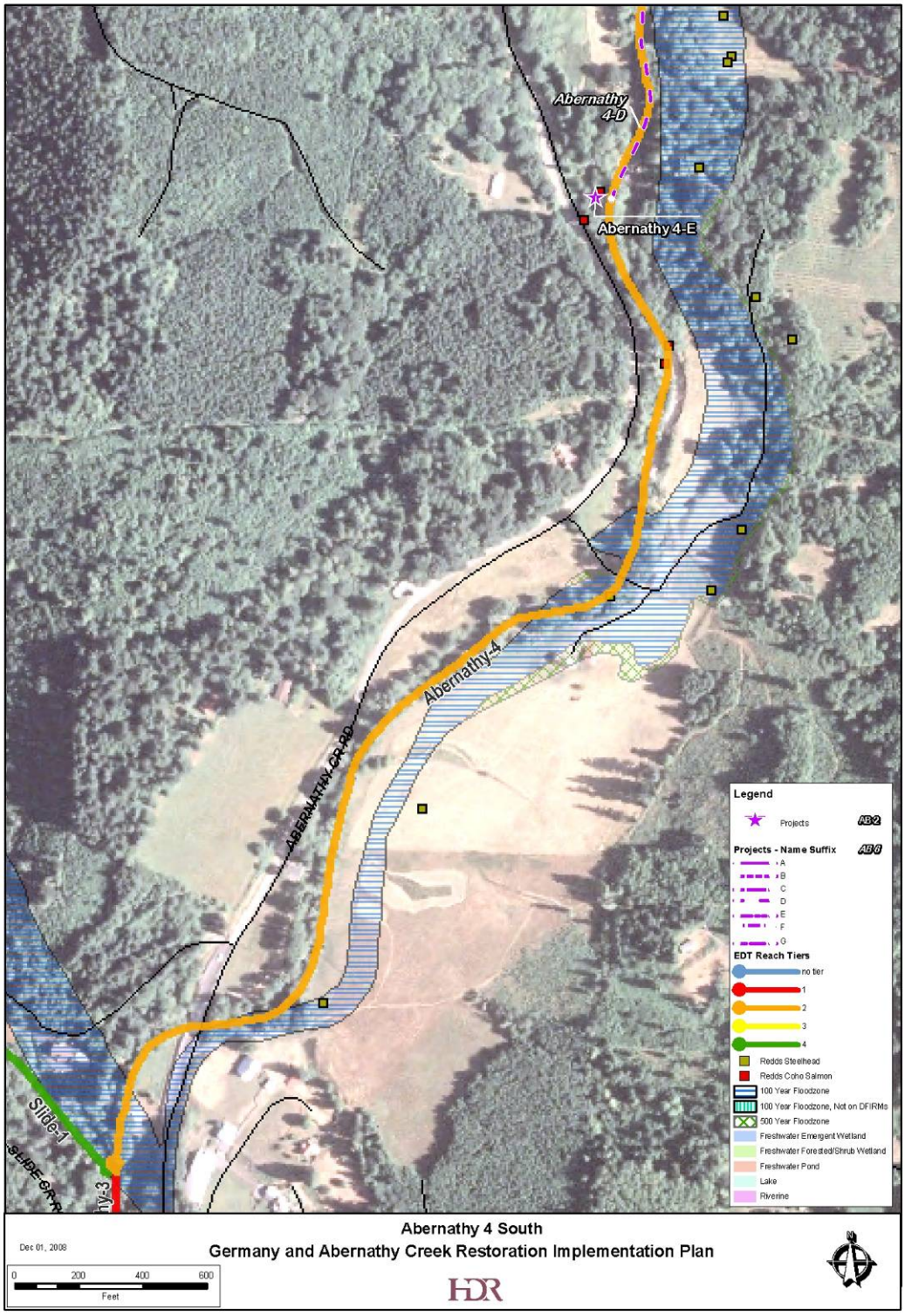
Abernathy 4 has an abundance of active and relict side-channels, indicating that this area has historically been dynamic in nature. Although some of the side-channels are hydrologically connected, other side-channels are perched above the active channel and therefore no longer accessed by floods on a regular basis. Overall, this is a depositional reach with channel gradients between 1-3%. The channel exhibits a plane-bed morphology with little pool habitat. The substrate consists of primarily large cobble and boulders. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 8. Three off/ side channel enhancement projects are proposed to increase habitat complexity and rearing opportunities for coho and winter steelhead. Two main channel projects are proposed that will increase habitat complexity and access to their floodplains. The main channel projects will be located and designed to complement the LWD and ELJs being installed by the Cowlitz Conservation District in this reach. These projects will increase rearing opportunities for coho and winter steelhead, and increase spawning habitat for Chinook and chum. Potential project locations are shown in Figures 7a and 7b, followed by project descriptions.

Table 8. Abernathy 4 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
slide creek to Technology Center	1.59 to 3.08	2	Chinook	C	M	Egg Incubation	39.4	Sediment Load
						Fry Colonization	12.5	Habitat Diversity
						Spawning	10.9	Habitat Diversity
			Coho	C	M	0-Age Inactive Rearing	91.1	Habitat Diversity
						0-Age Active Rearing	52.3	Habitat Diversity
						Egg Incubation	52.2	Channel Stability
			W Steelhead	P	M	Egg Incubation	52	Sediment Load
						0-Age Active Rearing	38	Habitat Diversity
						1-Age Active Rearing	27.9	Habitat Diversity
			Chum	P	L	Egg Incubation	36.1	Channel Stability
						Prespawn Holding	17.3	Habitat Diversity
						Spawning	6.3	Habitat Diversity

Figures 7a and 7b. Abernathy 4 project locations.




Abernathy 4-D
Abernathy 4-E
Abernathy-4
ABERNATHY CR RD
Slide-1
Legend
Projects
AB2
Projects - Name Suffix
AB0
A
B
C
D
E
F
G
EDT Reach Tiers
no tier
1
2
3
4
Redds Steelhead
Redds Coho Salmon
100 Year Floodzone
100 Year Floodzone, Not on DFIRMs
500 Year Floodzone
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Abernathy 4 South
Germany and Abernathy Creek Restoration Implementation Plan
Dec 01, 2008
0 200 400 600
Feet
HDR

Abernathy 4-A

Abernathy Creek (Abernathy 4). This proposed site is immediately downstream from the Tech Center and in the vicinity of observed spawning and redds. The proposed site is a large winter overflow channel, which appears to be one of the larger side channels (width and length) observed, and is likely activated during winter flows and flood events. There were recent signs of gravel deposits, residual pools were evident, and there were several amphibious species observed. The downstream confluence with the main stem is perched more than five feet above the current low water level. There is evidence of large gravel deposits here perhaps from pool scour. Enhancement of this side-channel with LWD will improve habitat conditions and increase frequency of side-channel activation. The riparian enhancement will complement recent riparian plantings done in the reach by the Cowlitz Conservation District.

1. Type of Project
   - Off/ Side Channel Enhancement
     - LWD Enhancement in side channel
     - Riparian Rehabilitation
2. Potential Causal Factors
   - Channel confinement limits floodplain inundation
   - Lack of upstream LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

Abernathy 4-B

Abernathy Creek (Abernathy 4). This project is involves over 300 feet of bank protection along the right bank. The side slopes are relatively steep and a house on the right bank is close the active channel. The landowner on right bank needs to have his structures protected, and the owner on the unconfined left bank needs to be willing to allow his land (floodplain) to be utilized by the creek.

1. Type of Project
   - Streambank Stabilization & Erosion Control
     - Add wood/rock material to the streambank toe
     - Revegetate streambanks
     - Install erosion control measures
2. Potential Causal Factors
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Sedimentation
   - Habitat diversity
4. Constraints
   - None

Abernathy 4-C

Abernathy Creek (Abernathy 4). The project is involves over 1000 feet of side channel rehabilitation, and reactivation, in order to hydrologically reconnect this functional floodplain that is no longer accessed by the river on an annual basis. This relict side channel cuts through mixed grasses and alder forests. The project would increase rearing opportunities for juvenile salmonids, increase floodplain function, and increase habitat diversity.

1. Type of Project
   - Side Channel Enhancement
     - Use engineering techniques to reconnect main channel to the relict side channel.
     - Add LWD to increase habitat complexity

- Floodplain connection

2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Streambed has degraded vertically and side channels have become elevated/ abandoned
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

Abernathy 4-D

Abernathy Creek (Abernathy 4). This main channel at this site has good access to both floodplains, which is a relatively uncommon condition. There is a pronounced lack of pool habitat and instream cover for salmonids. In-channel habitat is poor with no observed pools or LWD. The channel morphology appears to be at a transitional state between pool-riffle and plane-bed. The gradient was approximately 2% with large cobbles and a high degree of armoring. The low-flow wetted width was approximately 28 feet and the estimated bankfull discharge is 40 feet. Riparian buffer widths are excellent, but the tree species are mostly hardwoods. Approximately 1000 feet of main channel habitat can be enhanced with LWD and ELJs in order to increase complexity. LWD and ELJs will be located and designed to complement the LWD and ELJs being installed by the Cowlitz Conservation District in this reach. Invasive species should be removed and a planting program started to introduce conifers over approximately a 5 acre area.

1. Type of Project
   - LWD Enhancement
     - Add LWD to increase habitat complexity
   - Engineered Log Jams (4 structures)
   - Riparian enhancement
     - Remove invasive plant species and plant native species, including conifers
2. Potential Causal Factors
   - Lack of upstream LWD inputs
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity

- Key habitat quantity
- Temperature
- Channel stability

4. Constraints
   - None

Abernathy 4-E

Abernathy Creek (Abernathy 4).This site represents an opportunity improve conditions on a side channel, which appears to be active during winter flows. There were residual pools found in the side channel as well as recent sediment depositions; this site could be improved in order to provide rearing habitat. The outlet of the side channel is perched above the main channel (common occurrence) and excavation/maintenance may be required to keep this channel activated.

1. Type of Project
   - Off/ Side Channel Enhancement
     - Add LWD to increase habitat complexity in the side channel
     - Add engineered log jams (2) at the confluence to encourage hydrologic connection with the side channel
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology and sediment inputs
   - Lack of upstream LWD inputs
   - Riparian conditions do not support adequate LWD size and quantities
3. Limiting factors
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

4.2.4 Abernathy 5

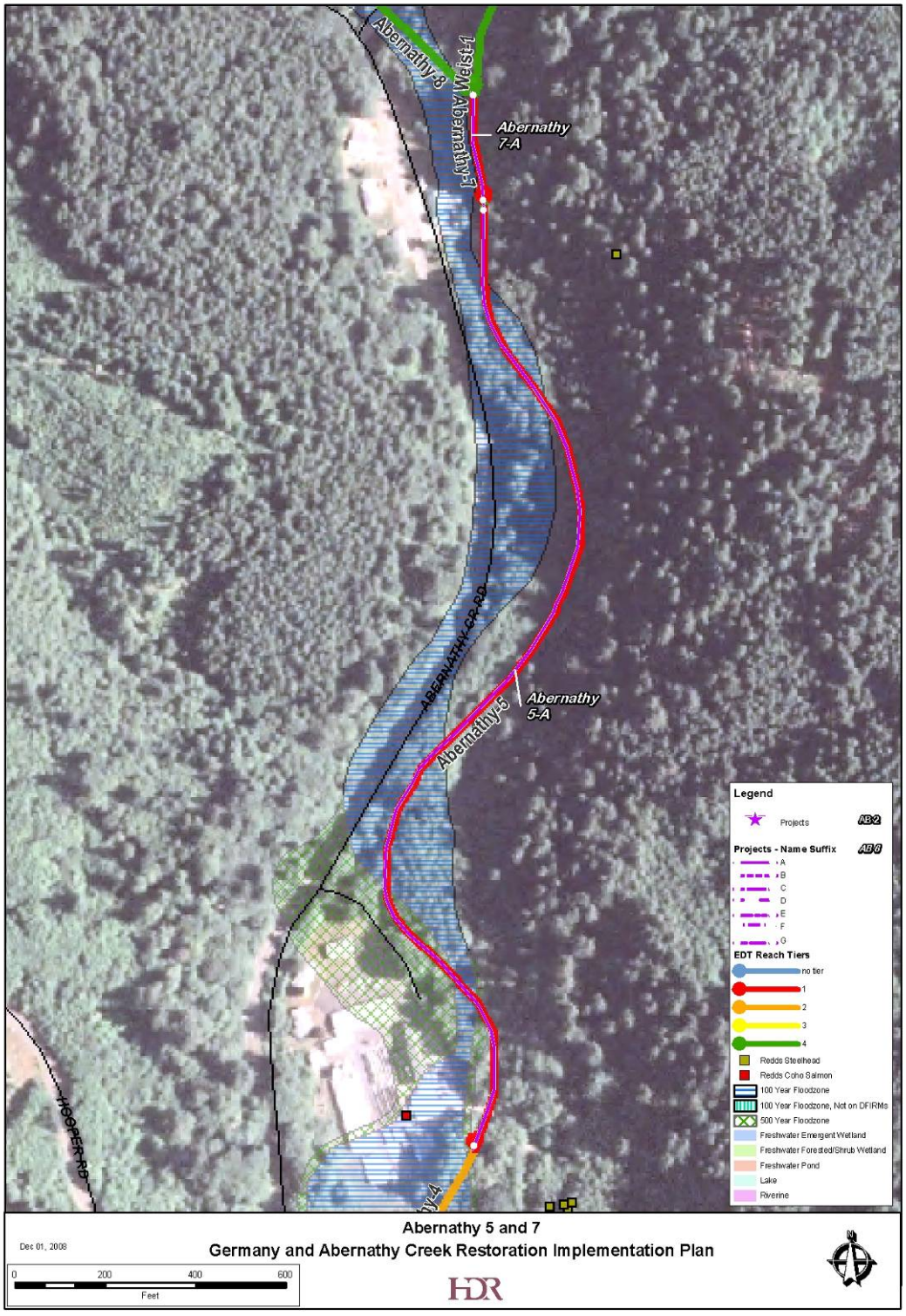
Abernathy 5 contains a >10 ft high natural bedrock formation/ waterfall. It is a natural barrier for fish passage during low flows. In addition, the downstream Technology Center Fish Hatchery limits upstream migration (for some fish populations) with the operation of their electric weir. This is a bedrock controlled area that appears to be relatively stable, but there is an overall lack

of armoring of gravels, and the morphology is plane-bed in nature. Overall, this is a transport reach with some areas that are depositional in nature. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 9. The single project proposed for this reach includes LWD enhancement and planting conifers in the existing riparian understory. The LWD enhancement would increase habitat diversity for Chinook fry colonization, coho rearing, winter steelhead rearing, and chum spawning. Potential project locations are shown in Figure 8, followed by project descriptions.

Table 9. Abernathy 5 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Abernathy Salmon Technology Center to Abernathy Falls (rm 3.08 to 3.53)	1	Chinook	C	L	Egg Incubation	36.3	Sediment Load
					Fry Colonization	3.8	Habitat Diversity
					Prespawn Holding	8.1	Key Habitat Quantity
		Coho	C	H	0-Age Inactive Rearing	52.5	Habitat Diversity
					Egg Incubation	48.3	Channel Stability
					0-Age Active Rearing	40.1	Habitat Diversity
		Wsteelhead	P	H	Egg Incubation	47.4	Sediment Load
					0-Age Active Rearing	33.5	Habitat Diversity
					1-Age Active Rearing	25.2	Habitat Diversity
		Chum	P	M	Egg Incubation	33.7	Sediment Load
					Prespawn Holding	11	Habitat Diversity
					Spawning	4.3	Habitat Diversity

Figure 8. Abernathy 5 project locations.



Abernathy 5-A

Abernathy Creek (Abernathy 5). Overall this area is beginning to show some riparian and instream habitat complexity; however this is still a limiting factor. There is no LWD within this reach and the riparian zone has few, if any, native conifers. There is some braiding in the area (depositional) and the introduction of LWD could facilitate the creation of a side channel at this location that could offer important refugia to salmonids. Any LWD project in this area would need to be imported and anchored to protect the adjacent Technology Center and bridges. There were redds observed at this site as the Technology Center and barriers (natural and anthropogenic) are limiting upstream fish migration.

1. Type of Project
   - LWD Enhancement
     - Add LWD to side channel
2. Potential Causal Factors
   - Channel Confinement limits floodplain inundation
   - Lack of upstream LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

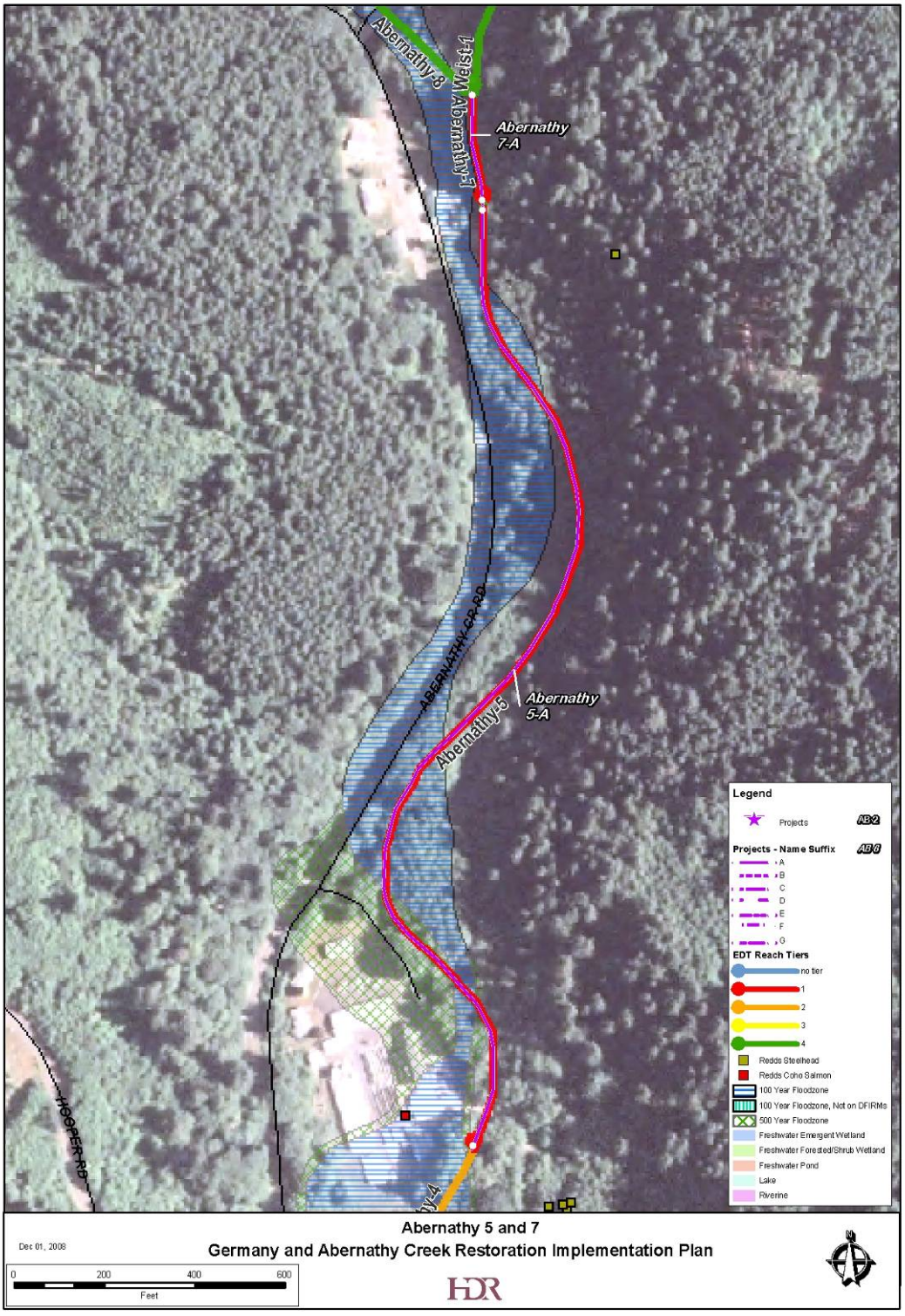
4.2.5 Abernathy 7

Abernathy 7 is upstream of large natural bedrock control area and adjacent to the Weist family home and there are several other homes on the right side of the creek. This is largely a sediment transport area with no riparian zone on the right bank with a larger riparian zone on the left bank. Upstream of this area there appears to be a steeper canyon section. There is limited potential to do in-channel work due to the physical controls and landowner management of LWD in the channel; conversations in the field suggested that some landowners were actively removing LWD from the stream. Overall, this is a transport reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 10. The single project proposed for this reach proposes rehabilitating riparian conditions along the active and a side channel. Riparian rehabilitation would regulate help regulate stream temperature for Chinook spawning. Improving riparian conditions will also facilitate long-term riparian function and therefore habitat diversity for Chinook, coho, and winter steelhead rearing. Minimizing fine sediment inputs from functioning riparian conditions will benefit Chinook, coho, and winter steelhead egg incubation. The potential project location is shown in Figure 9, followed by a project description.

Table 10. Abernathy 7 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Falls to Weist Cr (rm 3.53 to 3.58)	1	Chinook	C	L	Egg Incubation	39.4	Sediment Load
					Fry Colonization	0.3	Habitat Diversity
					Spawning	6.3	Temperature
		Coho	C	H	Egg Incubation	42.3	Sediment Load
					0-Age Active Rearing	23.2	Key Habitat Quantity
					Fry Colonization	3.4	Key Habitat Quantity
		Wsteelhead	P	H	Egg Incubation	46.5	Sediment Load
					Fry Colonization	2.7	Habitat Diversity
					0,1-Age Inactive Rearing	15.3	Habitat Diversity
		Chum	P		N/A		

Figure 9. Abernathy 7 project locations.



Abernathy 7-A

Abernathy Creek (Abernathy 7). This area offers limited potential due to physical controls and adjacent landowner perceptions. This is a sediment transport reach between a bridge and large bedrock control. The left bank riparian zone appears healthy but suffers in terms of a lack of conifers in the riparian zone and no evidence of LWD in the channel. The right bank riparian buffer zone has been severely impacted.

1. Type of Project
   - Riparian Rehabilitation
     - Use selective plantings of native species and conifers
2. Potential Causal Factors
   - Channel confinement limits floodplain inundation
   - Land-use has impacted the riparian zone
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

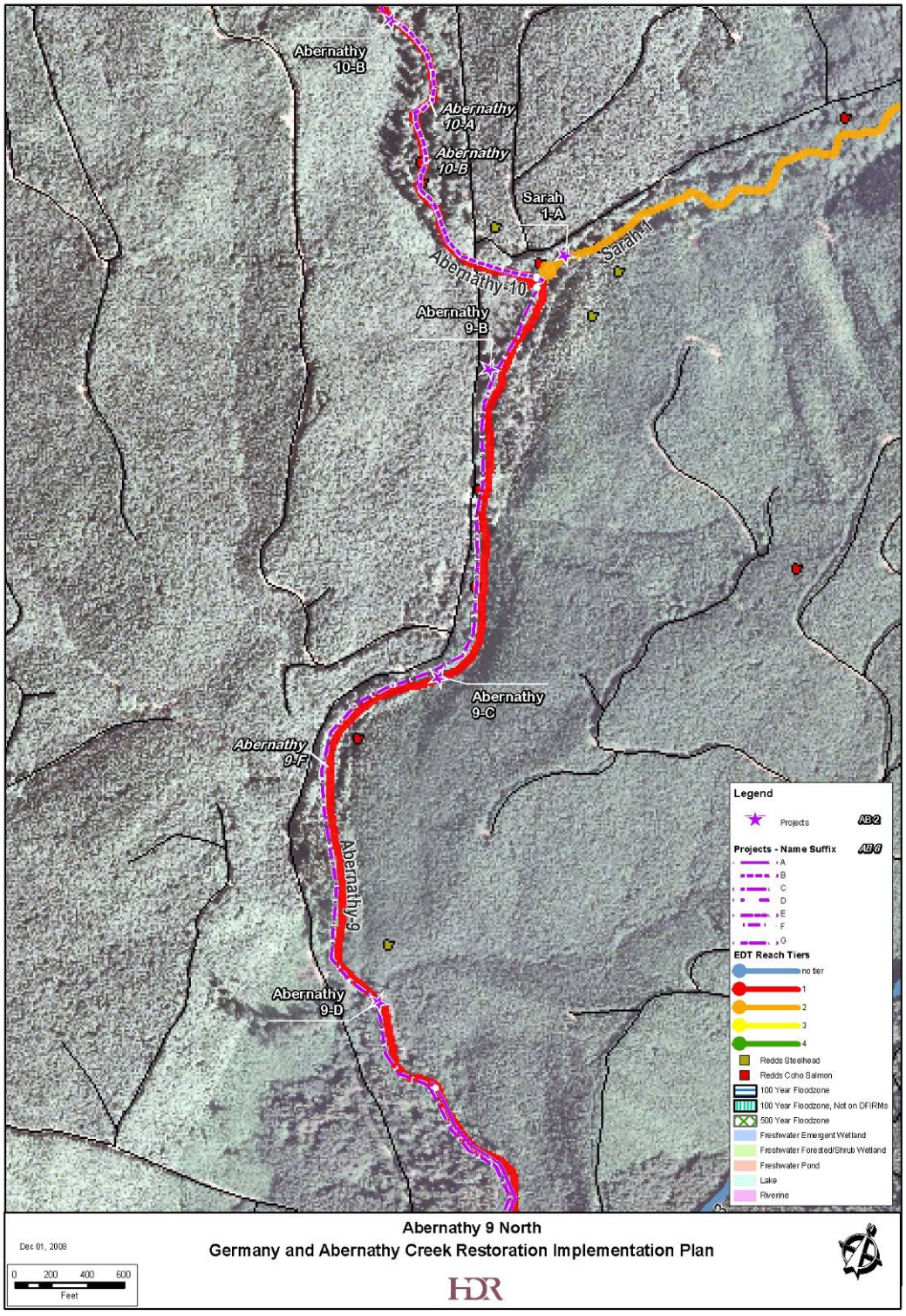
4.2.6 Abernathy 9

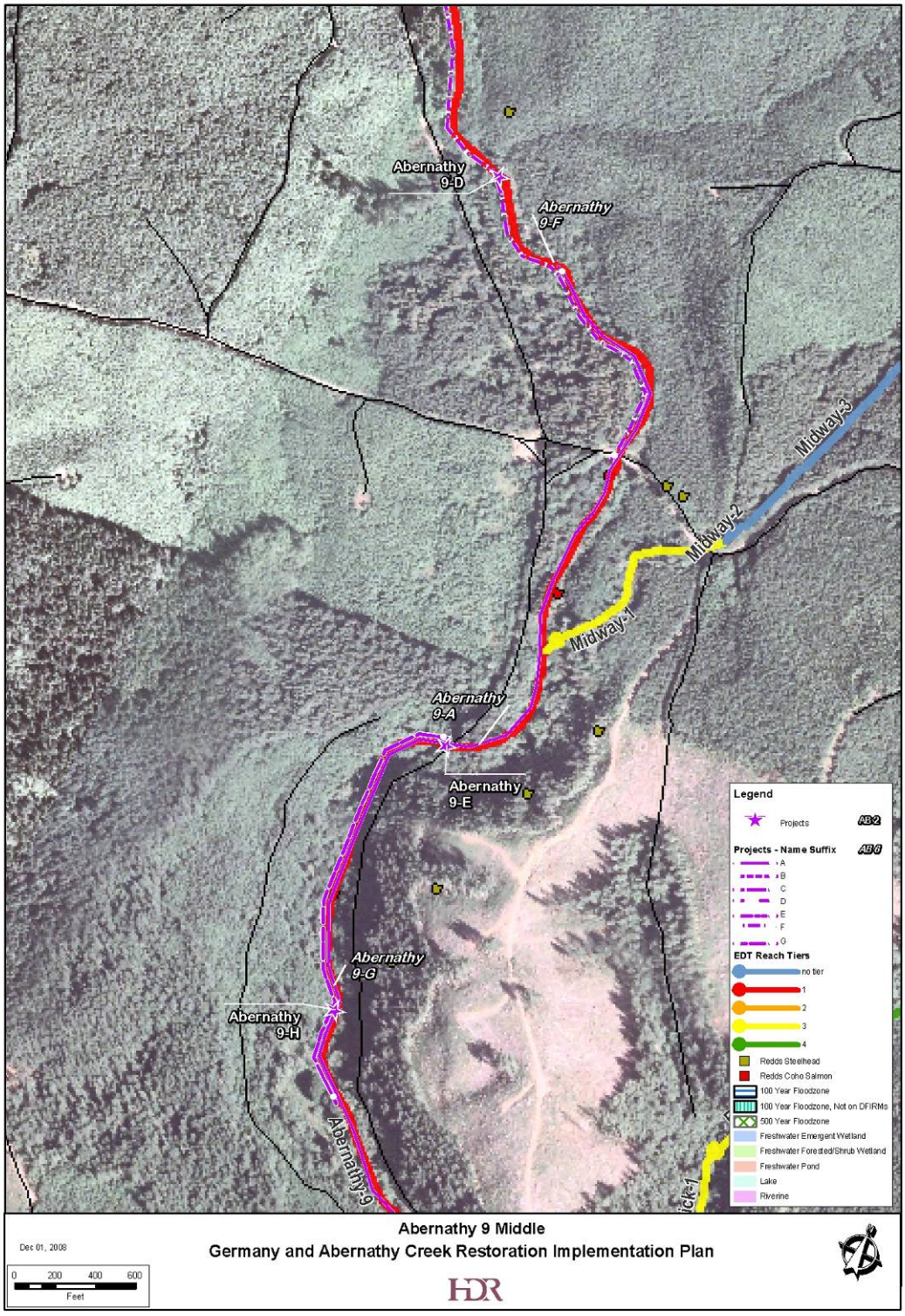
Abernathy 9 (tier 1) is nearly 3 miles long. It is relatively unconfined with a CMZ between 6-20 times the active stream width. There LWD density and channel complexity in most of the reach is poor. Perched benches within the CMZ have mature Alders and Maples with very few trees recruiting in the understory. There are a few high-flow channels in these benches, but for the most part there is little evidence of flow leaving the single active channel. Some segments of Abernathy 9 have a higher degree of LWD density. In these segments, a large portion of the CMZ is utilized in a more complex braided typology with more residual pools. Overall, this is both a transport and depositional reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 11. Many different projects are proposed for this reach. A large-scale effort to add LWD and plant conifers in the understory is proposed. This effort would increase habitat complexity and pool frequency in the main channel for coho and steelhead rearing. Projects involving re-connecting extensive off-channel habitat and smaller-scale side-channels are proposed and increase benefit coho rearing opportunities. Riparian Rehabilitation projects are proposed in the lower portion of Abernathy 9, where land use changes to rural residential. Riparian plantings will result in stream temperature regulation and contribute to LWD loading. An abandoned bridge on a de-commissioned road is also proposed. Potential project locations are shown in Figures 10a, 10b, and 10c, followed by project descriptions.

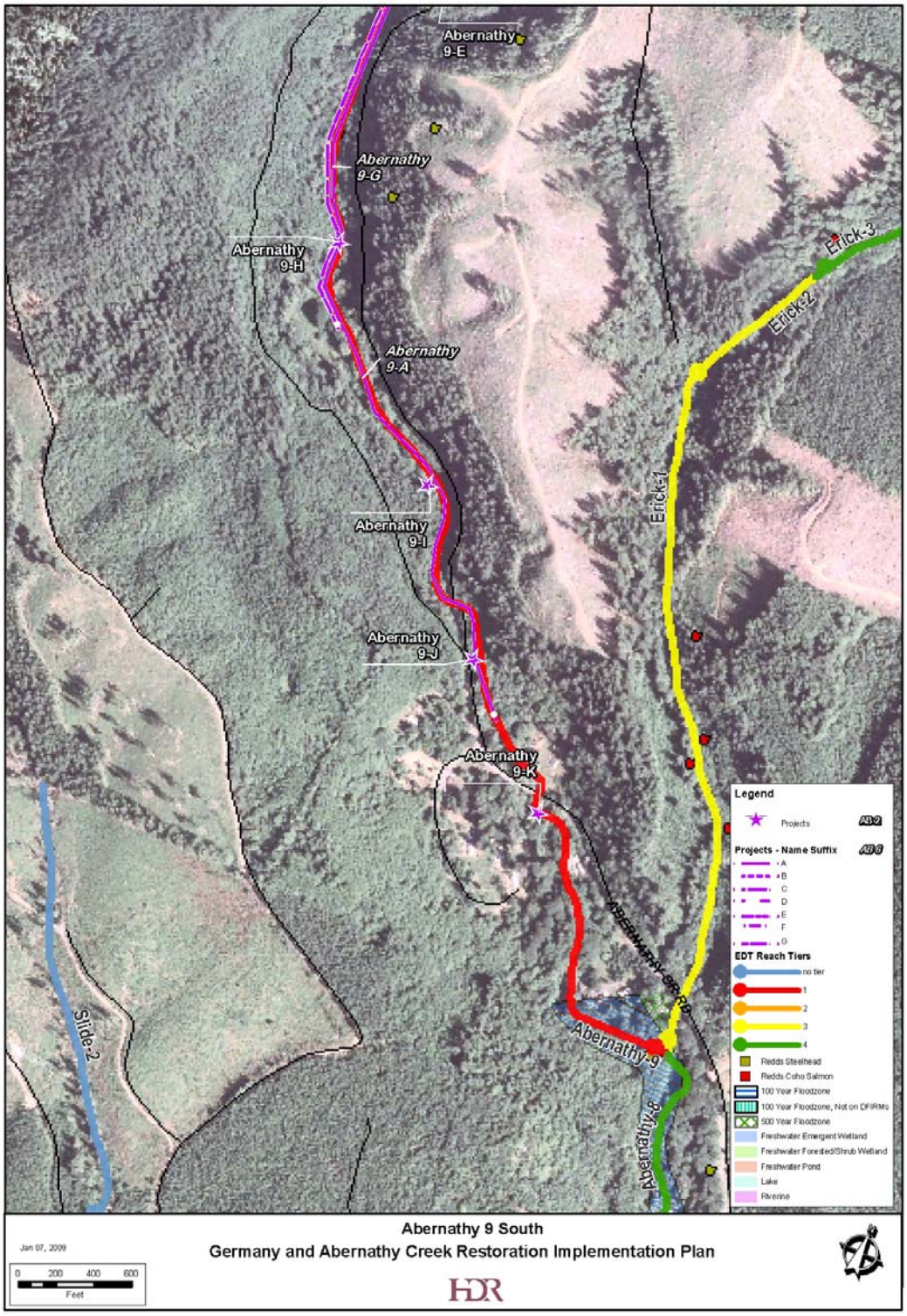
Table 11. Abernathy 9 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Eriek Cr to Sarah Cr (rm 5.77 to 8.61)	1	Chinook	C		N/A		
		Coho	C	L	0-Age Inactive	84.3	Habitat Diversity
					Egg Incubation	42.9	Sediment Load
					0-Age Active Rearing	22	Habitat Diversity
		Wsteelhead	P	H	Egg Incubation	39.7	Sediment Load
					0,1-Age Inactive Rearing	12.9	Habitat Diversity
					1-Age Active Rearing	10.5	Habitat Diversity
		Chum	P		N/A		

Figures 10a, 10b, and 10c. Abernathy 9 project locations.




Abernathy 9-D
Abernathy 9-F
Midway-3
Midway-2
Midway-1
Abernathy 9-A
Abernathy 9-E
Abernathy 9-G
Abernathy 9-H
Abernathy 9
Legend
Projects
Projects - Name Suffix
A
B
C
D
E
F
G
EDT Reach Tiers
no tier
1
2
3
4
Redds Steelhead
Redds Coho Salmon
100 Year Floodzone
100 Year Floodzone, Not on DFIRMs
500 Year Floodzone
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Dec 01, 2008
0 200 400 600
Feet
Abernathy 9 Middle
Germany and Abernathy Creek Restoration Implementation Plan
HDR


Abernathy 9-E
Abernathy 9-G
Abernathy 9-H
Abernathy 9-A
Abernathy 9-I
Abernathy 9-J
Abernathy 9-K
Erick-1
Erick-2
Erick-3
Slide-2
Abernathy-9
Abernathy-8
Legend
Projects
Projects - Name Suffix
A
B
C
D
E
F
G
EDT Reach Tiers
no tier
1
2
3
4
Redds Steelhead
Redds Coho Salmon
100 Year Floodzone
100 Year Floodzone, Not on DFIRMs
500 Year Floodzone
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Jan 07, 2009
0 200 400 600
Feet
Abernathy 9 South
Germany and Abernathy Creek Restoration Implementation Plan
HDR

Abernathy 9-A

Abernathy Creek (Abernathy 9). This project involves LWD enhancement and conifer plantings along the majority of the reach where LWD and channel complexity is insufficient (approx. 8000 feet). The riparian is mature hardwood (alder and maple) which will begin to provide LWD inputs over the next 20 years...but there is no conifer in the understory. Channel complexity in the active channel is low and the channel migration zone is perched and inaccessible. Increase hydraulic complexity and sediment sorting to create spawning and pool habitat with LWD. This project is limited to public land and does not currently include any private parcels in the project extent. Upon private landowner consent, this project may also include the private parcels at the downstream end of the reach. A conceptual design of this project is provided in Appendix E, Figure E-3.

1. Type of Project
   - LWD enhancement (from riparian)
     - Hand falling or cable yarding trees with intact rootwads should be aggressive (a tree every 30 feet or so)
   - Riparian Enhancement (underplanting)
     - Plant conifers in the understory
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat Diversity
4. Constraints
   - Access

Abernathy 9-B

Abernathy Creek (Abernathy 9). This project involves approximately 200 feet of off-channel habitat development. Only a small portion of the CMZ has been utilized in recent years and a lack of LWD is causing channel incision and reducing utilization of the entire CMZ. This project presents an opportunity for increasing rearing opportunities and quality for coho and steelhead by improving winter refuge habitat.

1. Type of Project
   - Side Channel Enhancement
     - Place ELJs (2) along perched benches in the CMZ with the objectives of either forming a discrete side-channel or eroding the perched bench to form a more braided complex channel.
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - Access

Abernathy 9-C

Abernathy Creek (Abernathy 9). This project involves approximately 1000 feet of off-channel habitat development. Only a small portion of the CMZ has been utilized in recent years; Lack of LWD is causing channel incision and reduced utilization of the entire CMZ; Rearing opportunities and quality for coho, steelhead; improved winter refuge habitat

1. Type of Project
   - Side Channel Enhancement

    - Place ELJs (4) along perched benches in the CMZ with the objectives of either forming a discrete side-channel or aggrading the perched bench to form a more braided complex channel.
2. Potential Causal Factors
    - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
        - Riparian conditions do not support adequate LWD size and quantities
        - Channel confinement limits floodplain inundation
3. Limiting Conditions
    - Habitat diversity
4. Constraints
    - None

Abernathy 9-E

Abernathy Creek (Abernathy 9). This proposed project is to remove an old decommissioned bridge on an abandoned road. The bridge may be restricting flows, increasing local velocities and disconnecting the main channel from the adjacent floodplain as well. In addition, habitat complexity is lacking and there were no observed LWD structures for more than ½ mile upstream of the bridge.

1. Type of Project
    - Bridge Removal
        - Remove channel confinement
2. Potential Causal Factors Addressed
    - Channel restriction
3. Limiting Conditions Addressed
    - Habitat Diversity
4. Constraints
    - Proximity to bridge

Abernathy 9-F

Abernathy Creek (Abernathy 9). This proposed project site is above and below a bridge on an active dirt road. Above the bridge the channel morphology is plane-bed, and there is a pronounced lack of habitat diversity and key habitat quantity. This condition continues for ¼ to ½ mile upstream. The riparian buffer area is adequate in terms of width; however species

composition is primarily hardwoods with mature conifers absent. There are opportunities for side channel reconnection along the left bank immediately downstream of the bridge. LWD should be increased upstream and downstream. Key ELJ structures could also be used to initiate greater connection with the downstream side channel and to assist with holding back debris from the bridge should it be mobilized. A conceptual design of this project is provided in Appendix E, Figure E-4.

1. Type of Project
   - Side Channel Enhancement
     - Employ ELJ (6) structures to divert flows to side channels
   - LWD enhancement (wood from riparian)
     - Employ hand crews upstream to cut/cable in LWD
2. Potential Causal Factors Addressed
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
     - Riparian conditions do not support adequate LWD size and quantities
     - Channel confinement limits floodplain inundation
3. Limiting Conditions Addressed
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Proximity to bridge

Abernathy 9-G

Abernathy Creek (Abernathy 9). This project site is approximately ¼ mile upstream from the termination of Abernathy Creek Rd. The potential project would build on existing habitat complexity within the main channel (between ¼ and ½ mile in length) and attempt to reactivate two very large side channels (½ miles in total). This site represents the greatest wood accumulation deposits found in the main channel from both Germany and Abernathy Creeks. The two side channels offer tremendous opportunities for improving existing off channel opportunities for salmonids, as well as other cold water species, and building on a large relict beaver lodge complex. Both side channels showed signs of being perched, although there were residual pools found sporadically along the downstream side channel due to a seep, while the other larger side had standing water within the relict beaver complexes. Both of these side channels would need to have engineering interventions on the main channel in order to

reestablish connections with the main channel. Up to eight ELJ structures could be implemented along the main channel to help in diverting flow and to provide increased channel complexity and gravel accumulations. A conceptual design of this project is provided in Appendix E, Figure E-5.

1. Type of Project
   - Side Channel Enhancement
     - Install 8 LWD jam(s) that are small (4-5 pieces) along reach
     - Install individual pieces of wood along entrance and exit of side channel
     - Selectively grade at confluence to hydrologically reconnect main and side channel
2. Potential Causal Factors Addressed
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Streambed has degraded vertically and side channels have become elevated/ abandoned
3. Limiting Conditions Addressed
   - Habitat diversity
4. Constraints
   - None

Abernathy 9-H

Abernathy Creek (Abernathy 9). This project involves approximately 450 feet of riparian enhancement. A decommissioned grade along creek did not get re-vegetated; gravel and cobble is actively aggrading along this reach and should left alone for future recruitment to the sediment-starved lower reaches.

1. Type of Project
   - Riparian Rehabilitation
     - Plant conifers along left bank
     - Manage invasive weeds
2. Potential Causal Factors
   - Channel confinement
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - None

Abernathy 9-I

Abernathy Creek (Abernathy 9). This project involves approximately 300 feet of side channel enhancement. A bench on the LB exists with a winter over-flow path. The creek is cutting into the RB and actively eroding fines. LWD could be used to divert water towards the bench and activate the side channel more frequently at lower flows.

1. Type of Project
   - Side-Channel Enhancement
     - Hand fall or cable yard trees with intact rootwads adjacent to perched benches in the CMZ
     - Install ELJ (1) structure
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Streambed has degraded vertically and side channels have become elevated/ abandoned
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - None

Abernathy 9-J

Abernathy Creek (Abernathy 9). This project involves approximately 200 feet or riparian enhancement. Land owners have converted riparian habitat into a grass yard.

1. Type of Project
   - Riparian Rehabilitation
     - Re-vegetate RB of reach with conifers
2. Potential Causal Factors
   - Land-use limits riparian buffer development
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - None

Abernathy 9-K

Abernathy Creek (Abernathy 9). This project involves approximately 200 feet or riparian enhancement. Landowners adjacent to the creek have converted former riparian habitat into a grassy area and there is no riparian buffer zone.

1. Type of Project
   - Riparian Rehabilitation
     - Re-vegetate right bank of the reach with conifers
2. Potential Causal Factors
   - Land-use limits riparian buffer development
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - None

4.2.7 Abernathy 10

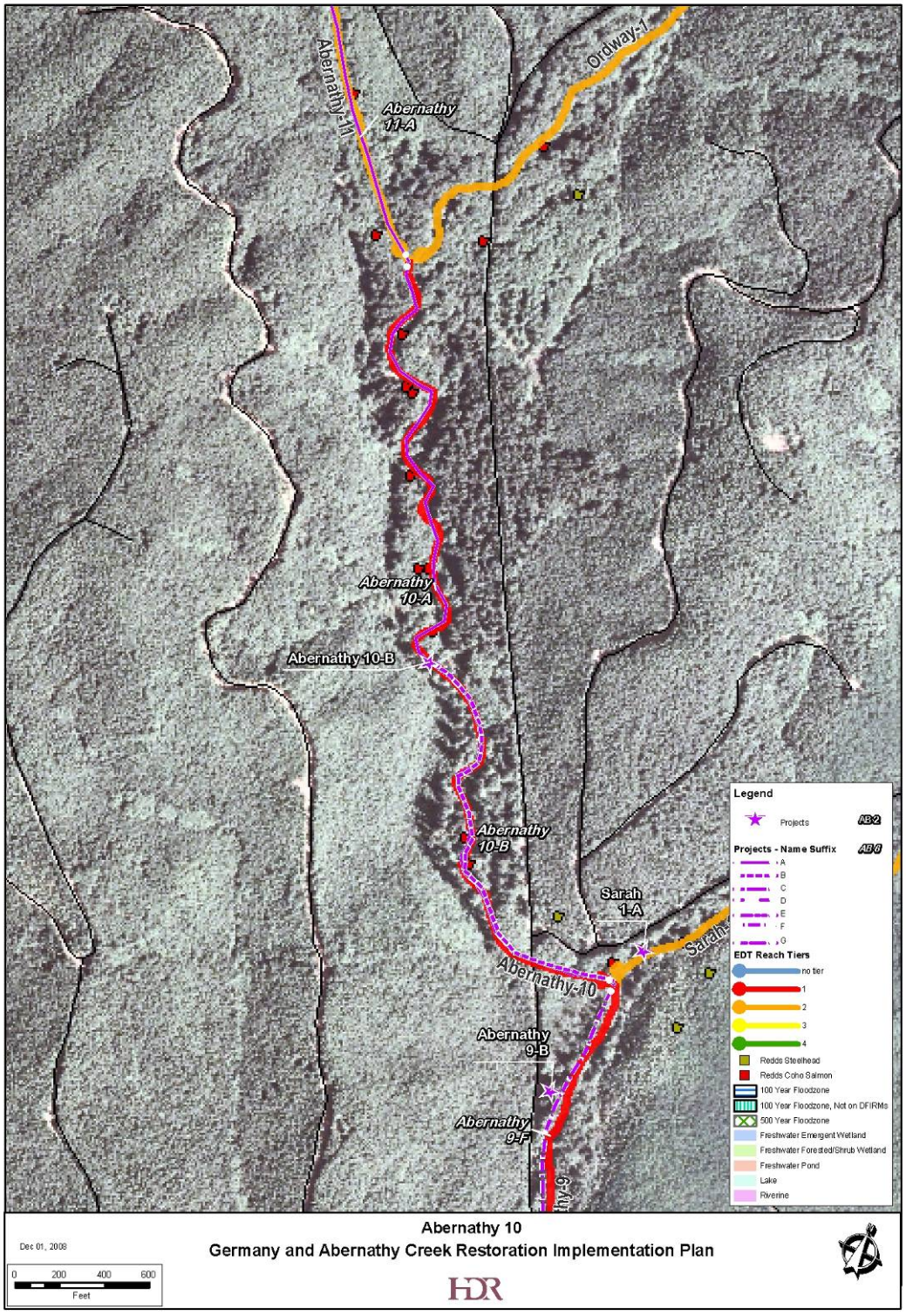
Abernathy 10 has much more flow than Abernathy 11 because of the contribution from Ordway Creek. Much like Abernathy 11, the riparian trees were mostly Alder with very few conifers in the understory. LWD density was low. Abernathy 10 has a larger channel migration zone with periodic off-channel beaver ponds and wetlands. Abernathy 10 also had more cobble and gravel to work with than Abernathy 11; this is probably the result of sediment inputs from Ordway Creek. Overall, this is a transport reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 12. Proposed projects include a LWD enhancement in the main channel with conifer plantings in the understory, and a large side channel enhancement project. Increasing the LWD density in the main channel will increase the

main channel key habitat quantity for coho and winter steelhead. The side channel project will increase key side channel habitat quantity for coho rearing. Potential project locations are shown in Figure 11, followed by project descriptions.

Table 12. Abernathy 10 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Sarah Cr to Ordway Cr (rm 8.61 to 9.41)	1	Chinook	C		N/A		
		Coho	C	H	Egg Incubation	37.9	Sediment Load
					0-Age Inactive	10.4	Key Habitat Quantity
					0-Age Active Rearing	6.1	Key Habitat Quantity
		Wsteelhead	P	H	Egg Incubation	38.4	Sediment Load
					0-Age Active Rearing	2.9	
					0,1-Age Inactive	2.8	
		Chum	P		N/A		

Figure 11. Abernathy 10 project locations.



Abernathy 10-A

Abernathy Creek (Abernathy 10). This project involves 4,220 feet of LWD and riparian enhancement. The riparian is mature hardwood (alder and maple) which will begin to provide LWD inputs over the next 20 years (estimated) but there is no conifer in the understory currently. Channel complexity in the active channel is low and paucity of LWD is causing reduced habitat diversity, and there is a lack of hydraulic complexity and sediment sorting for spawning and pool habitat. A conceptual design of this project is provided in Appendix E, Figure E-6.

1. Type of Project
   - LWD Enhancement
     - Hand falling or cable yarding trees with intact rootwads should be aggressive (a tree every 30 feet or so)
   - Riparian Enhancement (underplanting)
     - Plant conifers in the understory
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - None

Abernathy 10-B

Abernathy Creek (Abernathy 10). This project involves restoring 2,500 feet of off-channel habitat contained in roughly 5 acres. The off-Channel habitat (beaver ponds) is perched and inaccessible to fish; the active channel is incised. The relic side channel/ off-channel habitat could be incredible coho rearing habitat. Use a series of ELJs (4) to raise the elevation of the active channel and divert flow at head of the relict side channel in order to aggrade the channel (build up sediments) throughout the reach. This should facilitate better hydrologic connection with the current side channel. A conceptual design of this project is provided in Appendix E, Figure E-7.

1. Type of Project
   - Off/ Side Channel Enhancement
     - Install Engineered Log Jam(s) at upstream confluence of main and side channel
     - Add LWD material (from riparian) to side channel to increase habitat/promote gravel recruitment
     - Selectively grade at confluence to hydrologically reconnect main and side channel
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Key habitat quantity
4. Constraints
   - Access

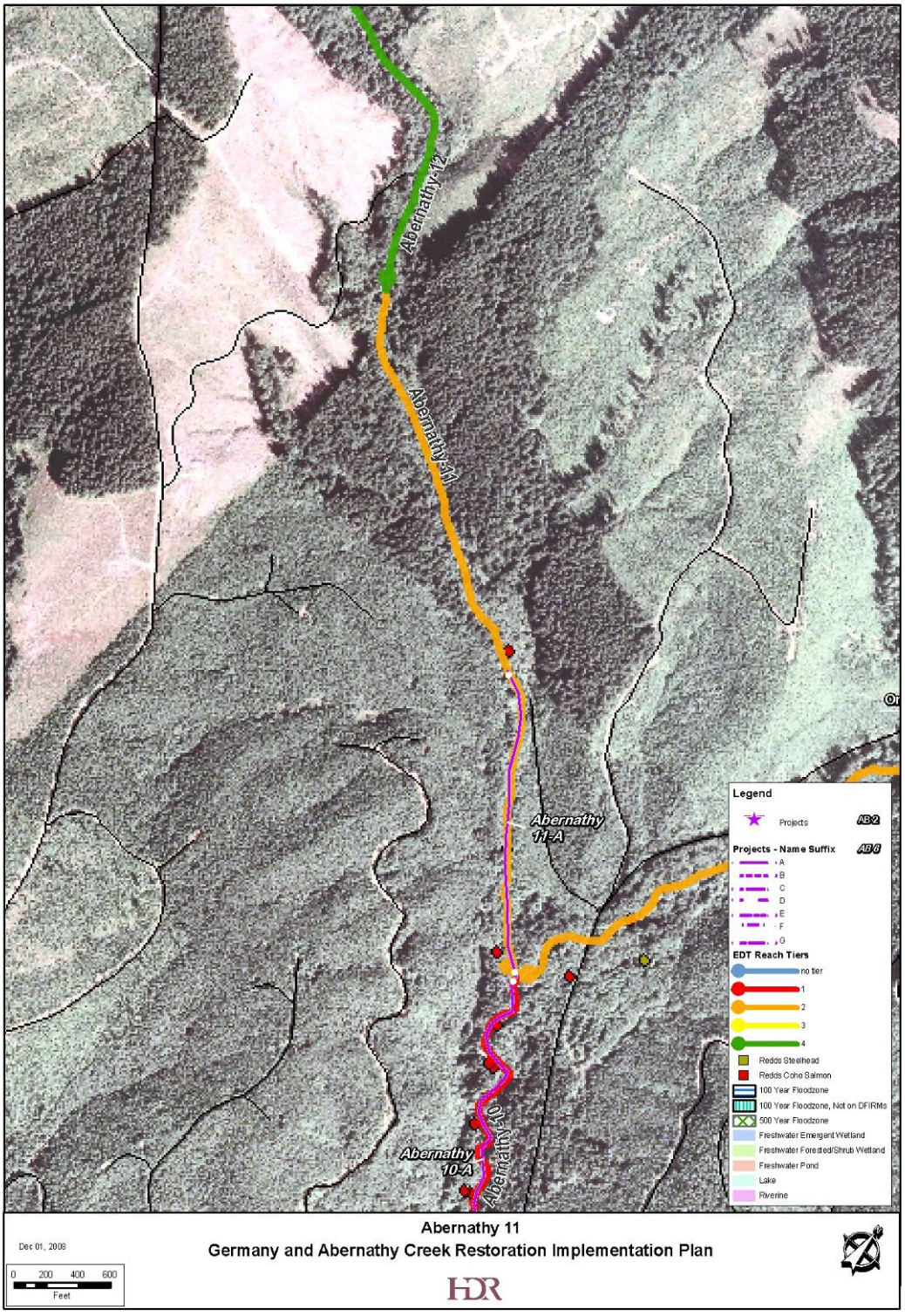
4.2.8 Abernathy 11

The upper 1/3 of Abernathy 11 is a small, complex, high gradient stream with a high density of LWD, including key pieces. The remaining downstream portion is a more simplified system with very little LWD. There riparian zone primarily consists of mature Alder. There are virtually no conifers in the understory. Overall, this is a transport reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 13. The one project proposed for this reach is to enhance LWD in the lower 2/3 of the reach. This action would increase habitat complexity and improve coho and winter steelhead rearing opportunities. Potential project locations are shown in Figure 12, followed by project descriptions.

Table 13. Abernathy 11 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Ordway cr to end of presumed coho/steelhead	9.41 to 10.26	2	Chinook	C		N/A		
			Coho	C	L	Egg Incubation	44.2	Sediment Load
						0-Age Inactive Rearing	38.4	Habitat Diversity
						0-Age Active Rearing	17.5	Key Habitat Quantity
			W Steelhead	P	M	Egg Incubation	40.7	Sediment Load
						0-Age Active Rearing	10.4	Habitat Diversity
						0,1-Age Inactive Rearing	13.3	Habitat Diversity

Figure 12. Abernathy 11 project locations.



Abernathy 11-A

Abernathy Creek (Abernathy 11). This project involves approximately 1500 feet of LWD and riparian enhancement. The riparian zone is mature hardwood (alder and maple) which could begin to provide LWD inputs over the next 20 years, however currently there is no conifer in the understory which is needed to provide LWD with adequate size. Overall, channel complexity in the active channel is low. A paucity of LWD is contributing to reduced habitat diversity, lack of hydraulic complexity, poor sediment sorting, and poor pool habitat.

1. Type of Project
   - LWD Enhancement (wood from riparian)
     - Hand falling or cable yarding trees with intact rootwads should be aggressive (a tree every 30 feet or so).
   - Riparian Enhancement (underplanting)
     - Plant conifer in the understory.
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Access

4.2.9 Cameron 1

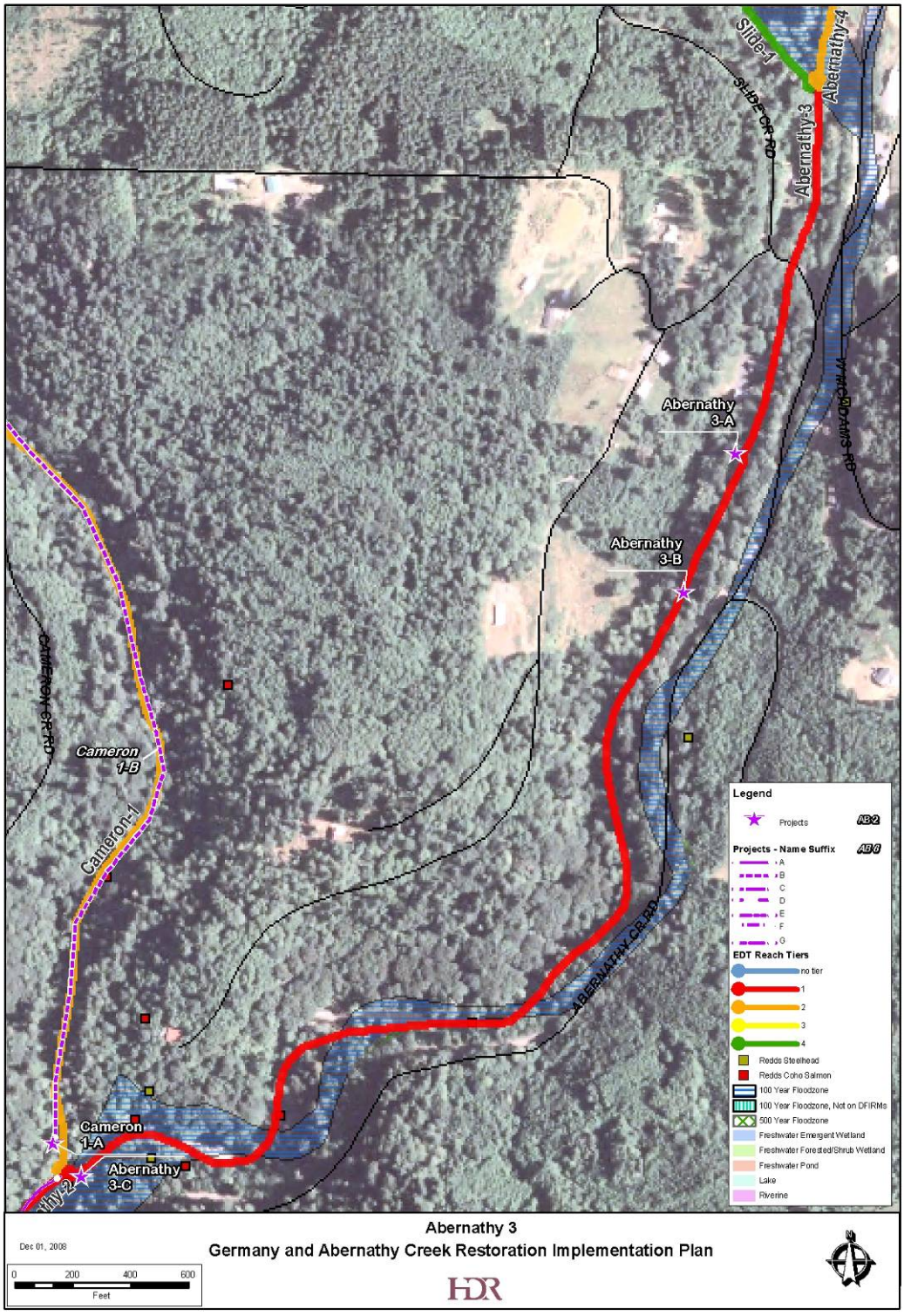
Cameron Creek is a large tributary that enters Abernathy Creek at RM 0.56. Cameron 1 (tier 2) is a high gradient reach with very little sediment. Much of the lower portion of Cameron 1 was scoured to bedrock. Although the riparian zone was intact and mature, very little LWD was present in the channel. Older mature Spruce was present in the lower segment of the reach. Habitat complexity and sediment retention had occurred in the few areas where LWD was keyed into the channel. The high gradient, transport nature of Cameron 1 may make LWD rehabilitation a challenge, considering the large upper watershed and likely large stream power during flood flows. The confluence at Abernathy Creek is a depositional area. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 14. Projects in this reach include enhancing a side channel near the confluence with Abernathy Creek and increase LWD densities. These projects would increase habitat complexity

and benefit coho fry colonization and rearing, winter steelhead rearing, and chum salmon spawning habitat. Potential project locations are shown in Figure 13, followed by project descriptions.

Table 14. Cameron 1 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
mouth to trib 1231894462314	0 to 3.13	2	Chinook	C		N/A		
			Coho	C	L	Egg Incubation	39.5	Sediment Load
						Fry Colonization	17.2	Habitat Diversity
						0-Age Active Rearing	36.9	Habitat Diversity
			W Steelhead	P	L	Egg Incubation	44.3	Sediment Load
						0-Age Active Rearing	19.8	Habitat Diversity
						0,1-Age Inactive Rearing	20.2	Habitat Diversity
			Chum	P	M	Egg Incubation	36.8	Channel Stability
						Prespawn Holding	8.4	Habitat Diversity
						Spawning	4.1	Habitat Diversity

Figure 13. Cameron 1 project locations.



Cameron 1-A

Cameron Creek (Cameron 1). This potential Rehabilitation site is located upstream of the confluence with Abernathy Creek. The project involves over 300 feet of side channel rehabilitation in order to increase habitat complexity and to provide off-channel winter and summer refugia for salmonids. Currently, this side channel is connected to the main channel. Although there is sporadic LWD, this project would seek to add LWD materials to increase holding areas and residual pool depths, provide gravel trapping, and decrease predation due to lack of cover. Smolts were observed at the downstream confluence with Abernathy.

1. Type of Project
   - Off/ Side Channel Enhancement
     - Add LWD to increase habitat complexity
2. Potential Causal Factors
   - Lack of upstream LWD inputs
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

Cameron 1-B

Cameron Creek (Cameron 1). This potential Rehabilitation site is located upstream of the confluence with Abernathy Creek. The project involves between ½ and 1 mile of main channel LWD work to reintroduce wood into the stream. There is a virtually no wood in this system, the channel form is mostly plane-bed and step pool, and there are healthy climax stands of large conifers in the adjacent riparian areas. This area represents an opportunity to protect mature existing riparian buffers that are not found in other drainages. This area is away from any roads and public access.

1. Type of Project
   - LWD Enhancement (wood from riparian)
     - Add LWD to increase habitat complexity
     - Preserve climax conifer communities
     - Employ hand crews upstream to cut/cable in LWD
2. Causal Factors
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

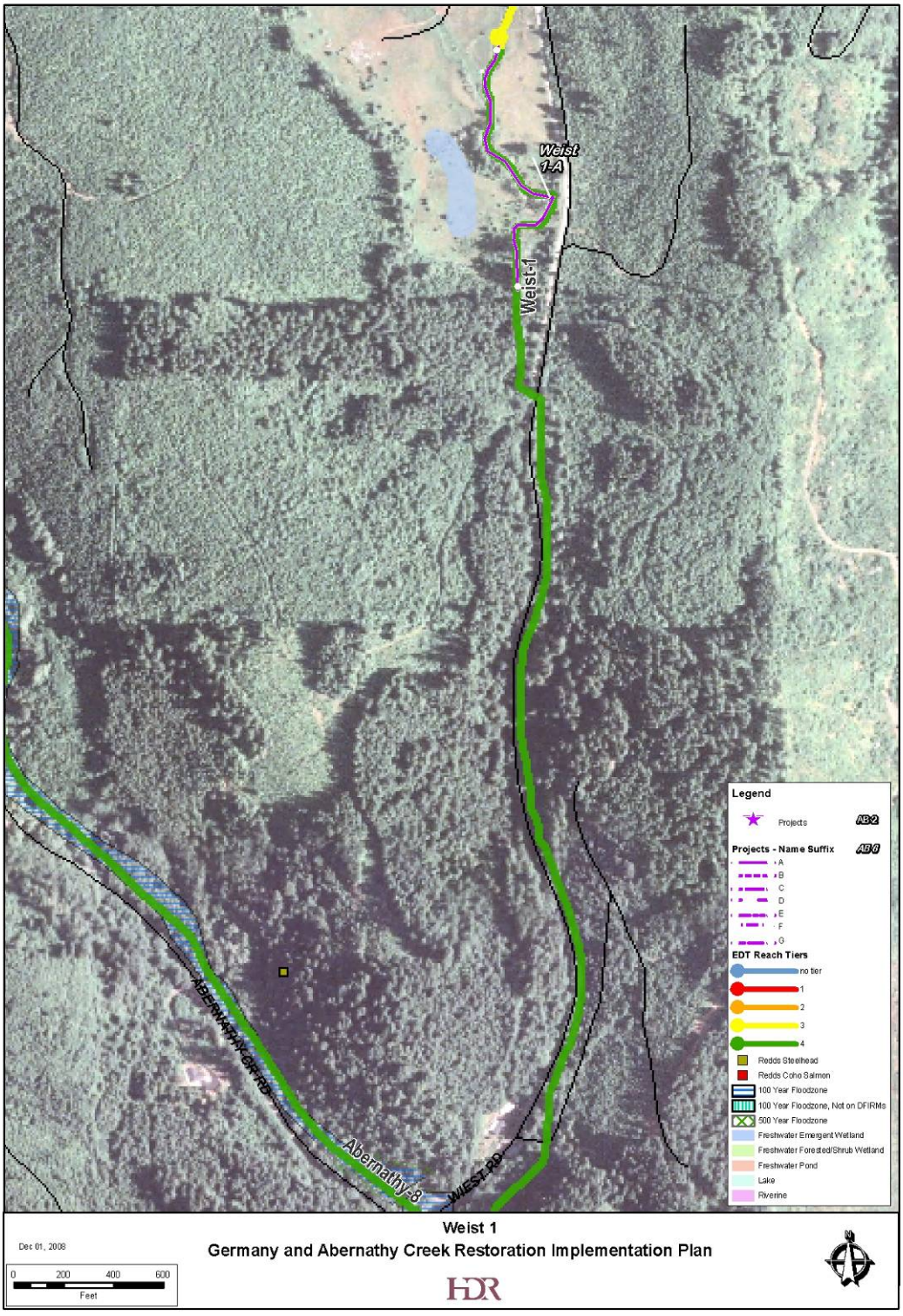
4.2.10 Weist 1

Weist Creek joins Abernathy Creek at the downstream portion of Abernathy 8. The lower ½ mile of Weist 1 is a steep canyon section that is confined by the adjacent road and is incised into bedrock. Above this is broad valley opens up with excellent meadow habitat. There is evidence of a recent homestead and the meadow has been cleared for agricultural production. This property appears to be abandoned. According to the Weist family (personal communication) this meadow used to support large cutthroat and steelhead trout. The single project proposed for this reach includes LWD enhancement and sided-channel enhancement that will increase habitat diversity for coho and winter steelhead rearing. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 15. Potential project locations are shown in Figure 14, followed by project descriptions.

Table 15. Weist 1 reach characteristics.

Reach	Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Weist-1	mouth to end of presumed CHFA	0 to 1.02	4	Chinook	C		N/A		
				Coho	C	L	Egg Incubation	52	Channel Stability
							0-Age Inactive Rearing	49.5	Habitat Diversity
							0-Age Active Rearing	26.5	Habitat Diversity
				W Steelhead	P	L	Egg Incubation	46.6	Sediment Load
							0-Age Active Rearing	17.2	Habitat Diversity
							Fry Colonization	10.2	Habitat Diversity
				Chum	P		N/A		

Figure 14. Weist 1 project locations.



Weist 1-A

Weist Creek (Weist 1). This potential Rehabilitation site is located in the middle/upper section of the creek above the canyon section. This area appears to have formally been used as pasture land and there are old abandoned structures on the property. The creek is low gradient at the project location and meanders through the property. Local knowledge has suggested that this area was once used by migratory cutthroat, coho and steelhead. The stream still has excellent habitat for coho and trout populations. The stream has been incised and has down-cut so that that the floodplain is not accessible to the stream. The adjacent riparian communities are primarily grasses.

1. Type of Project
   - Riparian Rehabilitation
   - LWD Enhancement (import wood)
   - Off/ Side Channel Enhancement
2. Potential Causal Factors
   - Channel confinement limits floodplain inundation
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Land-use limits riparian buffer development
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

4.2.11 Sarah 1

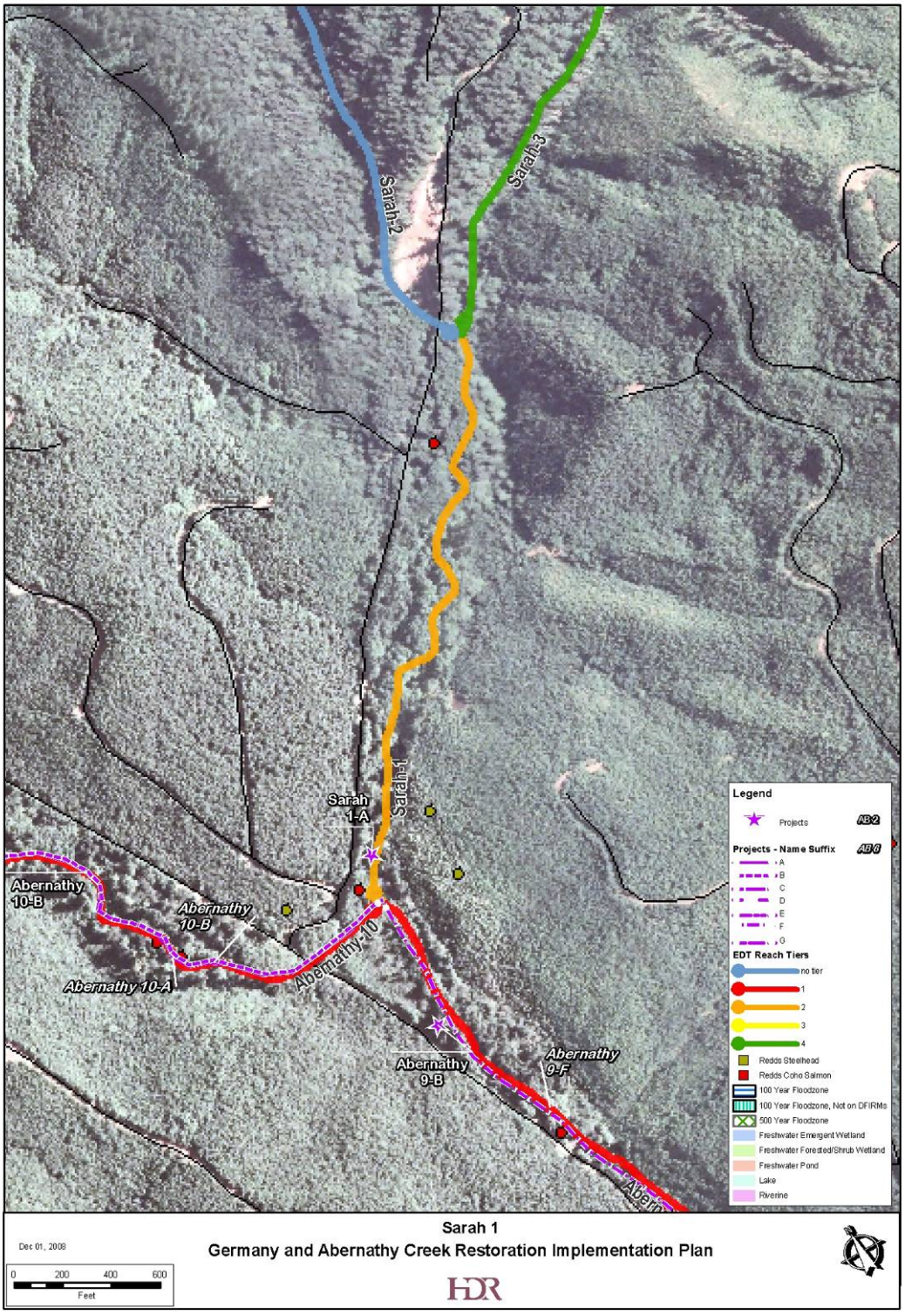
Sarah Creek is a small naturally confined stream that joins Abernathy Creek at the downstream end of Abernathy 10. Sarah 1 had a riffle/erosional habitat along much of the reach with some quality cobble/ gravel sediment. Towards the end of the reach, a large log was holding back bed load and forced the creation of a side-channel. The side-channel and several hundred feet downstream were scoured to bedrock. This scoured segment is a transport reach with a 5+ ft bedrock waterfall at the terminal end. This waterfall may be a passage barrier for coho but is probably passable for steelhead. After the waterfall, cobble and gravel sediments picked up again. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008)

are shown in Table 16. One LWD enhancement project is proposed for this reach. This project would increase habitat diversity for coho in the scoured reach and increase passage over the waterfall. Potential project locations are shown in Figure 15, followed by project descriptions.

Table 16. Sarah 1 reach characteristics.

Reach	Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Sarah-1	mouth to forks	0 to 0.49	2	Chinook	C		N/A		
				Coho	C	L	0-Age Inactive Rearing	63.7	Habitat Diversity
							Egg Incubation	40.3	Sediment Load
							0-Age Active Rearing	15.6	Key Habitat Quantity
				W Steelhead	P	M	Egg Incubation	40	Sediment Load
							0-Age Active Rearing	5.2	
							Fry Colonization	2.9	
				Chum	P		N/A		

Figure 15. Sarah 1 project locations.



Sarah 1-A

Sarah Creek (Sarah-1). This project involves 1,000 feet of LWD enhancement, including the area immediately downstream of a waterfall to increase passage for coho. This segment of reach is scoured to bedrock and this is a sediment transport reach.

1. Type of Project
   - LWD Enhancement (imported wood)
     - Increase passage over falls and/or the scoured segment by holding back bedload immediately downstream of the falls.
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Access

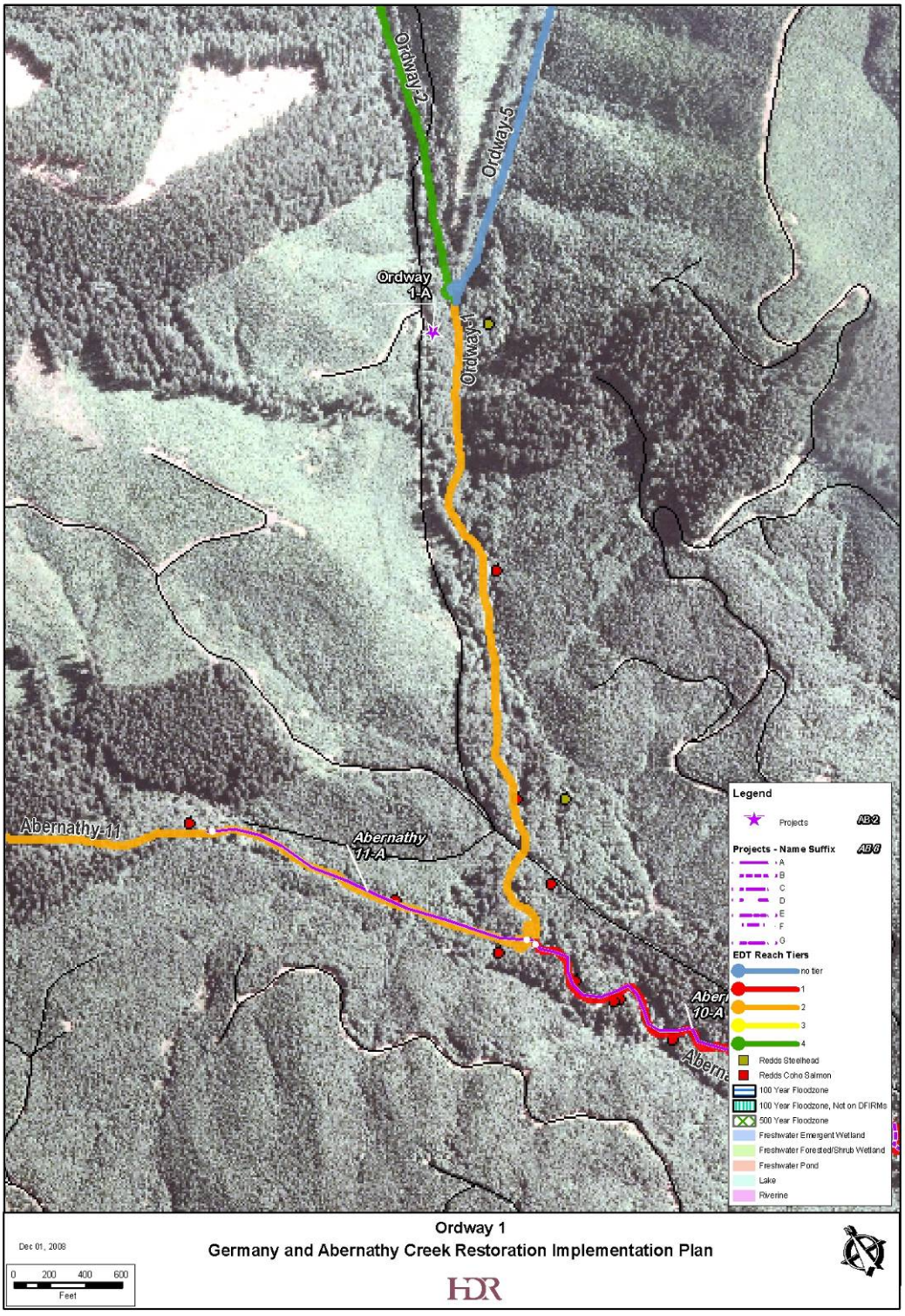
4.2.12 Ordway 1

Ordway Creek joins Abernathy Creek at the downstream end of Abernathy 11. Ordway Creek has a larger drainage area and more base flow than upper Abernathy Creek (i.e. upstream of confluence with Ordway Cr.). Ordway Creek also appeared to be contributing more significant amounts of bedload to Abernathy Creek based on the sediment deposits near the confluence with Abernathy Creek and the assumed greater stream power during high flow conditions. Ordway 1 (tier 2) was relatively confined, but had a few narrow marshy benches that could serve as off-channel habitat. The mouth of Ordway 1, downstream of bridge, is unconfined and complex with a high LWD density. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 17. One project in this reach is proposed to create a side channel in a marshy bench that contains significant seeps. This project would contribute to Coho juvenile rearing habitat. The potential project location is shown in Figure 16, followed by the project description.

Table 17. Ordway 1 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
ordway mouth to	0 to 0.72	2	Chinook	C		N/A		
			Coho	C	L	Fry Colonization	13.2	Habitat Diversity
						Egg Incubation	44.4	Sediment Load
						0-Age Active Rearing	28.5	Habitat Diversity
			W Steelhead	P	M	Egg Incubation	41.7	Sediment Load
						1-Age Active Rearing	8.8	
						0,1-Age Inactive Rearing	8.9	
			Chum	P		N/A		

Figure 16. Ordway 1 project locations.



Ordway 1-A

Ordway Creek (Ordway 1). The project involves enhancement of 105 feet of side channel habitat. An unconfined bench runs along the left bank. A spring coming off of the hillside has created channel along the nearly the entire bench. Minor excavation at the head of the bench could create a functional side channel. Woody debris along the channel could create pools for rearing and improved winter refuge habitat.

1. Type of Project
   - Off/ Side Channel Enhancement
     - Add LWD material (wood from riparian) to side channel to increase habitat/promote gravel recruitment
     - Selectively grade at confluence to hydrologically reconnect main and side channel
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Lack of upstream LWD inputs
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - Access

4.2.13 Germany 1 and 2

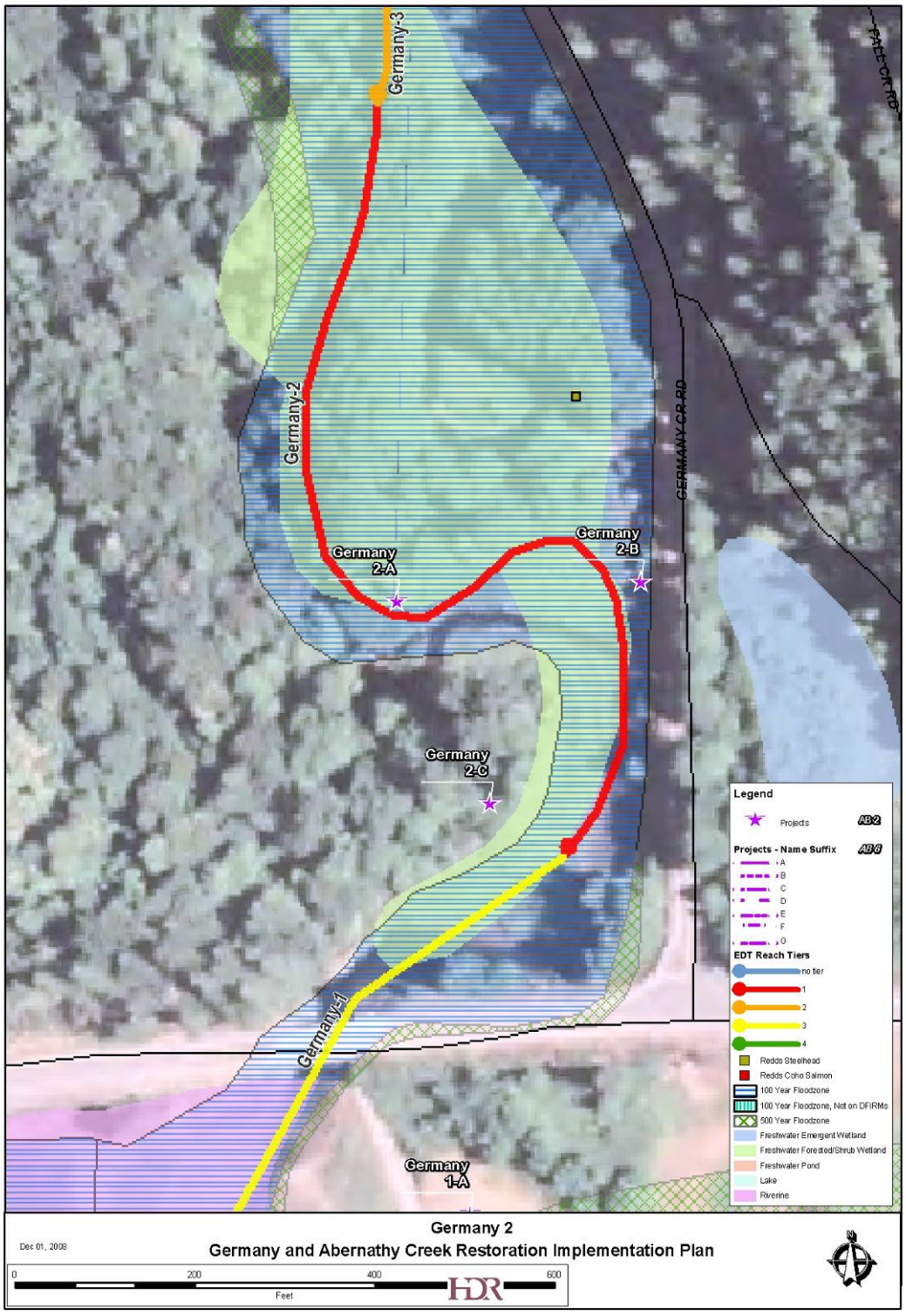
Germany 2 is a tidally influenced depositional area. There are several areas with large sediment accumulations with bar formations that are forcing the stream into adjacent areas. LWD jams were observed in several areas on the inside of meander bends and local scouring and channel complexities were observed. The adjacent Germany Creek Road parallels a good portion of this reach, imposing limited buffer widths on the left bank with limited shading and exposure to predation. Germany 1 is the confluence with the Columbia River. This area is beginning to deposit loads of fine material at the confluence. Native vegetation is lacking and there appears to be a concerted effort to limit erosion through the use of rip-rap along both banks. Historically, this area was most likely the site of very large wood debris jams, which currently do not exist. Overall, Germany 1 and 2 are depositional reaches. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 18. Proposed projects in this reach would result in several engineered log jams, riparian restoration, deflecting flow from Germany Creek Road, and restoring the delta. Multiple salmonid species use these reaches. The riparian restoration would regulate stream temperature for Chinook spawning, coho rearing, and

steelhead rearing. The LWD jams and bank restoration would increase cover, scour, channel complexity and rearing habitat for multiple Germany Creek and transient Columbia River migrants. Potential project locations are shown in Figure 17, followed by project descriptions.

Table 18. Germany 1 and 2 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Germany 1: mouth to slackwater	0 to 0.16	3	Chinook	C	M	Fry Colonization	0.6	Habitat Diversity
						Prespawn Migrant	0.1	Temperature
						0-Age Active Rearing	0.1	Key Habitat Quantity
			Coho	C	H	0-Age Inactive Rearing	10.3	Habitat Diversity
						0-Age Active Rearing	30.1	Habitat Diversity
						1-Age Active Rearing	4.3	Key Habitat Quantity
			W Steelhead	P	M	0-Age Active Rearing	28.2	Temperature
						Fry Colonization	5.3	Habitat Diversity
						1-Age Active Rearing	14.9	Temperature
			Chum	P	M	Fry Colonization	0.2	Habitat Diversity
						Prespawn Migrant	0.1	Habitat Diversity
Germany 2: slackwater to lower canyon	(rm0.16 to 0.39)	1	Chinook	C	H	Egg Incubation	37.6	Sediment Load
						Spawning	9	Temperature
						Fry Colonization	0.5	Habitat Diversity
			Coho	C	L	0-Age Active Rearing	24.7	Temperature
						0-Age Inactive Rearing	8.1	Habitat Diversity
						1-Age Active Rearing	3.3	Key Habitat Quantity
			Wsteelhead	P	H	Egg Incubation	54.8	Temperature
						0-Age Active Rearing	22.1	Temperature
						Fry Colonization	2.1	Temperature
			Chum	P	H	Egg Incubation	42	Sediment Load
						Prespawn Holding	8.4	Habitat Diversity
						Spawning	1	Habitat Diversity

Figure 17. Germany 1 and 2 project locations.



Germany 1-A

Germany Creek (Germany 1). This potential project site is located at the mouth of the Germany Creek downstream of the Hwy 4 bridge crossing. The area along the east side of the mouth has been protected by large rip- rap to protect against wave impacts from ship wake and tidal influences. There is an adjacent floodplain/terrace immediately behind the rip-rap. In general the rip-rap is functioning poorly and local conditions along the delta and beaches lack native species and LWD. There may be a potential to remove remnant hardened banks that aren't functioning properly.

1. Type of Project
   - Riparian Enhancement
     - Plant/seed with native species
     - Add nesting perches
   - Bank Stabilization (riprap removal)
   - Engineered Log Jams (3)
2. Potential Causal Factors
   - Lack of sediment recruitment
   - Channel confinement limits floodplain inundation
   - Land-use limits riparian buffer development
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Landownership unknown

Germany 2-A

Germany Creek (Germany 2.) This site is located in the tidal zone and has historically been a depositional reach for both sediment and LWD. There are some relict LWD debris jams in this reach. However, this reach is degraded and confined by the adjacent road and downstream boundary (bridge) which limits sediment and wood accumulation. This project attempts to

accumulate sediments and create more channel complexity through the use of ELJ structures. Any engineered structures at this site need to account for tidal influences. In addition, the lack of channel complexity has led to an increase in invasive plant species and an overall decrease in natives. Revegetation efforts should focus on reestablishing native ash, cottonwood, ninebark, and other native emergent species as well as treatment for invasive plant species, including policeman's helmet (*Impatiens glandulifera)* and reed canary grass (*Phalaris arundinacea*). A conceptual design of this project is provided in Appendix E, Figure E-8.

1. Type of Project
   - Engineered Log Jams
     - Use vertical pilings to anchor and build ELJs (5)
   - Riparian Rehabilitation
     - Plant native species and treat invasive plant species
2. Potential Causal Factors
   - Channel confinement limits floodplain inundation
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Lack of sediment recruitment
   - Lack of upstream LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Potential Constraints
   - Access for heavy equipment

Germany 2-B

Germany Creek (Germany 2). At this site a debris jam has piled up and a localized scour pool could threaten a section of the road which is approximately 15 feet away. This area is a natural depositional area and there is a large debris pile which is approximately 50 feet in length. Local bedload has forced the stream to impinge against the left streambank. A conceptual design of this project is provided in Appendix E, Figure E-9.

1. Type of Project
   - Bank Stabilization & Erosion Control
     - Riparian planting
     - Hard and soft (bioengineering) techniques
     - LWD placement to force main channel away from streambank
2. Potential Causal Factors
   - Channel is confined
   - Maximum velocity is directed toward left bank
   - Reduced riparian buffer zone
3. Limiting Conditions
   - Channel stability
   - Sediment load
4. Potential Constraints
   - None

Germany 2-C

Germany Creek (Germany 2). The proposed site is immediately upstream from the Germany Creek Bridge at the mouth of the Columbia River. This area is largely tidal in nature. There are large areas that have been infested with invasive species including reed canary grass and non-native blackberries. Overall the estimated area of treatment is greater than 5 acres. This area should be treated and replanted with native woody species and conifers. A conceptual design of this project is provided in Appendix E, Figure E-10.

1. Type of Project
   - Riparian Enhancement
     - Plant/seed with native species
     - Use mechanical, herbicide, plantings and other measures to remove invasive plants
2. Potential Causal Factors
   - Riparian complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Disturbances have increased exotics
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

4.2.14 Germany 3

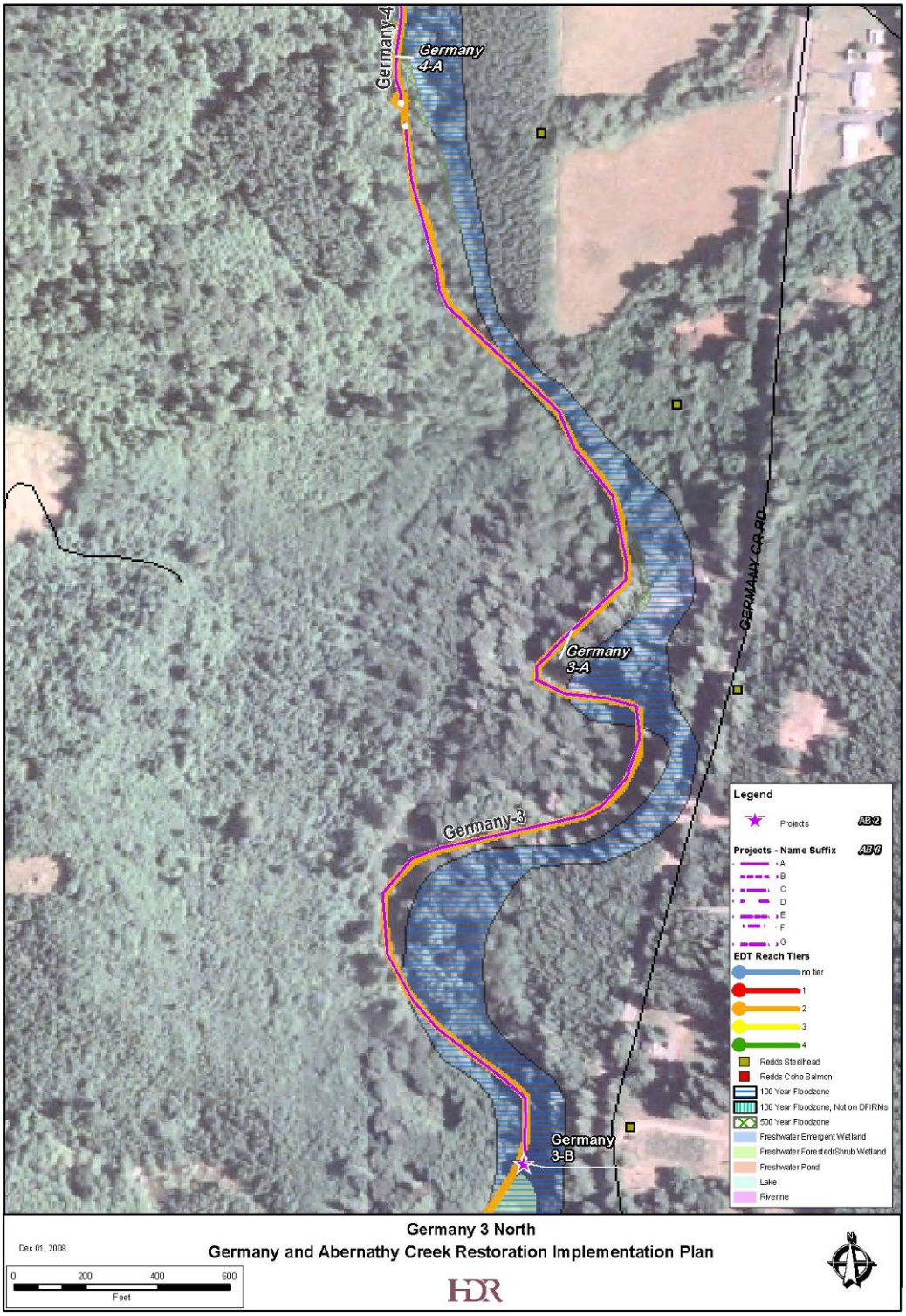
Reach 3 is a depositional reach with sediment forcing large side channels in the upstream portion and alternate point bars evident in the downstream portion of this reach. The reach, as a whole, has low LWD density and habitat diversity, but there are several discrete areas of higher habitat diversity. These areas are the result of relict LWD deposits which have trapped sediments, encouraged side-channel formation and are forcing pool scour. Sinuosity has improved throughout this area and in general there are greater opportunities to encourage dynamic process. Overall, this is a depositional reach. Reach characteristics from the recovery plan (LCFRB 2004)

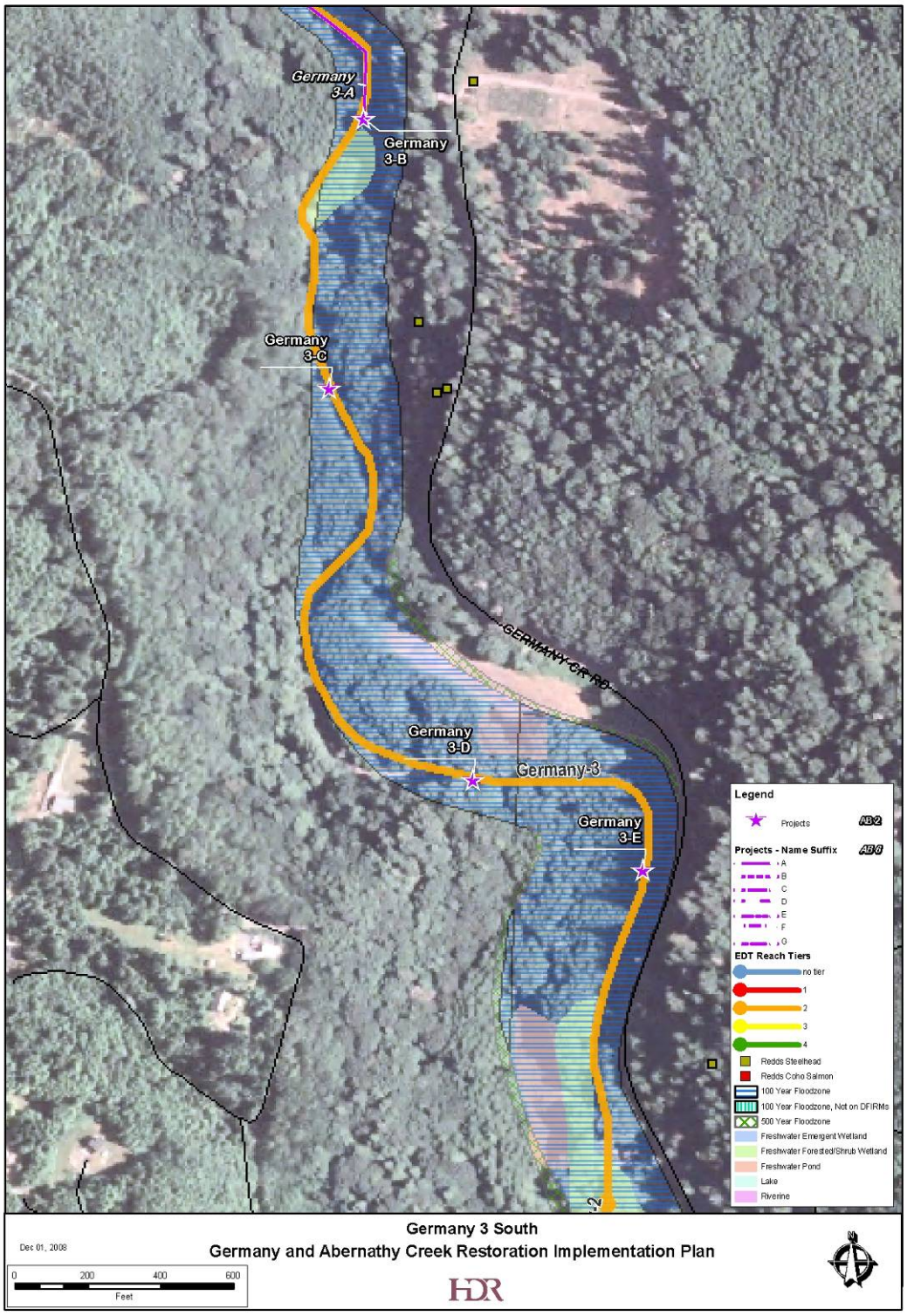
and HWS (LCFRB 2008) are shown in Table 19. Proposed projects in this reach include side channel enhancement with LWD, riparian enhancement, and mainstem LWD enhancement. The side channel projects would increase habitat diversity for rearing coho and steelhead. Increasing habitat diversity in the active channel would increase spawning habitat for chum and fry colonization for Chinook. Riparian enhancement would promote the regulation of stream temperature for Chinook spawning and winter steelhead rearing. At the downstream end of Reach 3, a bank protection project is proposed to force the active channel from an existing road. Potential project locations are shown in Figure 18a and 18b, followed by project descriptions.

Table 19. Germany 3 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
lower canyon	0.39 to 1.90	2	Chinook	C	M	Egg Incubation	37.9	Sediment Load
						Spawning	10.4	Temperature
						Fry Colonization	3.1	Habitat Diversity
			Coho	C	H	Egg Incubation	44.8	Sediment Load
						0-Age Active Rearing	25.9	Habitat Diversity
						0-Age Inactive Rearing	10.3	Habitat Diversity
			W Steelhead	P	M	Egg Incubation	55.8	Sediment Load
						0-Age Active Rearing	22.9	Temperature
						1-Age Active Rearing	11.7	Temperature
			Chum	P	M	Egg Incubation	42	Sediment Load
						Prespawn Holding	8.7	Habitat Diversity
						Spawning	1	Habitat Diversity

Figure 18a and Figure 18b. Germany 3 project locations.




Germany 3-A
Germany 3-B
Germany 3-C
GERMANY CR RD
Germany 3-D
Germany-3
Germany 3-E
Legend
Projects
AB2
Projects - Name Suffix
AB0
A
B
C
D
E
F
G
EDT Reach Tiers
no tier
1
2
3
4
Redds Steelhead
Redds Coho Salmon
100 Year Floodzone
100 Year Floodzone, Not on DFIRMs
500 Year Floodzone
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Germany 3 South
Germany and Abernathy Creek Restoration Implementation Plan
Dec 01, 2008
0 200 400 600
Feet
HDR

Germany 3-A

Germany Creek (Germany 3). The lower portion of Germany Creek 3A is considered excellent habitat and refugia for chum and Chinook species due to excellent off-channel habitat potential. This area can be characterized by lower gradients, low velocities, and as a depositional area. In general the area would benefit from inputs of LWD (loading) and riparian plantings. These objectives could be accomplished through hand-falling and cable-yarding trees into the creek, and planting along the entire reach. Due to the sensitive nature of this area it is recommended that any projects use a low footprint by minimizing heavy equipment in order to preserve important marsh and floodplain habitat.

1. Type of Project
   - LWD Enhancement (wood from riparian)
   - Riparian Enhancement (underplanting)
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Lack of upstream LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Sensitive wetland area; heavy equipment use should be minimized

Germany 3-B

Germany Creek (Germany 3). This site involves the enhancement and rehabilitation of up to two side channels on the left and right side of the main channel to increase coho rearing habitat off of the main channel. There is evidence of historical wood deposition within the side channels, and the side channels were hydrologically connected to the main channel. In addition, there may be opportunities to increase sediment mobility and to break-up the existing armor layer.

1. Type of Project
   - Off/ Side Channel Enhancement
     - LWD Enhancement (wood from riparian) to side and main channel to increase pools, cover, and reduce armoring

    - Add ELJs (4) to promote aggradation, enhance side-channel, scour, connectivity
    - Riparian Enhancement (underplanting); Conifer riparian plantings (understory Spruce and Cedar)
2. Potential Causal Factors
    - Lack of upstream LWD inputs
3. Limiting Conditions Addressed
    - Habitat diversity
    - Key habitat quantity
4. Potential Constraints
    - None

Germany 3-C

Germany Creek (Germany 3). This potential rehabilitation site has excellent potential for chum and coho spawning and rearing habitat. There were large residual pools found during the site visit. There is adequate hydrologic connection, and the floodplains appear to be inundated on a regular basis. Although the riparian buffer is adequate in terms of width, there are few mature conifers. There is little or no wood within the side channel and key habitat quantity and diversity is lacking; cover against predation for juvenile salmonids appears very low. Preservation of this area could help to protect this valuable spawning area refugia.

1. Type of Project
    - Side Channel Enhancement
        - LWD Enhancement (wood from riparian) in side channel
        - Encourage in-channel deposition to continue through reintroducing LWD
    - Riparian Enhancement (underplanting)
    - Property acquisition (if necessary)
2. Potential Causal Factors
    - Riparian conditions do not support adequate LWD size and quantities
    - Lack of upstream LWD inputs
    - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity

4. Potential Constraints
    - None

Germany 3-D

Germany Creek (Germany 3). Downstream from Site Germany 3-C, this site shows a more complex side channel formation with recent gravel entrapment and suitable spawning gravels. This is a large side channel with sporadic LWD (all hardwood), good residual pools, and adequate riparian conditions. This project could dramatically improve upon an area that is being actively used by salmonids. This project will build on off-channel enhancement work already completed by the Columbia Land Trust.

1. Type of Project
    - Side Channel Enhancement
        - LWD Enhancement to side channel (wood with rootwads); encourage deep scour pools and holding habitat; river may move back into this channel, so good to have habitat.
    - Riparian Enhancement (underplanting)
    -
2. Potential Causal Factors
    - Riparian conditions do not support adequate LWD size and quantities
    - Lack of upstream LWD inputs
    - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity
4. Constraints
    - None

Germany 3-E

Germany Creek (Germany 3). At this potential project site, the river is developing a well functioning pool-riffle sequence as gravel is deposited on the inside of the meander bend. This depositional area occurs immediately upstream from the tidally influenced Germany 2. Due to

the natural sediment accumulation, the river wants to move toward the left bank. The left bank has a poor riparian buffer width and the road is only 15 feet from the active channel. Shading is poor and there is a lack of a mature canopy. Although, the toe of the slope appears to be fairly stable this area could see signs of bank erosion in the future. Overall, this project could protect road, deflect maximum velocities away from left bank adjacent to the road and encourage channel to migrate toward the unconfined right channel bank. In addition, adding cover might assist in reducing harassment and potential poaching.

1. Type of Project
   - Bank Stabilization/ Protection
     - Hard and soft (bioengineering) techniques
     - LWD Enhancement (imported wood) to force channel away from streambank
     - Riparian Rehabilitation
2. Potential Causal Factors
   - Channel is confined
   - Maximum velocity is directed toward left bank
   - Reduced riparian buffer zone
3. Limiting Conditions
   - Channel stability
   - Temperature
   - Key habitat quantity
4. Constraints
   - Left bank is within 5-10 feet of Germany Creek Road
   - Smolt traps are in the area
   - Tidal zone should be considered in design

4.2.15 Germany 4

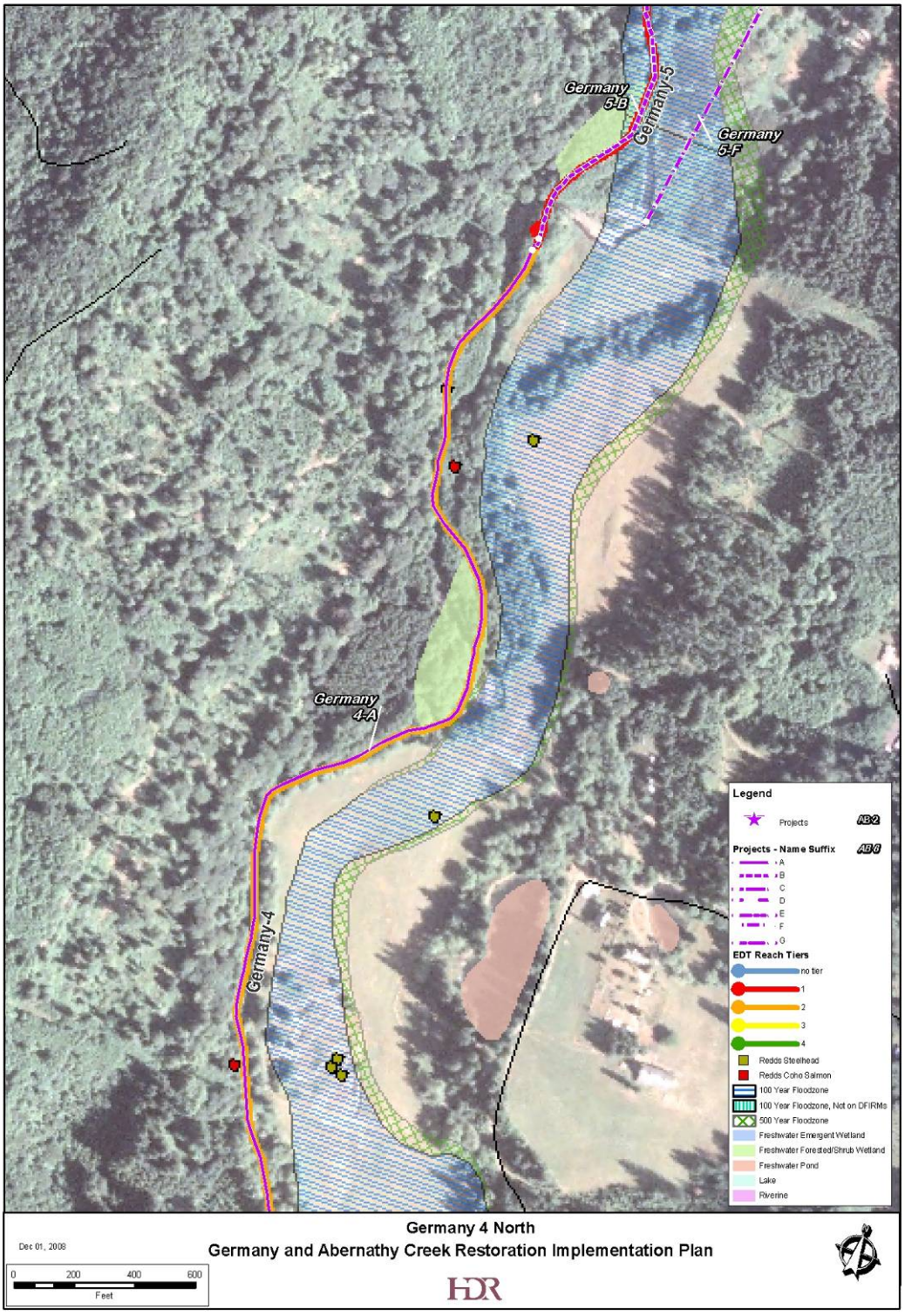
Germany 4 flows mostly through private landowners parcels on the east side (left bank). This region has agricultural use on the left bank, with minimal riparian buffers, while the west side (right bank) has a functional riparian zone. In general there is an overall lack of LWD throughout this entire reach. There may be opportunities to work with landowners on improving riparian and main channel habitat diversity and key habitat quantity. Overall, this is a depositional reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 20. Restoration objectives in this reach are to increase LWD density and riparian quality along the left (east) bank. Increased LWD density will promote gravel recruitment,

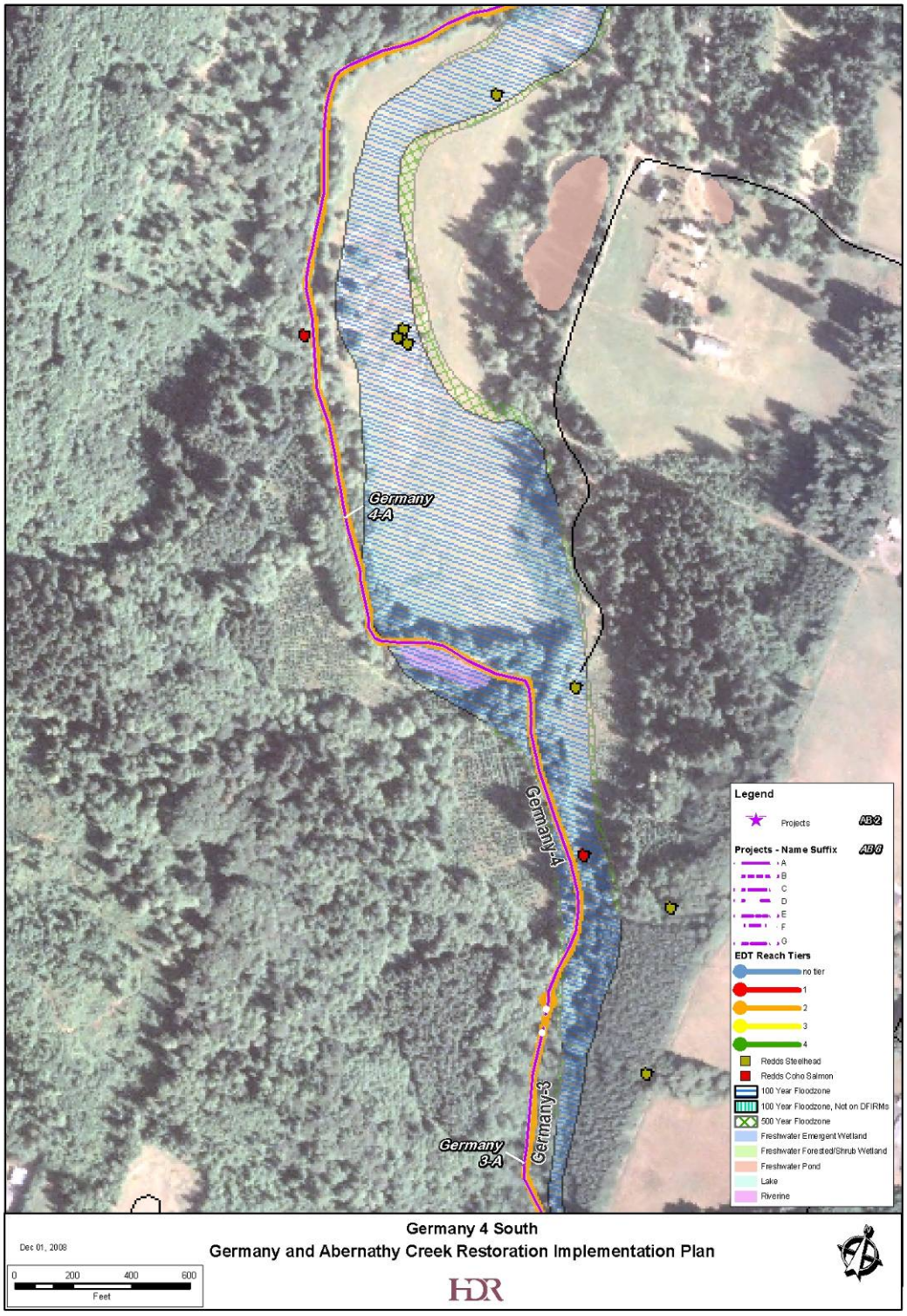
sorting, create pools, and provide fish cover for coho. Riparian rehabilitation along the left bank will regulate stream temperatures for Chinook spawning and winter steelhead juvenile rearing. Potential project locations are shown in Figures 19a and 19b, followed by project descriptions.

Table 20. Germany 4 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
lower canyon to end of presumed	1.90 to 3.06	2	Chinook	C	L	Egg Incubation	38.7	Sediment Load
						Spawning	9.8	Temperature
						Fry Colonization	3.3	Channel Stability
			Coho	C	H	Egg Incubation	45.2	Sediment Load
						0-Age Active Rearing	28.8	Habitat Diversity
						0-Age Inactive	13	Habitat Diversity
			W Steelhead	P	M	Egg Incubation	56.6	Sediment Load
						0-Age Active Rearing	23.8	Temperature
						1-Age Active Rearing	13.9	Temperature
			Chum	P		N/A		

Figures 19a and 19b. Germany 4 project locations.




Germany 4-A
Germany 4
Germany 3
Germany 3-A
Legend
Projects
AB2
Projects - Name Suffix
AB0
A
B
C
D
E
F
G
EDT Reach Tiers
no tier
1
2
3
4
Redds Steelhead
Redds Coho Salmon
100 Year Floodzone
100 Year Floodzone, Not on DFIRMs
500 Year Floodzone
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Dec 01, 2008
0 200 400 600
Feet
Germany 4 South
Germany and Abernathy Creek Restoration Implementation Plan
HDR

Germany 4-A

Germany Creek (Germany 4). Potential projects within this area should identify local landowners that are willing to work toward restoration goals. Project goals should be to evaluate existing riparian, floodplain and main channel conditions and to identify ways to improve water quality, decrease invasive species, develop large scale riparian rehabilitation (east side of the creek), and to improve channel complexity within the main channel.

1. Type of Project
    - LWD Enhancement (wood from riparian)
        - Falling or cable-yarding from right bank into the stream
    - Riparian Rehabilitation
2. Potential Causal Factors
    - Riparian conditions do not support adequate LWD size and quantities
    - Channel morphological complexity has been reduced
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity
    - Temperature
4. Constraints
    - Private landowner constraints

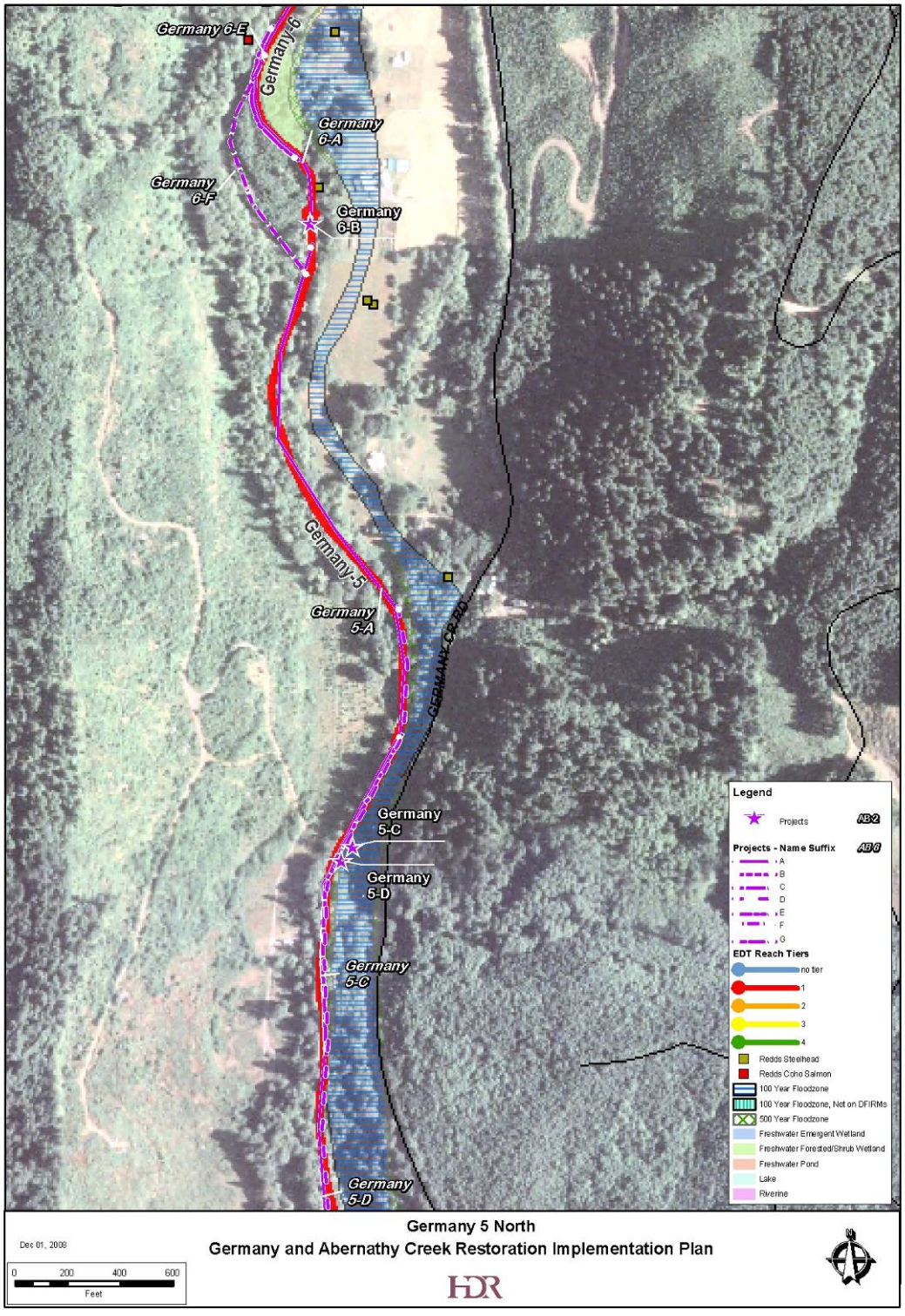
4.2.16 Germany 5

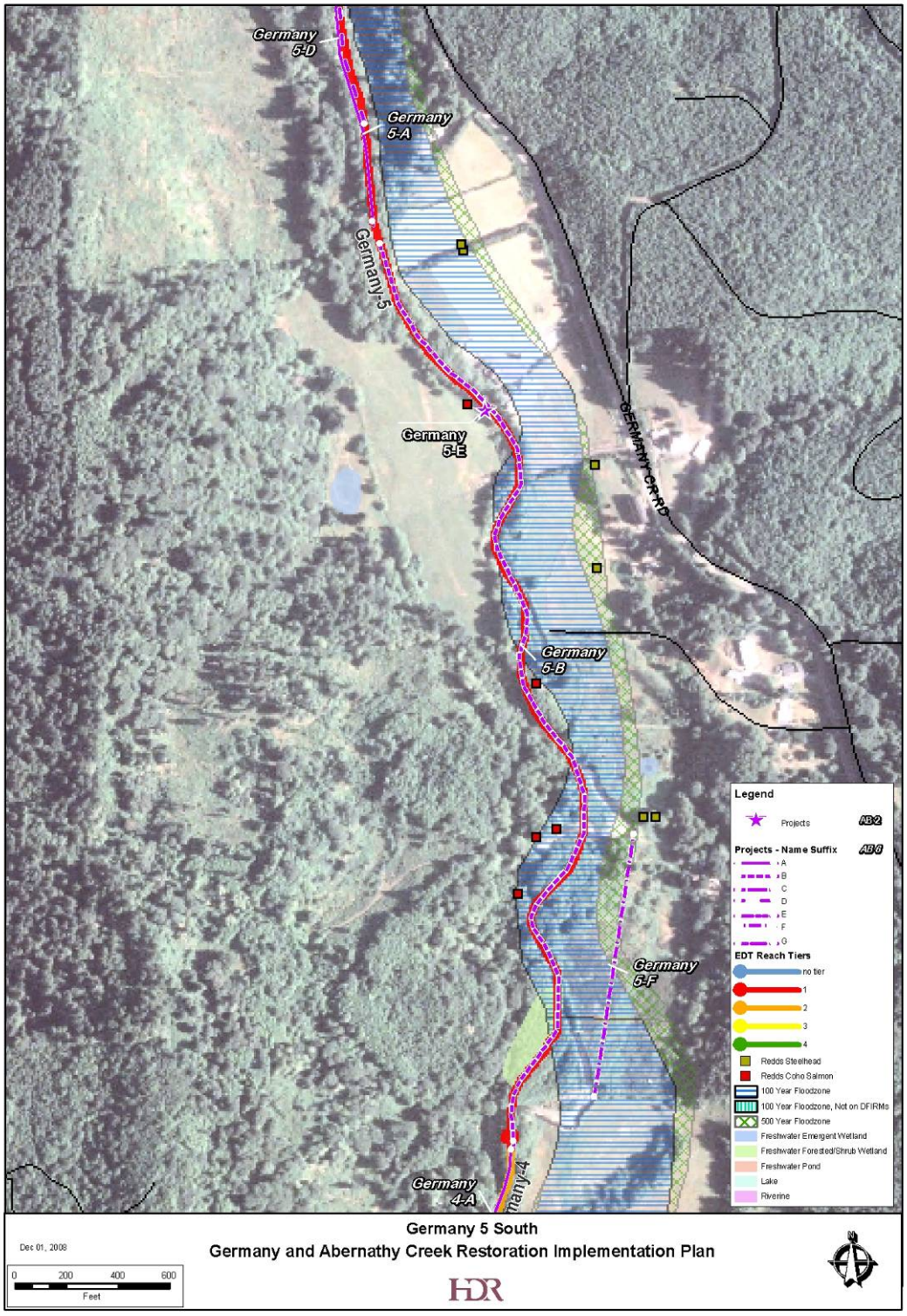
Germany 5 flows through private and public ownership. Channel morphology takes on the form of mostly plane-bed and pool riffle characteristics with the slope moderating from 3% in Reach 6 to an estimated 1-2% in Reach 5. Overall, the estimated bankfull width has increased from Reach 6, sediment availability/deposition has increased, and the floodplain is accessible in several areas. Substrate continues to be deeply armored within the main channel. There are numerous side-channels and riparian buffer widths appear adequate. LWD density is poor throughout the reach. Overall, this is a depositional reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 21. Restoration objectives in the upstream portion of this reach are to increase LWD density and riparian quality. Increased LWD density will promote gravel recruitment, sorting, create pools, and provide fish cover for coho and winter steelhead. Increased pool habitat will increase key habitat for Chinook pre-spawn rearing. Increased riparian quality will regulate water temperature for Chinook spawning and winter steelhead juvenile rearing. Restoration objectives in the downstream portion of this reach are to create and enhance side channel habitat for coho and winter steelhead juvenile rearing. Potential project locations are shown in Figures 20a and 20b, followed by project descriptions.

Table 21. Germany 5 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
end of presumed chum to end of known chfa (rm 3.06 to 4.70)	1	Chinook	C	L	Egg Incubation	37.9	Sediment Load
					Spawning	8.5	Temperature
					Prespawn Holding	5	Key Habitat Quantity
		Coho	C	M	Egg Incubation	43.2	Sediment Load
					0-Age Active Rearing	26.5	Key Habitat Quantity
					0-Age Inactive	17	Key Habitat Quantity
		Wsteelhead	P	H	Egg Incubation	52.8	Sediment Load
					0-Age Active Rearing	21.1	Temperature
					1-Age Active Rearing	11.7	Temperature
		Chum	P		N/A		

Figures 20a and 20b. Germany 5 project locations.




Germany 5-D
Germany 5-A
Germany 5
Germany 5-E
GERMANY CR RD
Germany 5-B
Germany 6-F
Germany 4-A
Legend
Projects
Projects - Name Suffix
A
B
C
D
E
F
G
EDT Reach Tiers
no tier
1
2
3
4
Redds Steelhead
Redds Coho Salmon
100 Year Floodzone
100 Year Floodzone, Not on DFIRMs
500 Year Floodzone
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Dec 01, 2008
0 200 400 600
Feet
Germany 5 South
Germany and Abernathy Creek Restoration Implementation Plan
HDR

Germany 5-A

Germany Creek (Germany 5). This project site is contained within the first half of reach 5 and the total length of the project is approximately ½ mile in length. Overall, this reach suffers from a dramatic loss of LWD and the focus of the site is on reintroducing LWD through loading the entire reach.

1. Type of Project
   - LWD Enhancement
     - Hand falling of mature alder and maple with cable-yarding or other mechanical ways
   - Riparian Enhancement
     - Conifer planting in the understory
2. Potential Causal Factors
   - Lack of upstream LWD inputs
   - Lack of sediment recruitment
3. Limiting Conditions
   - Key habitat quantity
   - Habitat diversity
   - Channel stability
4. Constraints
   - None

Germany 5-B

Germany Creek (Germany 5). This is a LWD Enhancement project that would involve bringing in material. At this site the channel is very entrenched, with vertical banks, and there is a need for increased habitat cover for fish. There is excellent evidence that this area is used for spawning.

1. Type of Project
   - LWD Enhancement (imported wood)
     - Importing LWD material to the site
   - Riparian Rehabilitation
     - Planting in deforested riparian zone
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Streambed has degraded vertically and side channels have become elevated/ abandoned
3. Limiting Conditions
   - Key habitat quantity
   - Habitat diversity
   - Channel stability
4. Constraints
   - None

Germany 5-C

Germany Creek (Germany 5). This project site represents an opportunity to combine side channel rehabilitation with instream placement of LWD for more then 1,000 feet of the creek. Overall, this section is attempting to recover some of its sinuosity, and there are recent sediment and wood deposits in the area. Rehabilitation efforts should focus on encouraging this depositional trend to increase gravel availability and to continue to facilitate the large side channel that has formed. Good access exists to implement this project.

1. Type of Project
    - LWD Enhancement (imported wood)
        - 1000 feet of LWD
    - Side Channel Enhancement
        - 1000 feet of LWD
    - Riparian Rehabilitation
        - 50% rehabilitation and 50% conifer underplanting
2. Potential Causal Factors
    - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity
    - Sediment load
4. Constraints
    - Private property

Germany 5-D

Germany Creek (Germany 5). This project represents an opportunity to develop side channel habitat in the mid-section of Germany Creek. This type of habitat is very rare in this section of Germany Creek.

1. Type of Project
    - Off/ Side Channel Enhancement; Engineered Log Jams
        - Heavy excavation
        - Add up to 22 ELJ structures to the main and side channel
        - Add LWD to side channel
    - LWD Enhancement (wood from riparian)
2. Potential Causal Factors
    - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
    - Lack of upstream LWD inputs
    - Riparian conditions do not support adequate LWD size and quantities
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity
4. Constraints
    - Road/bridge downstream- infrastructure protection may outweigh environmental needs

Germany 5-E

Germany Creek (Germany 5). This site is immediately upstream from a potential headcut that was observed in the main channel. This is in an area that is on private land and downstream of an area in which the channel has been straightened. The main channel shows little habitat diversity and complexity with pool habitat and side channel refugia absent.

1. Type of Project
    - Bank Stabilization/ Protection
        - Grade stabilization
2. Potential Causal Factors
    - Channel confinement limits floodplain inundation
    - Lack of upstream LWD inputs
    - Channel morphological complexity has been reduced
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity
    - Channel stability
4. Constraints

- Private landowner

Germany 5-F

Germany Creek (Germany 5). This downstream section of the reach is more depositional and sinuous than the upstream section and has a lower gradient. These characteristics are conducive to greater refugia and habitat for salmonids. There is an indication that this area contains large remnant wetland complexes, which were probably at one time old oxbows or areas that were hydrologically connected to the main channel on a regular basis through surface and groundwater. This is a depositional area. Currently, there is some evidence that this area still has emergent marsh/wetland potential.

1. Type of Project
   - Off/ Side Channel Enhancement
     - Excavation to reconnect to side channel
     - Use ELJs/LWD in main channel to deflect flows into the side channel
2. Potential Causal Factors
   - Streambed has degraded vertically and side channels have become elevated/ abandoned
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Private landowner

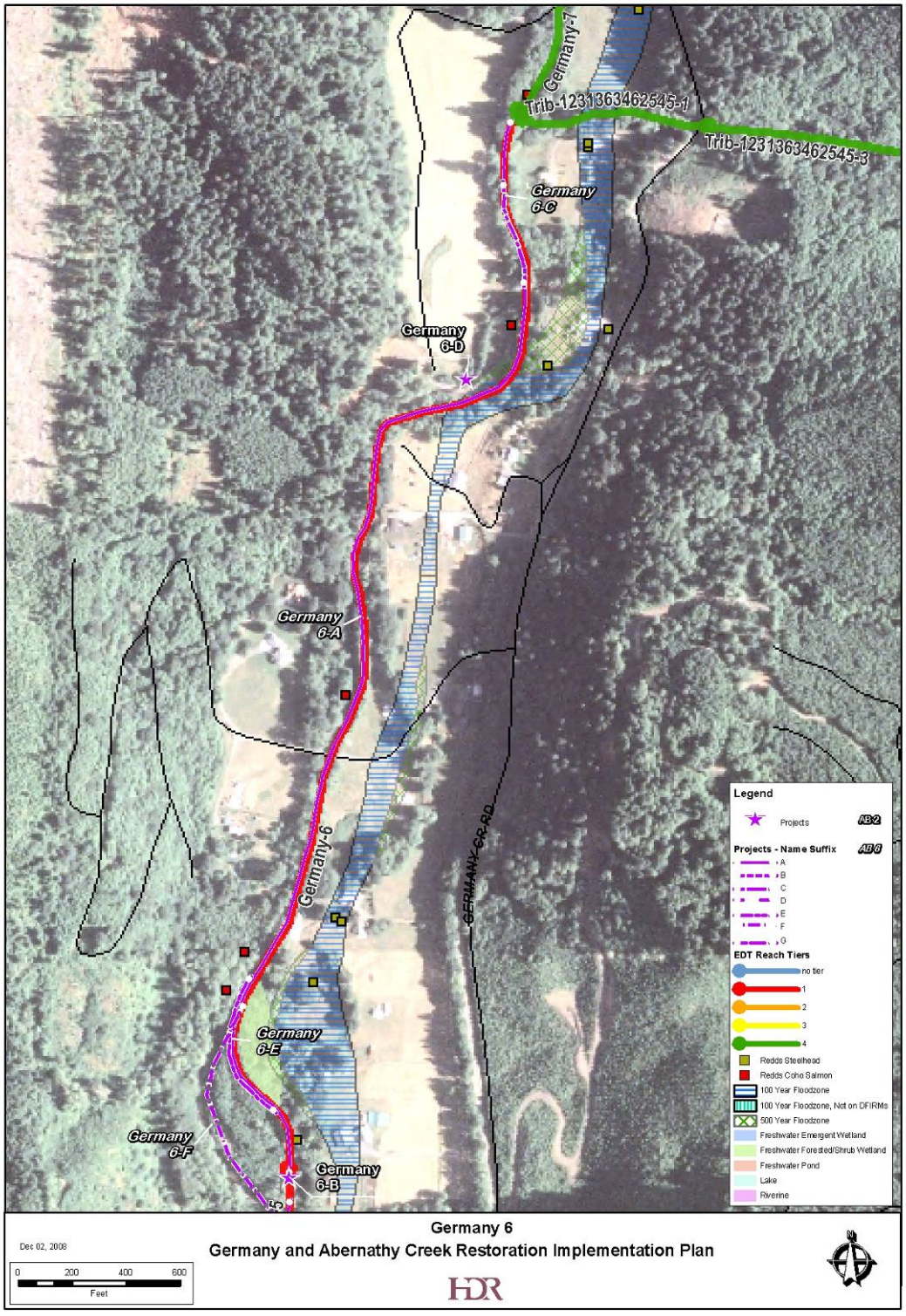
4.2.17 Germany 6

Germany 6 appears to be a transitional area in terms of geomorphic processes with large areas of bedrock control (step-pool morphology) and steeper slopes transitioning to agricultural valleys and gentler channel gradients (1% slope). Overall, the upper section is a sediment transport reach with little accumulated gravels and no observed LWD recruitment. The channel is deeply incised in areas with steep vertical banks. In addition the main channel is severely armored with gravel deposits lacking. This reach shows little instream habitat diversity due to a lack of LWD, confinement, and straightening through the agricultural area and an overall inability of the channel to access its floodplains. Further downstream, habitat diversity increases, slopes decrease, sediment deposits are evident and there is an availability of side-channels for salmon refugia. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 22. Restoration objectives in this reach are to increase LWD density and riparian quality in the upstream portion of the reach. In the downstream portion of the reach, the restoration objectives are to enhance existing side channels with LWD and riparian underplanting to increase habitat complexity, rearing opportunities, and winter refuge habitat for coho and steelhead. Potential project locations are shown in Figure 21, followed by project descriptions.

Table 22. Germany 6 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
end of chfa to trib1231363462545 (rm 4.7 to 5.55)	1	Chinook	C		N/A		
		Coho	C	L	0-Age Inactive Rearing	89.9	Habitat Diversity
					Egg Incubation	51.7	Channel Stability
					0-Age Active Rearing	42.8	Habitat Diversity
		Wsteelhead	P	H	Egg Incubation	53.7	Sediment Load
					0-Age Active Rearing	23.4	Habitat Diversity
					1-Age Active Rearing	18.5	Habitat Diversity
		Chum	P		N/A		

Figure 21. Germany 6 project locations.



Germany 6-A

This project would include a reach-wide effort to partner with private landowners in order to revegetate the riparian zone to create effective riparian buffers.

1. Type of Project
   - Riparian Rehabilitation
2. Potential Causal Factors
   - Reduced riparian buffer zone
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
   - Temperature
4. Constraints
   - Private land

Germany 6-B

Germany Creek (Germany 6). This project would involve protecting up to 50 feet of failing rip-rap material which has been used to control erosion of the left bank into the existing road (Germany Creek Road). Overall, the conditions here are dominated by bedrock controls, which function to stabilize in the vertical direction, and should prevent future channel downcutting/incision evident in this section and throughout the watershed. Thus, the expected adjustments to the channel would most likely occur in the horizontal direction. This area is a sediment transport area, with high velocities, and little opportunities for sediment storage. The road is approximately 5 to 10 feet from the active channel width, and there is evidence of recent failures. This is both a transport area in the upper part and a depositional in the lower portion.

1. Type of Project
   - Bank Stabilization/ Protection
     - This project involves protection of streambank from road failures and inputs of sediment from the road
2. Potential Causal Factors
   - Channel confinement
3. Limiting Conditions
   - Reduced riparian buffer zone

4. Constraints
    - Bedrock
    - Proximity to Road

Germany 6-C

This project involves treating invasive plants, rehabilitating the riparian areas by introducing native plants, increasing the riparian buffer zone width, and adding LWD. There are adjacent landowners at this project site. This project site involves over 500 feet of main channel improvements.

There are opportunities to improve riparian conditions, protect adjacent floodplains and improve conditions within the main channel. By planting and improving the riparian buffer width, future recruitment of LWD should occur, shading would improve channel heating and the buffer area would filter pollutants. This reach shows little instream habitat diversity due to a lack of LWD and an overall inability for the channel to access its floodplains. As a result, the main channel had incised, and stream channel morphology largely takes on a plane-bed form.

1. Type of Project
    - LWD Enhancement (imported wood)
        - Individual pieces (over 1000 ft using large single pieces)
        - Add 3-5 LWD and ELJ structures
    - Riparian Rehabilitation
        - 500-1000 ft length along both banks and 100 ft width planting
        - Remove invasive species
    - Preservation of Floodplain
        - Potential for easement
2. Potential Causal Factors
    - Riparian conditions do not support adequate LWD size and quantities
    - Channel confinement limits floodplain inundation
3. Limiting Conditions
    - Habitat diversity
    - Key habitat quantity
    - Temperature
4. Constraints
    - Private landowners
    - Landuse goals (active farming)

Germany 6-D

Germany Creek (Germany 6). Site 4 involves the protection of a dynamic section of the river, which appears to be going through both natural and anthropogenic changes. This appears to be a "natural" depositional area for sediment and LWD. There is a side channel that has formed which is hydrologically connected to the main channel. Sediment and LWD accumulation, and possible man made channel features, have forced the creation of this side channel. Recent gravel deposits can be found in the side channel. Additions of LWD would increase habitat complexity and assist with allowing this side-channel to become more hydrologically connected to the main channel. The project length is approximately 500 feet.

1. Type of Project
   - LWD Enhancement (imported wood); Riparian Rehabilitation
     - Add LWD to side channel (anchor because of bridge)
     - Riparian plantings (Left Bank)
     - Property acquisition or work with landowner for BMPs
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - Bridge downstream- infrastructure protection may outweigh environmental needs

Germany 6-E

Germany Creek (Germany 6). This project would be located in the lower half of Germany 6 reconnect a forested shrub wetland to the active channel.

1. Type of Project
   - Off/ Side Channel Enhancement
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Streambed has degraded vertically and side channels have become elevated/abandoned

3. Limiting Conditions
   - Habitat diversity
   - Key habitat quantity
4. Constraints
   - None

Germany 6-F

Germany Creek (Germany 6). This project will look at reconnecting a relict side channel on right bank of the channel.

1. Type of Project
   - Off/ Side Channel Enhancement; Engineered Log Jams; Riparian Enhancement (underplanting)
     - Instream ELJs (2) to deflect flow to side-channel
     - Excavation to reconnect to main channel
     - Riparian enhancement along side-channel
2. Potential Causal Factors
   - Channel morphological complexity has been reduced due to changes to hydrology, sediment and LWD inputs
   - Streambed has degraded vertically and side channels have become elevated/ abandoned
3. Limiting Conditions
   - Key habitat quantity
   - Habitat diversity
   - Channel stability
4. Constraints
   - None

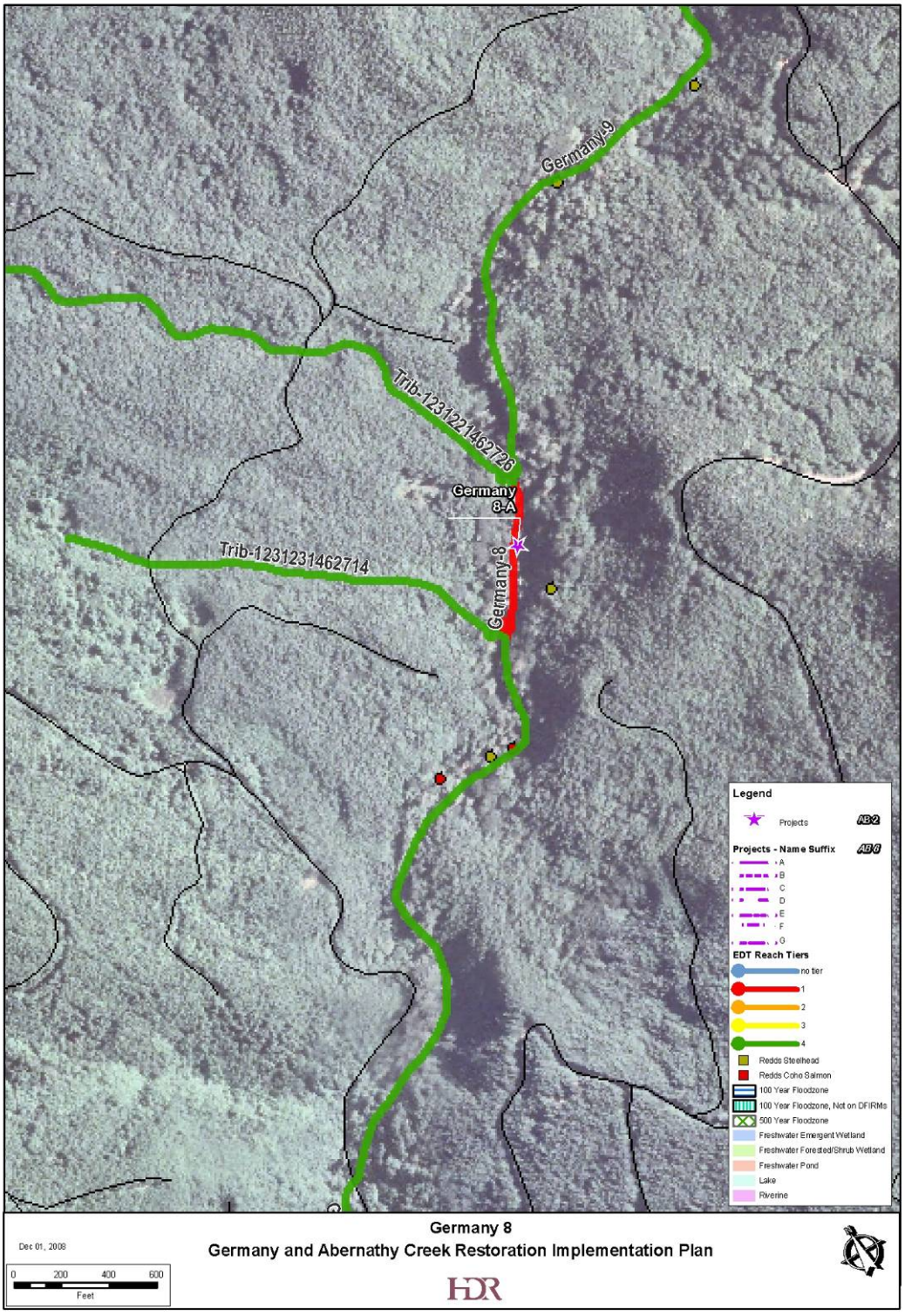
4.2.18 Germany 8

Germany 8 (Tier 1) is a short reach between two tributaries in the mid-section of the Germany Creek watershed. The left bank is confined by a steep valley wall. The right bank is relatively unconfined with a CMZ 6-20 times the average wetted channel width. The right bank and side channel has the potential to contribute quality coho off-channel habitat. The active channel is not currently accessing the unconfined floodplain on the right bank. There was no evidence of high flow channels or isolated pools. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 23. Restoration objectives in this reach are to increase LWD density to retain bedload, create hydraulic complexity, protect the left streambank, and increase access to the unconfined right bank. Meeting these objectives would increase habitat diversity for fry colonization and juvenile rearing, minimizing risk to increases in fines sediment loading for egg incubation. Potential project locations are shown in Figure 22, followed by project descriptions.

Table 23. Germany 8 reach characteristics.

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
rm 7.02 to 7.15	1	Chinook	C		N/A		
		Coho	C	M	Egg Incubation	43.1	Sediment Load
					0-Age Active Rearing	15.3	Habitat Diversity
					0-Age Inactive Rearing	17.7	Habitat Diversity
		Wsteelhead	P	H	Egg Incubation	47.5	Sediment Load
					0-Age Active Rearing	11.5	Temperature
					Fry Colonization	4.1	Habitat Diversity
		Chum	P		N/A		

Figure 22. Germany 8 project locations.



Germany 8-A

Germany Creek (Germany 8). The project involves approximately 1,000 feet of LWD enhancement. The right bank in this reach is unconfined off-channel habitat with seeps. The left bank is a steep confined hillside. The right bank is not perched, but the lack of LWD and hydraulic complexity may limit the amount of interaction with the floodplain on the left bank, however the left bank is not being undermined. There is about 600 feet of steep terrain that has to be crossed to access the reach from road 1110.

1. Type of Project
   - LWD Enhancement (imported wood)
     - Place LWD structures to retain bedload, create hydraulic complexity and protect the left streambank
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Reduced riparian buffer zone
   - Geologic and geotechnical underlying conditions
   - Fluvial action
3. Limiting Conditions
   - Habitat diversity
   - Sediment load
4. Constraints
   - None

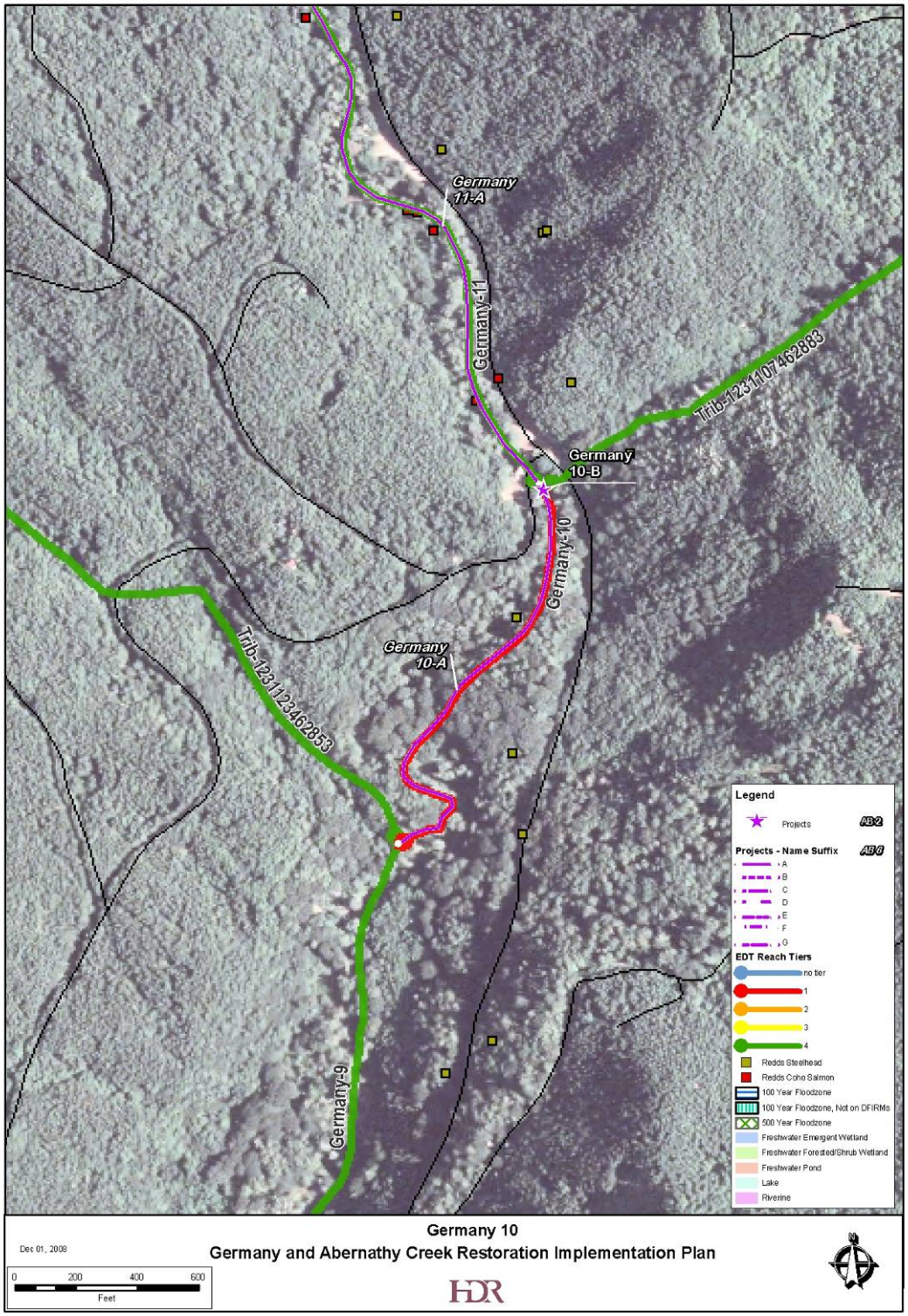
4.2.19 Germany 10

Germany 10 (tier 1) has a plane-bed typology with little channel complexity. There was a paucity of side channels and no recent recruitment of LWD. Germany 10 is different than the upstream reaches because of its relatively unconfined character. This relatively unconfined reach has perched "benches" in its CMZ (Channel Migration Zone) that could be utilized for off-channel habitat or could be laterally eroded over time to form more complex habitat in the main channel. The active channel cannot currently access the benches because of historical vertical incision from increased high flow events and a paucity of LWD to hold bed load. Restoration should focus on incorporating LWD to the reach to increase the elevation of the active channel and increase lateral movement of water within the reach. This could allow the active channel to access the off-channel habitat. This increase in off-channel habitat or main channel habitat complexity would increase rearing opportunities and winter refuge habitat for coho and steelhead. A culvert replacement project in this reach would allow fish access to a tier 4 stream. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 24. Potential project locations are shown in Figure 23, followed by project descriptions.

Table 24. Germany 10 reach characteristics

Description	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
rm 8.29 to 8.59	1	Chinook	C		N/A		
		Coho	C	L	Egg Incubation	41.7	Sediment Load
					Fry Colonization	4.3	Habitat Diversity
					0-Age Active Rearing	17.4	Habitat Diversity
		Wsteelhead	P	H	Egg Incubation	41.7	Sediment Load
					0,1-Age Inactive Rearing	8.2	Channel Stability
					1-Age Active Rearing	8.1	Habitat Diversity
		Chum	P		N/A		

Figure 23. Germany 10 project locations.



Germany 10-A

The project involves LWD enhancement throughout the reach. Falling trees or cable-yarding trees into the active channel will increase channel complexity. ELJs will also be placed in the active channel adjacent to unconfined benches to help access the off-channel habitat.

1. Type of Project
   - LWD Enhancement (wood from riparian); Engineered Log Jams
     - Add LWD material to main channel to increase habitat/promote gravel recruitment
     - ELJs (3) in the active channel adjacent to unconfined benches the active channel to access the off-channel habitat
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - Permission to thin existing riparian trees for use as LWD
   - Equipment access for construction of ELJs

Germany 10-B

Germany Creek (Germany 10 and Tributary 1231107462883). This culvert is located at the mouth of Tributary 1231107462883 to Germany Creek. The culvert appears to limit fish passage and may not adequately pass sediment and debris to downstream reaches. This project would involve either a culvert replacement or a culvert removal and bridge construction.

1. Type of Project
   - Culvert Replacement
     - Culvert replacement or a culvert removal and bridge construction
2. Potential Causal Factors
   - N/A
3. Limiting Conditions
   - Fish passage (not documented in plans)
4. Constraints
   - None

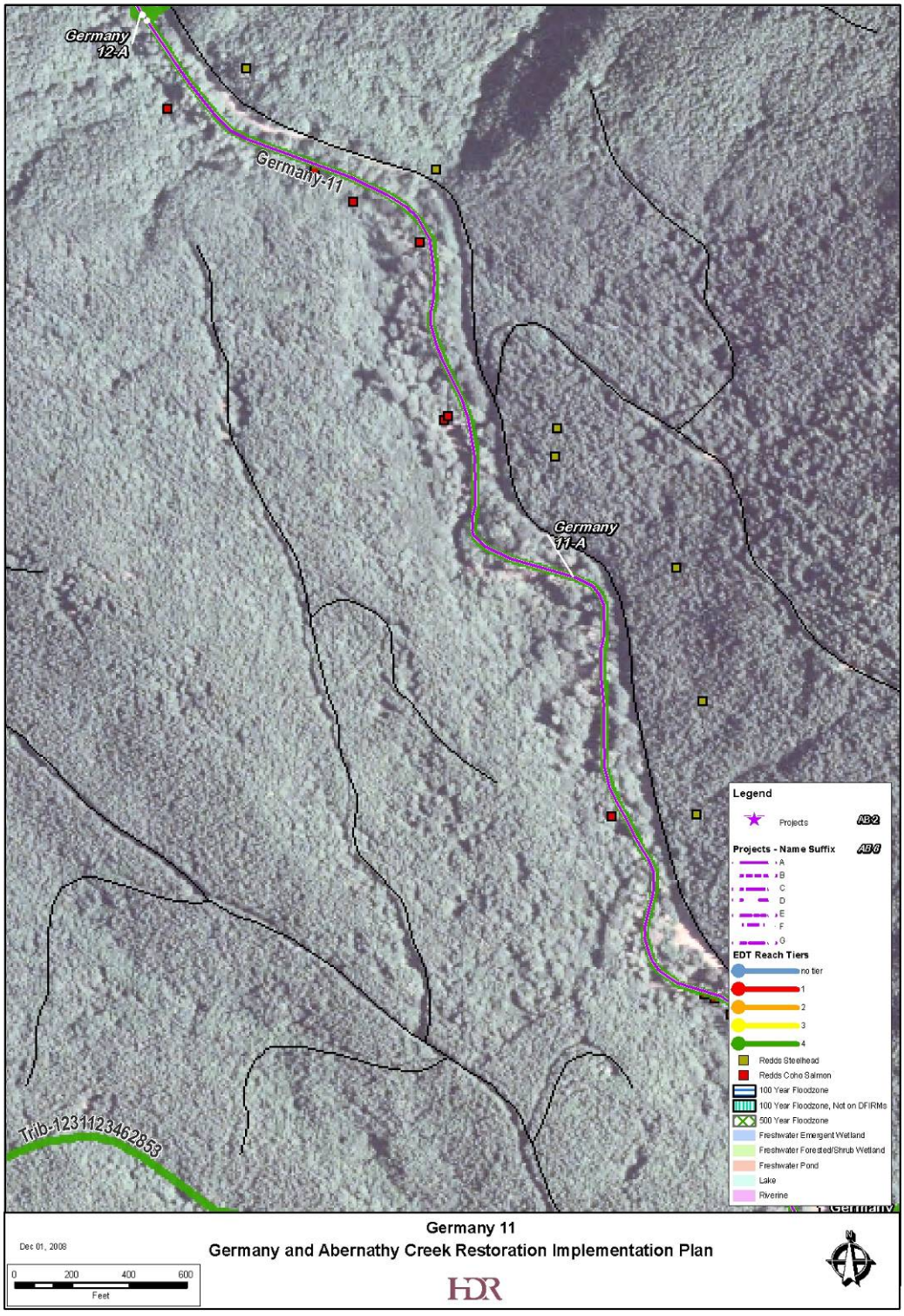
4.2.20 Germany 11

Germany 11 (tier 4) was very similar to Germany 12 in character, with a plane-bed typology with little channel complexity. There was a paucity of side channels and no recent recruitment of LWD. As a result, the LWD density and habitat diversity was poor throughout the reach. Overall, this is a transport reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 25. Restoration objectives in this reach are to increase LWD density. Increased LWD density will promote gravel recruitment, sorting, create pools, and provide fish cover for coho and winter steelhead. Potential project locations are shown in Figure 24, followed by project descriptions.

Table 25. Germany 11 reach characteristics.

Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Trib-1231209463005 to end of presumed CHFA	8.63 to 9.88	4	Chinook	C		N/A		
			Coho	C	L	0-Age Inactive Rearing	90.3	Habitat Diversity
						Egg Incubation	48.7	Channel Stability
						0-Age Active Rearing	40.4	Habitat Diversity
			W Steelhead	P	L	Egg Incubation	45.2	Sediment Load
						0,1 Age Inactive Rearing	33.4	Habitat Diversity
						1-Age Active Rearing	29.2	Habitat Diversity
			Chum	P		N/A		

Figure 24. Germany 11 project locations.



Germany 11-A

The project involves LWD enhancement throughout the reach. Falling trees or cable-yarding trees into the active channel will increase channel complexity and pool formation.

1. Type of Project
   - LWD Enhancement (wood from riparian)
     - Add LWD material to main channel to increase habitat/promote gravel recruitment
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - Permission to thin existing riparian trees for use as LWD

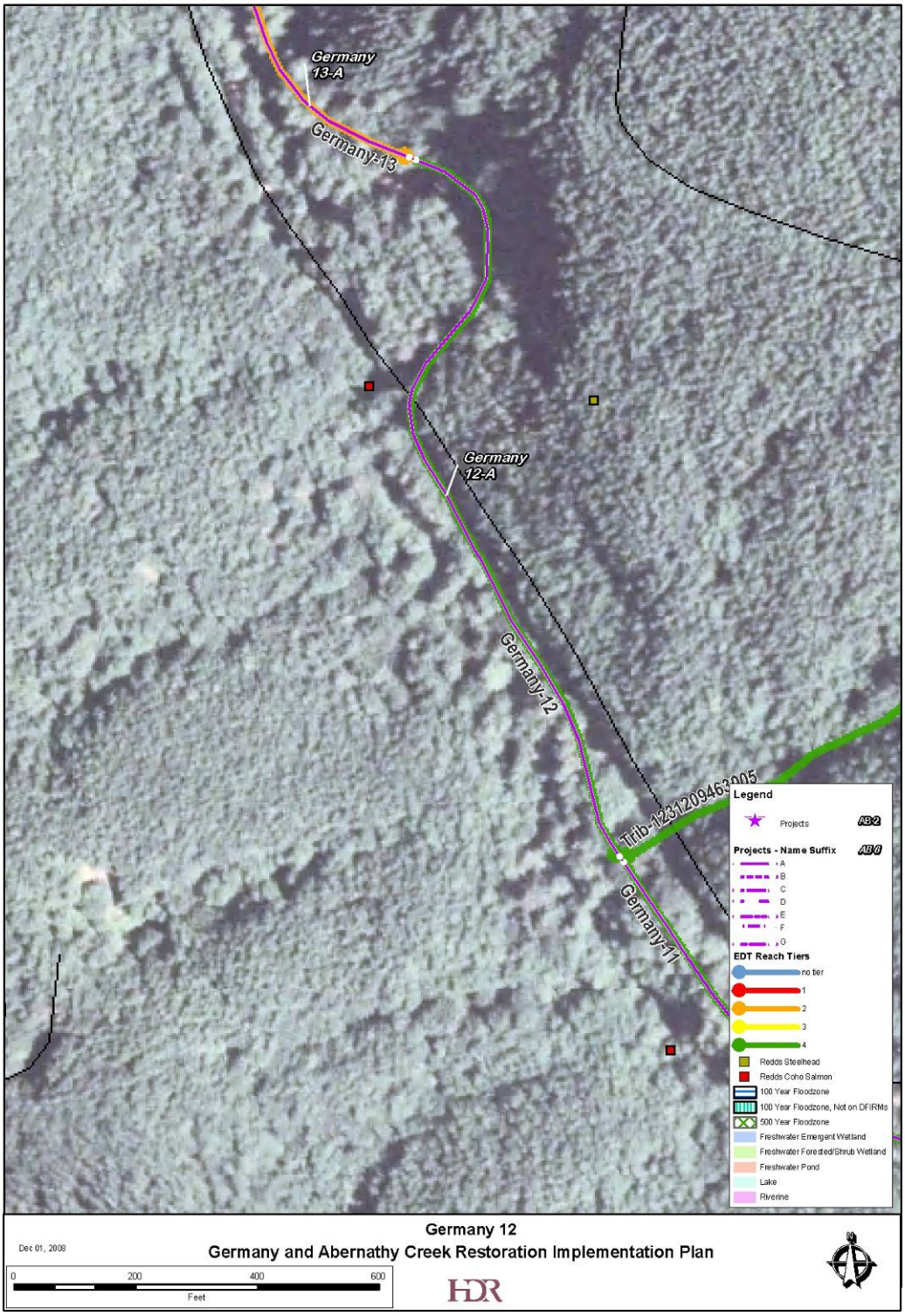
4.2.21 Germany 12

Germany 12 (tier 4) was very similar to Germany 13 in character, with a plane-bed typology with little channel complexity. Notable differences were the paucity of side channels and no recent recruitment of LWD. As a result, the LWD density and habitat diversity was poor throughout the reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 26. Restoration objectives in this reach are to increase LWD density. Increased LWD density will promote gravel recruitment, sorting, create pools, and provide fish cover for coho and winter steelhead. Potential project locations are shown in Figure 25, followed by project descriptions.

Table 26. Germany 12 reach characteristics.

Reach	Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Germany-12	Trib-1231209463005 to end of presumed CHFA	8.63 to 9.88	4	Chinook	C		N/A		
				Coho	C	L	0-Age Inactive Rearing	90.3	Habitat Diversity
							Egg Incubation	48.7	Channel Stability
							0-Age Active Rearing	40.4	Habitat Diversity
				W Steelhead	P	L	Egg Incubation	45.2	Sediment Load
							0,1 Age Inactive Rearing	33.4	Habitat Diversity
							1-Age Active Rearing	29.2	Habitat Diversity
				Chum	P		N/A		

Figure 25. Germany 12 project locations.



Germany 12-A

The project involves LWD enhancement throughout the reach. Falling trees or cable-yarding trees into the active channel will increase channel complexity and pool formation.

1. Type of Project
   - LWD Enhancement (wood from riparian)
     - Add LWD material to main channel to increase habitat/promote gravel recruitment
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - Permission to thin existing riparian trees for use as LWD

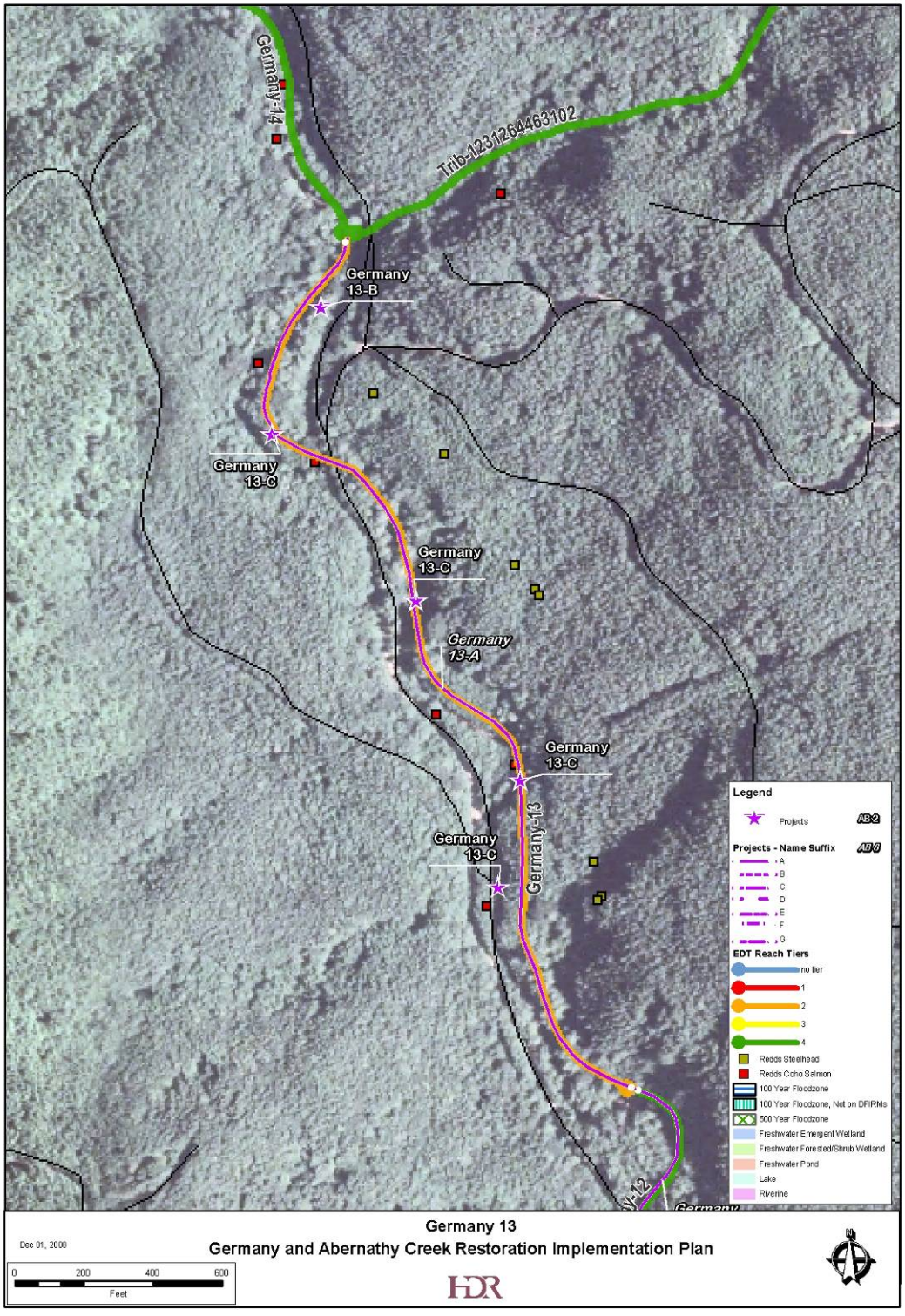
4.2.22 Germany 13

Germany 13 (tier 2) has a plane-bed typology with little channel complexity. There are a few side channels that were most likely activated during 1-2 year flood flows. This reach has recent recruitment of Alders throughout the reach, typically on cut banks. Pool formation and increased complexity often occurred at these locations. Overall, the LWD densities are not adequate to maximize salmonid production. The recent Alder recruitment resulted in local bank destabilization. Some of these locations had significant areas of exposed clay sediments that would be eroded during typical winter storm flows. Overall, this is a transport reach. Reach characteristics from the recovery plan (LCFRB 2004) and HWS (LCFRB 2008) are shown in Table 27. Restoration objectives in this reach are to increase LWD density, stabilize banks at four locations, and enhance one existing side channel. The LWD enhancement and side channel enhancement will increase habitat diversity, benefiting fry colonization and juvenile rearing. The bank stabilization project will decrease local fine sediment loading and increase sediment quality for egg incubation. Potential project locations are shown in Figure 26, followed by project descriptions.

Table 27. Germany 13 reach characteristics

Reach	Description	river mile	Tier	Species	Pop Group	Priority	Key Life History Stages	Productivity Change	Primary Limiting Factor
Germany-13	end of presumed fall chinook to trib 1231264463102	9.88 to 10.45	2	Chinook	C		N/A		
				Coho	C	L	Egg Incubation	43.1	Sediment Load
							Fry Colonization	10.8	Habitat Diversity
							0-Age Active Rearing	25.4	Habitat Diversity
				W Steelhead	P	M	Egg Incubation	42.5	Sediment Load
							0,1 Age Inactive Rearing	15.8	Habitat Diversity
							1-Age Active Rearing	11.8	Habitat Diversity
				Chum	P		N/A		

Figure 26. Germany 13 project locations.



Germany 13-A

The project involves LWD enhancement throughout the reach. Falling trees or cable-yarding trees into the active channel will increase channel complexity and pool formation.

1. Type of Project
    - LWD Enhancement (wood from riparian)
        - Add LWD material to main channel to increase habitat/promote gravel recruitment
2. Potential Causal Factors
    - Riparian conditions do not support adequate LWD size and quantities
    - Channel confinement limits floodplain inundation
3. Limiting Conditions
    - Habitat diversity
4. Constraints
    - Permission to thin existing riparian trees for use as LWD

Germany 13-B

Germany Creek (Germany 13). The project involves over 200 feet of side channel habitat improvements that could benefit winter coho and summer steelhead populations by increasing habitat and providing refugia. Many of the current side channels on Germany are not hydrologically connected and lack habitat complexity. Currently, this side channel is not activated during low flow and is perched a few feet from the low flow elevation. Constraints to this project include access.

1. Type of Project
   - Off/ Side Channel Enhancement; LWD Enhancement (Wood from Riparian)
     - Install LWD jam(s) at upstream confluence of main and side channel
     - Add LWD material to side channel to increase habitat/promote gravel recruitment
     - Selectively grade at confluence to hydrologically reconnect main and side channel
2. Potential Causal Factors
   - Riparian conditions do not support adequate LWD size and quantities
   - Channel confinement limits floodplain inundation
3. Limiting Conditions
   - Habitat diversity
4. Constraints
   - Access

Germany 13-C

Germany Creek (Germany 13). The project involves four actively eroding banks summing to approximately 550 feet of bank stabilization. All of these locations have been recently undercut with exposed clay banks and slope material susceptible to high flow erosion.

Site 1 – 178 feet

Site 2 – 87 feet


Site 3 – 160 feet


Site 4 – 125 feet

1. Type of Project
    - Bank Stabilization/ Protection
        - Stabilize hillside with biotechnical techniques
        - Add LWD material to protect bank
2. Potential Causal Factors
    - Reduced riparian buffer zone
    - Geologic and geotechnical underlying conditions
    - Fluvial action
3. Limiting Conditions
    - Sediment load
4. Constraints
    - Access

5.0 Cost and Prioritization Results

Project costs were estimated with a cost model and professional judgment as described in section 3.3. Projects were prioritized according to a method described in section 3.4. The method takes into account fish (total) benefits, cost, and opportunities/ constraints. The calculations and data leading to the prioritization scores are shown in Appendices C and D. A summary of the results is presented below in Table 28. The projects in Table 26 have been sorted by 1) reach tier, then 2) total benefit score. The total benefit score is the sum of the standardized (1-100) population/ reach and the standardized (1-100) PAR scores. Therefore, the total benefit scores range could potentially range from 0- 200 points. The total benefit/ cost ratio was standardized to a 1-100 point scale.

Table 28. Summary of Prioritized Projects, Cost, and Constraints.

EDT Reach	Project Name	Project Description	EDT Tier	PAR Score	Total Benefit Score	Cost	Benefit /Cost	Opportunity / Constraints Score
Abernathy 9	ABERNATHY 9G	Engineered Log Jams; LWD Enhancement (Wood from Riparian); Off/ Side Channel Enhancement (minor	1	101	141	$500,485	9	high opportunity
Abernathy 2	ABERNATHY 2A	Engineered Log Jams	1	35	135	$260,640	16	high opportunity
Abernathy 9	ABERNATHY 9A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	1	77	117	$589,262	6	moderate
Abernathy 10	ABERNATHY 10B	Off/ Side Channel Enhancement; Engineered Log Jams; LWD Enhancement (Wood from Riparian)	1	62	112	$608,933	6	high opportunity
Abernathy 3	ABERNATHY 3C	Engineered Log Jams; LWD Enhancement (Imported Wood)	1	21	112	$138,959	26	high opportunity
Abernathy 5	ABERNATHY 5A	LWD Enhancement (Imported Wood)	1	20	106	$137,500	25	high opportunity
Germany 2	GERMANY 2A	Engineered Log Jams; Riparian Rehabilitation	1	15	106	$282,360	12	high opportunity
Germany 5	GERMANY 5D	Off/ Side Channel Enhancement; LWD Enhancement (Wood from Riparian); Engineered Log Jams	1	46	105	$897,149	4	Constraints
Abernathy 3	ABERNATHY 3A	LWD Enhancement (Imported Wood)	1	10	101	$125,000	26	moderate
Abernathy 3	ABERNATHY 3B	Engineered Log Jams	1	10	101	$130,320	25	high opportunity
Germany 5	GERMANY 5A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	1	39	98	$274,732	11	moderate
Germany 2	GERMANY 2C	Riparian Rehabilitation	1	6	97	$298,650	10	high opportunity
Germany 2	GERMANY 2B	Bank Stabilization/ Protection; LWD Enhancement (Imported Wood); Riparian Rehabilitation	1	3	94	$47,325	63	high opportunity
Germany 5	GERMANY 5B	LWD Enhancement (Imported Wood); Riparian Rehabilitation;	1	34	93	$569,343	5	Constraints
Abernathy 9	ABERNATHY 9F	LWD Enhancement (Wood from Riparian); Engineered Log Jams	1	50	91	$221,659	13	high opportunity
Abernathy 1	ABERNATHY 1A	Engineered Log Jams	1	4	91	$80,000	36	high opportunity
Germany 5	GERMANY 5C	LWD Enhancement (Imported Wood)- main channel; LWD Enhancement (Imported Wood)- Side Channel; Riparian Rehabilitation	1	19	78	$189,096	13	Constraints
Germany 5	GERMANY 5F	Off/ Side Channel Enhancement	1	13	72	$223,570	10	Constraints
Germany 6	GERMANY 6F	Off/ Side Channel Enhancement; Engineered Log Jams; Riparian Enhancement (underplanting)	1	26	67	$330,490	6	Constraints
Abernathy 10	ABERNATHY 10A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	1	16	66	$120,357	17	high opportunity
Abernathy 7	ABERNATHY 7A	Riparian Rehabilitation	1	1	64	$36,200	56	moderate
Germany 5	GERMANY 5E	Bank Stabilization/ Protection	1	2	61	$43,440	45	Constraints
Germany 8	GERMANY 8A	LWD Enhancement (Imported Wood)	1	10	55	$187,000	9	high opportunity
Germany 6	GERMANY 6E	Off/ Side Channel Enhancement	1	12	53	$121,639	14	Constraints
Germany 6	GERMANY 6D	LWD Enhancement (Imported Wood); Riparian Rehabilitation	1	11	52	$72,160	23	Constraints
Germany 10	GERMANY 10A	LWD Enhancement (Wood from Riparian); Engineered Log Jams	1	9	50	$104,178	15	moderate
Germany 10	GERMANY 10B	Culvert Replacement	1	7	48	$55,000	28	high opportunity
Germany 6	GERMANY 6A	Riparian Rehabilitation	1	6	47	$612,658	2	Constraints
Abernathy 9	ABERNATHY 9C	Engineered Log Jams	1	6	47	$130,320	12	high opportunity
Germany 6	GERMANY 6C	LWD Enhancement (Imported Wood); Riparian Rehabilitation	1	4	45	$144,320	10	Constraints
Abernathy 9	ABERNATHY 9E	Bridge Remova	1	3	44	$100,000	14	high opportunity
Abernathy 9	ABERNATHY 9B	Engineered Log Jams	1	3	44	$115,000	12	high opportunity
Abernathy 9	ABERNATHY 9I	Off/ Side Channel Enhancement ; Engineered Log Jams	1	2	43	$64,367	21	high opportunity
Abernathy 9	ABERNATHY 9H	Riparian Rehabilitation; Riparian Rehabilitation	1	1	42	$123,409	11	high opportunity
Abernathy 9	ABERNATHY 9J	Riparian Rehabilitation	1	0	41	$27,424	48	high opportunity
Abernathy 9	ABERNATHY 9K	Riparian Rehabilitation	1	0	41	$27,424	48	moderate
Germany 6	GERMANY 6B	Bank Stabilization/ Protection	1	0	41	$42,000	31	Constraints
Germany 3	GERMANY 3A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	2	35	130	$243,905	17	high opportunity
Cameron 1	CAMERON 1B	LWD Enhancement (Wood from Riparian)	2	55	109	$95,000	37	high opportunity
Germany 3	GERMANY 3C	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	2	13	99	$60,209	52	high opportunity
Germany 3	GERMANY 3D	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	2	13	99	$72,250	44	high opportunity
Germany 3	GERMANY 3B	LWD Enhancement (Wood from Riparian); Engineered Log Jams; Riparian Enhancement (underplanting)	2	12	98	$244,567	13	high opportunity
Germany 3	GERMANY 3E	Bank Stabilization/ Protection; LWD Enhancement (Imported Wood); Riparian Rehabilitation	2	2	89	$40,565	69	high opportunity
Abernathy 4	ABERNATHY 4C	Off/ Side Channel Enhancement; LWD Enhancement (Imported Wood)	2	11	83	$219,113	12	moderate
Abernathy 4	ABERNATHY 4A	LWD Enhancement (Imported Wood); Riparian Rehabilitation	2	7	80	$101,024	25	high opportunity
Abernathy 4	ABERNATHY 4D	LWD Enhancement (Wood from Riparian); Riparian Rehabilitation; Engineered Log Jams	2	7	80	$252,771	10	moderate
Germany 4	GERMANY 4A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	2	6	79	$367,875	7	moderate
Abernathy 4	ABERNATHY 4E	LWD Enhancement (Imported Wood); Engineered Log Jams	2	5	78	$69,479	36	moderate
Abernathy 4	ABERNATHY 4B	Bank Stabilization/ Protection; Riparian Rehabilitation	2	4	77	$78,400	31	moderate
Germany 13	GERMANY 13A	LWD Enhancement (wood from riparian)	2	24	69	$60,000	37	high opportunity
Cameron 1	CAMERON 1A	LWD Enhancement (Imported Wood)	2	3	57	$112,500	16	high opportunity
Abernathy 11	ABERNATHY 11A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	2	12	48	$330,485	5	high opportunity
Germany 13	GERMANY 13B	Off/ Side Channel Enhancement ; LWD Enhancement (Wood from Riparian)	2	2	47	$112,500	13	high opportunity
Germany 13	GERMANY 13C	Bank Stabilization/ Protection	2	1	46	$47,784	31	moderate
Sarah 1	SARAH 1A	LWD Enhancement (Imported Wood)	2	9	45	$60,000	24	high opportunity
Ordway 1	ORDWAY 1A	Off/ Side Channel Enhancement; LWD Enhancement (Wood from Riparian)	2	0	36	$11,557	100	high opportunity
Germany 1	GERMANY 1A		3	11	79	$260,640	10	moderate
Wiest 1	Wiest 1	Off/ Side Channel Enhancement; LWD Enhancement (Imported Wood); Riparian Rehabilitation	3	16	34	$446,006	2	moderate
Germany 11	GERMANY 11A	LWD Enhancement (Wood from Riparian)	4	47	79	$100,000	25	high opportunity
Germany 12	GERMANY 12A	LWD Enhancement (Wood from Riparian)	4	10	42	$100,000	13	high opportunity

6.0 Implementation Schedule

The implementation schedule is primarily based on the project prioritization scheme (i.e. sorted by reach tier and then by total benefit score). This approach implements projects with the greatest degree of habitat benefit during the initial phases of implementation. Since the amount and timing of project funding is unknown, the "phasing" of project implementation is described instead of discrete years. However, each implementation phase could last 2 or more years to allow for design, permitting, and other logistics. Three "phases" were defined by trisecting the prioritized list in rank order. Each phase consists of 20 projects.

Within each phase, project "groups" were developed. Each group was defined because 1) the projects will likely have design interdependencies or are in proximity, or 2) the projects are of the same type and implementation as a group will gain mobilization and staff efficiencies. The group rank within each phase does not indicate priority. Rather, implementation may consider logistics such as planning, permitting, landowner outreach, etc. as the driving factors to determine which group of projects to implement first, second, etc. In addition, if funds are limited, some projects with lower "total benefit" or Benefit/ Cost" scores may not be implemented with the rest of the projects in a given group.

Three 2-year implementation phases would meet the IMW objectives of producing a treatment effect within the timeframe of their study design. If less than 100% of the projects are implemented within the 2-year window, then the remaining projects would get shifted down to the next phase for implementation. Another variation on this scheme is the movement of certain projects from one phase to another because of implementation efficiencies. For example, if a critical mass of the same project type (e.g. LWD enhancement) can be completed in a season with the same design staff and field crews, it may be worth implementing those projects together regardless of their phase. Project-specific constraints may also result in certain projects being shifted back to later phases or eliminated. For example, a project requires approval from multiple landowners may take longer to implement than a similar project without those challenges.

Phase 1 includes the top twenty projects. Groups A, B, E, and F were defined because of their proximity to each other and potential design interdependancies. Groups C and D were defined because the project types were similar and will likely require the procurement of common materials and contractors. For example, the group C projects will require an specialization in ELJ design and side-channel enhancement. The group D projects will likely require a forester to direct thinning in the existing riparian zone for LWD material, and a geomorphologist will need to direct placement of the LWD in the stream channel.

- Group A Rationale: Two tidal projects that may have design interdependencies
- Group B Rationale: Two tidal projects that may have design interdependencies
- Group C Rationale: Upper Abernathy projects that involve ELJs and Side-Channels
- Group D Rationale: All tree falling from riparian, cable-yarding, and conifer understory planting
- Group E Rationale: All involve placement of wood and may have design interdependencies
- Group F Rationale: Projects are all in Germany 5 or the d/s end of Germany 6; All have multiple landowners and project complexities that will need to be coordinated.

Table 29. Proposed Phase 1 Projects.

EDT Reach	Project Name	Project Description	Group	EDT Tier	PAR Score	Total Benefit Score	Cost	Benefit/ Cost	Opportunity / Constraints Score
Abernathy 9	ABERNATHY 9G	Engineered Log Jams; LWD Enhancement (Wood from Riparian); Off/ Side Channel Enhancement (minor grading)	C	1	101	141	$500,485	9	high opportunity
Abernathy 2	ABERNATHY 2A	Engineered Log Jams	A	1	35	135	$260,640	16	high opportunity
Abernathy 9	ABERNATHY 9A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	D	1	77	117	$589,262	6	moderate
Abernathy 10	ABERNATHY 10B	Off/ Side Channel Enhancement; Engineered Log Jams; LWD Enhancement (Wood from Riparian)	C	1	62	112	$608,933	6	high opportunity
Abernathy 3	ABERNATHY 3C	Engineered Log Jams; LWD Enhancement (Imported Wood)	E	1	21	112	$138,959	26	high opportunity
Abernathy 5	ABERNATHY 5A	LWD Enhancement (Imported Wood)	D	1	20	106	$137,500	25	high opportunity
Germany 2	GERMANY 2A	Engineered Log Jams; Riparian Rehabilitation	B	1	15	106	$282,360	12	high opportunity
Germany 5	GERMANY 5D	Off/ Side Channel Enhancement; LWD Enhancement (Wood from Riparian); Engineered Log Jams	F	1	46	105	$897,149	4	Constraints
Abernathy 3	ABERNATHY 3A	LWD Enhancement (Imported Wood)	E	1	10	101	$125,000	26	moderate
Abernathy 3	ABERNATHY 3B	Engineered Log Jams	E	1	10	101	$130,320	25	high opportunity
Germany 5	GERMANY 5A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	D	1	39	98	$274,732	11	moderate
Germany 2	GERMANY 2C	Riparian Rehabilitation	B	1	6	97	$298,650	10	high opportunity
Germany 2	GERMANY 2B	Bank Stabilization/ Protection; LWD Enhancement (Imported Wood); Riparian Rehabilitation	B	1	3	94	$47,325	63	high opportunity
Germany 5	GERMANY 5B	LWD Enhancement (Imported Wood); Riparian Rehabilitation	F	1	34	93	$569,343	5	Constraints
Abernathy 9	ABERNATHY 9F	LWD Enhancement (Wood from Riparian); Engineered Log Jams	C	1	50	91	$221,659	13	high opportunity
Abernathy 1	ABERNATHY 1A	Engineered Log Jams	A	1	4	91	$80,000	36	high opportunity
Germany 5	GERMANY 5C	LWD Enhancement (Imported Wood)- main channel; LWD Enhancement (Imported Wood)- Side Channel; Riparian	F	1	19	78	$189,096	13	Constraints
Germany 5	GERMANY 5F	Off/ Side Channel Enhancement	F	1	13	72	$223,570	10	Constraints
Germany 6	GERMANY 6F	Off/ Side Channel Enhancement; Engineered Log Jams; Riparian Enhancement (underplanting)	F	1	26	67	$330,490	6	Constraints
Abernathy 10	ABERNATHY 10A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	D	1	16	66	$120,357	17	high opportunity

Phase 2 includes the next twenty projects, in terms of rank priority. All groups in this phase were defined because the project types were similar and will likely require the procurement of common materials and contractors.

- Group G Rationale: All intensive riparian planting with invasive weed management
- Group H Rationale: All tree falling from riparian, cable-yarding, and conifer understory planting
- Group I Rationale: All involve LWD enhancement of ELJs that require importing wood from an external source.
- Group J Rationale: Mutually exclusive bank protection projects
- Group K Rationale: All involve side-channel enhancement requiring additional design considerations.
- Group L Rationale: Single culvert replacement project
- Group M Rationale: Single bridge removal project

Table 30. Proposed Phase 2 Projects.

EDT Reach	Project Name	Project Description	Group	EDT Tier	PAR Score	Total Benefit Score	Cost	Benefit/ Cost	Opportunity / Constraints Score
Abernathy 7	ABERNATHY 7A	Riparian Rehabilitation	G	1	1	64	$36,200	56	moderate
Germany 5	GERMANY 5E	Bank Stabilization/ Protection	J	1	2	61	$43,440	45	Constraints
Germany 8	GERMANY 8A	LWD Enhancement (Imported Wood)	I	1	10	55	$187,000	9	high opportunity
Germany 6	GERMANY 6E	Off/ Side Channel Enhancement	K	1	12	53	$121,639	14	Constraints
Germany 6	GERMANY 6D	LWD Enhancement (Imported Wood); Riparian Rehabilitation	I	1	11	52	$72,160	23	Constraints
Germany 10	GERMANY 10A	LWD Enhancement (Wood from Riparian); Engineered Log Jams	I	1	9	50	$104,178	15	moderate
Germany 10	GERMANY 10B	Culvert Replacement	L	1	7	48	$55,000	28	high opportunity
Germany 6	GERMANY 6A	Riparian Rehabilitation	G	1	6	47	$612,658	2	Constraints
Abernathy 9	ABERNATHY 9C	Engineered Log Jams	I	1	6	47	$130,320	12	high opportunity
Germany 6	GERMANY 6C	LWD Enhancement (Imported Wood); Riparian Rehabilitation	I	1	4	45	$144,320	10	Constraints
Abernathy 9	ABERNATHY 9E	Bridge Removal	M	1	3	44	$100,000	14	high opportunity
Abernathy 9	ABERNATHY 9B	Engineered Log Jams	I	1	3	44	$115,000	12	high opportunity
Abernathy 9	ABERNATHY 9I	Off/ Side Channel Enhancement ; Engineered Log Jams	K	1	2	43	$64,367	21	high opportunity
Abernathy 9	ABERNATHY 9H	Riparian Rehabilitation	G	1	1	42	$123,409	11	high opportunity
Abernathy 9	ABERNATHY 9J	Riparian Rehabilitation	G	1	0	41	$27,424	48	high opportunity
Abernathy 9	ABERNATHY 9K	Riparian Rehabilitation	G	1	0	41	$27,424	48	moderate
Germany 6	GERMANY 6B	Bank Stabilization/ Protection	J	1	0	41	$42,000	31	Constraints
Germany 3	GERMANY 3A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	H	2	35	130	$243,905	17	high opportunity
Cameron 1	CAMERON 1B	LWD Enhancement (Wood from Riparian)	H	2	55	109	$95,000	37	high opportunity
Germany 3	GERMANY 3C	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	H	2	13	99	$60,209	52	high opportunity

Phase 3 includes the last twenty projects, in terms of rank priority. All groups in this phase were defined because the project types were similar and will likely require the procurement of common materials and contractors.

- Group N Rationale: All tree falling from riparian, cable-yarding, and conifer understory planting
- Group O Rationale: All involve LWD enhancement of ELJs that require importing wood from an external source.
- Group P Rationale: All involve side-channel enhancement requiring additional design considerations.
- Group Q Rationale: Mutually exclusive bank protection projects

Table 31. Proposed Phase 3 Projects.

EDT Reach	Project Name	Project Description	Group	EDT Tier	PAR Score	Total Benefit Score	Cost	Benefit/ Cost	Opportunity / Constraints Score
Germany 3	GERMANY 3D	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	N	2	13	99	$72,250	44	high opportunity
Germany 3	GERMANY 3B	LWD Enhancement (Wood from Riparian); Engineered Log Jams; Riparian Enhancement (underplanting)	O	2	12	98	$244,567	13	high opportunity
Germany 3	GERMANY 3E	Bank Stabilization/ Protection; LWD Enhancement (Imported Wood); Riparian Rehabilitation	Q	2	2	89	$40,565	69	high opportunity
Abernathy 4	ABERNATHY 4C	Off/ Side Channel Enhancement; LWD Enhancement (Imported Wood)	P	2	11	83	$219,113	12	moderate
Abernathy 4	ABERNATHY 4A	LWD Enhancement (Imported Wood); Riparian Rehabilitation	O	2	7	80	$101,024	25	high opportunity
Abernathy 4	ABERNATHY 4D	LWD Enhancement (Wood from Riparian); Riparian Rehabilitation; Engineered Log Jams	O	2	7	80	$252,771	10	moderate
Germany 4	GERMANY 4A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	N	2	6	79	$367,875	7	moderate
Abernathy 4	ABERNATHY 4E	LWD Enhancement (Imported Wood); Engineered Log Jams	O	2	5	78	$69,479	36	moderate
Abernathy 4	ABERNATHY 4B	Bank Stabilization/ Protection; Riparian Rehabilitation	Q	2	4	77	$78,400	31	moderate
Germany 13	GERMANY 13A	LWD Enhancement (wood from riparian)	N	2	24	69	$60,000	37	high opportunity
Cameron 1	CAMERON 1A	LWD Enhancement (Imported Wood)	O	2	3	57	$112,500	16	high opportunity
Abernathy 11	ABERNATHY 11A	LWD Enhancement (Wood from Riparian); Riparian Enhancement (underplanting)	N	2	12	48	$330,485	5	high opportunity
Germany 13	GERMANY 13B	Off/ Side Channel Enhancement ; LWD Enhancement (Wood from Riparian)	P	2	2	47	$112,500	13	high opportunity
Germany 13	GERMANY 13C	Bank Stabilization/ Protection	Q	2	1	46	$47,784	31	moderate
Sarah 1	SARAH 1A	LWD Enhancement (Imported Wood)	O	2	9	45	$60,000	24	high opportunity
Ordway 1	ORDWAY 1A	Off/ Side Channel Enhancement; LWD Enhancement (Wood from Riparian)	P	2	0	36	$11,557	100	high opportunity
Germany 1	GERMANY 1A	Riparian Enhancement; Riprap Removal; Engineered Log Jams	O	3	11	79	$260,640	10	moderate
Wiest 1	Wiest 1	Off/ Side Channel Enhancement; LWD Enhancement (Imported Wood); Riparian Rehabilitation	P	3	16	34	$446,006	2	moderate
Germany 11	GERMANY 11A	LWD Enhancement (Wood from Riparian)	N	4	47	79	$100,000	25	high opportunity
Germany 12	GERMANY 12A	LWD Enhancement (Wood from Riparian)	N	4	10	42	$100,000	13	high opportunity

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