Appendix K

Fish Habitat and Fish Population Impacts

ASSESSMENT OF RELATIVE FISH HABITAT AND FISH POPULATION IMPACTS OF I-5 CORRIDOR REINFORCEMENT PROJECT ALTERNATIVES AND OPTIONS

Report to:

Bonneville Power Administration
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SUMMARY

Bonneville Power Administration (BPA) is proposing to construct a new 500-kV transmission line in a north/south alignment over approximately 70 miles between a new substation near Castle Rock, Washington and a new substation near BPA's existing Troutdale Substation in Multnomah County, Oregon. This assessment estimates the relative potential of route alternatives and options for impact on fish and fish habitat. This information will be used to prepare a National Environmental Policy Act Draft Environmental Impact Statement for the project.

Effects of transmission line and access construction and operation on fish resources will be a function of the number and types of project activities, the intensity of disturbance, the nature of the associated habitat impacts, and the response of fish species and populations to habitat alteration. Indices used in this assessment are based on indicators of: 1) project impacts on hydrology, sediment, riparian, and floodplain characteristics known to be strongly related to the productivity of fish habitat, and 2) changes in fish production occurring as a consequence of habitat alteration. This assessment does not provide absolute estimates of project impacts on fish resources, but the indices used in the assessment do provide a basis for evaluating the magnitude of project impact at multiple scales. For the purposes of this analysis, all project effects on fish resources are assumed to be indirect via their influence on fish habitat (see Figure 1). Index values and rankings are summarized in Table 1 and Table 2, respectively. Brief summaries follow.

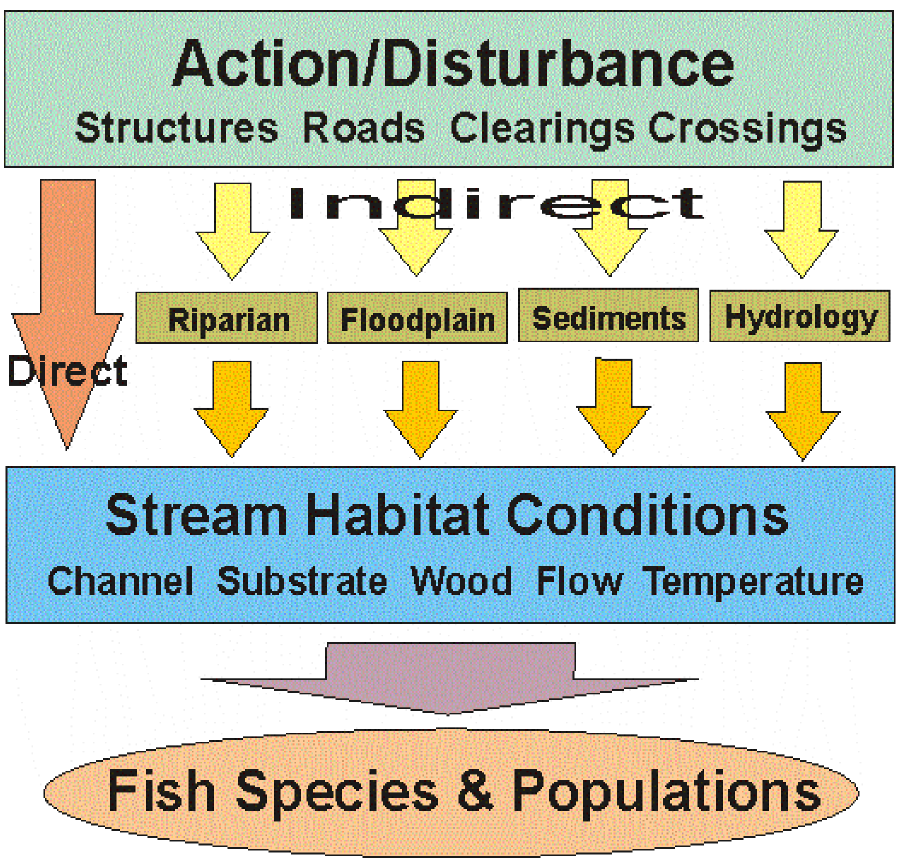

Figure 1. Conceptual description of habitat-mediated project effects on fish resources.

Table 1. **Summary of fish habitat and fish impact index values (sorted by increasing impact based on the Integrated Fish Impact index).**

Alternative	Hydrology	Sediment	Riparian		Floodplain	Fish Impact
			Near-term	Long-term		
West Option 2	127	303	5,592	9,024	15.3	0.08
West Option 3	141	295	6,153	9,750	15.6	0.09
East Option 3	962	106	9,340	10,287	10.2	0.09
East Option 2	875	94	10,312	11,546	10.4	0.09
West Option 1	111	368	5,926	9,112	21.9	0.11
West Alternative	118	361	6,054	9,239	18	0.11
Central Option 3	652	97	11,141	12,363	9.5	0.11
Central Option 2	687	114	10,550	12,575	7.7	0.14
Central Alternative	725	119	12,006	14,207	9.2	0.15
Central Option 1	744	119	12,373	14,797	9.2	0.15
East Option 1	921	105	7,483	8,559	9.1	0.19
East Alternative	929	106	9,344	10,252	10.9	0.19
Crossover Alternative	512	132	9,291	11,319	9	0.20
Crossover Option 2	523	146	9,385	11,413	9.4	0.21
Crossover Option 3	458	145	9,588	12,174	9.5	0.21
Crossover Option 1	515	146	10,027	12,200	10.7	0.24

Table 2. **Summary of fish habitat and fish impact index ranks (sorted by increasing impact based on the Integrated Fish Impact index; 1-highest impact; 16-lowest impact).**

Alternative	Hydrology	Sediment	Riparian		Floodplain	Fish Impact
			Near-term	Long-term		
West Option 2	14	3	16	15	4	16
West Option 3	13	4	13	12	3	14
East Option 3	1	12	10	10	8	15
East Option 2	4	16	5	7	7	13
West Option 1	16	1	15	14	1	11
West Alternative	15	2	14	13	2	12
Central Option 3	8	15	3	4	10	10
Central Option 2	7	11	4	3	16	9
Central Alternative	6	9	2	2	13	8
Central Option 1	5	10	1	1	12	7
East Option 1	3	14	12	16	14	6
East Alternative	2	13	9	11	5	5
Crossover Alternative	11	8	11	9	15	4
Crossover Option 2	9	5	8	8	11	3
Crossover Option 3	12	7	7	6	9	2
Crossover Option 1	10	6	6	5	6	1

Hydrology

The Stream Hydrology Impact Assessment evaluates the potential effects of alternative transmission line routes and new access roads on increased runoff and peak flows. This assessment used the Washington Forest Practice Board Manual (2011) method for hydrologic condition, which uses satellite imagery to quantify hydrologic maturity (the ability of vegetation to mitigate snow accumulation and snow melt). A single index was developed to gauge indirect effects. Index values reflect potential changes in the area of hydrologically immature cover within each subwatershed crossed by the alternatives and alternative options. Increases in hydrologically immature land cover can lead to increased runoff and peak flows.

The increase in hydrologically immature land cover as a consequence of transmission line corridors and new access roads would be low (less than about 1,000 acres) for all alternatives and alternative options. Consequently, the increase in runoff and peak flows would be low, at levels that would have no adverse impacts to stream channel habitat and fish resources. Potential impacts would generally be lowest for the West Alternative and options and greatest for the East Alternative and options. Rankings are best explained by the amount of hydrologically immature land cover already present. The West Alternative and options would cross subwatersheds that have higher urban development, greater agricultural land use, and greater hardwood cover–all already hydrologically immature. Proceeding east, there is less development, less agriculture, and higher conifer cover—clearing would convert more area to hydrologically immature land cover. However, in all instances, the percent change would be slight (<1%). Given the limited change, this indirect effect was not carried forward to the Fish Impact Assessment.

Sediment

The Sediment Impact Assessment evaluates the potential effects of construction of unsurfaced access roads and transmission line corridors on increased sediment delivery. This assessment used the Integrated Watershed Assessment method (LCFRB 2010a) for determining potential fine sediment delivery in subwatersheds crossed by the action alternatives. The potential effect of alternatives and alternative options on watershed-scale sediment delivery to stream channels was estimated as a function of: 1) the natural erodibility within a subwatershed, 2) the extent of the existing road network (aka "the managed condition"), 3) the effect of new roads on sediment generation and delivery, and 4) the effect of the transmission line corridors on sediment generation and delivery.

The increase in potential fine sediment delivery as a consequence of transmission line corridors and new access roads would be low for all alternatives and alternative options. Potential impacts would generally be greatest for the west alternative and options which would cross more erodible terrain, while the other alternatives and options would cross less erodible underlying geology. Even though the West Alternative and options would have the least unsurfaced road construction, they would have the greatest increase in sediment delivery because these roads would be constructed on an erodible geology. The results appear to show that alternatives requiring the construction of access roads in more erodible terrain would result in higher sediment impacts. The highest index values are found in the West Alternative and options, while the East and Central alternatives and options were found to have the lowest index values. However, in all instances, the percent change would be slight (<1%). Given the limited change, this indirect effect was not carried forward to the Fish Impact Assessment.

Riparian

The Riparian Impact Assessment evaluates the potential effects of alternative transmission line corridors on loss of riparian function along fish-bearing streams. This assessment used the Washington Forest Practice Board Manual (2011) method for assessing riparian function, which uses aerial photo interpretation to quantify two specific processes: 1) the recruitment of large woody debris, and 2) the provision of stream shade. Near-term and long-term indices integrate these assessments to gauge direct and indirect impacts. Index values reflect the length of stream cleared by alternatives and alternative options, weighted by the riparian function provided by the vegetation lost through clearing.

This loss of riparian vegetation as a consequence of transmission line clearing could have a measurable impact on fish populations. Near-term, it would be equivalent to the loss of about 1 to 2.5 miles of highly-functioning riparian vegetation. Long-term, the loss would be slightly greater. Near-term, the West Alternative and options would have the least riparian function loss while the Central Alternative and options would have the greatest. The West Alternative and options have discernibly greater levels of degradation and encroachment of non-forest land uses leading to lower riparian function ratings. Long-term, the ranking is correlated with length of stream cleared of forested vegetation. As riparian vegetation grows and reaches potential riparian function, differences in riparian function would decrease. East option 1 would have the least amount of stream length cleared. Otherwise, long-term rankings are more or less similar to near-term rankings. Given the magnitude of potential riparian function loss that could occur, this indirect effect was carried forward to the Fish Impact Assessment.

Floodplain

The Floodplain Impact Assessment evaluates the potential effects of alternative transmission line corridors, access roads, and transmission towers on loss of floodplain function along fish-bearing streams. This approach quantified the effect of alternatives and options on floodplains by integrating the following: 1) the amount of reduction in forest vegetation within floodplains, 2) the number and footprint area of new towers that would be constructed within the floodplain, and 3) the length and area of new or reconstructed roads within the floodplain. Index values reflect the total floodplain area affected.

The total floodplain area impacted would range from 7.7 to 21.9 acres as a consequence of transmission line clearing, new or improved access roads, and new towers. The West Alternative and options would have the greatest total impact area because they cross broad floodplain areas within the lower portion of large rivers. The East Alternative and options would generally have the second greatest impact. The Crossover and Central alternatives and options would generally have the least amount of impact. Given the total area of impact and due to the presence of existing floodplain impairments, the overall impact on floodplain processes, including floodplain inundation and long-term channel adjustment, is expected to be relatively minor. This effect was not carried forward to the Fish Impact Assessment.

Fish Impact

The Fish Impact Assessment uses production value of listed salmon and steelhead in streams as an index of the relative potential or risk of impact of alternative corridor routes on fish resources. While a variety of fish species occur in the region, listed salmon and steelhead are of particular concern and will be the focus of biological assessments required by their listing status. Fish impact potential is related to: 1) the fish production value in the stream reach affected by the project and 2) the extent to which reductions in fish production may be realized as a result of direct and indirect project-related impacts on fish habitat or fish habitat forming processes.

Fish production potential is expressed in terms of fish numbers (adult salmon), percentage of the population, and percentage of populations identified as a priority for salmon protection and restoration in Salmon Recovery Plans adopted by the State of Washington Department of Fish and Wildlife (WDFW) and the National Marine Fisheries Service (NMFS). Fish numbers are estimated within the footprint of the right-of-way at each stream crossing for each of the four listed salmon and steelhead species. Stream crossings are a convenient way to represent all project activities that might directly or indirectly affect fish habitat.

An Integrated Fish Impacts index describes the amount of fish potential that might be expected to be affected by fish habitat changes based on findings of the hydrology, sediment, riparian, and floodplain impact analyses in order to rate the loss of fish productivity associated with potential habitat impacts. The Integrated Fish Impacts index estimates the proportional reduction in fish numbers associated with project-related habitat degradation at the crossing scale. Units of this index are expressed as the average percentage of high priority populations for all listed salmon and steelhead species potentially affected by the alternatives and alternative options.

The proportional reduction in fish numbers associated with project-related habitat degradation would be quite low for all alternatives and options. The Integrated Fish Impacts index value would be 0.3% or less for all species and for most options. Population-level Integrated Fish Impacts index values up to 0.95% were estimated for winter steelhead due to several crossings occurring in relatively high-value streams for steelhead with highly-functioning riparian vegetation that will require clearing. Overall, the magnitude of reduction in fish production indicated by this index would not affect population recovery of these federally-listed species.

West Alternative and options rank among the lowest fish impacts based on the Integrated Fish Impacts index. Fish production potential is generally higher because routes included a higher number of crossings and many of these occurred at relatively high-value streams for anadromous species. However, project related habitat effects would be relatively low in comparison with other routes because many stream crossing would occur at locations where conditions in the right of way are already altered. Hence, these routes would generally require much less clearing of highly-functioning riparian vegetation. Differences among the alternatives and options were driven by variations in the Washougal basin east of Vancouver.

Crossover Alternative and options are generally ranked with highest impacts due to both higher fish production potential and more clearing of highly-functioning riparian vegetation. These routes would cross a greater number of anadromous fish-bearing streams, including many low to intermediate elevation streams which produce more fish and more species of fish on a per unit-length basis. Affected populations are more frequently identified in the salmon recovery plan as high priorities for habitat protection or restoration. More riparian zones in these areas would require clearing and riparian zones are more likely to be highly functional. Hence, reductions in fish production potential would likely be greater.

Central Alternative and options are generally ranked intermediate between East and Crossover alternatives and options in terms of fish impact based on the Integrated Fish Impacts index. The number of crossings of anadromous fish-bearing streams would be intermediate. Fish production potential is also intermediate at these crossings. The magnitude of riparian clearing and functional rating of riparian zones would be intermediate as well.

East Alternative and options rank from low to moderately high based on the Integrated Fish Impacts index. Fish production potential is relatively low because the number of crossings of anadromous fish-bearing streams would be lower than other alternatives and these routes would generally cross smaller, higher elevation streams that are inhabited at relatively low densities by a limited number of species (typically steelhead and coho). However, many of these crossing would require substantial clearing of relatively high-functioning riparian vegetation.

INTRODUCTION

Bonneville Power Administration is proposing to construct a new 500-kV transmission line in a north/south alignment over approximately 70 miles between a new substation near Castle Rock, Washington and a new substation near BPA's existing Troutdale Substation in Multnomah County, Oregon. The transmission line towers would carry conductors for the electricity, overhead ground wires for lightning protection, and fiber optic lines for communication needs. BPA would construct new and improve existing access roads to each tower site in order to accommodate construction and maintenance of the new transmission line.

Four route alternatives have been identified (Figure 2). Each alternative also includes options. Alternatives and alternative options consist of segments, some of which are sited parallel to existing transmission lines, either within or adjacent to the existing right-of way, and some are located in new right-of-way. This assessment evaluates alternatives and options based on their relative impacts to fish resources, including salmon and steelhead species listed under the U.S. Endangered Species Act (ESA). This information will be used to prepare a National Environmental Policy Act (NEPA) Draft Environmental Impact Statement (DEIS) for the project.

A variety of fish species occur in streams potentially affected by the project. Of particular concern are four listed salmon and steelhead species (including a total of six races):

- Lower Columbia River coho salmon (*Oncorhynchus kisutch*)
- Lower Columbia River Chinook salmon (*Oncorhynchus tshawytscha*) – spring and fall races
- Columbia River chum salmon (*Oncorhynchus keta*)
- Lower Columbia River steelhead (*Oncorhynchus mykiss*) – summer and winter races

Two other federally-listed species also occur in southwest Washington streams but are not likely to be affected by the project. Distribution of the threatened bull trout (*Salvelinus confluentus*) is mostly found in areas outside of the project influence. Eulachon (Columbia River Smelt, *Thaleichthys pacificus*) occur in the lower portions of major Columbia River tributaries where the scale of project impacts is expected to be minimal. Other noteworthy species with a wide distribution in the region include the resident coastal cutthroat trout (*Oncorhynchus clarki clarki*), and the anadromous Pacific lamprey (*Lampetra tridentata*).

Effects of transmission line and access construction and operation on fish resources will be a function of the number and types of project activities, the intensity and persistence of project disturbance, the nature of the associated habitat impacts, and the response of each fish species to habitat alteration. Fish species will be affected by the direct and indirect effects of project actions on fish habitat (see Figure 1). Direct effects on fish habitat might include stream channel alterations or migration blockages due to construction of structures or access roads within or across streams. Indirect effects on fish habitat might result from project alteration of watershed conditions affecting hydrology and sediment delivery or crossing-scale changes in riparian and floodplain function. Watershed and crossing-scale effects can impact fish production via changes to fish habitat that decrease fish carrying capacity and/or survival.

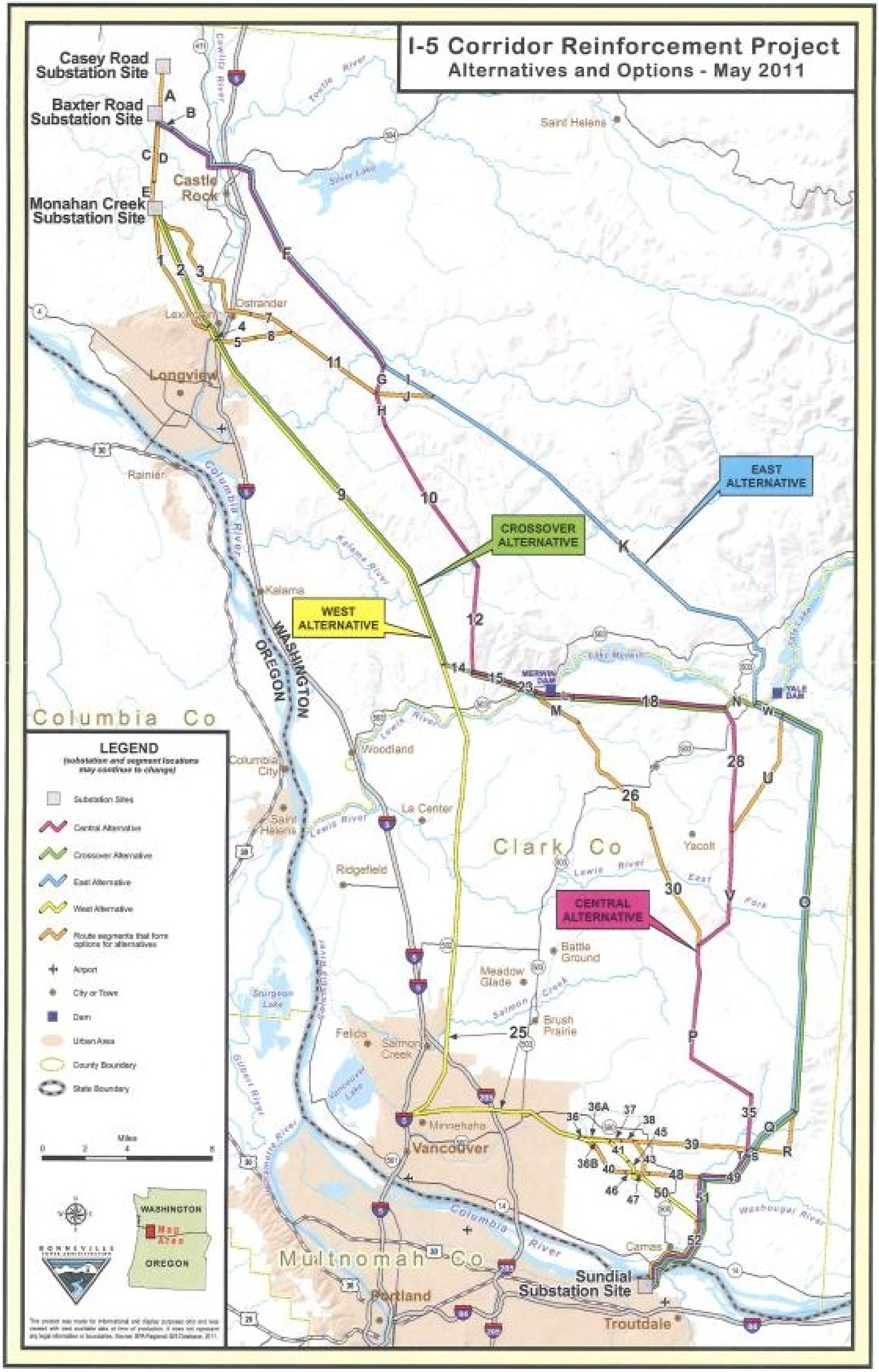

Figure 2. I-5 Corridor Reinforcement Project alternatives and options (May 2011).

This assessment uses *indices* of the project impacts on fish habitat and fish numbers that can be quantified with relatively high confidence. Indices used in this assessment are based on indicators of: 1) project impacts on hydrology, sediment, riparian, and floodplain known to be strongly related to the productivity of fish habitat, and 2) changes in fish production occurring as a consequence of habitat alteration. These indices provide a basis for comparison of the relative impact of project routes and alternatives on fish resources, and they are most useful for ranking routes and alternatives to inform selection of a preferred route through the DEIS. These indices also provide some basis for evaluating the magnitude of project impacts at a project scale. In addition, these indices will be useful for characterizing the causal mechanisms and spatial distribution of project impacts which will provide guidance for mitigation measures.

Stream Hydrology Impact Assessment

The Stream Hydrology Impact Assessment evaluates the potential effects of alternative transmission line corridors and new access roads on increased runoff and peak flows. Any given subwatershed might support none, some, or all of four listed salmon and steelhead species.

This assessment used the Washington Forest Practice Board (WaFPB) Manual (2011a) method for hydrologic condition of subwatersheds crossed by the action alternatives. These procedures integrate general watershed characteristics that are likely to significantly affect storm runoff, including land use patterns, structural features, disturbance history, and climate. This assessment focuses on land use patterns as they influence hydrologic maturity. Hydrologic maturity was interpreted from recent Landsat imagery within each subwatershed. Using this protocol provides a systematic means of characterizing hydrologic condition.

Using these interpretations, a single index value was developed to reflect the potential impacts of alternative transmission line corridors on increased runoff and on peak flows in affected subwatersheds. Index values were based on the potential impact of the vegetation clearing on the area of hydrologically immature land cover. Index values reflect potential impacts from transmission line corridors and new access roads. The index values capture a number of important considerations when analyzing impacts, including the area of vegetation cleared in construction and maintenance of transmission line corridors and new access roads and the dominant vegetation types and total crown closure of cleared areas.

Background

The hardened surfaces of new roadbeds and areas disturbed by new road construction could increase surface runoff and peak flows in streams (Grant et al. 2008). An increase in peak flows associated with transmission line clearing could occur through vegetation removal of hydrologically mature vegetation along the right-of-way. Continued maintenance of hydrologically immature cover along the right-of-way would occur. Opening of the canopy can cause greater snow accumulation, increased snowmelt in spring, accelerated melt rates, reduced rates of interception and evapotranspiration, and augmentation of storm runoff volume due to increased soil moisture or snowmelt (Harr 1981, Ziemer and Lisle 1998). The greatest potential for adverse change from increased runoff and peak flows in streams exists in watersheds within rain-on-snow and snow-dominated precipitation zones (Harr 1981).

Excessive peak flows can scour streambeds and in some instances can cause debris torrents that alter stream channels (Grant et al. 2008). Flooding and debris torrents in fish-bearing streams can degrade fish habitats by destroying egg pockets and rearing areas, altering pool and riffle sequences, and removing large woody debris (Booth 1990, Grant et al. 2008). Excessive peak flows can also expedite the flushing of available nutrients from streams (Lamberti et al. 1989). Water that runs off into streams is not available for recharging ground water sources which contribute to summer flows. Increased peak flows can result in simplified habitats, reduced nutrients, and unsuitable summer conditions, which decrease fish growth and survival (Bjornn and Reiser 1991, Spence et al. 1996). This assessment focuses on changes in vegetation conditions that could lead to these impacts. We address the potential magnitude of impacts to aquatic habitat via excessive peak flows in the Discussion.

Methods

Data

Locations of subwatersheds were obtained from the Washington Lower Columbia Fish Recovery Board (LCFRB) that was compiled as part of Recovery Plan development. All subwatersheds containing transmission line corridors or new access roads were assessed. A 150-foot buffer width was used to establish the transmission line corridor footprint. A 30-foot buffer width was used for new access roads. Only new access roads outside of the transmission corridor were assessed. Clearing due to new access roads inside the transmission line corridor are already covered by the transmission line corridor area.

Interpretation of hydrologic maturity was conducted using LANDFIRE data sets. LANDFIRE (also known as Landscape Fire and Resource Management Planning Tools) is an interagency vegetation, fire, and fuel characteristics mapping program, sponsored by the United States Department of the Interior and the United States Department of Agriculture (USDA), Forest Service. We used the Existing Vegetation Type (EVT) layer, which represents the species composition currently present at a given site, and the Existing Vegetation Cover (EVC) layer, which represents the vertically-projected percent cover of the live canopy layer. These layers are processed at a 30-meter cell resolution. We used the 2008 refresh, which is based on 2001 LANDSAT imagery but incorporates vegetation changes and disturbances through 2008.

Index

The Hydrologic Change index quantifies the potential change in the area of hydrologically immature land cover. This index is calculated at an adequate resolution to detect even minor changes. Hydrologically immature forested land cover is defined in the WaFPB Manual (2011a) method for hydrologic change as forested areas with less than 10% total crown closure and/or more than 75% of the tree crown in hardwoods. Non-forested land cover is also considered hydrologically immature. Attributes in the LANDFIRE data sets were used to apply these rules to determine area, pre- and post-project, in this condition. The correlation between LANDFIRE attributes and land cover is provided in Appendix A.

Results

Appendix A lists 87 subwatersheds crossed by all alternatives and options. For each subwatershed, the following information is provided by alternative and option:

- Is the subwatershed crossed by transmission line corridors or new access roads?
- Pre-project area (acres) of hydrologically immature land cover in the subwatershed
- Post-project area (acres) of hydrologically immature land cover in the subwatershed

Table 3 summarizes the Hydrologic Change index for each alternative and alternative option. It also summarizes the total area in subwatersheds crossed by the alternatives and options, the area in these subwatersheds with hydrologically immature land cover, the change (increase) in hydrologically immature conditions due to transmission line corridors and new access roads (outside of the transmission line corridors), and the index value. Alternatives and options are sorted from the lowest index value to the greatest, reflecting increasing impacts.

Table 3. Hydrologic Change index values for action alternatives and options. Values are sorted by increasing index score, from least hydrologic change to most.

Alternative	Total Subwater-shed Area (ac)	Hydrologically Immature Area (ac)			Hydrologic Change Index	Percent Change
		Pre-Project	Change-Trans. Line Corridors	Change - New Access Roads		
West Option 1	164,857	130,988	104	7	111	0.08%
West Alternative	161,133	127,612	111	7	118	0.09%
West Option 2	167,652	132,819	120	7	127	0.10%
West Option 3	180,528	143,156	132	10	141	0.10%
Crossover Option 3	195,587	114,316	422	36	458	0.40%
Crossover Alternative	184,405	108,041	477	35	512	0.47%
Crossover Option 1	184,405	108,041	479	35	515	0.48%
Crossover Option 2	195,587	114,316	487	36	523	0.46%
Central Option 3	207,371	119,872	605	47	652	0.54%
Central Option 2	208,504	119,032	633	54	687	0.58%
Central Alternative	217,922	121,872	676	49	725	0.59%
Central Option 1	224,210	124,932	694	50	744	0.60%
East Option 2	234,082	112,521	834	41	875	0.78%
East Option 1	211,468	94,457	867	53	921	0.97%
East Alternative	209,261	91,312	878	51	929	1.02%
East Option 3	209,261	91,312	897	64	962	1.05%

Hydrologic Change index values are substantially different at the extremes and exhibit a more or less uniform rate of decrease from the lowest to highest score. Despite these trends, the relative change in hydrologically immature conditions would be limited. Along the East Alternative and options, percent change from pre-project conditions would be about 0.78% to 1.05%. This decreases to about 0.6% for the Central Alternative and options; about 0.5% for the Crossover Alternative and options; and, only about 0.1% for the West Alternative and options. Overall, index values are generally lowest for the West Alternative and options and greatest for the East Alternative and options. The Central and Crossover alternatives and options are in the middle of the overall rankings.

Discussion

By using consistent assessment procedures informed by consistent data sources, results are comparable among alternatives and options. This assessment was a desktop exercise and more accurate determinations can be made through aerial photo interpretation. Specifically, better information could be obtained about the location of recent disturbances (e.g., urban development, land clearing, regeneration timber harvests) not represented by the LANDFIRE data. Any of these could improve determination of hydrologic immaturity, but this uncertainty affected all alternatives and options more or less equally. Therefore, the relative ranking of alternatives and alternative options is reliable for planning purposes.

The strongest predictor of increase in hydrologically immature land cover is the proportion of hydrologically immature land cover in subwatersheds crossed. It is inversely related to the index values. That is, as the proportion of hydrologically immature land cover increases there is less change in hydrologic conditions. There are two ways to interpret this. One way is that when there is more hydrologically immature land cover, odds are greater that it will be used by a transmission line—thus avoiding conversion of otherwise hydrologically mature land cover. The other way is that when there is more hydrologically mature land cover, odds are greater that it will be cleared, creating hydrologically immature conditions. Both appear to be at play.

The lowest change would occur along the West Alternative and options. Almost 80% of the land cover in subwatersheds which would be crossed by the West Alternative and options is hydrologically immature. There is higher urban development, greater agricultural land cover, and greater hardwood cover. There would also be greater use of existing transmission line clearings. Collectively, this would increase the amount of hydrologically immature land cover used and decrease the amount of mature land cover cleared. In comparison, about 40% to 50% of the land cover in subwatersheds which would be crossed by the East Alternative and options is hydrologically immature. There is less development, less agriculture, and more conifer cover. Forest management creates immature conditions, but only briefly. These factors appear to directly affect ranking of alternatives and alternative options.

A full hydrologic change analysis following the WaFPB Manual (2011a) integrates this information with physiographic and climatic characteristics to estimate the effect on water available for runoff (WAR)—the rain-plus-snowmelt input—and ultimately peak flow. Generally, water availability increases as snow accumulation and storm precipitation increase, but snowmelt can be moderated as storm temperatures and wind speeds decrease. According to the models, snow accumulation increases as elevation increases; however, elevation increases will moderate snowmelt via decreased storm temperatures. In the subwatersheds crossed by the action alternative, storm precipitation is directly related to elevation (WaDOT 2006). Land cover influences snow accumulation and snowmelt; hydrologically immature conditions will increase both by increasing snow-water equivalence and wind speeds, respectively.

These relationships provide a basis for assessing the utility of the Hydrologic Change index for assessing the potential effects of alternative transmission line routes and new access roads on increased runoff and peak flows. Preliminary model calculations indicate that 24-hour snowmelt does not exceed snow accumulation in these subwatersheds. Therefore, WAR is determined by storm precipitation and snowmelt; both of which are influenced by elevation. Snowmelt is also influenced by hydrologically immature land cover; this influence is moderated slightly with increased elevation. The overall implication of this is that the Hydrologic Change index is a fairly consistent measure of increased runoff across subwatersheds. The relative influence of increased runoff on peak flows varies, however, with flow and precipitation. But, given the low increase in hydrologically immature conditions, peak flow increases are likely low (<10%), as well. Peak flow increases less than 10% are assumed to have no adverse effects (WaFPB 2011a). Long-term changes in watershed conditions would therefore be minor; however, local impacts could occur that result in locally high impairment to hydrology functions.

Sediment Impact Assessment

The Sediment Impact Assessment evaluates the potential effects of alternative transmission line routes and new access roads on instream sediment and turbidity. Any given subwatershed might support none, some, or all of four listed salmon and steelhead species.

This assessment used the Integrated Watershed Assessment (IWA) analysis method (LCFRB 2010a) for determining potential fine sediment impairment of subwatersheds crossed by the action alternatives. These procedures integrate general watershed characteristics that are likely to significantly affect sediment delivery, including geology and land surface slope. We focused on patterns as they influence natural sediment delivery of the subwatershed, and sediment delivery from managed land use. Using this protocol provides a systematic means of characterizing potential sediment impacts.

Using these interpretations, a single index value was developed to reflect the potential impacts of alternative transmission corridor segments and access roads on increased sediment delivery in affected subwatersheds. Index values were based on the potential impact of the vegetation clearing and road construction and how those impacts affect erosion and sediment delivery. Index values reflect potential impacts to sediment delivery within each subwatershed crossed by transmission line corridors or new access roads.

Background

The project has the potential to influence sediment delivery to stream channels through the construction of unsurfaced access roads and through the construction of transmission line corridors. Road construction activities such as cutting and backfilling could expose topsoil or loose sediment. Newly constructed roadbeds and surfaces would be a mix of coarse and fine material. Traffic during construction and operation and maintenance has the potential to expose and loosen sediment. During rain events, fine sediments can be eroded from the road surface and delivered to ditches and ultimately to streams (Ziemer and Lisle 1998). Sediment production from roads would vary depending on design, surfacing, sediment controls, and traffic (Furniss et al. 1991). Increased sediment production from rain events and from traffic could increase sediment loading in streams (Luce and Black 2001).

Construction of transmission line corridors could expose topsoil or loose sediment in right-of-way clearings. Sediment could be eroded and delivered to streams during rain events. Clearing of riparian vegetation in transmission line corridors also increases the potential for hillside erosion as well as stream bank erosion and direct delivery of sediments to streams. Loss of vegetation along streams also decreases the buffering capacity of the riparian vegetation. Periodic vegetation removal during maintenance could result in long-term reduced buffering capacity of the riparian vegetation, increased potential for hillside erosion, and increased potential for stream bank erosion (Chamberlin et al. 1991).

Increased sediment loading in fish-bearing streams can alter habitats and reduce the growth and survival of fish (Anderson et al. 1996, Suttle et al. 2004). For many fish species, eggs are deposited among gravels on the stream bottom. When these gravels become clogged with sediments, the free flow of oxygenated water and removal of wastes is impaired, resulting in egg suffocation and mortality (Anderson et al. 1996). Suspended sediments can clog and abrade fish gills, affecting behavior or causing suffocation (Newcombe and Jensen 1996), and can also reduce water clarity, making it difficult for some fish to find food or detect predators (Sigler et al. 1984). Turbid water can cause a stress response in salmon (Redding et al. 1987), which may result in reduced growth and reduced ability to tolerate additional stressors. Turbid water can also alter outmigration behavior, impair immune system function, and degrade osmoregulation capabilities (Newcombe and Jensen 1996).

Methods

This assessment used the IWA natural erodibility rating (from LCFRB 2010a) and the existing unsurfaced road density to determine a Sediment Delivery index. The Sediment Delivery index for the "pre-project" condition is compared to a "post-project" Sediment Delivery index, which incorporates the change in unsurfaced road density and transmission line corridors. The analysis was performed at the "litho-subwatershed" spatial scale. This represents an area with the same underlying lithology within a subwatershed (Figure 3). The subwatersheds were determined using the LCFRB Subwatershed Dataset, and the underlying lithology was determined using the Washington Department of Natural Resources (WaDNR) 1:100,000 scale 2010 Geology dataset. Road densities were calculated using WaDNR 2012 transportation infrastructure data for Cowlitz and Clark counties.

Determining the Natural Erodibility Rating (N)

The natural erodibility rating characterizes a natural or background condition by integrating geology type and the underlying land surface slope. Higher N values are assigned to areas with highly erodible geology and steeper slopes, while the lowest values are found in areas with geology that is relatively hard to erode and with gentle land surface slopes. The land surface slope was calculated from the National Elevation Dataset 10-meter DEM.

The pre-project condition is represented by the index based on methods developed for the IWA analysis (LCFRB 2010a). This index takes into account the underlying geology, the land surface slope, and unsurfaced road density in a given area. The erodibility classes of various geology types are summarized in Table 4, while the slope classes are summarized in Table 5. The integration of these two variables (geology and slope) results in the N value, as given in Table 6.

Calculating the Sediment Delivery Index (S)

Pre-Project. The Sediment Delivery index is a relative index created to characterize sediment processes based on natural or background levels and to integrate the effects of unsurfaced roads on a given litho-subwatershed unit. The natural erodibility rating (N) is multiplied by the pre-project road density to calculate the pre-project Sediment Delivery index (S_{PRE}) value for a specific litho-subwatershed unit. The raw index scores for each litho-subwatershed unit were weighted by a given unit's share of subwatershed area in order to aggregate results to the subwatershed scale and ultimately to an action alternative scale.

Post-Project. The post-project Sediment Delivery index was calculated in the same manner as the pre-project index, but incorporates the density of new roads and transmission line corridors that would result from the project (see Figure 4). For this calculation, the length of new roads that would be constructed outside of the transmission line corridor was included along with the transmission line corridor length to arrive at a post-project road density within each litho-subwatershed unit. The post-project Sediment Delivery index is determined by multiplying the post-project road density (R_{POST}) by the natural erodibility rating (N) to calculate the post-project Sediment Delivery index (S_{POST}). The calculation steps are summarized below.

N = Natural Erodibility Rating (see Table 6)

Weighting Factor:

W = *Area of Litho-Subwatershed Unit/ Total Subwatershed Area*

Road Density:

R_{PRE} = *Road Density within Litho-Subwatershed Unit based on Pre-project Conditions*

R_{POST} = *Road Density within Litho-Subwatershed Unit based on Post-project Conditions*

Sediment Delivery index:

Sediment Delivery Index Based on Pre-project Conditions: $S_{PRE} = N * R_{PRE} * W$

Sediment Delivery Index Based on Post-project Conditions: $S_{POST} = N * R_{POST} * W$

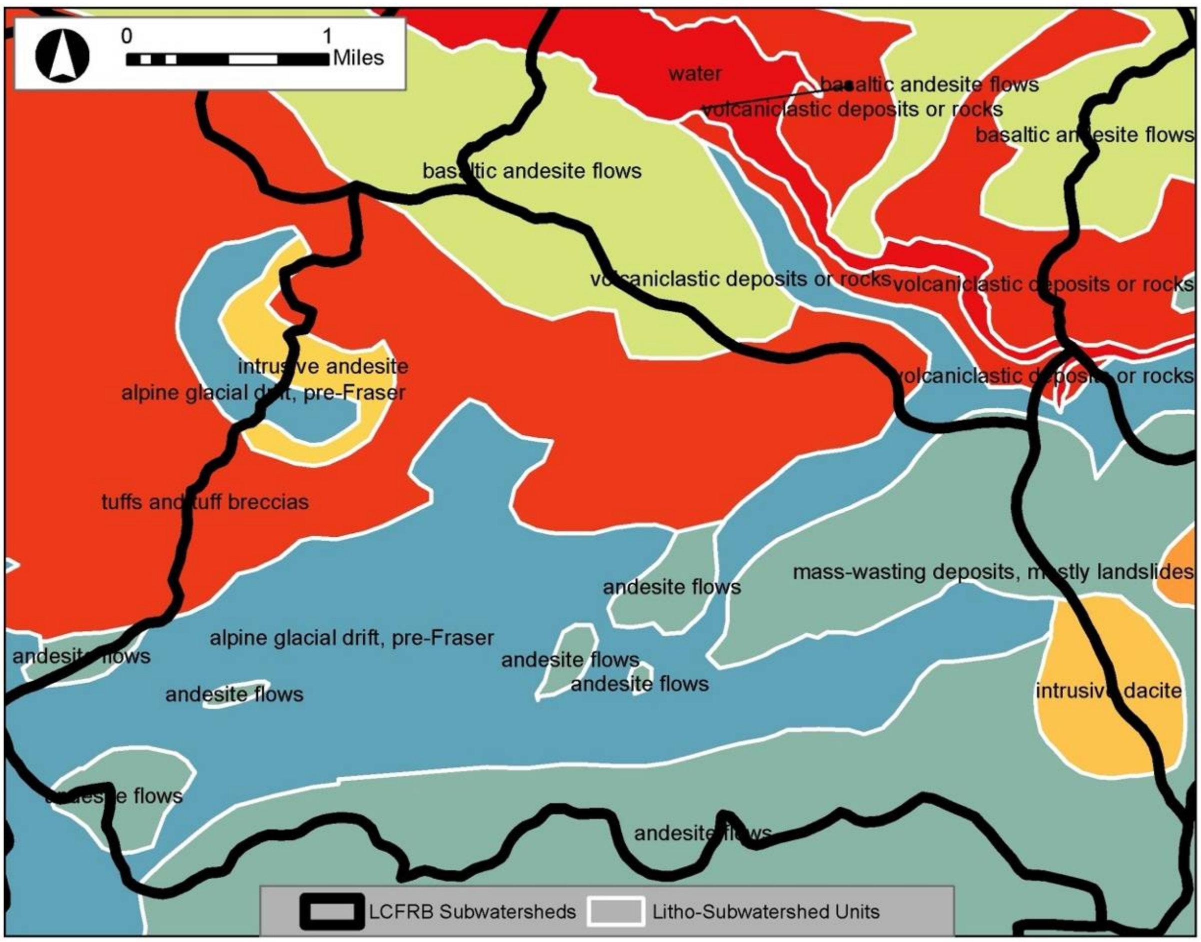

Figure 3. The geographic unit used for calculating the Sediment Delivery index, the litho-subwatershed unit, defined as an area of uniform geology within a given subwatershed. Results for the index (based on slope, erodibility of the geology and road density) were weighted by a given litho-subwatershed unit's area, relative to total subwatershed area.

Table 4. Erodibility of underlying geology, as presented in the IWA methodology (LCFRB 2010a).

Erodibility Class	Definition	Data Source	Score
High erodibility	Unconsolidated sediments of alluvial, glacial, or volcanic origin	IWA database	Uses IWA ratings
Moderate erodibility	Thinly bedded sedimentary rocks and pyroclastic deposits (i.e., volcanic materials not related to lava flows)	IWA database	Uses IWA ratings
Low erodibility	Massive igneous and sedimentary rocks	IWA database	Uses IWA ratings

Table 5. Land surface slope classes, as defined in the IWA methodology (LCFRB 2010a).

Rating	Definition	Data Source	Score
Steep slope	>65% slope	IWA database	Uses IWA ratings
Moderate slope	30-65% slope	IWA database	Uses IWA ratings
Low slope	<30% slope	IWA database	Uses IWA ratings

Table 6. Natural erodibility rating (N) based on erodibility of underlying geology and slope of a given litho-subwatershed unit.

Erodibility	Slope	Natural Erodibility Rating
Low	<30%	1
	30-65%	5
	>65%	10
Moderate	<30%	25
	30-65%	50
	>65%	75
High	<30%	50
	30-65%	75
	>65%	100

Calculating the Change Index (ΔS)

The final index calculation captures the difference between the pre- and post-project Sediment Delivery index values. By comparing pre- and post-project indices, we are able to discriminate between even minor changes in subwatershed-scale impairment.

$$\Delta S = S_{POST} - S_{PRE}$$

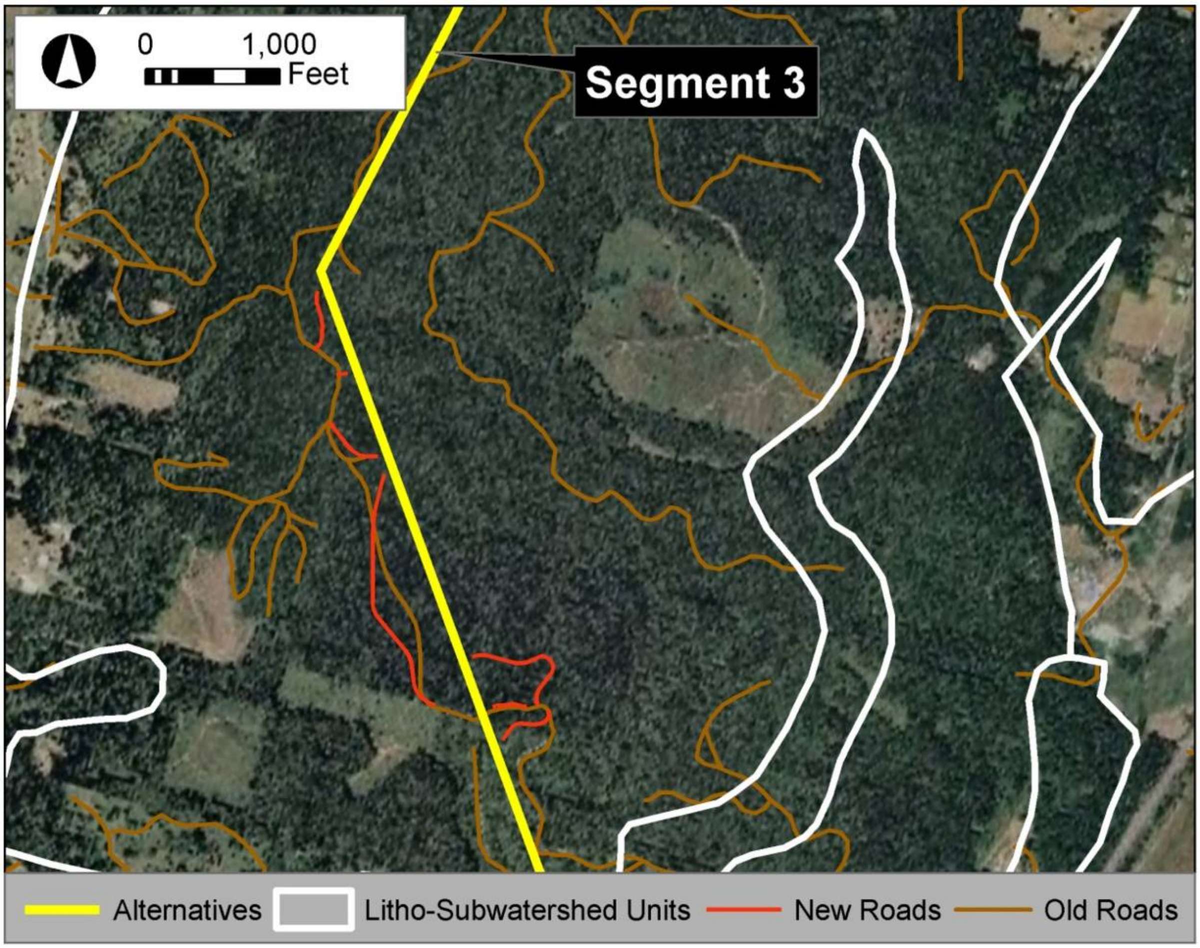

Figure 4. **Example of pre- and post-project road density calculations, looking at existing unsurfaced roads (brown lines) and new roads (red lines) and lengths of the various segments of the transmission lines (yellow) within each litho-subwatershed unit (white polygon).**

Results

The results of the sediment analysis are presented by alternative and option (Table 7). Generally, the largest impacts to sediment delivery would occur in the West and Central alternatives and options, while the Crossover and East alternatives and options are predicted to have lesser impacts. The raw change in index values range from 94.2 to 367.5 by alternative. Table 7 shows the mean percentage change from pre-project condition from results calculated at the subwatershed scale. The percentage change ranges from 0.00% to 0.25%.

Discussion

The various subwatersheds and geology types crossed by the action alternatives and options have different natural erodibility. Generally, the West Alternative and options would cross more erodible terrain, while the East Alternative and options would cross less erodible geology. Although the West Alternative and options are associated with the least amount of unsurfaced road construction, they would cause the highest potential impact to sediment delivery. The West Alternative and options would cross a large number of litho-subwatershed units with natural erodibility rating values of 25 and 50 (see Table 6). The results show that alternatives requiring the construction of access roads in more erodible terrain would result in higher sediment delivery impacts. The highest change values are found in the West Alternative and options, while the East and Central alternatives and options were found to have the lowest change index values.

The approach developed for estimating impacts to sediment delivery is based on the IWA methods (LCFRB 2010a). However, in order to provide enough sensitivity to detect the impact, the final index calculation was converted from a categorical score (functional / moderately impaired / impaired) to a continuous score. An evaluation using the IWA categorical scoring approach would not have been able to detect the changes to sediment delivery caused by the impacts associated with the various alternatives and options. Using the more sensitive approach developed for this analysis, the impacts to sediment delivery were detectable. However, for all alternatives and options, the post-project sediment delivery represents a very small percentage increase from pre-project conditions. Long-term changes in watershed conditions would therefore be minor; however, local impacts could occur that result in locally high impairment to sediment functions.

Table 7. Sediment Delivery index values for action alternatives and options. Values are sorted by increasing index score, from least increase in sediment delivery to most.

Alternative	New Corridor Length (mi)	New Access Road (mi)	S_{PRE}	S_{POST}	Sediment Delivery Index	Percent Change
East Option 2	75.0	20.3	240,523	240,617	94	0.00%
Central Option 3	70.1	26.2	265,184	265,280	97	0.15%
East Option 1	72.2	23.1	274,240	274,344	105	0.01%
East Alternative	74.0	22.5	264,581	264,687	106	0.00%
East Option 3	75.1	21.9	264,581	264,687	106	0.00%
Central Option 2	73.7	28.8	248,995	249,109	114	0.16%
Central Option 1	78.4	27.6	246,699	246,818	119	0.14%
Central Alternative	75.9	26.8	245,340	245,459	119	0.15%
Crossover	72.6	21.0	319,932	320,064	132	0.17%
Crossover Option 1	76.8	21.9	319,932	320,077	145	0.17%
Crossover Option 2	77.8	21.2	323,164	323,310	146	0.16%
Crossover Option 3	76.9	21.8	323,164	323,310	146	0.16%
West Option 3	71.8	18.4	595,292	595,587	295	0.23%
West Option 2	67.7	16.0	563,210	563,513	303	0.25%
West Alternative	66.2	16.0	554,446	554,807	361	0.25%
West Option 1	66.2	16.4	566,590	566,957	368	0.25%

RIPARIAN IMPACT ASSESSMENT

The Riparian Impact Assessment evaluates the potential effects of alternative transmission line routes on loss of riparian function along fish-bearing streams. Any given stream reach might support none, some, or all of four listed salmon and steelhead species.

This assessment used the WaFPB Manual (2011b) method for riparian function. These procedures define riparian function narrowly, focusing on two specific processes: 1) the recruitment of large woody debris, and 2) the provision of stream shade. Riparian function was interpreted from recent aerial photography at each crossing. Using this protocol provides systematic means of characterizing riparian function potentially impacted by different transmission routes in a quantitatively rigorous and transparent manner.

Using these interpretations, two index values were developed to reflect the potential impacts of alternative transmission corridor segments on loss of riparian function along fish-bearing streams. Index values were based on the potential impact of vegetation clearing at transmission line crossings on habitat conditions and how those impacts affect:

1. Near-term riparian function, and
2. Long-term riparian function.

Index values reflect potential impacts to riparian function along the stream reach immediately adjacent to the clearing at each transmission line crossing. The two index values capture a number of important factors when analyzing crossing impacts, including the length of forested riparian vegetation cleared along the fish-bearing stream, site characteristics limiting vegetation development, dominant vegetation types, average tree size classes, stand density classes, channel migration zones, stream width, canopy closure, elevation, and Washington Department of Ecology (WaDOE) stream temperature standards.

Background

Removal of forested vegetation along transmission line right-of-way corridors could reduce streamside shade and large woody debris recruitment. Some loss could be permanent since operations and maintenance would include periodic removal of tree saplings and other vegetation within transmission line right-of-way corridors in forested areas. This could result in long-term reductions in riparian function. Riparian vegetation can moderate stream temperature year-round (Beschta et al. 1987, Murphy and Meehan 1991) and riparian forests are a source of large woody debris which increases channel complexity (Bilby and Bisson 1998. Shade loss from streamside vegetation removal can lead to higher stream water temperature (Li et al. 1994) which can decrease fish survival (Lantz 1971, Beschta et al. 1987). Removal of future wood sources can impact fish growth and survival through simplification of habitat and destabilization of channel beds (Bisson et al. 1987, Grant et al. 1990) as well as a reduction in nutrients (Naiman et al. 1992, Spence et al. 1996).

This assessment focuses on the loss of riparian function from transmission line corridor crossings at fish-bearing streams. The length of stream cleared is at least 150 ft and, because of stream orientation and sinuosity, it is often greater. At these scales, loss of wood recruitment could be enough to significantly alter geomorphic processes (Montgomery et al. 2003) and the loss of stream shade could be enough to warm streams to levels harmful to fish inhabiting the stream reach (Cristea and Janisch 2007). In comparison, riparian clearing would not be required at substations. Clearing of forested vegetation would be required at ten or fewer new access road crossings for any alternative or alternative options; clearing would be limited to 30 ft. Clearing would be required at transmission line corridor crossings at non-fish-bearing streams, but effects from loss of riparian function on instream wood and stream temperature would be attenuated (Caldwell et al. 1991, Reeves et al. 2003). Many would be excluded from WaFPB riparian assessments because their influence on fish-bearing streams is insignificant.

Methods

Data

Locations and lengths of stream crossings were derived from the WaDNR database WCHYDRO from the Forest Practices Application Review System (FPARS). This reference data set, used for forest practices applications, represents fish habitat according to WAC 222-16-030 at a 1:24,000 hydrography scale or finer. Fish-bearing streams can include anadromous and non-anadromous species. A stream crossing includes all connected fish-bearing stream reaches intersected by the transmission line corridor.

Elevations at stream crossings were derived from United States Geological Survey (USGS) 1:24,000 topographic maps available from Environmental Systems Research Institute (ESRI). The stream elevation in the middle of the corridor was used. WaDOE stream temperature standards were derived from the WaDNR database STRMTEMP available from FPARS. This data set is also used in forest practice applications and represents stream temperature classifications designated in WAC 173-201A-030 at a scale of 1:250,000 polygon scale or finer.

Aerial photo interpretations of riparian vegetation were conducted off of i-cubed Nationwide Prime high resolution (1 meter or better) aerial photography imagery available from ESRI. The i-cubed Nationwide Prime imagery is a seamless, color mosaic of various commercial and government imagery sources, including the best available USDA Farm Services Agency National Agriculture Imagery Program imagery and enhanced versions of USGS Digital Ortho Quarter Quad imagery for other areas.

Indices

The Near-term Riparian Function index quantifies the potential for near-term riparian function loss. Index values were determined on a crossing-by-crossing basis using riparian function ratings determined via Table 8. Ratings are based on large woody debris (LWD) recruitment potential and stream shade hazard determined following WaFPB Manual (2011b) protocols. Ratings are converted from categorical to continuous variables to represent the relative loss in riparian function. These scalars are approximate but meaningful relative to one another. Crossings with high function ratings have greater loss than crossings with low ratings. Non-forest crossings are assigned a rating of zero (0). Function ratings are multiplied by the length of forested vegetation cleared at each crossing, then summed over all crossings to yield the index value for an alternative.

Table 8. Crossing-scale riparian function ratings based on LWD recruitment potential and stream shade hazard.

Shade Hazard	LWD Recruitment Potential		
	High	Moderate	Low
Low	High (1)	Moderate (0.67)	Low (0.33)
High	Moderate (0.67)	Low (0.33)	Low (0.33)

The near-term LWD recruitment potential rating is based on the dominant vegetation types, average tree size classes, and stand density classes found within 100 ft of the stream at each crossing. We classified near-term LWD recruitment potential into low, moderate, and high categories using the assessment protocols in the WaFPB Manual (2011b) (Table 9). Determinations were based on aerial photo interpretation at each crossing. Low LWD recruitment potential is associated with hardwood dominated stands and high LWD recruitment potential is associated with mixed or conifer dominated stands (see examples in Figure 5).

Table 9. LWD recruitment potential rating based on species composition, average tree size class, and stand density class (according to WaFPB 2011b).

Average Tree Size Class	Species Composition and Stand Density Classes					
	> 70% Hardwood		Mixed		> 70% Conifer	
	Sparse	Dense	Sparse	Dense	Sparse	Dense
Small <12" DBH	Low	Low	Low	Low	Low	Low
Moderate 12 to 20"	Low	Moderate	Moderate	High	Moderate	High
Large >20" DBH	Low	Moderate	Moderate	High	Moderate	High

The stream shade hazard rating is based on canopy closure, elevation, and WaDOE stream temperature standards. We classified shade hazard into low and high categories using the assessment protocols in the WaFPB Manual (2011b) (Table 10). Canopy closure determinations were based the visibility of the stream surface and stream banks. Determinations were based on aerial photo interpretation at each crossing. Elevations were determined from USGS topographic maps. WaDOE stream temperature standards were determined from FPARS data. High shade hazards are often associated with wider streams or streams with wide, active channel migration zones where adequate canopy cover over the stream is difficult to achieve. They are also associated with low elevation streams where more canopy cover is required to achieve shade targets. Low shade hazards are often found along streams with narrower, confined stream channels and/or high canopy closure (see Figure 6).

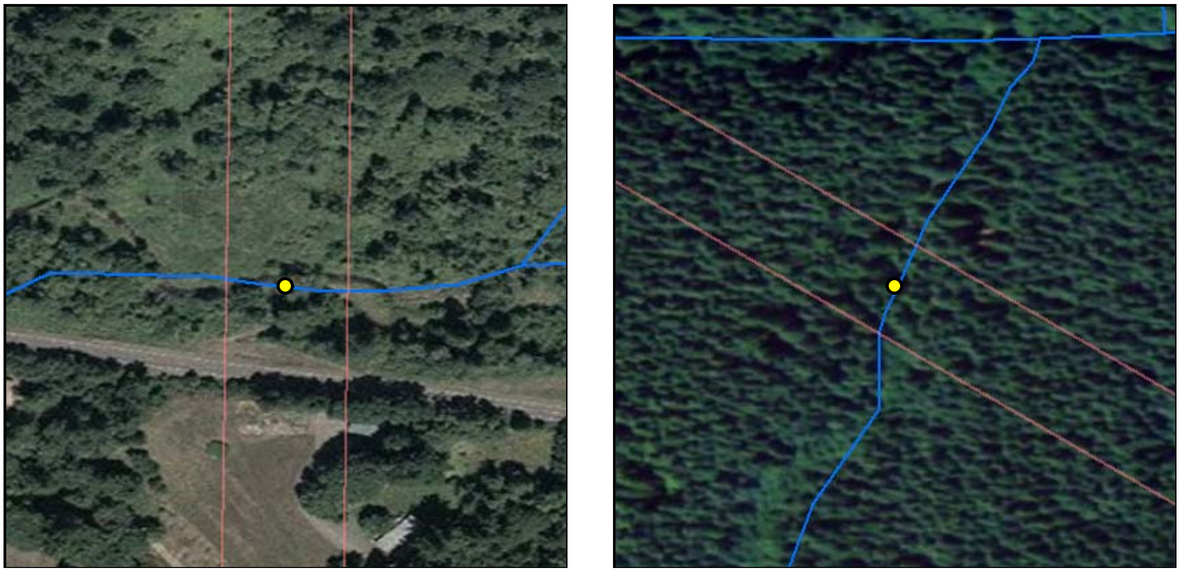

Figure 5. **Example of low LWD recruitment potential at a fish-bearing stream crossing (left, crossing 25-10) and high LWD recruitment potential (right, crossing K-6). Scale 1:4,800.**

Table 10. **Stream shade hazard rating based on canopy closure, elevation, and WaDOE stream temperature standard (according to WaFPB 2011b).**

Elevation (ft)	Canopy Closure				
	> 90%	70-90%	40-70%	20-40%	0-20%
Class AA WaDOE Standard - 16 deg C					
0-320	Low	High	High	High	High
320-680	Low	Low/High	High	High	High
680-1160	Low	Low	High	High	High
1160-1640	Low	Low	Low/High	High	High
1640-1960	Low	Low	Low/High	High	High
1960-2400	Low	Low	Low	High	High
Class A WaDOE Standard - 18 deg C					
0-120	Low	Low/High	High	High	High
120-440	Low	Low	High	High	High
440-680	Low	Low	Low/High	High	High
680-1000	Low	Low	Low/High	High	High
1000-1320	Low	Low	Low	High	High
1320-1640	Low	Low	Low	Low/High	High
1640-1960	Low	Low	Low	Low	High
1960-2320	Low	Low	Low	Low	Low/High
2320+	Low	Low	Low	Low	Low

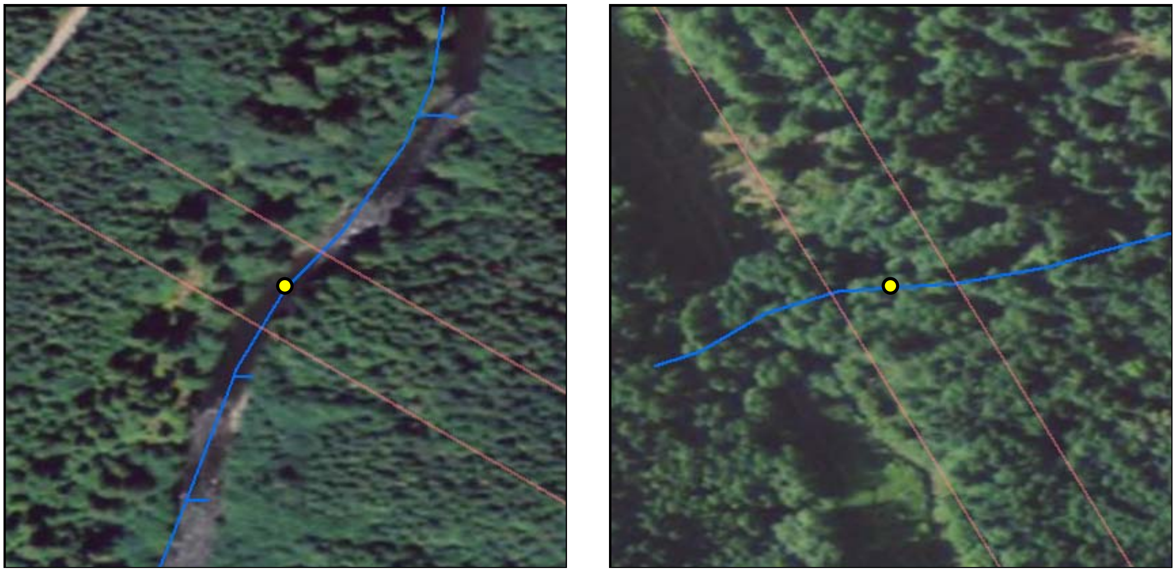

Figure 6. **Example of high stream shade hazard at a fish-bearing stream crossing (left, crossing K-8) and low stream shade hazard (right, crossing 9-25). Scale 1:4,800.**

Figure 7. **Examples of adjacent non-forest land use limiting to LWD recruitment potential and not to stream shade at a fish-bearing stream crossing (left, crossing M-2) and limiting to LWD recruitment potential and stream shade (right, crossing 36B-1). Scale 1:4,800.**

The Long-term Riparian Function index quantifies the potential for long-term riparian function loss. Index values were determined in the same manner as the Near-term Riparian Function index; however, they are based on projections of future riparian function summarized in Table 11. These projections incorporate forest successional pathways in the WaFPB Manual (2011b). Generally, as stands develop, conifer species composition increases through natural succession, as does average tree size and stand density. However, site factors can limit the development of high riparian function. High LWD recruitment potential and low stream shade hazard can be limited by adjacent non-forest land uses (see Figure 7). Low stream hazard can also be limited along wider streams or streams with wide, active channel migration zones. Site limitations to LWD and shade were interpreted based on aerial photo interpretation.

Table 11. Long-term riparian function based on near-term LWD recruitment potential and stream shade and limitations to LWD recruitment potential and/or stream shade.

Near-term LWD Recruitment Potential and Stream Shade Hazard	Long-term LWD Species Composition, Recruitment Potential, and Stream Shade Hazard			
	No Site Limitations	Limitations for LWD	Limitations for Shade	Limitations for Both
Non-forested	Non-forested	Non-forested	Non-forested	Non-forested
Predominantly Hardwood Low LWD Potential High Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard
Predominantly Hardwood Low LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard
Predominantly Hardwood Moderate LWD Potential High Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard
Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard
Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential High Shade Hazard	Predominantly Conifer Moderate LWD Potential High Shade Hazard
Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer Moderate LWD Potential Low Shade Hazard
Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential High Shade Hazard	Predominantly Conifer High LWD Potential High Shade Hazard
Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard
Predominantly Conifer Moderate LWD Potential High Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential High Shade Hazard	Predominantly Conifer Moderate LWD Potential High Shade Hazard
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Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard	Predominantly Conifer High LWD Potential Low Shade Hazard

Results

Appendix B lists 254 fish-bearing stream crossings encountered along all alternative transmission line routes. For each crossing, the following information is provided:

- Location of the intersection of the stream and the transmission route centerline
- Length of stream within the 150 ft wide transmission line corridor
- Length of stream cleared of forested vegetation within the corridor
- Near-term species composition, LWD recruitment potential, and shade hazard
- Near-term riparian function rating according to Table 8
- Limitations to development of long-term riparian function
- Long-term species composition, LWD recruitment potential, and shade hazard
- Long-term riparian function rating according to Table 8

Table 12 summarizes the Near-term Riparian Function index for each alternative and alternative option. The table also summarizes the total number of fish-bearing streams encountered along each alternative or alternative option, the number of non-forested stream crossings, length of stream cleared of forested vegetation, average crossing-scale riparian function rating, the near-term index value, and the ratio of the index value to the total length of stream cleared. Alternatives and options are sorted from the lowest to greatest index value, which corresponds to least riparian function loss to most.

Table 12. Near-term Riparian Function index for action alternatives and options. Values are sorted by increasing index score, from least riparian function loss to most.

Alternative	Total Number of Crossings	Total Non-forested Crossings	Total Length of Stream Cleared (ft)	Average Near-term Riparian Function Rating	Near-term Riparian Function Index	Ratio of Index to Stream Length Cleared
West Option 2	75	29	12,169	0.31	5,592	46%
West Option 1	73	27	13,029	0.32	5,926	45%
West Alternative	71	24	13,415	0.34	6,054	45%
West Option 3	79	28	12,910	0.33	6,153	48%
East Option 1	54	8	10,007	0.60	7,483	75%
Crossover Alternative	76	21	13,343	0.51	9,291	70%
East Option 3	63	7	11,061	0.72	9,340	84%
East Alternative	59	7	11,076	0.71	9,344	84%
Crossover Option 2	80	24	13,627	0.49	9,385	69%
Crossover Option 3	80	22	14,198	0.50	9,588	68%
Crossover Option 1	79	21	15,418	0.51	10,027	65%
East Option 2	66	7	12,326	0.72	10,312	84%
Central Option 2	69	6	14,048	0.69	10,550	75%
Central Option 3	66	6	13,482	0.76	11,141	83%
Central Alternative	74	6	14,841	0.73	12,006	81%
Central Option 1	76	6	15,430	0.73	12,373	80%

Near-term Riparian Function index values are substantially different at the extremes and exhibit a more or less uniform rate of decrease from the highest to lowest score. Despite these differences, clearing of forested vegetation is measurable along all alternatives and options. When scaled by the riparian function rating, it is approximately equal to the loss of 1 to 2.5 miles of highly functioning riparian vegetation; this is a high fraction of the forested stream length cleared. This level of loss could have measurable impact on fish populations. Values were lowest for the West Alternative and options and greatest for the Central Alternative and options. The East and Crossover Alternative and options were in the middle of the overall ranking.

Table 13 summarizes the Long-term Riparian Function index for each alternative and alternative option. The table also summarizes the total number of fish-bearing streams encountered along each alternative or alternative option, the number of non-forested stream crossings, length of stream cleared of forested vegetation, average crossing-scale riparian function rating, the long-term index value, and the ratio of the index value to the total length of stream cleared. Alternatives and options are sorted from the lowest to greatest index value which corresponds to least riparian function loss to the most.

Table 13. Long-term Riparian Function index for action alternatives and options. Values are sorted by increasing index score, from least riparian function loss to most.

Alternative	Total Number of Crossings	Total Non-forested Crossings	Total Length of Stream Cleared (ft)	Average Long-term Riparian Function Rating	Long-term Riparian Function Index	Ratio of Index to Stream Length Cleared
East Option 1	54	8	10,007	0.71	8,559	86%
West Option 2	75	29	12,169	0.46	9,024	74%
West Option 1	73	27	13,029	0.47	9,112	70%
West Alternative	71	24	13,415	0.49	9,239	69%
West Option 3	79	28	12,910	0.50	9,750	76%
East Alternative	59	7	11,076	0.80	10,252	93%
East Option 3	63	7	11,061	0.82	10,287	93%
Crossover Alternative	76	21	13,343	0.60	11,319	85%
Crossover Option 2	80	24	13,627	0.58	11,413	84%
East Option 2	66	7	12,326	0.82	11,546	94%
Crossover Option 3	80	22	14,198	0.61	12,174	86%
Crossover Option 1	79	21	15,418	0.60	12,200	79%
Central Option 3	66	6	13,482	0.84	12,363	92%
Central Option 2	69	6	14,048	0.82	12,575	90%
Central Alternative	74	6	14,841	0.87	14,207	96%
Central Option 1	76	6	15,430	0.87	14,797	96%

Long-term Riparian Function index values are substantially different at the extremes and exhibit a more or less uniform rate of decrease from the highest to lowest score. When scaled by the riparian function rating, it is approximately equal to the loss of 1.5 to 3 miles of highly-functioning riparian vegetation; this is a high fraction of the forested stream length cleared. This level of loss could have measurable impact on fish populations. The rankings according to the long-term index nearly match those using the near-term index. The most notable exception is that the East Alternative Option 1 would have the lowest riparian function loss. Otherwise, the West Alternative and options would have the lowest riparian function loss compared to the others.

Discussion

By using consistent assessment procedures informed by consistent data sources and conducted by one individual, results are comparable among alternatives and options. This assessment was a desktop exercise and more accurate determinations can be made through field investigation. Specifically, better information could be obtained about the location of streams within transmission line corridors, location of riparian assessment areas, stand development potential, site limitations to LWD recruitment potential and stream shade hazard, and stream shade provided by the existing canopy. Any of these could improve determination of riparian function, but this uncertainty affected all alternatives and options more or less equally. Therefore, the relative ranking of alternatives and alternative options is reliable for planning purposes.

While they appear similar, the near-term and long-term indices reflect different impacts. The near-term index reflects impacts to current riparian conditions—conditions that have been degraded by past forest management practices and continue to be limited by non-forest land uses that encroach on the riparian assessment areas. In comparison, the long-term index reflects impacts to potential riparian conditions—conditions that could result through natural succession with no further degradation due to non-forest land uses. While there are very similar outcomes from the two indices, reasons for the two outcomes differ.

The strongest predictor of near-term riparian function loss is the average near-term riparian function rating. As the average riparian function increases, so does the overall loss of riparian function that would occur with transmission line corridor. In the near-term, quality matters more than quantity. In comparison, the strongest predictor of long-term riparian function loss is the total length of stream cleared. As the length of stream cleared increases, so does the overall loss of riparian function. The spread between the high and low average riparian function decreases; and so does its importance. In the long-term, quantity matters more than quality.

The greatest increase in riparian function, near-term to long-term, would occur along the West Alternative and options. Despite higher numbers of non-forested stream crossings and greater limitations to LWD and shade development, these crossings currently have the lowest near-term riparian function. Adjoining non-forest land use pressures have played a large role in degrading riparian function. Thus, they have the greatest room for improvement. In comparison, riparian function for the other alternatives and alternative options are nearer to peak levels. The room for improvement along the other routes is limited.

This has little effect on the overall ranking. The lowest average riparian function ratings occur along the West Alternative and options, which would have some of the lowest levels of stream cleared. Many stream crossings are located within existing transmission line corridors and many others are located in agricultural or developed settings. Where there are forested crossings, hardwood species composition is greater. Non-forested land uses and wider streams and lower stream elevations limit riparian function and effectiveness. These factors lead to lower riparian function. When multiplied by lower length of stream cleared, index values are lower.

In comparison, the other alternatives and options have higher average riparian function ratings and most would have a greater length of stream cleared. They tend to have greater conifer species composition, fewer limitations from non-forested land uses, and narrower streams and higher elevations. These factors lead to higher LWD recruitment potential and lower stream shade hazards that translate to higher riparian function which, when multiplied by greater length of stream cleared, leads to higher index values. The one notable exception is East Alternative Option 1. This option would have the least length of stream cleared among all alternatives and options. Because of this, riparian function loss ranks relatively low to lowest.

Overall, the project would clear forested vegetation along approximately 2 to 3 miles of fish-bearing streams. Permanent changes to riparian function at project crossings could occur through the loss of large woody debris recruitment potential and stream shade. At the crossing scale, a range of large woody debris recruitment potential and stream shade would be lost along any project alternative. However, this loss of riparian function could be buffered by riparian function provided at the watershed scale.

FLOODPLAIN IMPACT ASSESSMENT

The Floodplain Impact Assessment evaluates the potential effects of alternative transmission line routes on loss of floodplain function along fish-bearing streams. Any given stream reach might support none, some, or all of four listed salmon and steelhead species.

This assessment used an interpretation of floodplain areas using Federal Emergency Management Agency (FEMA) 100-yr floodplain mapping, Light Detection and Ranging (LiDAR) imaging, and aerial photography. The protocols employed provide a systematic means of characterizing floodplain function potentially impacted by different transmission routes in a quantitatively rigorous and transparent manner.

Using these interpretations, a single index value was developed to reflect the potential loss of floodplain functions due to impacts from alternative transmission corridor segments, towers, and access roads. The following three types of impacts were evaluated and incorporated into the index:

1. reduction in forest vegetation within floodplains;
2. number and footprint area of new towers within the floodplain; and,
3. area of new or reconstructed roads within the floodplain.

Index values reflect the potential effect of transmission line routes on key indicators of floodplain function.

Background

Floodplains provide numerous important functions related to stream habitat and ecosystem health. Floodplains help to absorb stream energy during floods, provide for nutrient exchange, and provide habitat for aquatic and terrestrial species (Bolton and Shellberg 2001). Floodplains are also closely related to channel migration zones (CMZs) and frequently occupy a similar area on the landscape. Although CMZs were not delineated separately for this analysis, the assessment of floodplain impacts is assumed to also generally address impacts to CMZs. CMZs are important for stream geomorphic function and long-term formation of aquatic and floodplain habitats. As streams migrate and adjust within the CMZ, off-channel habitats are formed, new mainstem habitats are created, and gravel and large woody debris are recruited to the stream channel (Bolton and Shellberg 2001).

Methods

This assessment calculated floodplain acreage and forest cover that would be affected by transmission line route alternatives. It also quantified the number and acreage of new towers and the length and acreage of new or reconstructed roads within the floodplain. Values were calculated first at the stream crossing scale and were then aggregated up to the alternative scale.

Qualifying Floodplains

All fish-bearing stream crossings were considered for use in this analysis. To qualify as a floodplain for this analysis, floodplain areas must extend greater than 100 lineal feet from the stream edge (see below for determination of floodplain areas). Impacts associated with fish-bearing stream crossings with floodplains less than 100 ft wide are addressed in the Riparian

Impact Assessment (see above). To avoid duplication with the Riparian Function index, this analysis evaluates only those portions of the floodplain extending beyond 100 feet from the stream edge.

Determining Floodplain Area

For each qualifying stream crossing, the floodplain area within the transmission line corridor was delineated in a Geographic Information System (GIS) using LiDAR and aerial photo interpretation. Indicators used to identify floodplain areas included flood overflow channels, signatures of historical channel locations, and floodplain elevations in relation to the stream elevation. FEMA 100-year floodplains were used to help delineate the floodplain in areas where these data were available. Once the entire floodplain area polygon was delineated for a crossing, the portion of the floodplain within 100 ft of the stream edge was removed from the area to avoid duplication with the riparian assessment. See Figure 8 for an example of the floodplain delineation.

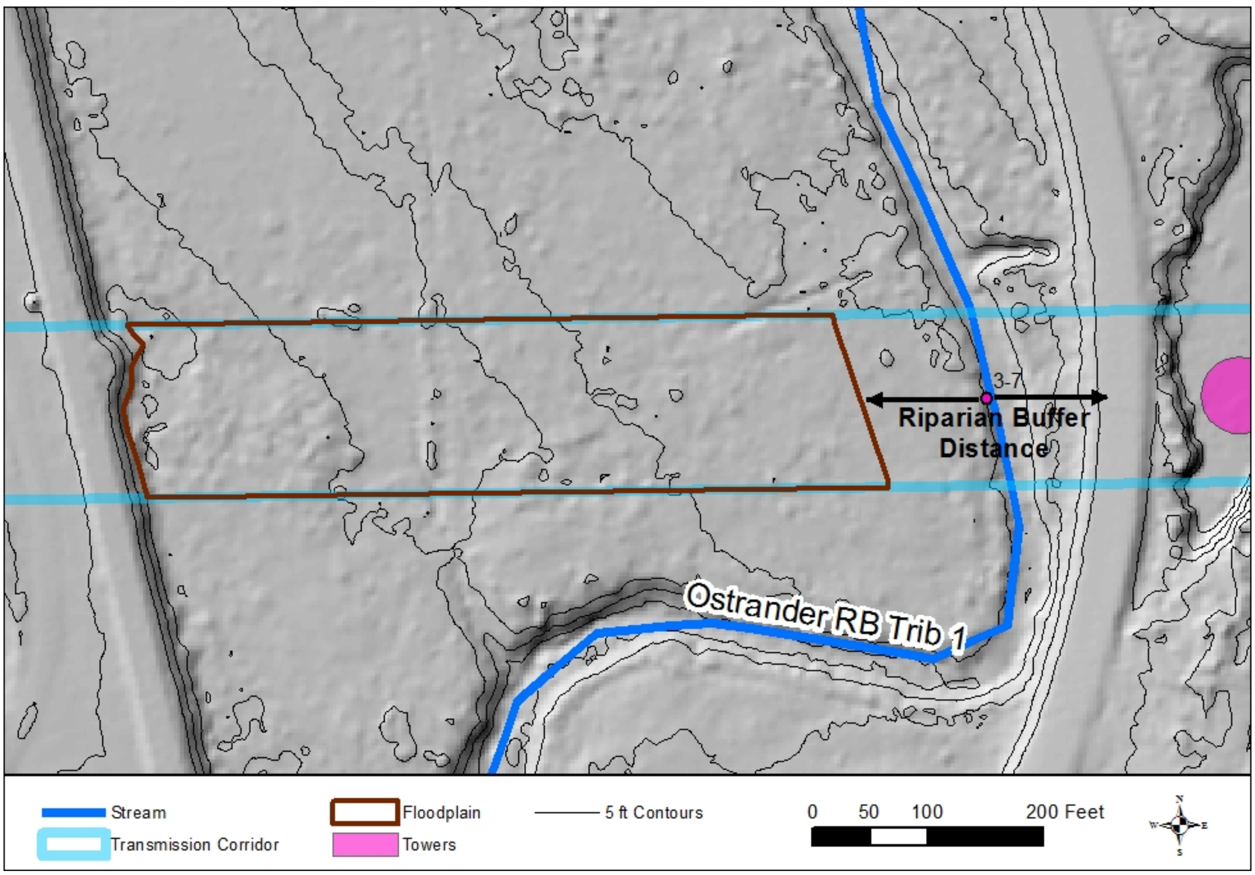

Figure 8. Example of floodplain delineation within a transmission line corridor using LiDAR digital elevation data.

Quantifying Impacts to Floodplain Vegetation

The amount of forest vegetation that would be cleared within transmission line corridors as a result of project impacts was calculated within floodplain areas at each crossing. This was calculated as the acreage of canopy cover for trees above approximately 3 feet in height. This was performed using aerial photo interpretation. See Figure 9 for an example of the delineation of forested floodplain vegetation.

Calculating Floodplain Tower Area

The number and area of new, additional transmission line towers within delineated floodplains was tabulated. Existing towers to be removed or replaced was accounted for so that the number and area of towers represents the net addition of new towers. Tower area is intended to approximate the permanent footprint of the tower. To be consistent with analyses in other DEIS sections, this was calculated as a 66-foot diameter circle.

Calculating Floodplain Road Area

The length and area of new or reconstructed roadways within floodplains was calculated for each delineated floodplain area at each crossing. To be consistent with analyses in other DEIS sections, road area was calculated assuming a 30-foot width for new roads and a 20-foot width for reconstructed roads, These road lengths and areas represent only the portion of roads located within transmission corridors, and do not capture roads in floodplains outside corridors. For this reason, a second calculation was performed, which is the total length of new or reconstructed roads within the FEMA-designated 100-year floodplain, whether they are within or outside of transmission corridor right-of-ways.

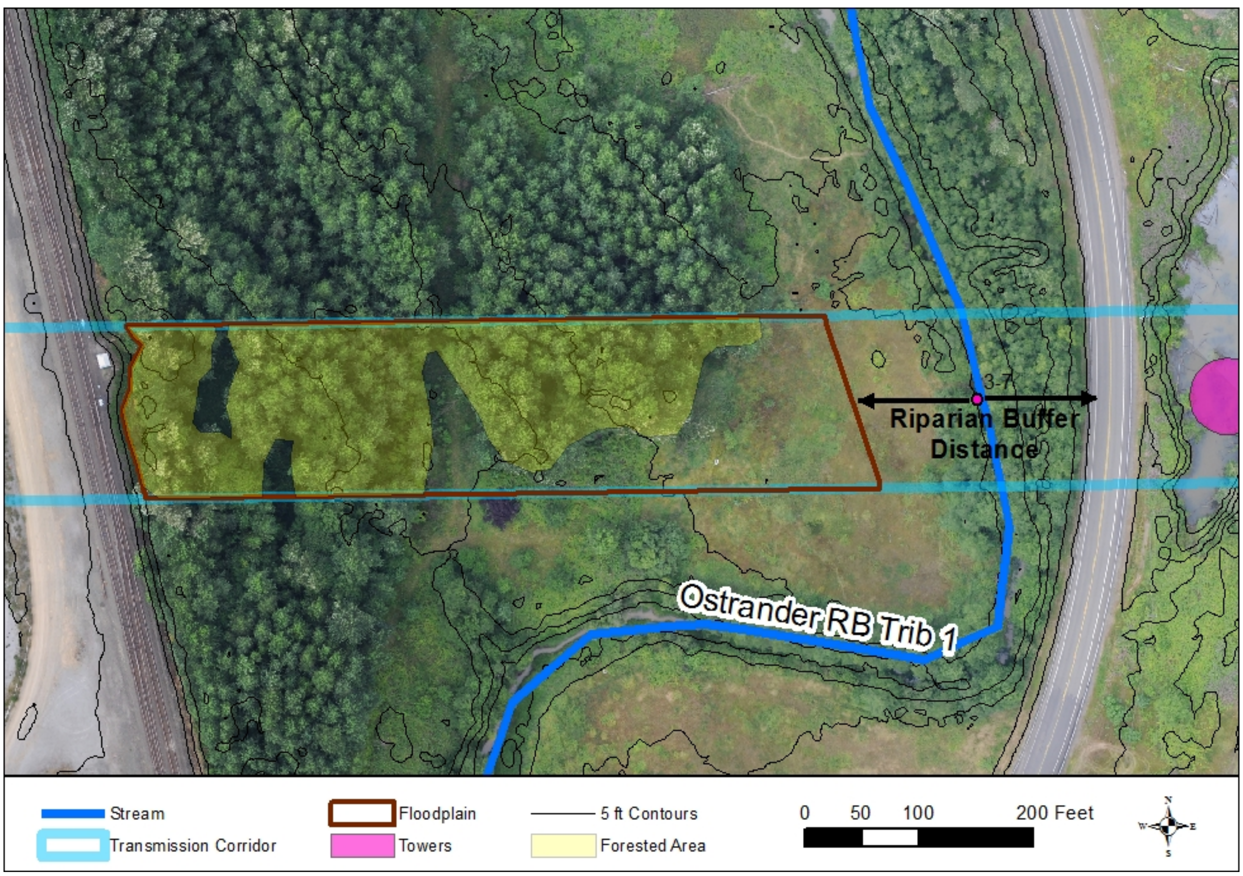

Figure 9. Example of the delineation of forested floodplain vegetation that would be cleared within a transmission line corridor.

Calculating the Total Floodplain Impact Area Index

A composite index of floodplain impact was calculated by summing the area of impact to floodplains due to forest vegetation clearing, tower construction, and road construction within the transmission line corridor. This value was calculated at each transmission line crossing by summing the area values for: 1) impacts to floodplain vegetation, 2) floodplain roads (within corridors), and 3) towers within floodplains.

Results

Out of a total of 254 fish-bearing crossings, 60 crossings had qualifying floodplains that were used in this assessment (see Appendix C for a listing). A summary of the total number of crossing per alternative and alternative option, along with the number of qualifying floodplain crossings used in this assessment, is presented in Table 14. The West Alternative and options would have the greatest number of floodplain crossings, followed by the Crossover Alternative and options.

The results of the Floodplain Impact Assessment for all alternatives are presented in Table 15. The Total Floodplain Impact Area index values are the sum of acreages for vegetation clearing, new towers, and new or reconstructed roadways within the portion of the floodplain crossed by the transmission line corridor. The West Alternative and options would have the greatest total impact area as well as the greatest values for all impact categories. The East Alternative and options would generally have the second-greatest impact values. The East and Central alternatives and options would have the least amount of total impact area but would fall within the middle of the range with respect to impacts to vegetation. The Crossover Alternative and options would generally have the least impact to vegetation. Road and tower impacts would be similar among the East, Central, and Crossover alternatives and options.

Table 14. Summary of total crossings (fish-bearing) and number of qualifying floodplain crossings by alternative. Values are sorted by number of qualifying floodplain crossings; the alternatives and options with the greatest numbers of floodplain crossings are listed at the bottom.

Alternative	Total Number of Crossings	Number of Qualifying Floodplain Crossings
Central Option 2	77	14
East Option 1	64	14
Central Option 3	72	14
East Option 3	69	14
East Option 2	72	14
Central Alternative	81	15
Central Option 1	85	15
East Alternative	65	16
Crossover Alternative	87	19
Crossover Option 1	90	19
Crossover Option 2	91	21
Crossover Option 3	91	21

Alternative	Total Number of Crossings	Number of Qualifying Floodplain Crossings
West Option 2	80	22
West Alternative	76	22
West Option 3	85	24
West Option 1	78	25

Table 15. Total Floodplain Impact Area index for action alternatives and options. Values are sorted by increasing impact area.

Alternative	Total Floodplain Area (acres)[1]	Impacts to Floodplain Vegetation (acres)[2]	Number of New Additional Towers[3]	New or Reconstructed Roads in Corridor (lineal ft)[4]	New or Reconstructed Roads in FEMA 100-yr Floodplain (lineal ft)[5]	Total Floodplain Impact Area (acres)[6]
Central Option 2	26.7	6.3	5	2,671	4,434	7.7
Crossover Alternative	40.8	7.3	8	2,932	8,835	9.0
East Option 1	32.5	7.9	7	2,675	4,598	9.1
Central Alternative	28.0	8.1	4	2,138	5,159	9.2
Central Option 1	28.0	8.1	4	2,138	5,159	9.2
Crossover Option 2	41.5	7.7	8	2,932	8,835	9.4
Crossover Option 3	41.6	7.8	8	2,932	8,835	9.5
Central Option 3	30.6	7.9	4	3,087	6,317	9.5
East Option 3	28.7	9.1	5	2,455	5,159	10.2
East Option 2	29.0	9.3	5	2,455	5,159	10.4
Crossover Option 1	50.3	8.5	13	3,417	8,745	10.7
East Alternative	29.6	9.8	6	2,455	5,159	10.9
West Option 2	73.2	11.4	18	5,911	27,605	15.3
West Option 3	73.6	11.7	19	5,911	27,883	15.6
West Alternative	88.2	12.6	23	7,657	31,702	18.0
West Option 1	113.8	15.9	27	8,578	42,128	21.9

[1]*Total floodplain area (beyond the 100-ft riparian buffer) crossed by the transmission corridor at qualifying stream crossings.*

[2]*Existing forest canopy cover within the floodplain area that is greater than approximately 3 feet in height.*

[3]*Represents net additional towers within the floodplain area. Towers that are replaced or relocated are not included.*

[4]*Represents length of new or reconstructed roads within the floodplain area.*

[5]*Represents length of new or reconstructed roads within FEMA-designated 100-yr floodplains. Includes roads within and outside transmission corridors.*

[6]*Sum of potential floodplain impacts within the transmission line corridor based on acreage of vegetation clearing, towers, and roads. Assumes 30 ft width for new roads, 20 ft width for reconstructed roads, and a 66-ft diameter circle for towers. Overlapping impact areas were accounted for in the summed values.*

Discussion

The results of the Floodplain Impact Assessment reflect the pattern of floodplain topography and existing land-use conditions across the study area. The West Alternative and options have the highest total impact areas (see Table 15) due to a larger number of floodplain crossings (see Table 14) and route segments that cross broad floodplain areas within the lower portions of large river systems, including the Lewis, East Fork Lewis, Salmon Creek, and Coweeman River. There would also be a significant amount of floodplain area crossed by the West Alternative and options in the Lacamas Creek valley upstream of Lacamas Lake. As a consequence, the West Alternative and options have the potential for the greatest amount of total floodplain area crossed, the greatest amount of vegetation clearing, the largest number of towers, and the most road construction (see Table 15). In contrast, the East, Central, and Crossover alternatives and options cross smaller streams with smaller floodplain areas, and thus have lower total impact values.

The degree of existing floodplain impairment is an important consideration when interpreting these results. Although the West Alternative and options have the highest total impact area values, these routes cross floodplains that are already greatly affected by existing agricultural and residential uses. These land uses have resulted in widespread clearing, road construction, ditching, filling, and grading within floodplain areas. For instance, although the total amount of floodplain clearing associated with the West Alternative and options ranges from 11 to 16 acres, up to 84-86% of these floodplain areas are already cleared, which suggests considerable existing impairment to floodplain processes. An even greater portion of these floodplains are further impacted by existing ditching and filling. The East, Central, and Crossover alternatives and options affect less floodplain area, and although these floodplains are generally less impaired, existing levels of clearing nevertheless range up to 67-83%.

Overall, due to the total extent of potential floodplain impacts, and given the degree of existing floodplain impairment, the potential for significant impairment of floodplain functions, including reach-scale flood inundation processes and channel migration rates, is expected to be low for all transmission line alternatives and options. This assessment should be viewed as an evaluation of the relative potential impact to floodplain function indicators. The total impact area values do not specifically quantify floodplain functions themselves. Further investigation of specific impacts and implications to stream geomorphic function and aquatic habitat will require field investigation and additional analysis of site-specific conditions.

Fish Impact Assessment

This assessment uses production value of listed salmon and steelhead in streams as an index of the relative potential or risk of impact of alternative corridor routes on fish resources. While a variety of fish species occur in the region, listed salmon and steelhead are of particular concern and will be the focus of biological assessments required by their listing status. Fish production value is defined for the purposes of this analysis as a number of fish or percentage of the fish population. Any given stream might support none, some, or all of four listed salmon and steelhead species. Different stream reaches may also be more or less productive for any given species depending on prevalent habitat conditions and their suitability for different stages of a species' life cycle (a reach is a stream segment defined by similar physical characteristics).

Fish impact potential is related to: 1) the fish production value in the stream reach affected by the project and 2) the extent to which reductions in fish production may be realized as a result of direct and indirect project-related impacts on fish habitat or fish habitat forming processes. Generally-speaking, routes with more stream crossings of high-value fish streams will have a greater potential for impact and higher fish production potential than routes with fewer crossings of low-value fish streams. Similarly, routes with greater hydrological, floodplain, riparian, or sediment disturbance are more likely to result in substantial degradation of the fish production potential. Four indices related to fish impact potential were calculated:

1. Net fish production potential,
2. Population potential,
3. Population potential for priority populations identified for salmon recovery, and
4. Fish impact related to project effects on fish habitat.

The first three indices (production potential, population potential, ESU potential) describe the potential for fish impacts of each route alternative. Fish potential is expressed in terms of fish numbers (adult salmon), percentage of the population, and percentage of populations identified as a priority for salmon protection and restoration in Salmon Recovery Plans adopted by the State of Washington and the National Marine Fisheries Service. Fish numbers are estimated within the footprint of the right-of-way at each stream crossing for each of the four listed salmon species. Stream crossings are a convenient way to represent all project activities that might directly or indirectly affect fish habitat.

The fourth index (integrated impacts) describes the amount of fish potential that might be expected to be affected by fish habitat changes associated with the project. Where fish potential indices identify the numbers of fish available within the project area, the impact identifies how much of that potential might be lost due to project effects. The fourth (integrated impacts) index is intended to represent the net effects of transmission line construction and maintenance on watershed, riparian, and floodplain processes and functions that directly and indirectly affect fish habitat. This assessment integrates findings of the hydrology, sediment, riparian, and floodplain impact analyses in order to rate the loss of fish productivity associated with potential habitat impacts.

Methods

Data

Analyses were based on salmon and steelhead data from the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2010b) which was adopted by the National Marine Fisheries Society as the Recovery Plan for this region. Distribution and abundance of listed salmonid species in southwest Washington streams was quantified on a reach-by-reach basis by the Washington Lower Columbia Fish Recovery Board and WDFW. These data were the basis for analyses of limiting factors, protection and restoration values, and recovery priorities established in the Salmon Recovery Plan. These data provide a systematic means of weighing the relative potential impact of different transmission routes in a quantitatively rigorous and transparent manner. Using the same data as the Recovery Plan has the added benefit of providing a clear description of potential take in ESA consultations for the transmission line project.

The LCFRB fish database describes fish numbers and the population contribution of each anadromous fish producing stream reach in southwest Washington (Table 16). Data were developed for all streams using the Ecosystem Diagnosis and Treatment (EDT) model. EDT is a mechanistic model that is based on the relationships between aquatic habitat characteristics and fish performance. The model estimates fish numbers from fish habitat quantity and quality (e.g. pools, hydrology, riparian conditions, sediment, water quality, and woody debris). Model inputs include descriptions of the physical stream environment, at a reach level, which are then related through a set of rules to life-stage specific survival. These survival characteristics are then integrated across the entire life history of the population. Results include estimates of population productivity, capacity, equilibrium abundance, and diversity. EDT is typically used to model conditions for the current (patient) and historical (template) scenarios.

Locations of crossings for each alternative transmission line segment were obtained from the stream crossings compiled as part of the Riparian Impact Assessment. Stream crossings were derived from the WaDNR database WCHYDRO from the Forest Practices Application Review System. This reference data set, used for all forest practices applications, represents fish-bearing streams at a 1:25,000 hydrography scale or finer as identified based on field surveys. Several data sets to were initially reviewed to identify fish-bearing streams: WaDNR's water typing, WDFW fish distribution data, EDT (which was used in salmon recovery planning), and critical habitat data sets from the National Oceanic and Atmospheric Administration and United Stated Fish and Wildlife Service. Under current stream typing rules utilized by the WaDNR, “F” streams contain the extents of all other the other data sources and therefore were utilized as the basis for determining fish-bearing streams crossed by the proposed project alternatives and options.

Fish bearing streams can include anadromous and non-anadromous species. Many crossings of small, high-gradient streams might contain only resident species such as cutthroat trout. As a result, a number of crossings could occur on fish-bearing streams that were not represented in EDT analysis of current anadromous species distribution. However, due to the widespread distribution of listed salmon and steelhead species, it was assumed for the purposes of this analysis that salmon and steelhead distribution is provides a representative index of relative project effects on fish species in general.[1]

Table 16. Example of reach and species-specific fish production data available for southwest Washington streams in the LCFRB salmon recovery database.

Subbasin	Reach	Length (meters)	Recovery Tier[1]	Fish /100 m	Production Rating[2]	Population Proportion[3]	Signifi-cance[4]	Potential (%)[5]
Coweeman	Baird Cr 1 A	1921	1	0.4	VL	0.002	VL	0.86
Coweeman	Baird Cr 1 B	2741	2	0.0	VL	0.000	VL	3.69
Coweeman	Baird Cr 2	1448	2	0.0	VL	0.000	VL	0.00

[1]Recovery tier = salmon recovery priorities based on multi-species production values (ranked in tiers 1-4).
[2]Production rating is a ranking of the production value relative to nominal values for the species (high, medium, low, very low).
[3]Population portion is the reach contribution to the entire subbasin's production of a species.
[4]Significance is a ranking of the importance of the reach to the local population based on population proportion.
[5]Potential is the percentage of current production relative to the historical production value.

Calculating the Fish Production Potential Index (F)

The Fish Production Potential index quantifies the potential impact of habitat degradation based on the estimated number of adult salmon produced in the area affected by transmission line crossings. This index value is calculated:

$$F_{sgc} = A_{spr} (T_{gc} / L_r)$$

where

F_{sgc} = Fish number (average number of adults) produced for species 's' for transmission line segment 'g' and crossing 'c'.

A_{spr} = Adults (average number) of species 's' and population 'p' produced in stream reach 'r'.

T_{gc} = Length of stream affected by line segment 'g' and crossing 'c'.

L_r = Length of reach 'r' (ft).

Length of affected stream was estimated based on the angle of line intersection with the stream and a transmission line corridor buffer width of approximately 150 ft.[2] Fish number per reach and reach length were obtained from the salmon recovery plan database as estimated from fish habitat using the EDT model. Based on the EDT fish values used in this application, the Fish Production Potential index can be defined as the average number of fish that would be affected if the crossing reduced habitat conditions at the crossing site by 100% of the current potential.

Fish Production Potential index values were calculated for each listed salmon species and race (coho, chum, fall Chinook, spring Chinook, winter steelhead). Each species consists of multiple

[1] *Other fish species such as cutthroat trout may occur in smaller streams that are not utilized by salmon and steelhead but in general greater project impacts on salmon and steelhead may be assumed to be positively correlated to greater impacts on other fish species such as cutthroat trout.*

[2] *BPA provided a polygon GIS database of transmission line clearing. This database was laid over stream centerlines to determine the length of stream potentially affected. Crossings could be perpendicular, but many were oblique. Affected length values used in this exercise include areas of additional riparian clearing but not areas that were previously cleared for other purposes.*

populations which might occur in one or more stream subbasins within the project area. Values were summed across species for a net index value for each crossing and across segments for a net value for each segment (Table 17). Similarly, values were summed for all segments in each route alternative or option.

Table 17. Example calculation of the Fish Production Potential index for two transmission line segments (units are adults per affected stream length).

				Chinook		Steelhead		
Segment	**Crossing**	**Coho**	**Chum**	**Spring**	**Fall**	**Summer**	**Winter**	**Net**
A	1	6.2	0.0	0.0	20.4	0.0	0.8	27.4
	2	1.6	0.0	0.0	5.5	0.0	3.5	10.6
	3	0.4	0.0	0.0	3.5	0.0	1.9	5.7
	Total	8.2	0.0	0.0	29.4	0.0	6.2	43.7
B	1	10.2	0.0	0.0	3.1	0.0	0.4	13.7
	2	2.8	0.0	0.0	0.8	0.0	1.7	5.3
	3	1.7	0.0	0.0	0.2	0.0	0.9	2.9
	Total	14.7	0.0	0.0	4.1	0.0	3.1	21.9

Calculating the Fish Population Potential Index (P)

The Fish Population Potential index quantifies the potential for impact of habitat degradation based on the estimated proportion of the local fish population produced in the area affected by transmission line crossings. This index is calculated in the same manner as the Fish Production Potential index, except that the fish production values are expressed in terms of the relative percentage of the population total, as opposed to numbers of fish:

$$P_{sgc} = (F_{sgc} / A_{sp.})\ 100$$

where

- P_{sgc} = Percentage of fish population produced for species 's' for transmission line segment 'g' and crossing 'c'.
- F_{sgc} = Fish number (average number of adults) produced for species 's' for transmission line segment 'g' and crossing 'c'.
- $A_{sp.}$ = Total adults (average number) of species 's' and population 'p' for all stream reaches combined.

Fish numbers per population were obtained from the salmon recovery plan database as estimated from fish habitat using the EDT model. Based on the EDT fish values used in this application, the Fish Population Potential index can be defined as the proportion of the population that would be affected if a crossing reduced habitat conditions at the crossing site by 100% of the current potential. This index can be thought of as a normalized value across populations so that comparisons can be made irrespective of population size.

Fish Population Potential index values are generated for each listed salmon species and race (coho, chum, fall Chinook, spring Chinook, winter steelhead). Each species consists of multiple populations which might occur in one or more stream subbasins within the project area. Values were summed within each population for each crossing or route (Table 18). Population totals were averaged to provide a net index value for each crossing or route. The index thus represents the average percentage of the six potential listed fish populations affected.

Table 18. Example calculation of the Fish Population Potential index for two transmission line segments (units are percentage of population in affected stream length).

				Chinook		Steelhead		Index
Segment	**Crossing**	**Coho**	**Chum**	**Spring**	**Fall**	**Summer**	**Winter**	**(avg.)**
A	1	2.07	0.00	0.00	4.08	0.00	0.40	1.09
	2	0.53	0.00	0.00	1.10	0.00	1.75	0.56
	3	0.13	0.00	0.00	0.70	0.00	0.95	0.30
	Total	2.73	0.00	0.00	5.88	0.00	3.10	1.95
B	1	3.40	0.00	0.00	0.62	0.00	0.20	0.70
	2	0.93	0.00	0.00	0.16	0.00	0.85	0.32
	3	0.57	0.00	0.00	0.04	0.00	0.45	0.18
	Total	4.90	0.00	0.00	0.82	0.00	1.50	1.20

<u>Calculating the Fish ESU Potential Index (E)</u>

The Fish Evolutionarily Significant Unit (ESU) Potential index uses the Fish Population Potential index and "weights" it based on the importance of the populations present (at a crossing) to the regional ESA recovery strategy:

$$E_{sgc} = P_{sgc}\, W_p$$

where

E_{sgc} = Percentage of fish population produced for species 's' for transmission line segment 'g' and crossing 'c', weighted by population significance to salmon recovery.

P_{sgc} = Percentage of fish population produced for species 's' for transmission line segment 'g' and crossing 'c'.

W_p = Population weight based on recovery plan priority (1.0 for primary populations, 0.5 for contributing populations, 0.0 for stabilizing populations).

The Salmon and Steelhead Recovery Plan recognizes that not every salmon population can be restored to high levels and targets different populations for different levels of improvement (see Table 19 for recovery objectives in the affected project area). Populations are categorized in decreasing level of significance as primary, contributing, or stabilizing (LCFRB 2010b):

Primary populations are targeted for restoration to high or very high viability. These populations are the foundation of salmon recovery. Primary populations are typically the strongest extant populations and/or those with the best prospects for protection or restoration.

Contributing populations are those for which some improvement will be needed to achieve a stratum-wide average of medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.

Stabilizing populations are those that would be maintained at baseline levels. These are typically populations at very low viability during the listing baseline. Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high.

The Fish ESU Potential index reflects both the relative significance of the affected stream area to the population and the relative importance of the population to the listed species. As such, the index is the most effective of the three fish indices for describing the relative significance of project effects to ESA-listed salmon and steelhead. The production and population indices provide supporting detail for the components of the ESU-scale index.

Table 19. Recovery objectives for lower Columbia salmon and steelhead populations affected by the action alternatives and options (LCFRB 2010b). Viability levels: Primary (P), Contributing (C), and Stabilizing (S).

	Chinook			Chum		Steelhead		Coho
	Fall	Late Fall	Spr.	Fall	Sum.	Win.	Sum.	
Lower Cowlitz	C	--	--	C	C	C	--	P
Coweeman	P	--	--			P	--	P
Kalama	C	--	C	C	--	P	P	C
NF Lewis	P	P	P	P	--	C	S	C
EF Lewis		--	--		--	P	P	P
Salmon	S	--	--	S	--	S	--	S
Washougal	P	--	--	P	--	C	P	C

<u>Calculating the Integrated Fish Impact Index (I)</u>

The Integrated Fish Impact index is a product of the Fish ESU Potential index and the estimated reduction in stream habitat conditions for fish associated with project-related activities:

$$I_{sgc} = E_{sgc} \left(C_{gc} R_{gc}\right)$$

where

I_{sgc} = Proportional reduction in fish population associated with riparian habitat function alterations for species 's' for transmission line segment 'g' and crossing 'c', weighted by population significance to salmon recovery.

E_{sgc} = Proportion of fish population produced for species 's' for transmission line segment 'g' and crossing 'c', weighted by population significance to salmon recovery.

C_{gc} = Proportion of the length of stream affected by line segment 'g' and crossing 'c' (T_{gc}), subject to project-related clearing of riparian vegetation.

R_{gc} = Proportional reduction in riparian function due to clearing of riparian vegetation by line segment 'g' and crossing 'c.'

The Integrated Fish Impact index describes a proportional reduction in fish production at the population scale based on the Riparian Impact Assessment. Riparian impacts were expressed as a product of the length of stream within the right-of-way footprint where clearing occurred, scaled by the near-term riparian function at the crossing. For crossings with high riparian function ratings (high LWD recruitment potential and low stream shade hazard), we applied a scalar of 1.0. Non-forested crossings were scaled by 0.0; crossings with moderate riparian function were scaled by 0.67; and, crossings with low function were scaled by 0.33. In this way, greater reductions in fish numbers would occur along streams with the greatest potential loss in habitat; no losses would occur along streams with no potential loss in riparian habitat function. Thus, greater loss of habitat and fish production potential would be associated with substantial clearing of high-function riparian habitat. Lesser loss of habitat and fish production potential would be associated with clearing of low-functioning riparian habitat (for instance, in cases where riparian vegetation has already been substantially degraded or removed).

Of the four habitat effects, only loss of riparian function would have measurable and potentially significant effects at the stream crossing scale (due to loss of large woody debris and stream shade). In comparison, sediment, hydrology, and floodplain effects would be relatively minor or indeterminate, or dispersed over a much broader area. Therefore, the Integrated Fish Impact index incorporated only potential impacts from loss of riparian function.

Results

Stream Crossing Inventory

Alternatives and options cross a total of 254 fish bearing streams. Of these, about 40% produce anadromous fish (Table 20). The balance support only resident species such as cutthroat trout. Numbers of fish-bearing stream crossings vary among the alternatives and options from 54 to 82. Similar differences are apparent in numbers of anadromous crossing. Tables and maps with more information on stream crossings may be found in the Appendix D.

Table 20. Number of stream crossings for action alternatives and options (sorted by increasing number for fish bearing streams).

Alternative	Fish bearing	Anadromous
East Option 1	54	25
East Alternative	59	24
East Option 3	63	23
Central Option 3	66	27
East Option 2	66	21
Central Option 2	69	30
West Alternative	71	39
West Option 2	72	40
West Option 1	73	39
Central Alternative	74	29
Crossover Alternative	75	32
Central Option 1	76	30
West Option 3	79	43
Crossover Option 2	80	35
Crossover Option 3	80	34
Crossover Option 1	82	33
All	**254**	**104**

Fish Production Potential Index

The Fish Production Potential index estimates the number of adult salmon or steelhead produced in the area affected by each transmission line crossing, all crossings in a route segment, and all segments in an action alternative or option. This index describes the maximum number of fish that might be affected by project-related changes in stream habitat conditions within the right-of-way footprint. Actual project impact on fish production will depend on the degree of habitat degradation (as reflected by the Integrated Fish Impact index).

Table 21 summarizes fish production values by species and totals for all species for the action alternatives and options. Fish production values varied substantially among all options at the extremes, although differences among many actions were relatively minor. Values were lowest for the East Alternative and options and greatest for the West Alternative and options.

Fish Production Potential index values were driven by the number of stream crossings and the significance of associated stream segments to different species. Large numbers of crossings increased the potential for fish effects. Based strictly on a fish number basis, some species such as chum and fall Chinook salmon would tend to be more greatly affected than others such as coho steelhead due to differences in fish densities in affected areas related to species life-history. The production potential of chum and fall Chinook salmon is relatively large in the larger, lower-elevation mainstem areas where this species concentrates for spawning. In contrast, coho and steelhead are widely distributed throughout a subbasin and typically occur at relative lower numbers in any given stream segment.

Table 21. Fish Production Potential index values for action alternatives and options (number of adult fish produced in affected stream sections, by species). Values are sorted by increasing index score.

			Chinook		Steelhead		Index
Alternative	**Coho**	**Chum**	**Fall**	**Spring**	**Winter**	**Summer**	**(Total)**
East Option 3	2.3	13.4	7.7	0.3	0.7	1.1	25.6
East Option 2	2.4	13.4	7.7	0.3	4.1	0.5	28.6
East Alternative	2.6	13.4	7.7	0.3	4.8	1.1	30.1
East Option 1	6.2	16.5	8.4	0.3	4.8	1.1	37.3
Central Alternative	3.4	13.8	36.3	9.6	5.9	0.4	69.4
Central Option 1	3.4	13.8	36.3	9.6	5.9	0.4	69.5
Central Option 2	2.9	13.8	37.1	9.6	5.8	0.4	69.6
Central Option 3	5.4	13.8	37.0	9.8	5.4	0.3	71.8
Crossover Alternative	5.7	25.0	41.2	9.5	6.1	0.8	88.4
Crossover Option 2	6.5	25.0	41.2	9.5	6.2	0.8	89.2
Crossover Option 3	8.2	25.0	41.2	9.5	6.2	0.8	90.9
Crossover Option 1	5.7	25.0	41.2	9.5	13.1	0.9	95.4
West Option 2	12.0	39.0	48.2	6.0	2.7	0.1	107.9
West Alternative	12.0	39.0	48.2	6.0	8.1	0.1	113.3
West Option 1	12.0	39.0	48.2	6.0	8.1	0.1	113.3
West Option 3	12.9	43.1	50.8	6.0	3.6	0.1	116.5

Fish Population Potential Index

The Fish Population Potential index estimates the proportion of the adult fish population produced in the area affected by each transmission line crossing, all crossings in a route segment, and all segments in an action alternative or option. Expressing fish indices in terms of population percentages rather than actual numbers somewhat dampened the disproportionate effects of some species related to life history differences. This index describes the maximum population percentage that might be affected by project-related changes in stream habitat conditions within the right-of-way footprint. Actual project impact will depend on the degree of habitat degradation (as reflected by the Integrated Fish Impact index).

Table 22 summarizes fish population values by species and averages for all species for a number of action alternatives and options. Fish population values varied among all options at the extremes, although differences among many actions were relatively minor. Values were generally lowest for the East Alternative and options and greatest for the Crossover and West alternatives and options (although there were exceptions to this pattern).

Fish Population Potential index values suggest that the scale of action effects would be quite low for all alternatives (based on the simplistic assumption that maximum effects would be equivalent to the fish production in the corridor alteration footprint as measured by stream length). Index values are 1% or less for most species and most options, but values up to 2.45% were estimated for chum salmon due to several crossings occurring in relatively high-value chum salmon habitat which is extremely limited. The combination of a large number of stream crossings and crossings in stream reaches utilized by multiple species tended to drive action alternatives or options with the highest potential for fish impact at a population scale.

Table 22. Fish Population Potential index values for action alternatives and options (percentage of population produced in affected stream sections, by species). Values are sorted by increasing index score.

			Chinook		Steelhead		Index
Alternative	**Coho**	**Chum**	**Spring**	**Fall**	**Winter**	**Summer**	**(Avg.)**
East Option 3	0.20	1.86	0.40	0.09	0.17	0.44	0.53
East Option 2	0.23	1.86	0.40	0.09	0.97	0.14	0.62
East Alternative	0.28	1.86	0.40	0.09	1.17	0.44	0.71
East Option 1	0.28	1.91	0.45	0.09	1.16	0.44	0.72
West Option 2	0.84	1.86	0.91	0.27	0.72	0.02	0.77
Central Option 2	0.21	1.87	0.58	0.44	1.42	0.12	0.77
Central Alternative	0.29	1.87	0.53	0.44	1.44	0.12	0.78
Central Option 1	0.29	1.87	0.53	0.44	1.45	0.12	0.78
Central Option 3	0.39	1.87	0.54	0.45	1.38	0.08	0.78
Crossover Alternative	0.38	2.04	0.79	0.42	1.54	0.39	0.93
Crossover Option 2	0.39	2.04	0.79	0.42	1.55	0.39	0.93
Crossover Option 3	0.43	2.04	0.79	0.42	1.55	0.39	0.94
West Option 3	1.03	2.45	1.06	0.27	0.96	0.02	0.96
West Alternative	0.84	1.86	0.91	0.27	2.05	0.02	0.99
West Option 1	0.84	1.86	0.91	0.27	2.05	0.02	0.99
Crossover Option 1	0.38	2.04	0.79	0.42	3.25	0.40	1.21

Fish ESU Potential Index

The Fish ESU Potential index estimates a weighted proportion of the adult fish population produced in the area potentially affected by each action alternative or option. Weights based on population priorities identified in the lower Columbia River salmon recovery plan tend to reduce the average potential index values for populations which are not targeted for high levels of protection or restoration. This index describes the maximum percentage of priority fish populations that might be affected by project-related changes in stream habitat conditions. Actual project impact will depend on the degree of habitat degradation (as reflected by the Integrated Fish Impact index).

Table 23 summarizes Fish ESU Potential index values by species and weighted averages for all species for the action alternatives and options. Fish population values varied among all options at the extremes although differences among many actions were relatively minor. Just 0.4% of the average population separates all alternatives. Values were generally lowest for the East alternative and options, and greatest for the Crossover and West alternatives and options (although there were exceptions to this pattern).

Index values suggest that the scale of action effect would be quite low for all alternatives (based on the simplistic assumption that maximum effects would be equivalent to the fish production in the corridor alteration footprint as measured by stream length). Index values are 1% or less for most species and most options, but values up to 1.95% were estimated for chum salmon due to several crossings occurring in relatively high-value chum salmon habitat which is extremely limited. A combination of multi-species production potential and a large number of stream crossings associated with an alternative or option tend to drive action alternatives or options towards higher levels of potential for fish impact.

Table 23. Fish ESU Potential index values for action alternatives and options (percentage of population produced in affected stream sections, by species, weighted by population priority for recovery). Values are sorted by increasing index score.

			Chinook		Steelhead		Index
Alternative	**Coho**	**Chum**	**Spring**	**Fall**	**Winter**	**Summer**	**(avg.)**
East Option 3	0.17	1.86	0.40	0.05	0.15	0.44	0.51
East Option 2	0.18	1.86	0.40	0.05	0.64	0.14	0.54
East Alternative	0.20	1.86	0.40	0.05	0.65	0.44	0.60
East Option 1	0.22	1.88	0.45	0.05	0.65	0.44	0.61
West Option 2	0.64	1.77	0.69	0.05	0.55	0.02	0.62
Central Option 3	0.27	1.87	0.53	0.07	0.95	0.08	0.63
Central Option 2	0.15	1.86	0.58	0.07	1.06	0.12	0.64
Central Alternative	0.22	1.87	0.53	0.07	1.06	0.12	0.64
Central Option 1	0.22	1.87	0.53	0.07	1.06	0.12	0.64
West Alternative	0.64	1.77	0.69	0.05	1.21	0.02	0.73
West Option 1	0.64	1.77	0.69	0.05	1.21	0.02	0.73
Crossover Alternative	0.31	1.95	0.79	0.05	0.98	0.39	0.75
Crossover Option 2	0.32	1.95	0.79	0.05	0.99	0.39	0.75
Crossover Option 3	0.36	1.95	0.79	0.05	0.99	0.39	0.76
West Option 3	0.73	2.36	0.84	0.05	0.66	0.02	0.78
Crossover Option 1	0.31	1.95	0.79	0.05	1.84	0.40	0.89

Integrated Fish Impact Index

The Integrated Fish Impact index estimates the proportional reduction in fish numbers associated with project-related habitat degradation at the crossing scale. Units of this index are expressed as the average percentage of high priority populations for all listed salmon and steelhead species. While the fish potential indices described the maximum numbers that might be affected, the Integrated Fish Impact index identifies the percentage by which affected populations are likely to be reduced by project-related habitat changes.

Table 24 summarizes Integrated Fish Impact index values by species and averages for all species for a number of action alternatives and options. Fish population values varied among all options at the extremes although differences among many actions were relatively minor. Just 0.16% of the average population index value separates all alternatives and options. Values were generally lowest for the West Alternative and options, intermediate for the Central Alternative and options and greatest for the Crossover Alternative and options. Values for the East Alternative and options ranked from relatively low to relatively high.

Index values suggest that the scale of action effects would be quite low for all alternatives. Index effects are 0.21% or less for all options where averaged for all species, but values up to 0.73% were estimated for winter steelhead due to several crossings occurring in relatively high-value streams with highly functional habitat that will require substantial clearing.

Table 24. Integrated Fish Impact index values for action alternatives and options (percentage reduction in priority fish populations due to project-related habitat effects). Values are sorted by increasing index score.

			Chinook		Steelhead		Index
Alternative	**Coho**	**Chum**	**Spring**	**Fall**	**Winter**	**Summer**	**(avg.)**
West Option 2	0.077	0.149	0.097	0.018	0.139	0.005	0.081
East Option 3	0.084	0.000	0.047	0.031	0.077	0.293	0.089
West Option 3	0.104	0.149	0.097	0.018	0.161	0.005	0.089
East Option 2	0.084	0.000	0.047	0.031	0.298	0.089	0.091
West Alternative	0.077	0.149	0.097	0.018	0.294	0.006	0.107
West Option 1	0.077	0.149	0.097	0.018	0.294	0.006	0.107
Central Option 3	0.127	0.003	0.092	0.022	0.412	0.025	0.113
Central Option 2	0.073	0.006	0.154	0.022	0.517	0.064	0.139
Central Alternative	0.118	0.006	0.136	0.022	0.530	0.064	0.146
Central Option 1	0.118	0.006	0.136	0.022	0.530	0.064	0.146
East Option 1	0.110	0.007	0.064	0.031	0.636	0.293	0.190
East Alternative	0.125	0.000	0.047	0.031	0.648	0.293	0.191
Crossover Alternative	0.076	0.016	0.128	0.018	0.729	0.258	0.204
Crossover Option 2	0.081	0.016	0.128	0.018	0.729	0.258	0.205
Crossover Option 3	0.093	0.016	0.128	0.018	0.730	0.258	0.207
Crossover Option 1	0.076	0.016	0.128	0.018	0.948	0.259	0.241

Discussion

Fish indices provide a systematic means for comparing relative differences in potential for project impact among the various corridor routes and alternatives. Index values are related to the number of stream crossings, lengths of affected stream, the significance of fish production in affected stream reaches, the priority of fish populations for salmon recovery, and the effects of project activities in proximity to stream crossings on fish habitat conditions.

The Integrated Fish Impact index reflects the relative significance of the affected stream area to priority-listed fish populations and the reduction in fish production associated with project activities in proximity to stream crossings. As such, the integrated index is the most effective of the fish indices for describing project effects on ESA-listed salmon and steelhead.

Rank order varied somewhat among the four indices as a result of differences in fish production value, stream reach significance to populations of each species, population priority for recovery, and the scale of habitat impact on fish production potential. Groupings in Table 25 denote alternatives and options with similar Integrated Fish Impact index values.

West Alternative and options rank among the lowest in terms of fish impacts based on the Integrated Fish Impact index. Fish production potential was generally higher because routes included a high number of crossings and many of these occurred at relatively high-value streams for anadromous species. However, project-related habitat effects were relatively low in comparison with other routes because many stream crossing occurred at locations where conditions in the right-of-way were already altered. Hence, these routes generally required much less clearing of highly-functioning riparian vegetation. Differences among the alternatives and options were driven by variations in the Washougal basin east of Vancouver.

Crossover Alternative and options generally ranked highest due to both high fish production potential and greater loss of highly-functioning riparian vegetation. These routes crossed a high number of anadromous fish-bearing streams, including many low to intermediate elevation streams which produced more fish and more species of fish on a per unit length basis. Affected populations were more frequently identified in the salmon recovery plan as high priorities for habitat protection or restoration. More riparian zones in these areas required significant clearing and riparian zones were more likely to have highly-functional riparian vegetation. Hence, reductions in fish production potential would be more likely to be greater.

Central Alternative and options were generally intermediate between East and Crossover alternative routes in terms of fish impact based on the integrated index. The number of crossings of anadromous fish bearing streams was intermediate as was the fish production value of these crossings. The magnitude of riparian clearing and functional quality of riparian zones was intermediate as well.

East Alternative and options ranked from low to moderately high based on the Integrated Fish Impact index. Fish production potential was relatively low because the number of crossings of anadromous streams would be lower than other alternatives and these routes would generally cross smaller, higher elevation streams inhabited at relatively low densities by a limited number of species (typically steelhead and coho). However, many of these crossings would require substantial clearing of relatively high-functioning riparian vegetation.

Table 25. Relative ranks of alternatives and options based on fish production, population and ESU indices (sorted by Integrated Fish Impact index in order of increasing index value – higher rank numbers denote lower impacts).

	Fish Potential						Riparian impact (%)[1]	Integrated impact		Group
	Production		Population		ESU					
	Fish no.	Rank	Index	Rank	Avg. %	Rank		Index	Rank	
West Option 2	107.9	4	0.77	12	0.62	12	13%	0.08	16	A
East Option 3	25.6	16	0.53	16	0.51	16	17%	0.09	15	A
West Option 3	116.5	1	0.96	4	0.78	2	11%	0.09	14	A
East Option 2	28.6	15	0.62	15	0.54	15	17%	0.09	13	A
West Alternative	113.3	3	0.99	3	0.73	7	15%	0.11	12	A
West Option 1	113.3	2	0.99	2	0.73	6	15%	0.11	11	A
Central Option 3	71.8	9	0.78	8	0.63	11	18%	0.11	10	A
Central Option 2	69.6	10	0.77	11	0.64	10	22%	0.14	9	B
Central Alternative	69.4	12	0.78	10	0.64	9	23%	0.15	8	B
Central Option 1	69.5	11	0.78	9	0.64	8	23%	0.15	7	B
East Option 1	37.3	13	0.72	13	0.61	13	31%	0.19	6	C
East Alternative	30.1	14	0.71	14	0.60	14	32%	0.19	5	C
Crossover Alternative	88.4	8	0.93	7	0.75	5	27%	0.20	4	C
Crossover Option 2	89.2	7	0.93	6	0.75	4	27%	0.21	3	C
Crossover Option 3	90.9	6	0.94	5	0.76	3	27%	0.21	2	C
Crossover Option 1	95.4	5	1.21	1	0.89	1	27%	0.24	1	D

[1] *Percentage of fish production in right-of-way footprint of stream crossings impacted by project-related riparian habitat effects. (This differs from simple riparian index values due to the crossing-specific significance of fish production.)*

None of the alternatives and options appear to pose a substantial risk to listed species. Fish indices suggest that the net effect of any project route on anadromous fish populations will be on the order of 1% even with the most pessimistic assumptions for impact at stream crossings (e.g., fish production potential is degraded to zero and no effective mitigation occurs). Habitat impact indices suggest that only a fraction of the potential fish production is likely to be lost due to project effects.

Relative differences identified among the alternatives appear to be quite small when considered on an absolute scale. While small relative differences might be identified among the various alternatives, these differences are practically negligible such that most options within an alternative are effectively interchangeable from a listed fish species point of view.

This is not to downplay the significance of the project when considered in aggregate with all of the other habitat and non-habitat related factors which have contributed to depletion and listing of these populations. Any given factor may contribute only a small impact but the combined effect of many small impacts has often proven to be substantial. It is also noteworthy that any additional impacts will further degrade the status of these listed species from current levels. Degradation of habitat conditions in high-priority fish populations and stream reaches is also contrary to objectives and strategies identified in the salmon and steelhead recovery plan.

Ultimately, fish index values are most robust as relative indices of differences in fish production potential or impact among the various route alternatives. Index values are likely to be correlated with actual values but may or may not precisely quantify the actual reduction in fish production that will result due to the project. Index values were defined to the extent possible in terms of meaningful units of effect so that these impacts might be placed in context with other considerations, such as wetlands or wildlife effects of the proposed project. However, these units should be considered with caution. Actual impacts might be more or less than the estimated fish production within the footprint of a stream crossing area. Project actions might impact a larger portion of the stream than just the footprint at each crossing. For instance, hydrology, sediment, and floodplain impacts, although small, may affect a relatively large portion of the watershed downstream. Similarly, riparian impacts can affect conditions both at the site of alteration and for a substantial distance downstream. On the other hand, project effects at each crossing may not be so severe as to degrade fish production in affected reaches to the degree reflected in the index. However, index values continue to robust indicators of relative difference among alternatives because values will consistently underestimate or overestimate actual impacts for all alternatives.

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Appendix A – Stream Hydrology Assessment Data

Two lookup tables were developed for LANDFIRE vegetation types found within the subwatersheds crossed by the transmission line routes. One table was created for EVT and the second table for EVC. The EVT lookup table (Table A-1) was used to distinguish forested and non-forested cover vegetation types (CFS_Forested = Yes/No). Within the forested vegetation types, EVT was further classified into conifer and hardwood forest cover (CFS_SubCoverType = Conifer/Hardwood). The EVC lookup table (Table A-2) was used to distinguish the watershed analysis hydrologic maturity classification of conifer (CFS_C_CLASS) cover types. Hardwood and non-forested cover types are treated as being hydrologically immature.

Table A-1. EVT lookup table for distinguishing forested and non-forested cover types (CFS_Forested) and conifer and hardwood cover types (CFS_SubCoverType).

EVT_VALUE	EVT_Name	SystmGrpPh	NVCSOrder	CFS_Forested	CFS_SubCoverType
82	Agriculture-Cultivated Crops and Irrigated Agriculture	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
81	Agriculture-Pasture and Hay	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
63	NASS-Row Crop-Close Grown Crop	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
65	NASS-Close Grown Crop	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
66	NASS-Fallow/Idle Cropland	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
67	NASS-Pasture and Hayland	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
64	NASS-Row Crop	Agricultural	Herbaceous / Nonvascular-dominated	No	N/A
60	NASS-Orchard	Agricultural	Tree-dominated	No	N/A
2182	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	Herbaceous / Nonvascular-dominated	No	N/A
11	Open Water	Non-vegetated	Non-vegetated	No	N/A
32	Quarries-Strip Mines-Gravel Pits	Developed	Non-vegetated	No	N/A
140	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland	Herbaceous / Nonvascular-dominated	No	N/A
75	Herbaceous Semi-dry	Grassland	Herbaceous /	No	N/A

EVT_VALUE	EVT_Name	SystmGrpPh	NVCSOrder	CFS_Forested	CFS_SubCoverType
			Nonvascular-dominated		
76	Herbaceous Semi-wet	Grassland	Herbaceous / Nonvascular-dominated	No	N/A
95	Herbaceous Wetlands	Grassland	Herbaceous / Nonvascular-dominated	No	N/A
2139	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	Herbaceous / Nonvascular-dominated	No	N/A
2171	North Pacific Alpine and Subalpine Dry Grassland	Grassland	Herbaceous / Nonvascular-dominated	No	N/A
31	Barren	Non-vegetated	Non-vegetated	No	N/A
2186	Introduced Upland Vegetation-Shrub	Shrubland	Shrub-dominated	No	N/A
2083	North Pacific Avalanche Chute Shrubland	Shrubland	Shrub-dominated	No	N/A
2084	North Pacific Montane Shrubland	Shrubland	Shrub-dominated	No	N/A
2003	North Pacific Sparsely Vegetated Systems	Sparsely Vegetated	No Dominant Lifeform	No	N/A
16	Developed-Upland Herbaceous	Developed	Herbaceous / Nonvascular-dominated	No	N/A
24	Developed-High Intensity	Developed	No Dominant Lifeform	No	N/A
25	Developed-Roads	Developed	No Dominant Lifeform	No	N/A
23	Developed-Medium Intensity	Developed	No Dominant Lifeform	No	N/A
17	Developed-Upland Shrubland	Developed	Shrub-dominated	No	N/A
13	Developed-Upland Deciduous Forest	Developed	Tree-dominated	No	N/A
15	Developed-Upland Mixed Forest	Developed	Tree-dominated	No	N/A
14	Developed-Upland Evergreen Forest	Developed	Tree-dominated	No	N/A
2039	North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	Conifer	Tree-dominated	Yes	Conifer
2018	East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	Conifer	Tree-dominated	Yes	Conifer
2035	North Pacific Dry Douglas-fir(-Madrone) Forest and Woodland	Conifer	Tree-dominated	Yes	Conifer

EVT_VALUE	EVT_Name	SystmGrpPh	NVCSOrder	CFS_Forested	CFS_SubCoverType
2174	North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest	Conifer	Tree-dominated	Yes	Conifer
2036	North Pacific Hypermaritime Seasonal Sitka Spruce Forest	Conifer	Tree-dominated	Yes	Conifer
2178	North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest	Conifer	Tree-dominated	Yes	Conifer
2038	North Pacific Maritime Mesic Subalpine Parkland	Conifer	Tree-dominated	Yes	Conifer
2046	Northern Rocky Mountain Subalpine Woodland and Parkland	Conifer	Tree-dominated	Yes	Conifer
2037	North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	Conifer	Tree-dominated	Yes	Conifer
2206	Pseudotsuga menziesii Giant Forest Alliance	Conifer	Tree-dominated	Yes	Conifer
2042	North Pacific Mesic Western Hemlock-Silver Fir Forest	Conifer	Tree-dominated	Yes	Conifer
2053	Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	Conifer	Tree-dominated	Yes	Conifer
2045	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	Conifer	Tree-dominated	Yes	Conifer
2173	North Pacific Wooded Volcanic Flowage	Conifer	Tree-dominated	Yes	Conifer
2157	North Pacific Swamp Systems	Conifer	Tree-dominated	Yes	Conifer
2041	North Pacific Mountain Hemlock Forest	Conifer	Tree-dominated	Yes	Conifer
2056	Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	Conifer	Tree-dominated	Yes	Conifer
2200	Pseudotsuga menziesii-Quercus garryana Woodland Alliance	Conifer-Hardwood	Tree-dominated	Yes	Conifer
2063	North Pacific Broadleaf Landslide Forest and Shrubland	Hardwood	Tree-dominated	Yes	Hardwood
2156	North Pacific Lowland Riparian Forest and Shrubland	Hardwood	Tree-dominated	Yes	Hardwood
2008	North Pacific Oak Woodland	Hardwood	Tree-dominated	Yes	Hardwood
2011	Rocky Mountain Aspen Forest and Woodland	Hardwood	Tree-dominated	Yes	Hardwood
2158	North Pacific Montane Riparian Woodland and Shrubland	Riparian	Tree-dominated	Yes	N/A

Table A-2. EVT lookup table for hydrologic maturity of conifer cover types (CFS_C_CLASS); hardwood and non-forest cover types are assumed to be hydrologically immature.

EVC_VALUE	CLASSNAMES	CFS_C_CLASS
100	Sparse Vegetation Canopy	Immature
101	Tree Cover >= 10 and < 20%	Intermediate
102	Tree Cover >= 20 and < 30%	Intermediate
103	Tree Cover >= 30 and < 40%	Intermediate
104	Tree Cover >= 40 and < 50%	Intermediate
105	Tree Cover >= 50 and < 60%	Intermediate
106	Tree Cover >= 60 and < 70%	Intermediate
107	Tree Cover >= 70 and < 80%	Mature
108	Tree Cover >= 80 and < 90%	Mature
109	Tree Cover >= 90 and <= 100%	Mature

Table A-3. List of Subwatersheds Crossed by the Transmission Line Routes

Central Alternative and Alternative Options

Subwatershed ID	Central Alternative			Central Option 1			Central Option 2			Central Option 3		
	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)
17080001060304	No	0	0	No	0	0	No	0	0	No	0	0
17080001060501	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793
17080001060502	Yes	5,207	5,226	Yes	5,207	5,226	Yes	5,207	5,226	Yes	5,207	5,226
17080001060503	Yes	1,724	1,749	Yes	1,724	1,749	Yes	1,724	1,749	Yes	1,724	1,749
17080001060504	Yes	6,903	6,907	Yes	6,903	6,907	Yes	6,903	6,907	Yes	6,903	6,907
17080001060506	Yes	1,484	1,486	Yes	1,484	1,486	Yes	1,484	1,486	Yes	1,484	1,486
17080001060601	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768
17080001060602	Yes	5,798	5,798	Yes	5,798	5,798	Yes	5,798	5,798	Yes	5,798	5,798
17080001060603	No	0	0	No	0	0	No	0	0	No	0	0
17080001060605	Yes	3,858	3,908	Yes	3,858	3,908	Yes	3,858	3,908	Yes	3,858	3,908
17080001060606	No	0	0	No	0	0	No	0	0	No	0	0
17080001090106	No	0	0	No	0	0	No	0	0	No	0	0
17080001090109	Yes	3,933	3,986	Yes	3,933	3,986	Yes	3,933	3,986	Yes	3,933	3,986
17080001090110	No	0	0	No	0	0	No	0	0	No	0	0
17080001090112	No	0	0	No	0	0	No	0	0	Yes	3,472	3,487
17080001090115	No	0	0	No	0	0	No	0	0	No	0	0
17080001090116	No	0	0	No	0	0	No	0	0	No	0	0
17080001090117	No	0	0	No	0	0	No	0	0	No	0	0
17080001090118	No	0	0	No	0	0	No	0	0	No	0	0
17080001090119	No	0	0	No	0	0	No	0	0	No	0	0
17080001090126	No	0	0	No	0	0	No	0	0	No	0	0
17080001090128	No	0	0	No	0	0	No	0	0	No	0	0
17080001090134	No	0	0	No	0	0	No	0	0	No	0	0
17080002040502	No	0	0	No	0	0	No	0	0	No	0	0
17080002040505	No	0	0	No	0	0	No	0	0	No	0	0
17080002050401	Yes	3,206	3,249	Yes	3,206	3,249	Yes	3,206	3,249	Yes	3,206	3,237
17080002050403	No	0	0	No	0	0	No	0	0	No	0	0
17080002050405	No	0	0	No	0	0	No	0	0	No	0	0

17080002050501	No	0	0	No	0	0	No	0	0	Yes	1,581	1,582
17080002050502	Yes	2,259	2,265	Yes	2,259	2,265	Yes	2,259	2,265	Yes	2,259	2,279
17080002050503	No	0	0	No	0	0	No	0	0	No	0	0
17080002050504	Yes	1,690	1,706	Yes	1,690	1,706	Yes	1,690	1,706	No	0	0
17080002050505	Yes	4,206	4,213	Yes	4,206	4,213	Yes	4,206	4,213	Yes	4,206	4,214
17080002050506	Yes	854	861	Yes	854	861	Yes	854	861	No	0	0
17080002050508	No	0	0	No	0	0	No	0	0	No	0	0
17080002050509	No	0	0	No	0	0	No	0	0	No	0	0
17080002050603	No	0	0	No	0	0	No	0	0	No	0	0
17080002050604	No	0	0	No	0	0	No	0	0	No	0	0
17080002050605	No	0	0	No	0	0	No	0	0	Yes	7,526	7,533
17080002050607	No	0	0	No	0	0	No	0	0	No	0	0
17080002050608	No	0	0	No	0	0	No	0	0	No	0	0
17080002050611	No	0	0	No	0	0	No	0	0	No	0	0
17080002050612	No	0	0	No	0	0	No	0	0	No	0	0
17080002050613	No	0	0	No	0	0	No	0	0	No	0	0
17080002050615	No	0	0	No	0	0	No	0	0	No	0	0
17080002060201	No	0	0	No	0	0	No	0	0	No	0	0
17080002060203	No	0	0	No	0	0	No	0	0	No	0	0
17080002060204	No	0	0	No	0	0	No	0	0	No	0	0
17080002060302	No	0	0	No	0	0	No	0	0	No	0	0
17080002060303	Yes	3,784	3,784	Yes	3,784	3,784	Yes	3,784	3,784	No	0	0
17080002060304	Yes	2,736	2,737	Yes	2,736	2,737	Yes	2,736	2,737	No	0	0
17080002060305	No	0	0	No	0	0	No	0	0	No	0	0
17080002060402	No	0	0	No	0	0	No	0	0	Yes	3,298	3,307
17080002060403	Yes	2,006	2,025	Yes	2,006	2,025	Yes	2,006	2,025	Yes	2,006	2,008
17080002060404	Yes	6,759	6,787	Yes	6,759	6,787	Yes	6,759	6,787	Yes	6,759	6,761
17080002060405	Yes	5,288	5,307	Yes	5,288	5,307	Yes	5,288	5,307	No	0	0
17080002060406	Yes	6,260	6,282	Yes	6,260	6,282	Yes	6,260	6,282	No	0	0
17080002060502	No	0	0	No	0	0	No	0	0	No	0	0
17080002060503	Yes	5,293	5,302	Yes	5,293	5,302	Yes	5,293	5,302	Yes	5,293	5,302
17080002060504	Yes	2,697	2,706	Yes	2,697	2,706	Yes	2,697	2,706	Yes	2,697	2,703
17080003040302	No	0	0	No	0	0	No	0	0	No	0	0
17080003040303	No	0	0	No	0	0	No	0	0	No	0	0
17080003040401	Yes	2,976	3,037	Yes	2,976	3,037	Yes	2,976	3,037	Yes	2,976	3,037
17080003040402	No	0	0	No	0	0	No	0	0	No	0	0

17080003040403	No	0	0	No	0	0	No	0	0	No	0	0
17080003040502	No	0	0	No	0	0	No	0	0	No	0	0
17080003040503	Yes	3,010	3,032	Yes	3,010	3,032	Yes	3,010	3,032	Yes	3,010	3,032
17080003040504	No	0	0	No	0	0	No	0	0	No	0	0
17080003040505	Yes	4,010	4,042	Yes	4,010	4,042	Yes	4,010	4,042	Yes	4,010	4,042
17080005070502	Yes	3,207	3,212	Yes	3,207	3,224	No	0	0	Yes	3,207	3,212
17080005070504	No	0	0	No	0	0	No	0	0	No	0	0
17080005070505	No	0	0	No	0	0	Yes	2,877	2,900	No	0	0
17080005070605	No	0	0	Yes	3,060	3,067	No	0	0	No	0	0
17080005070606	Yes	4,140	4,169	Yes	4,140	4,169	No	0	0	Yes	4,140	4,169
17080005080101	Yes	4,210	4,238	Yes	4,210	4,238	No	0	0	Yes	4,210	4,238
17080005080102	Yes	3,622	3,629	Yes	3,622	3,629	Yes	3,622	3,671	Yes	3,622	3,629
17080005080201	Yes	5,414	5,475	Yes	5,414	5,475	No	0	0	Yes	5,414	5,475
17080005080202	No	0	0	No	0	0	Yes	4,607	4,631	No	0	0
17080005080203	No	0	0	No	0	0	Yes	6,647	6,674	No	0	0
17080005080301	Yes	2,757	2,816	Yes	2,757	2,816	Yes	2,757	2,766	Yes	2,757	2,816
17080005080303	No	0	0	No	0	0	No	0	0	No	0	0
17080005080401	Yes	2,916	2,925	Yes	2,916	2,925	Yes	2,916	2,945	Yes	2,916	2,925
17080005080402	No	0	0	No	0	0	No	0	0	No	0	0
17080005080403	No	0	0	No	0	0	No	0	0	No	0	0
17080005080404	Yes	2,213	2,244	Yes	2,213	2,244	Yes	2,213	2,244	Yes	2,213	2,244
17080005080405	Yes	2,630	2,670	Yes	2,630	2,670	Yes	2,630	2,670	Yes	2,630	2,670
17080005080406	No	0	0	No	0	0	No	0	0	No	0	0

Crossover Alternative and Alternative Options

Subwatershed ID	Crossover Alternative			Crossover Option 1			Crossover Option 2			Crossover Option 3		
	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)
17080001060304	Yes	288	296	Yes	288	296	Yes	288	296	Yes	288	296
17080001060501	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793
17080001060502	Yes	5,207	5,226	Yes	5,207	5,222	Yes	5,207	5,226	Yes	5,207	5,226
17080001060503	No	0	0	No	0	0	No	0	0	No	0	0
17080001060504	Yes	6,903	6,907	Yes	6,903	6,907	Yes	6,903	6,907	Yes	6,903	6,907
17080001060506	Yes	1,484	1,539	Yes	1,484	1,539	Yes	1,484	1,539	Yes	1,484	1,539
17080001060601	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768
17080001060602	Yes	5,798	5,798	Yes	5,798	5,804	Yes	5,798	5,798	Yes	5,798	5,798
17080001060603	No	0	0	No	0	0	No	0	0	No	0	0
17080001060605	No	0	0	No	0	0	No	0	0	No	0	0
17080001060606	No	0	0	No	0	0	No	0	0	No	0	0
17080001090106	No	0	0	No	0	0	No	0	0	No	0	0
17080001090109	No	0	0	No	0	0	No	0	0	No	0	0
17080001090110	No	0	0	No	0	0	No	0	0	No	0	0
17080001090112	No	0	0	No	0	0	No	0	0	No	0	0
17080001090115	No	0	0	No	0	0	No	0	0	No	0	0
17080001090116	No	0	0	No	0	0	No	0	0	No	0	0
17080001090117	No	0	0	No	0	0	No	0	0	No	0	0
17080001090118	No	0	0	No	0	0	No	0	0	No	0	0
17080001090119	No	0	0	No	0	0	No	0	0	No	0	0
17080001090126	No	0	0	No	0	0	No	0	0	No	0	0
17080001090128	No	0	0	No	0	0	No	0	0	No	0	0
17080001090134	No	0	0	No	0	0	No	0	0	No	0	0
17080002040502	No	0	0	No	0	0	No	0	0	No	0	0
17080002040505	No	0	0	No	0	0	No	0	0	No	0	0
17080002050401	Yes	3,206	3,236	Yes	3,206	3,236	Yes	3,206	3,236	Yes	3,206	3,236
17080002050403	Yes	270	296	Yes	270	296	Yes	270	296	Yes	270	296
17080002050405	Yes	97	123	Yes	97	123	Yes	97	123	Yes	97	123
17080002050501	No	0	0	No	0	0	No	0	0	No	0	0
17080002050502	No	0	0	No	0	0	No	0	0	No	0	0

17080002050503	Yes	1,455	1,463	Yes	1,455	1,463	Yes	1,455	1,463	Yes	1,455	1,463
17080002050504	No	0	0	No	0	0	No	0	0	No	0	0
17080002050505	No	0	0	No	0	0	No	0	0	No	0	0
17080002050506	No	0	0	No	0	0	No	0	0	No	0	0
17080002050508	Yes	181	212	Yes	181	212	Yes	181	212	Yes	181	212
17080002050509	Yes	876	909	Yes	876	909	Yes	876	909	Yes	876	909
17080002050603	No	0	0	No	0	0	No	0	0	No	0	0
17080002050604	No	0	0	No	0	0	No	0	0	No	0	0
17080002050605	No	0	0	No	0	0	No	0	0	No	0	0
17080002050607	No	0	0	No	0	0	No	0	0	No	0	0
17080002050608	No	0	0	No	0	0	No	0	0	No	0	0
17080002050611	No	0	0	No	0	0	No	0	0	No	0	0
17080002050612	No	0	0	No	0	0	No	0	0	No	0	0
17080002050613	No	0	0	No	0	0	No	0	0	No	0	0
17080002050615	No	0	0	No	0	0	No	0	0	No	0	0
17080002060201	Yes	2,007	2,044	Yes	2,007	2,044	Yes	2,007	2,044	Yes	2,007	2,044
17080002060203	Yes	1,556	1,614	Yes	1,556	1,614	Yes	1,556	1,614	Yes	1,556	1,614
17080002060204	Yes	1,489	1,521	Yes	1,489	1,521	Yes	1,489	1,521	Yes	1,489	1,521
17080002060302	No	0	0	No	0	0	No	0	0	No	0	0
17080002060303	Yes	3,784	3,784	Yes	3,784	3,784	Yes	3,784	3,784	Yes	3,784	3,784
17080002060304	Yes	2,736	2,742	Yes	2,736	2,742	Yes	2,736	2,742	Yes	2,736	2,742
17080002060305	Yes	709	710	Yes	709	710	Yes	709	710	Yes	709	710
17080002060402	No	0	0	No	0	0	No	0	0	No	0	0
17080002060403	Yes	2,006	2,025	Yes	2,006	2,025	Yes	2,006	2,025	Yes	2,006	2,025
17080002060404	Yes	6,759	6,787	Yes	6,759	6,787	Yes	6,759	6,787	Yes	6,759	6,787
17080002060405	No	0	0	No	0	0	No	0	0	No	0	0
17080002060406	Yes	6,260	6,264	Yes	6,260	6,264	Yes	6,260	6,264	Yes	6,260	6,264
17080002060502	No	0	0	No	0	0	No	0	0	No	0	0
17080002060503	Yes	5,293	5,299	Yes	5,293	5,299	Yes	5,293	5,299	Yes	5,293	5,299
17080002060504	Yes	2,697	2,706	Yes	2,697	2,706	Yes	2,697	2,706	Yes	2,697	2,706
17080003040302	No	0	0	No	0	0	No	0	0	No	0	0
17080003040303	No	0	0	No	0	0	No	0	0	No	0	0
17080003040401	No	0	0	No	0	0	No	0	0	No	0	0
17080003040402	No	0	0	No	0	0	No	0	0	No	0	0
17080003040403	No	0	0	No	0	0	No	0	0	No	0	0

17080003040502	Yes	5,871	5,878	Yes	5,871	5,878	Yes	5,871	5,878	Yes	5,871	5,878
17080003040503	Yes	3,010	3,014	Yes	3,010	3,014	Yes	3,010	3,014	Yes	3,010	3,014
17080003040504	Yes	2,535	2,538	Yes	2,535	2,538	Yes	2,535	2,538	Yes	2,535	2,538
17080003040505	Yes	4,010	4,023	Yes	4,010	4,023	Yes	4,010	4,023	Yes	4,010	4,023
17080005070502	No	0	0	No	0	0	Yes	3,207	3,213	Yes	3,207	3,176
17080005070504	No	0	0	No	0	0	Yes	3,068	3,073	Yes	3,068	3,044
17080005070505	Yes	2,877	2,882	Yes	2,877	2,882	Yes	2,877	2,883	Yes	2,877	2,883
17080005070605	No	0	0	No	0	0	No	0	0	No	0	0
17080005070606	No	0	0	No	0	0	No	0	0	No	0	0
17080005080101	No	0	0	No	0	0	No	0	0	No	0	0
17080005080102	No	0	0	No	0	0	No	0	0	No	0	0
17080005080201	No	0	0	No	0	0	No	0	0	No	0	0
17080005080202	Yes	4,607	4,614	Yes	4,607	4,614	Yes	4,607	4,614	Yes	4,607	4,614
17080005080203	Yes	6,647	6,652	Yes	6,647	6,652	Yes	6,647	6,652	Yes	6,647	6,652
17080005080301	No	0	0	No	0	0	No	0	0	No	0	0
17080005080303	No	0	0	No	0	0	No	0	0	No	0	0
17080005080401	No	0	0	No	0	0	No	0	0	No	0	0
17080005080402	Yes	4,527	4,528	Yes	4,527	4,528	Yes	4,527	4,528	Yes	4,527	4,528
17080005080403	Yes	2,731	2,749	Yes	2,731	2,749	Yes	2,731	2,749	Yes	2,731	2,749
17080005080404	No	0	0	No	0	0	No	0	0	No	0	0
17080005080405	No	0	0	No	0	0	No	0	0	No	0	0
17080005080406	Yes	3,316	3,321	Yes	3,316	3,321	Yes	3,316	3,321	Yes	3,316	3,321

East Alternative and Alternative Options

Subwatershed ID	East Alternative			East Option 1			East Option 2			East Option 3		
	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)
17080001060304	Yes	288	296	Yes	288	296	No	0	0	Yes	288	303
17080001060501	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793
17080001060502	Yes	5,207	5,226	Yes	5,207	5,226	Yes	5,207	5,226	Yes	5,207	5,225
17080001060503	No	0	0	No	0	0	Yes	1,724	1,749	No	0	0
17080001060504	Yes	6,903	6,907	Yes	6,903	6,907	Yes	6,903	6,907	Yes	6,903	6,907
17080001060506	Yes	1,484	1,539	Yes	1,484	1,539	Yes	1,484	1,486	Yes	1,484	1,552
17080001060601	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768
17080001060602	Yes	5,798	5,798	Yes	5,798	5,798	Yes	5,798	5,798	Yes	5,798	5,798
17080001060603	No	0	0	No	0	0	No	0	0	No	0	0
17080001060605	No	0	0	No	0	0	Yes	3,858	3,908	No	0	0
17080001060606	No	0	0	No	0	0	No	0	0	No	0	0
17080001090106	No	0	0	No	0	0	No	0	0	No	0	0
17080001090109	No	0	0	No	0	0	Yes	3,933	3,986	No	0	0
17080001090110	No	0	0	No	0	0	No	0	0	No	0	0
17080001090112	No	0	0	No	0	0	No	0	0	No	0	0
17080001090115	No	0	0	No	0	0	No	0	0	No	0	0
17080001090116	No	0	0	No	0	0	No	0	0	No	0	0
17080001090117	No	0	0	No	0	0	No	0	0	No	0	0
17080001090118	No	0	0	No	0	0	No	0	0	No	0	0
17080001090119	No	0	0	No	0	0	No	0	0	No	0	0
17080001090126	No	0	0	No	0	0	No	0	0	No	0	0
17080001090128	No	0	0	No	0	0	No	0	0	No	0	0
17080001090134	No	0	0	No	0	0	No	0	0	No	0	0
17080002040502	Yes	5,129	5,130	Yes	5,129	5,130	Yes	5,129	5,130	Yes	5,129	5,130
17080002040505	Yes	977	979	Yes	977	979	Yes	977	979	Yes	977	979
17080002050401	Yes	3,206	3,236	Yes	3,206	3,236	Yes	3,206	3,249	Yes	3,206	3,237
17080002050403	Yes	270	296	Yes	270	296	No	0	0	Yes	270	297
17080002050405	Yes	97	123	Yes	97	123	No	0	0	Yes	97	126
17080002050501	No	0	0	No	0	0	No	0	0	No	0	0
17080002050502	No	0	0	No	0	0	Yes	2,259	2,265	No	0	0

17080002050503	Yes	1,455	1,463	Yes	1,455	1,463	No	0	0	Yes	1,455	1,463
17080002050504	No	0	0	No	0	0	Yes	1,690	1,706	No	0	0
17080002050505	No	0	0	No	0	0	No	0	0	No	0	0
17080002050506	No	0	0	No	0	0	Yes	854	873	No	0	0
17080002050508	Yes	181	212	Yes	181	212	No	0	0	Yes	181	214
17080002050509	Yes	876	909	Yes	876	909	No	0	0	Yes	876	911
17080002050603	No	0	0	No	0	0	No	0	0	No	0	0
17080002050604	No	0	0	No	0	0	No	0	0	No	0	0
17080002050605	No	0	0	No	0	0	No	0	0	No	0	0
17080002050607	No	0	0	No	0	0	No	0	0	No	0	0
17080002050608	No	0	0	No	0	0	No	0	0	No	0	0
17080002050611	No	0	0	No	0	0	No	0	0	No	0	0
17080002050612	No	0	0	No	0	0	No	0	0	No	0	0
17080002050613	No	0	0	No	0	0	No	0	0	No	0	0
17080002050615	No	0	0	No	0	0	No	0	0	No	0	0
17080002060201	Yes	2,007	2,044	Yes	2,007	2,044	Yes	2,007	2,036	Yes	2,007	2,044
17080002060203	Yes	1,556	1,614	Yes	1,556	1,614	Yes	1,556	1,566	Yes	1,556	1,616
17080002060204	Yes	1,489	1,521	Yes	1,489	1,521	No	0	0	Yes	1,489	1,523
17080002060302	Yes	4,951	5,012	Yes	4,951	5,012	Yes	4,951	5,012	Yes	4,951	5,012
17080002060303	Yes	3,784	3,841	Yes	3,784	3,841	Yes	3,784	3,841	Yes	3,784	3,841
17080002060304	Yes	2,736	2,752	Yes	2,736	2,752	Yes	2,736	2,752	Yes	2,736	2,752
17080002060305	Yes	709	714	Yes	709	714	Yes	709	714	Yes	709	714
17080002060402	No	0	0	No	0	0	No	0	0	No	0	0
17080002060403	No	0	0	No	0	0	No	0	0	No	0	0
17080002060404	No	0	0	No	0	0	No	0	0	No	0	0
17080002060405	No	0	0	No	0	0	Yes	5,288	5,315	No	0	0
17080002060406	No	0	0	No	0	0	Yes	6,260	6,269	No	0	0
17080002060502	No	0	0	No	0	0	No	0	0	No	0	0
17080002060503	No	0	0	No	0	0	No	0	0	No	0	0
17080002060504	No	0	0	No	0	0	No	0	0	No	0	0
17080003040302	Yes	1,390	1,460	Yes	1,390	1,460	Yes	1,390	1,460	Yes	1,390	1,460
17080003040303	Yes	614	631	Yes	614	631	Yes	614	631	Yes	614	631
17080003040401	No	0	0	No	0	0	No	0	0	No	0	0
17080003040402	Yes	2,117	2,137	Yes	2,117	2,137	Yes	2,117	2,137	Yes	2,117	2,137
17080003040403	Yes	1,794	1,845	Yes	1,794	1,845	Yes	1,794	1,845	Yes	1,794	1,845

17080003040502	No	0	0	No	0	0	No	0	0	No	0	0
17080003040503	No	0	0	No	0	0	No	0	0	No	0	0
17080003040504	No	0	0	No	0	0	No	0	0	No	0	0
17080003040505	No	0	0	No	0	0	No	0	0	No	0	0
17080005070502	Yes	3,207	3,212	No	0	0	Yes	3,207	3,212	Yes	3,207	3,212
17080005070504	No	0	0	Yes	3,068	3,084	No	0	0	No	0	0
17080005070505	No	0	0	Yes	2,877	2,890	No	0	0	No	0	0
17080005070605	No	0	0	No	0	0	No	0	0	No	0	0
17080005070606	Yes	4,140	4,169	No	0	0	Yes	4,140	4,169	Yes	4,140	4,169
17080005080101	Yes	4,210	4,238	No	0	0	Yes	4,210	4,238	Yes	4,210	4,238
17080005080102	Yes	3,622	3,629	Yes	3,622	3,685	Yes	3,622	3,629	Yes	3,622	3,629
17080005080201	Yes	5,414	5,475	No	0	0	Yes	5,414	5,475	Yes	5,414	5,475
17080005080202	No	0	0	Yes	4,607	4,641	No	0	0	No	0	0
17080005080203	No	0	0	Yes	6,647	6,647	No	0	0	No	0	0
17080005080301	Yes	2,757	2,821	Yes	2,757	2,766	Yes	2,757	2,821	Yes	2,757	2,821
17080005080303	Yes	3,170	3,192	Yes	3,170	3,189	Yes	3,170	3,192	Yes	3,170	3,192
17080005080401	No	0	0	Yes	2,916	2,945	No	0	0	No	0	0
17080005080402	No	0	0	No	0	0	No	0	0	No	0	0
17080005080403	No	0	0	No	0	0	No	0	0	No	0	0
17080005080404	Yes	2,213	2,260	Yes	2,213	2,285	Yes	2,213	2,260	Yes	2,213	2,260
17080005080405	No	0	0	No	0	0	No	0	0	No	0	0
17080005080406	No	0	0	No	0	0	No	0	0	No	0	0

West Alternative and Alternative Options

Subwatershed ID	West Alternative			West Option 1			West Option 2			West Option 3		
	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)	Crossed?	Pre-Project Immature (ac)	Post-Project Immature (ac)
17080001060304	No	0	0	No	0	0	No	0	0	No	0	0
17080001060501	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793	Yes	3,792	3,793
17080001060502	No	0	0	No	0	0	Yes	5,207	5,214	Yes	5,207	5,228
17080001060503	No	0	0	No	0	0	No	0	0	No	0	0
17080001060504	No	0	0	No	0	0	No	0	0	Yes	6,903	6,907
17080001060506	No	0	0	No	0	0	No	0	0	No	0	0
17080001060601	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768	Yes	3,767	3,768
17080001060602	Yes	5,798	5,806	Yes	5,798	5,804	Yes	5,798	5,806	Yes	5,798	5,798
17080001060603	Yes	4,759	4,765	Yes	4,759	4,760	Yes	4,759	4,767	Yes	4,759	4,765
17080001060605	No	0	0	No	0	0	No	0	0	No	0	0
17080001060606	No	0	0	No	0	0	No	0	0	Yes	3,434	3,439
17080001090106	Yes	3,763	3,767	Yes	3,763	3,767	Yes	3,763	3,767	Yes	3,763	3,767
17080001090109	No	0	0	No	0	0	No	0	0	No	0	0
17080001090110	Yes	6,978	6,979	Yes	6,978	6,979	Yes	6,978	6,979	Yes	6,978	6,979
17080001090112	No	0	0	No	0	0	No	0	0	No	0	0
17080001090115	Yes	1,882	1,882	Yes	1,882	1,882	Yes	1,882	1,882	Yes	1,882	1,882
17080001090116	Yes	998	998	Yes	998	998	Yes	998	998	Yes	998	998
17080001090117	Yes	1,111	1,111	Yes	1,111	1,111	Yes	1,111	1,111	Yes	1,111	1,111
17080001090118	Yes	6,645	6,645	Yes	6,645	6,645	Yes	6,645	6,645	Yes	6,645	6,645
17080001090119	Yes	1,720	1,720	Yes	1,720	1,720	Yes	1,720	1,720	Yes	1,720	1,720
17080001090126	Yes	701	701	Yes	701	701	Yes	701	701	Yes	701	701
17080001090128	Yes	3,064	3,064	Yes	3,064	3,064	Yes	3,064	3,064	Yes	3,064	3,064
17080001090134	No	0	0	Yes	3,376	3,376	No	0	0	No	0	0
17080002040502	No	0	0	No	0	0	No	0	0	No	0	0
17080002040505	No	0	0	No	0	0	No	0	0	No	0	0
17080002050401	No	0	0	No	0	0	No	0	0	No	0	0
17080002050403	No	0	0	No	0	0	No	0	0	No	0	0
17080002050405	No	0	0	No	0	0	No	0	0	No	0	0

17080002050501	No	0	0	No	0	0	No	0	0	No	0	0
17080002050502	No	0	0	No	0	0	No	0	0	No	0	0
17080002050503	No	0	0	No	0	0	No	0	0	No	0	0
17080002050504	No	0	0	No	0	0	No	0	0	No	0	0
17080002050505	No	0	0	No	0	0	No	0	0	No	0	0
17080002050506	No	0	0	No	0	0	No	0	0	No	0	0
17080002050508	No	0	0	No	0	0	No	0	0	No	0	0
17080002050509	No	0	0	No	0	0	No	0	0	No	0	0
17080002050603	Yes	5,000	5,005	Yes	5,000	5,005	Yes	5,000	5,005	Yes	5,000	5,005
17080002050604	Yes	5,896	5,896	Yes	5,896	5,896	Yes	5,896	5,896	Yes	5,896	5,896
17080002050605	No	0	0	No	0	0	No	0	0	No	0	0
17080002050607	Yes	2,720	2,720	Yes	2,720	2,720	Yes	2,720	2,720	Yes	2,720	2,720
17080002050608	Yes	1,900	1,906	Yes	1,900	1,906	Yes	1,900	1,906	Yes	1,900	1,906
17080002050611	Yes	1,338	1,339	Yes	1,338	1,339	Yes	1,338	1,339	Yes	1,338	1,339
17080002050612	Yes	4,403	4,404	Yes	4,403	4,404	Yes	4,403	4,404	Yes	4,403	4,404
17080002050613	Yes	6,010	6,010	Yes	6,010	6,010	Yes	6,010	6,010	Yes	6,010	6,010
17080002050615	Yes	2,280	2,280	Yes	2,280	2,280	Yes	2,280	2,280	Yes	2,280	2,280
17080002060201	No	0	0	No	0	0	No	0	0	No	0	0
17080002060203	No	0	0	No	0	0	No	0	0	No	0	0
17080002060204	No	0	0	No	0	0	No	0	0	No	0	0
17080002060302	No	0	0	No	0	0	No	0	0	No	0	0
17080002060303	No	0	0	No	0	0	No	0	0	No	0	0
17080002060304	No	0	0	No	0	0	No	0	0	No	0	0
17080002060305	No	0	0	No	0	0	No	0	0	No	0	0
17080002060402	No	0	0	No	0	0	No	0	0	No	0	0
17080002060403	No	0	0	No	0	0	No	0	0	No	0	0
17080002060404	No	0	0	No	0	0	No	0	0	No	0	0
17080002060405	No	0	0	No	0	0	No	0	0	No	0	0
17080002060406	No	0	0	No	0	0	No	0	0	No	0	0
17080002060502	Yes	7,667	7,668	Yes	7,667	7,668	Yes	7,667	7,668	Yes	7,667	7,668
17080002060503	Yes	5,293	5,305	Yes	5,293	5,305	Yes	5,293	5,305	Yes	5,293	5,305
17080002060504	No	0	0	No	0	0	No	0	0	No	0	0
17080003040302	No	0	0	No	0	0	No	0	0	No	0	0
17080003040303	No	0	0	No	0	0	No	0	0	No	0	0
17080003040401	No	0	0	No	0	0	No	0	0	No	0	0

17080003040402	No	0	0	No	0	0	No	0	0	No	0	0
17080003040403	No	0	0	No	0	0	No	0	0	No	0	0
17080003040502	Yes	5,871	5,878	Yes	5,871	5,878	Yes	5,871	5,878	Yes	5,871	5,878
17080003040503	Yes	3,010	3,014	Yes	3,010	3,014	Yes	3,010	3,014	Yes	3,010	3,014
17080003040504	Yes	2,535	2,538	Yes	2,535	2,538	Yes	2,535	2,538	Yes	2,535	2,538
17080003040505	Yes	4,010	4,021	Yes	4,010	4,021	Yes	4,010	4,021	Yes	4,010	4,021
17080005070502	No	0	0	No	0	0	No	0	0	No	0	0
17080005070504	No	0	0	No	0	0	No	0	0	No	0	0
17080005070505	Yes	2,877	2,882	Yes	2,877	2,882	Yes	2,877	2,882	Yes	2,877	2,882
17080005070605	No	0	0	No	0	0	No	0	0	No	0	0
17080005070606	No	0	0	No	0	0	No	0	0	No	0	0
17080005080101	No	0	0	No	0	0	No	0	0	No	0	0
17080005080102	No	0	0	No	0	0	No	0	0	No	0	0
17080005080201	No	0	0	No	0	0	No	0	0	No	0	0
17080005080202	Yes	4,607	4,614	Yes	4,607	4,614	Yes	4,607	4,614	Yes	4,607	4,614
17080005080203	Yes	6,647	6,652	Yes	6,647	6,652	Yes	6,647	6,652	Yes	6,647	6,652
17080005080301	No	0	0	No	0	0	No	0	0	No	0	0
17080005080303	No	0	0	No	0	0	No	0	0	No	0	0
17080005080401	No	0	0	No	0	0	No	0	0	No	0	0
17080005080402	Yes	4,527	4,528	Yes	4,527	4,528	Yes	4,527	4,528	Yes	4,527	4,528
17080005080403	Yes	2,731	2,749	Yes	2,731	2,749	Yes	2,731	2,749	Yes	2,731	2,749
17080005080404	No	0	0	No	0	0	No	0	0	No	0	0
17080005080405	No	0	0	No	0	0	No	0	0	No	0	0
17080005080406	Yes	3,316	3,321	Yes	3,316	3,321	Yes	3,316	3,321	Yes	3,316	3,321

APPENDIX B - RIPARIAN ASSESSMENT DATA

Table B-1. Riparian conditions and effects at transmission line corridor crossings of fish-bearing streams.

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
1-1	46.2579	-122.9766	Delameter Creek	175	175	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
1-3	46.2232	-122.9647	Unnamed Tributary to Leckler Creek	154	154	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
1-4	46.2167	-122.9572		151	151	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
1-5	46.2023	-122.9430		151	151	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
1-6A	46.1866	-122.9288	Unnamed Tributary to Cowlitz River	288	288	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
1-6B	46.1856	-122.9279		162	162	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
1-6C	46.1848	-122.9247	Unnamed Tributary to Cowlitz River	585	439	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
2-1	46.2584	-122.9761	Delameter Creek	175	0	Non-forested	0	NA	Non-forested	0
2-2	46.2536	-122.9724		233	0	Non-forested	0	NA	Non-forested	0
2-5	46.2367	-122.9594		162	0	Non-forested	0	NA	Non-forested	0
2-6	46.2345	-122.9577		261	261	Predominantly Hardwood Low LWD Potential Low Shade Hazard	0.33	W	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67
2-7A	46.2247	-122.9501	Leckler Creek	380	0	Non-forested	0	NA	Non-forested	0
2-7B	46.2240	-122.9496	Leckler Creek	384	0	Non-forested	0	NA	Non-forested	0
2-7C	46.2222	-122.9481	Leckler Creek	685	0	Non-forested	0	NA	Non-forested	0
2-8	46.2203	-122.9468	Unnamed Tributary to Leckler Creek	159	0	Non-forested	0	NA	Non-forested	0
2-9	46.2155	-122.9431		151	0	Non-forested	0	NA	Non-forested	0
2-10	46.2009	-122.9318		262	262	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
2-11	46.1929	-122.9256		164	164	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
2-12	46.1862	-122.9181	Unnamed Tributary to Cowlitz River	165	0	Non-forested	0	NA	Non-forested	0
3-1	46.2587	-122.9758	Delameter Creek	175	175	Conifer/Hardwood Mixed Moderate LWD Potential	0.33	SW	Predominantly Conifer Moderate LWD Potential	0.33

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						High Shade Hazard			High Shade Hazard	
3-2	46.2556	-122.9717		168	168	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
3-3	46.2485	-122.9540		167	167	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
3-4	46.2162	-122.9152	Sandy Bend Creek	154	154	Predominantly Hardwood Moderate LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67
3-5	46.2162	-122.9125	Cowlitz River	211	0	Non-forested	0	NA	Non-forested	0
3-6	46.2051	-122.9029		363	363	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
3-7	46.1961	-122.8951	Unnamed Tributary to Ostrander Creek	153	153	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	W	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67
3-9	46.1963	-122.8853		153	0	Non-forested	0	NA	Non-forested	0
3-10	46.1960	-122.8823	Ostrander Creek	289	289	Predominantly Hardwood Moderate LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67
4-1	46.1771	-122.9087	Cowlitz River	150	0	Non-forested	0	NA	Non-forested	0
5-1	46.1754	-122.8943		222	222	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
5-2	46.1778	-122.8778	Unnamed Tributary to Cowlitz River	244	244	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
7-1	46.1949	-122.8707	South Fork Ostrander Creek	257	257	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
7-2	46.1941	-122.8624		151	151	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
7-3	46.1904	-122.8457	Unnamed Tributary to South Fork Ostrander Creek	151	151	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
8-1	46.1826	-122.8514	South Fork Ostrander Creek	166	166	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-1	46.1706	-122.9024	Unnamed Tributary to Cowlitz River	178	178	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
9-2	46.1560	-122.8883		157	117	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
9-3	46.1493	-122.8788	Unnamed Tributary to Coweeman River	218	0	Non-forested	0	NA	Non-forested	0

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
9-4	46.1448	-122.8728	Unnamed Tributary to Coweeman River	223	0	Non-forested	0	NA	Non-forested	0
9-5	46.1414	-122.8672	Coweeman River	209	209	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
9-6	46.1390	-122.8637	Coweeman River	151	0	Non-forested	0	NA	Non-forested	0
9-7	46.1360	-122.8591	Coweeman River	155	0	Non-forested	0	NA	Non-forested	0
9-9	46.1131	-122.8253		1046	1046	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-10	46.1063	-122.8152	Unnamed Tributary to Turner Creek	166	166	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
9-11	46.0894	-122.7903		151	151	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-12	46.0775	-122.7727		175	175	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-13	46.0688	-122.7599		162	162	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-14	46.0680	-122.7587	Hatchery Creek	589	589	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
9-15	46.0581	-122.7440		228	228	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-16	46.0488	-122.7303		172	172	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
9-17	46.0424	-122.7210		220	220	Predominantly Hardwood Low LWD Potential Low Shade Hazard	0.33	W	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67
9-18	46.0412	-122.7192		157	157	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
9-20A	46.0238	-122.6986		523	523	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
9-20B	46.0220	-122.6973		245	245	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-21	46.0111	-122.6900	Kalama River	154	154	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
9-22	45.9941	-122.6784	Little Kalama River	223	223	Conifer/Hardwood Mixed Moderate LWD Potential	0.33	W	Predominantly Conifer Moderate LWD Potential	0.67

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						High Shade Hazard			Low Shade Hazard	
9-23	45.9910	-122.6763		186	0	Non-forested	0	NA	Non-forested	0
9-25	45.9782	-122.6679		158	158	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
9-26	45.9707	-122.6633		221	221	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
10-1	46.1184	-122.7265	Unnamed Tributary to North Fork Goble Creek	236	236	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
10-2	46.1052	-122.7135	Goble Creek	150	150	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
10-3	46.0407	-122.6398	Kalama River	179	179	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
10-4	46.0380	-122.6365	Unnamed Tributary to Kalama River	150	150	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
11-1	46.1832	-122.8295	South Fork Ostrander Creek	260	260	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
11-3	46.1582	-122.7710	Coweeman River	245	245	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
12-1	46.0152	-122.6345	Knowlton Creek	332	332	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
12-2	45.9964	-122.6349		100	100	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
14-1	45.9659	-122.6420		153	153	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
15-1	45.9630	-122.6199		156	156	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
15-2	45.9601	-122.6002	Colvin Creek	229	229	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
18-1	45.9532	-122.5161		152	152	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
18-2	45.9532	-122.5094		185	185	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
18-3	45.9532	-122.5034		151	151	Predominantly Conifer	1	N	Predominantly Conifer	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						High LWD Potential Low Shade Hazard			High LWD Potential Low Shade Hazard	
18-4	45.9532	-122.4969		177	177	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
18-5	45.9532	-122.4834		263	263	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
18-6	45.9533	-122.4646		357	357	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
18-7	45.9526	-122.4180		210	210	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
18-8	45.9526	-122.4134		365	365	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
23-1	45.9564	-122.5797		155	155	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
25-1	45.9414	-122.6454	Unnamed Tributary to Houghton Creek	177	133	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
25-2	45.9402	-122.6446	Houghton Creek	159	119	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
25-3	45.9380	-122.6433	Lewis River	151	151	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
25-4	45.9362	-122.6422	Lewis River	165	165	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	S	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67
25-5	45.9151	-122.6330		4	0	Non-forested	0	NA	Non-forested	0
25-7A	45.8893	-122.6334	Unnamed Tributary to Brezee Creek	1805	0	Non-forested	0	NA	Non-forested	0
25-7B	45.8785	-122.6337	Unnamed Tributary to Brezee Creek	566	424	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
25-8	45.8667	-122.6351	Riley Creek	171	128	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
25-9	45.8602	-122.6351	Riley Creek	203	152	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
25-10	45.8551	-122.6351	Lockwood Creek	152	152	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
25-11	45.8479	-122.6352	Unnamed Tributary to	160	120	Predominantly Hardwood	0.33	N	Conifer/Hardwood Mixed	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
			East Fork Lewis River			Low LWD Potential High Shade Hazard			High LWD Potential Low Shade Hazard	
25-12A	45.8414	-122.6352		174	174	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
25-12B	45.8408	-122.6352	Unnamed Tributary to East Fork Lewis River	177	177	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
25-13A	45.8366	-122.6347	Mason Creek	162	0	Non-forested	0	NA	Non-forested	0
25-13B	45.8354	-122.6345	Mason Creek	258	0	Non-forested	0	NA	Non-forested	0
25-14	45.8281	-122.6320	East Fork Lewis River	158	0	Non-forested	0	NA	Non-forested	0
25-15	45.8169	-122.6299	Unnamed Tributary to East Fork Lewis River	271	271	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
25-16A	45.8125	-122.6300	Unnamed Tributary to East Fork Lewis River	299	299	Predominantly Hardwood Low LWD Potential Low Shade Hazard	0.33	W	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67
25-16B	45.8112	-122.6300	Unnamed Tributary to East Fork Lewis River	1806	1806	Predominantly Hardwood Low LWD Potential Low Shade Hazard	0.33	W	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67
25-17	45.7994	-122.6299		150	112	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
25-18	45.7685	-122.6300		11	0	Non-forested	0	NA	Non-forested	0
25-19	45.7625	-122.6302		178	0	Non-forested	0	NA	Non-forested	0
25-20	45.7398	-122.6310	Unnamed Tributary to Mill Creek	157	157	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
25-21	45.7243	-122.6310	Salmon Creek	159	159	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
25-22	45.7145	-122.6311		155	116	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
25-23	45.7042	-122.6311		198	149	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
26-1	45.9352	-122.5250		153	153	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
26-2	45.9339	-122.5239		178	178	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
26-3	45.9281	-122.5187	Cedar Creek	637	637	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
26-4	45.9076	-122.5039		155	155	Conifer/Hardwood Mixed Moderate LWD Potential	0.67	N	Predominantly Conifer High LWD Potential	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						Low Shade Hazard			Low Shade Hazard	
26-5	45.8988	-122.4875		342	342	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
26-6	45.8982	-122.4864		157	157	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
26-7	45.8795	-122.4595		305	305	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
28-1	45.9490	-122.3804		162	162	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
28-2	45.9412	-122.3741		198	198	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
28-3	45.9312	-122.3724		150	150	Predominantly Hardwood Moderate LWD Potential High Shade Hazard	0.33	W	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
28-4	45.9255	-122.3715	Chelatchie Creek	155	155	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
28-5	45.9126	-122.3696	Unnamed Tributary to Cedar Creek	164	164	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
28-6	45.9048	-122.3696	Cedar Creek	153	153	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
28-7	45.8878	-122.3697		212	212	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
28-8	45.8866	-122.3697		154	154	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
30-1	45.8557	-122.4405		78	78	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
30-2	45.8512	-122.4380		167	167	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
30-3	45.8391	-122.4301	East Fork Lewis River	176	176	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
30-4	45.8316	-122.4246		162	162	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
30-5	45.7997	-122.3932		161	161	Conifer/Hardwood Mixed High LWD Potential	0.67	N	Predominantly Conifer High LWD Potential	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						High Shade Hazard			Low Shade Hazard	
30-6	45.7974	-122.3932		3	3	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
35-1	45.6801	-122.3315	Unnamed Tributary to Boulder Creek	251	251	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
35-2	45.6709	-122.3315	Little Washougal River	253	253	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
35-3	45.6687	-122.3315	East Fork Little Washougal River	164	164	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
36A-1	45.6565	-122.4840		386	386	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
36A-2	45.6565	-122.4731		502	0	Non-forested	0	NA	Non-forested	0
36B-1	45.6556	-122.4826		248	248	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
36B-2	45.6556	-122.4802		234	234	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
36B-3	45.6556	-122.4713		226	226	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
39-1	45.6568	-122.4171		152	152	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
39-2	45.6569	-122.3783		211	211	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
39-3	45.6569	-122.3766		208	208	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
39-4	45.6572	-122.3602		160	160	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
39-5	45.6569	-122.3494	Unnamed Tributary to Little Washougal River	289	289	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
39-6	45.6569	-122.3426	Little Washougal River	158	118	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
40-1	45.6526	-122.4824		155	155	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
40-2	45.6408	-122.4690		274	0	Non-forested	0	NA	Non-forested	0

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
40-3	45.6397	-122.4679		167	167	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
40-4	45.6351	-122.4611		186	0	Non-forested	0	NA	Non-forested	0
43-1	45.6393	-122.4312		178	178	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
43-2	45.6353	-122.4280		552	414	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
46-1	45.6354	-122.4488		173	0	Non-forested	0	NA	Non-forested	0
47-1	45.6354	-122.4373		181	0	Non-forested	0	NA	Non-forested	0
47-2	45.6354	-122.4280		181	0	Non-forested	0	NA	Non-forested	0
48-1	45.6354	-122.4248		903	0	Non-forested	0	NA	Non-forested	0
48-2	45.6354	-122.3757	Little Washougal River	279	279	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
49-1	45.6483	-122.3344	Unnamed Tributary to Little Washougal River	150	150	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
50-1	45.6320	-122.4398		150	150	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
50-2	45.6313	-122.4296		2194	1645	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
51-1	45.6250	-122.3742		153	0	Non-forested	0	NA	Non-forested	0
51-2	45.6229	-122.3741	Little Washougal River	162	0	Non-forested	0	NA	Non-forested	0
51-3	45.6182	-122.3735		151	0	Non-forested	0	NA	Non-forested	0
52-2	45.5867	-122.3778	Washougal River	159	0	Non-forested	0	NA	Non-forested	0
52-3	45.5800	-122.3969	Washougal River	151	0	Non-forested	0	NA	Non-forested	0
52-4	45.5793	-122.4029	Washougal River	164	164	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
A-2	46.3374	-122.9788		257	257	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
A-3	46.3269	-122.9786	Baxter Creek	332	332	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
B-1	46.3181	-122.9743	Baxter Creek	151	151	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
B-2	46.3175	-122.9722		181	181	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
C-1	46.3055	-122.9804	Unnamed Tributary to Arkansas Creek	288	0	Non-forested	0	NA	Non-forested	0

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
C-2	46.3041	-122.9804	Arkansas Creek	283	283	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	SW	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33
C-3	46.2894	-122.9803		245	0	Non-forested	0	NA	Non-forested	0
D-1	46.3046	-122.9793	Arkansas Creek	662	662	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
D-2	46.2900	-122.9792		171	171	Predominantly Hardwood Low LWD Potential High Shade Hazard	0.33	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
D-3	46.2818	-122.9791		22	22	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
E-1	46.2661	-122.9802	Monahan Creek	168	0	Non-forested	0	NA	Non-forested	0
F-1	46.3053	-122.9429	Whittle Creek	155	155	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-2	46.3011	-122.9298		153	153	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-3	46.2936	-122.9139	Cowlitz River	158	0	Non-forested	0	N	Non-forested	0
F-4	46.2939	-122.9085		160	160	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
F-5	46.2940	-122.9003		177	177	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-6	46.2926	-122.8914	Salmon Creek	153	153	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-7	46.2890	-122.8844		166	166	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-8	46.2841	-122.8836		157	157	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-9A	46.2614	-122.8669	Coal Mine Creek	170	170	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-9B	46.2610	-122.8665		186	186	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-10	46.2347	-122.8401		395	395	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-11	46.2303	-122.8337	Ostrander Creek	294	294	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
F-14	46.1903	-122.7713		470	470	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-15	46.1846	-122.7624		159	159	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-16	46.1806	-122.7562	Unnamed Tributary to Coweeman River	150	150	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
F-17	46.1725	-122.7459	Coweeman River	173	173	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	SW	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33
H-1	46.1282	-122.7355	North Fork Goble Creek	794	794	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
I-1	46.1558	-122.7094		151	151	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-1	46.1260	-122.6300		301	301	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-2	46.1169	-122.6080		174	174	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-3	46.1085	-122.5879	Gobar Creek	150	150	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
K-4	46.1001	-122.5691		167	167	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-5	46.0863	-122.5450		329	329	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-6	46.0851	-122.5429		162	162	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-7	46.0762	-122.5275		158	158	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
K-8	46.0686	-122.5144	Kalama River	153	153	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
K-9	46.0337	-122.4528		163	163	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-10	46.0233	-122.4339		243	243	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
K-11	46.0160	-122.4022		151	151	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-12	46.0086	-122.3699		151	151	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
K-13	45.9937	-122.3529	Speelyai Creek	188	188	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
K-14	45.9575	-122.3543	Lewis River	175	175	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
L-1	45.9528	-122.5589	Lewis River	200	200	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
M-1	45.9518	-122.5656	Lewis River	204	204	Predominantly Hardwood Moderate LWD Potential High Shade Hazard	0.33	S	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67
M-2	45.9431	-122.5456		167	167	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
M-3	45.9422	-122.5431	Pup Creek	163	163	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-1	45.9444	-122.3108	Canyon Creek	200	200	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
O-2	45.9071	-122.2924		189	189	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-3	45.8975	-122.2924		334	334	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-4	45.8896	-122.2925		167	167	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
O-5	45.8753	-122.2925		157	157	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-6	45.8605	-122.2926		155	155	Predominantly Conifer Moderate LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-7	45.8265	-122.2928		212	212	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-8	45.8149	-122.2928	East Fork Lewis River	192	192	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
O-9	45.8075	-122.2929		151	151	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-10	45.8029	-122.2929	King Creek	159	159	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-11	45.7595	-122.2904	Unnamed Tributary to Coyote Creek	176	176	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-12	45.7559	-122.2904	Coyote Creek	152	152	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
O-14	45.7409	-122.2904		152	0	Non-forested	0	NA	Non-forested	0
O-15	45.7392	-122.2904	Rock Creek	154	154	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
O-16	45.6901	-122.2904	Jones Creek	339	339	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-1	45.7675	-122.3903		27	27	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-2	45.7631	-122.3907		157	157	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-3	45.7540	-122.3915		211	211	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-4	45.7523	-122.3917		155	155	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-5	45.7455	-122.3920		160	160	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-6	45.7215	-122.3928		1305	1305	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-7	45.7169	-122.3927		143	143	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-8	45.7146	-122.3902		173	173	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-9	45.7127	-122.3850		191	191	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
P-10	45.7075	-122.3709		364	364	Conifer/Hardwood Mixed High LWD Potential	1	N	Predominantly Conifer High LWD Potential	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						Low Shade Hazard			Low Shade Hazard	
P-11	45.7027	-122.3579		153	153	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
Q-1	45.6666	-122.3198	Jones Creek	150	150	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67	W	Predominantly Conifer Moderate LWD Potential Low Shade Hazard	0.67
Q-2	45.6654	-122.3211	East Fork Little Washougal River	1130	1130	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
R-1	45.6802	-122.2906		176	176	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
R-2	45.6749	-122.2908		50	50	Predominantly Conifer High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
R-3	45.6709	-122.2909	East Fork Little Washougal River	154	154	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
R-4A	45.6699	-122.2910		360	360	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
R-4B	45.6662	-122.2911		407	407	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
R-5	45.6564	-122.3112		158	118	Predominantly Hardwood Moderate LWD Potential Low Shade Hazard	0.67	N	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1
S-1	45.6531	-122.3307		324	324	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
T-1	45.6531	-122.3316		324	324	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
U-1	45.9412	-122.3278		153	153	Conifer/Hardwood Mixed Moderate LWD Potential High Shade Hazard	0.33	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
U-2	45.8990	-122.3439		172	0	Non-forested	0	NA	Non-forested	0
U-4	45.8940	-122.3481		253	253	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
V-1	45.8568	-122.3673		151	151	Conifer/Hardwood Mixed Moderate LWD Potential Low Shade Hazard	0.67	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
V-2	45.8446	-122.3667		185	185	Conifer/Hardwood Mixed Low LWD Potential High Shade Hazard	0.33	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
V-3	45.8381	-122.3665		170	170	Conifer/Hardwood Mixed	1	N	Predominantly Conifer	1

Crossing[1]	Latitude[2]	Longitude[2]	Stream Name	Stream Length (ft)[3]	Clearing Length (ft)[4]	Near-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[5]	Near-term Riparian Function Rating[6]	Limits to Riparian Development[7]	Long-term Species Composition, LWD Recruitment Potential, and Stream Shade Hazard[8]	Long-term Riparian Function Rating[9]
						High LWD Potential Low Shade Hazard			High LWD Potential Low Shade Hazard	
V-4	45.8311	-122.3663		160	160	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
V-5	45.8157	-122.3658	East Fork Lewis River	170	170	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
V-6	45.8050	-122.3706	Rock Creek	158	158	Predominantly Conifer High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67
V-7	45.7995	-122.3797		165	165	Conifer/Hardwood Mixed High LWD Potential Low Shade Hazard	1	N	Predominantly Conifer High LWD Potential Low Shade Hazard	1
W-1	45.9553	-122.3512	Canyon Creek	153	153	Conifer/Hardwood Mixed High LWD Potential High Shade Hazard	0.67	S	Predominantly Conifer High LWD Potential High Shade Hazard	0.67

Notes:
[1] Stream crossing designations include the BPA segment number and a consecutive identification number increasing from north to south.
[2] Location is approximate, determined by the intersection of the stream segments crossed and the transmission line center line; NAD83 Washington State Plan South Coordinate System.
[3] Length of fish-bearing streams occurring within the transmission line corridor based on the intersection of fish-bearing stream hydrography lines and the 150 ft BPA corridor.
[4] Length of fish-bearing streams cleared of forested vegetation based on aerial photo interpretation of the proportion of forested vegetation along the fish-bearing stream hydrography lines.
[5] Near-term species composition, LWD recruitment potential, and stream shade hazard ratings interpreted per WaFPB riparian assessment procedures (2011b) (see Tables 2 and 3).
[6] Near-term riparian function rating determined using Table 8 based on near-term LWD recruitment potential and stream shade hazard.
[7] Site factors limiting high LWD recruitment potential (W), low stream shade hazard (S), or both (SW); no limitations to high riparian function (N); and, non-forested crossings (NA).
[8] Projected long-term species composition, LWD recruitment potential, and stream shade hazard based on near-term riparian function and site limitations to riparian function (see Table 11).
[9] Long-term riparian function rating determined using Table 8 based on long-term LWD recruitment potential and stream shade hazard.

Table B-2. Cross-reference of alternatives and options by BPA transmission line corridor segment.

Segment	West	West Option 1	West Option 2	West Option 3	Central	Central Option 1	Central Option 2	Central Option 3	East	East Option 1	East Option 2	East Option 3	Crossover	Crossover Option 1	Crossover Option 2	Crossover Option 3
1							C2									
2	WA	W1	W2	W3									XA	X1	X2	X3
3										E1						
4	WA	W1	W2	W3			C2						XA	X1	X2	X3
5							C2									
7										E1						
8							C2									
9	WA	W1	W2	W3									XA	X1	X2	X3
10					CA	C1	C2	C3								
11							C2			E1						
12					CA	C1	C2	C3								
14													XA	X1	X2	X3
15					CA	C1	C2	C3					XA	X1	X2	X3
18					CA	C1	C2						XA	X1	X2	X3
23					CA	C1	C2	C3					XA	X1	X2	X3
25	WA	W1	W2	W3												
26								C3								
28					CA	C1	C2									
30								C3								
35					CA	C1	C2	C3			E2					
36		W1	W2	W3												
36A			W2	W3												
36B	WA															
37			W2	W3												
38			W2	W3												
39				W3												
40		W1														
41	WA															
43			W2													
45	WA															
46		W1														
47														X1		
48			W2											X1		

49				W3	CA	C1	C2	C3	EA	E1	E2	E3	XA	X1	X2	X3
50	WA	W1												X1		
51			W2	W3	CA	C1	C2	C3	EA	E1	E2	E3	XA		X2	X3
52	WA	W1	W2	W3	CA	C1	C2	C3	EA	E1	E2	E3	XA	X1	X2	X3
A						C1										
B					CA	C1		C3	EA		E2	E3				
C															X2	
D																X3
E															X2	X3
F					CA	C1		C3	EA		E2	E3				
G					CA	C1		C3								
H					CA	C1	C2	C3								
I									EA		E2	E3				
J										E1						
K									EA	E1	E2	E3				
L					CA	C1	C2						XA	X1	X2	X3
M								C3								
N													XA	X1	X2	X3
O									EA	E1		E3	XA	X1	X2	X3
P					CA	C1	C2	C3			E2					
Q									EA	E1			XA	X1	X2	X3
R												E3				
S									EA	E1		E3	XA	X1	X2	X3
T				W3	CA	C1	C2	C3			E2					
U											E2					
V					CA	C1	C2				E2					
W									EA	E1	E2	E3	XA	X1	X2	X3

APPENDIX C – FLOODPLAIN ASSESSMENT DATA

Table C-1. Floodplain assessment data by stream crossing. Values are sorted according to Total Floodplain Impact Area; crossings with the greatest potential impact are at the bottom.

Xing	Stream	Total Floodplain Area (acres)[1]	Impacts to Floodplain Vegetation (acres)[2]	Number of New Additional Towers[3]	Tower Footprint Area (acres)[4]	New or Reconstructed Roads in Corridor (lineal ft)[5]	New or Reconstructed Roads in Corridor (acres)[6]	Total Floodplain Impact Area (acres)[7]
9-5	Coweeman River	1.2	0.0					0.00
18-5	Unnamed Tributary to Pup Creek	0.0	0.0					0.00
40-2	Unnamed Tributary to Lacamas Creek	1.4	0.0					0.00
51-1	Unnamed Tributary to Little Washougal R	0.0	0.0					0.00
52-3	Washougal River	2.3	0.0					0.00
2-1	Delameter Creek	0.0	0.0					0.00
C-2	Arkansas Creek	0.0	0.0					0.01
3-1	Delameter Creek	0.1	0.0					0.02
46-1	Lacamas Creek	2.5	0.0			81	0.02	0.02
52-4	Camas Slough	0.8	0.0			61	0.03	0.03
U-4	Cedar Creek	0.0	0.0					0.03
9-3	Unnamed Tributary to Coweeman River	0.8	0.0					0.03
H-1	North Fork Goble Creek	0.0	0.0					0.04
1-6A	Unnamed Tributary to Cowlitz River	0.1	0.1					0.07
39-6	Little Washougal River	0.1	0.1					0.08
52-2	Washougal River	5.8	0.0			246	0.09	0.09
40-4	Unnamed Tributary to Lacamas Creek	7.4	0.0			128	0.07	0.09
25-13A	Mason Creek	0.5	0.1					0.09
3-4	Sandy Bend Creek	0.1	0.1					0.10
25-10	Lockwood Creek	0.2	0.1					0.11
O-9	Unnamed Tributary to King Creek	0.1	0.1					0.11
D-1	Arkansas Creek	0.1	0.1					0.12
8-1	South Fork Ostrander Creek	0.2	0.1					0.15
51-2	Little Washougal River	0.5	0.2					0.16

Xing	Stream	Total Floodplain Area (acres)[1]	Impacts to Floodplain Vegetation (acres)[2]	Number of New Additional Towers[3]	Tower Footprint Area (acres)[4]	New or Reconstructed Roads in Corridor (lineal ft)[5]	New or Reconstructed Roads in Corridor (acres)[6]	Total Floodplain Impact Area (acres)[7]
O-10	King Creek	0.2	0.2					0.16
25-21	Salmon Creek	1.0	0.2					0.17
39-1	Matney Creek	0.3	0.2	1	0.02			0.20
3-10	Ostrander Creek	2.4	0.1			183	0.09	0.22
Q-1	Jones Creek	0.4	0.3	1	0.00			0.29
11-1	South Fork Ostrander Creek	0.4	0.4					0.36
9-4	Unnamed Tributary to Coweeman River	0.7	0.4					0.36
F-6	Salmon Creek	0.5	0.4					0.38
36B-3	Unnamed Tributary to Lacamas Creek	5.7	0.1	1	0.08	517	0.25	0.41
9-6	Coweeman River	4.0	0.1	2	0.16	507	0.21	0.42
E-1	Monahan Creek	0.6	0.4					0.43
25-4	Lewis River	0.4	0.4					0.44
35-2	Little Washougal River	0.6	0.5					0.45
2-7	Leckler Creek	5.8	0.3	1	0.08	220	0.09	0.47
L-1	Lewis River	0.5	0.5					0.47
Q-2	East Fork Little Washougal River	0.5	0.5					0.48
1-6C	Unnamed Tributary to Cowlitz River	1.3	0.2	1	0.03	533	0.35	0.50
F-11	Ostrander Creek	0.5	0.5					0.51
9-7	Coweeman River	3.0	0.5			67	0.03	0.52
25-3	Lewis River	0.8	0.5					0.54
B-1	Baxter Creek	0.6	0.6					0.56
F-3	Cowlitz River	1.1	0.6					0.57
F-17	Coweeman River	0.6	0.6					0.60
50-2	Unnamed Tributary to Lacamas Creek	8.5	0.1	4	0.30	430	0.23	0.67
26-3	Cedar Creek	3.1	0.2			949	0.65	0.77
36A-2	Unnamed Tributary to Lacamas Creek	3.9	0.7	1	0.08	491	0.17	0.84
25-13B	Mason Creek	4.8	0.0	2	0.16	1,154	0.73	0.89
36A-1	Lacamas Creek	9.4	0.4	4	0.31	576	0.27	1.00
50-1	Unnamed Tributary to Lacamas Creek	1.5	1.2	1	0.08	56	0.02	1.18

Xing	Stream	Total Floodplain Area (acres)[1]	Impacts to Floodplain Vegetation (acres)[2]	Number of New Additional Towers[3]	Tower Footprint Area (acres)[4]	New or Reconstructed Roads in Corridor (lineal ft)[5]	New or Reconstructed Roads in Corridor (acres)[6]	Total Floodplain Impact Area (acres)[7]
3-7	Unnamed Tributary to Ostrander Creek	2.2	1.4					1.37
K-13	Speelyai Creek	1.6	1.6	1	0.08	317	0.21	1.60
40-3	Lacamas Creek	8.0	0.7	3	0.24	1,883	1.22	2.10
36B-1	Lacamas Creek	13.2	1.0	4	0.31	1,810	1.08	2.37
25-14	East Fork Lewis River	13.0	3.2	4	0.31	759	0.41	3.78
40-1	Lacamas Creek	25.2	3.7	6	0.47	1,155	0.54	4.53
52-5	Columbia River	14.2	4.4	4	0.26	1,831	1.02	5.38

[1] *Total floodplain area (beyond the 100-ft riparian buffer) crossed by the transmission corridor at qualifying stream crossings.*

[2] *Existing forest canopy cover within the floodplain area that is greater than approximately 3 feet in height.*

[3] *Represents net additional towers within the floodplain area. Towers that are replaced or relocated are not included.*

[4] *Calculated as a 66-ft diameter circle at each tower location. Only portions of the circle that fall within the floodplain area are included.*

[5] *Represents length of new or reconstructed roads within the floodplain area.*

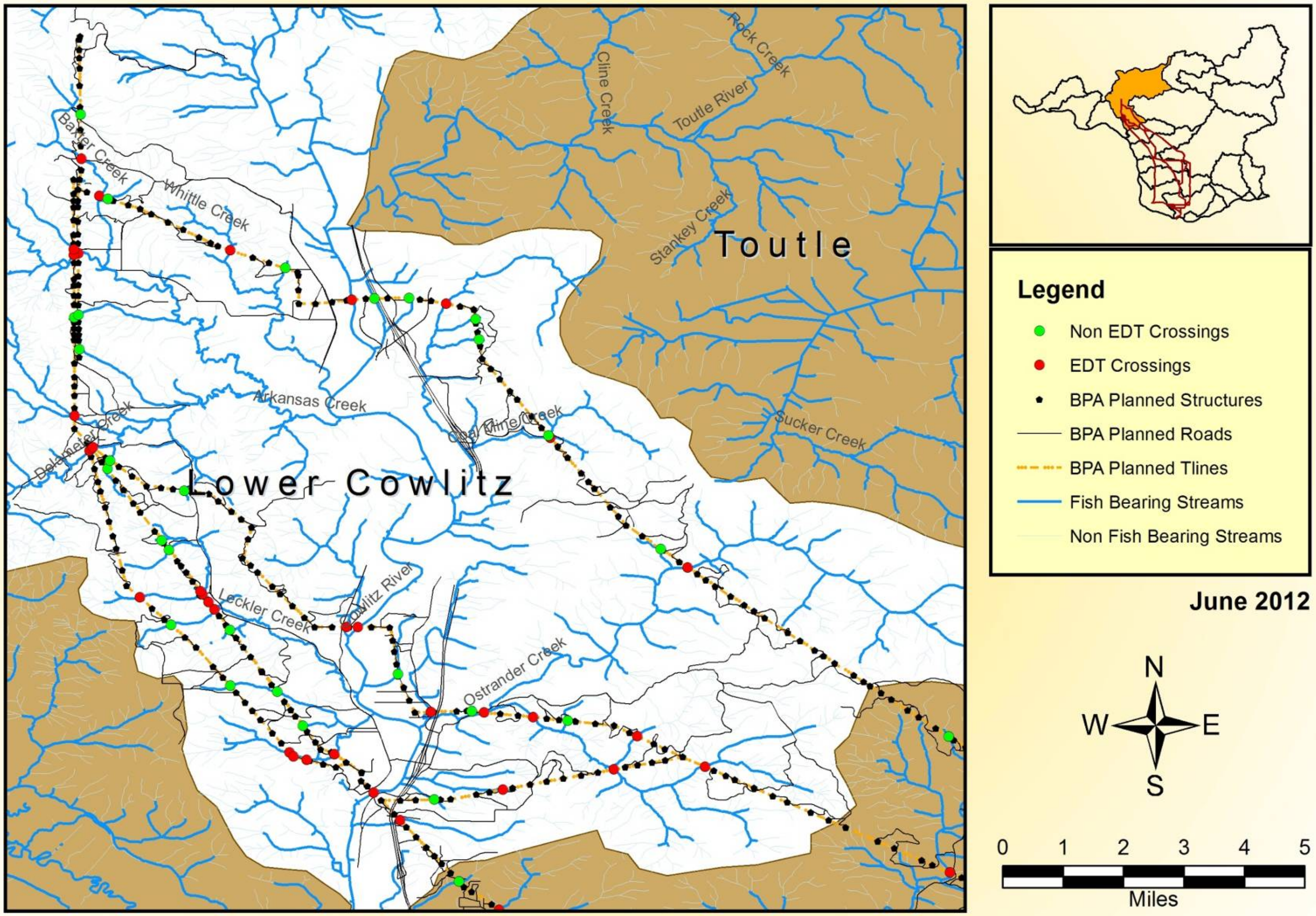
[6] *Calculated as 30 ft width for new roads and 20 ft width for reconstructed roads.*

[7] *Sum of potential floodplain impacts within the transmission line corridor based on acreage of vegetation clearing, towers, and roads. Overlapping impact areas were accounted for in the summed values.*

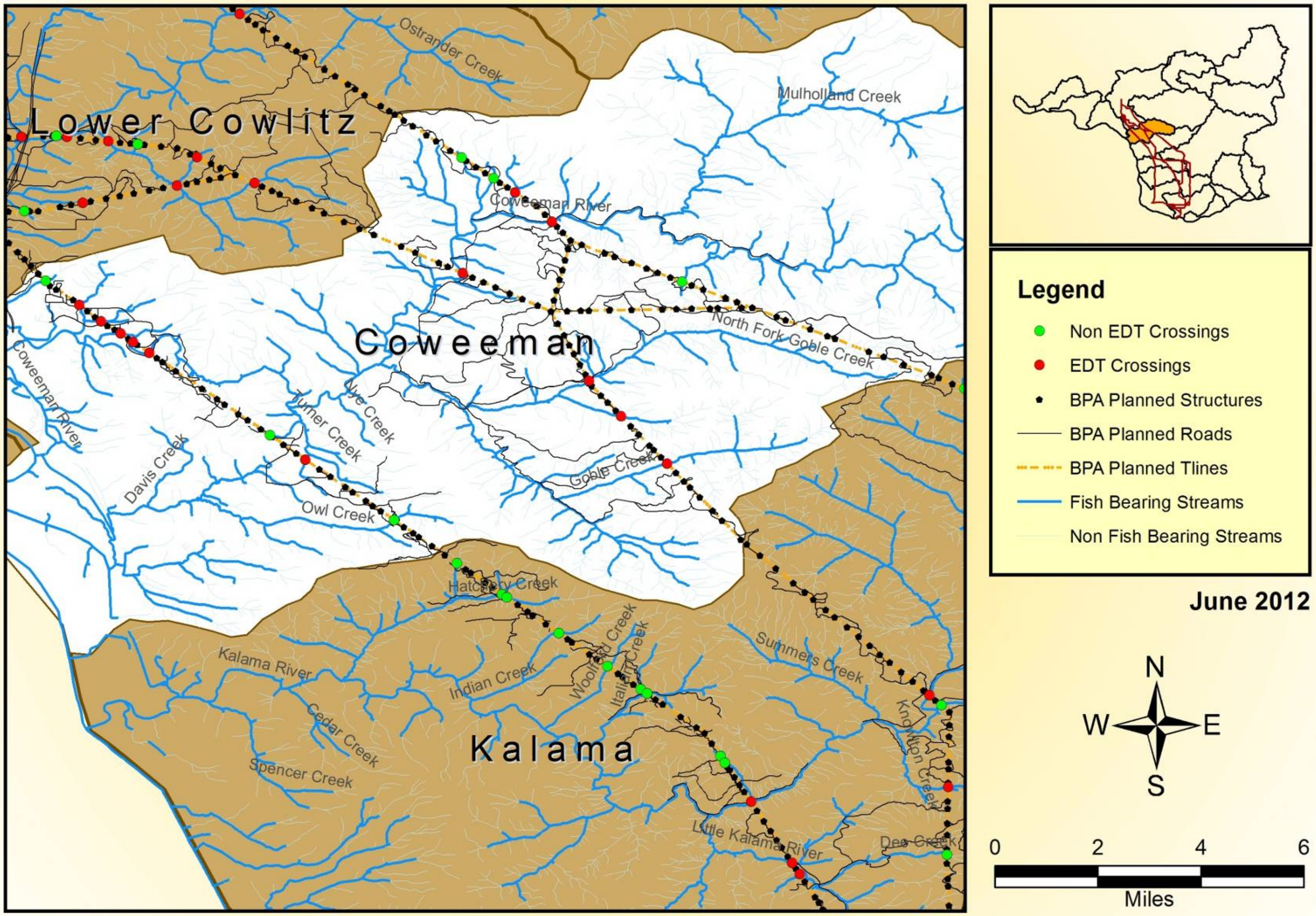
Appendix D – Fish Assessment Data

This Appendix includes figures showing EDT crossings within the major subbasins as well as tabular data of fish index values at the crossing-scale.

Lower Cowlitz



Coweeman



Lower Cowlitz
Coweeman
Kalama
Ostrander Creek
Mulholland Creek
Coweeman River
North Fork Goble Creek
Goble Creek
Turner Creek
Davis Creek
Owl Creek
Hatchery Creek
Kalama River
Indian Creek
Woolford Creek
Italian Creek
Summers Creek
Cedar Creek
Spencer Creek
Little Kalama River
Dee Creek
Knowlton Creek
Legend
Non EDT Crossings
EDT Crossings
BPA Planned Structures
BPA Planned Roads
BPA Planned Tlines
Fish Bearing Streams
Non Fish Bearing Streams
June 2012
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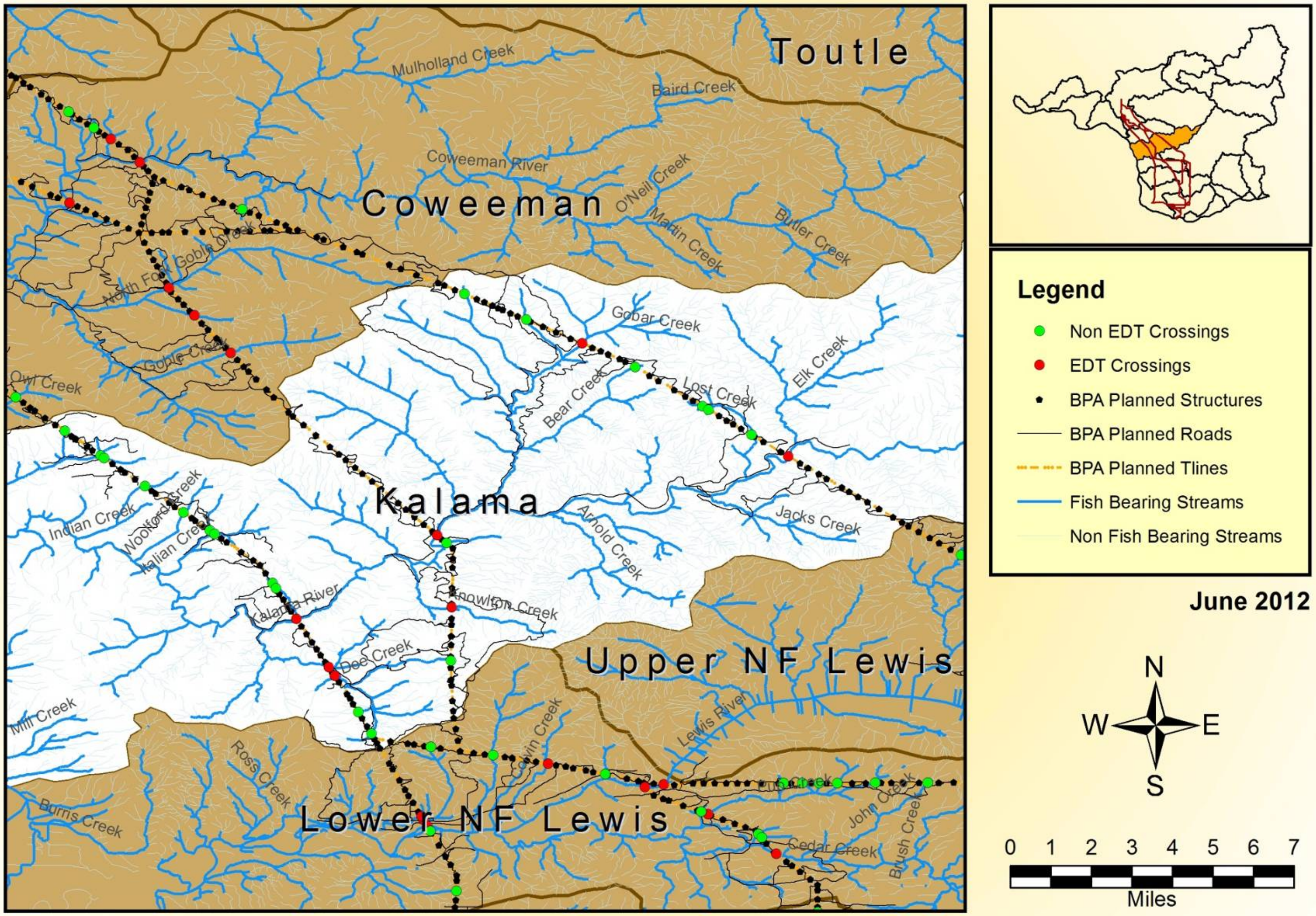
6
Miles

Kalama


Toutle
Coweeman
Kalama
Upper NF Lewis
Lower NF Lewis
Mulholland Creek
Baird Creek
Coweeman River
O'Neil Creek
Martin Creek
Butler Creek
North Fork Goble Creek
Goble Creek
Owl Creek
Gobar Creek
Elk Creek
Lost Creek
Bear Creek
Jacks Creek
Arnold Creek
Indian Creek
Woolford Creek
Italian Creek
Kalama River
Knowlton Creek
Dee Creek
Mill Creek
Ross Creek
Burns Creek
Cedar Creek
John Creek
Brush Creek
Lewis River
Legend
Non EDT Crossings
EDT Crossings
BPA Planned Structures
BPA Planned Roads
BPA Planned Tlines
Fish Bearing Streams
Non Fish Bearing Streams
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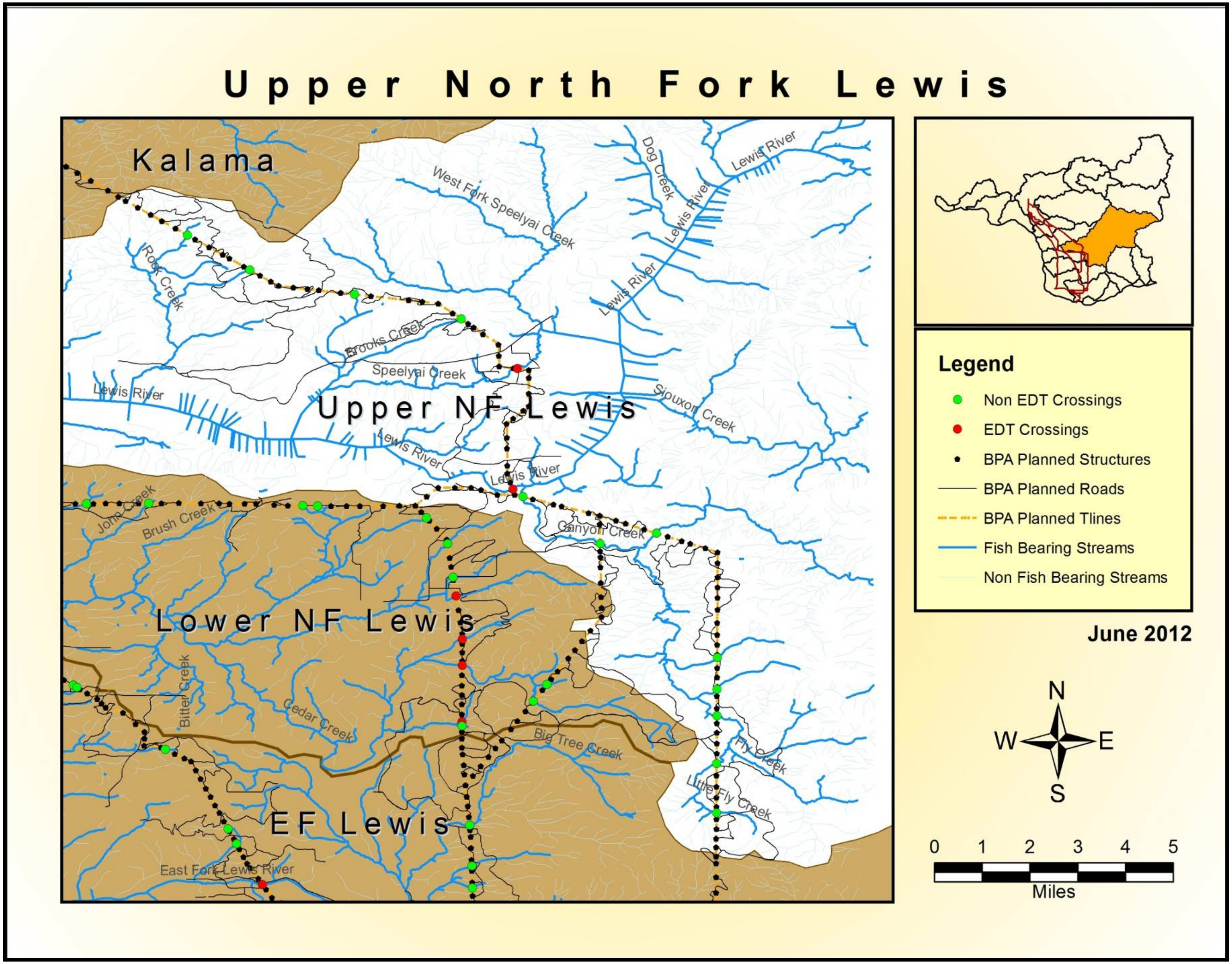

Upper North Fork Lewis
Kalama
West Fork Speelyai Creek
Dog Creek
Lewis River
Rock Creek
Brooks Creek
Speelyai Creek
Upper NF Lewis
Siouxon Creek
Lewis River
John Creek
Brush Creek
Canyon Creek
Lower NF Lewis
Bitter Creek
Cedar Creek
Big Tree Creek
Fly Creek
Little Fly Creek
EF Lewis
East Fork Lewis River
Legend
Non EDT Crossings
EDT Crossings
BPA Planned Structures
BPA Planned Roads
BPA Planned Tlines
Fish Bearing Streams
Non Fish Bearing Streams
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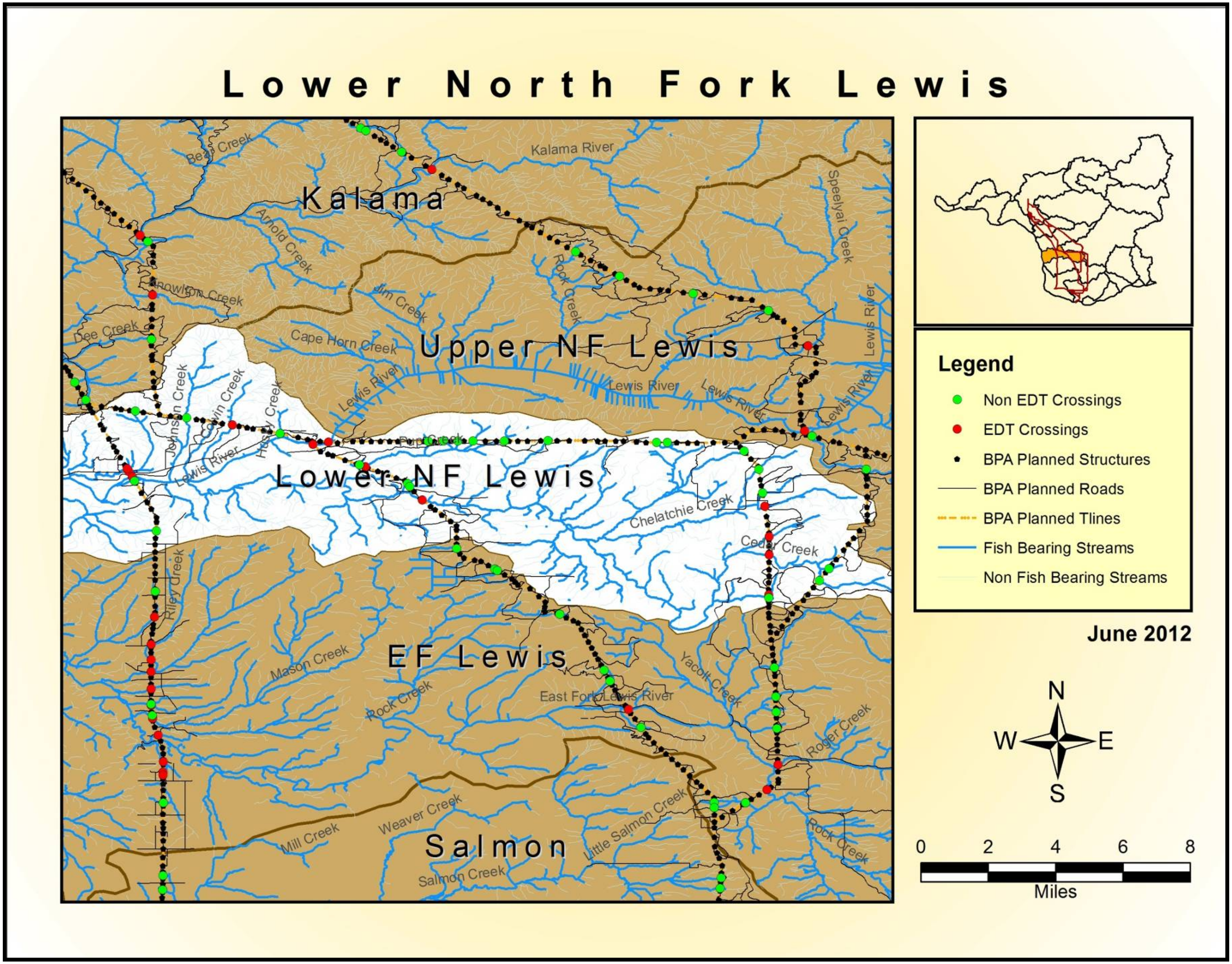
Lower North Fork Lewis
Kalama
Upper NF Lewis
Lower NF Lewis
EF Lewis
Salmon
Bear Creek
Kalama River
Arnold Creek
Knowlton Creek
Jim Creek
Rock Creek
Speelyai Creek
Lewis River
Dee Creek
Cape Horn Creek
Johnson Creek
Colvin Creek
Hayes Creek
Chelatchie Creek
Cedar Creek
Riley Creek
Mason Creek
Yacolt Creek
East Fork Lewis River
Roger Creek
Weaver Creek
Mill Creek
Little Salmon Creek
Salmon Creek
Legend
Non EDT Crossings
EDT Crossings
BPA Planned Structures
BPA Planned Roads
BPA Planned Tlines
Fish Bearing Streams
Non Fish Bearing Streams
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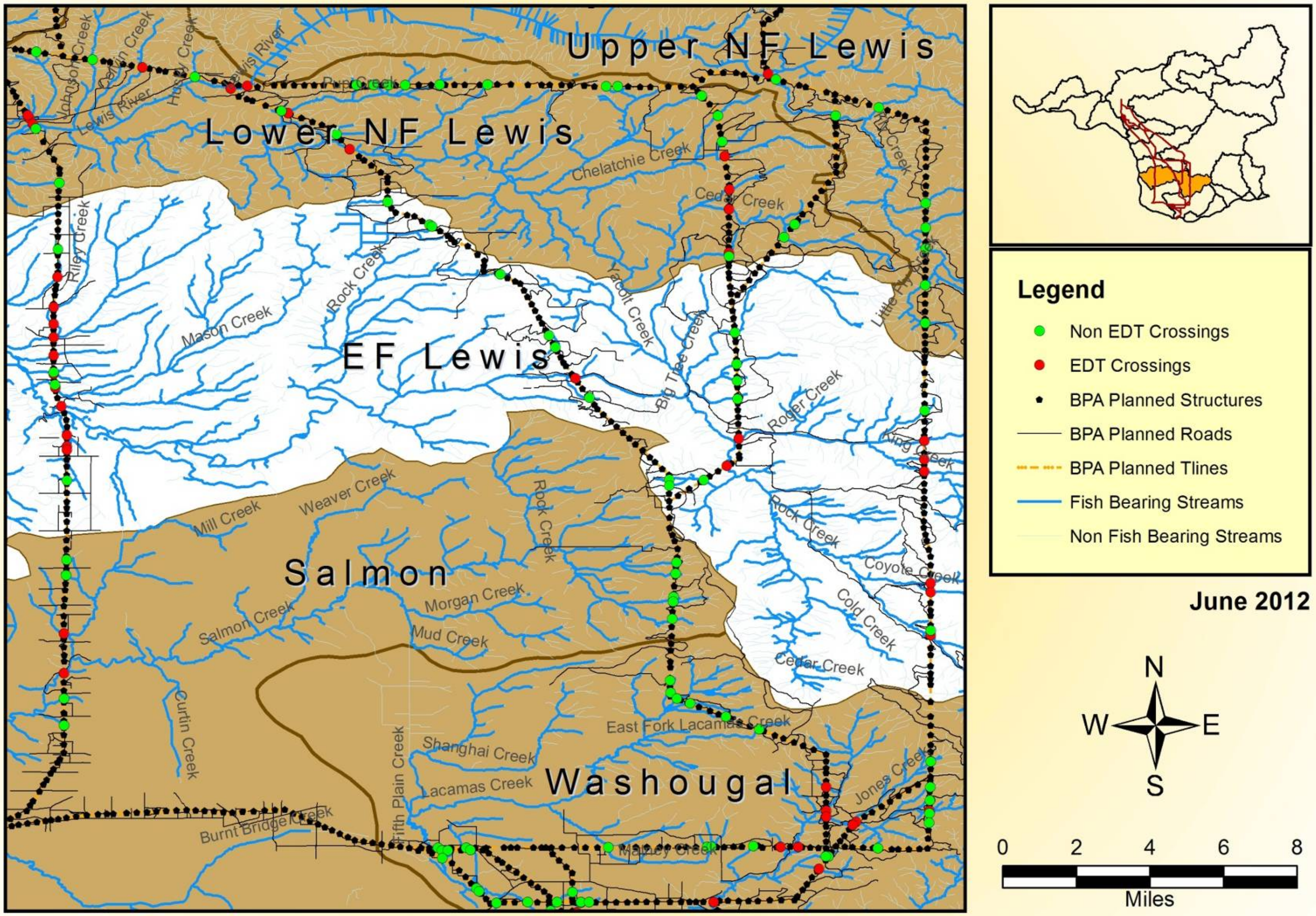
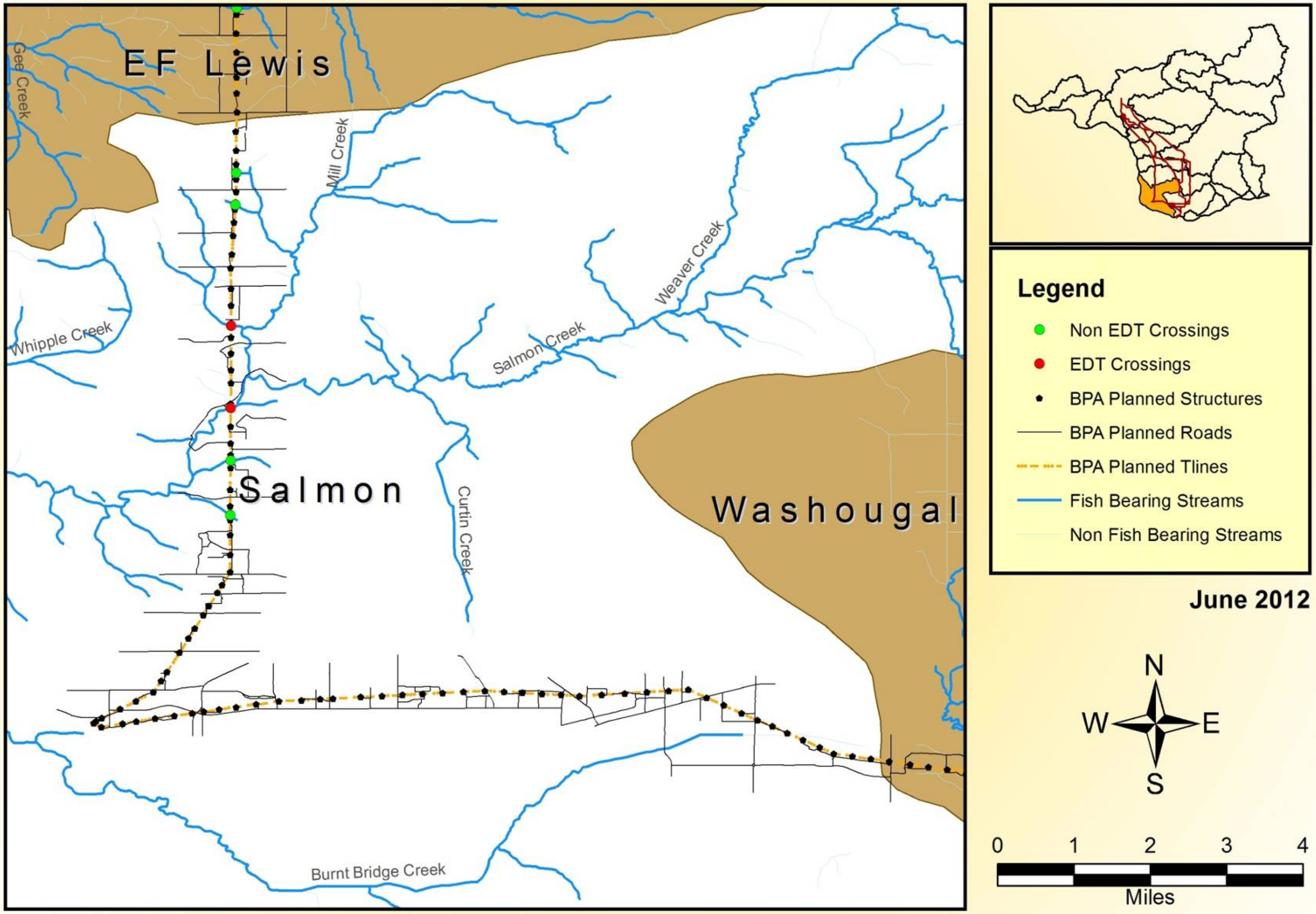
Miles

East Fork Lewis



Salmon



EF Lewis
Gee Creek
Mill Creek
Weaver Creek
Whipple Creek
Salmon Creek
Salmon
Curtin Creek
Washougal
Burnt Bridge Creek
Legend
Non EDT Crossings
EDT Crossings
BPA Planned Structures
BPA Planned Roads
BPA Planned Tlines
Fish Bearing Streams
Non Fish Bearing Streams
June 2012
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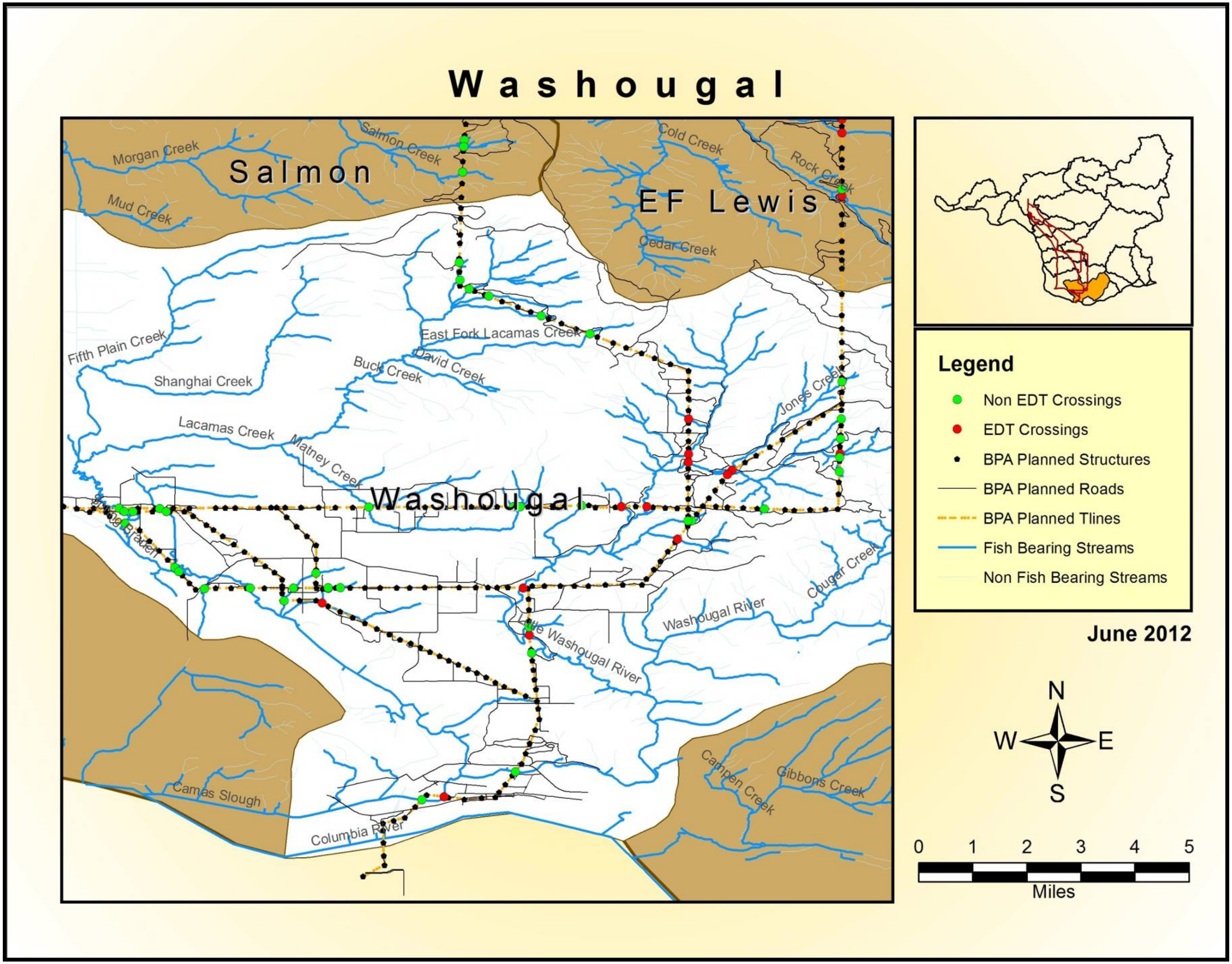
3
4
Miles



Washougal
Salmon
EF Lewis
Washougal
Morgan Creek
Salmon Creek
Mud Creek
Cold Creek
Rock Creek
Cedar Creek
Fifth Plain Creek
Shanghai Creek
East Fork Lacamas Creek
Buck Creek
David Creek
Jones Creek
Lacamas Creek
Matney Creek
Cougar Creek
Washougal River
Little Washougal River
Camas Slough
Columbia River
Campen Creek
Gibbons Creek
Legend
Non EDT Crossings
EDT Crossings
BPA Planned Structures
BPA Planned Roads
BPA Planned Tlines
Fish Bearing Streams
Non Fish Bearing Streams
June 2012
N
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0 1 2 3 4 5
Miles

Table D-1. Fish Production Potential index values (number of adult fish produced in affected stream sections by species) for route crossings of significant anadromous salmon and steelhead streams. Crossings are sorted in decreasing order of the total value.

Xing	Subbasin	Stream	EDT Reach	Coho	Chum	F Ck	S Ck	W Sh	S Sh	Total
25-3	LOWER NF LEWIS	Lewis River	Lewis 5	4.4	18.5	38.0	5.6	0.0	0.0	66.5
M-1	LOWER NF LEWIS	Lewis River	Lewis 7 B	0.3	0.4	29.2	9.3	0.3	0.0	39.5
L-1	LOWER NF LEWIS	Lewis River	Lewis 7 B	0.3	0.4	28.6	9.1	0.3	0.0	38.6
52-3	WASHOUGAL	Washougal River	Washougal 1 tidal	0.1	8.8	1.7	0.0	0.0	0.0	10.6
9-5	WASHOUGAL	Coweeman River	Coweeman 3	0.3	4.3	2.2	0.0	0.1	0.0	6.9
51-2	WASHOUGAL	Little Washougal River	Washougal 2 tidal	0.1	4.2	2.6	0.0	0.0	0.0	6.8
9-7	WASHOUGAL	Coweeman River	Coweeman 4 A	0.4	3.5	2.8	0.0	0.0	0.0	6.7
9-6	WASHOUGAL	Coweeman River	Coweeman 4 A	0.3	3.4	2.7	0.0	0.0	0.0	6.5
50-2	WASHOUGAL		Little Washougal 1 A & B	0.0	0.0	0.0	0.0	6.2	0.0	6.2
3-10	LOWER COWLITZ	Ostrander Creek	Ostrander Cr 1 B	3.1	2.9	0.0	0.0	0.0	0.0	6.1
Q-2	WASHOUGAL	East Fork Little Washougal River	Little Washougal 4 A	0.4	0.0	0.0	0.0	4.1	0.0	4.5
11-3	COWEEMAN	Coweeman River	Coweeman 7 & 8	0.4	0.0	3.7	0.0	0.2	0.0	4.3
F-17	COWEEMAN	Coweeman River	Coweeman 10	1.0	0.0	2.7	0.0	0.2	0.0	3.9
26-3	LOWER NF LEWIS	Cedar Creek	Cedar Cr 2 D	2.4	0.0	0.0	0.0	0.2	0.0	2.6
D-1	LOWER COWLITZ	Arkansas Creek	Arkansas Cr 3 A	2.5	0.0	0.0	0.0	0.0	0.0	2.5
39-6	WASHOUGAL	Little Washougal River	Little Washougal 2 C thru E	0.7	0.0	0.0	0.0	1.6	0.0	2.2
10-3	KALAMA	Kalama River	Kalama 9	0.0	0.0	0.0	0.5	0.8	0.3	1.5
2-7C	EF LEWIS	Leckler Creek	Leckler Cr 1 B	1.5	0.0	0.0	0.0	0.0	0.0	1.5
35-3	WASHOUGAL	East Fork Little Washougal River	Little Washougal 3	0.1	0.0	0.0	0.0	1.4	0.0	1.5
35-2	WASHOUGAL	Little Washougal River	Boulder Cr 1 A_C	0.1	0.0	0.0	0.0	1.2	0.0	1.3
F-3	LOWER COWLITZ	Cowlitz River	Lower Cowlitz-2 M	0.0	0.5	0.7	0.0	0.0	0.0	1.2
3-5	LOWER COWLITZ	Cowlitz River	Lower Cowlitz-2 H	0.0	0.7	0.3	0.0	0.0	0.0	1.0
4-1	WASHOUGAL	Cowlitz River	Lower Cowlitz-2 C	0.0	0.5	0.5	0.0	0.0	0.0	1.0
9-21	WASHOUGAL	Kalama River	Kalama 7	0.0	0.0	0.0	0.4	0.4	0.1	0.9
2-7B	EF LEWIS	Leckler Creek	Leckler Cr 1 B	0.8	0.0	0.0	0.0	0.0	0.0	0.9
H-1	COWEEMAN	North Fork Goble Creek	NF Goble Cr 1 B	0.1	0.0	0.0	0.0	0.7	0.0	0.8
48-2	WASHOUGAL	Little Washougal River	Little Washougal 1 A & B	0.0	0.0	0.0	0.0	0.8	0.0	0.8
V-6	EF LEWIS	Rock Creek	Rock Cr 1	0.0	0.0	0.0	0.0	0.8	0.0	0.8
25-13B	EF LEWIS	Mason Creek	M1_Mason Cr 1	0.7	0.0	0.0	0.0	0.0	0.0	0.8
C-2	LOWER COWLITZ	Arkansas Creek	Arkansas Cr 3 B	0.7	0.0	0.0	0.0	0.0	0.0	0.8
K-8	KALAMA	Kalama River	Kalama 15	0.0	0.0	0.0	0.3	0.0	0.4	0.7
7-1	LOWER COWLITZ	South Fork Ostrander Creek	SF Ostrander Cr 1	0.6	0.0	0.0	0.0	0.0	0.0	0.6
9-22	WASHOUGAL	Little Kalama River	LK1_Little Kalama 3	0.0	0.0	0.0	0.0	0.6	0.0	0.6
25-2	LOWER NF LEWIS	Houghton Creek	Houghton Cr 1 B	0.6	0.0	0.0	0.0	0.0	0.0	0.6
1-1	LOWER COWLITZ	Delameter Creek	Delameter Cr 3 A	0.5	0.0	0.0	0.0	0.0	0.0	0.5
2-1	LOWER COWLITZ	Delameter Creek	Delameter Cr 3 A	0.5	0.0	0.0	0.0	0.0	0.0	0.5
3-1	LOWER COWLITZ	Delameter Creek	Delameter Cr 3 A	0.5	0.0	0.0	0.0	0.0	0.0	0.5

Xing	Subbasin	Stream	EDT Reach	Coho	Chum	F Ck	S Ck	W Sh	S Sh	Total
25-21	SALMON	Salmon Creek	Salmon17	0.3	0.0	0.2	0.0	0.0	0.0	0.5
F-1	LOWER COWLITZ	Whittle Creek	Whittle Cr 2	0.5	0.0	0.0	0.0	0.0	0.0	0.5
25-14	EF LEWIS	East Fork Lewis River	M1_Mason Cr 1	0.4	0.0	0.0	0.0	0.0	0.0	0.5
2-7A	EF LEWIS	Leckler Creek	Leckler Cr 2	0.4	0.0	0.0	0.0	0.0	0.0	0.4
O-8	EF LEWIS	East Fork Lewis River	EF Lewis 16	0.0	0.0	0.0	0.0	0.0	0.4	0.4
F-11	LOWER COWLITZ	Ostrander Creek	Ostrander Cr 2	0.3	0.0	0.0	0.0	0.1	0.0	0.4
V-5	EF LEWIS	East Fork Lewis River	EF Lewis 14 A	0.0	0.0	0.0	0.0	0.3	0.1	0.4
1-3	LOWER COWLITZ	Unnamed Tributary to Leckler Creek	Leckler Cr RB Trib 2	0.4	0.0	0.0	0.0	0.0	0.0	0.4
3-4	LOWER COWLITZ	Sandy Bend Creek	Sandy Bend Cr	0.4	0.0	0.0	0.0	0.0	0.0	0.4
3-7	LOWER COWLITZ	Unnamed Tributary to Ostrander Creek	Ostrander RB Trib 1	0.3	0.0	0.0	0.0	0.0	0.0	0.3
O-9	EF LEWIS		EF Lewis 16	0.0	0.0	0.0	0.0	0.0	0.3	0.3
25-10	EF LEWIS	Lockwood Creek	L1_Lockwood Cr 1	0.3	0.0	0.0	0.0	0.1	0.0	0.3
30-3	EF LEWIS	East Fork Lewis River	EF Lewis 11	0.0	0.0	0.0	0.0	0.3	0.1	0.3
9-23	WASHOUGAL		LK1_Little Kalama 4	0.0	0.0	0.0	0.0	0.3	0.0	0.3
25-20	SALMON	Unnamed Tributary to Mill Creek	RBtrib2-1 (MillCr)	0.3	0.0	0.0	0.0	0.0	0.0	0.3
9-4	WASHOUGAL	Unnamed Tributary to Coweeman River	Coweeman RB Trib 1 B	0.3	0.0	0.0	0.0	0.0	0.0	0.3
39-5	WASHOUGAL	Unnamed Tributary to Little Washougal River	Little Wa RB Trib 2 C	0.1	0.0	0.0	0.0	0.2	0.0	0.3
F-16	COWEEMAN	Unnamed Tributary to Coweeman River	Coweeman RB Trib 7 (26.0079)	0.3	0.0	0.0	0.0	0.0	0.0	0.3
O-15	EF LEWIS	Rock Creek	Rock Cr 5 B	0.0	0.0	0.0	0.0	0.2	0.0	0.2
28-5	LOWER NF LEWIS	Unnamed Tributary to Cedar Creek	Booty Cr 1	0.2	0.0	0.0	0.0	0.0	0.0	0.2
11-1	LOWER COWLITZ	South Fork Ostrander Creek	SF Ostrander Cr 3	0.2	0.0	0.0	0.0	0.0	0.0	0.2
28-4	LOWER NF LEWIS	Chelatchie Creek	Big Cr 2	0.2	0.0	0.0	0.0	0.0	0.0	0.2
M-3	LOWER NF LEWIS	Pup Creek	Pup Cr 1 C	0.1	0.0	0.0	0.0	0.1	0.0	0.2
K-3	KALAMA	Gobar Creek	G1_Gobar Cr 5	0.0	0.0	0.0	0.0	0.2	0.0	0.2
25-9	EF LEWIS	Riley Creek	L1_Riley Cr 1	0.1	0.0	0.0	0.0	0.1	0.0	0.2
9-10	WASHOUGAL	Unnamed Tributary to Turner Creek	T1_Turner Cr LB Trib LB Trib	0.2	0.0	0.0	0.0	0.0	0.0	0.2
25-8	EF LEWIS	Riley Creek	L1_Riley Cr 1	0.1	0.0	0.0	0.0	0.1	0.0	0.1
10-2	COWEEMAN	Goble Creek	Goble Cr 3	0.0	0.0	0.0	0.0	0.1	0.0	0.1
10-1	COWEEMAN	Unnamed Tributary to North Fork Goble Creek	NF Goble Cr LB Trib 1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
9-3	WASHOUGAL	Unnamed Tributary to Coweeman River	Coweeman RB Trib 1 RB Trib	0.1	0.0	0.0	0.0	0.0	0.0	0.1
R-3	WASHOUGAL	East Fork Little Washougal River	Little Washougal 5	0.1	0.0	0.0	0.0	0.0	0.0	0.1
A-3	LOWER COWLITZ	Baxter Creek	Baxter Cr 1 B	0.1	0.0	0.0	0.0	0.0	0.0	0.1
49-1	WASHOUGAL	Unnamed Tributary to Little Washougal River	Jackson Family Cr 4	0.1	0.0	0.0	0.0	0.0	0.0	0.1