Appendix B: Selected Environmental Consequences of Alternatives D and E

The environmental consequences of Alternatives D and E which are important in the understanding of these alternatives and why they were dropped from consideration are disclosed in this appendix. Environmental consequences of the other issues tracked in Chapter 3 which are not discussed in this apppendix can be found in the applicable specialist reports which are part of the project file. Environmental consequences of ONP actions are the same as previously disclosed in Chapter 3 for the action alternatives and are not repeated here. These environmental consequences were described based on site conditions as existed in 2006 and have not been updated to reflect current conditions.

Road Management

Alternative D – Replace-in-Kind

Direct/Indirect Effects

Olympic National Forest
This alternative would replace the road in the approximate location that existed prior to the washout. The exact alignment would depend on the most advantageous design and would be a compromise between reducing encroachment into the river and decreasing hazard from ravel and rockfall from the high bank. The design would be a single lane road with turnouts at each end. The road running surface would be 14 feet wide with an additional 8 to 12 feet provided on the inside edge of the road at the base of the slope to provide suitable room for catching slope ravel. The high bank would be laid back to create a more stable slope, approximately 1 horizontal to 1 vertical. Laying the slope back would result in a large cut that moves the existing top of the slope back about 60 feet and would generate an estimated 13,250 cubic yards of material.

Costs
Construction and maintenance cost estimates are displayed in Table 29.

Table 29: Alternative D cost estimates

Item	Cost	Term	Estimated duration
Construction	$1,721,000	NA	NA
Annual Maintenance, New	$2,120/yr	short	1st 2 years
Annual maintenance, Life	$1320/yr	long	After 2-yrs – life of project
Annual maintenance beyond washout, Life	$9,200/yr	long	Life of project

User Safety
Potential rock fall and slide hazards would be reduced by laying the high bank back to a flatter

or long-term stable angle and by establishing an area for ravel to accumulate. Danger trees along the top of the slope would be removed.

Alternative E – Low-water Revetment

Direct/Indirect Effects

Olympic National Forest
This alternative would follow essentially the same horizontal alignment as Alternative D and would be operated with a seasonal closure. The surface of the road would include a catchment area or debris accumulation zone along the base of the slope. The road would be lower and set to the 10 year flood (Q_{10}) water surface elevation. The purpose of this alternative is to allow periodic inundation of the road during modest and larger floods, in this case the Q_{10} and larger floods.

Costs
Road construction costs are estimated to be lower than Alternative D but maintenance costs are estimated to be higher. This is expected to be the highest cost alternative with regards to road maintenance but is also the most difficult to predict. If the road is inundated by flood flows more frequently than predicted the costs would be expected to be higher. Accurately predicting the proper road surface elevation equivalent to the predicted water surface elevation (WSL) at the 10-year flood would be challenging because the estimated range between the WSL at the estimated 1.5-year flood and the 25-year flood is small. Analysis conducted during the Reach Analysis estimated that the difference in WSL between these two flows is only 2.8 feet. The WSL for the 10 year flood has not yet been estimated but would be between these two values. The issue of not estimating this level correctly which would result in either too frequent or only rare inundation is a concern for this alternative.

If the previous flood history used to estimate flood recurrence interval is not representative of current trends then this may increase the costs associated with this alternative. The potential for increased cost because of higher flows in the future relative to flows in the recent past is a possibility. An evaluation of the most recent (last 10 years) stream flow records suggests increases in large floods in recent years. Similarly increases in flows as a result of cyclic climate factors or long-term climate trends are possible. However the uncertainty involved in predicting these trends suggests that associated costs can not be quantified (see Climate Trends and Stream Flow discussion Chapter 3). These factors should be viewed as uncertainty associated with this alternative rather than elements that can be factored into design or impact assessments.

The costs associated with flood flows overtopping the road would be greater because they would occur much more frequently and inundation by floodwaters would be more extensive. Each time the road surface is flooded most of the surfacing could be washed away along with a limited amount of fill material. Most of the roadway template and riprap armor would be designed to withstand floods with return periods of 50 to 100 years.

The primary maintenance expected would be slough and slide clean-up, periodic resurfacing,

and occasional repair of flood damage (replacement of riprap and any eroded fill). The deposits that have accumulated at the toe of the slope would be collected through standard road maintenance and placed along the river margins (possibly right on the riprap) such that subsequent high flows could remove this material and continue to supply sediment from the high bank area to the downstream channel areas.

It is expected that significant maintenance would occur each time the road surface is inundated. There is a concern that annual road maintenance funding would be inadequate in the future to keep up with maintenance needed on this high maintenance cost alternative. Decreasing road maintenance budgets in recent years have been a concern to road managers and have resulted in a decrease in the amount of road maintenance conducted annually. As for reconstruction if severe flood damage is experienced it would be unreasonable to expect that any emergency flood repair funds (such as ERFO) would be available for this segment of road because it would be managed for relatively frequent inundation as compared with typical designs such as Alternative D.

Table 30: Alternative E cost estimates

Item	Cost	Term	Estimated duration
Construction	$1,396,000	NA	NA
Annual Maintenance, New	$6,040/yr	short	1st 2 years
Annual maintenance, Life	$4,840/yr	long	After 2-yrs – life of project
Annual maintenance beyond washout, Life	$9,200/yr	long	Life of project

User Safety
Unlike Alternative D this alternative would not lay back the slope of the high bank but would include a barrier along the inside edge of the road to provide for user safety against rockfall and sloughing from the high bank as well as establishing a catchment area. This would be a seasonal barrier which would be removed at the beginning of the seasonal road closure each October and would be replaced when the road is opened in April. The seasonal closure would also provide for user safety by closing the road during periods when the road would be prone to flooding, October 15 through April 30. Danger trees along the top of the slope would be removed.

Alternatives D and E

Cumulative Effects

Use of ONF road funds for any of the action alternatives would reduce the overall total road fund available to perform other road work on the Forest. The alternatives with higher expenses would have a greater impact in this regard.

Geotechnical and Geomorphic Processes

Alternative D – Replace-in-Kind

Direct/Indirect Effects

Olympic National Forest
The primary effects in regards to this alternative include: 1) slope stability and the potential for future or expanding washout, 2) fluvial processes, and 3) sediment supply.

With regards to large scale slope movement, so far all of the observed slope movements at the washout have been shallow movements involving ravel, collapse of blocks, and erosion of individual particles. This is also true for the comparable high bank slope at the next meander upstream. These types of movements are expected to result in accumulation of debris on the road surface and at the base of the slope. However a more stable slope angle would be created under this alternative and this would reduce the amount of debris accumulating at the base of the slope. The largest movements are not expected to close the road and would be removed with normal road maintenance. Slope movement would be expected to occur less in the long-term as the high bank revegetates. The potential for increased slope instability under Alternative D would be lower than Alternatives B and C, since the location is within stable landforms. Stability of the channel and risk of damage to riprap integrity during high flows would remain a concern however. There may be a slight increase in streambank instability in downstream reaches below the site of reconstruction in the channel due to the hardening of the bank and increased velocities since channel width of the Dosewallips River would be reduced.

In regards to future or an expanding washout the riprap along the channel edge would be designed to address this factor. The long-term trend of the river has been to shift into the hillside at this location (refer to the Reach Analysis). The potential for future washouts at this road location would remain although it is expected that riprap used would be large enough and keyed in deeply enough to minimize this potential to an acceptable level of risk.

Currently the high bank at the washout is over-steep meaning it is steeper than the predicted long-term stability of the slope. The slope evolution process involves erosion at the toe of the slope by the river which produces a very steep slope; then involves gradual erosion of the slope through ravel, collapse, rock fall and various shallow movements. Through this process the slope evolves toward a long-term stable angle unless erosion at the toe is maintained or re-initiated. Placing and maintaining a riprap fill under this alternative would be expected to eliminate (river) erosion at the toe of the slope. Sediment supply to the adjacent gravel bar at the inside of the bend to the pool tail at the washout and in the downstream response reach (alluvial unconfined segment) would be reduced and supply from this site would be eliminated.

The sites within the river immediately adjacent to the washout would likely become coarser (cobble dominated) and stay that way most of the time. Areas downstream would be more variable. During and for a few years following large floods and years of high sediment supply the areas downstream would be supplemented by sediment from other (upstream) sources. During periods of low supply the bed would be expected to be coarser more often and for longer

periods. An overall reduction in (coarse) sediment supply would limit channel bed gravel storage and could also limit habitat complexity, channel shifting, new side channel development, and wood loading.

Alternative E – Low-water Revetment

Direct/Indirect Effects

Olympic National Forest
Current high bank conditions and processes in terms of slope stability are as described for Alternative D. Construction of riprap to armor the road fill would limit the amount of river induced erosion at the base of the slope and slow recession. This would allow the natural shallow slope movements of ravel, collapse of blocks, and erosion of individual particles to lead to eventual stabilization of the slope in the long-term. Deep-seated, large-scale, or particularly active slope instability has not been observed in the area. A catchment area would be provided on the inside edge of the road to provide a setback for rock and debris fall and space for slope deposits to accumulate. This in combination with a catchment structure would keep an accumulation of deposits off the road. As with Alternative D slope movement would be expected to occur less in the long-term as the high bank revegetates but this condition would develop slower as more time would be needed for the high bank to stabilize naturally. The risk of slope instability under Alternative E would be lower than Alternatives B and C, and the same risk as Alternative D. The road would be located on a stable landform with the exception of the existing streambank failure. This would continue to erode into the new ditchline and catchment area. Stability of the channel and risk of damage to riprap integrity during high flows would remain a concern however. There may be a slight increase in streambank instability in downstream reaches below the site of reconstruction in the channel due to the hardening of the bank and increased velocities since channel width of the Dosewallips River would be reduced.

This alternative is designed to maintain a more natural supply of sediment from the high bank at the washout. It would also reduce encroachment of the road into the river because it is much lower in elevation. It would be designed to be over-topped during floods with estimated recurrence intervals of about 10 years (Q_{10}). Moderate to large floods such as Q_{10} and larger are expected to create the most sediment supply and substantial channel adjustments.

During floods the flow that expands over the road surface would be shallow and would not have the higher energy and shear stresses of the deeper channel areas. This flow would be expected to be ineffective with regards to spiral flow or secondary circulation and subsequent erosion of the high bank. The flow may remove some of the sediment accumulated at the base of the slope but the erosive energy may be insufficient to affect the bluff appreciably. The resulting flow might selectively remove the finer material but leave the more desirable coarse material at the base of the slope.

It is important to understand that this alternative would limit the amount of future sediment supply that would occur because the cycle of bluff slope erosion and sediment supply downstream is initiated through river erosion at the toe of the slope. Because the lower part of the slope along the channel margin would be armored with riprap the primary erosion forces

would not act directly on the base of the high bank and further bluff slope recession would be prevented. Sediment supply from the high bank would be reduced with respect to the natural condition but not as much as Alternative D.

This alternative is designed to allow the accumulated slope deposits to be transported by the river during floods when the road is over-topped. These deposits could become a road maintenance problem in years when the road is not over-topped by floods and if the flow over the road surface does not have sufficient energy to transport it downstream. A maintenance plan that includes banking the slope deposits along the riprap or along the channel margin downstream is a mitigation measure. This would allow sediment from the high bank to reach the channel but in amounts that are reduced over the natural (current) condition.

Alternatives D and E

Cumulative Effects

In terms of slope stability there is no overlap in space or time with any of the proposed activities and past, present, and reasonably foreseeable future activities identified for this area. Project effects are minor and in terms of slope stability are localized to the project area where there are no effects due to past, present, and reasonably foreseeable activities. Consequently there are no cumulative effects associated with slope stability for any of the action alternatives.

Soil Productivity

Alternative D – Replace-in-Kind

Direct/Indirect Effects

Olympic National Forest
Soil Productivity
Under Alternative D there would be fewer impacts to soil productivity than Alternatives B and C, but overall greater impacts to soils, watershed, and aquatics than Alternatives E and F. As a result of the reconstruction of FSR 2610 detrimental soil conditions would be primarily confined to the channel in the washout area and the high bank at the washout. Approximately 0.7 acre would be removed from the productive land base as a result of the area removed and disturbed above the top of the bluff. Additional surface erosion, soil displacement, and ravel would occur at the top of the bluff area until it becomes stabilized in 3 to 5 years. Surface erosion and sedimentation would also occur during the reconstruction especially across the washout area.

- Overall a net increase of 0.7 acre of new disturbance would result from this action. Within the upper watershed this is not considered to be significant and it would remain well below the Regional and Forest Standards for soil quality.

The indirect effects with soil productivity under Alternative D would be minor. Construction across the washout area would prevent the large streambank failure from depositing soil material and rock into the Dosewallips River. This material would be captured in a catchment and/or

ditchline area that would need to be removed through road maintenance on a regular basis. Other chronic road-related sedimentation would occur as a result of the road surfacing and fillslope materials being located directly within the channel. Vegetation should become established after a few years however which would reduce surface erosion and sedimentation from these slopes.

Mitigation measures identified in Chapter 2 are designed so that surface erosion, sedimentation, and water quality impacts should be minimized and would be within acceptable levels.

Hillslope Hydrology
Road reconstruction under Alternative D would not result in significant changes to the existing hillslope hydrology. Surface runoff and subsurface flows would be altered slightly with the establishment of a ditchline and culverts along the washout area reconstruction. The channel hydrology effects would be much greater than those to hillslope water and are described in the Aquatic Species and Habitat Conditions consequences section.

The wetlands along FRS 2610 to the east of the washout would not be affected under this alternative, nor would the tributary streams located east of the washout.

Alternative E – Low-water Revetment

Direct/Indirect Effects

Olympic National Forest
Soil Productivity
Under Alternative E there would be fewer impacts to soil productivity than Alternatives B, C, and D, and slightly more impacts than Alternative F. These impacts would mainly be concentrated to watershed and aquatic resources within the channel and downstream. As a result of the reconstruction of FSR 2610 detrimental soil conditions would be primarily confined to the channel in the washout area only. The high bank at the washout would not be disturbed so no impacts would occur to the area designated as late successional reserve. Additional surface erosion, soil displacement, and ravel would occur at the top of the bluff area until it becomes stabilized in 3 to 5 years. Surface erosion and sedimentation would also occur during the reconstruction especially across the washout area.

There would be no increase in area in a detrimental soil condition resulting from this action. Cumulative soil impacts in the upper watershed would remain well below the Regional and Forest Standards for soil quality.

The indirect effects with soil productivity under Alternative E would be minor. Construction across the washout area would prevent the large streambank failure from depositing soil material and rock directly into the Dosewallips River. This material would be captured in a catchment and/or ditchline area. Under this alternative road maintenance would then place this material on the lower fillslope edges adjacent to the river so that this important spawning gravel-sized material could enter the river during 10+ year flows. Other occasional road-related sedimentation would occur as a result of the road surfacing and fillslope materials being washed

off this segment when 10+ yr flows occur. Additional road surfacing would be needed when this occurs.

Mitigation measures identified in Chapter 2 for this alternative are designed so that surface erosion and sedimentation would be minimized.

Hillslope Hydrology
Road reconstruction under Alternative E would result in minimal changes to the existing hillslope hydrology. Surface runoff and subsurface flows would be slightly altered with the establishment of a ditchline and culverts along the reconstruction washout area.

The wetlands along FRS 2610 to the east of the washout would not be affected under this alternative, nor would the tributary streams located east of the washout.

Alternatives D and E

Cumulative Effects

The cumulative watershed effects area includes the entire Dosewallips watershed. The positive and negative effects include a combination of the management actions that occur on private, Olympic National Park, and National Forest System (NFS) lands, along with natural occurrences. The Dosewallips Watershed Analysis identified and described the negative effects of erosion and sedimentation, and the impacts from past management activities on aquatic habitat conditions. These resources are currently recovering from the past effects. Other detrimental conditions would remain in the watershed, comprised mainly of compacted surfaces (roading, developed and dispersed recreation sites).

Foreseeable management activities on National Forest lands include the Jackson Timber Sale and two miles of road decommissioning (FSR 2610-012). The timber sale would commercially thin approximately 1,000 acres and construct 3 miles of temporary road in the Rocky Brook subwatershed. Temporary roads would be decommissioned after use. These foreseeable actions would result in short-term sediment impacts associated with temporary road building and log haul, however they are anticipated to be relatively minor.

Other on-going and foreseeable activities on private lands include, but are not limited to the following: timber harvesting and road construction; agricultural uses; infrastructure development; dispersed recreation and off-road vehicle use. Implementation of all of these on-going and foreseeable off-site activities would occur a significant distance below the FSR 2610 washout.

All of the activities described above would result in additional detrimental soil conditions (both short and long-term), that would reduce soil productivity. Overall acres in a detrimental condition would be within Regional and Forest standards for soil quality. Within the upper watershed this is not considered to be significant and would remain well below the Regional and Forest Standards for soil quality, with a cumulative total of 42.7 acres for Alternative D and 42.0 acres for Alternative E in a detrimental condition. This includes the additional areas that are

currently in a long-term detrimental condition:

- 17 acres of Dosewallips road beyond washout (5.0 miles of road)
- 6 acres - Elkhorn Campground
- 8 acres – Dosewallips campground
- 8 acres trails, skid trails, unauthorized trails, dispersed recreation sites

Effects to soil productivity of past, present, and reasonably foreseeable activities in the Dosewallips watershed are described under the previous Olympic National Forest effects discussion. Since these effects are negligible or occur a significant distance below the proposed work site near the Dosewallips Falls, cumulative effects to soil productivity would be negligible.

Aquatic Species and Habitat Conditions

Alternative D – Replace-in-Kind

Direct/Indirect Effects

Olympic National Forest
Sediment
Source of spawning gravels and channel function
The project area represents the upstream extent of one of the three most important reaches for spawning habitat within the Dosewallips watershed (Labbe et al. 2005). Reconstructing the road corridor and hardening the streambank at the washout site would preclude the natural channel migration and erosion processes at the site and remove an important source area of spawning gravels for the complex and productive aquatic habitat immediately downstream. These processes are especially important in this location because of the amount of gravel potentially available, the limited gravel supplies available in adjacent stream reaches, the link between sediment supply and fish habitat, and the high quality and importance of fish habitat immediately downstream of the washout site.

As described under the Affected Environment section and detailed in the Reach Analysis (Cenderelli et al. 2003) the project area is unique in its ability to contribute substantial quantities of coarse sediments to this portion of the Dosewallips River. Potential coarse sediment inputs into the Dosewallips River are limited in the approximately 5-mile long hillslope confined reach immediately above the project area and in the approximately 3-mile alluvial unconfined reach immediately below the project area. The short terrace transition reach which includes the washout site provides an abundance of potential spawning gravel to the system because of the high glacial terraces immediately adjacent to the stream channel. The glacial terraces especially the high bank at the washout site also contain a high proportion of spawning gravel-size material and a relatively low proportion of fine sediments. Based on an analysis of the volume of eroding streambanks and the composition of the streambank materials the Reach Analysis concluded that approximately 41 percent of spawning gravels recently supplied to the channel within the project area originated from the eroding high bank at the washout site (Cenderelli et al. 2003).

Reconstructing the roadway and placing 680 feet of riprap through the washout would reduce the area of eroding bank (the area supplying sediment) in the terrace transition zone by about a 25 percent from the current condition (Cenderelli et al. 2003). Because of the high proportion of spawning gravel size substrate within the washout high bank relative to other eroding banks the impact to spawning gravel recruitment would be somewhat greater. Under Alternative D the road reconstruction and bank hardening at the washout site would reduce the volume of spawning gravel potentially recruited into the river from the project area by about 30 percent from current conditions (Cenderelli et al. 2003). These figures may have increased somewhat since 2002 due to the increased size of the eroding face of the high bank at the washout since the initial storm.

The length of riprap bank stabilization needed to protect the road would likely increase over time as the meander pattern changed and put additional pressure on the upstream and downstream ends of the new revetment (Leon 2004). Increasing the length of bank stabilization over time would cause further reductions in the amount of coarse sediment and spawning gravel potentially recruited from the high bank at the washout site.

How much gravel the natural bank erosion of the high bank at the washout would ultimately contribute to the stream channel if the road is not reconstructed, the timing and amount of sediment inputs, and how long the stream channel would continue to erode glacial terrace are all unknown. The stream channel would likely continue to be dynamic in the vicinity of the washout and alter both its location and shape in response to large flood events. There is no indication that the river channel will naturally shift location away from the washout site within the near future, however the rate of bank erosion along the outer bank at the washout site would probably decline over time as trees fall into the channel from the upper terrace and naturally stabilize the bank. Sediment inputs from the washout site would likely continue to be episodic (pulses) rather than a continuous steady input over the long-term.

Episodic inputs of coarse sediment and large wood are recognized as an important aspect of creating and maintaining complex, high quality fish habitat (Reeves et al. 1995). The large inputs of coarse sediment into the Dosewallips River from channel migration and erosion processes at the washout site are critical in developing and maintaining the high quality spawning and rearing habitat in the reach immediately downstream of the washout. A key assumption implicit in this analysis is that a large source of coarse sediment immediately upstream from a key habitat area is more important to maintaining that habitat than smaller sources of coarse sediment further away from the site.

The high quality, complex habitat that extends from the washout to the old Steelhead Campground one mile downstream is extremely important from a watershed context. This reach is one of three alluvial valley segments that are disproportionately important as salmon spawning and rearing areas in the Dosewallips watershed (Labbe et al. 2005). It is also one of the three primary spawning areas for Chinook and steelhead within the Dosewallips River.

Given the large percentage of coarse sediment and spawning gravel recruitment that would potentially be eliminated by the road reconstruction, the relatively limited gravel sources in the reach immediately above the project area, and the proximity of habitat immediately downstream

Alternative D would substantially reduce the quality of a key spawning and rearing reach within the Dosewallips River. Because habitat characteristics and quality typically vary over time in response to disturbances such as fires, floods, and large debris torrents, specific habitat degradation related to the road reconstruction may or may not be readily apparent. Over the long-term, reconstructing the road and preventing the coarse sediment inputs from the high bank at the washout that would otherwise occur would likely reduce the amount of time that the key spawning and rearing habitat in the reach immediately downstream would be considered to be in "good" condition and increase the amount of time that the habitat would be considered to be in "poor" condition (Shelmerdine 2006).

Approximately five log complexes would be constructed under this alternative as a mitigation measure to increase the production of gravel from one of the low terraces below the project area and to trap and temporarily store gravels that are being transported through the system. There is no expectation that the log complexes would fully make up for the loss of gravel inputs from the washout site. The terrace that the structures would be designed to erode is much smaller and the content of spawning sized gravels that make up the mid-level terrace is lower than the high bank at the washout so it would contribute much less spawning gravel. The long-term stability and effectiveness of the log complexes in mitigating the loss of coarse sediment inputs from the washout site is unknown.

The intent of the mitigation measure of placing large wood complexes along the channel margins downstream of the vicinity of the washout is to redirect flow and increase sinuosity erosion along the right bank of the mid-level terrace downstream of the riprap revetment. Increased erosion along this terrace would provide recruitment of gravels into the river which the road revetment prevents upstream. However the composition of substrate that makes up the mid-level terrace downstream of the washout is coarser than the high bank at the washout. Composition of the high bank (gravel and cobbles) is better sized for spawning gravels. So there is not a one-to-one replacement of quality and/or quantity of a spawning gravel source. One objective of these structures is to create channel complexity and high quality fish habitat. However these log complexes are somewhat experimental and there is no guarantee that the objectives will be fully achieved.

Spawning and Rearing Habitat within the Project Area

The project area is at the upper extent of one of three primary spawning reaches for Chinook and steelhead in the Dosewallips watershed. In 2002 after the washout occurred one Chinook salmon redd was documented just downstream of the washout (personal communication T. Johnson) and four coho salmon redds were also observed in the vicinity of the washout. Spawning data shows pink salmon and steelhead trout have spawned directly across from the proposed reconstruction site prior to the washout (personal communication T. Johnson).

Reconstructing the road under Alternative D would eliminate approximately 19,200 square feet of existing spawning habitat from direct filling in of the channel. Another approximately 44,400 square feet of spawning habitat would be lost from increased scour that would occur from the installation of the riprap revetment. Approximately a total of 63,600 square feet (about 1.5 acres) of anadromous spawning habitat would be lost or displaced.

If as the EDT model suggests that the spawning habitat for Chinook is currently underutilized in

the Dosewallips the reduction in spawning habitat from direct filling for the roadbed and the subsequent scour due to greater stream energy and lower sediment supply may not directly correlate to Chinook salmon mortalities.

Approximately 22,500 square feet (about 0.5 acre) of juvenile off-channel rearing habitat would also be lost or adversely impacted as a result of the road reconstruction due to channel shifts and subsequent scour (Cenderelli et al. 2003). The above areas of spawning and rearing habitat loss were calculated from channel conditions in 2002. Habitat changes that have occurred at the project site since that time may have altered the actual quantities of spawning and rearing habitat that would be eliminated or adversely impacted under this alternative.

Turbidity and Fine Sediment

Reconstructing the road and constructing the log complexes would create some substantial local inputs of fine sediment and turbidity into the Dosewallips River. Most of the fine sediment inputs associated with the project would occur during the instream water diversion activities and the subexcavation and placement of riprap along the left bank of the Dosewallips River. Turbidity and sediment inputs would be locally severe during these activities. Some sediment inputs into the river would also be caused during the second year when large wood would be buried into the river channel during the construction of the log complexes. Each of these inputs would generally be short-term during specific construction activities and would disappear quickly once those construction activities ended. While the input of fine sediments into the stream would be unavoidable the required mitigation measures would minimize impacts. Some additional streambed disturbance and generation of fine sediments and turbidity would be anticipated for at least one year as the streambed changes in response to the channel alterations.

Fine sediment generated in the Dosewallips River from construction activities would likely settle out within a short distance. Based on field experience with other construction projects deposition of fine sediments would be unlikely to be observable more than a few thousand feet below the project area.

Negative impacts of sediment and turbidity to fish immediately downstream of the project area during the instream construction phase would range from gill trauma, avoidance/displacement, and disruption of feeding behavior. Additionally the increased level of fine sediment generated during the in-channel construction work could reduce spawning, incubation, and rearing success within and immediately downstream of the project area for a short period; however the gradient, stream velocity, and discharge of Dosewallips River are sufficient to flush fines out of the system rather quickly. The newly deposited sediments would be remobilized rapidly by high water flows during the fall and winter. Observable fine sediment deposition within the project area from construction activities would be unlikely after a few years, at most. At a watershed scale the amount of sediment generated by this project would be indistinguishable in relation to the high levels of natural sediment carried by the river during typical frequent storm events.

Because the Dosewallips River is relatively swift and there are few substantial tributaries turbidity created during construction activities would likely remain in suspension for long distances. There would be a potential for short-term increases in turbidity to be observed down into the lower watershed.

The in-stream work would occur during summer low-flow conditions from July 16 to August 31. The timing restrictions would avoid direct impacts to migrating and spawning Chinook, coho, and pink salmon. The adult life stage of these salmon would not be in the river during the instream construction phase. Juvenile Chinook and pink salmon would also be unlikely to be in the river at this time. Juvenile coho, steelhead, cutthroat trout would be present in the river during the instream construction period. They have the potential to be impacted by the turbidity and fine sediment generated from the instream construction. Actual adverse impacts would depend on the magnitude and duration of the sediment and turbidity releases and the distance of the fish from the project area.

During the first and second winters following construction coarse sediment would also be mobilized due to channel adjustments from the riprap revetment and log jams and would likely settle out in pools just downstream of these sites. Scouring and filling in of redds due to gravel instability and sifting may also occur. Coarse sediment scoured from the project area would continue to be remobilized downstream following subsequent high water events. Because the instream construction would occur over two years, turbidity and sediment impacts from construction and the following winter seasons would be long-term (more than one year) in the project area. Additionally the high bank along the revetment would be cut back to 1 horizontal:1 vertical slope and it is anticipated erosion from this cutslope would last 1-2 years and be delivered to the Dosewallips until it becomes revegetated and stabilized. At the project scale there would be substantial short-term adverse impacts associated with the construction under this alternative.

Overall this indicator, sediment, would be degraded at both the project and watershed scales.

Large Woody Debris

Reconstructing the road and stabilizing the streambank at the washout would preclude natural channel migration and bank erosion processes which are currently contributing a substantial quantity of large trees to the river at the washout site. The watershed from the Forest boundary upstream appears to be in a relatively natural condition. Current amounts of large woody debris vary in the basin, the old Steelhead Campground reach immediately downstream of the washout currently has an abundant amount of large wood (Labbe et al. 2005).

The five constructed large wood complexes would partially mitigate for the future loss of large wood recruitment due to the road reconstruction and bank hardening at the washout site. The logs jams would be designed to create deep, complex pools and provide cover for fish. Three of the constructed wood complexes would also be designed to redirect flow into the right bank and increase bank erosion and potential future large wood recruitment.

Loss of large wood recruitment along the 680 feet of revetment would likely not have an impact at the watershed scale. However loss of the wood source immediately above the key spawning and rearing habitat immediately downstream could have an adverse effect on that habitat over the long-term.

Overall this indicator would be degraded at the project scale and maintained at the watershed scale.

Pool Frequency and Quality
Under Alternative D the entire river channel adjacent and immediately below the revetment would be altered. Existing pools would be filled in and others would be created by scour as the stream channel adjusted to the alterations. Approximately 22,500 square feet of rearing habitat would be directly filled in, lost due to channel shifts, or made less accessible due to channel response and adjustment to the revetment (Cenderelli et al. 2003). Effects would be limited to the immediate project area (see sediment discussion).

The formation of a large deep pool typically associated with bank stabilization projects would be less likely to occur at this site because of the extended riprap toe that would be placed under the channel bottom to protect the revetment.

This indicator would be degraded at the project scale and maintained at the watershed scale.

Off-Channel Habitat
Alternative D would be expected to eliminate or reduce seasonal access to two side channel areas within the project area. The side channel habitat that has developed behind the point bar immediately opposite the washout site would likely be eliminated due to channel shifts associated with the road reconstruction. This would reduce the ability of the project area to provide off-channel overwintering habitat for coho salmon, steelhead, and cutthroat trout.

Seasonal access into a second side channel habitat area upstream of the road reconstruction site on the north side of the river would also likely be reduced. As the river adjusts to the riprap revetment the channel would headcut upstream and cause the side channel (approximately 200 feet of side channel habitat) to be disconnected from the main channel at low flow conditions. This would reduce summer juvenile rearing habitat for coho salmon and to a lesser extent for steelhead and cutthroat trout. During higher winter flows the side channel would be reconnected with the mainstem of the Dosewallips River. At a watershed scale off-channel areas are relatively limited and any decrease is a negative impact.

This indicator would be degraded at the project scale and maintained at the watershed scale.

Width/Depth Ratio
This alternative would fill in a substantial portion of the existing river and constrict the stream channel, at least initially. Along the proposed revetment the bankfull channel width would decrease 30 to 40 percent through the meander bend (Cenderelli et al. 2003). The greatest reduction in bankfull width would occur near the upper portion of the washout. The reduced stream channel cross section would increase the flow energy and transport capacity at the site. The river would be expected to adjust with some combination of down cutting, lateral shifting and/or bed coarsening. The extended riprap toe would limit the amount of channel bed scour along the revetment. Adjustments from the reduced area of flow would likely include erosion of the point bar along the far bank and shifting the river channel to the south, away from the road. The long-term effect would likely be a channel that is slightly deeper with a coarser substrate. It would also likely be a bit narrower. As the stream channel adjusts it is also likely that the channel would headcut upstream of the revetment. The increased scour would eliminate or

displace approximately 63,500 square feet of anadromous spawning habitat directly across and up and downstream from the of riprap revetment. The largest change in channel geometry would occur during high water periods the first winter. Over time the channel would reach a new equilibrium. Impacts to stream channel geometry from the filling and relocation would be relatively localized and would not be observable at a watershed scale.

This indicator would be degraded at the project scale and maintained at the watershed scale.

Streambank Condition
Implementation of this alternative would prevent the natural, lateral channel migration processes from occurring in the vicinity of the washout. Natural inputs of coarse sediment and woody debris into the stream channel would not occur. Precluding the natural channel migration and erosion processes at the washout would in turn affect channel processes and fish habitat within the project area and immediately downstream from the washout.

Bank erosion would likely increase immediately upstream and downstream from the new riprap revetment because of the magnitude and direction of shear stresses acting on those banks. Over time the riprap revetment would likely need to be extended to protect the road corridor (Leon, 2004, Meander migration references).

Evaluation of aerial photographs indicate that the river channel in the washout area is dynamic and highly responsive. The river channel has changed its sinuosity and has undergone multiple cycles of widening and narrowing in response to large floods between 1939 and 1998. Regardless of whether the road is reconstructed this segment of the stream valley would continue to be dynamic and experience changes in channel dimensions and sinuosity in response to large floods. Channel responses to the proposed road reconstruction would most likely be limited to approximately 330 feet above the revetment (effect of headcutting). Downstream effects would be most obvious immediately downstream of the project area. Observable effects would be attenuated as you go further downstream. Measurable change would not be seen beyond the bedrock control reach approximately 3 miles downstream of the washout. Because of the forested environment and absence of infrastructure and private property the project would be unlikely to create the need for further bank hardening downstream, outside of the project area. Impacts to streambank condition would not be observed at a watershed scale.

This indicator would be degraded at the project scale and maintained at the watershed scale.

Drainage Network Increase
This alternative would not substantially affect this indicator; current conditions would be maintained at both project area and 5th field watershed scale.

Road Density and Location
Road density would be increase by approximately 0.1 miles over existing conditions. A substantially greater affect of Alternative D would be the construction of 680 feet of revetment along the Dosewallips River to protect the road. The road reconstruction would constrict the existing river channel by 30 to 40 percent (Cenderelli et al. 2003). There would also be substantial short-term instream impacts related to the construction phase of this alternative.

Because of the bank hardening and the associated reduction in channel margin complexity, habitat along the outer channel margin would be reduced. Incorporation of roughness trees along the toe of the riprap would slow river velocities down and temporarily mitigate for this reduction in rearing habitat. The roughness trees would likely only last a few year. After a few large storm events they would dislodge and float downstream. This alternative would degrade this indicator in the long-term at the project site. Impacts to road density and location would not be observed at a watershed scale and this indicator would be maintained.

Temperature
The lower portion of the Dosewallips River from River Mile 0 to River Mile 0.7 is designated as a water quality impaired 303d listed waterbody due to elevated water temperatures (Washington State 303d list, 2004). There are no 303d listed stream segments upstream on National Forest or National Park lands. This alternative would have no affect on water temperatures in the lower watershed. This indicator would be maintained at both the project and watershed scales.

Riparian Reserve Function
Localized disturbance to soil and vegetation would occur during project construction however this would be limited in extent and is anticipated to recover. The function of the riparian area at the site of the washout is primarily for large woody debris recruitment. Natural erosion processes which are the mechanism for large wood input into the river would not occur due to the bank hardening. The long-term effect would be the elimination of recruitment potential for LWD along 680 feet of streambank within the Riparian Reserve. Impacts to the Riparian Reserve would not be observed at a watershed scale.

This indicator would be degraded at the project scale and maintained at the watershed scale.

Sensitive Fish Species
The determination to Sensitive fish species, Puget Sound/Strait of Georgia Coho and Puget Sound Coastal Cutthroat Trout, found within the project area as related to this alternative would be “May impact individuals or habitat, but will not likely contribute to a trend towards Federal listing or cause a loss of viability to the population or species”.

Proposed and Threatened Fish and Critical Habitat
This alternative “may affect, and is likely to adversely affect” Puget Sound Steelhead, Puget Sound Chinook, and Critical Habitat for Puget Sound Chinook (see above effects of Alternative D). For Hood Canal summer chum and its associated critical habitat, and Coastal Puget Sound bull trout this alterative “may affect, and is not likely to adversely affect”.

Essential Fish Habitat
Alternative D would adversely affect EFH because of both the short and long-term adverse affects to Chinook, coho, and pink habitat in the mainstem Dosewallips River (see above Sediment section).

Summary
Alternative D clearly has the greatest adverse impacts to aquatic resources. It would create substantial short-term and long-term impacts. Several of the adverse impacts would extend well

beyond the immediate project area and could adversely impact aquatic habitat and/or fish populations at the watershed scale.

Rebuilding the road at the washout and stabilizing the streambank to prevent future washouts would re-establish the degraded stream conditions at the washout site that existed prior to the January 2002 storm. It would preclude the natural stream channel migration and erosion processes which are important for creating and maintaining high quality fish habitat. By eliminating the substantial inputs of coarse sediment and wood which are currently being produced from the washout site Alternative D would jeopardize the long-term maintenance of one of the primary spawning areas for Chinook and steelhead in the Dosewallips watershed.

This alternative would also create substantial adverse impacts at the site level. Reconstructing the road would fill in a substantial portion of the existing river channel at the washout site. The new roadbed would project up to 40 – 55 feet into the existing river channel from the base of the current washout. Over 40 percent of the existing channel would be filled in near the upper portion of the washout.

Reconstructing the road and relocating the river channel would eliminate a substantial amount of existing spawning habitat at the washout site either by direct filling for the roadbed or by the subsequent scour due to increased stream energy and decreased sediment supply. Chinook, coho, steelhead, and pink salmon have all been observed spawning in the project area.

Reconstructing the road and relocating the river channel would also eliminate or jeopardize the existing off-channel rearing habitat within the project area through channel shifts and subsequent scour.

Under this alternative approximately five log complexes would be constructed to partially mitigate for the substantial adverse impacts to aquatic resources. Although the complexes would likely be at least somewhat successful in meeting their objectives there is no expectation that the constructed log complexes would fully mitigate the adverse impacts of rebuilding the road in its previous location. Because constructed log placements are still somewhat experimental there would be a relatively high level of uncertainty with the long-term stability and effectiveness of these structures.

Cumulative Effects

Although the Dosewallips watershed is considered one of the more relatively intact watersheds in the Puget Sound, it is considered to have impaired ecological integrity (Frissell et at. 2000). Past and present activities in the watershed that have had a lasting detrimental affect on fish habitat include: timber harvest, splash dam operations, road building, bank hardening, LWD removal, dike construction, dispersed recreation, and conversion of floodplain to pasture land and residential development. Impacts to fish habitat occur on a gradient within the watershed. The magnitude and frequency of impacts as identified above to fish habitat are greater lower in the watershed and as you move up river fish habitat and the processes affecting habitat are less impaired.

Foreseeable activities on National Forest System lands include the Jackson Timber Sale, which would commercially thin approximately 1,000 acres and construct 3 miles of temporary road in the Rocky Brook subwatershed. There would be short-term sediment impacts associated with temporary road building and log haul however they are anticipated to be relatively minor. Any effects would occur well downstream from the FSR 2610 washout and there would be no cumulative impacts.

With the reopening of the road beyond the washout a larger area of bank hardening would be maintained in Alternative D (as in all the other action alternatives) than in Alternative A, with the riprap associated with the added 5 miles of road beyond the washout and the two campgrounds. Alternative D would add to the cumulative adverse effects to fish habitat from bank hardening actions in the watershed.

Effects from the road repair activities proposed by ONP further upstream in the watershed would not overlap with effects of this alternative. Past road and facility construction by the park has modified the amount of impervious or hard packed surface in the developed area of the park and likely changed the area drainage patterns slightly. Under this alternative with the reopening of the road park operations and road maintenance would be reinstituted. These activities would be confined to the existing road and developed area and could create negligible adverse impacts to fisheries resources from road maintenance activities such as grading and facility operation and use. This work could improve drainage as culverts are cleaned and ditchlines are cleared, resulting in beneficial, indirect effects to fisheries resources from decreased run off and improved water quality.

Maintenance of FSR 2610 below the washout would continue. There are a number of areas along the road where the river and road are adjacent to each other and the riprap and other bank stabilization measures at these points would continue to be maintained over time. These activities would occur well downstream from the washout and no cumulative impacts are anticipated.

Existing and foreseeable non-Federal activities in the lower Dosewallips watershed include timber sales, road construction, bank hardening, dike construction, LWD removal, and the conversion of floodplain to pasture lands and residential development. Assuming population increases in the lower watershed and population densities rise these future private and state actions will persist and will likely increase, thus exacerbating the adverse effects on salmonid habitat within the lower watershed.

Over the past 10 years approximately 10.1 miles of road have been decommissioned on National Forest System lands within the Dosewallips watershed. Two miles of existing roads are planned to be decommissioned on National Forest System lands within the next several years. Additionally there have been several positive efforts made to improve salmonid habitat in the lower watershed by local environmental groups, tribal, state and county governments. Projects such as levee removal, placing large wood, land acquisition and conservation easements to protect high value floodplain and riparian areas have been accomplished and are underway.

Alternative D would have the greatest impacts on cumulative effects to fish habitat when

compared to the other alternatives. Although measurable affects to the stream channel from this alternative would most likely not be distinguishable beyond 3 miles below the washout there would still be cumulative effects to fish and their habitat. As fish habitat in the lower watershed on state and private lands degrade from activities mentioned above fish utilization of habitat further up in the watershed, in relatively intact habitat, will become more important. As fish populations decline within the Dosewallips, especially Chinook and steelhead, the importance of healthy productive habitats and the processes that maintain them become more critical. The 680 feet of riprap revetment would result in the direct loss of approximately 86,000 square feet of anadromous spawning and rearing habitat. This would add incrementally to the elimination and destruction of fish habitat from bank hardening within the watershed. With regard to Chinook and a lesser extent coho, pink, steelhead and cutthroat, spawning habitat will be impacted below the washout. Because the majority of Chinook spawning occurs on National Forest (personal communication T. Johnson) and two of three spawning reaches occur below the washout, these spawning reaches are particularly important. Impacts to these reaches would have a long-term watershed scale effect to the population of Chinook in the Dosewallips.

Forest Plan Amendments

Alternative D would create substantial, short-term and long-term adverse impacts to aquatic habitat and fish in the Dosewallips watershed. This alternative would preclude the natural channel migration and erosion processes in the vicinity of the washout for the foreseeable future. It would cause direct short-term impacts to fish habitat by direct filling in of existing spawning habitat. Hydraulic changes caused by the filling in the channel and placing riprap to protect the road corridor would scour away additional existing spawning habitat and either obliterate existing off channel rearing habitat or make it less accessible. Because of the unique geologic characteristics of the washout site, the importance of the habitat immediately downstream as one of the key spawning areas for Chinook and steelhead within the watershed, and the influence of coarse sediment and wood from the washout area in maintaining the high quality habitat downstream, the adverse impacts created by this alternative would be at the watershed scale.

The magnitude, extent, and long-term nature of adverse aquatic impacts created under Alternative D would clearly be inconsistent with some of the Aquatic Conservation Strategy objectives (USDA/USDI 1994). Alternative D would also be inconsistent with the Forest Plan direction for Key Watersheds that management must maintain or improve conditions for at-risk fish (USDA/USDI 1994).

The proposed amendments to the Olympic Forest Plan would allow this alternative to be consistent with the Forest Plan. Impacts of this alternative are described in detail in the preceding pages.

Alternative E – Low-water Revetment

Direct/Indirect Effects

Olympic National Forest
Sediment

Source of spawning gravels and channel function

For the most part the substantial adverse effects to spawning gravel recruitment and channel function under Alternative E would be the same as for Alternative D. The reconstructed road and riprap revetment would preclude any further lateral channel migration and prevent future fluvial erosion of the high bank.

Although the road would be designed to be inundated during moderate and large floods and the river would theoretically have the ability to erode the high bank during these periods, the amount of new bluff slope erosion that would actually occur and the quantity of new gravels that would actually be recruited into the river would be very small. Bluff slope erosion and subsequent sediment recruitment is typically initiated by river erosion at the toe of the slope. This is the point at which the water is deepest and water velocities and sheer stress are greatest. The outside of a meander bend (at the toe of the washout high bank) is also the point where the secondary spiral circulation pattern which typically occurs around bends is most effective at creating erosion along streambanks. Because the road fill would be fully armored with riprap the primary erosion forces could not act directly on the base of the terrace and further bluff slope recession would be prevented (Shelmerdine 2006).

During floods the flow that would expand over the road surface would be shallow. It would not have the velocity, the high energy, or the shear stresses of the deeper channel areas. It would also have less spiral or secondary circulation. Flood flows over the road surface may recruit some of the sediment accumulated at the base of the slope from ravel or hillslope erosion, but the erosive energy would likely be insufficient to affect the bluff appreciably (Shelmerdine 2006).

Whether the flood waters over the road surface would have sufficient energy to transport gravel-sized substrate is uncertain. If the flood was relatively small and the floodwaters were shallow and relatively slow they could simply erode the fine sediments from the road surface and leave the coarse substrates behind.

Spawning and Rearing Habitat

Adverse effects to spawning and rearing habitat within the project area would be similar to Alternative D but they would be slightly less. The low-water revetment would have a slightly narrower footprint in the existing river channel than Alternative D. Alternative E would directly fill in approximately 5,000 square feet less habitat than Alternative D. Habitat loss caused by channel shifting and scour would likely be similar between the two alternatives. The long-term difference between Alternative D and Alternative E would likely be insignificant. Both alternatives would create substantial impacts to spawning and rearing habitat.

Turbidity and Fine Sediment Input

Adverse impacts due to fine sediment and turbidity would be similar to Alternative D however the impacts could be more chronic and more frequent. Because the road would be designed to flood this alternative has the potential of creating frequent in-channel work to maintain the riprap revetment. The low-water revetment which would be designed to be overtopped during a 10 year or larger flood event could be overtopped and require maintenance as often as every 1 to 3 years. The Duckabush River which should have comparable flows to the Dosewallips has recorded 10 year flow events in seven of the last ten years.

Due to the need for continued maintenance, sedimentation and turbidity impacts associated with instream construction work would most likely extend well beyond the initial construction phase of two years. This would extend instream construction/maintenance activities into long-term effects. However these long-term instream maintenance activities would not be of the same scale and magnitude as the original construction phase.

Under Alternative E long-term detrimental inputs of fine sediments into the Dosewallips River would occur each time the river overtops the road and the road surfacing erodes into the river. Based on recently streamflow records in an adjacent watershed this may occur every 1 to 3 years.

Large Woody Debris
Effects are the same as Alternative D.

Pool Frequency and Quality
Effects are the same as Alternative D.

Off-Channel Habitat
Effects are the same as Alternative D.

Width/Depth Ratio
For the most part effects are same as Alternative D. The revetment in Alternative E would only occupy 1/3 of the existing bankfull stream channel rather than ½ of the bankfull channel in Alternative D.

Streambank Condition
Effects are the same as Alternative D

Drainage Network Increase
Effects are the same as Alternative D.

Temperature
Effects are the same as Alternative D

Road Density and Location
For the most part effects are same as Alternative D. The revetment in Alternative E would occupy only 1/3 of the existing bankfull stream channel rather than ½ of the bankfull channel in Alternative D.

Riparian Reserve Function
Effects are the same as Alternative D.

Sensitive Fish Species
The effects of Alternative E on Puget Sound/Strait of Georgia Coho, Puget Sound/Strait of Georgia Chum, and Puget Sound Coastal Cutthroat Trout would be identical to the effects

created by Alternative D.

Proposed and Threatened Fish and Critical Habitat
ESA determinations for Puget Sound Steelhead, Puget Sound Chinook, Hood Canal summer chum, and Coastal Puget Sound bull trout are the same as for Alternative D. Puget Sound Chinook and Hood Canal summer chum Critical Habitat determinations are the same as for Alternative D.

Essential Fish Habitat
Effects are the same as Alternative D.

Summary
The effects of Alternative E on the aquatic environment would be very similar to those associated with Alternative D. It would create substantial short-term and long-term impacts. Several of the adverse impacts would extend well beyond the immediate project area and could adversely impact aquatic habitat and/or fish populations at the watershed scale.

Although the road would be designed to be overtopped during moderate and large floods the impacts on coarse sediment recruitment from the high bank at the washout site would be almost identical to Alternative D. Streambank armoring along the outside of the meander bend, the dynamics of streambed scour, and the limited capacity of shallow floodwaters over the roadway to transport coarse sediments would all preclude any substantial gravel recruitment from the high bank at the washout.

Adverse impacts due to direct channel filling and stream displacement would be less than Alternative D because the low road option would allow a narrower footprint for the road. Under Alternative E the new road would project out into the existing channel approximately 20 – 22 feet less than under the replace in kind alternative (Alternative D).

Over the long-term any difference in adverse impacts to the aquatic environment between Alternatives D and Alternative E would be insignificant.

Cumulative Effects

The cumulative effects of Alternative E to the aquatic environment would be identical to the cumulative effects created by Alternative D.

Forest Plan Amendments

Effects are the same as Alternative D.

Table 31: NMFS matrix indicators

	Effects of the Proposed Alternatives (Project Scale)						Effects of the Proposed Alternatives (Watershed Scale)						Environmental Baseline (Watershed scale)		
Indicator				Alt. D	Alt. E					Alt D	Alt. E		Properly Functioning	At Risk	Not Properly Functioning
Sediment				D	D					D	D			X	
Large Woody Debris				D	D					M	M			X	
Pool Frequency and Quality				D	D					M	M			X	
Off-channel Habitat				D	D					M	M			X	
Width/Depth Ratio				D	D					M	M		Unknown		
Streambank Condition				D	D					M	M			X	
Drainage Network Increase				M	M					M	M			X	
Road Density & Location				D	D					M	M			X	
Temperature				M	M					M	M		X		
Function of Riparian Reserves				D	D					M	M			X	

(R)estore = project is likely to have a beneficial impact on habitat indicator.
(M)aintain = project may affect indicator, but impact is neutral.
(D)egrade = project is likely to have a negative impact on the habitat indicator.

Terrestrial Species and Habitat

A summary of the environmental consequences of Alternatives D and E are presented here. A detailed discussion of the environmental consequences of these two alternatives can be found in the wildlife specialist reports for this project.

Table 32: Summary of effects to terrestrial species for ONF activities

Species or Species Groups	Species Status	Alternative D Replace-in-Kind	Alternative E Low-water Revetment
Marbled Murrelet	T	Remove 1.7 acre suitable habitat; 5 acres noise disturbance	Remove 1 acre suitable habitat; 5 acres noise disturbance
Marbled Murrelet Critical Habitat	Designated	Degrade 1.7 acre constituent element; plus remove up to 90 trees resulting in possible degrade of constituent element	Degrade 1 acre of constituent element; plus remove up to 90 trees resulting in possible degrade of constituent element
Northern Spotted Owl	T, MIS	Remove 1.7 acre suitable habitat (one activity center below habitat threshold); 7 acres noise disturbance	Remove 1 acre suitable habitat (one activity center below habitat threshold); 7 acres noise disturbance
Northern Spotted Owl Critical Habitat	Designated	Remove 1.7 acre constituent element; plus remove up to 90 trees resulting in possible degrade of constituent element	Remove 1 acre constituent element; plus remove up to 90 trees resulting in possible degrade of constituent element
Bald Eagle	S, MIS	No nest/roost habitat removal; may impact perch trees	No nest/roost habitat removal; may impact perch trees

Species or Species Groups	Species Status	Alternative D Replace-in-Kind	Alternative E Low-water Revetment
Terrestrial Mollusks	S	Remove 1.7 acre habitat, plus possible removal of up to 90 trees within habitat	Remove 1 acre habitat, plus possible removal of up to 90 trees within habitat
Van Dykes Salamander	S	Removal 1.7 acre of Riparian Reserve	Removal 1 acre of Riparian Reserve
Cope's Giant Salamander	S	Removal 1.7 acre of Riparian Reserve	Removal 1 acre of Riparian Reserve
Olympic Torrent Salamander	S	Removal 1.7 acre of Riparian Reserve	Removal 1 acre of Riparian Reserve
Townsend's Big-eared Bat	S	Remove 1.7 acre habitat (possible roost habitat); plus possible removal of up to 90 roost trees habitat	May remove 1 acre roost habitat; plus possible removal of up to 90 roost trees
Pacific Fisher	C, S (extirpated)	Degrade 1.7 acre habitat	Degrade 1 acre habitat
Deer and Elk	MIS	Increase road density 0.5 to 0.6 mi/mi^2; reduce optimal cover by 1.7 acre	Increase road density 0.5 to 0.6 mi/mi^2; reduce optimal cover by 1 acre
Pileated Woodpecker, Pine Martin	MIS	Remove 1.7 acre habitat, plus possible removal of up to 90 habitat trees	Remove 1 acre habitat, plus possible removal of up to 90 habitat trees
Primary Cavity Excavators	MIS	Remove 1.7 acre habitat, plus possible removal of up to 90 habitat trees	Remove 1 acre habitat, plus possible removal of up to 90 habitat trees
Northern Goshawk	SOC	Remove 1.7 acre habitat, plus possible removal of up to 90 trees within habitat	Remove 1 acre habitat, plus possible removal of up to 90 trees within habitat

Species or Species Groups	Species Status	Alternative D Replace-in-Kind	Alternative E Low-water Revetment
Olive-sided Flycatcher	SOC	Remove 1.7 acre habitat, plus possible removal of up to 90 trees within habitat	Remove 1 acre habitat, plus possible removal of up to 90 trees within habitat
Tailed frog and western toad	SOC	Remove 1.7 acre habitat	Remove 1 acre habitat
Forest Landbirds		Remove 1.7 acre, plus possible removal of up to 90 trees within habitat	Remove 1 acre, plus possible removal of up to 90 trees within habitat

T = USFWS, Federal, Threatened; SOC = USFWS, Species of Concern; S = R6 Sensitive species; MIS = ONF, Management Indicator Species; C = Candidate species.

Table 33: Terrestrial species effects determinations for ONF activities

Species or Species Groups	Species Status	Alternative D Replace-in-Kind	Alternative E Low-water Revetment
Marbled Murrelet	T	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Marbled Murrelet Critical Habitat	Designated	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Northern Spotted Owl	T, MIS	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Northern Spotted Owl Critical Habitat	Designated	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Bald Eagle	S, MIS	May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To the Population or Species	May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To the Population or Species
Terrestrial Mollusks	S	For the Sensitive warty jumping slug, May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To the Population or Species.	For the Sensitive warty jumping slug, May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To the Population or Species.
Van Dykes Salamander	S	No Impact	No Impact
Cope's Giant Salamander	S	No Impact	No Impact
Olympic Torrent Salamander	S	No Impact	No Impact

Species or Species Groups	Species Status	Alternative D Replace-in-Kind	Alternative E Low-water Revetment
Townsends' Big-eared Bat	S	May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To the Population or Species	May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To the Population or Species
Pacific Fisher	C, S	No Impact	No Impact

T = USFWS, Federal, Threatened; SOC = USFWS, Species of Concern; S = R6 Sensitive species; MIS = ONF, Management Indicator Species; C = Candidate species.

Social/Economic

The cost of the constructed log complexes required mitigation associated with alternatives D and E is estimated at $400,000 and is included in the present value of discounted costs for these two alternatives.

Table 34: Discounted costs

	Present Value of Discounted Costs	
Alternative	**Forest**	**Park**
D	$1,953,700	$525,400
E	$1,672,500	$525,400