Appendix 9: Draft Biological Assessment (detached)

This detachment is available on the park's website located at http://www.nps.gov/mora and on the Planning, Environment and Public Comment (PEPC) website located at http://parkplanning.nps.gov/mora.

MOUNT RAINIER NATIONAL PARK
CARBON RIVER ACCESS MANAGEMENT

BIOLOGICAL ASSESSMENT
and
ESSENTIAL FISH HABITAT ASSESSMENT

Flood damage along the Carbon River Road – February 2007.

June 2010

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Summary of Effect Determinations from the Biological Assessment

The following list is a summary of the effect determinations for Federally listed threatened, endangered, proposed, or candidate species that are known to occur and/or potentially occur in Mount Rainier National Park. The rationale for these determinations is described in detail in the accompanying Biological Assessment and Essential Fish Habitat Assessment. Formal consultation under section 7 of the Endangered Species Act with the U.S. Fish and Wildlife Service and National Marine Fisheries Service is required.

Species Name (Scientific Name)	Federal Status	Effect Determination
Bull trout (*Salvelinus confluentus*)	FT	**LAA**
Bull trout critical habitat	Designated/ Proposed	**LAA**
Canada lynx (*Lynx canadensis*)	FT	NE
Gray wolf (*Canis lupus*)	FE	NE
Grizzly bear (*Ursus arctos horribilis*)	FT	NE
Marbled murrelet (*Brachyramphus marmoratus*)	FT	**LAA**
Marbled murrelet critical habitat	Designated	NE
Northern spotted owl (*Strix occidentalis caurina*)	FT	NLAA
Northern spotted owl critical habitat	Designated	NE
Puget Sound steelhead (*Oncorhynchus mykiss*)	FT	**LAA**
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	FT	NLAA
Puget Sound Chinook salmon critical habitat	Designated	NLAA
Dolly Varden (*Salvelinus malma*)	FP	NE
Fisher (*Martes pennanti*) (West Coast DPS)	FC	NE
Magnuson-Stevens Act - Essential Fish Habitat	Designated	**LAA**
Bald Eagle (*Haliaeetus leucocephalus*)	BGEPA	NE
Definitions: LAA = “may affect, likely to adversely affect” NLAA = may affect, not likely to adversely affect” NE = “no effect”	FT = Federal Threatened FE = Federal Endangered FP = Federal Proposed FC = Federal Candidate DPS = Distinct Population Segment BGEPA = Bald and Golden Eagle Protection Act	

BIOLOGICAL ASSESSMENT

The purpose of this biological assessment is to evaluate the proposed Carbon River Access Management project, located in Mount Rainier National Park to determine to what extent the proposed action may affect federally-listed threatened, endangered, or proposed species. This biological assessment was prepared in accordance with legal requirements set forth under section 7 of the Endangered Species Act (16 U.S.C. 1536, *et seq.*), and follows the standards established in National Park Service Director's Order 12 (DO-12).

Introduction

The Carbon River Road provides visitor access to the Carbon River valley located in the northwest corner of Mount Rainier National Park. The road extends for 5 miles from the Park entrance to the Ipsut Creek campground, and provides access to several Park trails, including the popular Wonderland Trail and the Carbon Glacier. In November 2006, extreme flooding damaged sections of the Carbon River Road, altering the course of the Carbon River and Ipsut Creek, and removing several sections of the existing roadway. About 1.06 miles of the road is severely damaged, with another 1 mile of road surface damaged from the flooding (Table 1, below). After the flood, the Park Service "scratched out" several unimproved trail segments immediately adjacent to washed out sections of the road to provide public and administrative access to the area. Since the 2006 flood, the road has been closed to public vehicle access at the Park entrance, and public use of the road has been restricted to hiking and biking.

The Carbon River in this area forms a braided channel that is highly dynamic and has been aggrading at an accelerated rate over the past decade. Carbon River Road, which in some areas is lower than the adjacent Carbon River channel, has been damaged by flooding many times over its history, and increasingly so over the last few decades. The 2006 flood was the largest recorded at the downstream Fairfax stream gauge. As a result of long-term flooding effects, the park General Management Plan (GMP) Record of Decision (NPS 2002: 3) states that the park would eventually "close the Carbon River Road to private vehicles when there is a major washout of the road and convert the Ipsut Creek Campground to a walk-in/bike-in camping area." The 2006 fall flooding is considered a major washout.

The Mount Rainier National Park GMP also calls for the preservation of the Carbon River Road corridor so as to have no adverse effect on the Mount Rainier National Historic Landmark District (NPS 2002: 255). Although the GMP calls for closure of the Carbon River Road to private vehicles following a major washout, it also provides for continued use by administrative vehicles and conversion of the road to a hike and bike trail.

In planning for the future of the area, Mount Rainier National Park desires to preserve year round sustainable public access to the northwest corner of the park and to the unique and popular natural, historical and recreational features of the Carbon River Valley. The Carbon River Access Management project will define the nature and extent of public and administrative access to the Carbon River area, including for hikers, bicyclists, vehicles, camping, parking and trails.

Table 1. Summary of flood damage and proposed improvements along the Carbon River Road.

Mile	Area Name	Amount of road missing	Notes and proposed improvements
0	Carbon River Road at Entrance	N/A	No flood damage to road. Proposed engineered logjam to be constructed to protect the road in this area.
0.15	Maintenance Area	N/A	Bank erosion along the Carbon River threatens facilities in the maintenance area. Engineered logjams proposed to protect this area.
1.20	Old Mine Trailhead	N/A	Minor road damage in this area. Resurface and maintain road to Old Mine Trailhead. Construct small parking lot and vehicle turnaround.
1.45	Beginning of Falls Creek Washout	2,600 feet	Deep channel with both lanes missing. Construct by-pass trail, install erosion protection structures in road and trail, and in Falls Creek stream channel.
1.95	End of Falls Creek Washout / Former Falls Creek Picnic Area	(see above)	(Same as above)
3.14	Beginning of Ranger Creek Scour	200 feet	Partial lane missing – resurface 10 ft. wide hiking/biking trail surface. Remove Ranger Creek culvert, replace with trail bridge
3.58	Chenuis Falls Picnic Area	N/A	Eroding bank. Remove hanging culvert on small stream, replace with trail bridge.
3.93	Washout – MP 3.93	200 feet	One lane missing, install logjam or cribwall bank protection structure, reconstruct trail through the washed out section.
4.47	Washout – MP 4.47	200 feet	Two lanes missing - install logjam or cribwall bank protection structure, reconstruct trail through the washed out section.
4.62	Beginning of Ipsut Scour	1,000 feet	Deep channel with both lanes missing - re-construct trail through washed out section, possible bank protection
4.82	End of Ipsut Scour	(see above)	Install logjam or cribwall bank protection structure; reconstruct trail bridge over Ipsut Creek.
4.82	Ipsut Creek Bridge (former channel)	100 feet	Remove asphalt road surfaces, retain bridge.
4.99	Ipsut Campground and Wonderland Trailhead	N/A	Remove vault toilets and close/restore part of Ipsut Campground.

Project Location

The Carbon River Access Management project is located in Mount Rainier National Park, Pierce County, Washington. The project area is located in the upper Carbon River watershed, which is a major tributary to the Puyallup River (Figure 1). The legal description of the project area is summarized in Table 2:

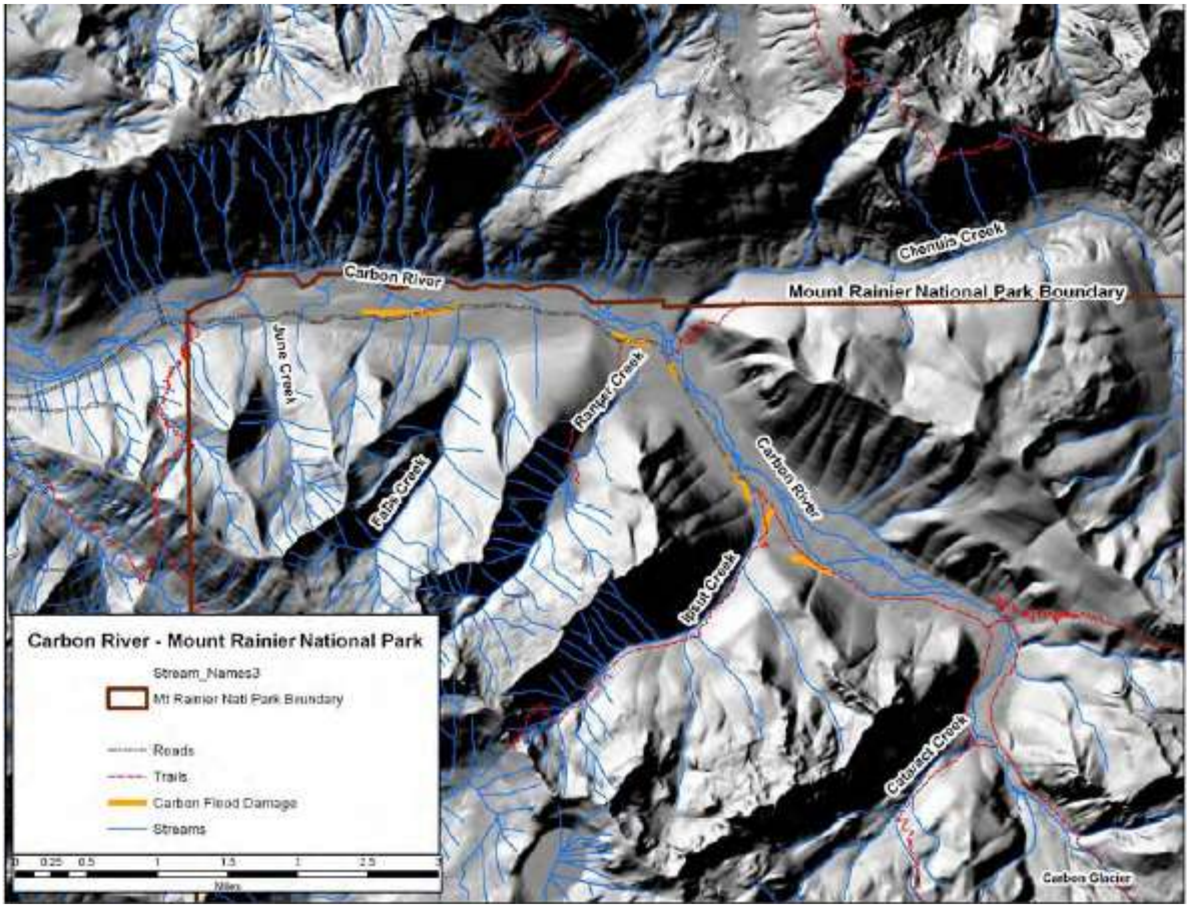

Figure 1. General vicinity of Carbon River flood-damaged areas.

Table 2. Summary of townships and sections in the Carbon River Access Management area, Pierce County, Washington, Willamette Meridian.

Township	Range	Sections	County
17 North	07 East	1, 2, 3, 4	Pierce
17 North	08 East	5, 6, 7, 8	Pierce
18 North	07 East	33, 34, 35, 36	Pierce

Consultation History

Informal consultation between the Fish and Wildlife Service and the Park was initiated by the Park in February 2007 with a site visit to view the flood-damaged areas. Meetings and correspondence between the Park and the Fish and Wildlife Service regarding this project have continued since that time, and have culminated with the joint preparation of this Biological Assessment.

Description of the Proposed Action

The Park Service has prepared a draft Environmental Assessment for the Carbon River Access Management project that identifies and evaluates a range of alternatives for this project. The alternatives range from no action (which maintains the current situation) to reconstructing the road up to milepost (MP) 4.4, or abandoning the road and constructing a new Wilderness bypass trail. The proposed action is described in the draft Environment Assessment as Alternative 2 which would maintain an improved hiking and biking trail in the historic Carbon River Road corridor.

Summary of the Proposed Action

Under the proposed action, the Carbon River Road would be open to public vehicle access from the entrance (MP 0.0) to the Old Mine Trailhead located at MP 1.22. Public access beyond the Old Mine Trailhead turnaround would be via an improved hiking/bicycling trail (10 ft. wide) within or adjacent to the Carbon River Road up to the Ipsut Creek Campground and Wonderland Trailhead (MP 5.05). Major sections of the Carbon River road remain passable and will be maintained for use as a trail. An improved trail would be constructed to bypass the washed-out sections of the road. Trail sections would be hardened with a gravel surface. Because the designated Wilderness boundary is located 100 feet on either side of the centerline of the existing Carbon River Road, the bypass trail segments will be located within 100 feet of the existing Carbon River Road alignment.

The width of the improved trail would safely accommodate hikers and bicyclists and occasional administrative vehicles, including all-terrain vehicles (ATVs) or light trucks to transport supplies and materials. Over time, the two lane roadway now extant in some sections would be converted to the multiuse trail. There would be no conversion of the roadway unless current or future damage to it precluded maintaining it. For some time to come, the Carbon River corridor would include sections of former roadway connected by new sections of improved multiple-use trail. As additional parts of the Carbon River Road are washed out in subsequent flooding, they too would be modified and reconstructed as part of the proposed trail.

Other elements of this proposal include improving parking areas at the Park entrance and at the Carbon River Maintenance Area. An expanded vehicle turnaround would be provided at Old Mine Trailhead. Park entrance and maintenance facilities will be upgraded and relocated. Some culverts on the Carbon River Road will be removed to restore fish passage and natural hydrologic functions. Trail bridges would be constructed to replace the culverts. Erosion protection measures, such as engineered logjams, will be constructed at key locations to protect Park facilities and undamaged sections of the Carbon River Road. Camping opportunities will be maintained at Ipsut Creek, and day-use picnic opportunities will be maintained at the Park entrance, Chenuis Creek trailhead, and at the Ipsut Campground. The historic Ipsut Creek Patrol Cabin will be relocated to a new location in the Ipsut Campground.

Project Elements

Parking Areas

Visitors would continue to park their vehicles in the small entrance parking area (which contains parking for approximately 12 vehicles) and in overflow areas along the road (parallel parking for 30 vehicles) up to the Carbon River Maintenance Area for approximately ¼ mile. Parking would also likely continue to occur in undesignated road shoulder areas outside the current Carbon River entrance. Additional parking area will be made available in the former Carbon River Maintenance Area for 20 vehicles. Overflow parking outside the entrance would be discouraged. The Old Mine Trailhead parking area would be converted to become a vehicle turnaround area. The turnaround area would accommodate passenger vehicles and would include a designated passenger drop-off / pick-up area.

Carbon River Entrance Facilities

The existing ranger station would be removed. The area formerly occupied by the building would be reconfigured and replaced with formal parking and picnicking. A small visitor contact station would be constructed on the south side of the road. If replacement was warranted, the vault toilets would be relocated from the north side of the road to the south side of the road. The Carbon River Entrance Arch would be reconstructed. In addition, a toll booth and small visitor contact station would be constructed on the south side of the road near the Entrance to replace some functions now served by the existing Ranger Station.

Carbon River Maintenance Area

All buildings and structures, except the historic CCC garage would be removed and replaced with formal parking and picnicking. Pending funding, the historic CCC garage would be relocated to the Thompson property. An interpretive exhibit would be placed at the former Carbon River Maintenance area and interpretive exhibits at the Entrance to explain changes that have occurred in the area.

Carbon River Road and Trail Facilities

The Carbon River Road would be retained between the entrance and the Old Mine Trailhead (a distance of 1.2 miles). This intact section of two-lane road would be reconstructed and maintained to historic road standards, with a crown and side ditches. Surfacing between the Entrance and the Old Mine Trailhead would be compacted, crushed gravel.

Public vehicles would be allowed to drive this section of road up to a turnaround provided, but would not be able to park at this location or along the narrow, winding road back toward the entrance because of poor sight distance and potential damage to large, old growth trees. The turnaround would allow drop-off and pick-up of passengers but the driver would need to return to the maintenance area, entrance or beyond to park and then rejoin their group afterwards.

Between the Old Mine Trailhead and Ipsut Creek, the road would be converted to an improved trail. An improved trail would be constructed to bypass the washed-out sections of the road. The improved trail will be up to 10 ft. wide and constructed of imported rock spalls compacted and overlain with imported $^{5}/_{8}$ inch crushed gravel, suitable for hiking and most bicycles. The trail will allow for administrative access via ATV-type vehicles to expedite trail maintenance, law enforcement and emergency access. All administrative operations would initially or eventually include more use of helicopters, particularly for emergencies.

The trail sub base for the majority of new trail construction (through or around washout areas) would utilize large native rock of assorted sizes to create a substantial base. The amount of rock fill needed for the trail construction is not yet determined, but is estimated to be hundreds of cubic yards. New stringer bridges, with rock filled gabion basket abutments, would be built over streams and low spots prone to future flooding. There are three specific wash out sections where the base is mostly silt and sand with very little native rock with which to build a sub base. Wide, flat rock filled gabion mattresses will be installed through these sections to provide the necessary sub base for the trail. These sections are: 1) a 440 foot section beginning at MP 1.56; 2) a 50 foot section beginning at MP 1.74; and 3) a 630 foot section beginning at MP 1.78.

Trail construction and maintenance would comply with ADA standards to the greatest extent possible from the Carbon River entrance to Ipsut Creek Campground, but may not be fully ADA accessible. Handicapped visitors with small electric motorized wheelchairs would be allowed to use the trail as conditions permit. Over time, however, as more flooding occurs and conditions worsen throughout the corridor accessibility may gradually worsen. The intent will be to maintain a formal improved trail throughout the corridor for as long as possible, but over time some reroute sections may become informal unimproved trail.

A total of approximately 1 mile of by-pass trails will be constructed at 3 different locations. The longest by-pass section is located at Falls Creek, with approximately 2,600 feet of by-pass trail needed, and the Ipsut Creek washout (1,000 ft. of trail needed) (Table 1, above). By-pass trail construction at Falls Creek will occur at a distance of 10 to 50 ft. from the bank of the Falls Creek / Carbon River side channel.

Additional repairs will be needed along intact road sections to repair surface scouring at Ranger Creek and other locations as needed. Most trail improvements will occur within the existing "scratched out" by-pass trail sections that have been in place since 2007, although some minor realignments may be necessary to reduce the risk of trail failure and improve trail safety. Trail realignments will be designed to minimize impacts to forest vegetation and large trees. Some limited live tree removal will be needed, as well as removal of downlogs, stumps, and understory vegetation to facilitate trail alignments (Table 3). Blasting may be needed to remove stumps in some locations. Additional trees may be identified for removal as the project is developed.

Table 3. Summary of live tree removal needed for trail realignments.

Carbon Road/Trail Mile Point	**Tree removal: small trees < 16 inch diameter**	**Tree removal: large trees ≥ 16 inch diameter**
Falls Creek Washout – MP 1.45 to 1.95	W. hemlock - 10 trees Silver fir – 1 tree Red alder – 1 tree	1 - 18" W. hemlock 1 – 16" W. hemlock 1 – 16" W. redcedar 1 – 24" W. redcedar
MP 4.47 Washout – MP 4.47 to 4.57	W. hemlock - 5 trees	none
Ipsut Creek Washout MP 4.6 to 4.8	W. hemlock - 3 trees Silver fir – 2 trees	1 - 18" W. hemlock 1 – 18" Silver fir
Total trees	22 small trees	6 large trees

Note: Additional trees may be identified for removal as the project is implemented. This estimate is based on current trail design survey notes compiled in March 2010.

Future unimproved trail would be constructed of native soil and rock and native and imported wood, where needed. Where needed, over time, sections of raised trail or boardwalk could also be constructed. In washout areas, a structural permeable design (to allow water passage) would likely serve as the base of the trail.

Rock Hauling and Storage

The project will require the use of imported rock. Both coarse rock material and crushed rock will be used to for this project. Rock for the project will originate from a private quarry located near Enumclaw, and will be hauled via dump truck to the Park maintenance area. Rock storage will occur at the maintenance area and the Old Mine Trailhead area. The haul route from Enumclaw to the Park entrance is all located on paved State and County highways. ATVs with trailers will be used to haul rock to trail construction sites from the Old Mine Trailhead.

Stream Crossings

Road culverts between the Entrance and the Old Mine Trailhead would continue to be maintained. Culverts in this section of the road do not cross fish-bearing streams. From MP 1.2 up to Ipsut Creek campground there are 23 culverts. Most of these are cross drain culverts that do not connect to stream channels. Several culverts were washed out during the flood and are now embedded in stream banks or in debris jams. A total of 10 trail bridge crossings have been identified along the corridor. There are 6 crossings over fish-bearing streams, including large culverts at Falls Creek and Ranger Creek (Table 4). All culverts on fish bearing streams now present barriers to fish passage. The Falls Creek culvert is located in an abandoned stream channel and is completely filled with stream sediment and no longer functions as a culvert. The Falls Creek culvert no longer crosses an active fish bearing stream, but is included here because of its location on the edge of the Falls Creek – Carbon River side channel. The concrete bridge at Ipsut Creek (MP 4.85) is not included in the list of fish stream crossings, as this bridge crosses the former Ipsut Creek stream channel that is now abandoned. Under the proposed action, the bridge will remain in this location for use as a trail bridge.

Culverts on fish bearing streams will be excavated and removed to improve fish passage and natural hydrologic function in these streams. Trail crossing structures such as log-stringer bridges will be constructed to replace corrugated metal pipes. Culvert removal and replacement work will occurring during summer low-flow periods when some streams are completely dry or have minimal flow levels. Culverts will be removed using a small excavator. Culvert pipe will be cut into sections and hauled out using ATVs or small trucks, or sections may be hauled out with a helicopter.

Culvert removal in flowing streams (e.g. Ranger Creek) will require project-area dewatering and fish removal prior to excavating the pipe. Instream excavation will occur during the Washington Department of Fish and Wildlife approved season for inwater work (July 16 to August 15).

For a complete list of all project criteria to minimize impacts associated with stream crossings and heavy equipment use, refer to the Avoidance and Minimization Measures (p. 31).

Table 4. Summary of stream crossings over fish-bearing streams in the Carbon River corridor.

Carbon Road/Trail MilePoint	Stream Name	Existing Structure	Replacement Structure	Fish habitat/ comments
1.468	Falls Creek trib. #1	24 inch corrugated metal pipe (cmp), partially buried.	Remove culvert, replace with 4-stringer bridge, 15 feet long. Install grade-control check dam upstream of crossing.	Seasonally dry tributary, presumed rearing for habitat for bull trout/ steelhead
1.496	Falls Creek trib. #2	24 inch cmp, partially buried.	Remove culvert, replace with 4-stringer bridge, 15 feet long. Install grade-control check dam upstream of crossing.	Seasonally dry tributary, presumed rearing for habitat for bull trout/ steelhead
1.644	Falls Creek, new stream channel location.	Existing trail bridge over the new Falls Creek stream where it enters the road washout.	Existing trail bridge will be replaced in the new trail alignment. Replace with a 4-stringer bridge, 35 feet long with gabion basket abutments.	May be seasonally dry in some years. Documented bull trout rearing habitat – proposed bull trout critical habitat. Presumed rearing habitat for steelhead.
1.680 – Not a fish-bearing stream-crossing	Falls Creek historic crossing location, now filled with gravel.	11' x 6' cmp, 33 ft. in length. Structure is completely filled with gravel, non-functional.	Remove culvert, back-fill trench with coarse rock and re-grade site to existing trail alignment and elevation.	Excavation site intersects with the new Falls Creek/Carbon River side channel. May be seasonally dry. Bull trout presence documented in new side channel up to this culvert location.
3.142	Ranger Creek	12' x 7.6' cmp, 30 ft. in length. Structure has a 1 ft. drop at culvert outfall, creating a partial barrier to fish passage. The bankfull width is about 22 ft. wide above the culvert.	Remove culvert. Construct steel I-beam bridge, 40 ft. long, 10 feet wide with concrete footings.	Documented bull trout spawning and rearing, steelhead rearing habitat. Designated as bull trout critical habitat. Culvert removal will restore fish access to 0.5 miles of high quality spawning and rearing habitat.
3.586	Unnamed tributary at Chenuis Creek trailhead.	9.6' x 6.6' cmp, 39 ft. in length. Structure has a 3 ft. drop at the culvert outfall, and is a total barrier to fish passage. Large sediment deposit above the culvert, bankfull width above the culvert is about 15 ft. wide.	Remove culvert. Construct steel I-beam bridge, 30 ft. long, 10 feet wide with concrete footings.	Documented bull trout presence at the culvert outlet. Culvert removal will restore fish access to 0.25 miles of high quality spawning and rearing habitat.
4.802	Ipsut Creek, new stream channel location resulting from 2006 flood.	Current log-trail bridge over stream is 6' x 40'. Bankful width at this crossing is about 30 ft.	Install a new 8' x 50' log stringer bridge, on elevated footings.	Documented bull trout spawning and rearing. Designated as bull trout critical habitat.

Erosion Protection Measures

The Carbon River shoreline along the south bank of the river from the Park entrance upstream to the Ipsut Creek confluence is approximately 4.77 miles in length. Bank erosion analysis completed by the Park indicates significant bank erosion in the road washout areas over the past decade. The Park will build or contract out to be built several erosion prevention structures along approximately 1,630 linear feet of the Carbon River channel at 7 different locations. Additional bank protection structures are proposed at Falls Creek and Ipsut Creek (Table 5, below). Several of the structures (engineered log jams or crib-wall structures) would be installed along the bank of Carbon River, others structures will be built into the road or trail. Appendix 1 provides location maps and conceptual designs for each proposed structure. All structures installed in the river will use accumulations of logs, rootwads, and large wood to create structures that maintain important fish habitat features and use natural fluvial processes to achieve the desired bank protection. The wood will be harvested from within the Carbon River floodplain as directed by Park Biologists. No trees in the Park would be felled to be used in the structures. If additional wood is needed the Park will purchase wood from local sources and haul the logs to the project site. River cobbles will be excavated from exposed gravel bars in the main Carbon River channel to use as ballast in the log jam structures. In channel excavation with heavy equipment will occur in isolation from flowing water, and will only occur during the approved season for inwater work. In some locations the Carbon River would have to be temporarily diverted around a work site so construction could take place in the dry. For a complete list of all project criteria to minimize impacts associated with instream excavation and heavy equipment use, refer to the Avoidance and Minimization Measures (p. 31).

Several different types of bank protection structures are proposed. The Park solicited conceptual designs and recommendations from Geomax Engineering, Inc. and Entrix, Inc. consultants. The bank protection structures are not intended to prevent flooding; rather, they are intended to change the character of potential flood damage from deep scouring and head-cutting to sheet flow, quickly diverted off the road or to minimize wide-scale bank erosion along the river side of the road. Neither consultant had recommendations that could sustainably alter the character of flooding in the Falls Creek washout area because this area is lower than the adjacent river bed. The following types of structures are proposed:

Rock barbs

Barbs are low-elevation structures that are projected into the channel from a bank and angled upstream to redirect flow away from the bank and to control erosion. Barbs function similarly to weirs in that flow spills over the barb toward the center of the channel, reducing the water velocity near the bank. Barbs also increase channel roughness, which dissipates energy, reduces channel-bed shear stress and interrupts sediment transport (ISPG 2003:6-23). Due to uncertainty about project funding, a rock barb structure is proposed at the maintenance area, with the intention that the rock used for the structure could later be recycled as ballast in an engineered logjam at the same location.

Engineered log jams

Engineered log jams (ELJs) are collections of large wood that redirect flow and provide stability to an eroding streambank or downstream gravel bar. Engineered log jams are used to realign a channel or redirect flow away from a streambank to protect it from erosional forces. They are also used to increase channel roughness to reduce flow velocities and shear stress along eroding banks. Large-woody-debris jams create a hydraulic shadow, a low-velocity zone for some distance downstream that allows sediment to settle out and stabilize. By locating a log jam along an eroding bank, the bank downstream of the jam becomes a deposition zone rather than an erosion zone. The deposition zone tends to become vegetated and continues to grow in volume over time. Engineered log jams as a bank-protection treatment are still considered experimental, but they are becoming increasingly popular as bank protection because they integrate fish-habitat restoration with bank protection (ISPG 2003:6-31). Engineered log jams are proposed at the Park entrance and maintenance area (Table 5). Refer to Appendix 1 for a conceptual design drawings of engineered log jams.

Log crib walls and log/rock roughened toes

Log crib walls are structures built of logs laid horizontally and separated by smaller wooden spacers. Cribwalls are essentially vertical retaining walls constructed of stacked logs and back-filled with rock. Log cribwalls are typically applied as bank protection on steep slopes. They are often installed where floodplain encroachment has occurred, and a near-vertical structure is required to protect an eroding streambank. As part of construction, the existing bank is usually excavated where the cribwall will be placed to minimize channel confinement at the site and the log cribwall should be extended below the anticipated depth of scour in the adjacent channel (IPSG 2002: 6-99).

Log / rock roughened toes are structural features that prevent erosion at the toe of a streambank. The toe refers to that portion of the streambank that extends from the channel bottom up to the lower limit of vegetation or to a distinct break in slope between the top of the bank and the streambed. Log toes can provide the foundation for upper-bank treatments such as reinforced soil or resloped banks. Log toes are generally constructed of logs and gravel fill between logs, but may also include components made of large woody debris to provide additional habitat value. Log toes may also incorporate large rock or rip-rap material to provide added protection. Log toes differ from log cribwalls in two primary ways: 1) log toes are not structural retaining walls, and 2) the top elevation of log toes does not exceed the lower limit of vegetation on the bank (IPSG 2002: 6-79).

Due to equipment limitations to access areas beyond the Falls Creek washout, the Park is proposing to use gabion baskets as a substitute for rip-rap in the construction of log/rock roughened toe structures. In this application, the Park is proposing to use river rock excavated from the Carbon River channel to fill gabion baskets to construct roughened toe bank protection structures in the washouts above Falls Creek (Table 5). Refer to Appendix 1 for proposed locations and conceptual design drawings.

Drop structures, check dams, and roughness trees

Drop structures are low-elevation weirs (or check-dams) that span the entire width of the channel. They are designed to spill and direct flow away from an eroding bank, dissipate and redistribute energy and provide grade stabilization. Drop structures are commonly used in degrading channels to restore the channel bed to a more stable profile and elevation. They can also act as grade-control structures. Drop structures are typically constructed with logs and rock, and the configuration of the structure may vary from straight weirs, upstream-oriented chevron weirs, or arch configurations (ISPG 2003:6-31). Roughness trees are logs with rootwads or whole trees that are placed parallel to an eroding streambank to reduce bank erosion. When positioned properly, roughness trees reduce bank erosion, trap sediment, and allow the establishment of vegetation, which ultimately results in the stabilization of actively eroding banks (ISPG 2003:6-61).

The Park is proposing to install a series of drop structures in the Falls Creek washout, which is now functioning as the Falls Creek stream channel and as an active side channel of the Carbon River. The Falls Creek structures will use both roughness trees and drop structures to reduce bank erosion and scour along the south bank of the channel adjacent to the proposed trail location. All drop structures will be constructed with low notches with a maximum drop height of 8 inches to maintain fish passage. For a complete list of all project criteria to minimize impacts associated with instream structures refer to the Avoidance and Minimization Measures (p. 32). Drop structures are proposed at Falls Creek, and in other tributary streams to control stream gradient (Table 5). Refer to Appendix 1 for conceptual design drawings and location maps.

Rock and log-filled road humps

Road or trail humps will be constructed in several locations along the access route. These structures are designed to divert surface flow off of the road surface and minimize road surface scour during flood events. The basic concept is to construct a ditch in the road and then fill the ditch with logs or large rock that will deflect surface flow and road scour if the road is overtopped by floodwaters. Road humps are proposed at several locations along the Carbon River road/trail corridor (Table 5). Refer to Appendix 1 for conceptual design drawings and location maps.

Table 5. Summary of erosion control structures proposed for the Carbon River Road/Trail. Refer to Appendix 1 for location maps and a more detailed description and conceptual drawings of the proposed structures.

Carbon Road / Trail Mile Point	General location	Structure type	River/stream channel directly affected (below the bankfull channel width)	Fish Habitat/Comments
0.0	Park entrance - south bank of Carbon River braided channel complex	Potential site for (2) Engineered log jams (60' x 20')	1,200 ft^2 / 60 linear ft. Carbon River channel will be occupied by each log jam. The construction foot print is estimated to be 2x the structure area = 4,800 ft^2 /240 linear ft.	Yes - below OHWM along south bank of Carbon River – near confluence of June Creek and main Carbon River – wet site, requires water diversion. – Potential steelhead, Chinook, bull trout spawning habitat.
0.15	Maintenance area - south bank of Carbon River braided channel complex	(1) Rock barb deflector to potentially be replaced later in time with (2) Engineered log jams (60' x 60' each)	3,600 ft^2 / 60 linear ft. in Carbon River channel will be occupied by each log jam. The construction foot print is estimated to be 2x the structure area = 14,400 ft^2 /240 linear ft.	Yes – below OHWM along south bank of Carbon River – may be seasonally dry.
0.20 – 1.45	Carbon River Road between Maintenance area and Falls Creek washout	(5 to 9) Rock/log core road humps.	No direct instream construction work is indicated in this area.	No fish stream crossings are indicated in this section of the road.
1.45 – 1.95	Falls Creek washout	Approx. (26) instream log drop structures	2,600 linear feet of Falls Creek / Carbon River side channel – approx. 1 log structure per 100 ft. of stream channel. 2 additional drop structures may be installed on Falls Creek tributaries.	Yes – proposed bull trout critical habitat, rearing habitat for bull trout, steelhead
2.95	Bedrock knob area between Falls Creek and Ranger Creek – Described as an expanding floodplain scour channel.	Approx. (4) instream log drop structures	400 linear ft. of floodplain scour channel adjacent to road – approx. 1 structure per 100 linear ft. of channel.	Unknown. The channel is seasonally dry; connectivity to Carbon River is not described.
3.459	Washout at milepost 3.46	Gabion log / rock roughened toe structures 15' x 240'	3,600 ft^2 /240 linear ft. of Carbon River channel – would be filled with logs/rock/ and gabion baskets. River rock excavation for gabions is estimated at 1,300 CY.	Yes – below OHWM along south bank of Carbon River– may be seasonally dry.

Table 5 continued. Summary of erosion control structures proposed for the Carbon River Road/Trail. Refer to Appendix 1 for location maps and a more detailed description and conceptual drawings of the proposed structures.

Carbon Road / Trail Mile Point	General location	Structure type	River/stream channel directly affected (below the bankfull channel width)	Fish Habitat/Comments
3.58	Hanging culvert tributary at Chenuis Trailhead	Approx.(3) instream log drop structures	Large accumulation of sediment above culvert (650 CY). Drop structures needed to control head cutting at culvert removal site. 300 linear ft. of stream channel – approx. 1 log structure per 100 ft. of stream.	Yes - access to channel is currently blocked by hanging culvert at Chenuis trailhead. Culvert removal will provide fish access to approx. 0.25 miles of high quality spawning and rearing habitat for bull trout.
3.76	Road surface scour at milepost 3.76	Rock/log core road humps.	Approximately 100 feet of road surface scour damage.	No – located on the edge of the active floodplain, but above the OHWM. Dry site, no water diversion needed
3.93	Road washout at milepost 3.93	Gabion log / rock roughened toe structures 15' x 200'	3,000 ft^2 /200 linear ft. of Carbon River channel – would be filled with logs/rock/ and gabion baskets. River rock excavation for gabions is estimated at 1,084 CY.	Yes – below OHWM along south bank of Carbon River – may be seasonally dry
4.47	Road washout at milepost 4.47	Log crib wall or gabion log / rock roughened toe structures 15' x 380'	5,700 ft^2 /380 linear ft. of Ipsut Creek channel – would be filled with logs/rock/ and gabion baskets to construct log crib wall. River rock excavation for gabions is estimated at 2,060 CY.	Yes – below OHWM along south bank of Carbon River – near confluence of Ipsut Creek and Carbon River. Sensitive site for river gravel excavation due to close proximity with Ipsut Creek – may be seasonally dry

Table 5 continued. Summary of erosion control structures proposed for the Carbon River Road/Trail. Refer to Appendix 1 for location maps and a more detailed description and conceptual drawings of the proposed structures.

Carbon Road / Trail Mile Point	General location	Structure type	River/stream channel directly affected (below the bankfull channel width)	Fish Habitat/Comments
4.62	End of the intact road below the Ipsut Creek scour.	Buried groin structure.	No direct instream construction work is indicated in this area. Structure may eventually be exposed by flood erosion.	No – Buried groin structure would be located about 60 feet back from the Ipsut Creek –Carbon River channel.
4.65	Threatened trail segment adjacent to lower Ipsut Creek at MP 4.65	Potential site for a gabion log / rock roughened toe structure adjacent to trail location. 15' x 130'	Structure estimated at 1950 ft^2 / 130 linear ft. – toe-roughened structure to protect trail location. River rock excavation for gabions is estimated at 704 CY.	Yes – below OHWM along lower Ipsut Creek – wet site, requires water diversion. Bull trout spawning/ rearing habitat, potential steelhead spawning/ rearing habitat.
4.8	Ipsut Creek diversion	Stream diversion site that would divert lower Ipsut Creek into a former channel location and reduce risk to this section of trail.	Diversion out of current channel would result in dewatering about 800 ft. of stream. Diversion to old channel would rewater about 650 ft. of abandoned channel.	Yes – below OHWM along lower Ipsut Creek – Diversion would result in net loss of 150 ft. of spawning /rearing habitat. Fish capture and removal from dewatered channel required.

Excavation of River Gravels from the Carbon River

Several thousand yards of river rock will be excavated from exposed bars in the main Carbon River channel for use in the construction of engineered log jams, and other bank protection structures. The total amount of gravel needed is estimated at over 5,500 cubic yards for bank protection structures in washed out road sections. The in channel excavation area for river gravels is currently estimated at approximately 1.14 acres distributed across 4 sites. Excavation of river gravels is limited to that needed for the construction of bank protection structures. Excavation is limited to dry, exposed gravel bars, and cannot exceed the depth of the adjacent water level in the river. For a complete list of all project criteria to minimize impacts associated with instream excavation and heavy equipment use, refer to the Avoidance and Minimization Measures (p. 31).

Carbon River Road and Facility Obliteration/Restoration

There would be no active restoration of the Carbon River Road not encompassed by the proposed trail. The width of the historic road corridor would be retained where possible, including the existing canopy width and roadside vegetation. Cross-drain culverts would be retained, while culverts over streams will be removed and replaced with trail bridges. Other road characteristics, including the crown and side ditches would likely be lost over time due to the inability to get heavy equipment into the area to maintain these.

Ipsut Creek Campground

Ipsut Creek Campground would be rehabilitated as a hike-in/bike-in backcountry camp with 15 individual sites and three group sites. Thirteen sites would be removed and restored. The three group sites would either be within the campground in combined sites or would be located in the former Ipsut Creek Trailhead Parking Area. Vault toilets would be removed and replaced with backcountry toilets. This will entail flying in a pump and tank with a helicopter so the vaults can be pumped before being dismantled. All asphalt, bumper-stops, buildings, some picnic tables and campsites, and most signs would be removed. The Ipsut Creek bridge would be retained as long as it is viable for public trail use and doesn't impede hydrological conditions. If either of these two occurred, it would be removed. The former chlorinator building and amphitheater storage shed would also be removed. Bear-proof food storage containers would be added in the campground. The Ipsut Creek Patrol Cabin, which was deconstructed following the 2006 flood would be reconstructed in a new location on higher ground near Ipsut Creek Campground in the former Ipsut Creek Trailhead Parking Area.

New Facilities Outside the Park Boundary

If possible, a new parking area would be identified and constructed outside the Carbon River Entrance on land intended for the boundary expansion or via agreement park partners.
Upon acquisition of boundary expansion lands, planning will begin for relocation of drive-in camping and administrative facilities outside the Carbon River Entrance. All future developments associated with a potential boundary expansion will be evaluated in a separate analysis, and are not addressed further in this Biological Assessment.

Helicopter Use

A large, double-rotor helicopter (such as a Boeing Vertol 107 II or a Chinook 47-D) will be used to fly equipment into and out of the Ipsut Creek campground area. Flight staging areas will occur at the Thompson Property (located approximately 2.2 miles west of the Park), the Maintenance Area, and Ipsut Creek campground. A helicopter may also be used to fly-in logs or equipment for the construction of bank protection structures in the washout areas. The flight corridor for project activities would occur over the Carbon River channel for approximately 7 miles from the Thompson Property up to Ipsut Creek Campground. For a complete list of all project criteria to minimize impacts associated with helicopter use, refer to the Avoidance and Minimization Measures (p. 30).

Work Activities and Project Equipment:

A variety of equipment and tools are needed to complete this project. Large dump trucks will be needed to haul rock and gravel for road repairs from the entrance to MP 1.22. Trail construction will require the use of small dumptrucks or ATVs to haul rock, tools, supplies, and personnel into work sites. Multiple trips per day will be required over a work season that could extend from late March into November. A tracked excavator will be needed remove culverts and place erosion control structures. Chainsaws will be needed to clear down logs and vegetation for trail realignments, and for erosion control structures. Helicopters will be used to fly equipment into and out of the project area. All of this equipment generates loud noises that could disturb or displace wildlife from the project area.

Table 6 is a summary list of the various types of equipment likely to be used and the approximate sound levels (decibels) (dB) associated with each. Sound levels are generally reported in dBA which refers to the A-weighted dB scale which represents the normal range of human hearing. Table 7 provides a summary of the estimated noise contours used to calculate the area affected by project generated noise.

Table 6. Summary list of various equipment and typical noise levels that will be used for the Carbon River access management project.

Equipment	Typical noise level (dBA)	Distance from source	Reference
ATV 4 x 4	75-89	50 ft.	1
Backhoe	78-80	50 ft.	2
Chainsaws – various models	77-88	50 ft.	3
Chainsaw – Stihl 038 model	91	50 ft.	4
Chainsaw – Stihl 044 model	83-88	50 ft.	5
Chainsaw – Stihl 025 model	78	50 ft.	6
Concrete Saw	90	50 ft.	2
Concrete Mixer Truck	79-85	50 ft.	2
Dozer	82-85	50 ft.	2
Dump Truck	76-84	50 ft.	2
Excavator	81-85	50 ft.	2
Generator	81-82	50 ft.	2
Grader	89-92	50 ft.	7
Grapple (on backhoe)	85-87	50 ft.	2
Jackhammer	85-89	50 ft.	2
Loader	79-80	50 ft.	2
Pick-up Truck	55-75	50 ft.	2
Portable Pump	77-81	50 ft.	2
Rock Drill	81-85	50 ft.	2
Roller	80-85	50 ft.	2
Helicopter – Boeing Vertol 107-II (Double-rotor, 10,000 lb. lift capacity commonly used for logging operations)	91-97	195 ft.	8
Helicopter – Chinook 47-D (Double-rotor military helicopter, 20,000 lb. lift capacity).	93-98	394 ft.	9

References:

1. Martin et al. 2005 – California Off-Highway Vehicle Noise Study, Table 4.1 – EPA F-76 Test results for ATVs (Note: All but one of the ATVs tested at 75-79 dB at 50 ft.).
2. FHWA 2006 – Highway Construction Noise Handbook – Table 9.1 – Default noise emission reference levels.
3. NPC 2005 – Chain saw noise levels - based on reported values of 106-117 dB at the operator, and adjusted for a "soft site" attenuation of -7.5 dB for every doubling of distance from source.
4. USFWS 2003, p. 273 – Sound measurements for chainsaws - Olympic Natl. Forest Programmatic Biological Opinion. Based on a maximum sound level of 90.8 dB for the Stihl 038 at 50 ft. The peak sound reading for this saw was 104.2 dB at 50 ft.
5. NPS 2009 – Sound measurements for chainsaws - based on reported values of 112-117 dB at the operator, and adjusted for a "soft site" attenuation of -7.5 dB for every doubling of distance from source.
6. Delaney and Grubb 2001 (p.25). Typical chainsaw noise at 15 m was 77.8 dBA for a Stihl 025.
7. Delaney and Grubb 2004 (p.41). Sound recordings of road maintenance equipment. Based on reported values of 83.3 to 85.9 dBA for road graders at a distance of 30m in a forest setting.
8. USFS 2008 – Sound measurements for helicopters during logging operations.
9. Newman et al. 1984 – Noise measurement flight test for Boeing Vertol 234/Chinook 47-D.

Table 7. Estimated noise contours for various project activities.

Type of Equipment	Approximate sound level at 1 m (3.28 ft.) from source	Typical sound level at 50 ft. from source	Approximate distance to 92 dB contour	Approximate distance to 70 dB contour	Approximate distance to near ambient levels (45 dB)
Road Grader[1]	120 dB	91 dB	45 ft.	340 ft.	~2,900 ft.
Chainsaws, (large models), loud end of spectrum[2]	117 dB	88 dB	33 ft.	260 ft.	~2,100 ft.
Heavy Equipment (Excavators, Dump Trucks)[3]	115 dB	85 dB	26 ft.	210 ft.	~1,700 ft.
Portable pumps, ATVs, Loaders[4]	110 dB	81 dB	18 ft.	130 ft.	~1,200 ft.
Helicopter[5] – Boeing Vertol 107-II (Double-rotor, 10,000 lb. lift capacity commonly used for logging operations)	n/a	n/a	450 ft.	>3,000 ft.	>10,000 ft.
Helicopter[6] – Chinook 47-D (Double-rotor military helicopter, 20,000 lb. lift capacity)	n/a	n/a	800 ft.	>3,000 ft.	>10,000 ft.

Note: All values are approximate based on a "soft-site" attenuation rate of -7.5 dB for every doubling of distance from the source (WSDOT 2008).

[1] Based on sound measurements reported in Delaney and Grubb 2004.
[2] Based on sound measurements reported in NPS 2009, NPC 2005, and USFWS 2003.
[3] Based on sound measurements reported in FHWA 2006.
[4] Based on sound measurements reported in FHWA 2006 and Martin et al. 2005 (ATVs).
[5] Based on sound measurements reported in USFS 2008, which used a -6 dB standard attenuation rate.
[6] Based on sound measurements reported in Newman et al. 1984, and analysis presented in USFWS 2009 (Greenwater BiOp).

Project Schedule and Duration

The project work and activities associated with the Carbon River access management project will occur over a period of 3 or 4 work seasons depending upon funding. The work season identified by the Park for this project begins in mid-March and extends into mid-November. Project implementation is expected to occur from late summer 2010 through 2013 or 2014.

The following dates are significant for evaluating effects to listed species in this Biological Assessment:

- *April 1 to August 5* – is the marbled murrelet early nesting season and is a critical period for disturbance at nest sites. Project work that occurs during this period is likely to adversely affect marbled murrelets.

- *August 6 to September 15* – is the late marbled murrelet nesting season. Potential disturbance to murrelets can be minimized with daily operating restrictions during this period. Project work that occurs during this period is not likely to adversely affect marbled murrelets.

- *September 16 – April 1* – is the winter non-nesting season for murrelets. Project work that occurs during this period has no effect to marbled murrelets.

- *July 16 to August 15* – is the approved season (31 days) for inwater work with heavy equipment in the upper Carbon River and its tributaries. This restriction is not applicable at project sites that are seasonally dry from July to October.

- *July 9 to August 22* – is the extended season (45 days) for inwater work associated with the installation of bank protection structures along the main Carbon River.

Project implementation schedule

The general sequencing of the project under Alternative 2 is expected to take 3 to 4 work seasons to implement. The actual dates for implementation may change from this general outline, depending upon project funding and the completion date of the Environmental Assessment. Projects that require inwater excavation with heavy equipment or water crossings with heavy equipment are constrained to the approved season for inwater work to minimize impacts to listed fish species. If all compliance documents are completed by August 2010, the following general schedule could be implemented:

2010 work season – assumes project work activity will begin after August 6:

- Remove buildings at the Park Entrance and Maintenance areas.
- Ipsut Creek Campground area decommissioning.
- Install road humps and regrade the Carbon River Road to the Mine Trailhead.
- Construct Mine Trailhead turnaround and vehicle parking.

2011 work season (approximately March 15 to November 15):

- By-pass trail construction through the Falls Creek washout.
- Install check dams, drop structures, roughness trees at Falls Creek washout, Magirl Channel, and Bedrock Knob.
- Install engineered log jams at Park Entrance and Maintenance Areas.
- Reconstruct trail surface in damaged sections of road and install road humps between Falls Creek and Chenuis Trailhead area.

2012 work season:

- Install toe-roughened gabions / log cribwalls structures through road washouts located between the Falls Creek and the Ipsut Creek Campground.
- Reconstruct trail sections through or around washouts.
- Reconstruct trail surface in damaged sections of road and install road humps in intact sections of road between Chenuis Trailhead and Ipsut Creek.

2013 work season:

- Excavate large culverts at Ranger Creek, Chenuis Trailhead, and Falls Creek
- Construct trail bridges to replace large culverts
- Construct new trail bridge at Ipsut Creek

Table 8 provides a summary of the estimated project schedule:

Table 8. Summary of the **2010** proposed work schedule (Alternative 2).

General Area / Mile Post	Project Activity	Expected work dates	Estimated duration	Equipment needed
Park entrance to maintenance area MP 0.00 to 0.15	Remove buildings at the Park Entrance and Maintenance areas	Aug 6 - Sept 15 and/or Sept 16 – Nov 15	10 days	Excavator Front end loader dump truck
Ipsut Creek Campground MP 4.9 MP 0.0 to 4.99	Install composting toilets, remove asphalt and old vault toilets	Aug 6 - Sept 15 and/or Sept 16 – Nov 15	15 days	Helicopter, Chainsaw ATV's Jack hammer Generator Power tools
Park entrance to Mine Trailhead MP 0.0 to 1.20	Install road humps and regrade road to the Mine Trailhead, construct 5 car parking and vehicle turn-around.	Sept 16 – Nov 15	20 days	Road grader Chainsaw Excavator Dump truck
Falls Creek washout MP 1.45 to 1.95	Fall trees necessary for trail realignments Blast stumps (?) necessary for trail realignments.	Sept 16 – Nov 15	10 days	ATVs Chainsaws

Table 8 continued. Summary of the **2011** proposed work schedule. All dates are approximate and subject to change pending project funding availability and site conditions encountered during implementation.

General Area / Mile Post	Project Activity	Expected work dates	Estimated duration	Equipment needed
Park entrance to Ipsut Campground MP 0.00 to 4.99	Continue current management: Open Carbon Road / Trail for public access after winter season, includes down fall removal, cleaning water bars, trail bridge repairs, cleaning water bars and ditches, minor by-pass trail reconstruction as needed, depending on flood damage.	Mar 15 – April 15	10 to 30 days depending upon flood damage	ATVs Chainsaws Dump truck Excavator Road Grader
Mine Trailhead and Falls Creek washout MP 1.2 0 to 1.95	By-pass trail construction along the Falls Creek washout – constructing and placing gabion baskets for trail base using material imported to Falls Creek and transported to sites with ATVs	April 15 – July 15	30 days	ATV's Chainsaws Front end loader, Dump truck
Falls Creek washout MP 1.45 0 to 1.95	Install drop structures (check dams) and roughness trees in the Falls Creek / Carbon River side channel	July 16 – August 15	20 days	ATVs Chainsaws Excavator Power winch
Bedrock Knob (MP 2.9) Magirl Channel MP 3.4)	Install drop structures (check dams) in the Magirl Channel / Carbon River side channel	July 16 – August 15	10 days	ATVs Chainsaws Excavator Power winch
Park entrance MP 0.00 Maintenance Area MP 0.15	Install (2) engineered log jams at the Park Entrance – wet site requires water diversion. Install (2) engineered log jams at the maintenance area	July 9- Aug 22	45 days + upland staging activities may occur prior to and after these dates	Excavator Front end loader Portable pump 7- Dump truck Log Truck
Falls Creek washout (MP 1.45) to Road washout at MP 3.93	Remove culverts and install new trail bridges in Falls Creek area (except the large abandoned culvert on old Falls Creek channel). Reconstruct trail surface in damaged sections of road and install road humps between Falls Creek to 1st major washout above Chenuis Trailhead area.	July 16 – Nov 15	30 days	ATVs Excavator Front end loader Portable pump- Dump truck
Falls Creek washout to Ipsut Creek – new trail segments MP 1.95 to 4.8	Fall trees necessary for trail realignments Blast stumps (?) necessary for trail realignments.	Sept 16 – Nov 15	10 days	ATVs Chainsaws

Table 8 continued. Summary of the **2012** proposed work schedule. All dates are approximate and subject to change pending project funding availability and site conditions encountered during implementation.

General Area / Mile Post	**Project Activity**	**Expected work dates**	**Estimated duration**	**Equipment needed**
Park entrance to Ipsut Campground MP 0.00 to 4.99	Continue current management: Open Carbon Road / Trail for public access after winter season, includes down fall removal, cleaning water bars, trail bridge repairs, cleaning water bars and ditches, minor by-pass trail reconstruction as needed, depending on flood damage.	Mar 15 – April 15	10 to 30 days depending upon flood damage	ATVs Chainsaws Dump truck Excavator Road Grader
Chenuis Trailhead to Ipsut Creek MP 1.2 0 to 1.95	Reconstruct trail surface in damaged sections of road and install road humps between between Chenuis Trailhead and Ipsut Creek	April 15 – July 15	30 days	ATV's Chainsaws Front end loader, Dump truck
Chenuis Trailhead to Ipsut Creek	Install toe-roughened gabions / log crib wall structures through (4) road washouts located between Falls Creek and the Ipsut Creek Campground.	July 9 – August 22	20 to 30 days for each site. 45 days + upland staging activities may occur prior to and after these dates	ATVs Chainsaws Excavator Helicopter (?)
Ipsut Creek MP 4.8	Divert Ipsut Creek from new channel location into abandoned channel location – dewatering protocol and fish removal required.	July 16 – August 15	5 days	ATVs Chainsaws Excavator Helicopter (?)

Table 8 continued. Summary of the **2013** proposed work schedule. All dates are approximate and subject to change pending project funding availability and site conditions encountered during implementation.

General Area / Mile Post	**Project Activity**	**Expected work dates**	**Estimated duration**	**Equipment needed**
Park entrance to Ipsut Campground MP 0.00 to 4.99	Continue current management: Open Carbon Road / Trail for public access after winter season, includes down fall removal, cleaning water bars, trail bridge repairs, cleaning water bars and ditches, minor by-pass trail reconstruction as needed, depending on flood damage.	March 15 – April 15	10 to 30 days depending upon flood damage	ATVs Chainsaws Dump truck Excavator Road Grader
Chenuis Trailhead Hanging Culvert MP 3.586	Remove culvert, replace with trail bridge. Install drop structures in stream channel above crossing. Requires site dewatering protocol.	July 16 – August 15	10 days	ATV's Chainsaws Excavator
Ranger Creek Culvert	Remove culvert, replace with trail bridge. Requires site dewatering and fish removal protocol.	July 16 – August 15	10 days	ATVs Chainsaws Excavator
Falls Creek Culvert MP 1.68	Remove culvert, back-fill trench with coarse rock and re-grade site to existing trail alignment and elevation. May require site dewatering or sediment control due to intersection with the active Carbon River side channel.	July 16 – August 15	10 days	ATVs Chainsaws Excavator
Ipsut Creek Trail bridge MP 4.8	Replace existing trail bridge with new trail bridge.	July 16 – August 15	10 days	ATVs Chainsaws Excavator

Avoidance and Minimization Measures

The following list of protective measures would be implemented throughout the duration of the project to minimize effects to listed species and water quality.

Minimize disturbance to nesting Marbled Murrelets
(Source: USFWS 2003)

- Felling of large trees in suitable nesting habitat for marbled murrelets will not occur during the marbled murrelet nesting season (April 1 – September 15). Tree felling is not permitted from April 1 through September 15 to protect nesting murrelets, eggs, and young in stands that are identified as suitable murrelet nesting habitat. Large trees are defined as conifers with a diameter-at-breast-height of 16 inches or greater.

- All project activities located will only occur 2 hours after official sunrise, and will cease 2 hours prior to official sunset during the murrelet nesting season (April 1 to September 15) [1]. This restriction avoids potential disruption to murrelets during their daily peak activity periods for feeding and incubation exchanges.

- Blasting activities will not occur between April 1 and August 5. This restriction avoids potential disruption of murrelets during their early nesting season which includes incubation and brooding of hatchlings.

- All food items would be stored inside vehicles, trailers, or trash dumpsters except during actual use to prevent unnatural attractants to crows, jays, and other wildlife which have been identified as predators of murrelet eggs and young.

[1]A typical conservation measure is to avoid all construction activities during the murrelet early nesting season (04/01 to 08/05). This measure has not been included here because the Park has determined that compliance with this measure is not feasible for Alternative 2 due to the need to comply with inwater-work seasons.

Minimize disturbance to nesting Spotted Owls:
(Source: USFWS 2007)

- Felling of large trees in suitable nesting habitat for spotted owls will not occur during the spotted owl nesting season (March 15 – September 15). Tree felling is not permitted during the nesting season to protect nesting spotted owl, eggs, and young in stands that are identified as suitable nesting habitat. Large trees are defined as conifers with a diameter-at-breast-height of 16 inches or greater.

- Blasting activities will not occur between March 15 and July 30. This restriction avoids potential disruption of spotted owls during their early nesting season which includes incubation and brooding of hatchlings.

Minimize impacts to Bull Trout, Steelhead, and Chinook:
(Sources: USFWS 2007, WDFW and USFS 2005)

Follow the appropriate Washington Department of Fish and Wildlife (WDFW) guidelines for the timing of in-water work. Such guidelines are intended to avoid in-water work during periods when salmonid eggs and fry incubate within stream gravels.

- In-water work is restricted to the period of **July 16 to August 15** for all Carbon River tributaries streams such as Ranger Creek (WAC-110-206).

- The extended in-water work season for the mainstem Carbon River is **July 9 to August 22.** This applies to work associated with placement of engineered logjams or other bank protections structures along the Carbon River.

- Projects which require in-water excavation with heavy equipment (i.e., culvert removal and placement of engineered logjams) will follow the approved work-site isolation, dewatering, and fish removal protocol described below.

- Fish within construction sites that will be dewatered or isolated from the main waterbody shall be captured and safely moved from the job site. Fish capture and transportation equipment shall be available on the job site during all inwater activities.

- Any pump used for diverting water from a fish bearing waterbody shall be equipped with a fish guard to prevent passage of fish into the pump. The pump intake shall be screened with 3/32 inch or smaller mesh. Screen maintenance shall be adequate to prevent injury or entrapment to juvenile fish and shall remain in place whenever water is withdrawn from the waterbody through the pump intake.

Exceptions:
In-channel work below the ordinary high-water line may occur outside the specified inwater work period in areas that are dry during the proposed work period. Many side-channels and other fish-bearing streams within the Carbon River floodplain are seasonally dry from mid-summer into the fall months.

Extended in water work season for installation of engineered log jams:
The Park Service has identified the need for an extension to the inwater work season in order to construct engineered log jams near the Park entrance. Based on a review of this request by the WDFW, USFWS, and NMFS, the agreed upon extension for this work is July 9 to August 22 for project work in the Carbon River (G. Piazza, WDFW pers. comm. 04/08/2010, J. Walters, NMFS, pers. comm. 04/08/2010). This extension minimizes potential impacts to bull trout or Chinook which may be staging to spawn in project areas in late August. This extension does not apply for inwater work in Carbon River tributaries such as Ranger Creek and Ipsut Creek.

Fish Passage Criteria for Instream Structures:
(Sources: SHRG 2004 – *Stream Habitat Restoration Guidelines* and WAC-110-070)

Hydraulic drop is the difference in elevation between the water surface upstream and downstream of the structure. To maintain fish passage for juvenile salmonids, the following hydraulic drop criteria apply:

Drop structures or grade-control structures: The maximum hydraulic drop for instream structures is 0.7 feet (8 inches). This drop height can be achieved by placing notches in structures, or by setting the structure at an angle such that the desired drop height is achieved. The maximum hydraulic drop criteria must be satisfied at all flows between the low and high flow design criteria.

Recommended weir spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot high weir in a stream with a two-percent gradient will have a minimum spacing of 50-feet (1/0.02)).

Fish Removal and Dewatering Protocol:
(Source: USFWS 2007)

The following procedures will be used to isolate and dewater sites which require inwater work with heavy equipment. All fish capture, removal, and handling activities shall be conducted by an experienced fisheries biologist or technician.

1. Isolate the Construction Site and Remove Fish

Install block nets at up and downstream locations and leave in a secured position to exclude fish from entering the project area. Leave nets secured to the stream channel bed and banks until fish capture and transport activities are complete.

If block nets or traps remain in place more than one day, monitor the nets and or traps at least on a daily basis to ensure they are secured to the banks and free of organic accumulation and to minimize fish predation in the trap.

Fish Capture Alternatives:

Collect fish by hand or dip nets, as the area is slowly dewatered.

Seining – Use seine with mesh of such a size to ensure entrapment of the residing fish.

Minnow traps – Traps will be left in place overnight and in conjunction with seining.

Electrofishing – Prior to dewatering, use electrofishing only where other means of fish capture may not be feasible or effective.

The protocol for electrofishing includes the following:

If fish are observed spawning during the in-water work period, electrofishing shall not be conducted in the vicinity of spawning adult fish or active redds.

Only Direct Current (DC) or Pulsed Direct Current (PDC) shall be used.

Conductivity <100: use voltage ranges from 900 to 1100. Conductivity from 100 to 300: use voltage ranges from 500 to 800. Conductivity greater than 300: use voltage to 400.

Begin electrofishing with minimum pulse width and recommended voltage and then gradually increase to the point where fish are immobilized and captured. Turn off current once fish are immobilized.

Do not allow fish to come into contact with anode. Do not electrofish an area for an extended period of time. Remove fish immediately from water and handle as described below. Dark bands on the fish indicate injury, suggesting a reduction in voltage and pulse width and longer recovery time.

Fish Handling and Release
Fish must be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided—large buckets (five-gallon minimum to prevent overcrowding) and minimal handling of fish.

Place large fish in buckets separate from smaller prey-sized fish. Monitor water temperature in buckets and well-being of captured fish. As rapidly as possible (especially for temperature-sensitive bull trout), but after fish have recovered, release fish upstream of the isolated reach in a pool or area that provides cover and flow refuge. Document all fish injuries or mortalities and include in annual report.

2. Dewater the Construction Site

Upstream of the isolated construction area, divert flow around the construction site with a coffer dam (built with non-erosive materials) and an associated pump or a by-pass culvert. Diversions constructed with material mined from the streambed or floodplain is not permitted. Small amounts of instream material can be moved to help seal and secure diversion structures.

Pumps must have fish screens with 3/32 inch or smaller mesh. Dissipate flow energy at the bypass outflow to prevent damage to riparian vegetation or stream channel. If diversion allows for downstream fish passage (i.e., is not screened), place diversion outlet in a location to promote safe reentry of fish into the stream channel, preferably into pool habitat with cover.

When necessary, pump seepage water from the de-watered work area to a temporary storage and treatment site or into upland areas and allow water to filter through vegetation prior to reentering the stream channel.

3. Rewater the Construction Site

Upon project completion, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden increase in stream turbidity. Monitor downstream during re-watering to prevent stranding of aquatic organisms below the construction site.

Pumping equipment must be staged away from the rivers; except for the pump hose, which may extend down to the edge of the rivers. Pump intakes must be screened with 3/32 inch or smaller mesh on the end of pump hose to filter-out aquatic organisms. This screen should be cleaned of debris periodically.

Place a spill containment enclosure around the pump and or generator to contain gas, oil or other fluids.

<u>Minimize Heavy Equipment Impacts to Aquatic and Riparian Habitats:</u>
(Sources: USFWS 2007, WDFW and USFS 2005)

- Establish staging areas (used for construction equipment storage, vehicle storage, fueling, servicing, hazardous material storage, etc.) at least 150 feet away from streams in a location and manner that will preclude erosion into or contamination of streams or wetlands.

- All equipment used for instream work shall be cleaned and leaks repaired prior to entering the project area. Remove external oil and grease, along with dirt and mud prior to construction. Thereafter, inspect equipment daily for leaks or accumulations of grease, and fix any identified problems before entering streams or areas that drain directly to streams or wetlands.

- Heavy equipment used for in-water work will use bio-degradable hydraulic fluids.

- If the project includes excavation of the streambed or banks, those work areas shall be isolated from flowing waters to protect water quality and minimize turbidity.

- All equipment shall be cleaned of all dirt and weeds before entering the project area to prevent the spread of noxious weeds.

- Equipment used for instream or riparian work shall be fueled and serviced in an established staging area located at least 150 feet away from streams. When not in use, vehicles shall be stored in the staging area.

- Minimize the number and length of stream crossings and access routes through riparian areas. Stream crossings and access routes should be at right angles.

- Heavy equipment will follow planned routes of access, will travel across dry, un-wetted substrates to the extent possible, and will only cross wetted channels at designated locations.

- Existing roadways or travel paths will be used whenever reasonable. Minimize the number of new access paths to minimize impacts to riparian vegetation and functions.

- Project operations must cease under high flow conditions that inundate the project area, except for efforts to avoid or minimize resource damage.

- Initiate rehabilitation of all disturbed areas in a manner that results in similar or better than pre-work conditions through spreading of stockpiled materials, seeding, and/or planting with locally native seed mixes or plants. Planting shall be completed no later than spring planting season of the year following construction.

<u>Minimize Water-Quality Contamination from Concrete and Treated Wood:</u>
(Sources: WDFW and USFS 2005)

- Fresh concrete, concrete by products, or other chemical contaminants shall not be allowed to enter waterbodies. Structures containing concrete shall be sufficiently cured to prevent leaching prior to contact with the waterbody.

- Treated wood used for bridges or other structures shall meet or exceed the standards established in the most current edition of "*Best Management Practices For the Use of Treated Wood in Aquatic Environments*" developed by the Western Wood Preservers Institute..

<u>Project Criteria for Culvert or Trail Bridge Placements:</u>
(Sources: USFWS 2007, WDFW and USFS 2005, WAC-220-110-070)

- Structure types may include closed-bottomed culverts, open-bottomed arch or box culverts, or bridges.

- The structure width shall never be less than the bankfull channel width. The stream width inside the culvert or between bridge footings shall be equal to or greater than the bankfull width.

- Culverts in fish-bearing streams shall be designed, installed, and maintained to provide passage for all fish species and all life stages that are likely to be encountered at the site.

- Stream crossing structures (culverts or bridges) must accommodate a 100-year flood flow while maintaining sediment continuity (similar particle size distribution) within the culvert as compared to the upstream and downstream reaches.

- Culvert removal or placement sites shall be dewatered or isolated from flowing waters to protect water quality and minimize turbidity.

- Culvert removal or replacement projects in fish-bearing streams will only occur during the approved inwater work season (July 16 – August 15).

- Structures containing concrete must be cured or dried before they come into contact with stream flow.

- Bridge abutments must be placed outside the bankfull channel width.

- Embedment – If a closed culvert is used, the bottom of the culvert shall be buried into the streambed not less than 20% and not more than 50% of the culvert height. For open-bottomed arches and bridges, the footings or foundation shall be designed to be stable at the largest anticipated scour depth. Substrate and habitat patterns within the culvert should mimic stream patterns that naturally occur above and below the culvert. Coarser material may be incorporated to create velocity breaks during high flows, thereby improving fish passage, and to provide substrate stability.

- Grade Control Structures – Grade control structures are permitted to prevent headcutting above or below the culvert or bridge. Grade control typically consists of boulder structures that are keyed into the banks, span the channel, and are buried in the substrate. Grade-control structures must accommodate fish passage for all species and life stages of fish present.

- When removing woody debris from the road-crossing inlet, place the debris downstream of the road crossing.

<u>Project Criteria for Permanent Culvert or Bridge Removal</u>
(Sources: USFWS 2007, WDFW and USFS 2005, WAC-220-110-070)

- All fill material and man-made structures shall be removed from stream channels. The natural stream channel profile shall be restored. Bottom width opening of the fill removal at stream channel crossings shall be equal to, or greater than, the natural bankfull channel width.

- Streambanks shall be shaped to blend in to the existing natural banks upstream and downstream from the crossing removal.

- Streambed substrates shall mimic the natural streambed characteristics upstream and downstream of the crossing removal. Large woody material and/or large rocks may need to be placed within the crossing removal site to accomplish this objective.

- The toe of the excavation shall be stabilized with large wood, appropriately sized rock, and/or vegetation as necessary to prevent excessive erosion of the new streambanks.

- When removing culverts on fish-bearing streams, construction sites shall be dewatered or isolated from flowing waters to prevent generation of sediment and minimize turbidity.

- Dewatering is not required for culvert or ford removals on non-fish bearing streams unless substantial excavation of stream channel or culvert bedding materials will be required after the existing culvert or structure is removed.

Project Criteria for Inchannel Gravel Removal
(Source: WAC-110-140)

Limited excavation of river gravels and cobbles for project fill is permitted. Gravel excavation is limited to dry gravel bars within the main Carbon River channel only. The following technical provisions apply to gravel removal projects:

- Gravel removal from a watercourse shall be limited to removal from exposed bars and shall not result in a lowering, over time, of the average channel cross-section profile through the project area or downstream.

- Gravel removal from the Carbon River will only occur during the approved inwater work season (July 9 – August 22).

- An "excavation line" shall be established. "Excavation line" means a line on the dry bed, at or parallel to the water's edge. The excavation line should be established at a distance that will avoid excavation disturbance within the wetted channel. The excavation line may change with water level fluctuations.

- An "excavation zone" shall be defined as the area between the "excavation line" and the bank or the center of the bar. The "excavation zone" shall be identified by boundary markers placed by the applicant and approved by the department prior to the commencement of gravel removal.

- Excavation shall begin at the excavation line and proceed toward the bank or the center of the bar, perpendicular to the alignment of the watercourse.

- Bed material shall not be removed from the water side of the excavation line.

- Equipment shall not enter or operate within the wetted perimeter of the watercourse, except at designated equipment crossing sites.

- Gravel may be removed within the excavation zone from a point beginning at the excavation line and progressing upward toward the bank or the center of the bar on a minimum two percent gradient. It may be necessary to survey the excavation zone upon completion of the gravel removal operation to ensure the two percent gradient is maintained and that no depressions exist.

- The depth of gravel excavation from exposed bars is limited to the depth of the adjacent water level.

- No excavation of gravels from within wetted channels is allowed.

- At the end of each work day the excavation zone shall not contain pits, or potholes, or depressions that may trap fish as a result of fluctuation in water levels.

- The upstream end of the gravel bar shall be left undisturbed to maintain watercourse stability waterward of the ordinary high water line.

- Large woody material shall be retained waterward of the ordinary high water line and repositioned within the watercourse. Other debris shall be disposed of so as not to reenter the watercourse.

- Equipment shall be inspected, cleaned, and maintained to prevent loss of petroleum products waterward of the ordinary high water line.

<u>Project Criteria for Moving Inchannel Large Wood for use in Engineered Logjams</u>

- Only logs that are isolated and no portion of the log is buried on dry gravel bars in the Carbon River braided channel zone may be moved for use in logjams.

- No logs that are interacting with the wetted channel width may be moved, except within the construction footprint of a project site.

- Equipment shall not enter or operate within the wetted perimeter of the watercourse, except at designated equipment crossing sites, and will only occur during the approved inwater work season for the Carbon River (July 9 – August 22).

Project Action Area – Upper Carbon River Watershed

In a Biological Assessment, the project action area is defined as all areas to be affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action (50 CFR §402.02). The Carbon River Access Management project action area includes both terrestrial and aquatic habitats. For the purposes of this analysis, the project action area includes the Carbon River valley from the Thompson Property (identified as a helicopter staging area) located approximately 2 miles west of the Park Entrance up to the Ipsut Creek Campground. To delineate the action area, we plotted a general flight corridor for helicopters over the Carbon River from the Thompson Property up to Ipsut Campground. We then mapped a 1-mile buffer along the flight corridor to represent the general area in which project noise (from helicopters) will extend, and also includes all terrestrial and aquatic habitat areas that may be affected by the project (Figure 2).

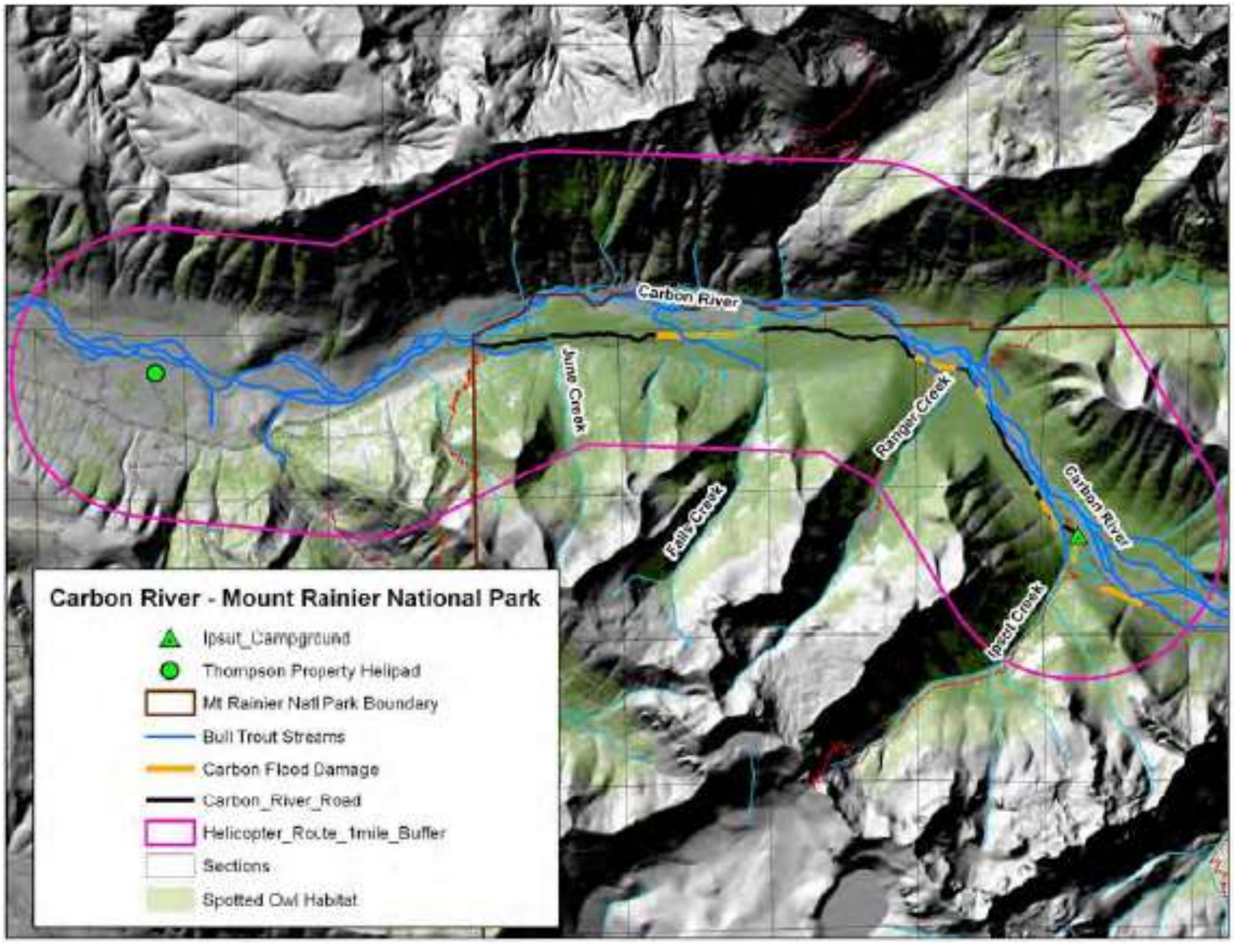

Figure 2. Project action area in the upper Carbon River watershed.

The project action area includes the Carbon River, and adjacent upland areas located on National Park, National Forest, and private lands. The Carbon River is a glacial fed tributary of the Puyallup River basin that contributes approximately 30 percent of the Puyallup River flow. Flowing approximately 32 miles from the Carbon and Russell Glaciers on Mt. Rainier, the Carbon River has nineteen tributary streams and has been considered to represent the largest and most productive habitat available for natural salmonid production in the Puyallup River basin (Kerwin 1999, p. 49). The project action area is located in the upper Carbon River watershed, from approximately River Mile (RM) 22 at the Thompson Property up to the Ipsut Creek area at approximately RM 29.

The damaged segment of the Carbon River Road lies on the south side of the Carbon River, west of the Carbon Glacier. The road is constructed on old river terraces within the potential channel migration zone of the Carbon River. Forest vegetation in the action area ranges from early-seral shrub/alder forest within the active Carbon River channel, to late-successional and old-growth forest which occupies much of the floodplain adjacent to the Carbon River in the Park. Old-growth forest age in the project area ranges from 300 to 600 years. Common forest plant associations in the upper Carbon River valley include western hemlock and Pacific silver-fir series (USFS 1998). The forest type is characterized by mixed forests of western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), Pacific silver fir (*Abies amabilis*), Douglas-fir (*Pseudotsuga menziesii*), Alaska yellow cedar (*Chamaecyparis nootkatensis*), and noble fir (*Abies procera*). This vegetation association is the most extensive type in the Park. Mature forests of this type occupy areas lacking extremes of temperature and moisture. Common understory shrubs include vine maple (*Acer circinatum*), Sitka alder (*Alnus sinuata*), Sitka mountain ash (*Sorbus sitchensis*), devil's club (*Oplopanax horridus*), and Cascade bilberry (*Vaccinium deliciosum*) (Franklin et al. 1988).

Proposed, Threatened, Endangered, and Candidate Species in the Action Area

We consulted the websites for the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to obtain a current list of federally-listed species in the project action area. There are currently 32 fish and wildlife species that are federally listed as threatened, endangered, proposed, or candidate species in western Washington. We reviewed species occurrence records maintained by the Park and the Washington Department of Fish and Wildlife. The following species are known to occur or potentially occur in Mount Rainier National Park, and may occur in the project action area. Listed species that are not included in Table 9 are not present in the project area because the project area is clearly outside the recognized range of the species. Only the species listed in Table 9 will be addressed in this assessment.

Table 9. Federally listed threatened, endangered, proposed, or candidate species that are known to occur and/or potentially occur in Mount Rainier National Park.

Species Name (Scientific Name)	**Federal Status**	**Species habitat present in or near the project action area?**	**Species presence documented in or near the project action area?**	**Probability of species occurrence in project action area?**
Bull trout (*Salvelinus confluentus*)	FT	Yes	Yes	High
Bull trout critical habitat	Designated/ Proposed	Yes	Yes	High
Canada lynx (*Lynx canadensis*)	FT	Yes	No	Low
Gray wolf (*Canis lupus*)	FE	Yes	No	Low
Grizzly bear (*Ursus arctos horribilis*)	FT	Yes	No	Low
Marbled murrelet (*Brachyramphus marmoratus*)	FT	Yes	Yes	High
Marbled murrelet critical habitat	Designated	Yes	No	Low
Northern spotted owl (*Strix occidentalis caurina*)	FT	Yes	Yes	High
Northern spotted owl critical habitat	Designated	Yes	No	Low
Puget Sound steelhead (*Oncorhynchus mykiss*)	FT	Yes	Yes	High
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	FT	Yes	Yes	Moderate
Puget Sound Chinook salmon critical habitat	Designated	Yes	No	Low
Dolly Varden (*Salvelinus malma*)	FP	Yes	No	Low
Fisher (*Martes pennanti*) (West Coast DPS)	FC	Yes	No	Low
Magnuson-Stevens Act - Salmon Essential Fish Habitat	Designated	Yes	Yes	High
Bald Eagle (*Haliaeetus leucocephalus*)	BGEPA	Yes	Yes	Moderate
Definitions: High = Suitable habitat is present, species presence has been documented in the project action area. Moderate = Suitable habitat is present, but species presence has not been confirmed in the project area. Low = Species habitat is marginal or not present in the project area, or there is very low likelihood of species presence based on current species distribution.		FT = Federal Threatened FE = Federal Endangered FP = Federal Proposed FC = Federal Candidate DPS = Distinct Population Segment BGEPA = Bald and Golden Eagle Protection Act		

Status, Environmental Baseline and Effect Determinations for species with a low-likelihood of presence in the Action Area

Canada Lynx (*Lynx canadensis*)

The Canada lynx (lynx) was listed as threatened within the contiguous U.S. in 2000. In the final listing rule, the Fish and Wildlife Service determined that the lynx was threatened by the inadequacy of existing regulatory mechanisms associated with federal land and resource management plans (USFWS 2000).

The lynx is rare in Washington, probably numbering fewer than 100 individuals in the state (Stinson 2001). Resident lynx populations presently occur only in the mountains of north-central and northeastern Washington, although transient individuals occasionally occur outside these areas (USFWS 2009). Lynx occur in boreal forests that have cold, snowy winters and provide an abundant prey-base of snowshoe hares. Recent efforts to identify suitable lynx habitat in the Washington Cascades have focused on large contiguous stands of subalpine fir, Engelmann spruce, and lodgepole pine, generally above 4,000 feet in elevation (USFWS 2009).

Mount Rainier National Park contains some suitable habitat for lynx and their favorite prey, the snowshoe hare, in subalpine areas below the tree line, but lynx habitat in the Park is considered to be marginal (Stinson 2001). Historical records indicate small numbers of lynx were present in the southern Washington Cascades, but this population appears to have been extirpated from the region (Stinson 2001). Surveys conducted in the Washington Cascades from 1998 through 2000 failed to detect lynx in the southern Washington Cascades (Stinson 2001). The Fish and Wildlife Service classifies the southern Washington Cascades as a “peripheral area” where there are few verified historical or recent records of lynx, records are sporadic, and the quality and quantity of habitat to support adequate densities of snowshoe hare or sustain a lynx population is questionable (USFWS 2005).

Given the wide-ranging nature of lynx, it is possible that transient lynx may occasionally occur in the Park. Lynx habitat within the Park may be adequate to sustain short-term survival of during lynx dispersal, but these areas are not likely to support resident lynx. Potential effects to lynx including disruption of denning behaviors, loss of denning or foraging habitats, new road construction in lynx habitat, or increased winter recreation in lynx habitat would not occur. **Therefore, the proposed action would have no effect to Canada lynx**.

Gray Wolf (*Canis lupus*)

Wolves were classified as a federally-listed endangered species in Washington in 1973. They were delisted under federal law in 2009 in the eastern third of Washington, and remain federally listed in the western two-thirds of the state (WDFW 2009). Gray wolves were formerly distributed throughout most of Washington, but declined rapidly as a result of aggressive eradication efforts. Wolves were essentially eliminated as a breeding species from Washington by the 1930s, although infrequent reports of animals continued in the following decades, suggesting that small numbers individuals continued to disperse into Washington from adjacent areas. As wolf numbers have increased in the northern Rocky Mountains region, reliable reports of wolves have increased in Washington since 2005 (WFDW 2009).

As of September 2009, Washington had two breeding packs of wolves; one was confirmed in Okanogan/Chelan counties in 2008 and one in Pend Oreille County in 2009. There are also indications of an additional pack in the Blue Mountains and a few solitary wolves in other scattered locations (WDFW 2009). The expansion of the currently small breeding population in Washington is expected as a result of increased dispersal of wolves from recovering populations in Idaho and Montana, and dispersers from British Columbia. Wolves can live in essentially any habitat that supports an abundance of natural prey and has minimal conflict with human interests and uses.

In the vicinity of the Park, there have been several unconfirmed wolf sightings reported over the past 20 years (Almack and Fitkin 1998; WDFW 2009). The most recent documented sighting occurred in 2002, with a single wolf sighted running across Highway 410 at Chinook Pass (WDFW 2007; 2009). Given the wide-ranging nature of wolves, it is possible that transient individuals occasionally occur in the Park. Given the present low wolf population in Washington, the probability that resident wolves are present in the Park is extremely low.

Primary management considerations for wolves include reducing the likelihood of human/livestock encounters and maintaining adequate prey populations (WDFW 2009). On federal lands, this is achieved primarily through roads management, and by reducing open road densities in wolf habitat (USFWS 1994, p.33). The proposed action would result in a slight reduction in open road densities within the Park, and will likely result in reduced visitor use to the Carbon River valley compared to historic visitor use prior to the washout. Based on the reduction in open roads in the Park, the overall effect of the proposed action to potential gray wolf habitat would be neutral or slightly beneficial. However, until the wolf population in Washington increases significantly, it is unlikely that resident wolves will be present in the Park. Potential effects to wolves including disruption of denning behavior or new road construction in wolf habitat would not occur. **Therefore, the proposed action would have no effect to gray wolf**.

Grizzly Bear (*Ursus arctos horribilis*)

The grizzly bear was classified as a threatened species in the contiguous U.S. in 1975. Declining populations resulting from human-caused mortality, fragmentation of habitats, small populations, and isolation of remnant populations are the primary reasons for listing (USFWS 1993). Grizzly bears occupy large home ranges and require vast areas of undeveloped landscape encompassing a wide range of forest, shrub, riparian, and alpine habitats. Wilderness areas within Mount Rainier National Park (Park) provide potential grizzly bear habitat. From 1989 to 1994, there were 6 unconfirmed sightings of grizzly bears within a 20-mile radius of the Park, including 2 sightings of bears in the Park in 1993 and 1994 (Almack and Fitkin 1998). These sightings were classified by the Washington Department of Fish and Wildlife (WDFW) as “high reliability” observations where grizzly bears where identified by two or more physical characteristics

(Almack and Fitkin 1998). No sightings of grizzly bears have been reported in vicinity of the Park since 1994 (WDFW 2007).

Grizzly bears are rare in Washington, and are believed to be resident only in the North Cascades and in the Selkirk Mountains of northeastern Washington (Almack and Fitkin 1998). The revised grizzly bear recovery plan (USFWS 1993) identified the North Cascades Ecosystem in Washington as one of six areas south of Canada that are considered essential for grizzly bear recovery. The North Cascades Ecosystem includes primarily federal lands located north of Interstate 90, and was estimated to have a minimum population of 5 grizzly bears (USFWS 1993). The Park is not included in the North Cascades grizzly bear recovery zone.

Given the wide-ranging nature of grizzly bears, it is possible that transient bears may occasionally occur within the Park. However, given the present low bear population in the North Cascades recovery zone, the probability that resident grizzly bears are present in the park is extremely low. Management considerations for grizzly bear include reducing the likelihood of human encounters with bears. This is achieved primarily through road management and by reducing open road densities in grizzly bear habitat (USFWS 1993). The proposed action would result in a slight reduction in open road densities within the Park, and will likely result in reduced visitor use to the Carbon River valley compared to historic visitor use prior to the washout. Based on the reduction in open roads in the Park, the overall effect of the proposed action to potential grizzly bear habitat would be neutral or slightly beneficial. However, until the grizzly bear population in the North Cascades recovery zone increases significantly, it is unlikely that resident grizzly bears will be present in the Park. Potential effects to grizzly bear including disruption of denning behaviors, loss of denning or spring foraging habitats, or new road construction in grizzly bear habitat would not occur. **Therefore, the proposed action would have no effect to grizzly bear**.

Dolly Varden (*Salvelinus malma*)

The Dolly Varden was proposed for listing as federally threatened in 2001. Because the species co-occurs with bull trout in Washington, and the species is difficult to distinguish from bull trout, the species was proposed for listing under the "Similarity of Appearance" provisions of the Act (USFWS 2001). In western Washington, bull trout and Dolly Varden can occur in the same watershed. Historical distribution of Dolly Varden has been difficult to surmise due to the confusion in identifying bull trout and Dolly Varden. Current evidence suggests that the Dolly Varden in Washington tend to be located in isolated populations in headwater tributaries above anadromous fish barriers (USFWS 2004, p. 48). Recent DNA analysis conducted on native char present in the Park suggests that only bull trout are present in the Park. **Therefore, the proposed action would have no effect to Dolly Varden**.

Fisher (*Martes pennanti*)

The fisher (West Coast Distinct Population Segment) in Washington, Oregon, and California was listed as a federal candidate species in 2004. The Fish and Wildlife Service determined that listing the fisher as a threatened or endangered species was warranted (USFWS 2004), because the species has been extirpated from most of its historical range, and only small, isolated populations remain (USFWS 2004).

The historical range of the fisher in western Washington likely included all the wet and mesic forest habitats at low to mid-elevations (Hayes and Lewis 2006). Fishers use late-successional conifer forests for denning and foraging habitat. Fisher use forest structures, such as large live trees, snags and logs, for giving birth and raising their young, as well as for rest sites (Hayes and Lewis 2006).

Historical trapping records and fisher specimens collected in Washington confirms that fisher occurred throughout the Cascades, including historical occurrences from Mount Rainier National Park (Hayes and Lewis 2006). Extensive carnivore surveys conducted throughout the Washington Cascades during the past 20 years (including surveys in Mount Rainier National Park) failed to detect fisher (Reid et al. 2010).. Based on a lack of recent sightings or trapping reports, the fisher is considered to be extirpated or reduced to scattered individuals in Washington (USFWS 2004). A self-sustaining fisher population is not likely to become re-established in the Washington Cascades without a planned reintroduction effort (Hayes and Lewis 2006).

Mount Rainier National Park contains approximately 28,000 acres of potential fisher habitat, including old-growth forests in the Carbon River valley (Hayes and Lewis 2006). These forests are considered important for recovery if a fisher population is to be successfully reintroduced to the southwestern Washington Cascades. The proposed project would result in minor effects to potential fisher habitat, including loss of scattered individual large trees, and continued recreational use of the Carbon River road/trail system. Potential effects to fisher including disruption of denning behaviors or loss of denning and foraging habitat would not occur. **Therefore, the proposed action would have no effect to fisher**.

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle was removed from the federal list of threatened and endangered wildlife on August 8, 2007. Therefore, consultation under section 7 of the Endangered Species Act is not required for this species. However, the bald eagle remains a protected species under the federal Bald and Golden Eagle Protection Act (USFWS 2007).

There are no known bald eagle nests or winter communal roosting sites within Mount Rainier National Park (WDFW 2007). The likelihood of bald eagles nesting in the upper Carbon River valley is very low due to the lack of anadromous salmon and waterfowl populations as food sources. Transient bald eagles may occasionally pass through the Carbon River area during seasonal migrations. Because there are no bald eagle nests in the project area, potential disturbance to nesting or wintering bald eagles will not occur. **Therefore, the proposed action would have no effect to the bald eagle.**

Northern spotted owl (*Strix occidentalis caurina*)

Status and summary of species biology

The northern spotted owl (spotted owl) was listed as a threatened species in 1990 because of widespread loss of suitable habitat across the species range and the inadequacy of existing regulatory mechanisms to conserve the species (USFWS 1990). Many populations of spotted owls continue to decline, especially in the northern parts of the species' range. Over the past decade it has become apparent that competition from the barred owl (*S. varia*) poses a significant threat to the spotted owl. Past habitat loss and current habitat loss are also threats to the spotted owl, even though loss of habitat due to timber harvest has been greatly reduced on Federal lands for the past 2 decades (USFWS 2008).

Spotted owls are long-lived, non-migratory birds that establish territories that they defend against other owls and avian predators. Spotted owls range across their territories over the course of the year hunting for prey. In western Washington, spotted owls prey almost entirely on northern flying squirrels and other small mammals (Forsman et al. 2001). Spotted owls are mostly nocturnal, although they also forage opportunistically during the day. Spotted owl territories are large and encompass thousands of acres of forest habitat. Suitable spotted owl habitat is generally mature or old-growth forest that has a moderate to high canopy closure; a multi-layered, multi-species canopy dominated by large overstory trees; numerous large snags and down logs; and sufficient open space below the canopy for owls to fly through (Thomas, et al. 1990). Forests with these characteristics provide nesting and roosting sites for spotted owls and support the highest densities of northern flying squirrels (Carey 1995).

In the Washington Cascades, an average spotted owl territory encompasses over 6,000 acres (USFWS 1992). For management purposes, a 1.8-mile radius circle is used to map spotted owl territories. Within the annual home range there is a core area of concentrated use during the nesting season (Bingham and Noon 1997). Spotted owl monitoring has indicated that established spotted owl territories are fairly stable, and that some territories may be occupied by different pairs of spotted owls over many years (Forsman et al. 1984, p. 19). The actual nest-tree used within a territory may change from year to year, but alternate nest trees are usually located within the same general core area (equal to a 0.7-mile radius around an established activity center) (Forsman et al. 1984, p. 32).

At Mount Rainier, the spotted owl nesting season extends from March 15 through September 30. The nesting season is divided into early and late seasons. The early nesting season is defined as March 15 to July 31. Early nesting season behavior includes nest site selection, egg laying, incubation, and brooding of nestlings to the point of fledging (Forsman et al. 1984, pp. 32-38). The late nesting season extends from August 1 through September 30. During this period, the juvenile spotted owls have left the nest and are able to fly short distances, but they remain close to the nest site and depend upon the adults for feeding. By late summer, the adults are rarely found roosting with their young and usually only visit the juveniles to feed them at night (Forsman et al. 1984, p. 38). Juvenile owls typically disperse away from their natal sites in late September or early October, and become non-territorial "floaters" for 2 to 5 years before they acquire their own territories (Forsman et al. 2002, p. 2).

Environmental Baseline

Status of Spotted Owls in Mount Rainier National Park

Mount Rainier National Park contains approximately 80,000 acres of suitable spotted owl habitat (Myers 2009). Spotted owl habitat extends up to an elevation of about 4,800 feet in the Park. Surveys for spotted owls have been conducted annually in the Park since 1997 as part of an ongoing spotted owl demography study (Herter et al. 2008, Myers 2009). In 2008, there were 31 historic spotted owl sites surveyed in the Park. Spotted owls were detected at 15 sites (11 pairs, and 4 singles), and nesting pairs were documented at 5 sites in the Park (Myers 2009). In 2009, spotted owls were detected at 13 sites in the Park, including 7 pair sites, but there were no nesting attempts documented (Herter 2009). It is common for spotted owls to nest in alternating years, with most nesting attempts occurring in even years, and relatively few nesting attempts documented in odd years (Anthony et al. 2006). The apparent lack of nesting in 2009 is not unusual considering the low numbers of pairs present in the Park, and the documented nesting that occurred in 2008. Not all suitable habitat in the Park is surveyed for spotted owls. Approximately 10 percent of the suitable habitat in the Park is not surveyed during annual monitoring, and additional owl pairs may be present in these areas.

Mount Rainier National Park constitutes approximately 40 percent of the entire Rainier Spotted Owl Demographic Study Area (DSA). The spotted owl population in the north half of the Rainier DSA has declined significantly and now over half of the spotted owls remaining in the DSA (including most of the breeding pairs) are located within the Park (Herter et al. 2009). Monitoring in the Rainier DSA indicates the spotted owl population has declined annually since 1995, resulting in a loss of approximately 40 to 60 percent of the occupied owl territories in the study area (Anthony et al. 2006). Competition with barred owls is implicated as the primary cause for this decline (Herter et al. 2008). Barred owls have now been detected at 84 percent of spotted owl sites monitored in the Park (Myers 2009). Barred owls were first detected in the Park in 1986, and by 2006 there were 37 probable barred owl territories identified in the Park (Myers 2009). Despite the apparent high densities of barred owls in the area, low numbers of spotted owls continue to persist and successfully reproduce in the Park.

Although spotted owl habitat in the Park is restricted to a relatively narrow band around the perimeter of Mount Rainer, this habitat currently supports a small population of spotted owls and is considered essential for the long-term conservation of the species. In the spotted owl recovery plan, the Fish and Wildlife Service identified suitable spotted owl habitat in the Park as part of a network of “Managed Owl Conservation Areas” in western Washington. The Managed Owl Conservation Areas represent areas which the Fish and Wildlife Service considers essential for spotted owl recovery (USFWS 2008, p. 13).

Status of Spotted Owls in the Action Area – Carbon River

The upper Carbon River valley contains approximately 12,300 acres of suitable spotted owl habitat, including over 7,200 acres of habitat within the Park (60 percent). Spotted owl habitat in the Carbon River valley extends up to an elevation of approximately 4,500 feet, and is somewhat topographically isolated from habitat in adjacent river valleys. Within the Park boundary, spotted owl habitat is relatively pristine, with minor habitat loss (< 25 acres) associated with existing Park developments (i.e., roads, trails, and campgrounds). Outside the Park, much of the forested area on private and National Forest lands has been previously harvested, resulting in the fragmentation and loss of much of the suitable spotted owl habitat outside the Park boundary.

Spotted owl monitoring efforts have documented 4 spotted activity centers in the Carbon River valley, 3 territories in the Park, and 1 historic spotted owl territory located just north of the Park in the Mt. Baker-Snoqualmie National Forest (Figure 3). However, this site has not been monitored since 1998 (Herter et al. 2008). Spotted owl occupancy at historic activity centers in the area has been inconsistent in recent years. No spotted owls were detected in the Carbon River valley in 2008. In 2009, a new pair of spotted owls was detected at Ipsut Creek, and a single male spotted owl was detected near Green Lake (Herter et al. 2009). The male at Green Lake was only sighted once, and surveyors speculate it may have been the same male that was present at Ipsut Creek in 2009, but this is uncertain (Herter et al. 2009).

Spotted owl surveys within the project area are not comprehensive. Spotted owl habitat near the Park entrance at June Creek may not be adequately covered by annual demography surveys. However, the likelihood that additional, undetected spotted owl sites occur within the project area is considered discountable based the on the lack of documented historic sites near June Creek and the general decline of the spotted owl population in the Rainier demography study area.

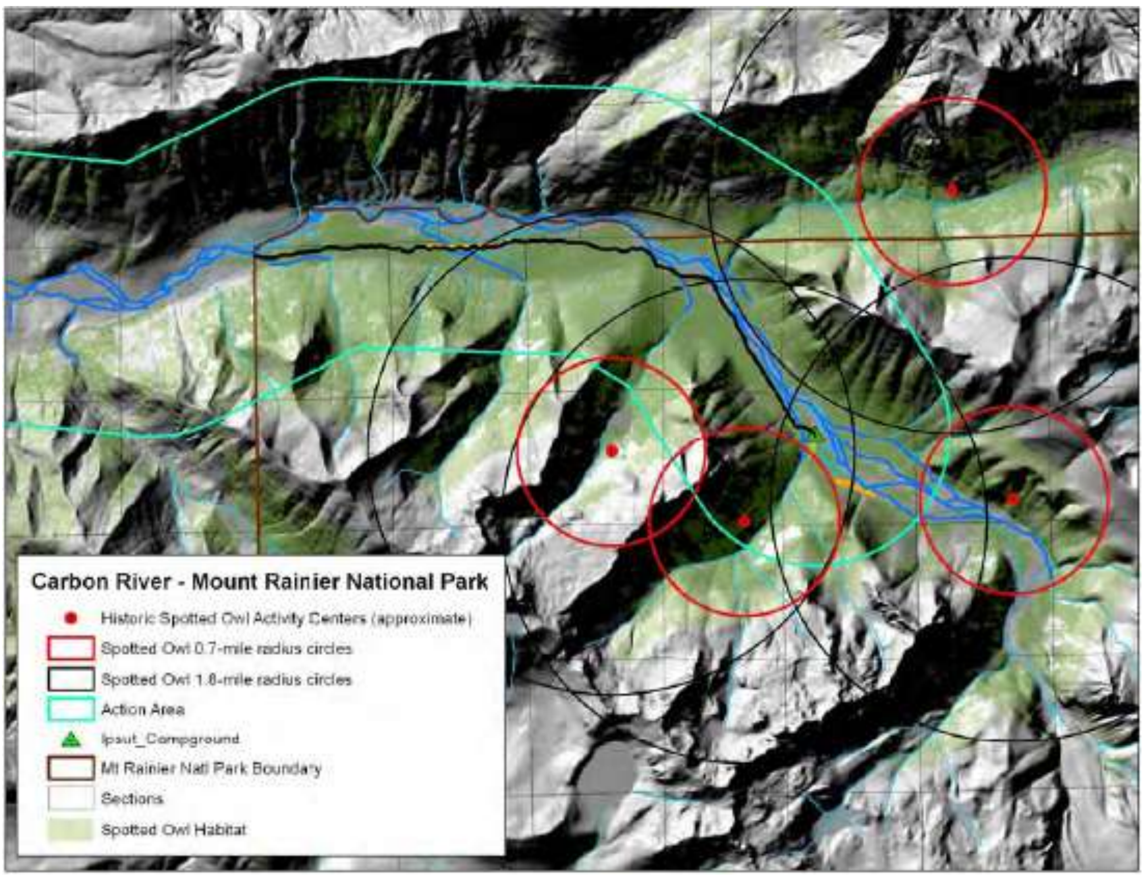

Figure 3. Historic and active spotted owl territories in the upper Carbon River watershed.

Direct Effects to Spotted Owls

Potential Disturbance to Spotted Owls from Project Noise and Activity

The use of helicopters, excavators, chainsaws, and other motorized equipment will introduce increased levels of sound into the project area over the course of 4 work seasons. Project work will coincide with the spotted owl nesting season (March 15 – Sept 30), and will continue into the fall months after the nesting season. Noise and activities associated with road and trail construction, as well as construction of bank erosion protection structures have the potential to disturb spotted owls in the project area. The response of spotted owls to project noise disturbance is not well defined and is variable between individuals. Spotted owl responses to noise disturbance range from no apparent reaction, to an alert response where the owls are attentive for the duration of the activity; to a flush response (Delaney et al. 1999, p.68). Significant disturbance occurs when noise or project activity causes a spotted owl to become so agitated that it flushes away from an active nest site or aborts a feeding attempt during incubation or brooding of nestlings (USFWS 2003, p. 273). Such events are considered significant because they have the potential to result in reduced hatching success, fitness, or survival of juveniles. Specific threshold indicators for disturbance include:

(a) *Nesting spotted owls that are exposed to noise that is greater than or equal to 92 dB at an active nest site during the early nesting season*. This sound threshold is based primarily on two studies. Awbrey and Bowles (1990, p. 21) suggest that noise begins to disturb (i.e., cause an alert response, but not flight) most raptors at around 80-85 dB, and that the threshold for flight response is around 95 dB. Mexican spotted owls (*Strix occidentalis lucida*) exposed to helicopter noise elicited alert responses (i.e., head turning towards noise) when helicopters were an average of 0.25 mile (400 m) away, but owls did not flush from their roosts until the noise from helicopters exceeded 92 dB and occurred within a distance of less than 344 ft. (105 m) (Delaney et al. 1999 pp. 66-68).

(b) *Nesting spotted owls that are exposed to ground-based activities with motorized equipment within a distance of 197 ft. (60 m) or approximately 65 yards from an active nest site during the early nesting season.* This distance threshold is based on two studies. Delaney et al. (1999) reported that Mexican spotted owls exposed to chainsaw noise flushed when chainsaws were operated within a distance of 344 ft. (105 m) and the sound level for chainsaws was greater than 46 dB (Delaney et al. 1999 pp. 66-68). However, only 2.8 percent (1 of 36) of the chainsaw trials at distances greater than 60 m resulted in a flush response, but over 70 percent of chainsaw trials at distances less than or equal to 60 m resulted in a flush response. The sound levels associated with the chainsaw tests were in the range of 54 to 61 dB at 197 ft. (60 m). Delaney and Grubb (2003, p. 22) reported that a northern spotted owl flushed in response to motorcycles passing within a distance of 220 ft. (67 m). The sound levels reported for motorcycles (61-82 dB at 50 to 65 ft.), are comparable to or less than sound levels reported for many types of motorized equipment.

It is important to note that not all spotted owls exposed to chainsaw or motorcycle noise in these studies flushed, and that spotted owls that were previously exposed to helicopters or chainsaw noise were less likely to flush during subsequent exposures, suggesting some birds have the ability to tolerate or habituate to such disturbances (Delaney et al. 1999, p. 69).

Spotted owls also did not flush from nests during incubation or brooding of nestlings, suggesting that spotted owls are reluctant to leave the nest during the early stages of the breeding cycle (Delaney et al. 1999 p. 71; Delaney and Grubb 2003, p. 22). However, the researchers in the Mexican spotted owl study did not challenge incubating spotted owls with chainsaw noise at distances of less than 60 m due to the high flush rates observed for non-nesting birds exposed to chainsaw noise at less than 60 m (Delaney et al. 1999, p. 65). Considering the limited evidence available for spotted owls suggests that 60 m (65 yards) is a reasonable distance to assume a flush response may occur from ground-based, motorized activities.

<u>Exposure of spotted owls to project noise</u>

We used a Geographic Information System (GIS) to evaluate potential exposure of spotted owls to project noise (Figure 4). Based on the estimated sound attenuation contours and the disturbance thresholds described above, we calculated potential disturbance buffers within the project area (Figure 4).

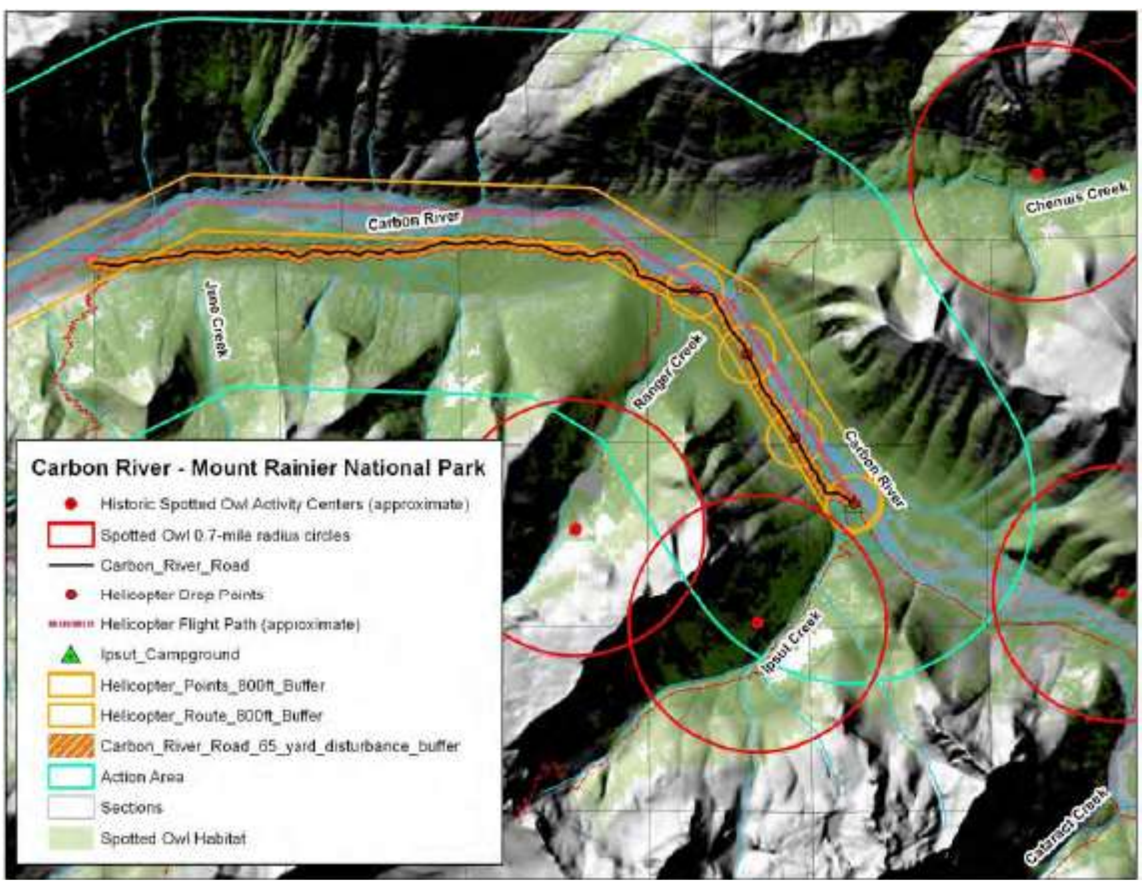

Figure 4. Overlap of project noise contours with spotted owl 0.7-mile radius core areas.

Use of motorized equipment along the Carbon River Road/Trail

Based on the disturbance thresholds described above, we mapped a 65 yard “disturbance” buffer along either side of Carbon River Road/Trail to represent the area where spotted owls may be flushed by the use of motorized equipment. The 65 yard disturbance buffer exceeds the estimated 92 dB sound contour for all project equipment except helicopters and blasting. For each mile of the road, there is approximately 48 acres located within the 65 yard disturbance buffer. The total area associated with the disturbance buffer along the Carbon River Road/Trail is approximately 240 acres, but only about 180 acres are actually forested and provide suitable spotted owl habitat. These areas will be subjected to noise and activity of varying degrees on a daily basis over the next 4 years from late March through mid-November.

The Carbon River Road/Trail corridor occurs within the potential home ranges of 3 spotted owl territories (Figure 3). The site with the closest proximity to the trail is the Ipsut Creek activity center, which is located approximately 0.84 mile from the Ipsut Creek Campground. This site was occupied by a pair of spotted owls in 2009. Spotted owls from these territories may occasionally forage or roost in the forested areas along the road/trail corridor. Because spotted owls do occasionally change nest locations within their core areas, we used the 0.7 mile-radius core area circles to represent the areas where potential spotted owl nest sites are most likely to occur. Based on the distribution of known occupied and historic spotted owl nest sites in the project area, we do not expect any spotted owl nest sites to occur within the 65-yard disturbance buffer along the Carbon River Road/Trail (Figure 4, above).

Over the course of the 4 years of project implementation, it is likely that individual spotted owls that are foraging or roosting in close proximity to the road may occasionally be flushed away from a foraging perch or a roosting site by project noise and activity. Such flush responses that occur away from an active nest site are considered to be insignificant, because the owls are simply moving away from the source of disturbance, rather than being forced to flush away from an active nest site.

The Park has included a daylight operating restriction for project implementation which restricts project work to daylight hours only from April 1 to September 15 (p. 30, above). Spotted owls are primarily nocturnal, and forage for prey almost exclusively at night, with peak activity levels occurring after sunset and prior to sunrise (Forsman et al. 1984, p. 51). By avoiding project activity during these nocturnal periods, normal spotted owl foraging behaviors would not be disrupted by project activities along the Carbon River Road/Trail.

Helicopter use

The Park identified the Ipsut Creek Campground as a site where a helicopter will be used to fly out equipment and materials. The road washouts at MP 3.43, MP 3.93 and MP 4.47 were also identified as potential sites where a helicopter may be used fly in logs and equipment for constructing bank protection structures. The duration of helicopter use over the 4 years of project implementation is relatively brief, and is estimated as multiple flights at each site for a period of 2 to 3 days. For this assessment, we assumed the Park will contract a Chinook 47-D, which is a double-rotor helicopter with a 20,000 lb. lift capacity. The Chinook 47-D is a very loud helicopter with an estimated 92 dB sound contour at 800 feet (Table 7). Based on the 92 dB disturbance threshold described above, we expect any spotted owls located within an 800 ft.-radius of the helicopter flight path and drop sites would potentially flush in response to helicopter noise.

We used GIS to map 800 ft. disturbance buffers to indicate areas that would be exposed to helicopter noise levels of 92 dB or greater (Figure 4). Based on the current distribution of known occupied and historic spotted owl nest sites in the project area, we do not expect any spotted owl nest sites to occur within the 800 ft. – helicopter disturbance buffer along the Carbon River Road/Trail (Figure 4, above). As with ground-based activities along the Carbon Road/Trail corridor described above, there is a potential for individual spotted owls that are foraging or roosting within the helicopter disturbance areas to be temporarily displaced by noise disturbance. However these effects are considered to be insignificant with no implications for impaired fitness, survival, or reproductive capability.

At Ipsut Creek Campground, the helicopter disturbance buffer slightly overlaps the 0.7 mile-radius core area circle for the Ipsut Creek spotted owl site. There is a potential for noise disturbance to occur if the spotted owls at this territory select an alternate nest tree near the campground. Helicopter flights at Ipsut Campground will be scheduled to occur after August 6, and may not occur until after September 15. Helicopter use that occurs during the latter half of the spotted owl breeding season (Aug. 1 – Sept. 30) would not significantly disrupt nesting spotted owls. In the late nesting season, juvenile spotted owls have fledged and are able to thermoregulate, fly short distances, and are no longer completely dependent upon the adults for daily feedings (Forsman et al. 1984, p. 38). A flush response from either an adult or juvenile at this stage of development is not likely to reduce the juvenile owls' fitness or ability to survive. Therefore the biological effect of potential noise disturbance that occurs during the late nesting season is considered to be insignificant.

Blasting for trail realignments

The Park has identified several locations along the Carbon River Road/Trail that may require blasting to remove stumps for trail alignments. The noise associated with blasting is highly variable and depends on size of the charge and the material being blasted. The USFWS identified blasts of 2 lbs. or less to have a disturbance radius of 120 yards (USFWS 2003, p.282). Based on sound measurements taken during a previous project, the noise from a rock blasting project was reported as approximately 88 dB at 500 feet (NPS 2008). For this project, all blasting activities will be scheduled to occur after August 6. Based on the timing of blasting activities and the current distribution of known occupied and historic spotted owl nest sites in the project area, the effects of blasting to spotted owls would be insignificant.

Recreational use in the Carbon River corridor

The Carbon River corridor currently receives over 30,000 visitors per year. Visitor use may increase over time as access in the corridor is improved. Visitor uses include hiking, camping, and picnicking along trails and at the Ipsut Creek campground. Most visitors stay on or close to Park trails, so the potential for visitors to encounter spotted owls is limited to those instances when spotted owls may be roosting near a trail. Swarthout and Steidl (2001) studied flush responses of Mexican spotted owls in constricted canyons in the Utah desert in which hikers walked close to roosting spotted owls. They found that 95 percent of flushes by adult and juvenile spotted owls occurred within distances of 24 m and 12 m, respectively, of the hikers, and that a 55-m buffer "would eliminate virtually all behavioral responses of owls to hikers" (p. 312). In this study, spotted owls were apparently much more sensitive to the presence of hikers than what is generally reported for northern spotted owls. This may be due to the narrow canyon setting in which the study was completed, where the spotted owls were apparently threatened by the close approach of hikers. Spotted owl researchers in the Pacific Northwest report that most spotted owl roosts and virtually all nest sites are located high enough in the forest canopy that spotted owls rarely flush even when someone walks directly under a roost or nest site (USFWS 2003, p. 279). Northern spotted owls can be flushed by hikers that approach within 20 to 30 ft. when the owls are roosting close to the ground, but such instances are uncommon (USFWS 2003, p. 279).

Considering the current distribution of known occupied and historic spotted owl nest sites in the project area, we do not expect that Park visitors will be hiking directly under active spotted owl nest trees. As with ground-based activities along the Carbon Road/Trail corridor described above, there is a potential for individual spotted owls that are foraging or roosting near trails or campgrounds to be flushed by the close approach of hikers. Flushing a spotted owl from a roost site is considered to be insignificant with no implications for impaired fitness, survival, or reproductive capability.

Indirect Effects to Spotted Owls

Trail realignments along the Carbon River Road/Trail corridor may indirectly affect spotted owls by removing key habitat elements such as large trees and snags, and understory vegetation. Trail construction activities would result in removal of approximately 28 trees dispersed across 3 different trail sections. The total area of vegetation loss associated with trail realignments is estimated at less than 0.5 acres dispersed across 3 sites. Because spotted owls occupy large territories that encompass thousands of acres of forest habitat, the loss of scattered individual trees within a stand of suitable habitat is considered to be an insignificant habitat modification, because the affected stands would continue to provide suitable habitat for spotted owls roosting and foraging behaviors.

Effects of Interrelated or Interdependent Actions

One inter-related action associated with the Carbon River Access Management project will be the future need to remove hazard trees in the vicinity of campgrounds, trailheads, and visitor parking areas. The Park completed a Hazard Tree Management Plan in 2006. In accordance with the Management Plan, hazard trees may only be felled during the period of October 1 through March 14. This seasonal restriction avoids hazard tree removal during the nesting season for spotted owls. Therefore, potential disturbance or injury to spotted owls from hazard tree removal is not anticipated.

Once the Carbon River Access Management project has been completed, there will be a need to continue active management of the road and trail system. It is highly likely that flood damage will continue occur along the Carbon River corridor, which will require continued trail and road reconstruction efforts. We anticipate the ongoing effects of trail and road maintenance will be similar to effects of the current project.

Cumulative Effects

Under section 7 of the Endangered Species Act (16 U.S.C. 1536, *et seq.*), cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Biological Assessment (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

In the Carbon River action area, there is a mix of non-Federal timber land and National Forest lands located adjacent to the Park. National Forest lands on the adjacent Mt. Baker-Snoqualmie National Forest in the Carbon River valley are designated as Late-Successional Reserves, or as Wilderness. Non-federal lands in the area are managed primarily for timber production, but almost all forest that was potential spotted owl habitat on these lands has been previously harvested. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222).

Northern Spotted Owl Conclusion and Effect Determination

Considering the current status of the spotted owl in project area, and the direct, indirect, and cumulative effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect, but is not likely to adversely affect the northern spotted owl.** This determination is based on the rationale that habitat loss associated with the proposed action is minor with no significant effects to spotted owls. Individual spotted owls that are foraging or roosting within the project area may be temporarily displaced by noise disturbance, but this disturbance would not occur directly at spotted owl nest sites. Therefore, the effects from noise disturbance are considered to be insignificant with no implications for impaired fitness, survival, or reproductive capability.

Designated Northern Spotted Owl Critical Habitat

The USFWS originally designated critical habitat for the northern spotted owl in 1992. The 1992 designation was superseded by a revision to the critical habitat designation in 2008 (USFWS 2008). Under both designations, critical habitat was not designated in National Parks. However, adjacent National Forest lands that border Mount Rainier National Park are designated as critical habitat. The primary constituent elements identified in the spotted owl critical habitat final rule include forest types that support the spotted owl across its geographic range when they occur in concert with a) nesting, roosting, foraging, and/or dispersal habitat, or b) lands capable of developing one or more of these habitats in the future (USFWS 2008). Actions associated with the Carbon River Access Management plan would have no direct or indirect effects to the primary constituent elements of spotted owl critical habitat. **Therefore, the proposed action would have no effect to designated northern spotted owl critical habitat**.

Marbled Murrelet (*Brachyramphus marmoratus*)

Status and summary of species biology

The marbled murrelet (murrelet) was listed as a threatened species in Washington, Oregon, and northern California in 1992. The primary reasons for listing included extensive loss and fragmentation of old-growth forests which serve as nesting habitat for murrelets and human-induced mortality in the marine environment from gillnets and oil spills (USFWS 1992). Although some threats such as gillnet mortality and loss of nesting habitat on Federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (USFWS 2010). Surveys from 2000 to 2008 have documented that murrelet populations throughout the listed range have continued to decline at a rate of 2.4 to 4.3 percent per year. This represents an overall population decline of 19 to 34 percent since 2000 (USFWS 2010).

Murrelets are small, diving seabirds that spend most of their life in nearshore marine waters foraging on small fish and invertebrates, but use old-growth forests for nesting. Murrelets nest in forested areas up to 52 miles inland from their saltwater foraging areas (Hamer 1995, p. 167). Nests occur primarily in large, old-growth trees, with large branches or deformities that provide a suitable nest platform. Murrelets do not build a nest, but rather create a nest depression in moss or litter on large branches (Nelson 1997). In Washington, the murrelet breeding season occurs between April 1 and September 15 (Hamer et al. 2003). For management purposes, the USFWS defines the murrelet early nesting season as April 1 through August 5. Early nesting season behaviors include egg laying, incubation, and brooding of nestlings. The late nesting season is defined as August 6 through September 15. During the late season, murrelet chicks are left unattended at the nest site until they fledge, except during feedings by the adults, with all chicks fledging by mid-September (Hamer et al. 2003). Both parents feed the chick, which receives one to eight meals per day (Nelson 1997). Most meals are delivered at dawn, while about a third of the food deliveries occur at dusk and intermittently throughout the day (Nelson and Hamer 1995a).

Nest site predation is suspected to be the principal factor limiting murrelet reproductive success. Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure (Nelson and Hamer 1995b; McShane et al. 2004). Nest failure rates of 68 to 100 percent have been reported in some areas (USFWS 2010). The risk of predation by avian predators appears to be highest in close proximity to forest edges and human activity, where many corvid species (e.g., jays, crows, ravens) are in highest abundance (McShane et al. 2004).

The marbled murrelet recovery plan identifies 6 broad “Marbled Murrelet Conservation Zones” across the listed range of the species to geographically define recovery goals and objectives. In Washington, there are two conservation zones: Puget Sound (Conservation Zone 1) and Western Washington Coast Range (Conservation Zone 2) (USFWS 1997). Conservation Zone 1 includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border and extends inland 55 miles from the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Forest lands in the Puget Trough have been predominately replaced by urban development and the remaining suitable habitat in Zone 1 is typically a considerable distance from the marine environment, lending special importance to nesting habitat close to Puget Sound (USFWS 1997). The murrelet population in Conservation Zone 1 has been declining over the past decade. The murrelet population in 2008 was estimated at 4,699 birds (95% confidence limit = 3,497 – 6,201 murrelets) (USFWS 2009). Mount Rainier Park is located in Conservation Zone 1, and all murrelets nesting in the Park are considered to be part of the Conservation Zone 1 murrelet population.

Environmental Baseline

Status of Murrelets in Mount Rainier National Park
The Park Service has conducted surveys for murrelets in the Park annually since 1994. To date, murrelet presence has been documented within four watersheds: the Carbon, Mowich, Puyallup, and Nisqually River basins (NPS 2009). Based on the presence of suitable murrelet nesting habitat and multiple detections indicating presence or occupancy behaviors, it is assumed that murrelets are nesting in these areas. However, because of the difficulty of detecting murrelet nests, no active nests have been located within the Park (NPS 2009).

With the establishment of the Northwest Forest Plan in 1994, the range of the murrelet for management and conservation purposes was established at 55 miles inland from marine waters in Washington (Raphael et al. 2006, p.101). Essentially the entire Park, with the exception of a small area in the southeast corner of the Park, is located within the potential range of the murrelet. The murrelet potential nesting habitat maps produced by Raphael et al. (2006, p.119) indicate there is approximately 26,500 acres of potential murrelet nesting habitat in the Park extending up to an elevation of about 3,800 ft., which constitutes about 11 percent of the Park area.

The Park provides large blocks of murrelet nesting habitat and supports reproductive pairs of murrelets. Because the most of the Park is designated Wilderness, high-quality murrelet nesting habitat within the Park is largely undisturbed by development or human presence. Murrelet nesting habitat within the Park is considered essential for the long-term conservation and recovery of murrelets (USFWS 1997).

Status of Murrelets in the Action Area – Carbon River
The upper Carbon River valley contains approximately 5,600 acres of suitable murrelet habitat, including over 3,900 acres of habitat within the Park (70 percent). Murrelet habitat in the Carbon River valley extends up to an elevation of approximately 3,800 feet. Within the Park boundary, murrelet habitat is relatively pristine, with minor habitat loss (< 25 acres) associated with existing Park developments (i.e., roads, trails, and campgrounds). Outside the Park, much of the forested area on private and National Forest lands has been previously harvested, resulting in the fragmentation and loss of much of the suitable murrelet habitat outside the Park boundary. Based on the work by Marzluff and Neatherlin (2006), we expect murrelets nesting in close proximity (within a 1 km radius) to Ipsut Creek campground may have a higher rate of nest predation due to the potential for increased corvid abundance adjacent to campgrounds.

The Park has conducted both audio-visual surveys (1994-2009) and ornithological radar surveys (2000 -2009) in the Carbon River valley (NPS 2009, ABR 2009). These surveys have documented hundreds of audio-visual observations of both murrelet presence and occupancy behaviors in the Carbon River corridor from Park entrance up to Ipsut Creek Campground (Figure 5). The Carbon River on the survey data, the Carbon River valley supports the highest density of nesting murrelets in the Park.

Radar-surveys of murrelets can provide an index for the number of murrelets using a particular drainage, and the technique has been widely used in several different study areas (e.g., Rapheal et al. 2002). In the Carbon River, the number of murrelets detected entering the watershed was used as the index for murrelet abundance (ABR 2009). From the 2000 to 2009, the number of murrelets detected entering the upper Carbon River drainage with radar ranged from 2 to 30 birds, with a 10-year average of about 11 to 14 murrelets (ABR 2009). In 2009, the mean landward count of 9.5 murrelets generally fell in the low end of other mean radar counts at the Carbon River site (ABR 2009). The authors note that first ten years of data show a slight negative trend in radar counts of murrelets at the Carbon River site, but that given the high inter-annual variation in counts, it is premature to make definitive statements regarding murrelet trends in the Carbon River drainage until more years of data are collected (ABR 2009).

If we assume that an average of 12 murrelets detected by radar represent 12 nesting pairs, the potential density of murrelets nesting in the upper Carbon River valley is approximately 1 pair per 467 acres of suitable nesting habitat (5,600 acres of habitat / 12 pairs = 467 acres per pair).

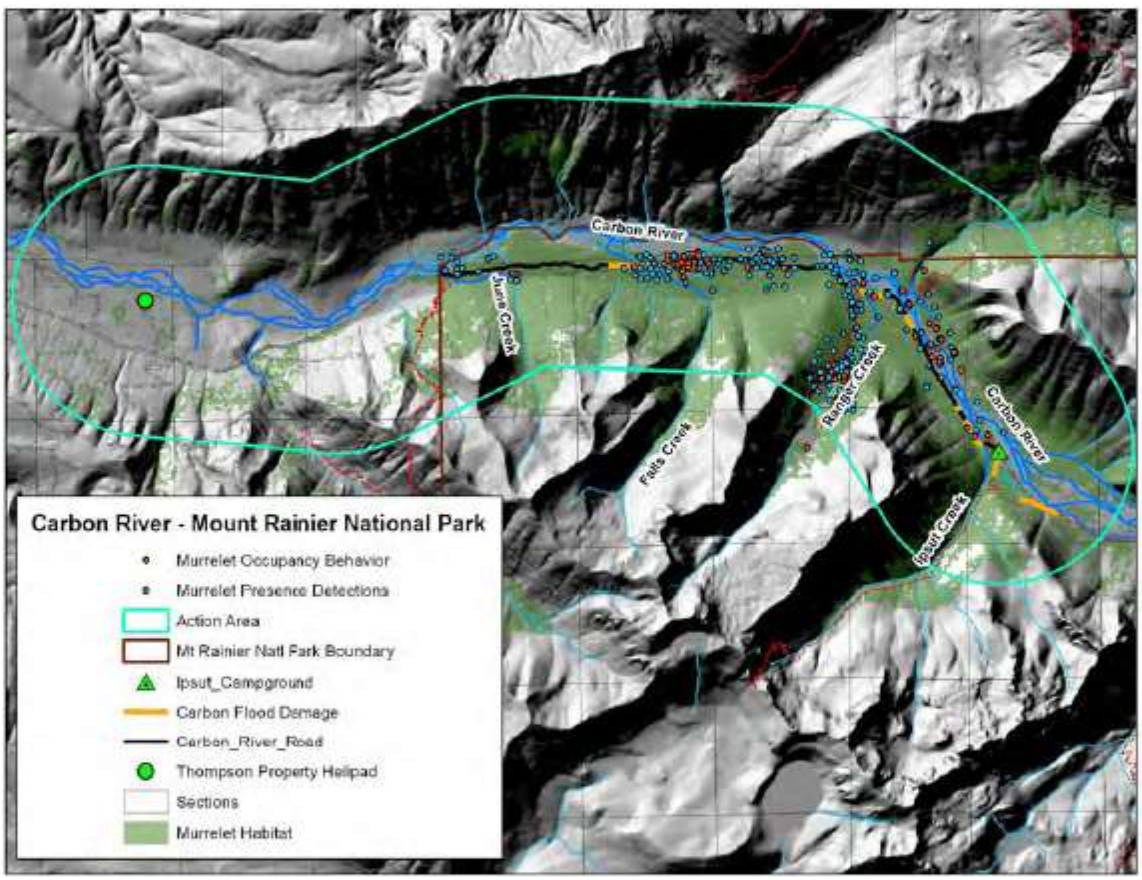

Figure 5. Murrelet nesting habitat and documented murrelet presence and occupancy detections in the upper Carbon River valley.

Direct Effects to Marbled Murrelets

Potential Disturbance to Murrelets from Project Noise and Activity

The use of helicopters, excavators, chainsaws, and other motorized equipment will introduce increased levels of sound into the project area over the course of 4 work seasons. Project work will coincide with the murrelet nesting season (April 1 – Sept. 15), and will continue into the fall months after the nesting season has passed. Noise and activities associated with road and trail construction, as well as construction of bank erosion protection structures have the potential to disturb murrelets nesting in the project area.

There is limited information concerning murrelet vulnerability to disturbance effects. In general, responses to noise disturbance at nest sites have been modifications of posture and on-nest behaviors without flushing or abandoning the nest (Long and Ralph 1998, USFWS 2003, Hebert and Golightly 2006). Significant disturbance occurs when noise or project activity causes a murrelet to become so agitated that it flushes away from an active nest site or aborts a feeding attempt during incubation or brooding of nestlings (USFWS 2003, p. 273). Such events are considered significant because they have the potential to result in reduced hatching success, fitness, or survival of juveniles. Specific threshold indicators for disturbance to murrelets include:

(a) *Nesting murrelets that are exposed to project noise that is greater than or equal to 92 dB at an active nest site during the early nesting season (April 1-August 5);or during dawn/dusk hours at any time during the nesting season*. There is no direct research on murrelets that indicates that very loud sounds will cause a murrelet to flush from a nest. The 92 dB threshold is derived from research on other bird species. Awbrey and Bowles (1990, p. 21) suggest that noise begins to disturb (i.e., cause an alert response, but not flight) most raptors at around 80-85 dB, and that the threshold for flight response is around 95 dB. Mexican spotted owls exposed to helicopter noise did not flush from their roosts until the noise from helicopters exceeded 92 dB, and the helicopters were within a distance of 105 m (Delaney et al. 1999 pp. 66-68). Brown (1990) subjected crested terns (*Sterna bergii*) to simulated aircraft noise and noted that at 95 dB, approximately 15 percent of birds were startled and about 8 percent of terns flushed. Based on these data, the USFWS concluded that murrelets exposed to sound levels 92 dB or greater could flush from a nest (USFWS 2003, p. 275).

(b) *Nesting murrelets that are exposed to prolonged, ground-based activities with motorized equipment within a distance of 105 ft (32 m) or 35 yards from an occupied nest tree during the early nesting season; or during dawn/dusk hours at any time during the nesting season. Prolonged exposure is defined as more than 2 days.* This threshold is based primarily on information provided in Long and Ralph (1998), Hamer and Nelson (1998), USFWS (2003), and Hebert and Golightly (2006).

Hebert and Golightly (2006) monitored nesting murrelets exposed to chainsaw noise and the presence of people hiking on trails in Redwood National and State Parks in northern California. Chainsaw disturbance tests were conducted for 15 minute intervals at a distance of 25 m from the base of occupied nest trees (n = 12). Murrelet nests were located in the upper forest canopy, with an average nest height of 51 m (156 ft) above ground, and average nest tree height of 61 m (200 ft) (p. 19).

Adult and chick responses to chainsaw noise, vehicle traffic, and people walking on forest trails resulted in no flushing and no significant increase in corvid presence (pp. 35-39). However, adults exposed to chainsaw noise spent more time with their head raised, and their bill raised up in a posture of alert, vigilant behavior. When undisturbed, adult murrelets spent 95 percent of the time resting or motionless. Many adult murrelets exposed to an operating chainsaw ultimately experienced complete nest failure, but the authors caution that the relationship, if any, between the disturbance trials during the incubation period, and fledging success was unclear. Overall reproductive success was similar for control (13%) and experimental nests (30%) (p. 37).

Murrelet chicks exposed to chainsaw noise also spent more time with their head raised, and their bill up during the disturbance trials, although compared to pre- and post-disturbance trials, the relationship was not statistically significant (p. 36). All three chicks exposed to chainsaw disturbance fledged (p. 29). Hebert and Golightly (p. 36) conclude that chainsaw noise disturbance lasting 10 to 15 minutes, at a distance greater than 25 m from the nest does not appear to induce long-term behavioral changes. None of the murrelets in this study were exposed to sound levels that approached 92 dB, so the results of this study do not confirm or refute the 92 dB threshold currently used by the USFWS.

The relevance of the behavioral responses seen in adults tending nests is unknown, but the behavior is similar to an adult murrelet reaction to the presence of a nest predator (p. 35). The authors suggest that prolonged noise disturbance at nest sites could produce short term behaviors that have unknown consequences. If a murrelet responded to noise disturbance by moving or shifting position, this might facilitate observation by a predator and expose the nest to increased risk of predation. Additionally, the energetic cost of increased vigilance to protracted disturbance, or especially disturbances that occurred coincidental in time with food delivering could have negative consequences for nesting success (p. 37). Adult murrelets typically feed their chicks in the early morning, and occasionally in the evening. Operating chainsaws while an adult approaches a nest to feed a chick may cause sufficient disturbance to result in abortion or delay of the feeding. The abortion of a single feeding trip could deprive the chick of 25-50% of its daily energy and water intake, which could potentially have a significant negative impact on fledging success (p. 38). In summary, Hebert and Golightly (2006, p. 40) recommend avoiding extended disturbance to incubating adults and avoiding disturbance to chicks at the time food deliveries are most likely to occur: early morning and late evening.

The USFWS (2003) review of murrelet responses to disturbance concluded that the use of heavy equipment within 35 yards of a nest tree could cause a murrelet to flush (p. 277). This distance was derived from a reported instance of 2 murrelets flushing from a tree in response to people slamming car doors and talking loudly within a distance of 30 m of the tree (p. 277). Hamer and Nelson (1998, p. 9) noted that adult murrelets would abort feeding attempts or flush off the nest branch during attempted food deliveries when people on the ground were visible to the birds and within a distance of 15 to 40 m, or occasionally when vehicles passed directly under a nest tree.

Murrelet chicks appear to be much more difficult to disturb than adults, and there are no documented instances of a nestling murrelet falling due to sound or visual disturbance, including disturbances due to researchers climbing nest trees, handling young, and placing cameras close to young (USFWS 2003, p. 269). Based on this review, the USFWS concluded that significant disturbance with a potential for injury for murrelets would only occur as a result of an adult murrelet flushing from the nest during incubation or brooding, or adults aborting a feeding of the chick (USFWS 2003, p. 274).

Overall, it appears that murrelets are not easily disrupted from nesting attempts by human disturbance except when confronted at or very near the nest itself. The study completed by Hebert and Golightly (2006) is the first experimental study that has monitored murrelet responses to disturbance events in a controlled manor. In this study, adult murrelets exposed to people operating chainsaws or groups of hikers passing nearby on Park trails did not flush from the nest. Murrelets have evolved several mechanisms to avoid predation; they have cryptic coloration, are silent around the nest, minimize movement at the nest, and limit incubation exchanges and chick feeding to occur during twilight hours (Nelson 1997). Hebert and Golightly (2006) suggest that flushing as a result of a disturbance or activity on the ground; might not provide a benefit compared to the potential risk of exposure to predators. When confronted with the presence of potential predators, murrelets remain on the nest in alert or defensive postures (Hamer and Nelson 1998, Hebert and Golightly 2006), and do not flush unless confronted directly by a large predator such as a raven (Singer et al. 1991).

Based on the best available information concerning murrelet responses to disturbance associated with noise, activity, and human presence we conclude the following:

1. Adult murrelets are most likely to exhibit a flush response while attempting to deliver food to the chick at dawn or dusk. Therefore, disturbance activities that occur in close proximity to occupied nests during dawn or dusk periods can cause adult murrelets to flush and abort a feeding attempt. *For the purpose of this analysis, we define close proximity as 35 yards for ground-based activities with motorized equipment, or the 92 dB sound contour for helicopters and blasting.*

2. Adult murrelets that are incubating an egg are not likely to flush from disturbance, *unless the birds are exposed to sounds 92 dB or greater*. Short-term ground-based disturbance events (such as operating a chainsaw for 15 minutes or less during mid-day periods) do not appear to have any significant effect to murrelet adults or chicks.

3. The normal behavior of incubating adults is to rest and remain motionless during the day. Prolonged disturbance disrupts this normal behavior by causing the adults to remain vigilant and alert during a time when they are normally resting. *For the purpose of this analysis, prolonged exposure is defined as more than 2 days of activity in the same location during the early nesting season.* Adult murrelets exchange incubation duties approximately once every 24 hours at dawn (Nelson 1997). We assume that each adult can tolerate noise disturbance for a 1-day cycle without consequence to individual fitness or increased predation risk to the egg.

4. Murrelet chicks appear to be mostly unaffected by disturbance. The greatest risk to murrelet chicks from disturbance is the potential for missed feedings, which occur primarily during dawn and dusk periods.

<u>Exposure of Murrelets to Project Noise and Disturbance</u>

We used a Geographic Information System (GIS) to evaluate the potential exposure of murrelets to project noise (Figure 4). Based on the estimated sound attenuation contours and the disturbance thresholds described above, we calculated potential disturbance buffers within the project area (Figure 6).

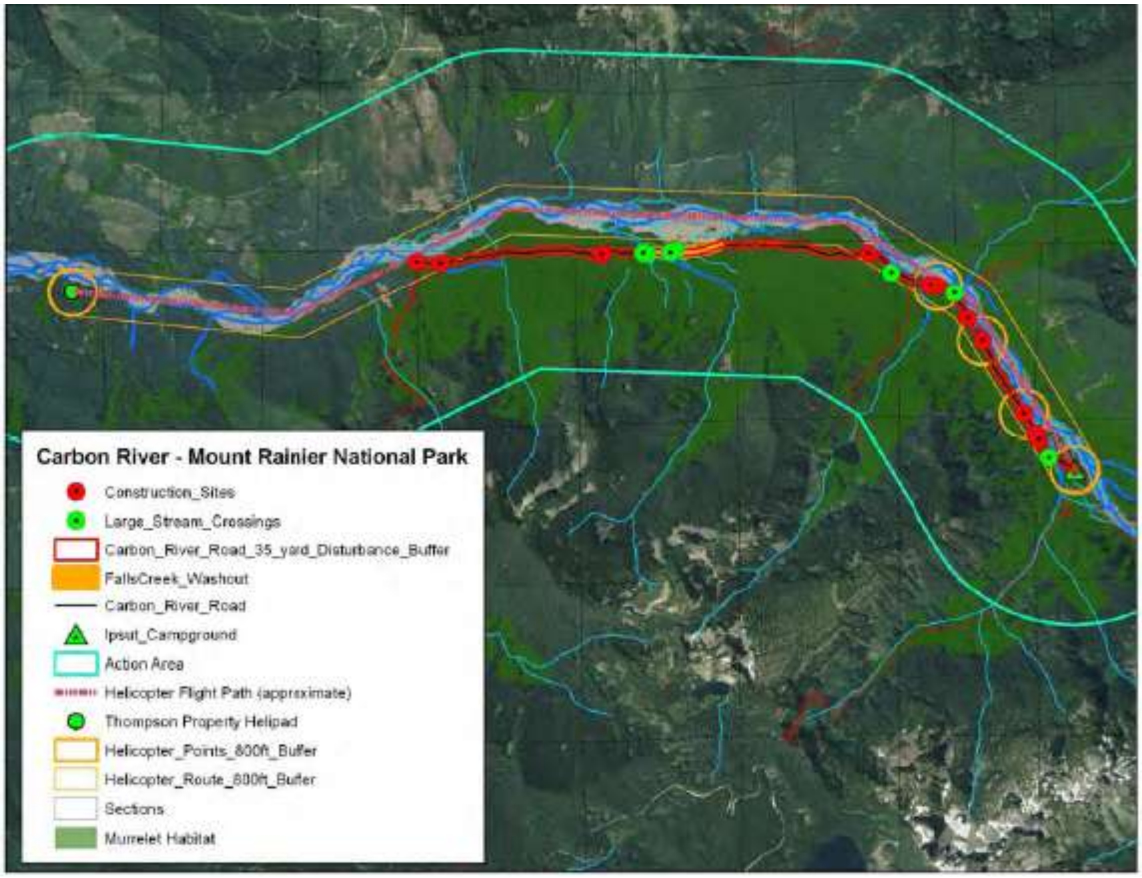

Figure 6. Overlap of project noise contours with murrelet nesting habitat in the project area. Large stream crossings, construction sites, and helicopter points are locations that will be subject to prolonged disturbance.

Use of motorized equipment along the Carbon River Road/Trail

Based on the disturbance thresholds described above, we mapped a 35 yard "disturbance" buffer along either side of Carbon River Road/Trail to represent the area where murrelets would most likely be disturbed by proximity to motorized equipment regardless of dB levels. The 35 yard disturbance buffer exceeds the estimated 92 dB sound contour for all project equipment except helicopters and blasting. For each mile of the road, there is approximately 25 acres located within the 35-yard disturbance buffer. The total area associated with the disturbance buffer along the Carbon River Road/Trail is approximately 128 acres, but only about 110 acres are actually forested and provide suitable murrelet nesting habitat.

Based on the documented history of murrelet occupancy behaviors in the upper Carbon River watershed, we assume that all suitable murrelet nesting habitat in the project area is occupied habitat. **All murrelets associated with 110 acres of nesting habitat** adjacent to the Carbon River Road/Trail corridor will be subjected to noise and activity of varying degrees of intensity on a daily basis over the next 4 years from April 1 through September 15.

The Park has incorporated a daily activity schedule for the Carbon River project. Project work will only occur 2 hours after official sunrise, and will cease 2 hours prior to official sunset during the murrelet nesting season (April 1 to September 15). This restriction avoids potential disruption to murrelets during their daily peak activity periods for feeding and incubation exchanges. Based on our review of the murrelet disturbance literature, we conclude that Park trail crews and contractors that are travelling to and from work sites in vehicles, on ATVs, or on foot along the Carbon River corridor during mid-day hours are not likely to cause a murrelet to flush off a nest, or cause an adult murrelet to abort a food delivery to a chick.

Due to timing constraints required for inwater work, most work at bank protection sites and major stream crossings will occur during the early murrelet nesting season. Based on our review of the murrelet disturbance literature, we expect that murrelets nesting in close proximity to these major construction sites will be exposed to prolonged disturbance that will result in a significant disruption of nesting behaviors, with implications for reduced individual fitness, reduced hatching success, and increased risk of nest predation for any murrelets nesting in close proximity to the construction sites. The acres of nesting habitat exposed to prolonged disturbance vary based on the project footprint and duration. The most intensive disturbance areas will be associated with construction of bank protection structures, and construction of trail through the Falls Creek washout area. Due to the prolonged exposure to construction activities during the early nesting season, we expect murrelets associated with 110 acres of nesting habitat adjacent to the Carbon River Road have an increased likelihood of nest failure as a result of project disturbance for a period of 3 to 4 years.

Disturbance from Helicopters

The Thompson Property will be used as a base for helicopter operations. There is no suitable murrelet nesting habitat indicated at this property, so we do not anticipate disturbance to murrelets associated with this site. The Ipsut Creek Campground and road washouts at MP 3.43, MP 3.93 and MP 4.47 are identified as helicopter drops sites for equipment and materials. Helicopter work at the Ipsut Campground will be scheduled to occur after the murrelet nesting season, so there would be no effect to murrelets from helicopters at this site. Helicopter use at the road washouts will likely occur in July, during the early murrelet nesting season. The duration of helicopter use over the 4 years of project implementation is relatively brief, and is estimated as multiple flights at each site for a period of 2 to 3 days. Helicopters will generally hover no closer than 200- 300 feet from the ground and ferry logs at above 500 feet for safety purposes.

For this assessment, we assumed the Park will contract a Chinook 47-D, which is a double-rotor helicopter with a 20,000 lb. lift capacity. The Chinook 47-D is a very loud helicopter with an estimated 92 dB sound contour at 800 ft. We used GIS to map 800 ft. disturbance buffers to indicate areas that would be exposed to helicopter noise levels of 92 dB or greater (Figure 6). Within the general helicopter flight path there is approximately **400 acres** of murrelet nesting habitat within the disturbance buffer, and about 25 acres of murrelet nesting habitat are associated with each of the 3 helicopter drop sites located at the road washouts for a total of about 75 acres. Based on the 92 dB disturbance threshold described above, we expect any nesting murrelets located within an 800 ft.-radius of the helicopter flight path and drop sites would potentially flush off a nest in response to helicopter noise. Noise disturbance in the vicinity of the helicopter drop sites is expected to have the highest likelihood of resulting in a murrelet flush response due to prolonged noise and debris movement from rotor-wash (downwash and side-wash) near potential nest sites.

Rotor wash is the high velocity air movement under a helicopter. Large helicopters, such as the Chinook-47, can generate rotor wash in excess of 120 knots. This strong wind may cause ground crew personnel difficulty in walking or standing and its force can move unsecured material. The greatest rotor wash velocity occurs between 20 to 60 feet outside the rotor disc. With a 60-foot rotor span, on each rotor system, the effective length of a CH-47 (with blades turning) is approximately 100 feet from the most forward point of the forward rotor to the most rearward point on the aft rotor (www.globalsecurity.org, 2010). For this analysis, we assume that the most severe rotor-wash effects are limited to a radius of 160 feet from the ship. This equates to a rotor-wash area of approximately 2 acres per drop site, or a total of 6 acres**.** Considering that the helicopter drops sites are located along the bank of the Carbon River, less than half of the potential rotor wash area will actually affect murrelet habitat. For young that have not fledged, the rotor wash from a large helicopter could cause a chick to fall off a nest branch or prematurely fledge. This activity could cause direct injury to murrelet eggs, chicks, or fledglings throughout the breeding period (April 1 – September 15) (USFWS 2007, p. 165-168). However, given the small amount of habitat affected by rotor wash, the probability of a direct injury to a murrelet chick is very low. It is much more likely that murrelets will be subjected to non-lethal disturbance effects from helicopter noise associated with the 400 acres of habitat along the flight path during 1 nesting season.

Blasting for trail realignments

The Park has identified several locations along the Carbon River Road/Trail that may require blasting to remove stumps for trail alignments. The noise associated with blasting is highly variable and depends on size of the charge and the material being blasted. The USFWS identified blasts of 2 lbs. or less to have a disturbance radius of 120 yards (USFWS 2003, p.282). For this project, the size of charges needed for blasting has not been defined. All blasting activities will be scheduled to occur after August 6. Based on the seasonal timing, blasting could directly affect a murrelet chick on a nest during a mid-day blast, but would not result in flushing an adult off a nest.

Based on sound measurements recorded by Park staff, the noise from a previous trail blasting (rock) project was reported as approximately 88 dB at 500 feet (NPS 2008, Wonderland Trail BA). Using a standard noise attenuation of -7.5 dB for each doubling of distance, the sound levels in this example would have been approximately 145-150 dB at the source. We do not expect murrelets chicks would be killed by in-air sound pressure or flying debris from trail blasting, but individuals could sustain injury in the form of temporary hearing loss. Dooling and Pooper (2007, p. 7) reported that birds exposed to a single impulse of noise at 140 dB or greater are likely to suffer hearing damage. A blast with a sound of 150 dB would attenuate to less than 130 dB within 25 ft. Murrelet nests are generally located high in the forest canopy at a height of 65 to 105 feet above ground level (McShane et al. 2004, p. 4-52). Considering the example above, it is unlikely that a murrelet nest would be located in close enough proximity to a blasting event for a chick to sustain hearing damage. Therefore, the potential for injury from limited blasting for trail construction to murrelets is discountable.

Recreational use in the Carbon River corridor

The Carbon River corridor currently receives over 30,000 visitors per year. Visitor use may increase over time as access in the corridor is improved. Visitor uses include hiking, camping, and picnicking along trails and at the Ipsut Creek campground. Most visitors stay on or close to Park trails, so the potential for visitors to encounter murrelets is limited to those instances when a murrelet may be nesting in a tree directly adjacent to a road, trail, parking area, or campground. There have been reported instances of murrelets flushing off a nest branch while attempting to deliver food to a chick in response to the presence of people on the ground within a distance of 15 – 40 m (Hamer and Nelson 1998, p. 9), but these situations are considered uncommon (USFWS 2003, p. 277). Hebert and Golightly (2006, p.31) in their study of park trails did not record any instances of murrelet flush responses or detect any significant relationship between murrelets nesting success and proximity to Park trails and roads. The authors (p. 39) conclude that mitigation in the form of reducing access to trails in Parks appears to be unwarranted, but they caution that the established link between human use of trails and campgrounds and increased corvid densities has implications for reduced murrelet nesting success.

Disturbance associated with annual opening of the Carbon River corridor in the spring

Due to the uncertain nature of trail repair work that may be needed to allow visitor and Park staff access to the project area, we expect that significant, short-term disturbance events associated with opening the Carbon River Road/Trail in the spring could occur at any location within the corridor over the 4 years of project implementation. Any site that requires onsite work for a period of more than 2 days (such as rebuilding a trail bridge) during the early nesting season is likely to disrupt any murrelets nesting within a 35 yard radius from the work site.

Indirect Effects to Murrelets

Increased risk of predation in areas of human activity

The relationship between human activities and predators, and their potential impact on murrelet nesting success has been identified as a significant threat to murrelet (USFWS 2010). The risk of predation on murrelet nests by avian predators appears to be highest in close proximity to forest edges and human activity. In many studies, significantly more predators (especially corvids), occurred in campgrounds, along suburban edges, and in other areas close to human development (McShane et al. 2004).

Based on the work by Marzluff and Neatherlin (2006), we expect murrelets nesting in close proximity (within a 1 km radius) to Ipsut Creek campground may have a higher rate of nest predation due to the potential for increased corvid abundance adjacent to campgrounds. We also expect that murrelet nesting habitat immediately adjacent to the Carbon Road/Trail between the Park Entrance and the Ipsut Campground also has a high risk of predation due to the long history of recreational use in the corridor. Approximately 500 to 600 acres of murrelet nesting habitat are exposed to increased predation risk due to recreational use in the corridor. This represents about 10 percent of the available murrelet nesting habitat in the upper Carbon River basin.

Under the Carbon River Access Management Plan, the effects associated with increased predation risk in the Carbon corridor will continue to occur, and are not likely to significantly change over the current existing levels. Short of closing the area to public access, there is relatively little that can be done to prevent these effects, other than to manage garbage collection facilities to reduce wildlife access to human garbage.

Loss of potential nesting habitat
Trail realignments along the Carbon River Road/Trail corridor may indirectly affect murrelets by removing key habitat elements such as large trees with potential nest platforms, or trees that provide canopy cover for potential nest platforms. Trail construction activities would result in removal of approximately 28 trees dispersed across 3 different trail sections (Table 3). The total area of vegetation loss associated with trail realignments is estimated at less than 0.5 acres dispersed across 3 sites. Felling of large trees greater than 16 inches diameter will only occur outside the murrelet nesting season, so there is no chance that an occupied nest tree would be felled, or an adjacent tree providing canopy cover for on occupied nest site would be felled.

We do not know if any of the trees identified for felling contain potential murrelet nest platforms, but considering the limited number of trees to be removed and the sizes classes, the probability that one of these trees is a murrelet nest tree is extremely low. Murrelets in some areas are known to reuse to the same nest trees from year to year, but this appears to be most common in landscapes that have limited nesting habitat, and less common in landscapes with large tracts of available nesting habitat (Burger et al. 2009, p. 217). Because there are large stands of suitable nesting habitat within the upper Carbon River basin, we expect that the loss of a few individual trees during the non-breeding season would not result in a significant disruption of murrelet breeding behavior in subsequent years.

Effects of Interrelated or Interdependent Actions

One inter-related action associated with the Carbon River Access Management project will be the future need to remove hazard trees in the vicinity of campgrounds, trailheads, and visitor parking areas. The Park completed a Hazard Tree Management Plan completed in 2006. In accordance with the Management Plan, hazard trees may only be felled during the period of October 1 through March 14. This seasonal restriction avoids hazard tree removal during the nesting season for murrelets. Therefore, potential disturbance or injury to murrelets from hazard tree removal is not anticipated, and the effects of hazard tree removal have been analyzed and authorized through previous consultation with the USFWS.

Once the Carbon River Access Management project has been completed, there will be a need to continue active management of the road and trail system. It is highly likely that flood damage will continue occur along the Carbon River corridor, which will require continued trail and road reconstruction efforts. We anticipate the ongoing effects of trail and road maintenance will be similar to effects of the current project.

Cumulative Effects

Under section 7 of the Endangered Species Act (16 U.S.C. 1536, *et seq.*), cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Biological Assessment (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

In the Carbon River action area, there is a mix of non-Federal timber land and National Forest lands located adjacent to the Park. National Forest lands on the adjacent Mt. Baker-Snoqualmie National Forest in the Carbon River valley are designated as Late-Successional Reserves, or as Wilderness. Non-federal lands in the area are managed primarily for timber production, but almost all forest that was potential murrelet nesting habitat on these lands has been previously harvested. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222).

Marbled Murrelet Conclusion and Effect Determination

Surveys indicate the Carbon River valley probably supports the highest density of nesting murrelets of any location within the Park. Old-growth forest in the Park and the adjacent Wilderness areas provide high quality murrelet nesting habitat that is mostly free from development and the presence of people. However, the Carbon River Road access corridor has a long history of recreational use, and likely supports a higher density of murrelet nest predators. As long as the Park continues to manage the Carbon River corridor for recreational access, murrelets nesting in close proximity to the road and Ipsut Creek Campground will likely have a higher rate of nest failure from predation and human disturbance. Short of the closing the area to public access, these effects are essentially unavoidable.

Considering the current status of the marbled murrelet in project area and the effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect, and is likely to adversely affect the marbled murrelet**. This determination is based on the rationale that the timing and duration of project construction activities is likely to result in significant disturbance and disruption of marbled murrelet nesting behavior, and is likely to result in an increased potential for nest failure for murrelets associated with approximately 110 acres of nesting habitat for a period of 3 to 4 years, and all murrelets associated with approximately 400 acres of nesting habitat will be exposed to significant short-term disturbance associated with helicopter use during 1 year. The maximum area of disturbance would be 410 acres in one year. These effects occur in areas that are already subjected to increased levels of predation due to the history of recreational use in the Carbon River corridor.

The number of murrelets exposed to these adverse effects is unknown. There is approximately 5,600 acres of potential murrelet nesting habitat in the upper Carbon River valley. Disturbance to 410 acres of represents about 7 percent of the available nesting habitat. The Carbon River valley supports an average of 12 pairs of nesting murrelets each year, with an average density of 467 acres of nesting habitat per pair. We assume that at least 1 nesting pair of murrelets per year will be subjected to adverse effects from disturbance, including potential nest failure. We do not expect that the adverse effects would result in the loss of this small, local population of nesting murrelets because over 90 percent of the nesting habitat in the Carbon River valley is essentially pristine and located away from the influence of developments and human presence.

Designated Marbled Murrelet Critical Habitat

The USFWS designated critical habitat for the marbled murrelet in 1996 (USFWS 1996). Critical habitat was not designated in National Parks. However, adjacent National Forest lands that border Mount Rainier National Park are designated as critical habitat. The primary constituent elements identified in the marbled murrelet critical habitat rule include (1) individual trees with potential nesting platforms, and (2) forested areas within 0.5 mile of individual trees with potential nesting platforms, and a canopy height of at least one-half the site potential tree height. This includes all such forests, regardless of contiguity (USFWS 1996). Actions associated with the Carbon River Access Management plan would have no direct or indirect effects to the primary constituent elements of designated marbled murrelet critical habitat. **Therefore, the proposed action would have no effect to designated marbled murrelet critical habitat**.

Federally Listed Fish Species and Critical Habitat

<u>Listed Fish Species in the Action Area</u>

The project footprint is located in the upper Carbon River watershed from the Park Entrance at RM 23 upstream to the Ipsut Creek Campground at approximately RM 28. The aquatic action area includes the Carbon River for 0.5 miles downstream from the Park entrance to account for any sediment plumes and changes in the channel configuration that may result from placement of bank protection structures in the stream channel.

The action area supplies habitat to multiple life stages of species listed under the ESA including eggs, juveniles, and adult Puget Sound Chinook salmon, Puget Sound steelhead, and bull trout (Figure 7). The action area also includes designated critical habitat for Chinook and bull trout, and is Essential Fish Habitat for Chinook and coho salmon. Other salmonid species present in the action area include coastal cutthroat trout, rainbow trout, mountain whitefish, and eastern brook trout (USFS 1998).

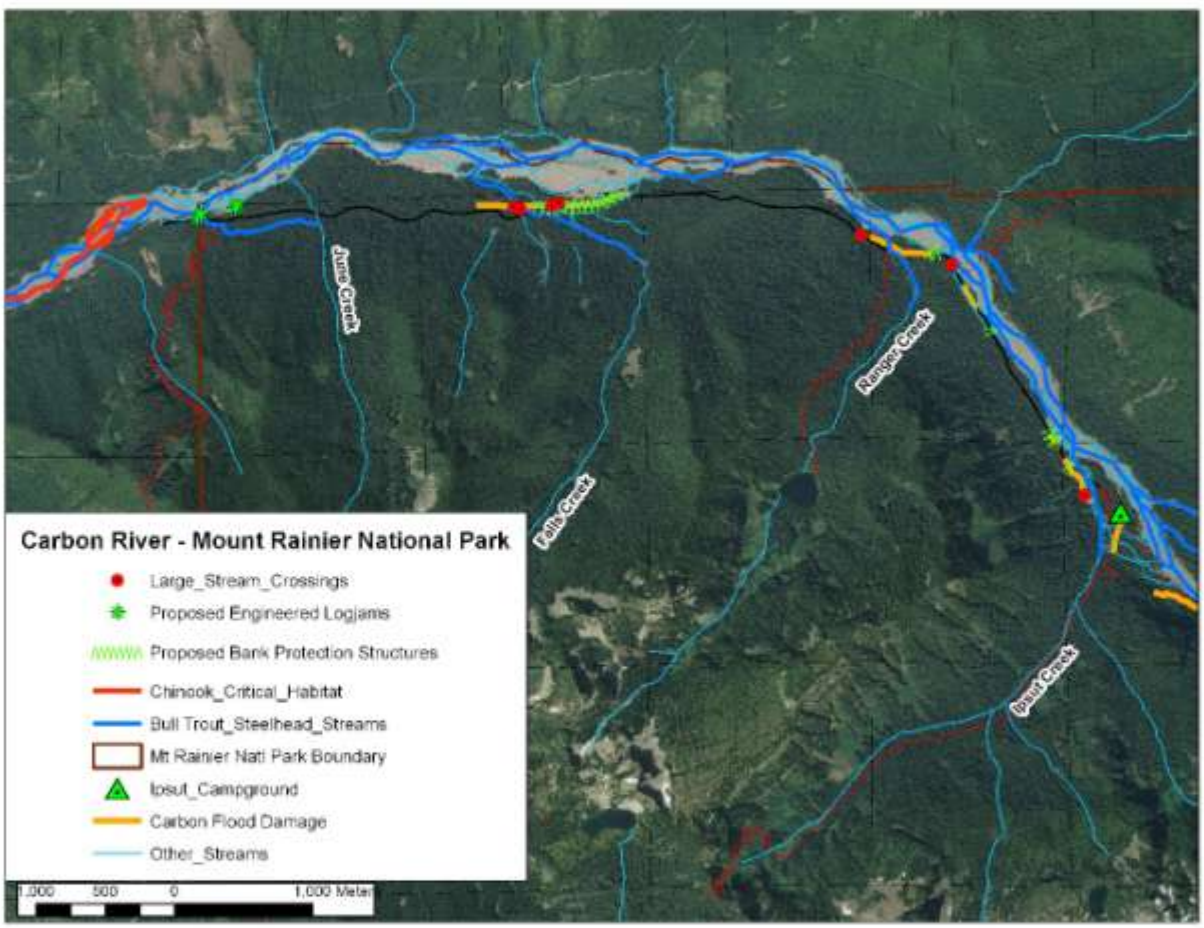

Figure 7. Distribution of listed fish habitat and proposed actions in the upper Carbon River.

For this analysis, we provide a brief overview of the environmental baseline, listing status, life history information, and describe the species presence and habitat use in the action area. The effects analysis will examine the direct and indirect effects of the proposed action to listed fish and their habitats.

<u>Aquatic Environmental Baseline Conditions in the Action Area</u>

Water quality and flow regime

The Carbon River has a high level of suspended sediment due to its origins at the Carbon Glacier on Mount Rainier. Based on water quality data collected on the Carbon River, the suspended sediment concentration is in the range of 120 to 475 milligrams per liter during mid-July through mid-August, with average values likely at the lower of end of this range around 150 mg/L during the in-water work window of the proposed project (WDOE 2010). This range of suspended solids equates to a range of 22 to 88 NTUs (nephelometric turbidity units). A maximum turbidity of 400 NTUs was estimated for a winter storm flow of 6,700 cfs. With the exception of high flow events during the winter, turbidity levels are highest during the summer and correspond with increased runoff from the Carbon Glacier. Mean flows during this period are in the range of 300 to 500 cfs, as reported at the USGS gage station located at Fairfax (USGS 2008). The lowest mean flows for the Carbon River actually occur in September and October (mean flows = 310 – 315 cfs), after the preferred inwater work window (USGS 2008). Tributary streams such as Ranger Creek and Ipsut Creek have very low levels of turbidity during the summer. Inwater work windows are based on the timing of fish spawning and incubation, rather than strictly on low flow periods.

Other water quality indicators such as water temperature and contaminants have not been monitored consistently. However, the Washington Department of Ecology water quality database indicates there are no water quality standard violations noted for the Carbon River, and all indicators except suspended solids are ranked as high quality (WDOE 2010).

Channel conditions and sediment

The Carbon River channel carries a very high bedload due to active sources of coarse sediment from glacial outwash. In the action area, the river forms a braided “D4” channel type which is typical of glacially fed rivers which have a high sediment supply (Rosgen 1994). Braided channels are naturally unstable and harbor important habitat-maintaining and formation processes including local gravel-size sediment input (the size suitable for salmonid spawning), and recruitment of large wood from the erosion of alluvial terraces. Braided reaches include important salmonid habitat, including side- and off-channel habitats, and channel margins consisting of eroding banks and habitat complexity provided by large wood. Floodplain springs, forested side channels, and valley wall tributary streams provide the most productive and complex fish spawning and rearing habitats in the system.

The braided active channels in the Carbon River are unstable with bedload consisting of large rubble, boulders, and pockets of fine sorted materials (Kerwin 1999, p. 49). Although the upper Carbon River has additional sediment loading from management related activities (e.g. forest roads), sediment loading from glacial erosion is an order of magnitude higher than from management activities (USFS 1998). Between 1990 and 1996, that active channel widened by up to 100 feet in several locations, and the channel is aggrading rapidly. The widening and lateral channel migration are likely a result of extreme peak flows and resulting bedload movements associated with several record flows that have occurred since 1990, and the retreat of the Carbon Glacier that began in the early 1980's. Natural aggradation of the Carbon River bed has resulted in more frequent flooding of the Carbon River Road over the past 2 decades. Flood damage to the road has resulted in major washouts which have resulted in altered stream channels and deposition of large amounts of road surface materials into tributary streams, most notably in the Falls Creek area.

Impacts from existing bank protection structures

The presence of the Carbon River Road and bank armoring with riprap to protect the road has altered natural channel migration in several locations along the upper Carbon River. As described in the Environmental Assessment (Affected Environment – historical levees) (NPS 2010), there are three segments of riprap located along the road in the Park. Riprap is located near Falls Creek, just east of the Green Lake Trailhead and near Chenuis Falls. The riprap associated with Falls Creek is approximately 20 feet long and consists of large angular rocks that may be mixed with historic riprap. Riprap associated with the Green Lake Trailhead is significantly longer stretching from 2.69 miles to 2.95 and contains large rock material. Finally, the riprap near the Chenuis Falls Trailhead stretching from 3.48 miles to 3.82 miles, serves as a retaining wall buffering the edge between the Carbon River and the Carbon River Road. The amount of bank armoring with rip-rap along the upper Carbon River within the Park is about 0.58 miles, with an additional 0.12 miles immediately below the Park boundary near June Creek. The total amount of riprap that is currently affecting the upper Carbon River channel (from the USFS 7810 bridge upstream) is estimated at approximately 0.7 mile. Additional areas of historic rip-rap, log cribbing, and gabions are located at various locations along the floodplain, but many of these structures do not currently interact with the active river channel, and the total length of these historic structures is unknown. Perhaps as much as 30 percent of the road length (~1.5 miles) has some form of bank protection in the floodplain (B. Samora, pers. comm. 06/19/2010). Bank armoring with rip-rap halts natural channel migration, disrupts the natural recruitment of large wood, and increases channel depth and scour along the toe of the rip-rap, all of which reduce channel complexity and degrade fish habitat (ISPG 2003, p. 6-69).

Impacts associated with existing culverts

The Carbon River Road has a long history of flood damage resulting in direct input of road fill sediments and potentially contaminants (e.g. oil and grease vehicles) into tributary streams (USFS 1998). The Carbon River Road is identified in the draft bull trout recovery plan as high priority area for addressing chronic habitat degradation associated with unstable road locations (USFWS 2004, p. 239). Culverts in tributary streams crossed by the Carbon River Road block natural sediment transport and have resulted in significant aggradation of sediment behind culverts, resulting in seasonal loss of surface flow in some stream segments, particularly in the Falls Creek area (NPS 2009). Scour and erosion at culvert outlets has left several culverts perched, forming partial or full barriers to fish passage, most notably at the Ranger Creek and the unnamed tributary stream at the Chenuis Falls Trailhead. These culverts block fish access to at least 0.75 miles of high quality spawning and rearing habitat in these streams.

Impacts from climate change
Salmonids throughout the Pacific Northwest are likely affected by climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (ISAB 2007, Battin et al. 2007.). The largest driver of climate-induced decline in salmonid populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmon eggs (Battin et al. 2007). Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmonid mortality. Recent trends in channel widening and increased peak flow events in the Carbon River indicate climate change effects are already having a profound impact on salmonid habitats in the upper Carbon River, and are these effects are likely to become more severe with further recession of the Carbon Glacier. Refugia habitat provided by floodplain tributary streams in the upper Carbon River will become increasingly important for maintaining viable fish populations as habitat in the Carbon River becomes increasing unstable with the ongoing effects of climate change.

Summary of the Aquatic Environmental Baseline (Matrix of Pathways and Indicators)

The condition of habitat in the action area is evaluated in terms of seven broad classes of habitat features (pathways), each of which has a related set of specific metrics (indicators) that are rated based on their functional condition. Baseline conditions for each indicator are described on a relative scale of functionality ("functioning properly," "functioning at risk" or "not properly functioning"). This analytical framework is referred to as the Matrix of Pathways and Indicators (NMFS 1996; USFWS 1999). The scale of this analysis is at the upper Carbon River 6^{th}-field watershed. The environmental baseline information for the watershed is summarized from the Forest Service's 1998 *Carbon River Watershed Analysis* (USFS 1998), and other sources of information as cited (Table 10). The overall ranking for the watershed is "functioning at risk" due to past and ongoing aquatic habitat degradation associated with roads, stream crossings, and increased peak flows and bedload from the Carbon Glacier.

Table 10. Summary of the Environmental Baseline in the upper Carbon River watershed ("Matrix of Pathways & Indicators").

Pathway	Indicator	Baseline Conditions	Rationale/Comments
Water Quality	Temperature	Functioning At Risk	Not listed as a concern in the WDOE water quality assessment or identified in State 303(d) list (WDOE 2010) Riparian harvest outside Park may influence tributary stream temperature in some areas.
	Sediment / Turbidity	Functioning At Risk	High natural turbidity from glacial sources in Carbon River. Very high water quality in tributary streams (WDOE 2010).
	Chemical Contamination & Nutrients	Functioning Properly	Not listed as a concern the WDOE water quality assessment or identified in State 303(d) list (WDOE 2010).
Habitat Access	Physical Barriers	Not Properly Functioning	Culverts on several tributary streams present partial or full barriers to fish passage.
Habitat Elements	Substrate	Functioning At Risk	Chronic road sediment sources delivered to key tributary streams along Carbon River Road.
	Large Woody Debris	Functioning At Risk	Past logging on private and National Forest lands in watershed has reduced old-growth riparian to less than 50% (USFS 1998)
	Pool Frequency / Quality	Functioning At Risk	Pool habitat potentially decreasing in Carbon River due to increasing bedload from Carbon Glacier.
	Large Pools	Functioning At Risk	Pool habitat potentially decreasing in Carbon River due to increasing bedload from Carbon Glacier.
	Off-Channel Habitat	Functioning At Risk	Side channel habitats constrained or directly impacted by location of Carbon River road in several areas.
	Refugia	Functioning At Risk	Refugia habitats are present, but are currently reduced due to passage barriers.
Channel Conditions & Dynamics	Width/Depth Ratio	Functioning At Risk	Width/depth ratio is increasing in Carbon River due to rapid channel widening in response to peak flood events and increasing bedload from Carbon Glacier.
	Streambank Condition	Functioning At Risk	Rapid channel widening and bank erosion in response to increased peak flood events and increasing bedload from Carbon Glacier.
	Floodplain Connectivity	Functioning at Risk	Bank armoring with rip-rap to is present in several locations both above and below Park boundary.
Flow / Hydrology	Peak / Base Flows	Functioning at Risk	Peak flow events appear to be increasing in severity. 3 largest recorded flood events with flows over 12,000 cfs have occurred in since 1991(USGS 2010 Fairfax gage data). Most likely cause is due to effects of Carbon Glacier recession, rather than clear-cut timber harvesting in watershed.
	Drainage Network	Functioning at Risk	Moderate increase in drainage network – road density is 1.33 mi/mi^2 (USFS 1998).
Watershed Conditions	Road Density / Location	Not Properly Functioning	Low road density overall (<2 mi/mi^2), but presence of valley bottom roads causes chronic flood damage and sediment delivery to tributary streams (USFWS 2004).
	Disturbance History	Functioning at Risk	Past logging on private and National Forest lands in watershed has reduced old-growth to less than 50% but recent clearcuts are less than 15% (USFS 1998).
	Riparian Areas	Functioning at Risk	Past logging on private and National Forest lands in watershed has reduced old-growth riparian to less than 50% (USFS 1998)

Bull Trout (*Salvelinus confluentus*) **and Designated/Proposed Bull Trout Critical Habitat**

Status and summary of species biology

The bull trout was listed as a threatened species in the coterminous United States in 1999. Throughout its range, bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, incidental angler harvest; entrainment and introduced non-native species (USFWS 1999).

Bull trout exhibit both resident and migratory life-history strategies. Resident bull trout completed their life cycles in the streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form), or saltwater (anadromous form) to rear as subadults and to live as adults. Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (USFWS 1999).

Bull trout typically spawn from August through November during periods of decreasing water temperatures. Cold water temperatures play an important role in determining bull trout habitat quality. Bull trout are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel. Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater. Depending on water temperature, incubation is normally 100 to 145 days. After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (USFWS 1999).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools. Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (USFWS 1999).

Critical habitat for bull trout in the coterminous United States was designated in 2005. On January 14, 2010, the USFWS issued a proposed rule that would significantly revise bull trout critical habitat (USFWS 2010). The 2010 proposed critical habitat designation includes all areas identified in the 2005 designation, as well as additional areas that have been identified as essential for the conservation of bull trout. In the Puget Sound region, over 1700 miles of streams and shorelines are proposed as bull trout critical habitat, including many streams within Mount Rainier National Park. The existing 2005 critical habitat designation remains in place until the proposed rule is finalized.

For the purpose of this Biological Assessment, we are analyzing the effects to proposed bull trout critical habitat as if it was a final designation. The primary constituent elements identified in the 2010 proposed bull trout critical habitat rule include:

(1) Springs, seeps, groundwater sources, and subsurface water connectivity (hyporehic flows) to contribute to water quality and quantity and provide thermal refugia.

(2) Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

(3) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

(4) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure.

(5) Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.

(6) Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 in.) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.

(7) A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.

(8) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

(9) Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass; inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.

In freshwater areas, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (USFWS 2010).

In the draft recovery plan for Coastal – Puget Sound Distinct Population Segment of bull trout, the USFWS identified the Puyallup River and its tributaries as a core area for bull trout recovery (USFWS 2004, p. 20). A core area is large watershed or river basin that contains habitat necessary to support all life stages of bull trout (e.g., spawning, rearing, migration, overwintering, and foraging habitat) and contains one or more local populations of bull trout. A local population is defined as a group of bull trout that spawn within a particular stream or portion of a stream system. The Puyallup core area has five identified local populations: the upper Puyallup and Mowich Rivers; Carbon River; upper White River; West Fork White River; and Greenwater River (USFWS 2004). With the exception of the Greenwater River local population, rivers and streams within the Park provide important spawning and rearing habitat for all of the local populations in the Puyallup core area. Within the Puyallup River core area, the USFWS has identified 306.5 miles of rivers and stream habitat as bull trout critical habitat, including 59.1 miles in Mount Rainier National Park (19 percent) (USFWS 2010, p. 2331).

Both anadromous and fluvial/resident bull trout local populations have been identified in the Puyallup River core area. Limited information is available regarding the distribution and abundance of bull trout in this core area. Local populations in the Puyallup core area are estimated to have fewer than 100 spawning adults, based on the low number of observed redds in spawning streams and low numbers of migrating adults counted at the Buckley fish trap on the lower White River (USFWS 2004, p. 221).

Many of the headwater reaches of the Puyallup River basin are either within the Park or in designated Wilderness areas which provide high quality habitat. The presence of brook trout in many parts of the Puyallup basin, including National Park waters is considered an ongoing threat to bull trout (USFWS 2004, 194). A majority of the basin outside of the National Park boundary has been significantly altered by a variety of factors including dams that impede natural bull trout migration, extensive timber harvest and associated road construction; conversion of landscape to residential, commercial, and agricultural use; substantial channelization of lower mainstem reaches; and total commercial development of the estuarine habitat. These factors have undoubtedly reduced the overall productivity and abundance of bull trout populations in the Puyallup River basin, and strongly influence the number and distribution of bull trout now present in the Park (USFWS 2004, p.121).

Bull Trout in the Carbon River

Bull trout critical habitat has been identified from the Carbon River confluence with the Puyallup River, upstream for approximately 32.7 miles. The Park boundary is located at approximately river mile 23. All known reports of spawning bull trout in this watershed are confined to the upper Carbon River, indicating a spatial separation from other bull trout local populations in the Puyallup core area. Therefore, bull trout in Carbon River are currently considered to represent a local population (USFWS 2004, p. 123). The overall abundance of the Carbon River local population is currently unknown, but is estimated to be less than 100 spawning adults. Migratory connectivity to other local populations and forage areas within the Puyallup basin is believed to be good, although the canyon reach in the Carbon River may present some short-term upstream migration delays (USFWS 2004, p. 123).

The Park collected fin clip samples from 100 individual native char in 2006 to assess genetic variation within and among bull trout collected from three tributaries to the Puyallup River in the Park (Carbon, White and West Fork). Of the 100 individuals analyzed, four fish were identified as brook trout and all other individuals were identified as bull trout. Levels of genetic variation observed over all three populations were comparable to those observed in other populations in Puget Sound and coastal Washington and somewhat lower than observed in other inland populations of bull trout. Within the three populations, the lowest levels of genetic variation occur in the Carbon River. Significant genetic variation was observed among all three populations suggesting that each of the three tributaries contains a distinct local spawning population. The level of variation between the White River and the West Fork White River was much lower than the level of variation between these two tributaries and the Carbon River. These data suggest that geneflow occurs between the White River and West Fork White River but individuals do not likely migrate between the Carbon River and the other two local populations.

Fisheries surveys have detected juvenile, subadult, and adult bull trout in the upper Carbon River and in several tributary streams including June Creek, Falls Creek, Chenuis Creek, and Ipsut Creek (USFWS 2004, p. 123, NPS 2009). Park staff documented spawning bull trout and bull trout redds in June Creek, Chenuis Creek, a small tributary stream to lower Chenuis Creek, Ranger Creek, and lower Ipsut Creek (Figure 7). Of the 33 bull trout redds documented in Carbon River tributaries since 2002, 17 redds were counted in Ranger Creek, indicating this is likely the most significant spawning stream for the Carbon River local population (NPS 2009). In 2009, Park staff counted 5 bull trout redds in Ranger Creek. Spawning activity has generally been documented from late September into October in the Carbon River tributaries, but active spawning may begin as early as mid-September based on bull trout surveys in the upper White River basin (Marks et al. 2009, p. 167). Table 11 provides a summary of the bull trout streams in the action area and their current conditions:

Table 11. Summary of bull trout critical habitat and existing conditions in the action area from RM 22.5 upstream to RM 30.7. This includes 0.5 miles downstream from the Park entrance upstream to the end of known bull trout distribution, 1.4 miles downstream from Carbon Glacier, and encompasses all known documented spawning locations for Carbon River bull trout.

Stream Segment	**Approximate stream length (miles) designated as bull trout critical habitat**	**Comments/Existing Conditions**
Carbon River – main channel	7.90	The active Carbon River channel is 500 to 1,300 ft. wide, with an average width of about 600 ft. During normal summer flows, the wetted channel width is about 20 to 25 percent of the active channel width, and is divided into 3 to 5 braided channel segments. About 2 miles of Carbon River Road (40 %) is located at a distance of 0 to 200 feet from the Carbon River within the active channel migration zone, and is rated as having a high risk of failure (Appendix 1). Bank armoring with rip-rap is located along approx. 0.25 mile of the south bank (2 percent).
Carbon River – additional braided channel segments	5.88	
June Creek	0.66	Lower 0.17 miles (25 %) of June Creek is located within 200 feet of Carbon Road and Park entrance parking facilities. Trail bridge crossing on lower stream. Bull trout spawning has been documented both above and below the culvert crossing on county road.
Falls Creek	0.97	3 stream crossings, Falls Creek and 2 tributaries, extensive flood damage from road scour along 0.5 miles. Gravel aggradation in vicinity of the road causes tributary streams to go dry seasonally, resulting in loss of perennial fish habitat. Lower 0.4 miles now carries combined flow from Falls Creek and an active Carbon River side channel. A total of 13 fish (cutthroat and bull trout) were counted in the new scour channel in 2007. Emergency flood repairs in 2007 (check dams) installed in the scour channel block fish passage into upper Falls Creek (NPS 2009).
Ranger Creek	0.61	Identified as the most significant spawning stream for the upper Carbon River. The Lower 0.21 miles below culvert is now combined with an active Carbon River side channel which closely parallels the road, and is beginning to cause road failure. Culvert is partial barrier to fish passage, blocks access to upper 0.5 miles of bull trout spawning and rearing habitat, although spawning bull trout have been documented above the culvert. Road fill at culvert is failing, resulting in road fill deposition in the stream, and degradation of spawning habitat. Upstream side of culvert is forming a logjam and gravel aggradation. The culvert is highly threatened and could fail with the next major flood (NPS 2009).
Unnamed tributary at Chenuis Falls trailhead (not designated as critical habitat)	0.25	Culvert crossing is total barrier to fish passage, blocks access to 0.25 miles of potential spawning and rearing habitat. Extensive aggradation of fine sediment above culvert (estimated at over 600 cubic yards, Appendix 1).
Chenuis Creek	0.12	Recreation trail to falls. Trail does not cross stream directly, but parallels stream along lower 200 feet. High quality spawning and rearing habitat in lower reach of stream below barrier falls.
Chenuis Creek trib.	0.32	Recently documented bull trout spawning tributary. Recreation trail to falls crosses stream with a trail bridge.
Ipsut Creek	0.54	Major changes to channel configuration resulted from 2006 flooding. Side channel from Carbon River now intercepts Ipsut Creek above the historic road crossing. The concrete bridge is blocked by a massive logjam, and caused the channel to reroute and scoured out 0.21 miles of road surface. The Lower 0.5 miles of Ipsut Creek channel now carries the combined flow of Ipsut Creek and an active side channel of the Carbon River.
Totals	17.00 miles	13.78 miles of braided channels along Carbon River from RM 22.5 up to RM 30.7 is identified as critical habitat. 3.22 miles of tributary streams identified as critical habitat (19 %).

Note: All stream miles are approximate values derived from GIS data and based off 1:24,000 scale maps used to designate bull trout critical habitat (USFWS 2010). These values underestimate the total length of accessible habitat in this area due to inaccuracies in mapping.

Puget Sound Steelhead (*Oncorhynchus mykiss*)

Status and summary of species biology

The Puget Sound (PS) steelhead Distinct Population Segment (DPS) was listed as a threatened species in 2007 (NMFS 2007). The DPS includes all naturally spawned anadromous winter-run and summer-run steelhead populations, in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks. The PS steelhead DPS includes more than 50 stocks of summer- and winter-run fish, the latter being the most widespread and numerous of the two run types (NMFS 2007).

The principal factors for listing the PS steelhead include widespread declines in adult abundance, threats to diversity posed by use of two hatchery steelhead stock, and the present or threatened destruction, modification, or curtailment of its habitat or range. Barriers to fish passage and adverse effects on water quality and quantity resulting from dams, the loss of wetland and riparian habitats, and agricultural and urban development activities have contributed and continue to contribute to the loss and degradation of steelhead habitats in Puget Sound (NMFS 2007). Critical habitat for PS steelhead has not been proposed or designated.

Both steelhead and rainbow trout are present throughout the Puyallup River watershed. The steelhead is the anadromous form of rainbow trout; offspring from either steelhead or rainbow trout can become anadromous, or remain in freshwater (resident form) their entire lives. However, the Federal threatened species status does not pertain to resident rainbow trout.

Steelhead are generally categorized as winter-run or summer-run, depending on the time of the year they return to freshwater river systems to reproduce. Steelhead can spawn more than once during their life-cycle. Scales collected from 1984 to 2005 by Puyallup Tribal Fisheries biologists at the USACE trap on the White River, and analyzed by WDFW, show an average of 5% (range 0-26.4%) repeat spawners returning annually (commonly females). The majority of steelhead returning to the Puyallup River system are winter-run fish that generally enter the river beginning in winter (January), and continue through spring (June). Peak migration occurs from mid-April through early May. Puyallup Tribal Fisheries spawning ground data shows peak spawning takes place in the upper Puyallup and White River basins in late April to early May; and in the lower White River, peak spawning occurs typically in mid-late May. Steelhead spawning occurs in the mainstem Puyallup, White, and Carbon rivers; although, the majority of spawning takes place in tributary streams (Marks et al. 1999), including streams within Mount Rainier National Park.

After fertilized eggs are deposited in the gravel substrate, the embryonic development and emergence of fry takes between 4-8 weeks depending on water temperature. Depending on spawning timing, steelhead eggs and alevins can be present in stream gravels into early July. Juvenile steelhead will rear in freshwater for 1- 4 years before migrating to marine waters in the spring. Scale data from winter steelhead captured in the White River trap from 1985 to 2004 shows the majority of young wild winter steelhead migrate to saltwater after 2 years in freshwater (81.6%). After spending between 1-4 years in saltwater; adult winter steelhead will return to the Puyallup River system at 3-7 years of age, with most returning after 2-3 years in saltwater (Marks et al. 1999).

The winter steelhead stocks in the Puyallup basin have been declining since 1990. The precipitous decline within just the past few years has created serious concern among fisheries managers. Factor(s) responsible for the decline in steelhead escapement are unknown, especially when other salmon species are experiencing relatively good success. Escapement numbers for the USACE trap in Buckley during 2005 (152 adults) was the lowest ever recorded since 1941. South Prairie Creek averaged 150 redds annually (range 93-196) from 1999 to 2004; however, only 32 redds were observed in 2005 (Marks et al. 1999).

PS Steelhead in the Carbon River

The majority of PS steelhead spawning in the Carbon River basin occurs in South Prairie Creek and in the lower 11 miles of the Carbon River. The 2002 stock assessment completed by WDFW indicates the Carbon River steelhead stock is depressed due to a long-term negative trend and a short-term severe decline in wild spawner escapement estimates (WDFW 2002). Spawning ground survey data from 1995 to 2006, shows an average of 15.8 redds annually (range 0-54) in the Carbon River (from the Park boundary downstream to the Puyallup River) and an average redd count of 133 (range 32-196) in South Prairie Creek. The authors note that steelhead surveys over the past three years have been incomplete due to poor survey conditions (Marks et al. 2009).

Suitable spawning habitat for PS steelhead is present in the upper Carbon River and in tributaries such as Ranger Creek (Marks et al. 2009). Past surveys at Ipsut Creek have not documented spawning PS steelhead in this area (Marks et al. 2009). There have been no systematic surveys for PS steelhead in the Carbon River above the Park boundary, so the number of steelhead that spawn in this part of river is unknown, but is expected to be low based on the overall low abundance of PS steelhead in the Carbon River. Fish surveys completed by Park Service staff have documented juvenile steelhead/rainbow in the Carbon River, Ipsut Creek, Chenuis Creek and Ranger Creek, and juvenile coho salmon in June Creek. Based on habitat accessibility and long freshwater residence time for juvenile steelhead, we consider the current potential distribution of steelhead in the upper Carbon River to be the same as the distribution of bull trout (Figure 7, above).

Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) **and designated critical habitat**

Status and summary of species biology

The Puget Sound (PS) Chinook salmon Evolutionarily Significant Unit (ESU) was listed as a threatened species on March 24, 1999, and threatened status was reaffirmed in 2005 (NMFS 2005). The ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The Puget Sound ESU is comprised of 31 historically quasi-independent populations of PS Chinook salmon, of which 22 are believed to be extant. (Good et al. 2005). Critical habitat for PS Chinook including both rivers and nearshore marine waters in the Puget Sound basin was designated in 2005 (NMFS 2005).

The Puyallup River basin has two historically independent populations of PS Chinook: Puyallup River fall-run and White River spring-run (Ruckelshaus et al. 2006). The Puyallup River fall-run includes PS Chinook that spawn and rear in the Carbon River and its tributaries. Most fall-run PS Chinook enter the Puyallup River system in mid- to late July and spawn from mid-September to early November. Incubation occurs from mid-September to late February when the fry emerge from the gravel and begin their downstream migration. Most fall-run PS Chinook express an "ocean type" life history. After emergence from redds, ocean type Chinook fry migrate downstream to lower river and estuary habitats, where they rear through early August before outmigrating to the ocean as an age 0 smolt (Healy 1991). A small number of fall-run PS Chinook express a "stream type" life history where the juveniles rear in their natal rivers for over a year before outmigrating to the ocean as an age 1 smolt (Healy 1991). Approximately 99 percent of Puyallup River fall-run Chinook are ocean type fish, with the remaining one percent being stream type fish (Beechie et al. 2006). PS Chinook rear in the ocean for 1 to 5 years before returning to their natal river to spawn (Healy 1991).

The mean number of natural Chinook spawners in the Puyallup River between 1998 and 2002 was 1,679, with a range of 1,193 to 1,988, which is about 4 percent of the estimated historical population of 42,000 fish (Good et al. 2005). Fall-run PS Chinook natural spawning occurs primarily in South Prairie Creek up to RM 15, the Puyallup River mainstem up to the Electron Dam, and in the lower Carbon River (Marks et al. 2009).

<u>PS Chinook in the Carbon River</u>

The majority of PS Chinook spawning in the Carbon River basin occurs in South Prairie Creek and the lower 11 miles of the Carbon River (Marks et al. 2009). The upper limit of potential Chinook salmon distribution within the Carbon River has not been clearly defined. The Carbon River watershed analysis shows potential Chinook distribution up to the Ipsut Creek confluence at about RM 28 (USFS 1998, p. 2-61). Suitable spawning habitat for Chinook is present in the upper Carbon River along channel margins and pool tailouts. Surveys at Ipsut Creek have not documented spawning Chinook in this area (Marks et al. 2009). Fall spawning surveys by Park fisheries staff over the past five years have not detected Chinook. There have been no reported observations of PS Chinook in the upper Carbon River since the 1980's (G. Piazza, WDFW pers. comm. 04/08/2010). Recent spawning surveys completed by the Puyallup Tribe in 2008 documented only 1 PS Chinook redd in the lower Carbon River (between RM 8.5 - 9.5) and 369 redds in South Prairie Creek (Marks et al. 2009). This information suggests that PS Chinook salmon spawning is probably rare in the upper Carbon River, but the area is potentially accessible to PS Chinook salmon, and may occasionally be used by these fish in years of high abundance. For this analysis, we assume that PS Chinook potentially occur in the Carbon River up to RM 28.

Critical habitat for PS Chinook salmon has been designated in the Carbon River up to about RM 22.7, approximately 0.3 mile downstream from the Park boundary, and within the defined action area (Figure 7). The primary constituent elements of PS Chinook salmon critical habitat that are located within the action area are (NMFS 2005)**:**

1. Freshwater spawning sites with water quantity and quality conditions and substrate that support spawning, incubation, and larval development;

2. Freshwater rearing sites with (1) water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility, (2) water quality and forage that support juvenile development, and (3) natural cover such as shade, submerged and overhanging large wood, logjams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;

3. Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks that support juvenile and adult mobility and survival.

Effects to Bull Trout, Steelhead, Chinook and Listed Fish Critical Habitat

The proposed action includes several projects that will require the use of heavy equipment below the bankfull elevation in the Carbon River and its tributaries. These projects will result in both direct and indirect effects to listed fish and their habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures:

- Direct short-term effects (i.e., stress, injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation and dewatering.

- Direct short-term effects (i.e., stress and/or injury) resulting from exposure to construction-related turbidity and sediments.

- Indirect short-term effects (mortality and reduced incubation success) associated with stream substrate scouring and deposition in fish spawning areas that result from changes in channel configuration.

- Permanent effects to instream habitat structure, function, and diversity. The project will construct bank protections structures that will inhibit natural channel migration and recruitment of large wood in the affected areas. Structures will also result in local scouring and deposition of stream substrates and sediments. The project would also improve natural stream habitat function and connectivity over the long-term by removing barrier culverts and replacing them with bridges.

Construction activities have the potential to kill or injure a limited number of adult, subadult, and juvenile bull trout, and juvenile steelhead. Temporary exposures to turbidity plumes may also significantly disrupt normal fish behaviors (i.e., ability to successfully feed, move, and/or shelter). These exposures may temporarily cause fish to avoid the action area, may impede or discourage free movement through the action area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions.

The seasonal timing for inchannel excavation work (July 16 - August 15 for Ranger Creek and Ipsut Creek, and July 9 to August 22 for Carbon River) will avoid direct impacts to spawning fish and incubating eggs, alevins, and pre-emergent fry. Indirect effects to salmonid eggs and fry may occur during the first season after project implementation as disturbed instream construction sites respond and adjust to increased streamflows during the fall and winter months.

Direct and Indirect Effects to Listed Fish Species

Direct effects associated with worksite isolation, dewatering, and fish removal

Work area isolation and dewatering are conservation measures intended to reduce exposure and the risk of potential injury associated with increased turbidity and sedimentation, operation of heavy equipment, and extensive placement of rock and large wood. While a small number of individual bull trout and juvenile steelhead may be exposed to stresses resulting from fish capture, handling, and exclusion, these practices have the benefit of reducing more intense exposures and/or exposures that might affect a substantially greater number of individuals. It is possible that a limited number of juvenile bull trout and steelhead may be killed or injured when capturing and removing fish from isolated work areas. Based on their life history, we do not expect juvenile Chinook to be present in the action area during the inwater work season and exposed to fish handling, and we expect any adult Chinook that may be present would move away from worksites and would not be exposed to fish handling.

We assume that all fish exposed to dewatering and fish handling will experience sublethal effects and a low mortality rate. Our expectation that rescue activities will result in a low frequency of lethal effects is based on research studies achieving low mortality rates (0.5 to 9 percent). These research-related mortality rates considered the cumulative handling mortality associated with capture by electrofishing, anesthetizing, measuring, tagging, and holding tagged fish overnight (e.g., Peterson et al. 2004, pg. 757; Gowan et al. 1994, pg. 2630). Rescued fish will be exposed to much less manipulation and much shorter duration of captivity, making mortality rates on the low end of this range a reasonable expectation. Sublethal effects will include a variety of minor injuries and exposed fish will be temporarily disrupted from their normal behavior during the capture and relocation activities.

When in-water work occurs within isolated reaches of streams, fish that avoid capture and rescue are at risk of being crushed or buried during placement of material and operation of equipment in wetted channels. The substrate-oriented behavior of bull trout fry, especially their tendency to hide in interstitial spaces in the substrate as an escape response, increases their susceptibility to being crushed or buried during in-water construction. A few juvenile fish (most likely age 0 fry) will likely avoid capture and die as a result of local work site dewatering and construction impacts. Stream substrate in project areas is frequently compressed by new fill, coffer dams, and heavy equipment.

The total number of fish exposed to worksite isolation and dewatering effects is unknown. For this analysis, we are using estimates of stream length and area affected to represent these effects. For dewatering and fish handling effects we are assuming that 1.5 x the length of each proposed bank protection structure will be dewatered for work site isolation, and 100 ft. for each culvert removal site that requires dewatering. In total, we expect direct effects (i.e., stress, injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation and dewatering along 0.38 miles of streams. Most of these effects (0.30 mile) are located along the margin of the Carbon River channel (Tables 11, 12, 13, 14).

Direct and Indirect Effects associated with turbidity, sediment, substrate scour and deposition

Construction of bank protection structures and culvert removal will cause increased transport of suspended sediment and turbidity, at and below a project site. Worksite isolation and erosion control measures will greatly reduce these impacts. However, once onsite construction is completed and a worksite is exposed to flowing water, there will be increased levels of turbidity released in the project vicinity. These project-related sediment plumes will be of short duration (hours to 1 day), but may occur more than once per project site depending upon stream flow. Following construction, both fine and coarse sediments at the project site will be subject to scouring and deposition which can result in short-term adverse affects (1 season) to downstream fish spawning and rearing habitats.

Direct Effects to Fish from Turbidity/Suspended Sediment

Fish in the vicinity of project sites will be exposed to project-related turbidity plumes.
High levels of turbidity can adversely affect fish and have lethal or sublethal effects depending on the sediment concentration and the duration of exposure (Newcombe and Jensen 1996). Foltz et al. (2008, p. 335) reported that the peak sediment concentrations below culvert removal sites ranged from 11 mg/L to 900 mg/L, with an average of 830 mg/L for projects that employed best management practices to minimize turbidity. Projects that did not employ erosion control measures had average sediment concentrations over 13,000 mg/L. The average concentration of 830 mg/L is well above the normal background levels of 120 to 400 mg/L in the Carbon River. These concentrations can be expected to last for several hours after construction to 1 day after construction. Based on minimization measures incorporated into the project, we expect that the stream channel excavation will generate relatively low-levels of suspended sediments that are comparable to the mitigated values reported by Foltz et al. (2008, p. 335).

Exposure to suspended sediment concentrations of 830 mg/L for a period of 3 to 24 hours would be expected to cause sublethal effects to juvenile and adult salmonids such as avoidance, abandonment of cover; short-term reductions in feeding rates, gill irritation, and increased respiration (Newcombe and Jensen 1996, p. 699). These sublethal effects are considered to be a significant impairment of normal behaviors. A similar exposure to salmonid eggs and alevins can result in delayed hatching, reduced growth, and a potential mortality rate of 0 to 20 percent

Juvenile steelhead, bull trout juveniles and adults, and potentially adult Chinook will be exposed to turbidity plumes. Juvenile Chinook will not be exposed to turbidity plumes based on their life history and the inwater work season.

For this analysis we assume that concentrations of suspended sediments that "may affect" listed fish can extend downstream for up to 0.5 RM (800 m) from instream construction sites. This is based on the findings of Foltz et al.(2008, p. 336) who reported turbidity levels sufficient to affect fish behavior at up to 850 m (0.52 RM) downstream, but most streams had returned to near background levels within 0.5 RM. Sediment concentrations 100m downstream of the excavation sites were reduced by an order of magnitude, but did not change the turbidity values sufficiently to meet regulatory limits (Foltz et al. 2008, p. 329). Based on a number of instream construction projects that have been monitored in western Washington, the USFWS assumes that significant levels of suspended sediment and turbidity are most likely to occur within a distance of 600 ft. from instream construction sites (USFWS 2007, pp. 124-125). Based on this, we used 600 ft. to estimate the areas where fish are most likely to be subjected to adverse effects from turbidity plumes. In total, we expect direct effects (i.e., stress and/or injury) resulting from short-term exposures to construction-related turbidity and sediment along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels (Tables 11, 12, 13, 14, below).

Direct and Indirect Effects to Fish from Sediment and Substrate Embeddedness

Fine sediments from turbidity plumes will deposit rapidly below project sites causing short-term increases in substrate embeddedness in deposition areas. Following construction, both fine and coarse sediments at project sites will be subjected to scouring and deposition which can result in short-term adverse effects (1 season) to downstream fish spawning habitat. These sediment deposits can adversely affect salmonid eggs, alevins, and age-0 fry if deposited in fish spawning areas through increased substrate embeddedness, or loss of redds due to scouring effects. Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987). Deposition of fine sediments can reduce the water flow through the substrate and, therefore, reduce oxygen to eggs and alevins which can decrease egg survival, decrease fry emergence rates (Bash et al. 2001; Cederholm and Reid 1987; Chapman 1988), and delay the development of alevins (Everest et al. 1987).

The inwater work window occurs in July and August during a period of decreasing flows in the Carbon River. Mean flow levels in the Carbon River and its tributaries will continue to remain at low levels during the bull trout and Chinook spawning period in September and October. Therefore, fish that spawn directly below construction sites are at risk of having the redds scoured or buried due to changes in the channel configuration, resulting in decreased egg survival and fry emergence rates. Any reduction in incubation success is a significant adverse effect. Bull trout eggs are most likely to be affected by substrate impacts, although it is possible that Chinook eggs could be affected as well in the vicinity of the Park entrance. Due to the timing of steelhead spawning in the spring, it is unlikely that steelhead eggs will be impacted by changes in substrates. Any changes due to seasonal scouring and deposition will have occurred over the first winter after construction and prior to steelhead spawning.

For this analysis we assume that significant increases in fine sediment (particle sizes less than 5 mm) in stream substrates that "may affect" listed fish can occur for up to 0.3 RM (500 m) downstream from instream construction sites and culvert removal sites. This is based on the findings of Lachance et al. (2008, p. 336) who recommend 500 m (1,640 ft) as a threshold distance to account for the effects of culvert placements in trout spawning streams (Lachance et al. 2008, p. 1836). However, based on a number of instream construction projects that have been monitored in western Washington, the USFWS assumes that significant levels of scour and sediment deposition are most likely to occur within a distance of 600 ft. from instream construction sites (USFWS 2007, pp. 124-125). Based on this, we used 600 ft. to estimate the areas where fish are most likely be subjected to adverse effects from increased substrate embeddedness and substrate scour and deposition effects. In total, we expect indirect effects associated with stream substrate scouring and sediment deposition in fish spawning areas that result from changes in channel configuration along 2.68 miles of streams. The effect is mortality and reduced incubation success for 1 season in the affected areas. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat (Tables 11, 12, 13, 14, below).

Effects of Sediment on Salmonid Food Sources

Salmonids favor certain groups of benthic macroinvertebrates, such as mayflies, caddisflies, and stoneflies. These species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987; Waters 1995). Any modification of the streambed by deposited sediments will most likely have a profound effect upon the benthic invertebrate community (Waters 1995). The degree to which substrate particles are surrounded by fine material was strongly correlated with macroinvertebrates abundance and composition (Birtwell 1999). At an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995). The potential effects to salmonid food sources are considered a general degradation of fish habitat conditions. For this analysis, we assume that the extent of adverse impacts associated with sediment and substrate impacts listed in Tables 11, 12, 13, and 14, account for these effects.

Direct and Indirect Effects to Fish Habitat

Effects of Bank Protection Structures along the Carbon River

Large bank protection structures are proposed in 5 locations along the Carbon River between the Park Entrance and Ipsut Creek Campground. This segment of the Carbon River is approximately 5 miles long. The total length of bank protection proposed by the Park is 1,060 ft. (0.20 mile). This represents about 4 percent of bank along the south side of the river, or 2 percent of the total river bank in the area considering both the north and south banks. The existing bank armoring with rip-rap in this section of the river is estimated at 0.7 miles along the south bank, so the combined total of existing bank protection and new structures will equal approximately 0.9 miles or about 18 percent of the south bank of the Carbon River between the Park Entrance and Ipsut Creek Campground. These bank treatments will function to directly armor or reinforce eroding banks and deflect flows away from the river bank to protect threatened sections of the Carbon River Road.

Bank protection structures that halt lateral scour and natural channel migration disrupt the natural fluvial process of bank erosion. Bank erosion recruits sediment and wood to the stream, creates and maintains in-stream and floodplain habitats (e.g., side channels), maintains overall aquatic habitat diversity within the stream corridor, and enables the stream to respond to changing conditions within its watershed (SHRG 2004). Much of the large wood that enters the upper Carbon River is transported downstream during flood events and contributes to formation of logjams and fish habitat features in the lower watershed. Any reduction of large wood inputs due to bank protections is considered to be an adverse effect to listed fish critical habitat.

Construction of bank protection structures will require work site isolation, dewatering, and sediment and erosion control measures. Each site requires extensive excavation of the bank and channel bed to allow the structure to placed below the potential scour depth of the river and built up from that elevation. Bank protection structures also need to be keyed into intact bank areas, resulting in streambank and riparian area disturbance and short or long-term loss of riparian vegetation at construction sites, which is an adverse effect to listed fish critical habitat.

The proposed stream bed and stream bank stabilization measures include a series of approximately (4) engineered logjams, (3), toe-roughened gabion /log structures, (1) rock barb, and (1) log cribwall. At this time, funding for these structures has not been secured. Additionally, the bank protection measures proposed by the Park are conceptual designs. Final designs and engineering considerations have not been completed, and some structures may be determined to be infeasible. For the purpose of this Biological Assessment, we are analyzing the general effects anticipated from the proposed conceptual designs in Appendix 1.

Rock barbs

Under the proposed action, a single rock barb structure will be placed in the maintenance area. The structure will be recycled later as ballast for an engineered log jam on the same site. For a barb to be effective, the footprint of the barb is excavated down below the potential scour depth of the river channel and built up from that level. Barbs redirect flow away from an eroding bank. Realignment of flow and redistribution of sediment may impact existing fish spawning areas. A decrease in bank erosion will reduce periodic inputs of gravel and woody debris into the channel, which represents a lost opportunity for continued development of habitat complexity. Riparian function is also impacted by replacing riparian vegetation with a barb (ISPG 2003, p. 6-26). Because of these effects, rock barbs are considered an adverse effect to listed fish critical habitat.

Engineered Logjams

Engineered log jams generally produce scour adjacent to themselves. The scour at the margin of the jam and the associated downstream deposition moves the location of the main current away from an eroding bank. Engineered log jams offer a distinct advantage over most rock structures such as barbs and groins. As scour holes develop adjacent to the log jam, the interlocking nature of log jams allow them to deform and settle; effectively retaining the structural integrity of the structure (ISPG 2003, p. 6-33). Engineered log jams can provide valuable fish and wildlife habitat. Immediately following placement of engineered log jams, there may be temporary, short-term impacts on spawning and rearing habitat. Existing spawning areas may shift or scour; while others may accrete with fines while new spawning areas are forming. It may take the channel a period of time to adjust to the jams. However, the long-term habitat benefits of engineered log jams generally outweigh these short-term impacts. The structural and hydraulic diversity that engineered log jams provide creates habitat for a multiple fish species at nearly every stage of life. Engineered log jams create excellent cover, holding and rearing habitats. At the tailout from the scour hole created by an engineered log jam, spawning habitat may be created. The detritus they accumulate, particularly smaller twigs and leaves that decay rapidly, also serves as a food to some aquatic insects that fish consume (SHRG 2004). Placement of engineered logjams results in unavoidable short-term direct and indirect impacts to listed fish. Engineered logjams that are not keyed into rip-rap hardened banks do not result in long-term adverse effects to listed fish critical habitat because the structures create complex habitat features and are biodegradable.

Log cribwalls and rock / log toe-roughened structures
Log cribwalls can be very effective at controlling bank erosion and can provide relatively permanent protection. However, permanent protection eliminates a source of sediment supply and recruitment of large woody debris, which affects the natural balance of erosion and deposition within a channel. Also, cribwalls tend to arrest downstream meander migration, increasing bank erosion upstream and/or downstream from their placement. Because logs have a limited life span, this effect is not permanent, but it may go on for decades. The reduced roughness characteristics of log cribwalls may also have a detrimental impact to adjacent spawning beds, cover and holding habitat. Roughness can be enhanced in the design of a log cribwall by incorporating roughness elements such as rootwads into the cribwalls construction (ISPG 2003, p. 6-100).

Log and rock roughened toe structures harden the bank into a relatively uniform and permanent position and shape, resulting in short-term lost opportunity for sediment supply, recruitment of large woody debris and off-channel habitat. Log toes are considered superior to rock toes in terms of providing habitat elements, and log toes will eventually degrade; rock does not. Fish tend to prefer the complexity of wood structures more than rock, so log toes are the preferred bank-protection option over rock toes. Salmonids are found along riprap banks, but the habitat is not preferred in most cases where they have a choice. Rock toes and revetments with large woody debris have been shown to have more fish abundance than plain rock (ISPG 2003, p. 6-91). Because these structures are designed to halt lateral channel migration, they are considered to be an adverse effect to listed fish critical habitat.

Gabions
Due to equipment limitations along the upper Carbon River Road, the Park is proposing to use gabions in the place of large riprap in the construction of toe-roughened structures. Gabion baskets would be filled with river rock excavated onsite and used in place of boulders in the construction of log and rock roughened toe structures.

The use of gabions in bank protection structures is limited to specific applications, and is generally not recommended in areas where gabions will be exposed to high velocity currents and potential damage from floating logs or other debris. Under these conditions, the wire can be damaged and the protection lost. Gabions must also be protected against impact from large woody debris and sharp objects. These materials tend to distort and break the gabions (Freeman and Fishenich 2000, p. 8). Gabions are not identified as a recommended technique in the Washington State Integrated Streambank Protection Guidelines (ISPG 2003).

The most important consideration for the installation of gabions is the stability of the stream. If the stream is undergoing rapid changes in base elevation (down- cutting or deposition), there is a high risk of failure due to the structures being overwhelmed or flanked (Freeman and Fishenich 2000, p. 3). Considering the rapid rate of lateral scouring occurring along the Carbon River, the risk of gabion failure is high. The U.S. Forest Service used gabions for bridge abutments on the Carbon River Bridge (Forest Road 7810, located just below the Park boundary) from 1986 to 1996. These gabions were frequently damaged and undermined by high flows on the Carbon River, and ultimately failed (USFS 1998).

Over time the gabion baskets can rust and break due to abrasion, resulting in a potential hazard to fish, wildlife and people (CDFG 1998, p. VII-7). Fish may be injured on the broken rusted wires or become trapped behind mats of vegetation or debris that are wedged in the wire mesh. Because gabions are non-biodegradable, create a potential hazard to fish, and are designed to halt lateral channel migration, they are considered to have an adverse effect to listed fish critical habitat.

Excavation of River Rock for Gabions

Due to equipment limitations along the upper Carbon River Road, the Park is proposing to use river rock excavated from gravel bars in the active Carbon River channel to use for fill in gabions in the place of large riprap in the construction of toe-roughened structures. Excavation of river rock is limited to dry gravel bars, although equipment (e.g., a small excavator and ATVs with trailers) may need to cross wetted channels to access excavation sites. Equipment crossings will be confined to single designated crossing point for each site. All channel excavation is limited to the depth of the adjacent wetted channel elevation. No excavation below the wetted channel elevation is proposed, and all excavation of rock below the bankfull channel width will occur during the approved inwater work season.

The amount of gravel needed for proposed bank protection structures has been roughly estimated at over 5,100 cubic yards. Some of the rock needed will come from within the footprint of proposed structures. Additional rock will be excavated from gravel bars within the braided channel complex. To estimate the area associated with gravel excavation, we assumed that each cubic yard will result in an average of 9 ft^2 of gravel bar surface excavation. Based on the estimated project construction footprint for bank protection structures (1.15 acres) and additional excavation area needed for rock (0.74 acres), an estimated total 1.89 acres of channel area will be excavated in 5 locations along the Carbon River between the Park entrance and Ipsut Creek (Table 11). Most gravel excavation would occur along a 1.14 mile reach located between MP 3.46 and 4.47 along Carbon River Road. The channel in this section is about 500 ft. wide by 6,000 ft. long, and occupies an area of about 70 acres. About 25 percent of the channel width is occupied by wetted channels, so there are about 50 acres of exposed gravel bars in this reach. The proposed gravel excavation would affect about 4 percent of the exposed gravel bars in this reach.

The Carbon River channel is transporting massive amounts of stream bedload and sediment annually. The removal of gravel does not represent a significant loss stream substrate material. The effects of the gravel excavation will primarily be in the form of indirect effects to adjacent areas as the channel configuration changes during subsequent high flow events. Any bull trout or Chinook redds that are located in the vicinity of the gravel excavation sites are likely to be scoured or buried as a result of subsequent channel adjustments during high flow events.

We are not able to predict exactly how much area or what the configuration of excavated areas will be. To estimate the adverse impacts to stream substrates we assumed that each site that requires additional gravel excavation results in a doubling of adverse substrate impacts (Table 11).

Use of large wood from within the Carbon River channel

Some logs from the active Carbon River channel will be moved for use in the construction of bank protection structures. There are large deposits of logs and other woody debris located on dry gravel bars in the Carbon River channel. These are locations that collect woody debris over time and often result in the formation of stable, vegetated gravel bars, or result in the formation of debris jams that interact with the channel to create local scour and deposition features. Large wood in the floodplain can also be transported downstream during flood events and contributes to formation of logjams and fish habitat features in the lower reaches of the watershed.

This action will relocate existing large wood within the channel, but would not result in a net reduction of large wood within the affected stream reaches. Only logs that are located in the footprint of a construction site, or are located on adjacent dry gravel bars may be moved. The total number of logs to be used from the river channel has not been quantified. For each 100 ft. of log crib structure, approximately 28-35 logs are needed (Appendix 1). Under alternative 2, there are approximately 820 ft. of log structures proposed at 3 locations above Ranger Creek (Table 11). Assuming there are 30 logs needed per 100 ft. of structure, a total of 246 logs would be needed to construct 820 ft. of bank protection structures. At road washouts there are typically several large trees that have fallen into the scoured area that could be used in the construction of bank protection structures. The expectation is that onsite logs will provide some of the needed material for each structure (e.g., 25 percent), and that additional logs will purchased from a commercial source and brought in with a helicopter as needed. Logjams near the Park entrance will be constructed primarily with purchased logs.

No intact logjams that are interacting with active, wetted channels may be moved, except within the construction footprint of proposed bank protection structures. Due to the limited area involved in the proposed wood relocation, the use of large wood from the Carbon River channel would have only minor, insignificant effects to listed fish critical habitat.

Heavy equipment may need to cross wetted channels to access and transport logs. Equipment crossings will be confined to a single designated crossing point for each construction site, and use of heavy equipment below the bankfull channel width will occur during the approved inwater work season. Adverse impacts associated with heavy equipment crossings and gravel bar disturbance (e.g., substrate and turbidity impacts) are limited to the immediate project area. For this analysis, we assume that the extent of adverse impacts listed in Table 11, account for these effects.

Streambank disturbance and loss of riparian vegetation
Construction of bank protection structures will result in adverse effects to streambanks, including removal or damage to streamside vegetation while construction activities are occurring, and removal or reshaping of streambank materials during site preparation or project feature installation. These streambank modifications remove overhead cover for fish, and remove bank-stabilizing plants and materials (e.g., rocks and large wood), which results in short-term increases in turbidity and downstream sediment deposition. Impacts to listed fish also include removal of stream vegetation, which increases solar radiation, decreases overhead cover for listed fish, and reduces contribution of terrestrial food to listed fish. Due to the limited amount vegetation removal proposed, the potential effects to water temperature are considered to be insignificant. For this analysis, we assume that the extent of adverse impacts associated with the construction footprint listed in Table 11, accounts for short-term and long-term streambank disturbance effects.

Chemical contaminants from heavy equipment
Constructing the proposed bank protection structures will require that one or more pieces of heavy equipment enter and operate below the bankfull channel width of the Carbon River. A release of harmful materials (e.g., fuel, lubricants, hydraulic fluid, etc.) is possible. All equipment operating below the bankfull width will use vegetable-based hydraulic fluid, and no oils, fuels, cleaning agents or solvents, concrete or equipment wash water, slurry, waste, or construction debris will be discharged to surface waters or onto land with a potential to reenter surface waters. With full implementation of the minimization and avoidance measures, effects to water quality due to chemical contamination during construction are unlikely to occur and are therefore discountable.

Future flood damage and deposition of road / trail surface fill into the Carbon River
Road segments in the vicinity of the washouts and along other flood damaged area have a high risk of future floods. There is a high probability that flooding will damage road segments and deliver road or trail surface fill into the Carbon River. Road and trail humps installed along will function to limit the severity and extent of surface erosion. Considering the magnitude of bedload movement that occurs during high flow events in the Carbon River, the effects of road/trail fill delivered to the Carbon River channel are considered to be insignificant. Road/trail fill materials that are delivered to tributary streams (e.g. Falls Creek) is considered an adverse impact to fish spawning and rearing habitat.

Table 11. Summary of aquatic impacts associated with bank protection structures along the **Carbon River.**

Mile Point General location	**Structure type**	**Estimated construction impacts within the bankfull channel width**				
		Constr-uction footprint (length)	**Constr-uction footprint (area)**	**Additional excavation area for river rock**	**Worksite isolation / dewatering and fish handling**	**Extent of adverse turbidity/ substrate impacts**
MP 0.0 – Park entrance Carbon River at June Creek	(2) Engineered log jams (60' x 20')	240 ft.	4,800 ft^2	NA	180 ft.	840 ft.
MO 0.15 Maintenance Area Carbon River	(1) Rock barb deflector to be replaced with (2) Engineered log jams (60' x 60' each)	240 ft.	14,400 ft^2	NA	180 ft.	840 ft.
Washout at MP 3.46 Carbon River below Chenuis Falls Trailhead	(1) Gabion log / rock roughened toe structure 15' x 240' River rock for gabions is estimated at 1,300 CY	240 ft.	3,600 ft^2	8,100 ft^2	360 ft.	840 ft. x 2 = 1,680 ft.
Road washout at MP 3.93 Carbon River	(1) Gabion log / rock roughened toe structure 15' x 200' River rock excavation for gabions is estimated at 1,084 CY	200 ft.	3,000 ft^2	6,756 ft^2	300 ft.	800 ft. x 2 = 1,600 ft.
Road washout at MP 4.47 Carbon River near Ipsut Creek	(1) Log crib wall or gabion log / rock roughened toe structure 15' x 380' River rock excavation for gabions is estimated at 2,060 CY	380 ft.	5,700 ft^2	12,840 ft^2	570 ft.	980 ft. x 2 = 1,960 ft.
Carbon River Totals		1,300 ft.	31,500 ft^2 0.72 acres	27,696 ft^2 0.63 acres	1,590 ft. 0.30 mile	6,920 ft. 1.31 miles

Assumptions:
1 cubic yard of gravel excavation = 9 ft^2 of gravel bar surface area.
Each site that requires additional gravel excavation results in a doubling of adverse substrate impacts.
Worksite isolation and dewatering = 1.5 x proposed structure length
Logjam construction footprint = 2 x length and width of proposed structure
Gabion log / rock roughened toe footprint = 1 x length and width of proposed structure.
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Worksite isolation and dewatering along the Carbon River is confined to the channel margin along the south bank.

<u>Effects to Fish Habitat in the Falls Creek/Carbon River Side Channel</u>

Modified Drop Structures as Partial Check Dams
The footprint of the Carbon River Road in the vicinity of Falls Creek was scoured to a depth of about 6 ft. below ground level for a distance of about 2,600 feet. The scour channel intercepts Falls Creek for a short distance (400 ft.) along the old footprint of the road, but most of the channel length is now an active side channel of the Carbon River. Prior to 2010, the scour channel has gone dry in late July and remained dry into the fall months. Since the 2006 flood, subsequent high water events have deepened the scour channel and increased the connectivity with the Carbon River, and now it is uncertain if the channel will continue dry up during the summer. The channel captures both surface flows and ground water, and is used seasonally by bull trout and other salmonids as rearing habitat. Fish spawning has not been documented in the channel, but may occur in or below the project area in the lower stream reach that now carries the combined flows from Falls Creek and the Carbon River side channel.

The Park proposes to use onsite logs and wood debris to create modified drop structures (Appendix 1) along approximately 2,600 linear feet of the channel. The total number of structures has not been determined, but is estimated at 1 structure per 100 ft. of channel. The objective is to dissipate stream energy and cause channel aggradation behind the structures. The structures will be positioned to deflect flows away from the south bank (trail side) of the channel, and encourage bank erosion and channel widening along the north bank of the channel. All drop structures will be constructed with low notches with a maximum drop height of 8 inches to maintain fish passage over the structure. No dewatering or fish handling is anticipated in this area, because there would be no excavation with heavy equipment below the bankfull channel width. Construction turbidity is expected to be minimal, and there is a possibility that the channel could be dry during construction.

There is a high level of uncertainty associated with predicting the effects of these structures. The Falls Creeks area was ranked as having an extremely high risk of future flooding and lateral channel migration along the Carbon River (Appendix 1). Potential outcomes include:

- A diversification and improvement of stream habitat complexity due to the placement of large wood into the wetted channel width. These features will encourage local scouring and deposition that will create small pool/riffle features in the channel, and could ultimately improve the productivity and capability of the side channel to support fish.

- During high flow events, check dams could constrict flows and have a damming effect that causes water to back up and scour around the structures, resulting in more severe bank erosion and a widening of the channel. High levels of substrate aggradation in the treated area could result in a subsequent loss of surface flows during low flow periods, and stranding or mortality of fish trapped in isolated areas.

- Blocked fish passage for juvenile salmonids. Considering the number of structures proposed; there is a high probability that one or more structures could create partial or total barriers to fish passage. These structures will need to be monitored annually to ensure fish passage is maintained.

Considering the high level of uncertainty, significant adverse impacts to fish habitat associated with excessive aggradation of stream substrates and potential losses of surface flow during low flow periods, as well partial barriers to fish migration are anticipated along 4,500 ft. of the Falls Creek / Carbon River side channel (Table 12).

Location of Carbon River Road Hiking and Biking Trail in the Riparian Zone
The by-pass trail that will be constructed in the Falls Creek area is located at a distance of 0 to 25 feet from the south bank of the channel for about 2,600 feet. Therefore, the trail location will have a direct and long-term impact on streambank condition and riparian vegetation along this area. Primary stream shade and nutrient inputs would still be provided by overstory trees along the trail corridor, but there will be a continued, long-term loss of about 0.6 acres of streamside understory vegetation along this section. These impacts will result in reduced organic inputs via litterfall and terrestrial invertebrates to the stream, resulting in a reduced aquatic primary productivity in this reach.

The primary impact associated with this trail location is the high risk of trail failure during future flood events. There is a high probability that this section of the trail will be subjected to frequent flood damage and delivery of the trail surface materials to the channel, resulting in local aggradation of sediments in this reach. Trail humps installed throughout this section would reduce the severity of this impact, but adverse impacts to stream substrates are likely to continue to occur from this trail location. For this analysis, we assume that the extent of adverse impacts listed in Table 12, account for these effects.

Table 12. Summary of aquatic impacts along the **Falls Creek/Carbon River** side channel.

Mile Point General location	**Structure type**	**Estimated construction impacts within the bankfull channel width**				
		Const-ruction footprint (length)	**Constr-uction footprint (area)**	**Additional excavation area for river rock**	**Worksite isolation / dewatering and fish handling**	**Extent of adverse turbidity/ substrate impacts**
MP 1.468 – Falls Creek trib. #1 (CR 21) Estimated channel width = 5 ft.	Remove 2' x 30' cmp, replace with 4-stringer bridge, 15 ft. long. Install grade-control check dam upstream of crossing	50 ft.	250 ft^2	NA	NA – seasonally dry	650 ft. Beneficial effect = restored access to 0.05 miles of fish rearing habitat
MP 1.496 – Falls Creek trib. #2 (CR 19) Estimated channel width = 10 ft.	Remove 2' x 30' cmp, replace with 4-stringer bridge, 15 ft. long. Install grade-control check dam upstream of crossing.	50 ft.	500 ft^2	NA	NA – seasonally dry	650 ft. Beneficial effect = restored access to 0.2 mile of fish rearing habitat
MP 1.644 – Falls Creek, new stream channel location. Estimated channel width = 20 ft.	Existing trail bridge will be replaced in the new trail alignment. Replace with a 4-stringer bridge, 35 feet long with gabion basket abutments.	20 ft.	400 ft^2	NA	NA – seasonally dry	NA – Impacts accounted for with instream structures along the side channel.
MP 1.680 – Falls Creek historic channel location, now filled with gravel. – intersects with active Falls/Carbon side channel	11' x 6' cmp, 33 ft. in length. Remove culvert, back-fill trench with coarse rock and re-grade site to existing trail alignment and elevation.	Excavate 20 ft. along south bank of active side channel	NA	NA	30 ft. – at intersection with active Falls/Carbon side channel.	NA- impacts accounted for with instream structures along the side channel.
MP 1.56 – 1.95 Falls Creek/ Carbon River side channel - Estimated average channel width = 25 ft.	Install approx. (26) logs / modified drop structures along 2,600 ft. of channel 2,600 ft. of riparian impacts with trail location.	Estimated at 20 ft. for each structure =520 ft. below bankfull,	13,000 ft^2	NA	NA – not proposed due to no excavation below bankfull width with heavy equipment	3,200 ft. Substrate impacts along entire length and 600 ft. downstream.
Totals for Falls Creek/Carbon side channel		660 ft.	14,150 ft^2 0.32 acres	-	30 ft.	4,500 ft. 0.85 mile

Assumptions:
Worksite isolation and dewatering = 1.5 x proposed structure length, or 100 ft. for culvert sites.
Log check dams or modified drop structures = 20 ft. of streambed disturbance for each structure
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Effects of Culvert Removal at Ranger Creek and other sites

As described above under direct and indirect effects to fish, we expect that culvert removal will result in unavoidable, short-term adverse effects to fish including mortality of juvenile fish and eggs. Culverts at Ranger Creek and the Chenuis Falls trailhead tributary have large deposits of sediments that have aggraded above the culverts. The Chenuis Falls trailhead tributary will most likely require the placement of a series of drop structures to control channel incision and upstream headcutting after culvert removal. Even with these structures in place, there will be downstream movement and deposition of sediments after culvert removal. Large scour pools below the culvert outfalls will likely fill in and eventually attain a profile that is more consistent with the natural profile of these streams. Despite these short term impacts, the removal of barrier culverts is identified as a high priority recovery action in the draft bull trout recovery plan (USFWS 2004, p. 245). Replacing undersized culverts that were partial or full barriers to fish will improve the ability of rearing salmonids to use all available rearing habitat more effectively. Restoring fish passage and access to high quality floodplain tributary habitat will contribute to improved survivorship, population growth and potential recovery (Table 13).

Table 13. Summary of aquatic impacts at **Ranger Creek/Chenuis Falls** Trailhead tributary.

Mile Point General location	**Structure type**	**Estimated construction impacts within the bankfull channel width**				
		Const-ruction footprint (length)	**Constr-uction footprint (area)**	**Additional excavation area for river rock**	**Worksite isolation / dewatering and fish handling**	**Extent of adverse turbidity/ substrate impacts**
MP 3.142 Ranger Creek – channel width is about 25 ft.	12' x 7.6' cmp, 30 ft. in length. Remove culvert. Construct steel I-beam bridge, 40 ft. long, 10 feet wide with concrete footings.	30 ft.	750 ft.	NA	100 ft.	630 ft. 0.12 mile
Ranger Creek beneficial effects = restored access to 0.5 mile of high quality spawning and rearing habitat						
MP 3.586 Unnamed tributary at Chenuis Falls trailhead channel width is about 15 ft.	9.6' x 6.6' cmp, 39 ft. in length. Remove culvert. Construct steel I-beam bridge, 30 ft. long, 10 feet wide with concrete footings. Install grade-control check dam upstream of crossing.	60 ft.	900 ft.	NA	100 ft.	660 ft. in Carbon River side channel below culvert. 0.125 mile
Tributary beneficial effects = restored access to 0.25 mile of spawning and rearing habitat						

Assumptions:
Worksite isolation and dewatering = 1.5 x proposed structure length, or 100 ft. for culvert sites.
Log check dams or modified drop structures = 20 ft. of streambed disturbance for each structure
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Effects to Fish Habitat at Ipsut Creek

Major changes to channel configuration in Ipsut Creek resulted from the 2006 flooding. An active side channel from the Carbon River now intercepts Ipsut Creek above the historic road crossing, and now the lower 0.5 miles of Ipsut Creek channel now carries the combined flow of Ipsut Creek and the side channel. About 1,100 feet of the new Ipsut Channel is located in the former footprint of the Carbon River Road (Appendix 1). The new channel location threatens the by-pass trail in the vicinity of MP 4.65. There are 2 scenarios considered to address this threatened trail section:

1. Construction of a 130 ft. gabion log/rock roughened toe structure. Along with the short-term direct and indirect adverse impacts associated with fish handling (195 ft.) and substrate impacts (1,460 ft.), this action would result in long-term adverse effects to fish habitat from bank protection and placement of non-biodegradable gabions within the active stream channel (Table 14). Due to the increasing flows from the active Carbon River side channel in this area, this structure will likely be subjected to increasing flows over time, and the long-term risk of structure flanking and failure is very high.

2. The alternative scenario is to divert the Ipsut Channel into a former stream channel location below the Ipsut Trail bridge. This action would require construction of a stream diversion channel and gradual dewatering and fish removal along approximately 800 ft. of the Ipsut Channel. Due to the complexity of this channel and the large size of streambed cobbles, it is likely that a high percentage of small fish (age 0 fry and age 1 juveniles) would be missed by fish salvage efforts and will die due to dewatering. The amount of stream channel excavation required to divert the Ipsut Channel has not been estimated. The abandoned channel that would be rewatered is about 650 ft. long. Therefore, there would be a net loss of approximately 150 ft. of spawning and rearing habitat (Table 14). The effectiveness of a stream diversion in this area is highly uncertain. Channel cross-section surveys based on LiDAR imagery indicate this area is approximately 15 ft. lower in elevation than the adjacent Carbon River channel, indicating a high risk that more Carbon River flow will be captured and directed down the Ipsut Channel. Therefore there is a risk that spawning bull trout could build redds in the diverted channel during the fall months, and then the entire area could undergo substantial changes in response to winter high flows. The channel could migrate back into its current location (a slightly lower elevation) with the result that any redds that were located in the diversion channel would be lost. However, this option ultimately has less of a long-term impact to listed fish habitat because there would be no construction of bank protection structures with the objective to permanently halting natural channel migration processes.

Both scenarios result in significant adverse direct and indirect effects to fish (primarily bull trout) and critical habitat. The most significant difference is that there is a much higher risk of direct and indirect mortality of fish in the channel dewatering scenario, and there is a net loss of about 150 ft. of spawning and rearing habitat, which represents about 5 percent of the Ipsut Creek critical habitat designation (approx. 2,850 ft.). Both scenarios have a high risk of failure (Table 14).

Table 14. Summary of aquatic impacts at the **Ipsut Creek/Carbon River** side channel.

Mile Point General location	**Structure type**	**Estimated construction impacts within the bankful channel width**				
		Const-ruction footprint (length)	**Constr-uction footprint (area)**	**Additional excavation area for river rock**	**Worksite isolation / dewatering and fish handling**	**Extent of adverse turbidity/ substrate impacts**
MP 4.65 - trail location threatened by Ipsut/Carbon channel - channel width is about 35 ft.	Potential site for (1) Gabion log / rock roughened toe structure 15' x 130ft' River rock excavation for gabions is estimated at 704 CY	130 ft.	1,950 ft.	4,386 ft^2	195 ft.	730 ft. x 2 = 1,460 ft.
MP 4.8 Ipsut/Carbon Potential site for stream diversion - channel width is about 35 ft.	Potential diversion out of current channel would result in dewatering about 800 ft. of stream. Diversion to old channel would rewater about 650 ft. of abandoned channel.	NA	NA	Unknown – estimated at 50' x 30' to create channel diversion 1,500 ft^2	800 ft.	800 ft. in the dewatered channel, and 650 ft. in new channel. w/ a net loss of 150 ft. of spawning rearing habitat.
MP 4.802 Ipsut/Carbon new channel location – channel width is about 35 ft.	Existing trail bridge will be replaced. Construct a small log cribwall structure on west bank as bridge abutment. Replace bridge with a new 8' x 50' log stringer bridge, on elevated footings	25 ft.	700 ft.	NA	NA - not proposed due to limited work below bankfull channel width.	25 ft. – limited to the immediate area of trail bridge construction work.
Totals for Ipsut Creek/Carbon side channel without stream diversion		155 ft.	2,650 ft.	4, 386 ft^2	195 ft.	1,460 ft. 0.28 mile
Totals for Ipsut Creek/Carbon side channel with stream diversion\		25 ft.	700 ft.	1,500 ft^2	800 ft./	1,475 ft. 0.28 mile

Assumptions:
1 cubic yard of gravel excavation = 9 ft^2 of gravel bar surface area.
Each site that requires additional gravel excavation results in a doubling of adverse substrate impacts.
Worksite isolation and dewatering = 1.5 x proposed structure length, or 100 ft. for culvert sites.
Gabion log / rock roughened toe footprint = 1 x length and width of proposed structure.
Log check dams or modified drop structures = 20 ft. of streambed disturbance for each structure
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Summary of Direct and Indirect Effects to Listed Fish Species and Critical Habitat

The proposed action includes several projects that will require the use of heavy equipment below the bankfull elevation in the Carbon River and its tributaries. These projects will result in both direct and indirect effects to listed fish and their habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. Project impacts will occur over a period of three to four years, depending on funding and the logistics of project implementation:

- Direct effects (i.e., stress, injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation and dewatering along 0.38 miles of streams. Most of these effects (0.30 mile) are located along the margin of the Carbon River channel (Table 15).

- Direct effects (i.e., stress and/or injury) resulting from short-term exposures to construction-related turbidity and sediment along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels (Table 15).

- Indirect effects associated with stream substrate scouring and sediment deposition in fish spawning areas that result from changes in channel configuration along 2.68 miles of streams. The effect is mortality and reduced incubation success for 1 season in the affected areas. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat (Table 15).

- Long-term adverse effects to fish habitat structure, function, and diversity. The project will construct bank protections structures that will inhibit natural channel migration, degrade riparian vegetation, and inhibit the recruitment of large wood to stream channels in the affected areas along 0.72 miles of stream channels. Most of these impacts are located in the Falls Creek area (0.49 mile), and along the Carbon River (0.20 mile). The Cumulative effect of proposed structures and existing structures would be 0.9 miles of bank protection structures along the Carbon River. Future maintenance of bank protection structures will result in continued adverse impacts from turbidity and substrate effects that are similar to initial construction impacts (Table 15).

- Long-term beneficial effects associated with restored habitat access to approximately 1 mile of floodplain tributary streams, including Ranger Creek. Removal of Ranger Creek culvert will restore access to approximately 0.5 miles of high quality spawning and rearing habitat (Table 15).

Table 15. Summary of fish habitat impacts along the Carbon River Access Corridor.

Location	**Long-term adverse stream bank impacts**	**Worksite isolation / dewatering and fish handling**	**Extent of adverse turbidity/ substrate impacts**	**Beneficial effects from restored habitat access**
Carbon River Effects limited to channel margin along south bank.	1,060 ft.	1,590 ft. 0.30 mile	6,920 ft. 1.31 miles	NA
Falls Creeks, Falls Creek tributaries, and Carbon side channel	2,650 ft.	30 ft.	4,500 ft. 0.85 mile	0.25 mile
Ranger Creek	25 ft.	100 ft.	630 ft.	0.5 mile
Unnamed tributary stream at Chenuis Falls trailhead	25 ft.	100 ft.	660 ft. in Carbon River side channel	0.25 mile
Ipsut Creek/Carbon side channel *without stream diversion*	155 ft.	195 ft.	1,460 ft. 0.28 mile	NA
Total Estimated Adverse Impacts for Project	**3,815 ft. 0.72 mile**	**2,015 ft. 0.38 mile**	**14,170 ft. 2.68 miles**	-
Total Estimated Beneficial Effects for Project	-	-	-	**1 mile**

Long-term adverse stream bank impacts are associated with the bank protection structures, reconstruction of the by-pass trail through the Falls Creek washout, and 25 ft. for each trail bridge location.

In the analysis of the aquatic environmental baseline, we applied the *Matrix of Diagnostics / Pathways and Indicators* (NMFS 1996, USFWS 1999) and determined that the overall condition of the upper Carbon River watershed is “functioning at risk” due to past and ongoing degradation of aquatic habitats, primarily from roads. The effects of the proposed action includes restoring habitat access, and both short and long term degradation of other habitat elements. Considering all the effects, we conclude that the condition of the upper Carbon River watershed (“functioning at risk”) would not significantly change as a result of this action (Table 16).

Table 16. Summary of the effects of the action to aquatic habitat indicators in the action area (“Matrix of Pathways & Indicators”). The habitat pathways listed here correlate to the primary constituent elements of bull trout and PS Chinook critical habitat.

Pathway	Indicator	Baseline Conditions	Effects of the Action (Restore – Maintain – Degrade)
Water Quality	Temperature	Functioning at Risk	Maintain – effects of the action are neutral.
	Sediment / Turbidity	Functioning at Risk	Degrade - short-term increases associated with project implementation along 2.68 miles. No long term effects.
	Chemical Contamination & Nutrients	Functioning Properly	Maintain – effects of the action are neutral.
Habitat Access	Physical Barriers	Not Properly Functioning	Restore – culvert removals restore access to 1 mile of habitat.
Habitat Elements	Substrate	Functioning at Risk	Degrade – short term effects associated with project implementation along 2.68 miles. Long-term effects associated with chronic road sediments will continue to be delivered to key tributary streams along Carbon River Road –Falls Creek, Ranger Creek.
	Large Woody Debris	Functioning at Risk	Degrade – long-term effects associated with bank protection structures along 0.20 miles that limit future large wood recruitment in affected areas. .
	Pool Frequency / Quality	Functioning At Risk	Maintain – effects of the action are neutral.
	Large Pools	Functioning At Risk	Maintain – loss of deep scour pools at culvert outfalls, but long-term effects are neutral.
	Off-Channel Habitat	Functioning At Risk	Degrade – side channel habitats are constrained or directly impacted by location of Carbon River road in several areas. Future development constrained by proposed bank protection structures.
	Refugia	Functioning At Risk	Restore – improved access to important refugia habitat in floodplain tributary streams would be restored.
Channel Conditions & Dynamics	Width/Depth Ratio	Functioning At Risk	Degrade – project impacts associated with drop structures in the Falls Creek/Carbon side channel are likely to degrade the width/depth ratio of the channel.
	Streambank Condition	Functioning At Risk	Degrade –short term habitat impacts from project implementation and long term effects associated with location of Carbon River Road adjacent to stream banks.
	Floodplain Connectivity	Functioning at Risk	Degrade – long-term effects associated with bank protection structures.
Flow / Hydrology	Peak / Base Flows	Functioning at Risk	Maintain – effects of the action are neutral.
	Drainage Network	Functioning at Risk	Maintain – effects of the action are neutral.
Watershed Conditions	Road Density / Location	Not Properly Functioning	Maintain – effects of the action are neutral, and do not significantly improve road location issues in watershed.
	Disturbance History	Functioning at Risk	Maintain – effects of the action are neutral.
	Riparian Areas	Functioning at Risk	Degrade –short term habitat impacts from project implementation and long term effects associated with the continued location of Carbon River Road adjacent to stream banks.

Effects of Interrelated and Interdependent Actions

It is likely that sections of the Carbon River Road / Trail will be subjected to frequent flood damage and delivery of the trail and road surface materials to stream channels, resulting in local sedimentation or aggradation effects. Depending on the severity of the flood damage, some trail sections may be damaged and rebuilt several times over subsequent years. Trail and road humps would reduce the severity of these impacts, but adverse impacts to stream substrates are likely to continue to occur from this trail and road location. For this analysis, we assume that the extent of adverse impacts listed in Table 15, account for these effects.

Cumulative Effects

Under section 7 of the Endangered Species Act (16 U.S.C. 1536, *et seq.*), cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Biological Assessment (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Forest Practices

In the Carbon River action area, there is a mix of non-Federal timber land and National Forest lands located adjacent to the Park. National Forest lands on the adjacent Mt. Baker-Snoqualmie National Forest in the Carbon River valley are designated as Late-Successional Reserves, or as Wilderness. Non-federal lands in the area are managed primarily for timber production. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222). These rules were revised in 2000 to be more protective of riparian areas and unstable slopes. However, despite these protective measures, adverse effects associated with timber harvest and forest roads to listed fish are likely to continue to occur in the upper Carbon River watershed.

Bull Trout Conclusion and Effect Determination

The upper Carbon River supports a small local population of spawning and rearing bull trout. This population is significant because it potentially supports a full array of life history forms including resident, fluvial, and anadromous bull trout, and there are no man-made physical barriers on the Carbon River that isolate these fish from accessing habitat and populations elsewhere in the Puyallup River basin. Although bull trout are known to be present in the Carbon River year-round, we expect that the unstable habitat conditions limit the number of bull trout that actually spawn or rear in the upper Carbon River itself. Recent evidence of increased peak flows and rapid channel widening indicate the Carbon River is becoming increasingly unstable. Floodplain tributary streams and side channels provide stable, complex habitats that provide essential spawning and rearing habitats for the Carbon River bull trout local population. The location of the Carbon River Road in the floodplain has resulted in past and ongoing degradation of bull trout habitat, including passage barriers and chronic deposition of road sediments into key spawning and rearing streams. The Carbon River Road was specifically identified in the draft bull trout recovery plan as a high priority location to minimize or eliminate road-related habitat degradation. The proposed action would result in both short-term and long-term adverse and beneficial effects to bull trout. However, the fundamental problem of the Carbon River Road/Trail location within the active floodplain and channel migration zone presents a significant challenge to the Park in terms of maintaining access in the corridor while minimizing impacts to bull trout. As long as the Park continues to manage the road for access purposes, there will continue to be ongoing adverse effects to bull trout and bull trout critical habitat.

Considering the current status of the bull trout in project area, and the direct, indirect, and cumulative effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect, and is likely to adversely affect bull trout.** This determination is based on the rationale that the project will result in significant adverse effects, including direct injury from fish capture and handling in 0.38 miles of streams, and injury or mortality of bull trout and bull trout eggs associated with 2.38 miles of spawning and rearing habitat in the upper Carbon River and associated floodplain tributaries. The adverse effects associated with this action will occur over a period of 3 to 4 years in dispersed locations, and some key spawning habitats will not be affected by the action. Therefore, we do not expect that the adverse effects associated with the Carbon River Access Management Plan will lead to significant population declines at the scale of the Carbon River local population or the Puyallup River bull trout core area population

Designated/Proposed Bull Trout Critical Habitat Conclusion and Effect Determination

Bull trout critical habitat has been identified from the Carbon River confluence with the Puyallup River, upstream for approximately 32.7 miles, and includes approximately 17 miles of tributary streams and braided river channels above the Park Entrance. Considering the current status of the bull trout critical habitat in project area, and the effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect, and is likely to adversely affect designated and proposed bull trout critical habitat.** This determination is based on the rationale that the project will result in short-term adverse effects to bull trout critical habitat primary constituent elements, including water quality, stream substrates, prey species abundance, and complex stream habitats and processes, associated with 2.38 miles of bull trout spawning and rearing habitat in the upper Carbon River and associated floodplain tributaries. The project would also result in long-term adverse effects to complex stream habitats and processes associated with 0.72 miles of critical habitat. The beneficial effect of restoring access to approximately 1 mile of floodplain tributaries is significant, but does not negate the "likely to adversely affect" determination associated with other project elements.

Puget Sound Steelhead Conclusion and Effect Determination

The Carbon River supports a small population of winter-run PS steelhead. This population has declined significantly over the past two decades, and is now persisting at very low levels, with most fish spawning in the lower Carbon River and South Prairie Creek, well outside the action area. The number of PS steelhead that spawn in the upper Carbon River within the Park is unknown, but is expected to be very low given the depressed population status for this stock.

Juvenile PS steelhead are expected present in the upper Carbon River year-round, and spawning adults may be present from January through June. Floodplain tributary streams and side channels provide stable, complex habitats that provide spawning and rearing habitats for the Carbon River PS steelhead stock, and past fisheries surveys indicate low numbers of juvenile PS steelhead are present in tributaries such as Ranger Creek and Chenuis Creek. The location of the Carbon River Road in the floodplain has resulted in past and ongoing degradation of PS steelhead habitat, including passage barriers and chronic deposition of road sediments into tributary spawning and rearing streams. The proposed action would result in both short-term and long-term adverse and beneficial effects to PS steelhead. Fish passage would be restored in Ranger Creek, but ongoing degradation of aquatic habitat will continue to occur due to the location of the road/trail in the active floodplain.

Considering the current status of the PS steelhead in project area, and the effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect, and is likely to adversely affect PS steelhead.** This determination is based on the rationale that the project will result in significant adverse effects, including direct injury from fish capture and handling in 0.38 miles of streams, and sublethal injury of juvenile steelhead associated with short-term turbidity plumes along 2.38 miles of streams in the upper Carbon River and associated floodplain tributaries. Based on the timing of PS steelhead spawning and incubation, we do not anticipate adverse effects or mortality to incubating PS steelhead eggs from the proposed actions. The adverse effects associated with the action will occur over a period of 3 to 4 years in dispersed locations. The most significant spawning and rearing habitats for the Carbon River PS steelhead stock occur well outside action area and would not be affected by the action at all. Therefore, we do not expect that the adverse effects associated with the Carbon River Access Management Plan will lead to a significant population decline at the scale of the Carbon River or the Puyallup River winter-run PS steelhead stocks. Critical habitat for PS steelhead has not been proposed or designated; therefore there would be no effect to critical habitat.

Puget Sound Chinook salmon Conclusion and Effect Determination

The Carbon River supports a small population of fall-run PS Chinook salmon. This population has declined significantly over the past two decades, and is now persisting at very low levels, with most fish spawning in the lower Carbon River and South Prairie Creek, well outside the action area. The number of PS Chinook that spawn in the upper Carbon River within the Park is unknown, but is expected to be very low given the depressed population status for this population. No PS Chinook have actually been documented in this part of the river since the 1980s, but surveys for these fish in the Park have been limited.

Considering the current status of the PS Chinook salmon in project area, and the effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect but is not likely to adversely affect Chinook salmon.** Given the low numbers of PS Chinook that spawn in the lower Carbon River, it is highly unlikely that any PS Chinook will actually be exposed to adverse effects from this project. Although the upper Carbon River is accessible to Chinook salmon, the probability that these fish are present in the upper Carbon River is very low. The potential for direct effects to spawning adults from turbidity plumes and indirect effects to

Chinook salmon redds from channel scouring and sediment deposition is considered to be discountable.

Designated PS Chinook Salmon Critical Habitat Conclusion and Effect Determination

Critical habitat for PS Chinook salmon has been designated in the Carbon River up to about RM 22.7, approximately 0.3 mile downstream from the Park boundary, and within the defined action area. In this analysis, we assumed that short-term project generated turbidity plumes could extend downstream from project sites for approximately 0.5 miles, but that the most severe turbidity effects would occur within a distance of 600 ft. downstream. Therefore, there would be short-term water-quality effects from turbidity plumes along 0.2 miles of the Carbon River, downstream from the Park entrance. These effects would be confined to the channel margin along the south bank of the river, and are not expected to be severe enough to result in sublethal effects to any PS Chinook salmon that would be present in the affected critical habitat areas.

Considering the current status of the PS Chinook critical habitat in project area, and the effects of the proposed action, we conclude that the Carbon River Access Management Plan **may affect, but is not likely to adversely affect designated PS Chinook salmon critical habitat.** This determination is based on the rationale that the project will result in short-term, insignificant effects to PS Chinook salmon critical habitat primary constituent elements, including water quality and stream substrates. The critical habitat designation is located far enough downstream from project activities that adverse effects from turbidity and substrate impacts are unlikely to occur.

MAGNUSON-STEVENS FISHERY CONSERVATION and MANAGEMENT ACT

ESSENTIAL FISH HABITAT ASSESSMENT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA;16 U.S.C. 1855(b)), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a Federal fisheries management plan. The consultation requirements of §305(b) of the MSA provide that Federal agencies must notify NOAA Fisheries regarding an action that may adversely affect EFH (50 CFR 600.920(a)(3)) and provide NOAA Fisheries with an EFH Assessment (50 CFR 600.920(e).

The objective of this EFH assessment is to determine whether or not the Proposed Action "may adversely affect" designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area. Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH (50 CFR 600.810).

Mandatory contents of an EFH Assessment are: a description of the proposed action; an analysis of the potential adverse effects of that action on EFH and the managed species; the Federal action agency's conclusions regarding the effects of the action on EFH; and proposed mitigation, if applicable (50 CFR 600.920 (e)).

Identification of Essential Fish Habitat in the Project Action Area

EFH has been designated to protect waters and substrates necessary for fish spawning, breeding, feeding, or growth to maturity (MSA § 3(10)). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable artificial barriers, and longstanding, naturally-impassable barriers. The geographic extent of freshwater EFH is specifically inclusive of all aquatic habitats within entire watersheds. For this action, the Puyallup River basin (USGS hydrologic unit number 17110014) is identified as EFH for Chinook salmon, coho salmon, and pink salmon (*O. gorbuscha*).

Chinook salmon
As described in the previous sections, the potential spawning distribution of Chinook salmon extends into the upper Carbon River to about RM 28. Therefore, EFH for Chinook salmon will be directly affected by the proposed action.

Coho salmon
Coho salmon are distributed throughout all reaches of the Puyallup River basin that are accessible to anadromous fish. As with PS Chinook, coho are assumed to be present in the Carbon River up to about RM 28, and in floodplain tributary streams (USFS 1998), and juvenile coho were observed by Park fisheries staff in June Creek in 2008. Therefore, EFH for coho will be directly affected by the proposed action.

Pink salmon
The distribution of pink salmon in the Puyallup River basin is limited primarily to the mainstem Puyallup River; the lower Carbon and White rivers; South Prairie Creek and Fennel Creek. In the Carbon River, pink salmon have not been documented above RM 8 (Marks et al. 1999), well below the project action area. Therefore, there would be no effect to EFH for pink salmon.

Description of the Proposed Action

The description of the proposed action and the associated conservation measures designed to minimize impacts to listed fish species and critical habitats are described in the previous sections of this document.

Summary of the Effects of the Proposed Action

As described in detail in the previous sections of this document, the proposed action includes several projects that will require the use of heavy equipment below the bankfull elevation in the Carbon River and its tributaries. These projects will result in both direct and indirect effects to Chinook and coho salmon EFH. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. Project impacts will occur over a period of three to four years, depending on funding and the logistics of project implementation:

- Direct effects to EFH resulting from short-term exposures to construction-related turbidity and sediment along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels.

- Indirect effects to EFH associated with stream substrate scouring and sediment deposition in fish spawning areas that result from changes in channel configuration along 2.68 miles of streams. The effect is mortality and reduced incubation success for 1 season in the affected areas. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat.

- Long-term adverse effects to EFH habitat structure, function, and diversity. The project will construct bank protections structures that will inhibit natural channel migration, degrade riparian vegetation, and inhibit the recruitment of large wood to stream channels in the affected areas along 0.72 miles of stream channels. Most of these impacts are located in the Falls Creek area (0.49 mile), and along the Carbon River (0.20 mile).

- Long-term beneficial effects to EFH associated with restored habitat access to approximately 1 mile of floodplain tributary streams, including Ranger Creek. Removal of Ranger Creek culvert will restore access to approximately 0.5 miles of high quality spawning and rearing habitat for coho salmon.

EFH Conclusion and Effect Determination

Based on the direct and indirect effects we conclude that the proposed action **may adversely affect EFH** for Chinook and coho salmon. The most significant spawning and rearing habitats for Carbon River Chinook and coho salmon occur well outside the action area and would not be affected by the action at all. Therefore, we do not expect that the adverse effects to EFH associated with the Carbon River Access Management Plan will lead to significant population-level effects for these species. Consultation pursuant to §305(b) of the MSA with NOAA Fisheries is required.

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Appendix 1 - Conceptual Designs of Proposed Bank Protection Structures

Proposed Location of Flood Protection Structures in Carbon River Historic Road Corridor March 2010

The following flood protection measures are for alternatives 1-5 of the Carbon River EA. All actions unless otherwise noted will be described for the preferred alternative (Alternative 2) maintain existing Carbon River Road for a 6 to 10 foot hiking, bicycle path 1.2 miles from the Park Boundary to Ipsut Campground approximately 5 miles from the Park Boundary. The first 1.2 miles of the road will be open to public vehicle traffic and used for parking.

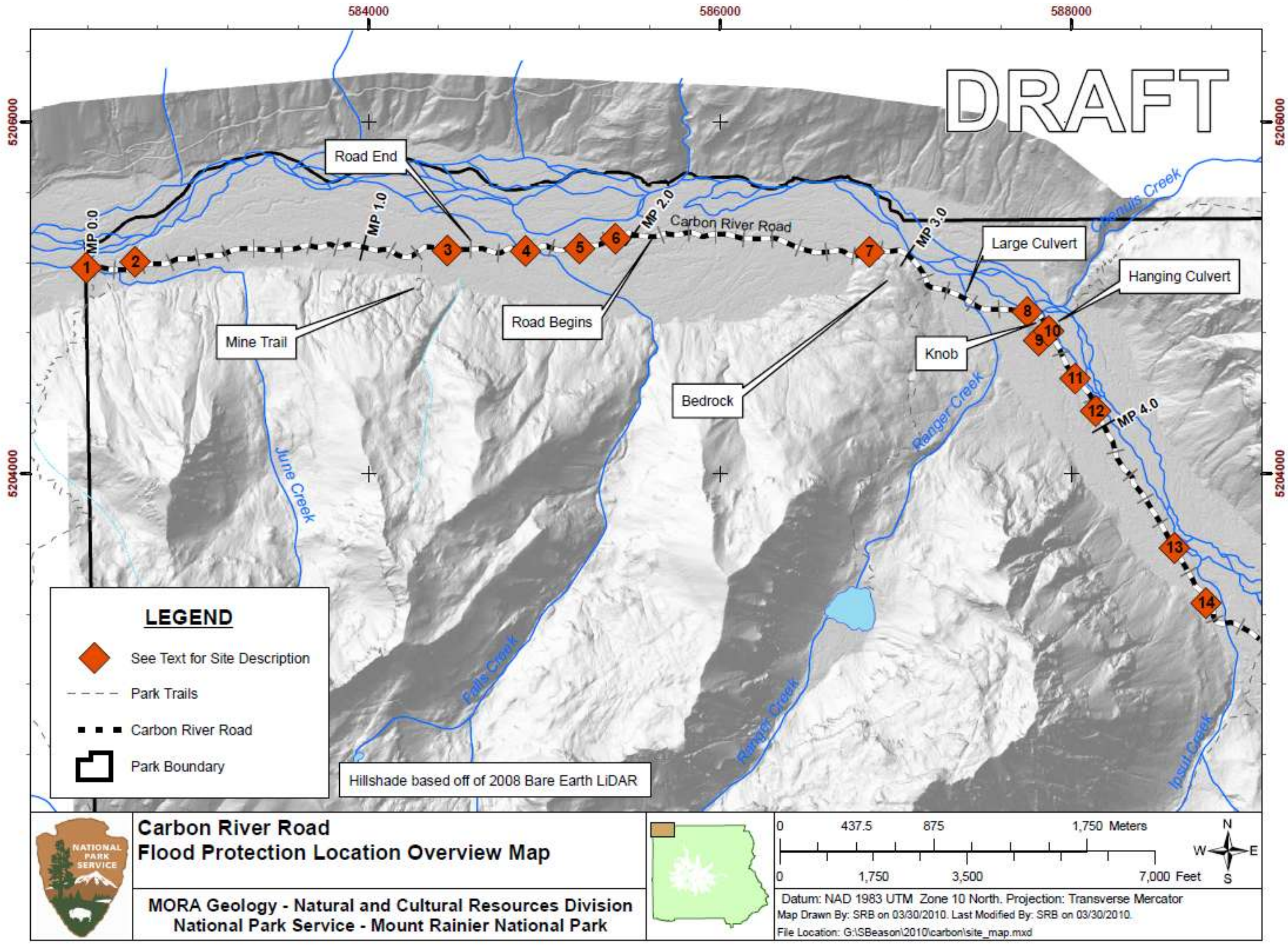

Figure 1: Carbon River Road Flood Protection Location Map. Please cross reference 6 sheet overview map of road corridor.

Proposed action

The park will build or contract out to be built several flood control and bank erosion prevention structures along 5 miles of the Carbon River Road. Several of the structures would be built in the Carbon River and/or associated side channels. All structures in the river will use significant amounts of wood to reduce impacts to and improve habitat for fish and other aquatic invertebrates. The wood will be harvested from within the river bottom and/or along the banks of the river as directed by Park Biologists. If additional wood is needed, the park will purchase wood from local sources. In some locations, the Carbon River and its tributaries would have to be temporarily diverted so construction could take place in a dry channel. Some structures will be built in the existing road to transport flood water from tributaries of creeks that run across the road. In some locations, check dams would be built across tributaries of creeks running across the road to channel them into existing culverts or under bridges. In the two locations where the Carbon River captured the road, we would cut existing logs in the channel to create check dams that will allow the channel to naturally aggrade (fill back in).

Risk assessment overview

The risk assessment shows the relative hazard along the entire Carbon River Road/Trail corridor from the park boundary uphill 5.04 miles to Ipsut Campground. These threats include: flooding, river avulsion (complete change in channel), aggradation, bank erosion and other geomorphic forces. The risk analysis is based on aerial photos, LiDAR, available damage maps, prior field reconnaissance, digitized maps of bank erosion, ground photos and professional judgment. Each segment of the road was assigned a category that relates to its potential risk of the previously mentioned geologic forces. The scale is: Low, Low-Medium, Medium, Medium-High, High and Extreme. A rating of "extreme" indicates that significant damages have already occurred at this location and there is a significant risk for damage to occur during another flood. A rating of "low," on the other hand, means that little to no damage has occurred in the past and the risk of damage to that segment of road/trail is significantly lower, but not completely risk-free. These road segments were digitized in ArcGIS and the total length of the segments were calculated (Figure 2). Each segment and its justification are included in Appendix A. Detail Maps are included in Appendix B.

Results of the risk assessment indicate that approximately 37.1% of the road corridor is categorized as Low; 12.5% is Low-Medium; 10.3% is Medium; 7.2% is Medium-High; 12.1% is High; and the remaining 20.8% of the road corridor is categorized as Extreme (Table 1). It is important to note that these delineations are based on spatial data and have not been field checked. A field check will occur in April to confirm and improve the draft risk assessment.

Hazard Class	Length			Percentage
	(m)	(ft)	(mi)	
Low	3,006.03	9,862.31	1.87	37.09%
Low-Medium	1,011.47	3,318.47	0.63	12.48%
Medium	838.37	2,750.55	0.52	10.34%
Medium-High	582.96	1,912.61	0.36	7.19%
High	981.59	3,220.44	0.61	12.11%
Extreme	1,684.27	5,525.81	1.05	20.78%
Total	**8,104.69**	**26,590.19**	**5.04**	

Table 1: Totals for each Hazard Class in DRAFT Relative Risk Assessment for the Carbon River Road

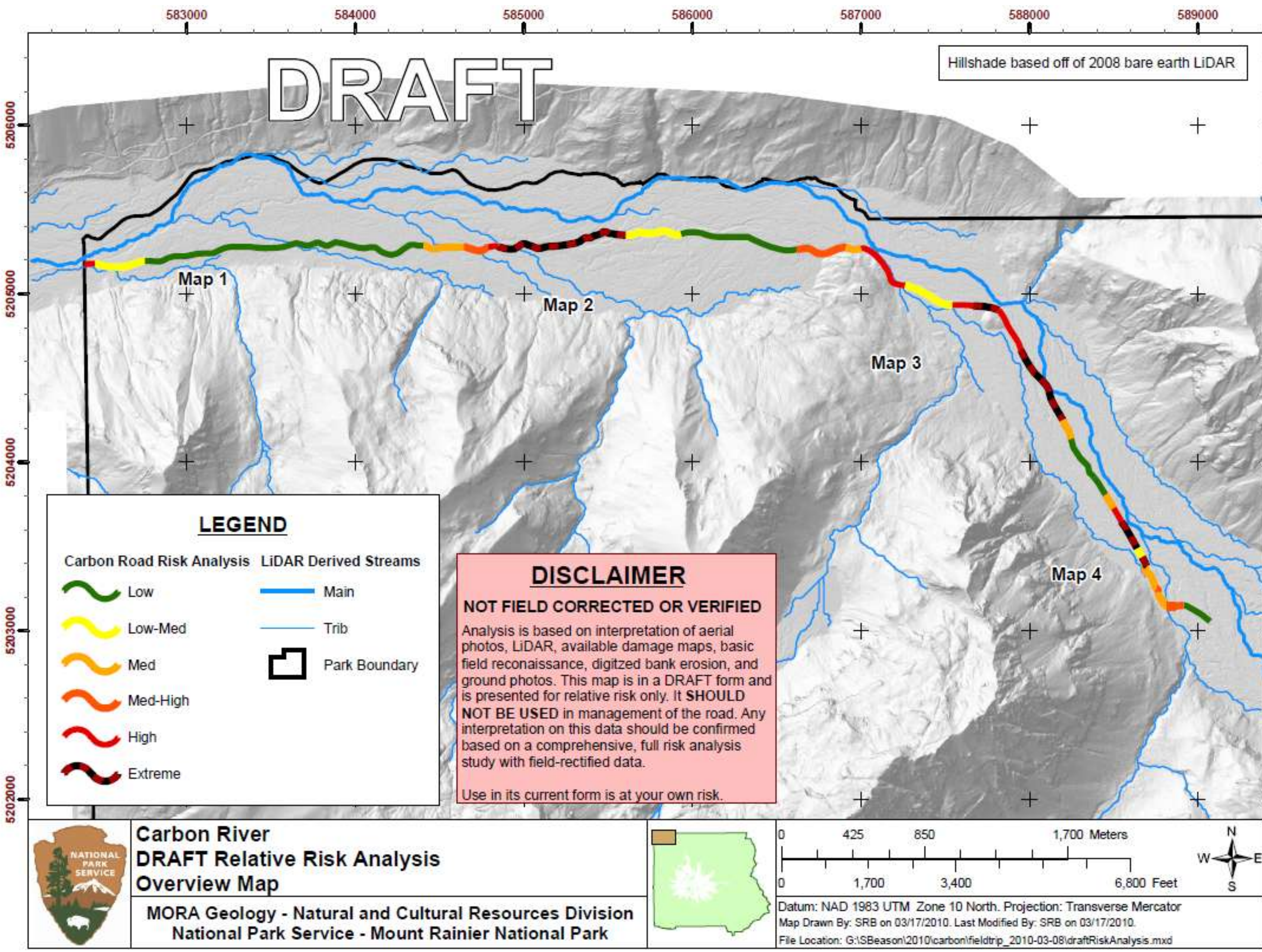

Figure 2: DRAFT Relative Risk Analysis on the Carbon River Corridor.

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Site #1: Park boundary

Figure 3: View of bank at toe of rip rap about 40 feet from Carbon River Road

Risk: Bank Erosion threatening Carbon River Road.
Proposed flood protections: Augmentation of existing natural log jam.
Size of structure: Length: 40-60 feet; Width: 20 feet; Height: approximately 4 feet.
Duration of project: 5 days.
Materials needed: Approximately 10 pieces of wood 20 to 40 feet long, 18 to 24 inches dbh. Additional wood taken from immediate area and approximately 20 yards of large cobble from river.
Construction methods: Work would be timed to take place during low flow or no flow. If needed flow would be diverted from the area by building a diversion dam out of existing river material upstream of work site. Excavator would be used to place additional logs and wood in and upstream of existing log jam, cobble would be placed over the wood to add weight. No excavation would be necessary for this work. Access to this site is from the road at the site.
Equipment needed: Excavator dB 81-85 at 50 feet (Data taken from EPA Report - EPA 550/9-76-004)
Expected outcome: Deposition of river aggregate and wood in front of log jam to deflect river flows away from bank. Scour pools in the vicinity of the logjam (especially along the front of the structure) would be developed and be fish- and aquatic invertebrate-friendly.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Below
Diversion: Potential
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #2: Maintenance area at Carbon River Entrance

Figure 4: View of bank looking upstream from river bed towards Maintenance Area

Risk: Bank Erosion threatening Carbon River entrance area, road and parking area.
Proposed flood protections: Flow Deflection Engineered Log Jams (ELJ's) (Figure 5).
Size of structure: 4 ELJ's - Length 60 feet by 60 feet approximately 4 to 10 feet high
Duration of project: 90 days on site
Materials needed: For each log jam we would need approximately 104 logs ranging in length from 8 to 45 feet long, diameter of logs ranges from 8 to 24 inches. Each ELJ requires 30 CY of slash for infill and river cobble for ballast and topping material. Total number of logs for 4, 60 X 60 foot ELJ equals 416, total slash equals 120 CY, total ballast and rock and dirt ballast and topping 60 CY.

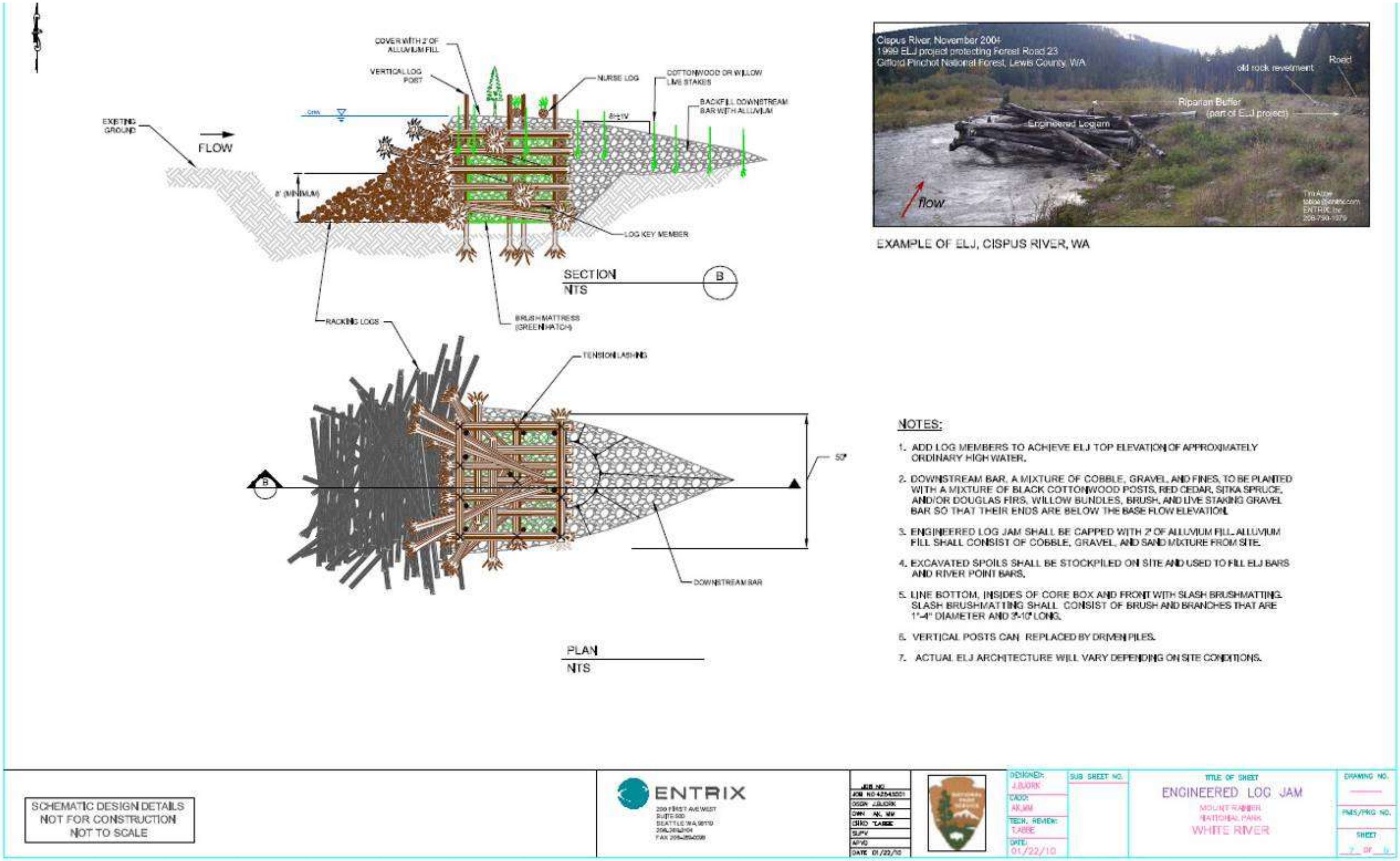

Figure 5: Typical design of Flow Deflection Engineered Log Jams (ELJ's)

Construction methods: Work would be timed to take place during low flow or no flow. The majority of the site has been in the dry since the flooding in November 2008. Wood from the immediate site and existing natural log jam would be used to construct ELJ's; additional wood if needed would be purchased locally and brought to the site. Access to the site would be from river bank at Maintenance Area. A large excavator would be used to excavate holes for pilings; depth of hole is below bottom of scour level, exact design of ELJ's to be determined by A&E. Water from excavation would be pumped onto the forest floor far enough away from the river edge to allow sediment to filter out before water returns naturally to river. River cobble from immediate area would be used for infill and topping of ELJ as needed. One end of the ELJ's would be buried in and anchored to the river bank as shown in Figure 5.

Equipment used: Excavator dB level at 50 feet of equipment 85-81, Front end loader db at 50 feet of equipment 82 , Portable pump dB at 50 feet < 85.(EPA Report - EPA 550/9-76-004), (WLF Lessons Learned Portable Pump Operations and Hearing Protection, 7-2009) Dump truck 81 dB at 50 feet , Log Truck 80-90 dB at 50 feet.

Expected outcome: ELJ's would deflect river flows away from bank. Area directly below ELJ would create eddy providing fish habitat. Slash and log structure of the ELJ would be both fish- and aquatic invertebrate-friendly.

Environmental issues and river impact:

100 year flood plain: Yes
OHWM: Above
Diversion: Potential
Excavate River Bed: Yes
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #3: Falls Creek tributaries approximately 1.2 miles before road end (MP 0.2 to MP 1.4)

Figure 6: Tributary crossing road/trail in the Falls Creek Fan Area.

Risk: Falls Creek tributary migration and road capture of stream. This area will be repaired remain open to vehicle traffic.

Proposed flood protections: Rock -cored log cribs with pilings, rock-cored cribs no pilings, rock-cored road hump with large rock, gravel covered log hump. Check dams would be installed in woods at tributaries flowing across road with sufficient size to allow fish passage in tributaries.

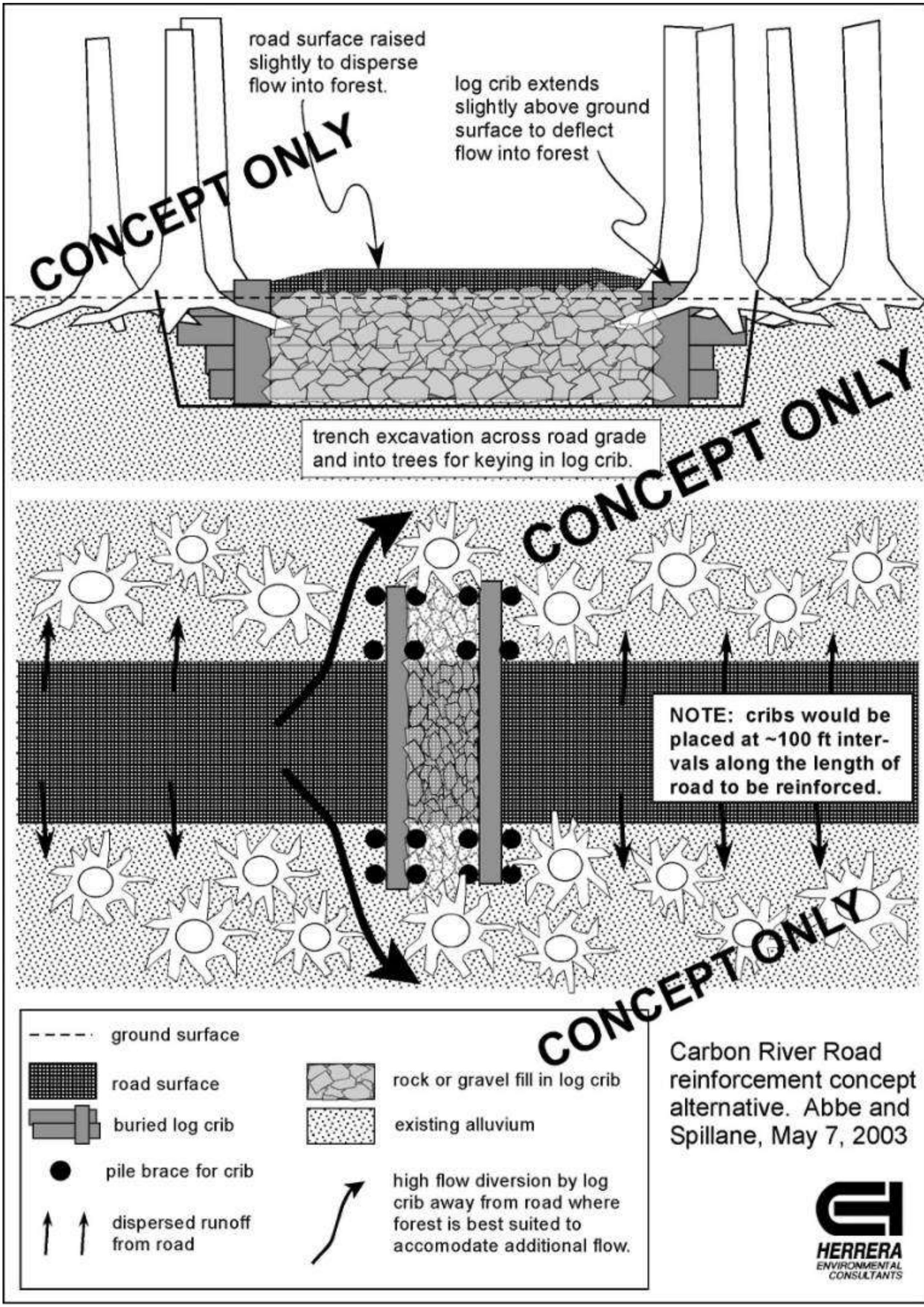

Figure 7: Rock-cored log cribs with pilings

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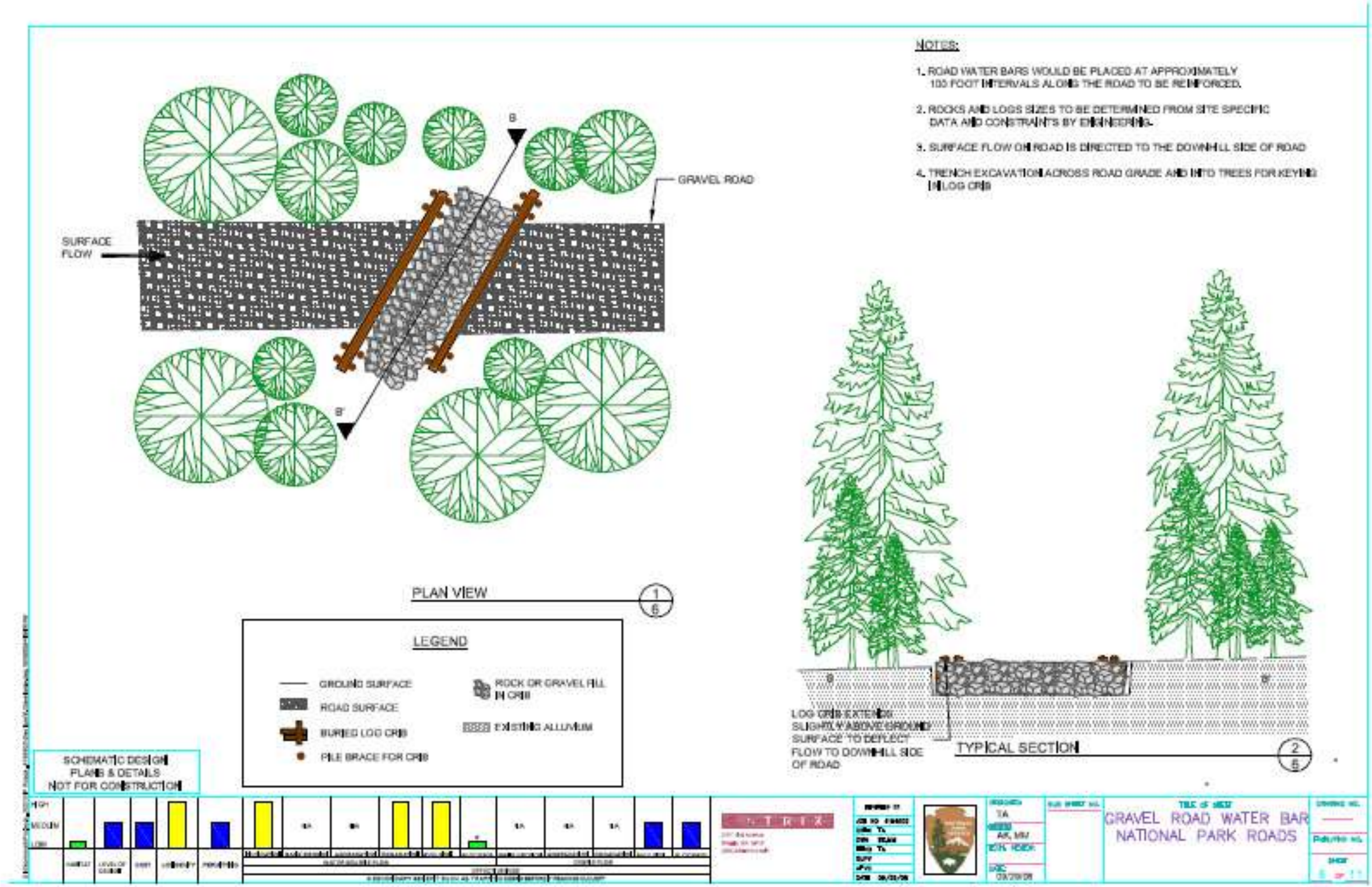

Figure 8: Gravel road water bar design

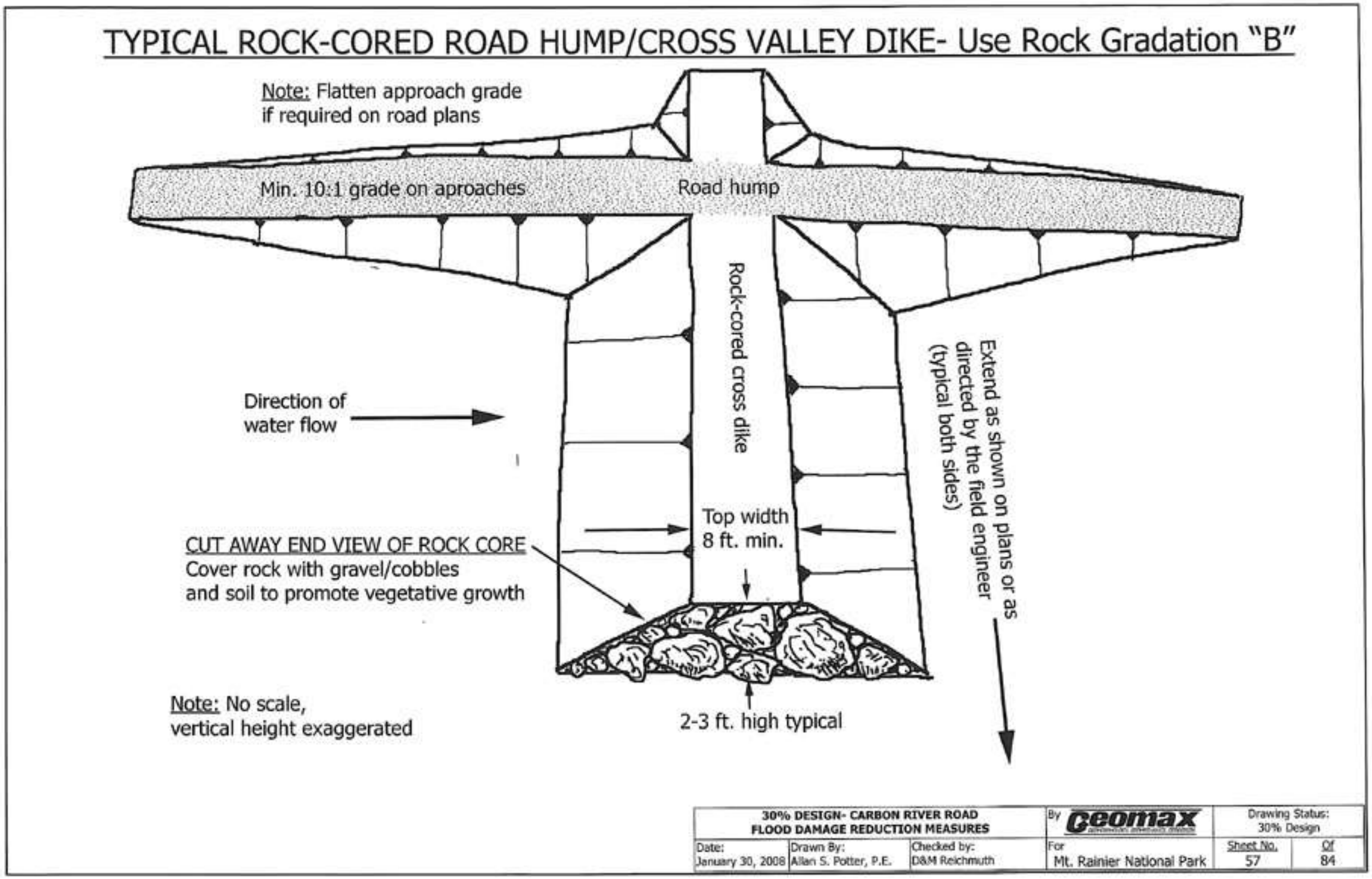

Figure 9: Rock-cored road hump with large rock

Figure 10: Gravel covered log hump

Size of structure: 5 to 9 structures 12 to 15 feet long , exact length and width would be determined by A&E.
Duration of project: 5 to 7 days for each hump or crib. 1 day for each check dam, 1 day for each Gravel covered hump. Size and location of cribs, humps and check dams would be determined by engineer and constructed as needed.
Materials needed: 18 Logs and 10 to 15 feet of rock fill as needed for each crib. Large 2-3 foot imported rock and native soil would be used for rock-cored hump, location length and width would be determined by engineer. Log hump requires 1-2 logs covered with native cobble rock and gravel.
Construction methods: All materials would be gathered on site except large rock for rock-cored hump and crushed gravel for surface. If logs are not available logs would be purchased and brought to site.
Equipment used: Equipment used: Excavator 81-85 dB at 50 feet , Front end loader 82dB at 50 feet , Dump truck 81dB at 50 feet , Log Truck 80-90db at 50 feet, Chainsaw 102-110 dB at 10 feet.
Expected outcome: Cribs, humps, gravel covered logs and check dams would capture water running over the road and channel it across the road.
Environmental Issues and River Impact:
100 year flood plain: Yes
OHWM: Above
Diversion: No
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: No
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Sites #4 to 6: Falls Creek/Carbon Side Channel (approximately MP 1.4 to MP 2.0)

Figure 11: Developing side channel of the Carbon River in the former Carbon River Road Prism. Current hiking trail is not shown but out of frame to the left of the photo.

Risk: Carbon River migration and road capture and bank erosion. Leakage across vegetated island between Carbon River and new channel is pervasive along length of island.

Proposed flood protections (Alternative 2): The area considered for treatment includes only the portion of the flood channel next to the trail, and not the part from the trail to the Carbon River.

We propose to make check/spanner dams from existing spanning wood. No heavy equipment will be used in the stream channel, but can be used from the trail right-of-way. Details of the construction include (Figure 12):

1) The river-side end of the log is cut and dropped into the channel. If the log end can be moved, the length of the log should be slightly longer than the channel width, and the river-side end of the log dropped slightly upstream of its original location. The (raised) trail-side part of the log is chocked with woody debris.
2) It is preferable that the trail-side end of the log, which remains on the stream bank, is the root-wad.
3) Wood can be brought in for additional check-dams, if possible, by equipment on the trail.

4) All work will be supervised by a geomorphologist or geologist.
5) All actions should be documented, so adaptive management can be applied to future work.

The rationale is that lower end of the spanner will provide fish passage. If the lower end of the spanner has a greater diameter than that possible for fish passage, the end can be notched, at the direction of the Fish Biologist (Figure 12, step 5). The chocked side of the spanning log will increase channel roughness, reduce trail-side bank erosion, and promote stream deposition.

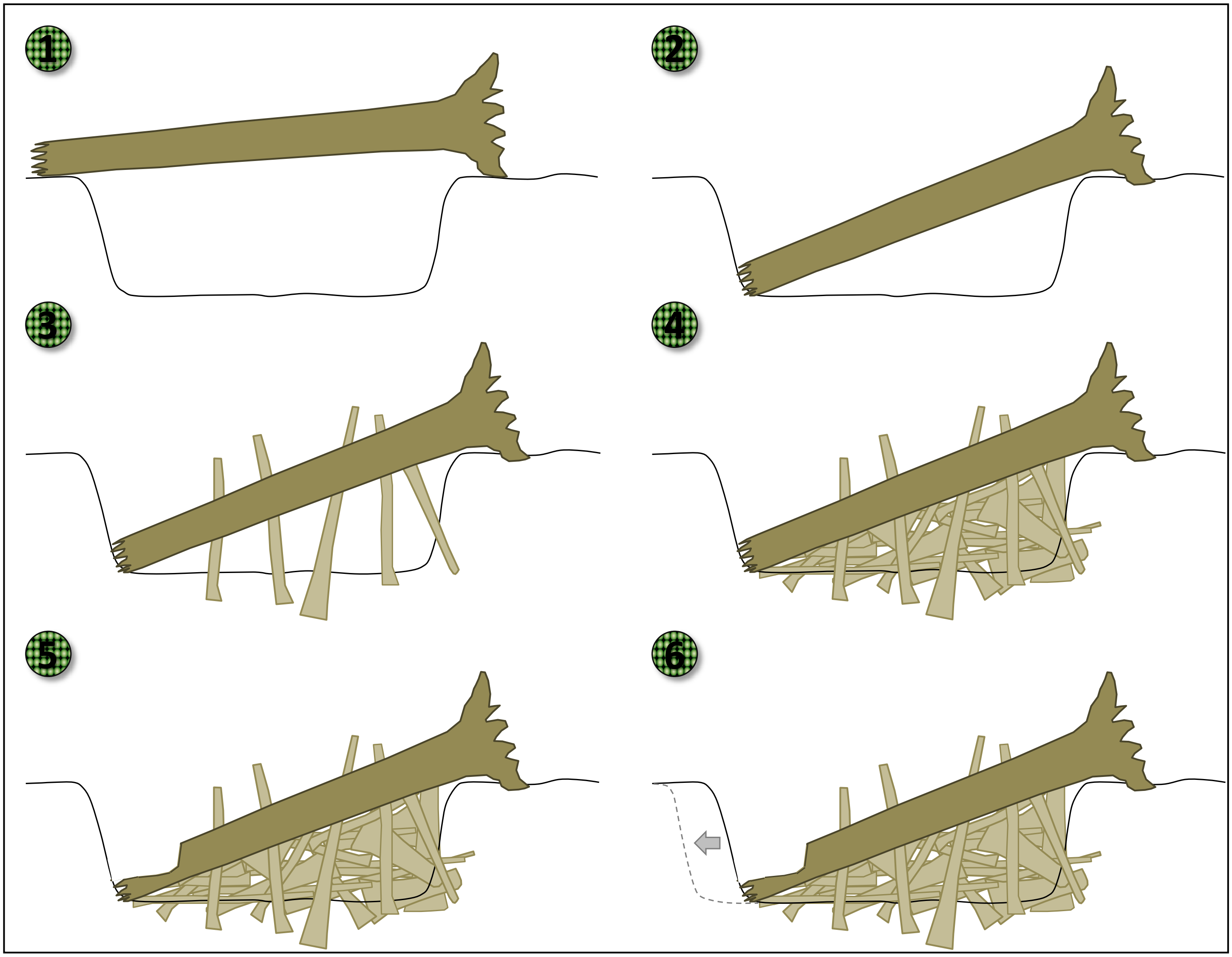

Figure 12: Construction of the Log Spanner for Alternative 2. 1) Spanning tree shown in profile view, facing upstream. Bank to be protected is the side with the intact rootwad; 2) Tree is preferably cut to a width just greater than current channel and pulled into channel with the top portion of the fallen tree facing upstream; 3-4) upstream side of spanner is chocked with large woody debris; 5) if necessary for larger dbh trees, a notch is cut in the tree to encourage fish passage; and 6) the goal of the spanner is to encourage aggradation behind structure, allow fish passage over top of structure, discourage bank erosion on the rootwad side of the structure and encourage bank erosion on the opposite bank.

Figure 13: Longitudinal profile of the Falls Creek/Carbon River new side channel. Alternatives 2, 3 and 4 require flood protection structures between the 8000 and 10,500 foot mark on the Carbon River Road.

Proposed flood protections (Alternatives 3 and 4): Reconstruct one lane road in new channel protecting edge with toe roughened rip rap (Figure 14) or a complex crib wall (Figure 15). There would be road access to this site under alternatives 3 and 4 and large rock could be hauled to the site. Additionally, check/spanner dams could be constructed as described previously (Figure 12).
Size of structure: Check dams would be one log high and span the width of the channel. Structures would vary with size of available wood. The number of structures depends on availability of wood and depth of aggradation during flood events. Due to the possibility of a river end-run around the structures, toe roughened rip rap or complex crib walls would need to protect the entire length of the affected area, approximately 2,600 linear feet.
Duration of project: Alternative 2: 10 to 20 days; Alternatives 3 and 4: 30 to 60 days.
Materials needed: Alternative 2 would use existing logs. Alternatives 3 and 4 would need a significant number of trucked-in trees (up to 15 per 40 foot section of protection), large rock and crushed gravel for road surface.
Construction methods: Described previously in this section.
Equipment used: Equipment used: Excavator dB level at 50 feet of equipment 85-81, Bull Dozer D-5 or D-6 85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet. For Alternatives 3 and 4, a dump truck 81dB at 50 feet and all Alternative 2 equipment.
Environmental Issues and River Impact:
100 year flood plain: Yes
OHWM: No
Diversion: No
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

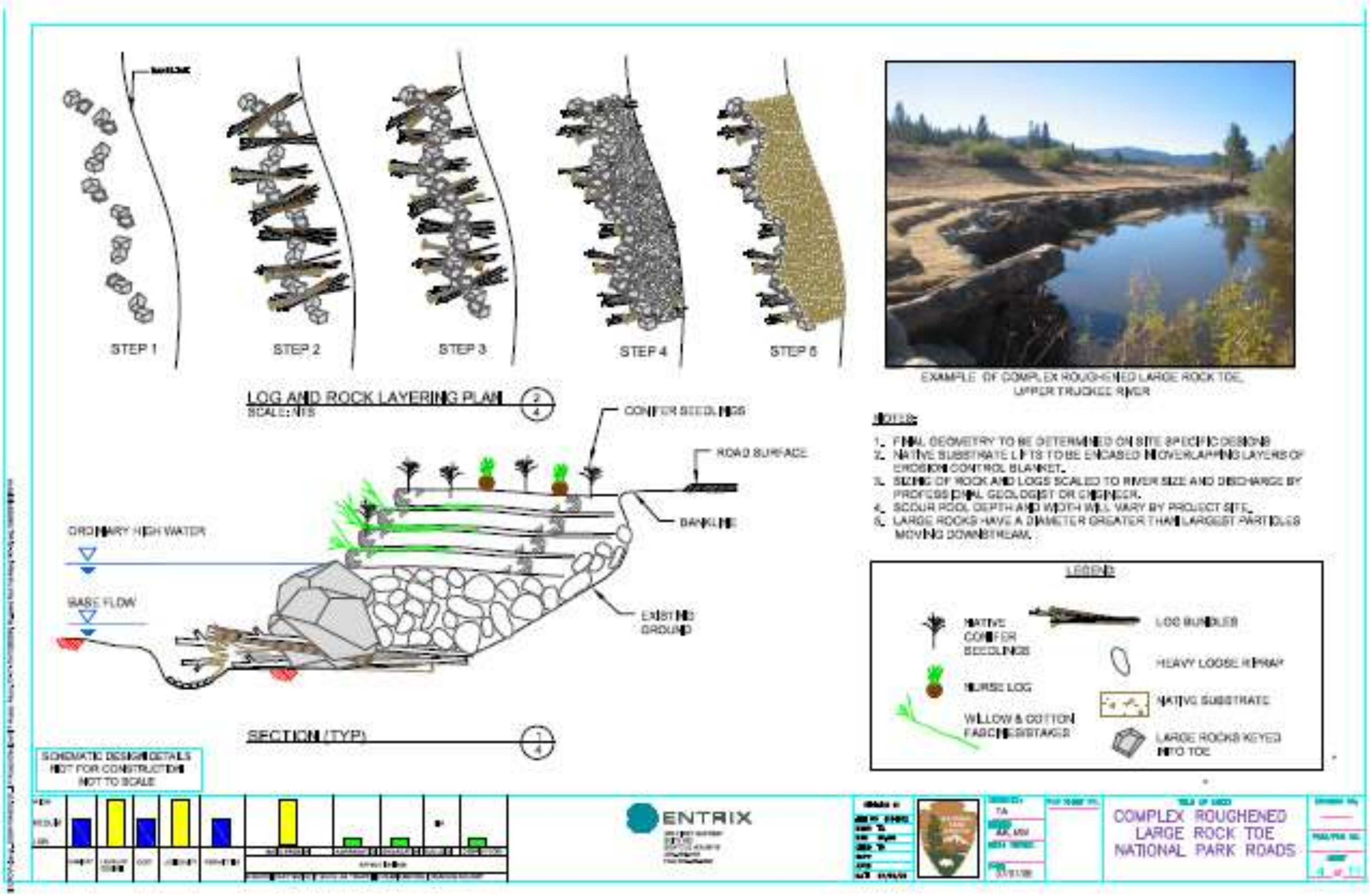

Figure 14: Typical design for toe-roughened rip rap

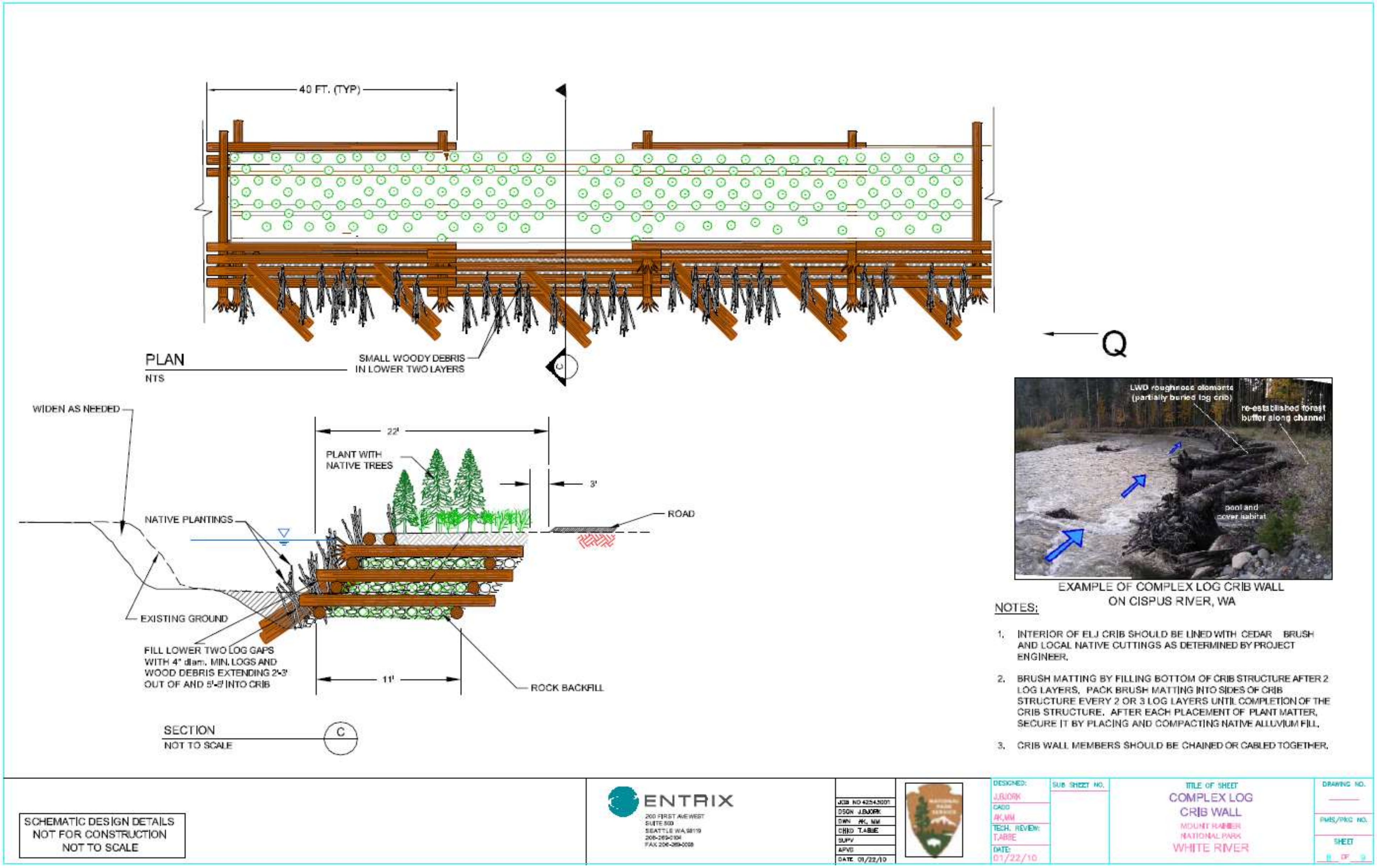

Figure 15: Complex crib wall

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Site #7: Just downstream of a bedrock knob at approximately MP 2.9

Figure 16: Expanding channel near road edge. Carbon River mainstem is visible through woods.

Risk: Carbon River migration, road capture of stream, and bank erosion.
Proposed flood protections: (1) Check/spanner dams from dropping existing spanners (as described at sites 4-6; Figure 12); (2) Repair or move trail as needed; and (3) Leave all future windfall to channel and trail.
Size of structure: Size of structure is dependent on size of spanning wood. However, all structures would allow for adequate fish passage at the direction of a Fish Biologist. If necessary, structures could be notched on the far end to allow for adequate fish passage (Figure 12 step 5).
Duration of project: 5-10 days
Materials needed: Logs
Construction methods: Similar construction methods for Alternative 2 on Sites 4-6.
Equipment used: Small excavator 81-85 dB level at 50 feet, Bull Dozer D-5 or D-6 85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet.
Expected outcome: River rock and sediment would accumulate behind check dams eventually filling in the new channel, and reducing threat of bank erosion.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Below
Diversion: No
Excavate River Bed: No
Excavate River Bank: Yes

Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

<u>Site #8:</u> <u>Washout at milepost 3.5</u>
See Sites #11-13 for discussion.

<u>Site #9:</u> <u>"Magirl channel" near Chenuis Falls trail</u>

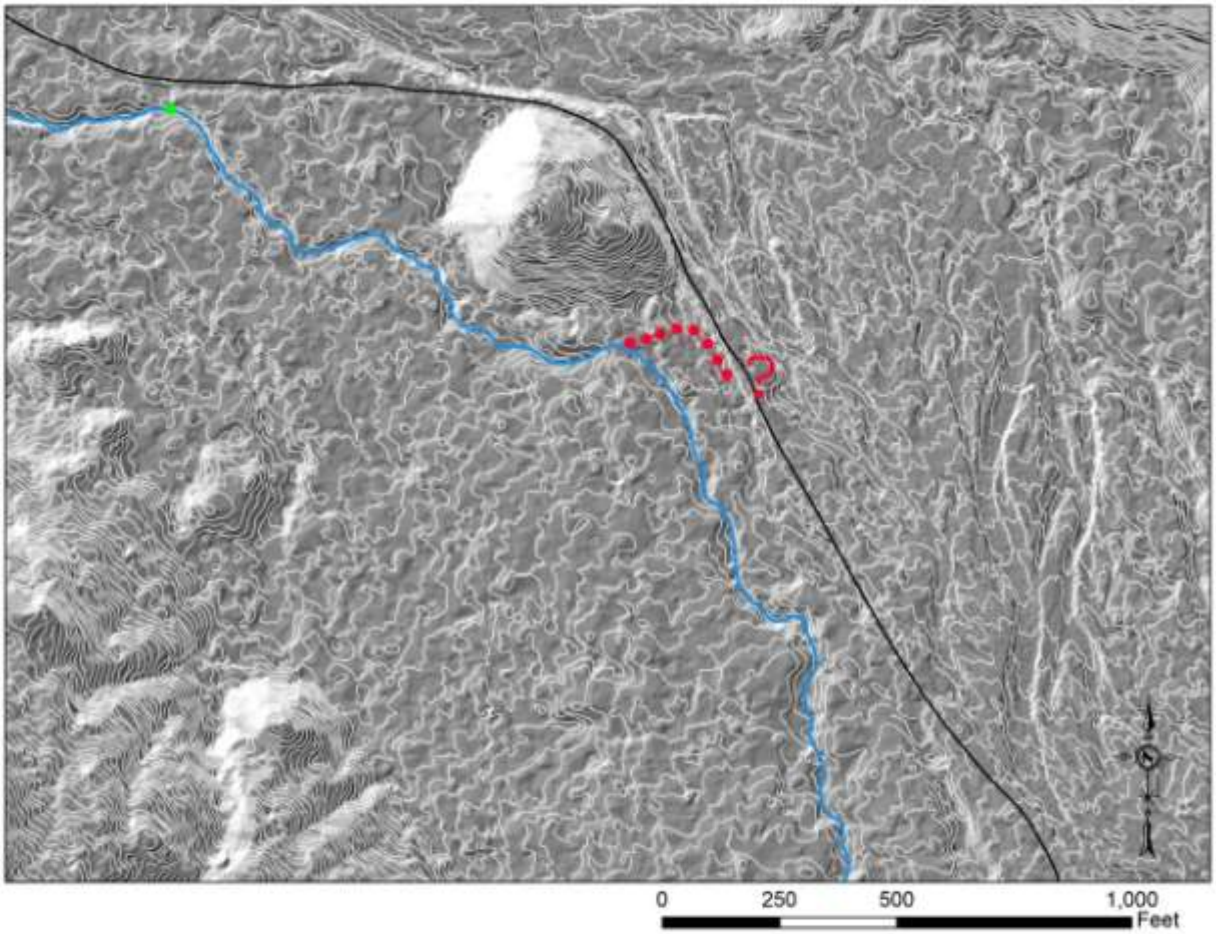

Figure 17: "Magirl channel" intersecting road upstream of rock knob.

Risk: Aggradation in Magirl Channel causes water to flow across Carbon River Road in various places below knob. Head cut of channel may incise and cause road capture by mainstream of Carbon.
Proposed Flood Protections: Install grade control structures downstream of knob.

Figure 18: “Magirl channel” near the Carbon River Road.

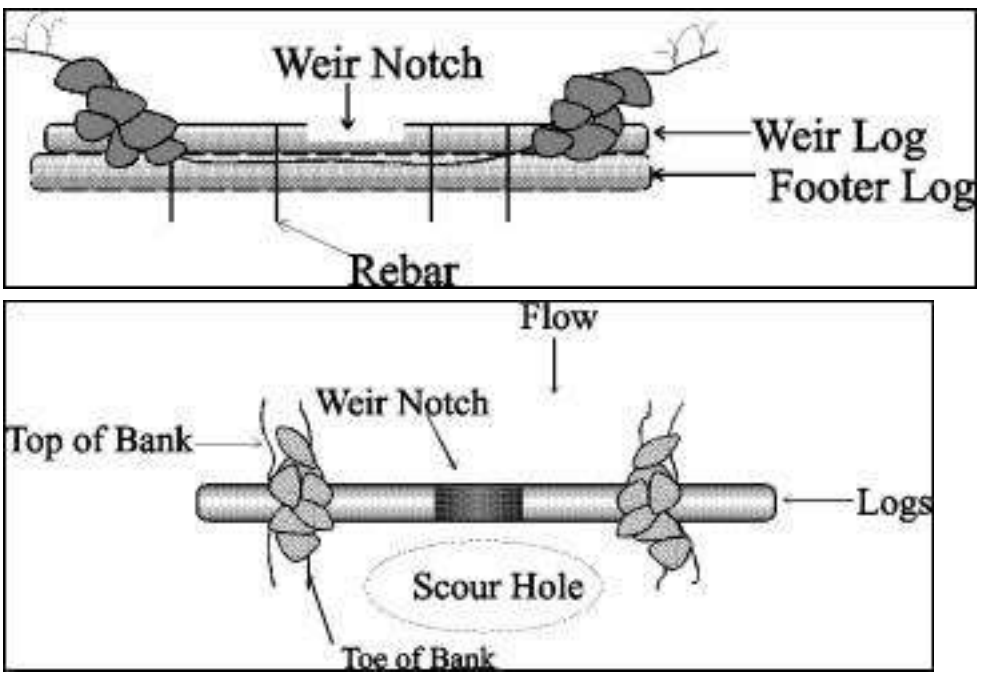

Figure 19. Notched log grade control. 3 logs proposed per structure, with off-set, notched logs for fish passage.

Size of structure: Two grade control structures. Structure size depends on site conditions
Duration of project: 5 to 8 days
Materials Needed: Logs
Construction methods: Two grade controls are recommended just upstream of a large, hanging culvert which is due to be removed (Site 10). This is because headward erosion can be propagated up both Ranger creek and from the tributary which flows to the hanging culvert. Grade controls will consist of a series of 3 logs, with off-set fish passage notches (Figure 19). Headcut erosion, subsequent to culvert removal, may cause the culvert tributary to capture upper Ranger creek, eliminating the need for 1 grade control. Please see the discussion in Site 10.
Equipment used: Equipment used: Small Excavator 81-85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet. Some logs may be put in place by hand with a come-along.
Expected Outcome: Reduce or eliminate head cut.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Above
Diversion: No
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: No
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #10: Large hanging culvert near the "Magirl channel"

Figure 20: Hanging culvert near "Magirl channel"

Risk: The "Magirl Channel" flows to a hanging culvert that is approximately 6 ft off of the bed of the Carbon River. This presents a serious fish passage concern and the culvert is scheduled to be removed. When this occurs, a large sediment bulge which has been accumulating behind the culvert will be head cut and mobilized downstream (Figure 21) unless check dams are installed. An analysis of the longitudinal profile shows that there is approximately 650 cubic yards of material that could be supplied to the river if the channel is allowed to headcut without grade control structures.

Proposed action: Removing hanging culvert and install check dams as described at Site 9. Also includes removal of other large and hanging culverts along the road.

Duration of project: 1 to 3 days for each culvert.

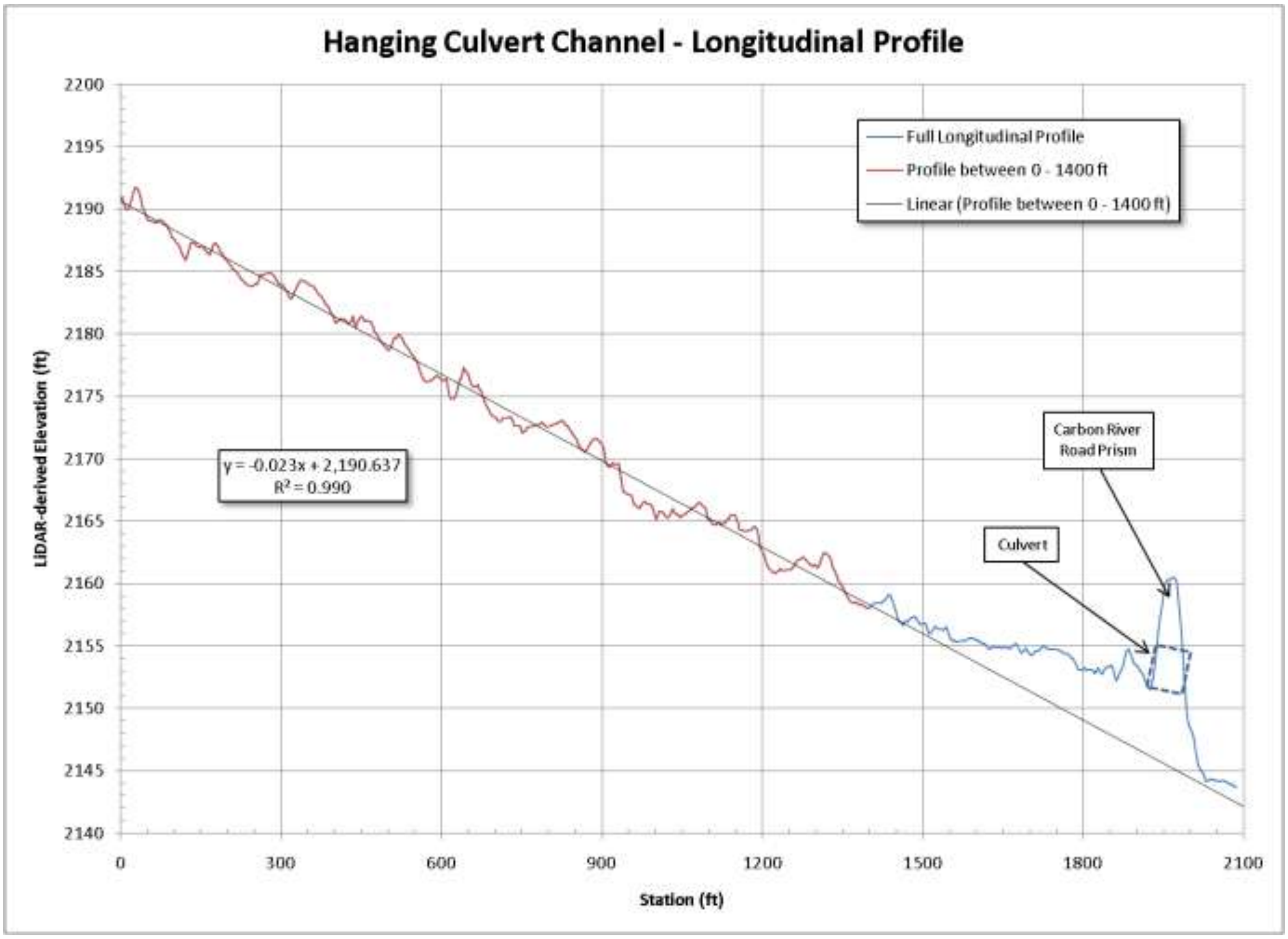

Figure 21: Longitudinal profile of the "hanging culvert" channel near the Magirl channel showing a sediment bulge behind the culvert and Carbon River Road prism.

Materials Needed: Logs
Construction methods: Under Alternative 2, a small excavator would be used excavate around each culvert. Some of the larger culverts would have to be cut into smaller pieces using a cutting torch before the small excavator could lift it out of the stream. If the pieces were cut small enough they could be hauled out of the area using an ATV , larger pieces could be hauled out with the excavator or by helicopter. Alternative 3 describes construction of a one lane vehicle road to Chenuis Falls Trail or 0.5 miles from Ipsut Campground respectively. Under Alternative 4 we would construct a 15 foot single lane road through all three bites. A small dumptruck could be used to haul out culverts under these alternatives.
Equipment used: Small excavator 81-85 dB level at 50 feet , ATV 350CC 80 dB level at 50 feet, Helicopter (Huey and Chinook) 101-102 dB in helicopter.
Expected outcome: Stream passage would revert to natural state, reduced impediment to fish passage.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Below
Diversion: No
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: No
Fish T&E: Bull trout other?

Bird T&E: Spotted Owl and Marbled Murrelet

<u>Sites #11, 12 and 13 (including #8):</u> <u>Bank erosion and road washout at MP 3.5, 3.8, 3.9 and 4.5</u>

Figure 22: Bank erosion sites. (a) Site 8, MP 3.5; (b) Site 11, MP 3.8; (b) Site 12, MP 3.9; (c) Site 13, MP 4.5.

Risk: Continued bank erosion, heavy aggradation in river next to cut pushing river into bank during flooding. In order to determine the relative risk for the "bite" sites, bank erosion rates were calculated. See Appendix C for maps showing the bank erosion at each washout site. Aerial photos from 2002 and 2007 and LiDAR data from 2008 were analyzed to determine the bank position during each time frame. The area of bank loss was determined in ArcGIS and shown in Table 2. Overall, bank erosion is a serious concern at each site, averaging 5-15 ft per year during the analysis period. It is likely that the most erosion occurred in the 2006 flood; however, bank erosion did occur between 2007 and 2008 which indicates the erosive forces of small to moderate floods are actively eroding banks at and in the vicinity of the bite sites. The risk for future bank erosion has been previously calculated (in the Risk Analysis) and is listed as "Extreme." It is anticipated that without further protection, bank erosion and damage to the extant portions of the Carbon River Road will continue.

Area	Time Period			Length		Area loss by Bank Erosion		Avg Loss in Period		Average Loss Per Year	
	From	To	Total	m	ft	sq m	sq ft	m	ft	m	ft
Washout MP 3.5	2002	2007	5	302.543	992.596	6,831.467	73,533.303	22.580	74.082	4.516	14.816
	2007	2008	1	302.543	992.596	1,901.160	20,463.911	6.284	20.617	6.284	20.617
	2002	2008	6	302.543	992.596	8,732.627	93,997.214	28.864	94.698	4.811	15.783
Washout MP 3.8	2002	2007	5	207.114	679.509	1,439.654	15,496.307	6.951	22.805	1.390	4.561
	2007	2008	1	207.114	679.509	620.496	6,678.965	2.996	9.829	2.996	9.829
	2002	2008	6	207.114	679.509	2,060.150	22,175.272	9.947	32.634	1.658	5.439
Washout MP 3.9	2002	2007	5	151.942	498.498	1,273.894	13,712.083	8.384	27.507	1.677	5.501
	2007	2008	1	151.942	498.498	469.215	5,050.593	3.088	10.132	3.088	10.132
	2002	2008	6	151.942	498.498	1,743.110	18,762.676	11.472	37.638	1.912	6.273
Washout MP 4.5	2002	2007	5	253.390	831.333	5,380.565	57,915.923	21.234	69.666	4.247	13.933
	2007	2008	1	253.390	831.333	730.396	7,861.915	2.882	9.457	2.882	9.457
	2002	2008	6	253.390	831.333	6,110.961	65,777.837	24.117	79.123	4.019	13.187

Table 2: Bank erosion rates at the washout locations between 2002, 2007 and 2008.

Proposed Flood Protections: Toe roughened gabion (adaptive management), toe-roughened rip rap (Figure 14), or complex crib wall (Figure 15).
Size of structure: Structure size depends on site conditions. Approximate lengths of the washouts are: 240 ft at MP 3.8; 200 ft at MP 3.8; 200 ft at MP 3.9; and 380 ft at MP 4.5 Height of cut bank varies from 3 to 12 feet.
Duration of project: 10 to 20 days for each bite.
Materials needed: Logs, wire "baskets" and river cobble. The number and size of logs would depend on length and height of structure. For a 100 foot long by 15 foot high by 15 foot wide structure we would need 28 -35 logs with branches for the toe structure. The amount of cobble needed to fill 3 foot square gabions for a 100 foot long structure would be approximately 1628 square feet or 542 CY. We would need and additional 400 plus feet of log for the cribbing for a 100 foot long structure.
Construction methods: Gabion baskets would be filled on site using cobble from river. A small excavator would be used to fill and place gabions as shown in design. If logs are available near the site they would be cut to length, moved with excavator or with come-along and laid in place. If logs aren't available on site they would be purchased locally and flown by helicopter to the site. There isn't access to this location for large vehicles or equipment, hauling logs or rock in by truck is not an option being considered under Alternative 2. Alternative 3 describes construction of a one lane vehicle road to Chenuis Falls Trail or 0.5 miles from Ipsut Campground respectively. Under Alternative 4 we would construct a 15 foot single lane road through all the washouts. In addition to the toe-roughened gabions, we also consider crib structures (figure 15). Due to equipment limitations, relatively small wood (estimated maximum of about 2 foot dbh, 30 feet length) wood will be used. At most times of the year all three sites are dry, if necessary we would have to divert water away from the site to work in the wet. To do this we would excavate a temporary channel reinforced with river bed material.
Equipment used: Alternative 2, a small Excavator dB level at 50 feet of equipment 85-81, Chainsaw 103-110 dB at 10 feet, helicopter (Huey and Chinook) 101-102 dB in helicopter.
Expected Outcome: Eliminate bank erosion to protect remaining hiking, bicycling trail.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Below
Diversion: Potential
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: Yes
Fish T&E: Bull trout other?

<u>Bird T&E:</u> Spotted Owl and Marbled Murrelet

Site #14: New channel in Ipsut Campground access road approximately 1620 feet long.

Figure 23: New Channel Ipsut Road at Campground Entrance Looking Down Stream

Risk: The Carbon augmented Ipsut creek, locally known as Ca-put creek, is about 40 feet average (20 to 60 feet) from the current trail. Because of this relatively large vegetation buffer, erosion risk to most of the trail is not considered high. There is a 20 ft section of trail (Figure 24) Check dams are no longer being considered.

Duration of project: One of the proposed structures would take 20-30 days. Construction of a diversion channel without structure would take about 5 days.

Materials Needed: Would use existing logs, river bed material and native plants.

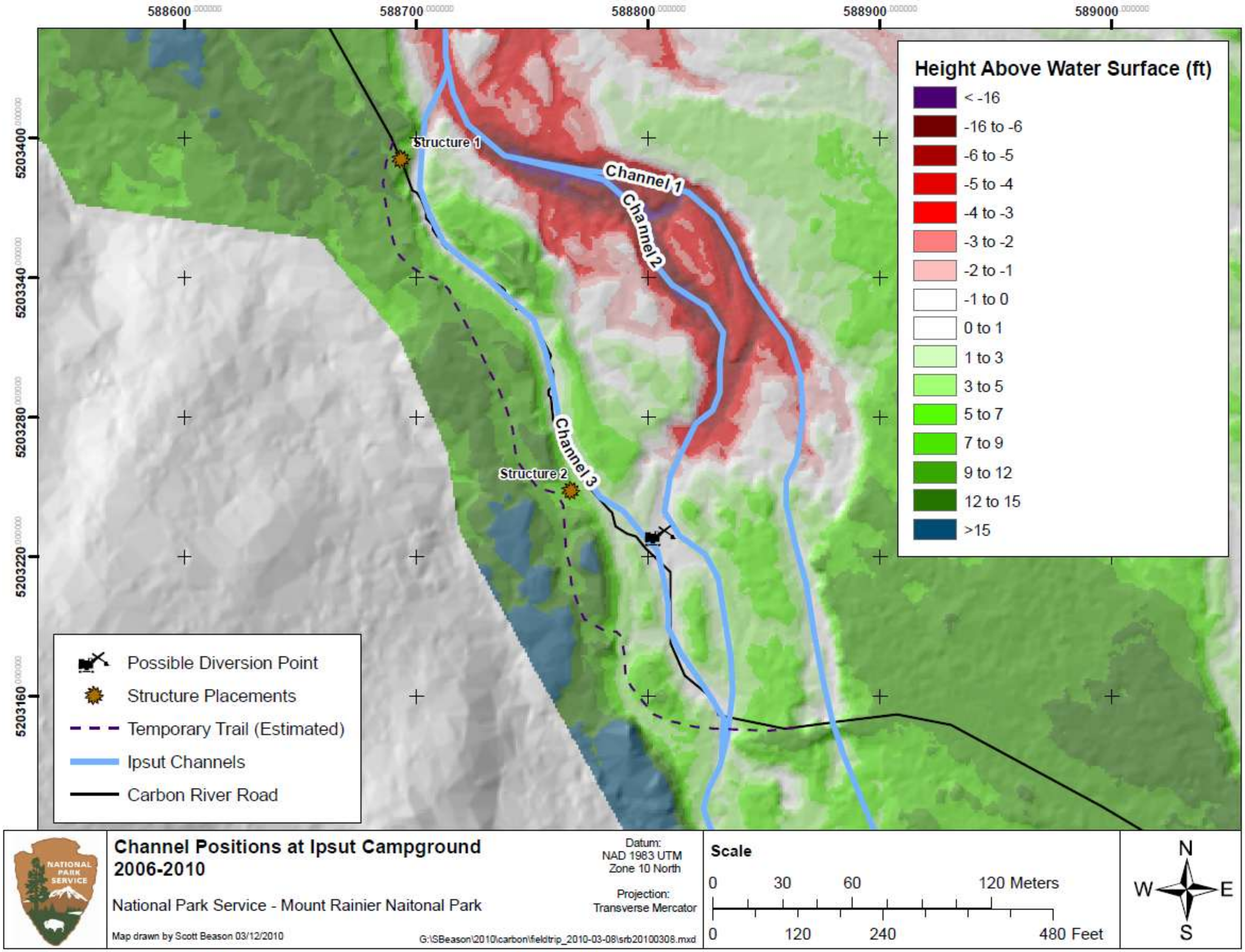

Figure 24. Location of proposed Ca-put (Ipsut) creek structures, and diversion. Channel 1 is the pre-2006 Ipsut Creek alignment, Channel 2 is the post-2006 Ca-put alignment

and Channel 3 is the current Ca-put creek alignment.

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Construction methods: For compliance purposes, 2 areas for protection are submitted. The 1st is the current road end (figure 24), and 2 structure-types are considered: launch-able (buried) groins (figure 25) and a toe-roughened crib wall (figure 26). The former will not require any diversion of Ca-put creek, as the infrastructure will be buried in the existing (dry) road, and exhumed by flood waters. Please note, that this structure will potentially protect only 590 feet of road (from Ca-put creek to the washout at MP 4.5), and cost/benefits should be considered.

The 2nd area for potential protection (Figure 24) is where the trail is only about 20 feet from the channel. A crib (figure 26) is considered here. A temporary diversion of Ca-put is likely required. A small excavator would be used to place logs and fill structure as shown in design. If logs are available near the site they would be cut to length, moved with excavator or with come-along and laid in place. If logs aren't available on site they would be purchased locally and flown by helicopter to the site. There isn't access to this location for large vehicles or equipment, hauling logs or rock in by truck is not an option being considered under Alt. 2. Alt. 3 describes construction of a one lane vehicle road to Chenuis Falls Trail or 0.5 miles from Ipsut Campground respectively. Under Alt. 4 we would construct a 15 foot single lane road through all three bites to the end of the road at the Ipsut washout.

Another alternative, to increase the distance between the channel and the trail, is to permanently divert the current stream to its immediately previous (last winter) location (Channel 2 in Figure 24). A diversion channel could be constructed using a small excavator and bull dozer. The diversion point could be reinforced with a log crib structure. (Figure 26.)

Equipment used: Small excavator 81-85 dB level at 50 feet, Bull Dozer D-5 or D-6 85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet

Expected Outcome: Groins and crib wall would dissipate energy and or deflect flow away from river bank and trail. Diversion channel would channel flow away from river bank and trail.

Environmental issues and river impact:

100 year flood plain: Yes
OHWM: Below
Diversion: Yes
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

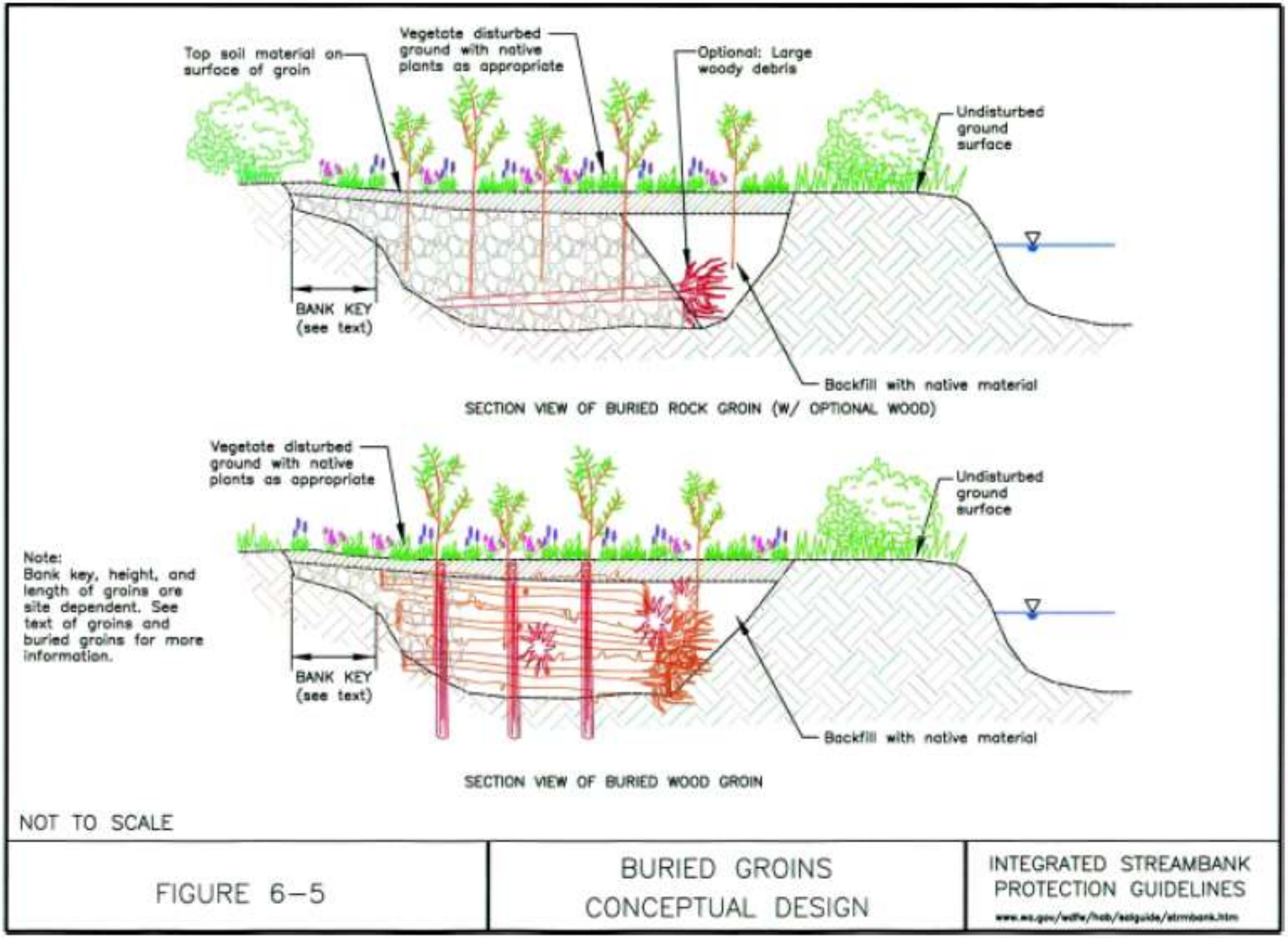

Figure 25. Self-launching (buried) log groin. Flood waters exhume wood structure.

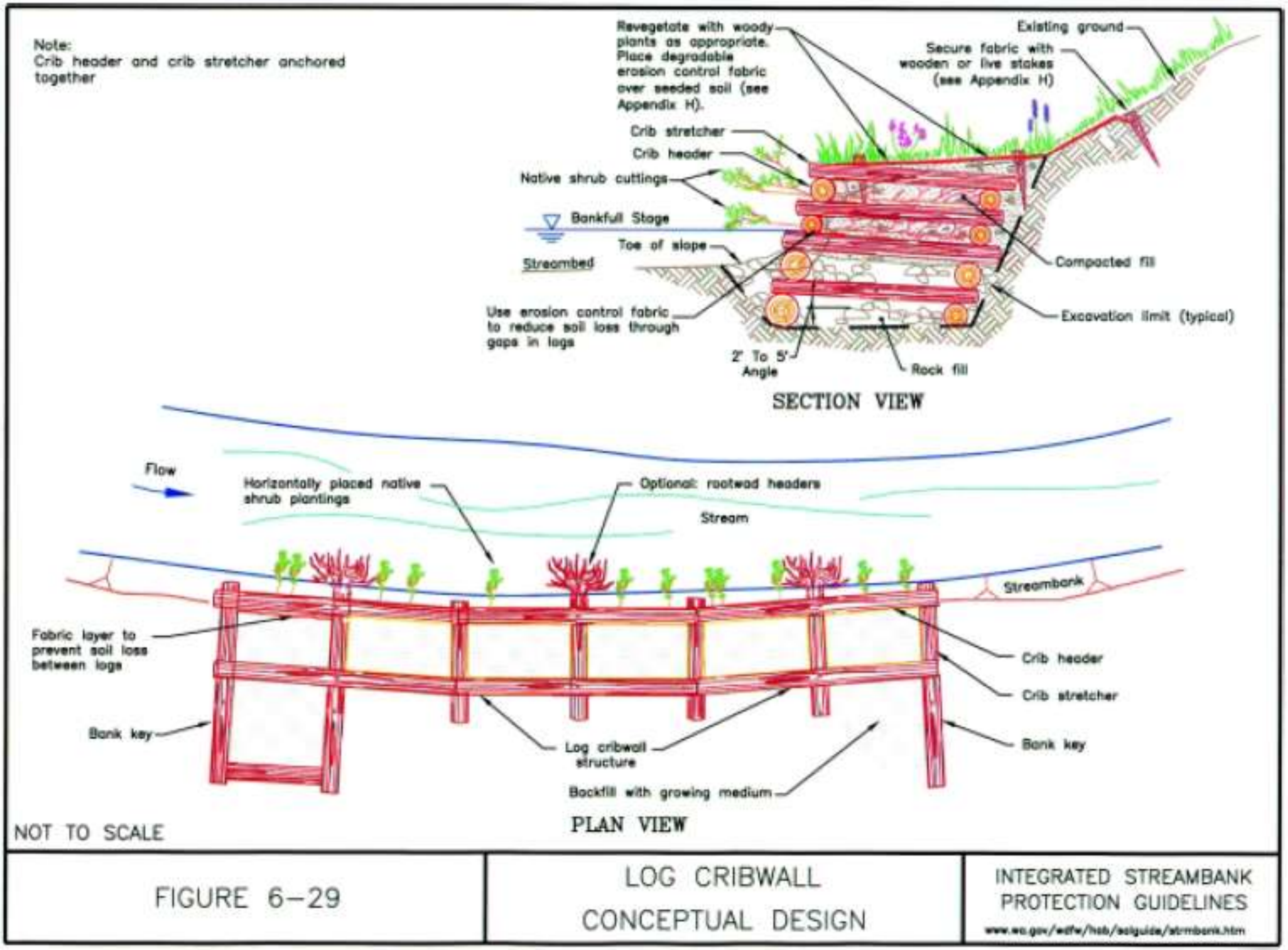

Figure 26. Log crib wall, with optional toe-roughening

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APPENDIXES

APPENDIX A: Road Segments and Justifications for DRAFT Relative Risk Assessment – Carbon River Road.
APPENDIX B: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road (B-1 – B-4).
APPENDIX C: Bank erosion maps at road washouts (C-1 – C-4).

APPENDIX A: Road Segments and Justifications for DRAFT Relative Risk Assessment – Carbon River Road.

Name	Ft Along Road		Milepost		Length	Risk Category	Justification
	Start	End	Start	End	(m)		
Carbon River Road	0	200	0	0.038	61.448	High	Bank Erosion, Bank within 10 m of road, danger to park infrastructure
Carbon River Road	200	1,200	0.038	0.227	306.441	Low-Med	Bank Erosion, Bank w/in 50 m of road, danger to park infrastructure
Carbon River Road	1,200	6,800	0.227	1.288	1717.653	Low	Road on terrance, >500m to river
Carbon River Road	6,800	7,600	1.288	1.439	245.737	Med	Avulsion hazard, Possible Bank Erosion, Road falling off of terrace
Carbon River Road	7,600	8,100	1.439	1.534	153.095	Med-High	Avulsion, Bank Erosion, Lower Terrace
Carbon River Road	8,100	8,300	1.534	1.572	61.718	High	Avulsion, Bank Erosion, Little Terrace, Side Channel in proximity of road
Carbon River Road	8,300	10,900	1.572	2.064	797.010	Extreme	In Side Channel, Avulsion, Current surface is below Main Stem elevation, Bank Erosion, Side Channel Widening
Carbon River Road	10,900	11,100	2.064	2.102	61.710	Low-Med	Avulsion, Bank Erosion, Side Channel on south side
Carbon River Road	11,100	12,000	2.102	2.273	275.665	Low-Med	Relict Side Channel, lower elevation on south side
Carbon River Road	12,000	14,300	2.273	2.708	705.421	Low	High terrace, Presence of Side Channel on north side
Carbon River Road	14,300	15,300	2.708	2.898	307.110	Med-High	Side Channel just north, Bank Erosion, Spillover from Main stem. Risk is between Medium and Medium-High here.
Carbon River Road	15,300	15,600	2.898	2.955	91.727	Med	Bank Erosion, Spillover from Main Stem, Presence of Side Channel. Needs to be field checked
Carbon River Road	15,600	16,800	2.955	3.182	367.919	High	Active Bank Erosion, Carbon River main stem aimed at bank, High relief above main stem presents hazard. Variable risk through section.
Carbon River Road	16,800	17,800	3.182	3.371	306.630	Low-Med	Active Bank Erosion, Main Stem near Bank, Lower Terrace
Carbon River Road	17,800	18,200	3.371	3.447	122.893	High	Active Bank Erosion, Main Stem near Bank, Side Channel in proximity to road.
Carbon River Road	18,200	18,700	3.447	3.542	153.797	Extreme	Active Bank Erosion, Loss of road, "Bite Me" Location,Risk of main stem Avulsion
Carbon River Road	18,700	19,600	3.542	3.712	275.083	High	Active Bank erosion, Main Stem very near road along section, Side Channels to the west.
Carbon River Road	19,600	20,400	3.712	3.864	246.223	Extreme	Active Bank Erosion and river overtopping, Loss of road, "Natty Lite" location, Main stem avulsion hazard
Carbon River Road	20,400	21,200	3.864	4.015	244.612	Extreme	Active Bank Erosion, Loss of road, "Little Bite" location, MS Avulsion
Carbon River Road	21,200	21,600	4.015	4.091	122.758	Med	Proximity of Main stem, Avulsion hazard, Bank Erosion, Low Relief to river channel
Carbon River Road	21,600	22,500	4.091	4.261	275.872	Low	Slight Bank erosion, Main stem within 100 m of Road
Carbon River Road	22,500	22,900	4.261	4.337	123.060	Low	High Terrace, significant Bank Erosion in MS >100 m away from road

Carbon River Road	22,900	23,200	4.337	4.394	91.591	Med	Significant Bank Erosion near road, Low relief between road and river.
Carbon River Road	23,200	23,500	4.394	4.451	92.529	High	Significant Bank erosion within Wilderness, downstreamof Bite
Carbon River Road	23,500	24,100	4.451	4.564	184.024	Extreme	Loss of Road @ "Big Bite", Active Bank Erosion, Main Stem Avulsion
Carbon River Road	24,000	25,300	4.545	4.792	54.890	Med-High	Complete loss of Road, Extensive Bank erosion, Avulsion of Carbon River and Ipsut Creek.
Carbon River Road	24,100	24,300	4.564	4.602	61.025	Low-Med	Road bookended by Bites, Bank Erosion, Possible Erosion starting at Ipsut side moving downstream on road prism.
Carbon River Road	24,300	24,000	4.602	4.545	58.601	Extreme	Complete loss of Road, Extensive Bank Erosion, Main stem Carbon River and Ipsut Creek Avulsion
Carbon River Road	25,300	26,300	4.792	4.981	184.026	Low	Possible Long Term Road Damage from Main Stem Avulsion
Rerouted Trail by Ipsut	0	375	0.000	0.071	114.040	Med	Bank Erosion, High Relief
Rerouted Trail by Ipsut	375	450	0.071	0.085	22.734	Med-High	Bank Erosion, Ca-put channel within 20 ft of trail
Rerouted Trail by Ipsut	450	1000	0.085	0.189	172.514	Med	Bank Erosion, High Relief
Rerouted Trail by Ipsut	1000	1150	0.189	0.218	45.135	Med-High	Possible damage due to Carbon River diversion upstream into Ipsut Creek Channel

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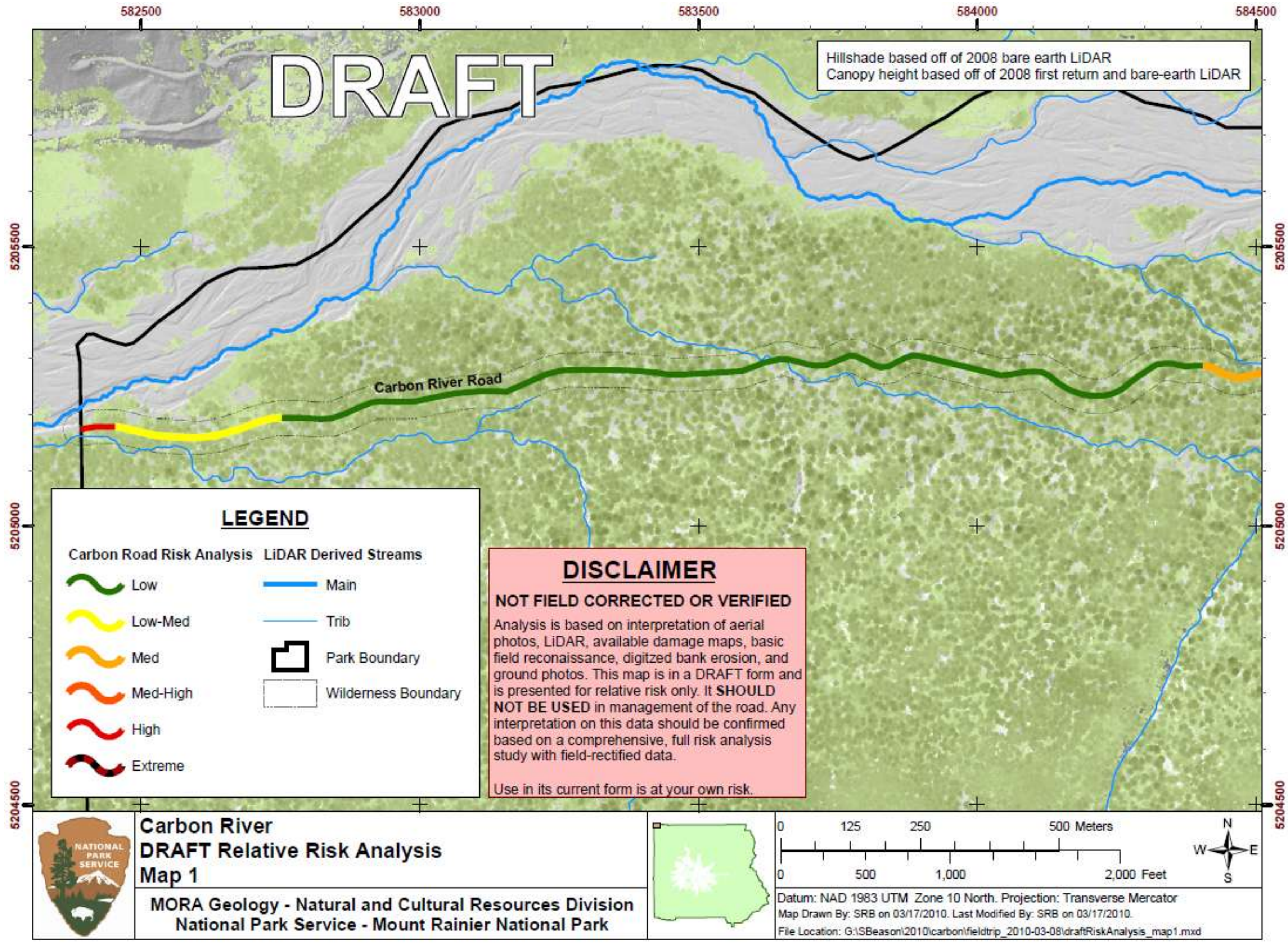
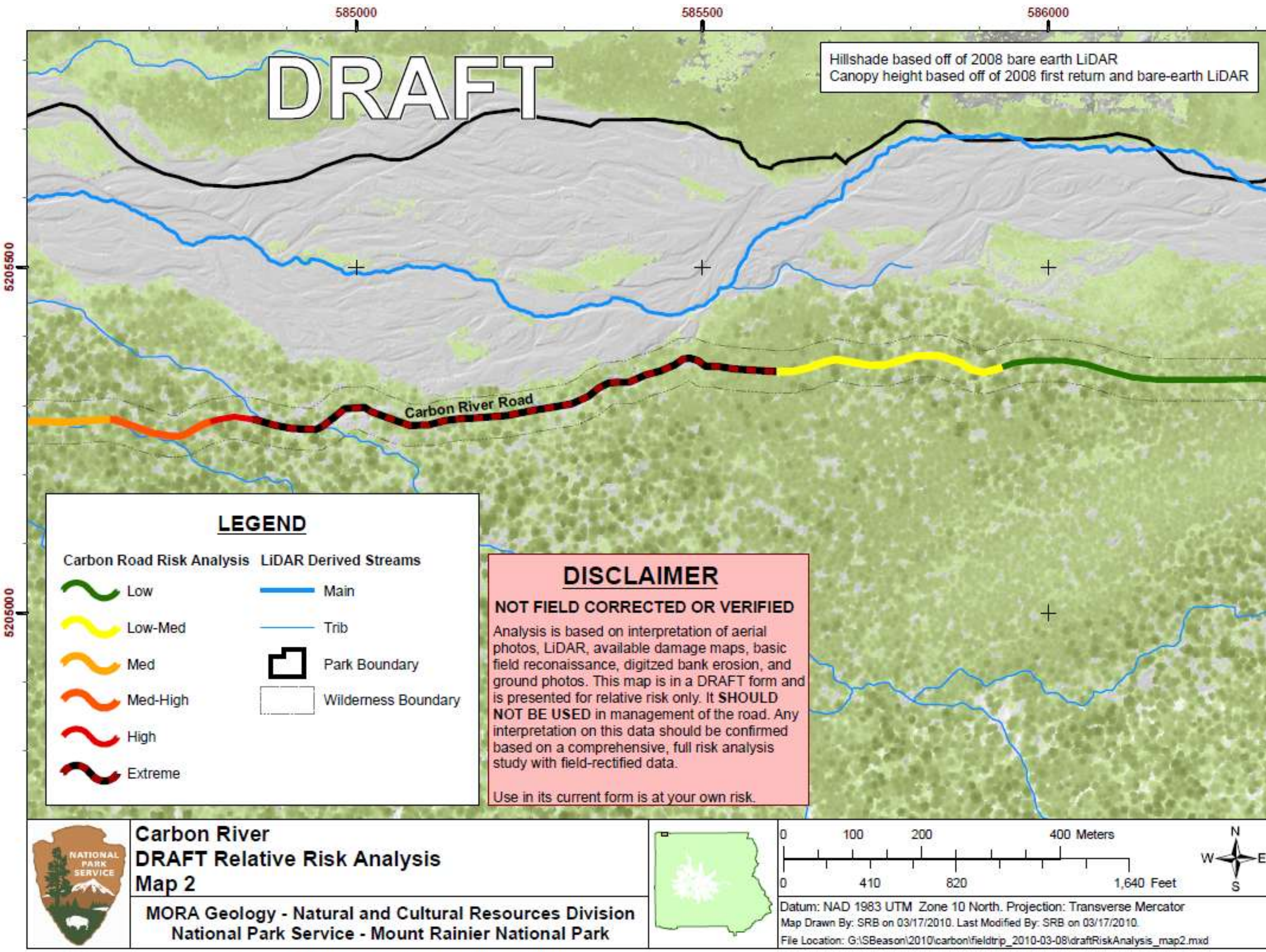
APPENDIX B-1: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.

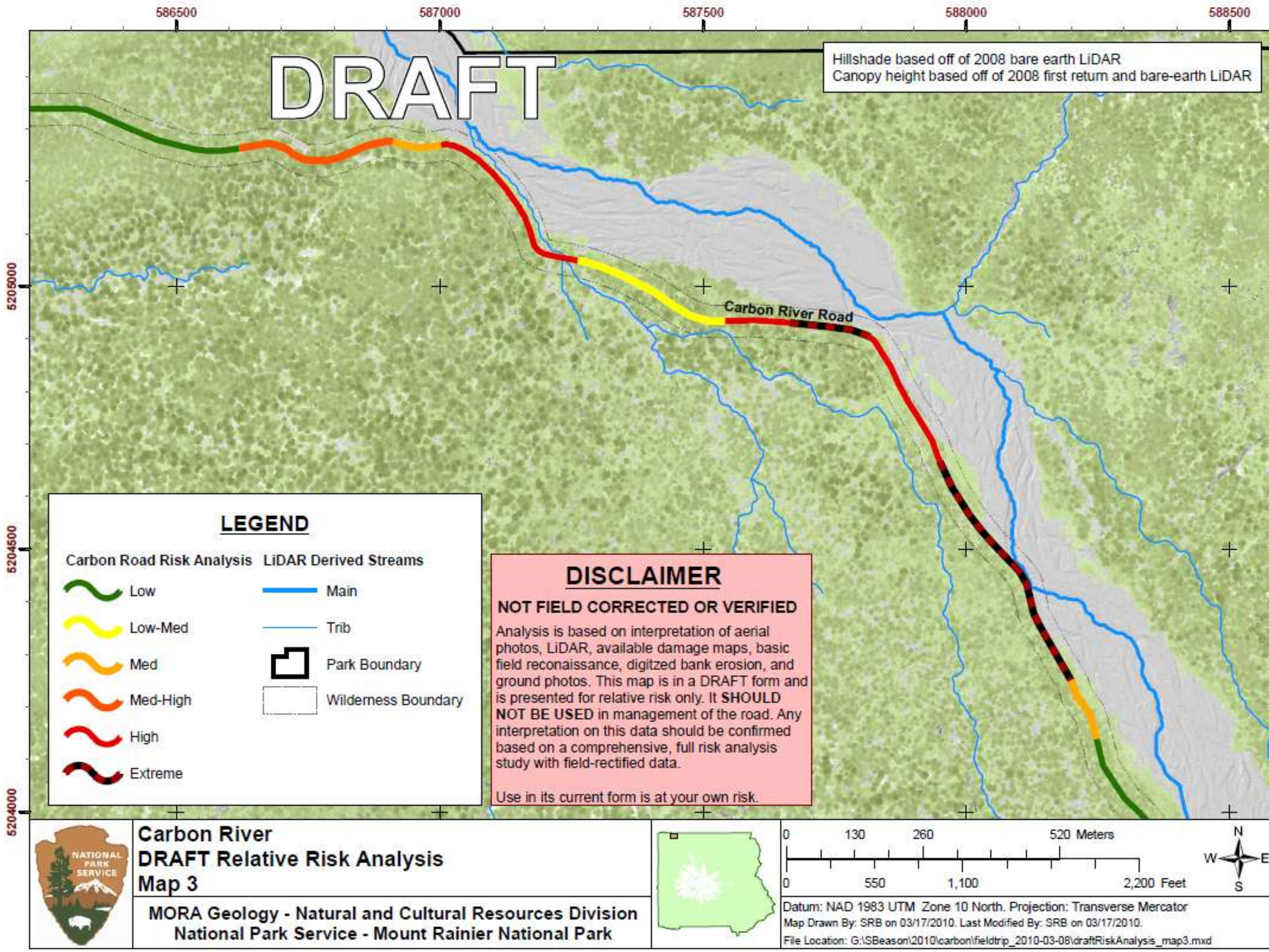

582500
583000
583500
584000
584500
5205500
5205000
5204500
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 1
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 125 250 500 Meters
0 500 1,000 2,000 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map1.mxd

APPENDIX B-2: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.

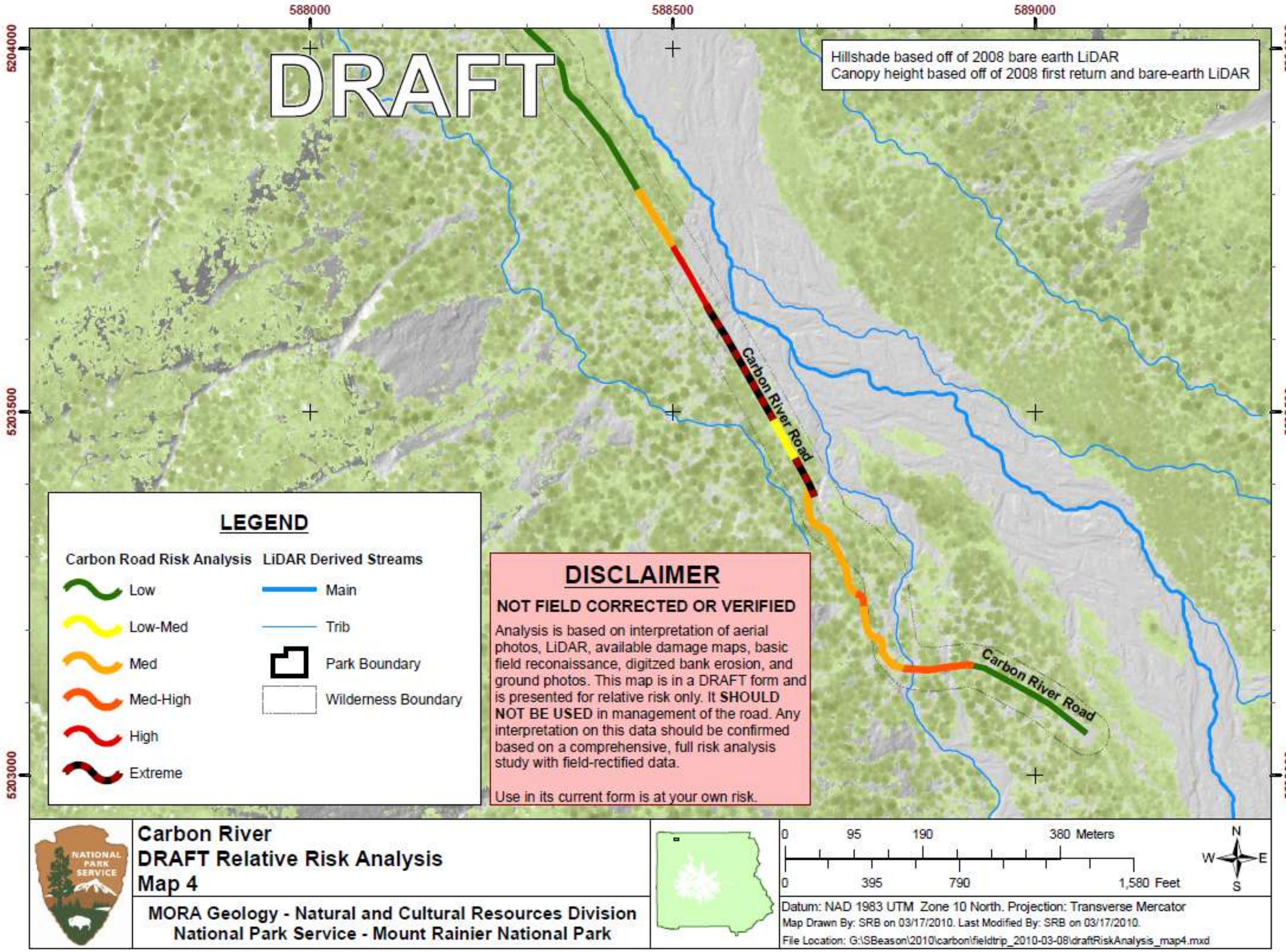


585000
585500
586000
5205500
5205000
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 2
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0
100
200
400 Meters
0
410
820
1,640 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map2.mxd

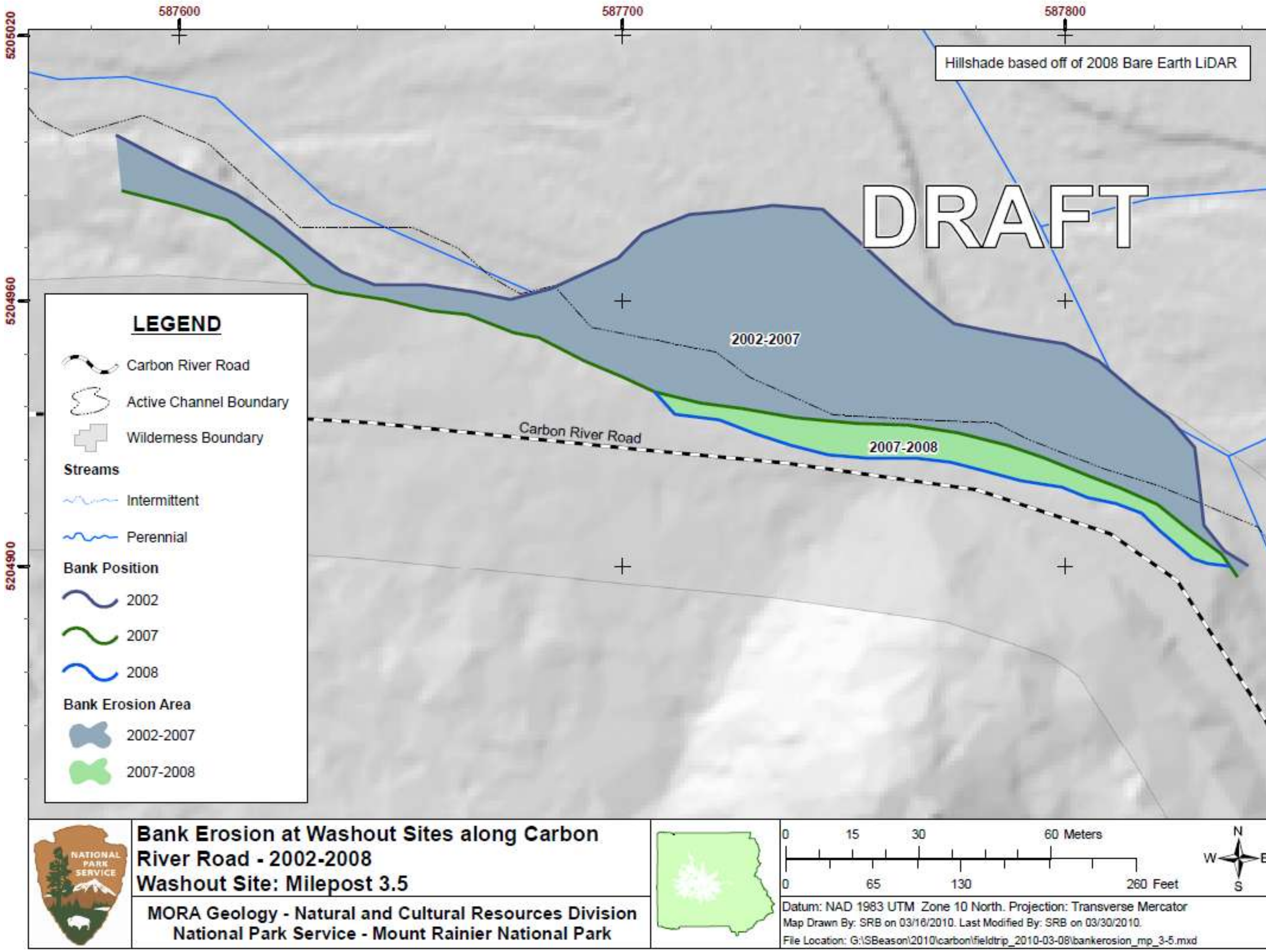
APPENDIX B-3: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.


586500
587000
587500
588000
588500
5205000
5204500
5204000
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 3
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 130 260 520 Meters
0 550 1,100 2,200 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map3.mxd

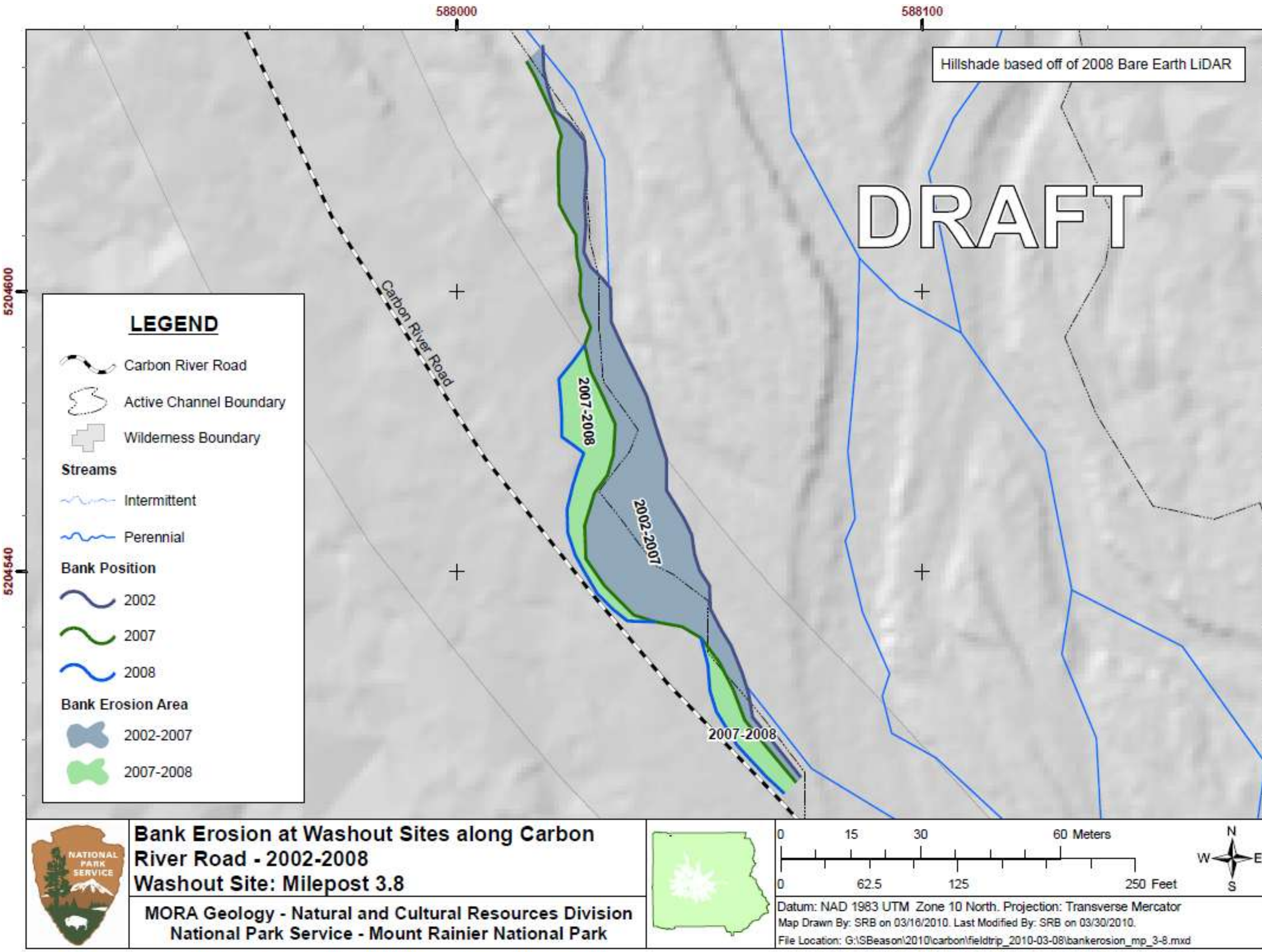
APPENDIX B-4: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.


588000
588500
589000
5204000
5203500
5203000
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 4
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 95 190 380 Meters
0 395 790 1,580 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map4.mxd

APPENDIX C-1: Bank erosion maps at road washouts.


587600
587700
587800
5205020
5204960
5204900
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
2002-2007
2007-2008
Carbon River Road
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
NATIONAL PARK SERVICE
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 3.5
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 15 30 60 Meters
0 65 130 260 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_3-5.mxd

APPENDIX C-2: Bank erosion maps at road washouts.


588000
588100
5204600
5204540
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
Carbon River Road
2007-2008
2002-2007
2007-2008
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 3.8
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 15 30 60 Meters
0 62.5 125 250 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
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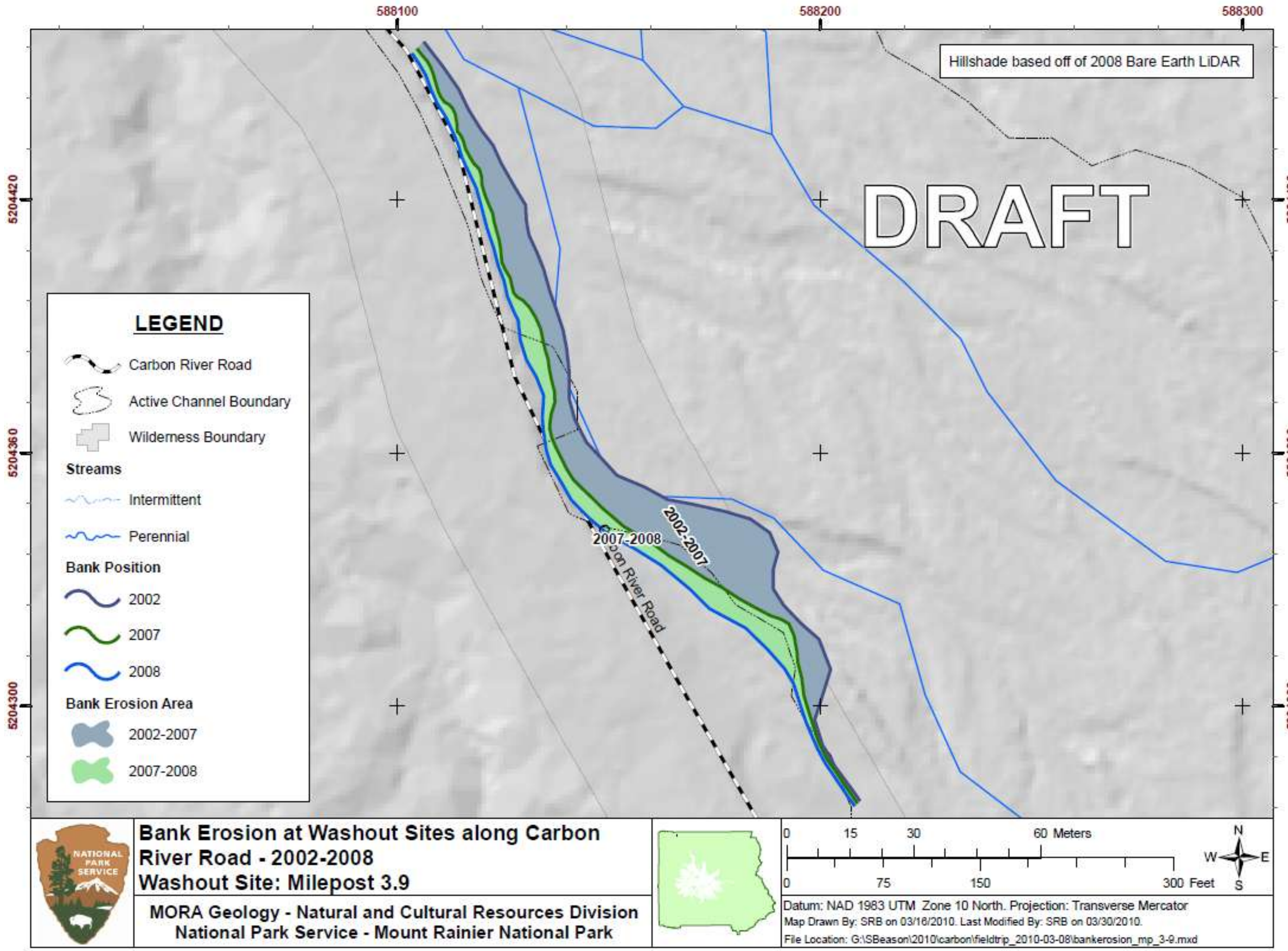
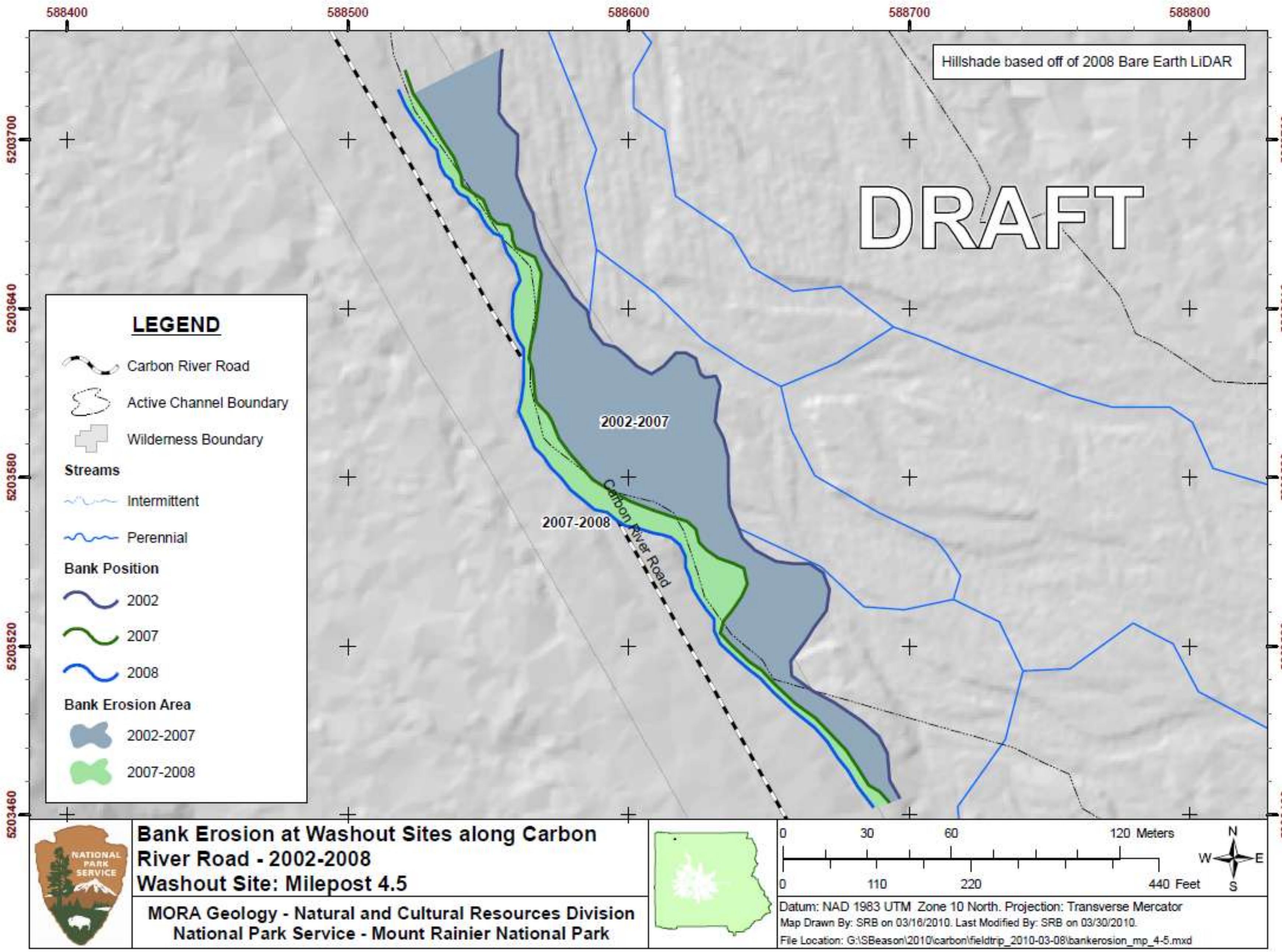
APPENDIX C-3: Bank erosion maps at road washouts.


588100
588200
588300
5204420
5204360
5204300
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
2002-2007
2007-2008
Carbon River Road
NATIONAL PARK SERVICE
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 3.9
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 15 30 60 Meters
0 75 150 300 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_3-9.mxd

APPENDIX C-4: Bank erosion maps at road washouts.


588400
588500
588600
588700
588800
5203700
5203640
5203580
5203520
5203460
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
2002-2007
2007-2008
Carbon River Road
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
NATIONAL PARK SERVICE
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 4.5
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 30 60 120 Meters
0 110 220 440 Feet
N W E S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_4-5.mxd