7. NON-ROAD SOURCES OF EROSION

7.1 CRITICAL QUESTIONS

The following five "critical questions," created by Oregon Department of Forestry, were answered during the sediment source analysis in the Nehalem watershed analysis.

1. *What is the distribution of slopes prone to shallow, rapidly moving landslides on state forest lands within the watershed? Map high, moderate, and low hazard areas using the following criteria:*
   - *Low – Slopes below 60%*
   - *Moderate – Slopes 60-79%*
   - *High – Slopes above 79%*
2. *What is the distribution of debris flow-prone channels on state forest lands within the watershed? Map channels as: likely, uncertain, or unlikely to deliver wood to fish-bearing streams.*
3. *Are there locations with gullies or other active surface erosion areas in the watershed? Map any locations.*
4. *Are there deep-seated, active, or recently active moving landslides? Map any locations.*
5. *Are there any unusually prone soils on steep slopes (>79%) in the watershed: Map any locations.*

The five critical questions are intrinsically linked to one another. As such, this report is organized in a manner that integrates the discussion of the questions. The assessment component, as defined by the ODF, is contained within Sections 7.2 through 7.5 and the analysis component is contained within Section 13.

7.2 CRITICAL QUESTIONS REGARDING SHALLOW LANDSLIDING AND DEBRIS FLOWS

A landslide and debris flow model was applied to the Nehalem watershed to answer critical questions #2. Critical question #1 required development of a slope category map (i.e., Low <60%, Moderate 60 – 79%, and High >79%). The empirically calibrated landslide model included both slope and convergence and may be a more appropriate descriptor of slide potential on convergent as well as on planar slopes compared to slope maps alone.

7.2.1 Shallow Landslide and Debris Flow Modeling

There are a variety of models developed to predict shallow landslides and debris flows in humid temperate landscapes such as the Oregon Coast Range (Sidle 1987, 1992; Benda and Cundy 1990; Hungr et al. 1984; Fannin and Rollerson 1993; Montgomery and Dietrich 1994). Most of these models require information on hillslope topography, including network characteristics of headwater systems such as channel gradients and tributary junction angles. The shallow landslide models are more physically based (e.g., Sidle 1987, 1992; Montgomery and Dietrich 1994) while the debris flow models are more empirically based because of the lack of physics-based debris flow models (e.g., Benda and Cundy 1990).

7.2.1.1 An Empirical GIS-Based Model for Landslide Potential

A detailed discussion on the GIS-based model for landslide potential in the Upper Nehalem watershed is included in Appendix D. A summary description of the model is provided in this section.

The empirically-based shallow landslide and debris flow model used in the Nehalem Watershed Analysis was based on the most detailed field inventory of landslides and debris flows available in the Oregon Coast Range. Following the very large 1996 storm that triggered numerous landslides and debris flows in the Oregon Coast Range, the Oregon Department of Forestry (ODF) initiated a comprehensive landslide and debris flow inventory (Robison et al. 1999). To circumvent the limitations of using aerial photograph alone (i.e., many shallow slides and debris flows cannot be detected under forest canopy), ODF conducted a field-based inventory. Within the five study sites located in the Oregon Coast Range, landslides and debris flows were inventoried using field surveys of all channels and scour paths of landslides and debris flows. Information collected included hillside gradient, aspect, slope form, slide volume, soil characteristics, channel gradient, junction angles, etc. (see Appendix C in Robison et al. 1999 for further details on study design).

The empirical model used herein, was designed to use field or air-photo mapped landslide locations with digital elevation models (DEM) (refer to Miller et al. 2003, and Miller and Burnett in review). The model was intended for use over regional scales (10^2-10^4 km^2), and therefore must use readily available GIS data.

The empirical landslide model searched topography (using 10-m DEMs) for combinations of steep slopes and topographic convergence (based on the topography commonly associated with

failures in the ODF 1999 inventory) (Figures D-1 and D-2 in Appendix D). Topographic convergence was defined as "spoon-shaped" depressions that concentrate the flow of groundwater during storms and also caused soils to thicken over century time periods. The role of forest vegetation was assessed in the model based on the ODF landslide inventories. Effect of vegetation in the landslide model was apparent from the variation in the relative landslide rates. The highest landslide density was associated with roads (i.e., 4.5 times the lowest landslide rate of forests categorized as either mature or old growth stands). The "open" category, that defines mostly recent clearcuts, had the second highest landslide rate of 3.7 times the Large Forest rate. The third highest rate 1.5 times the lowest rate was contained within "mixed" forests that generally encompassed second growth forests. Hence, from the empirical analysis, clearcuts and roads had high landslide rates compared to old forests. The high landslide rates associated with young forests (e.g., clearcuts) could have been due to some combination of low rooting strength and hydrological factors such as increased soil moisture due to reduced evapotranspiration.

In the landslide analysis for the Nehalem watershed analysis, present-day vegetation patterns included four different land-cover types in accordance with CLAMS vegetation mapping (Ohmann and Gregory 2002). These land-cover types included "OPEN" (non-forested areas and recent clear cuts [<10 years]), "MIXED" (hardwood stands, and mixed conifer and hardwood stands, and young to intermediate-aged stands (~10-80 years), and "large" (old, mixed hardwood and conifers, and old conifer stands [>80 years]). The Nehalem landslide analysis did not utilize a "road" land use category.

The landslide model did not include small streamside failures (often referred to as inner gorge landslides) in the ODF inventory because of the inability of 10-m DEMs to resolve inner gorge topography. Individual landslide sites in the ODF inventory were geo-spatially referenced on 10-m DEMs. Since the goal was to develop a model that utilized a digital database, the slope gradients associated with failure sites were derived from the DEM (and not from the field measurements). Since 10-m DEMs commonly underestimate slope gradients, the predicted locations of potential landslide sites as indexed by a variable landslide density may occur on lower DEM gradient areas compared to what may be found in the field. Hence, it is not appropriate to use a DEM-based slope gradient map with the predicted landslide density index to compare or contrast slide potential. A slope map can be used as a stand- alone measure of failure potential, with the understanding that 10-m DEMs underestimate slope gradients. Likewise, the 10-m DEM-based landslide density predictions are a stand-alone representation of failure potential. The DEM slope gradients associated with potential failures are likely less than the field gradients measured at those locations.

7.2.1.2 An Empirical GIS-Based Model for Debris Flow Potential

The debris flow component of the model employed four topographic factors: 1) channel slope, 2) valley width or confinement, 3) tributary junction angles, and 4) cumulative length of scour and deposition (i.e., rate of volume increase or decrease). In the model, debris flow runout was separated into zones of scour, transitional flow, and deposition, following the three classes identified in the field by ODF personnel. The functional relationships between debris flow scour and deposition and the four topographic factors were based on research illustrating the physical constraints of debris flow travel. For example, debris flow movement (1) declined with decreasing channel slope (Swanson and Lienkaemper 1978; Benda and Cundy 1990; Fannin and Rollerson 1993; Fannin and Wise 2001), (2) declined at sharp-angled tributary junctions (Benda and Cundy 1990), (3) was less in large forests, (4) was longer in clearcuts (Ketcheson and Froelich 1978; May 2002), and (5) increased with larger debris volumes (Benda and Cundy 1990).

The four vegetation types previously described for the CLAMS vegetation mapping (Ohmann and Gregory 2002) were evaluated in the debris flow model. Three specific study sites, the Elk Creek, Scottsburg, and Mapleton sites, from the ODF landslide study (Robison et al. 1999) were used in the analysis. Debris flow runout was sensitive to forest cover class, with higher probabilities of debris flows associated with OPEN cover classes compared to LARGE classes (Miller and Burnett in review). This result was likely due to the fact LARGE cover class was statistically associated with fewer field observations of debris flow scour, more deposition, and shorter runout paths than other cover classes. This finding was consistent with previous studies of debris flow movement in the Oregon Coast Range (Ketcheson and Froelich 1978, May 2002).

7.2.2 Wood Recruitment and the Importance of Debris Flows

Field surveys for this watershed analysis along 2.2 miles (3.6 km) of channels were used to estimate the types of wood recruitment sources in the Nehalem watershed. Of the 35 percent of total woody debris pieces that could be identified to a source, 66 percent originated from bank erosion, 30 percent from mortality, and 4 percent from streamside (inner gorge) landsliding (Figure D-3, Appendix D). Of the recruited wood to stream channels, 54 percent was deciduous and 46 percent was conifer (Figure D-3, Appendix D). Approximately 75 percent of all woody debris entered the channel from 60 feet from the stream bank and approximately 90 percent of all wood entered the channel within a distance of 85 feet.

Wood originating from debris flows is difficult to identify unless the debris flows are recent and logs can be linked to specific deposits. A field survey of woody debris was conducted along 1.4

miles (2.3 km) of a fourth-order channel with a high density of predicted debris flow-prone headwater streams. A series of old debris flow deposits were encountered along the study segment. The wood survey revealed the highest in-channel wood volume in apparent spatial association with the highest density of debris flow-prone headwater streams (Figure D-4, Appendix D). Statistical analysis of the spatial proximity of wood storage to headwater streams to verify the relationship between debris flows and wood loading was not accomplished for this analysis. Simulation modeling in landscapes similar to the Nehalem in the central Oregon Coast Range and in western Washington indicate debris flows can be locally significant in wood delivery to fish-bearing streams (Benda and Sias 2003, USFS 2002). Also refer to the section on Natural Disturbance, Section 3.2, for further information on the significance of debris flows in wood recruitment.

7.2.3 Spatial Probability Predictions

The debris flow model predictions represent spatial probabilities based on the 1996 ODF landslide inventory. Probabilities estimated by the model are based on the proportion of observed sites with similar attributes that have been similarly affected by debris flow occurrences based on field mapping. The model calculated probabilities based on spatial proportions within the study areas. For example, if one were to randomly select a site on a map containing landslide-initiation locations plotted as points, the model would estimate the probability that the selected site lands on a plotted initiation point. Likewise, if one were to randomly choose a point in the channel network, the model would estimate the probability of that point having been mapped with debris flow scour or deposition. Hence, modeled probabilities reflect the proportion of channels having similar topographic and forest cover attributes where debris flow impacts were mapped in the field following two very large storms in 1996 (Robison et al. 1999). A probability of 1 percent, for instance, indicated that of one hundred similar channel reaches, only one on average would have contained evidence of a debris flow after the 1996 storms. Low probabilities did not necessarily translate into small effects, but may translate to a low frequency of occurrence. In addition, the spatial probabilities were based on landslides and debris flows mapped in a single year. These data did not provide information on temporal patterns of landslides and debris flows. To obtain insights into temporal patterns of landslides and debris flows in landscapes such as the Nehalem watershed, refer to the video simulations in the USFS educational CD on landscape dynamics (USFS 2002).

7.2.4 Application of the Shallow Landslide-Debris Flow Model to the Nehalem Watershed

7.2.4.1 Landslide – Debris Flow Parameters

It is assumed for this analysis, the fish species of highest concern related to landslide and debris flow impacts in the Nehalem watershed include anadromous forms of coho, Chinook, and steelhead (see also Section 10, Fish, Fish Habitat, and Amphibians, of this report). Based on fish distribution analyses in the Nehalem and from other locations in the Oregon Coast Range, a channel threshold gradient of less than 12 percent was selected to define anadromous fish-bearing channels.

The model predictions take several forms that could be used to help manage landslide and debris flow risk in the Nehalem watershed. For more information on how field based methods can be integrated with model predictions for managing debris flow risk, see Benda et al. (2005). For each of the 13 ODF management basins, three model predictions were made (all at the 10-m DEM scale): 1) landslide density, 2) debris flow probability, and 3) debris flow wood recruitment corridors (i.e., along headwater streams) (Table 7-1). In addition, as required in critical question #1, a slope gradient map is included that categorizes hillslopes into three domains of high (>79%), moderate (60 – 79%), and low (<60%).

As described above, predictions of debris flows were sensitive to forest vegetation. The model applied to the Nehalem watershed utilized present-day vegetation types as contained in the CLAMS (satellite-based vegetation layer). No changes in forest cover due to forestry activities was included in the predictions, although they could be incorporated in the model and they may effect the debris flow predictions (and landslide density predictions). In addition, no road effects were included in the landslide analysis.

Table 7-1. Descriptions of the landslide – debris flow indices used in the Nehalem Watershed Analysis. See model description above for interpretation of "landslide density" and "debris flow probability."

Landslide – Debris Flow Indices	**Description**
1) Slope gradient.	According to ODF guidelines for the Nehalem Watershed Analysis, the management basins were mapped according to three slope gradient categories: Low (<60%), Moderate (60 – 79%), and High (>79%).
2) Landslide density.	Landslide density is the number of slides predicted per square kilometer (based on model calibration – see model description). Each pixel is assigned a landslide density based on local topographic attributes. Although the absolute values pertain only to the calibration area (see Miller and Burnett in review), the relative difference from point to point provides a quantitative measure of differences in landslide potential. *Nevertheless, because of the low resolution of digital topographic information, landslide density predictions are best used for large-scale screening. Field investigation is strongly encouraged (see Figure D-5).*
3) Average debris flow probability.	The potential for debris flow scour or deposition (average debris flow probability) is a function of slope gradient, channel confinement, tributary junction angles, and forest cover along the entire runout path. *This parameter provides information for determining the relative likelihood that a debris flow will flow through a channel* <u>*given a slide potential*</u>*.* Variation in the parameter value (probability) indicates the relative likelihood and runout of debris flows
4) Debris flow wood delivery corridors.	This index provides a relative probability that a pixel will be traversed by a debris flow from upslope that delivers to channels of less than 12%. The mapped wood delivery corridors (headwater streams only) can be used to identify those channels that are likely to deliver wood to lower gradient, fish-bearing streams.

7.2.4.2 Interpreting Model Results: Answering Critical Questions

Model predictions refer directly to the likelihood of shallow landsliding on planar and convergent slopes, and on the likelihood of debris flows to scour headwater channels and to deposit sediment and wood into fish bearing channels. Predictions are in terms of landslide density and probability of debris flows.

Interpreting model predictions in the context of forest management is dependent on the management and/or ecological perspective adopted. For example, landslides and debris flows can be assumed destructive to fish habitat in all cases. Conversely, debris flows provide sources of sediment and wood, and hence are sources of habitat development and heterogeneity over a long-term horizon. The scientific literature ranges across these two perspectives (refer to Section 3.2, Natural Disturbance, for an overview of the effects of debris flows on channel environments).

The slope gradient and landslide density maps provided herein, should be considered qualitative indices for landslide potential and hence, used primarily as a screening tool. This qualification is primarily related to the low resolution of the available digital topographic information (10-m DEMs). The landslide density maps likely over predict the slide hazard in some areas, although they may also under predict potential instability where bedrock hollows cannot be resolved with 10-m DEMs. When these indices are used in conjunction with aerial photographs and topographic maps, they can help indicate whether forestry activities can contribute to instability and whether additional field evaluation is necessary. If slope stability is not considered an issue, then the debris flow analysis and associated maps need not be consulted. However, when the screening tools and field-based stability analysis indicate shallow failures are a significant possibility, then the debris flow maps (see Items #3 and #4 in Table 7-1) can be used to help interpret the potential for debris flows to travel to fish-bearing streams. In addition, the debris flow-prone channels most likely to contribute wood to low gradient, fish-bearing streams can be estimated from the maps on wood recruitment.

ODF's critical question #2 requested a map of debris flow-prone channels "likely" or "unlikely" to deliver wood to fish-bearing streams. The average debris flow probability and debris flow wood delivery corridors can be arrayed according to "likely" through "unlikely" by having those categories span the predicted high – low range of probabilities. Refer to the flowchart in Figure D-5, Appendix D, that summarizes a procedure for managing landslide and debris flow risk. This flowchart provides guidance on how to use the four map products developed during this analysis.

7.2.4.3 Individual Forest Management Basins

The study area and legend for the slope stability and debris flow analysis are shown in Figures D-6 and D-7, respectively in, Appendix D and the legend is included in Figure 7-1, below. Results of the model predictions for: (1) slope gradient, (2) landslide density, (3) debris flow probability, and (4) debris flow wood recruitment corridors comprise 52 figures and can be found in Appendix D. We have selected representative figures to show a range of prediction results for each of the four parameters. These data are presented in Figures 7-2 to 7-5.

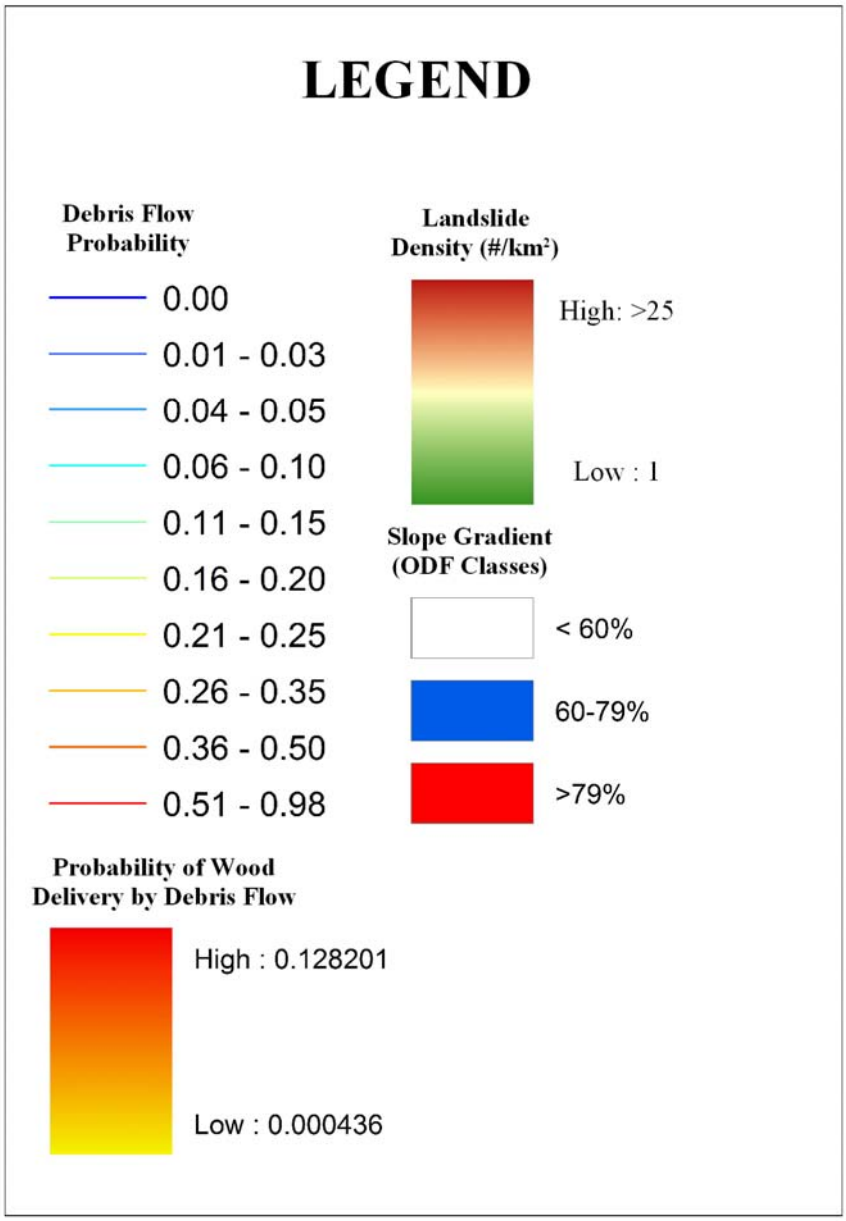


Figure 7-1. Legend for the four landslide and debris flow maps used in the Nehalem Watershed Analysis. Refer to Table 7-1 and discussion of models for more details.

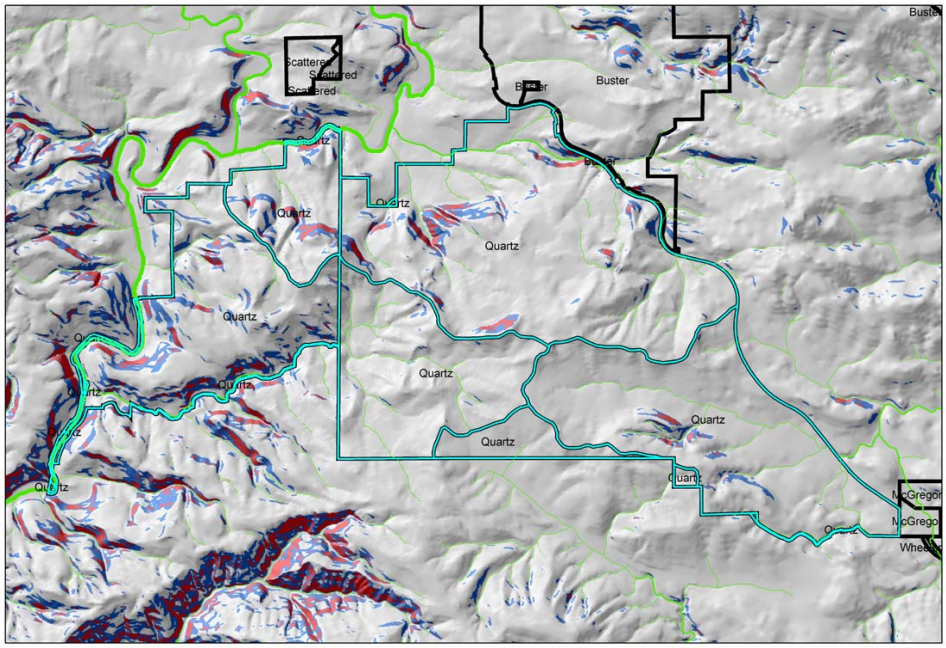


Figure 7-2. Slope gradient map for the Quartz Management Basin. Refer to the Legend in Figure 7-1.

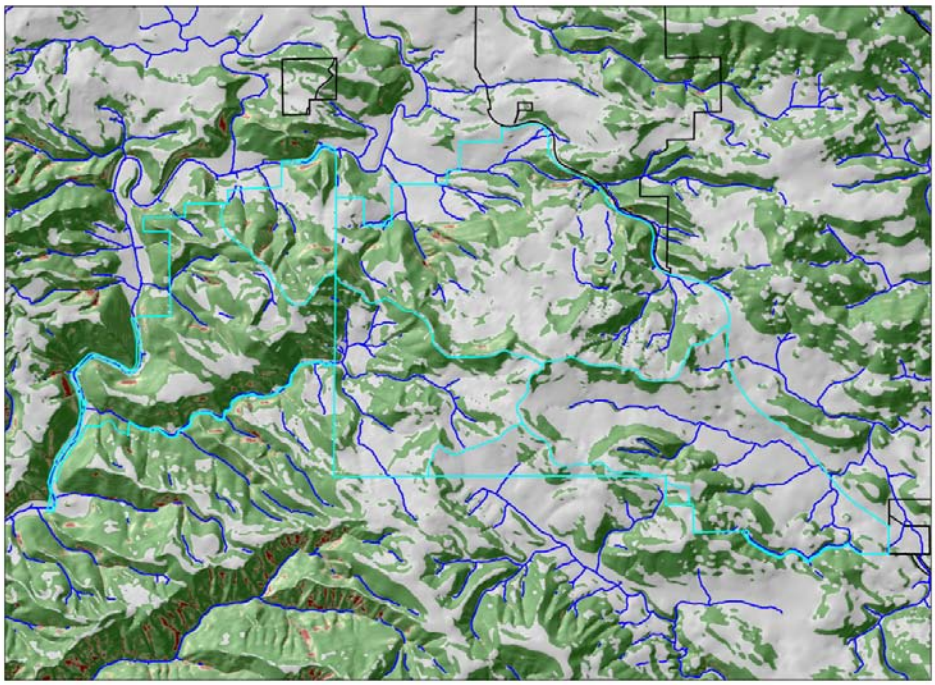


Figure 7-3. Predicted landslide density for the Quartz Management Basin. Refer to the Legend in Figure 7-1; the gray areas have no predicted landslide density.

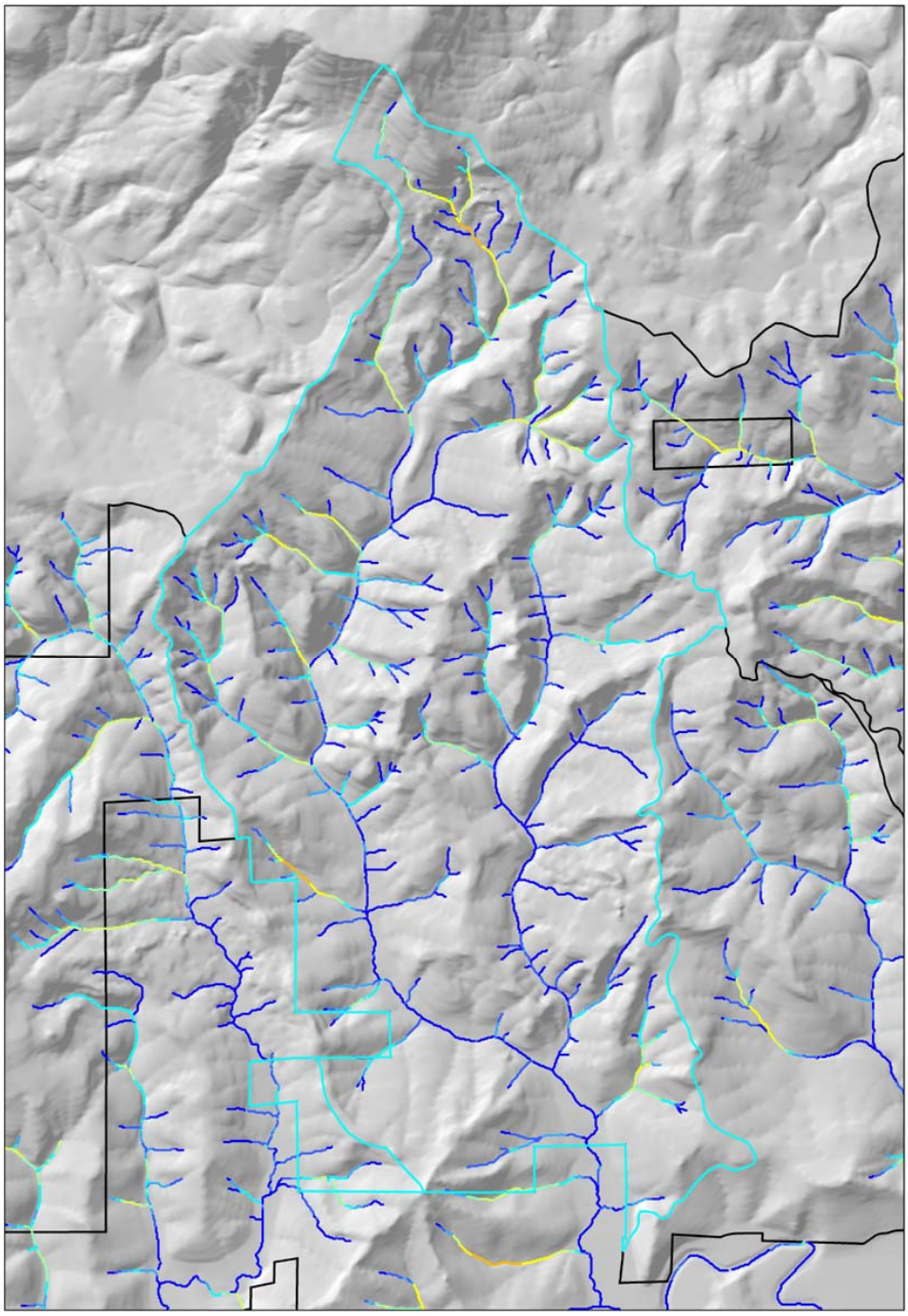


Figure 7-4. Predicted debris flow probability for the Northup Management Basin. Refer to the Legend in Figure 7-1. The predicted probabilities reflect cumulative landslide densities (that could trigger debris flows) and not individual pixel-based landslide potential shown in the landslide density map.

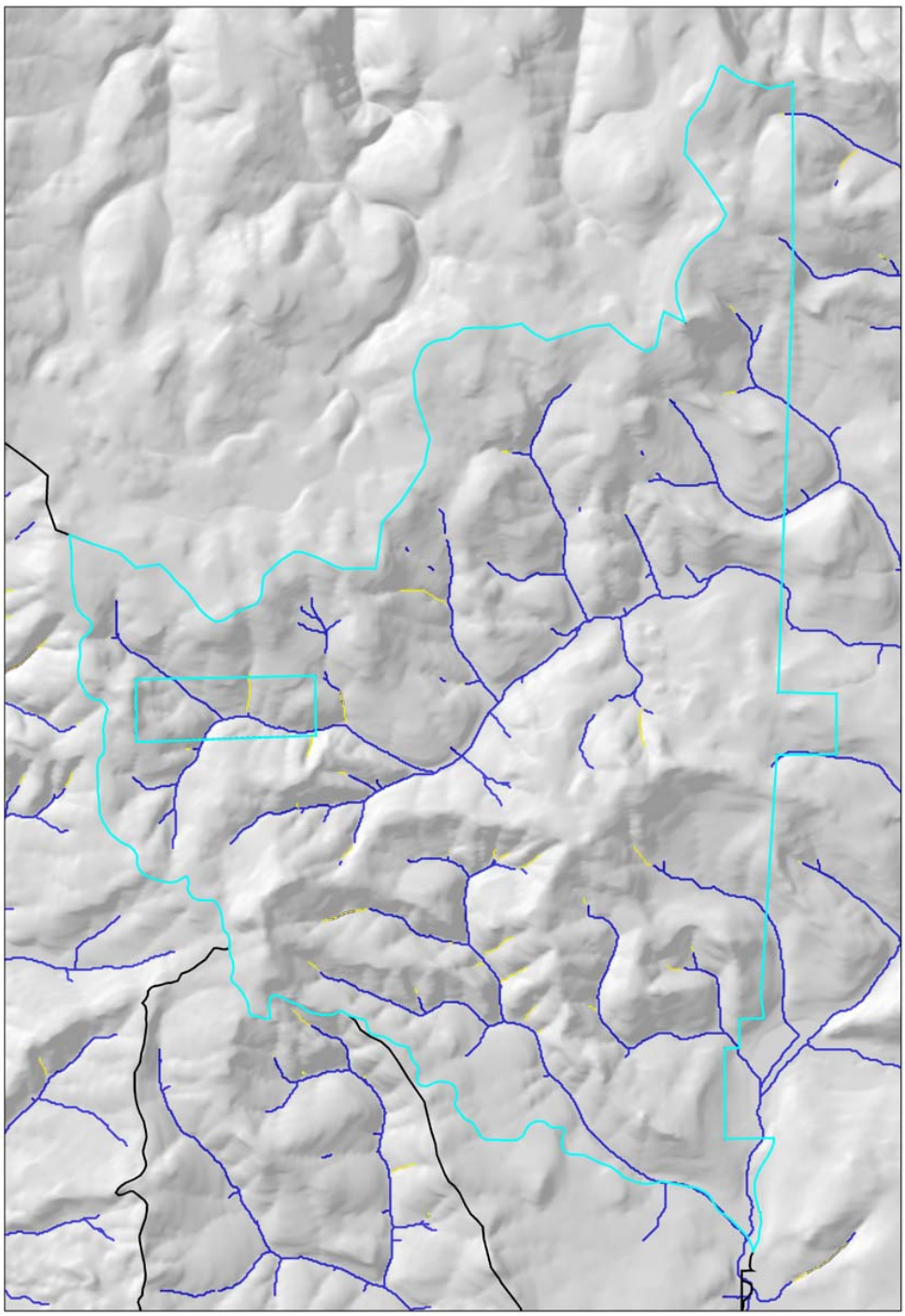


Figure 7-5. Headwater streams predicted to contribute wood to larger, fish-bearing streams in the Fishhawk Management Area. Refer to the Legend in Figure 7-1. The predicted probabilities reflect cumulative landslide densities (that could trigger debris flows) and not individual pixel-based landslide potential shown in the landslide density map.

7.2.4.4 Comparison Among Basins

There is significant variability across the Nehalem study area in predicted slope stability (as illustrated in the landslide density predictions) and debris flow potential. A plot of the cumulative distributions of debris flow probabilities illustrates the degree of variability at the HUC 6th field watersheds (Figure D-60, Appendix D). A visual display of this variability is shown in Figure D-61, Appendix D. The highest values (areas of the highest density of debris flow-prone channels) occur toward the western margin of the upper Nehalem watershed and decrease eastward.

It is important to stress the landslide modeling results indicated that the majority of the area encompassed by the Nehalem watershed analysis has a relatively low risk of landslides and debris flows. This result was due to the lack of very steep and highly convergent topography. Consequently, the risk posed by shallow landslides and debris flows to aquatic resources and water quality was low throughout much of the Nehalem study area. Fishhawk, Quartz, and Northup Management basins had the highest probabilities of shallow landslides and debris flows.

7.3 LOCATIONS OF GULLIES OR ACTIVE SURFACE EROSION

Critical question #3: "Are there any locations with gullies or other active surface erosion areas in the watershed (and map any locations)?

7.3.1 Overview

Active surface erosion can include gullies, small rills, and sheetwash. Active surface erosion in forested environments is generally associated with either direct runoff from roads, following fires on hydrophobic soils, or in areas cleared of vegetation (i.e., clearcuts). Gullies, rilling and sheetwash require overland flow, a process whereby infiltration capacity of the soil is less than rainfall intensity. This process is not common in forested humid landscapes where infiltration capacity is almost always higher than rainfall intensity. Based on 2005 road surveys of forest roads in the project area, gullies and other forms of surface erosion are not a significant issue in the Upper Nehalem. Road condition and drainage issues associated with roads are described in Chapter 8 – Road-Related Sediments.

7.4 DEEP-SEATED LANDSLIDES

Critical question #4: "Are there deep-seated, active or recently active moving landslides (map any locations)?

7.4.1 Overview

Deep-seated landslides may involve rapid displacement of large blocks or groups of blocks and the formation of debris flows. However, in other cases, movement may be slow or incremental (accelerated soil creep or strain). Subtle features, such as tension cracks and deformed trees, may characterize landslide activity. Some deep-seated landslides can contain both types of failures. Important environmental factors related to deep-seated landslides include soil and bedrock properties, soil depth, and both regional and local groundwater response to multi-year precipitation.

Deep rotational failures are typically triggered by the build up of pore water pressure in mechanically weak, and often clay rich rocks (Swanston 1974). Slumping involves the downward and backward rotation of a soil block or groups of blocks. The uppermost area of failure, where the soil breaks away from the slope, is often steep and generally bare of vegetation and the toe is hummocky or broken by individual slump blocks following the failure.

Deep-seated failures are often classified according to level of activity, such as active to recent, historical active, dormant young, and dormant mature (Cruden and Varnes 1996). Determining the potential effects of forestry activities on deep-seated failures often requires long-term detailed field monitoring (Swanston 1974) or a combination of aerial photographic interpretation and modeling (Miller 1995). In general, the role of forestry activities on deep-seated landslides in bedrock remains an open question. No general principles, such as the role of timber harvest on shallow failures in bedrock, exist.

7.4.2 Methods

Oregon Department of Forestry supplied the deep-seated landslide analysis that consisted of mapped landslides on GIS shape files (Figure D-62, Appendix D). The map shows the locations of deep-seated failures in bedrock and hence provides a general guide to this form of mass movement in the Nehalem watershed.

The following ODF methodology was used in the analysis of deep-seated failures for the Nehalem watershed analysis. Deep-seated, large-scale landslide landforms are often recognizable on topographic maps. With an understanding of scale and shape of large landslides, a geologist or other trained observer can recognize landforms that “might” be deep-seated, large-scale landslides. This type of mapping should be viewed much like a GIS screen, for possible areas of interest. This approach should not be considered highly accurate for including all possible large scale landslides (since the topographic map has limitations in accuracy). There is

no way to tell from the topography if features truly are of landslide origins. Obviously, the level of failure activity cannot be determined solely from topography viewed from maps or from aerial photography. The set of shapes drawn in the GIS for the Upper Nehalem Watershed Assessment represents a first approximation that is fairly good at the scale of large landslides and fairly poor for smaller landslide features.

The methodology for producing the landslide maps examines topography Digital Raster Graph (DRG) and draws polygons where a shape of large-scale landslide features exists. Landslide features are detected using the following attributes:

- Steep sloped areas often somewhat uniquely located and limited in length.
- Often arcuate or curvilinear (curved in = spoon shaped) at the up-slope end.
- Gentle slopes below the up-sloped end, typically hummock shaped.
- Lower slope often curved out (fan shaped), often with youthful drainage dissection.
- Toe of slope might be pushing the stream out along a fan-shaped toe.

In addition, the latest geology maps that cover the Tillamook Highlands (Wells et al. 1995) and the Astoria Basin (Niem and Niem 1992) *were* used to further identify large landslides. The geology maps that include "landslide deposits" designations were available where watersheds fall in areas where fairly recent, quadrangle-scale geologic mapping has been published.
All landslide debris map units including the shape and location of these features that were not picked up in the earlier process, were added to the Nehalem maps. The shape files were sent to the Districts. District personnel provided local knowledge concerning recent activity and added unmapped areas known to have recent movement.

7.4.3 Additional Information Needs

No other additional information is required for the development of a large-scale screening tool. However, small deep-seated landslides can only be detected using field surveys. These features, when encountered in the field by geologists or foresters, should be used to update the landslide database in GIS.

7.5 UNUSUALLY EROSION PRONE SOILS ON STEEP SLOPES

Critical question #5: "Are there any unusually erosion-prone soils on steep slopes (>79%) in the watershed (and map any locations)?

7.5.1 Overview

Erosion in this context can refer to either mass wasting or surface erosion and gullying. Soil type is believed to play a minor role in shallow landsliding in humid temperate landscapes, such as the Nehalem. Indeed, none of the major shallow landslide models commonly used in the Pacific Northwest Region, or in the Oregon Coast Range specifically, include a parameter for soil type.

Soil type is likely more important in the process of surface erosion. However, as described in the answer to critical question # 3 ("Are there locations with gullies or other active surface erosion areas in the watershed?"), surface erosion, with the exception of road-related erosion, is anticipated to be uncommon in the Nehalem watershed. This assumption is because most forest soils have surface infiltration capacities that exceed rainfall intensities and consequently overland flow is rarely generated.

7.5.2 Additional Information Needs

Areas with slope gradients greater than 79 percent are limited to very local areas based on 10-m digital elevation models. In general, soil surveys are conducted at large scales and are generally not of a sufficiently fine detail to link local areas of very steep slopes (i.e., > 79%) with soil mapping units.

The issue of mapping scale has led to the following caveat found in the Oregon Soils Atlas: "*The general soil map[s]…shows broad areas that have distinctive patterns of soils, relief, and drainage…The general soil map can be used to compare the suitability of large areas for general land uses…Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure….*"

Detailed, site-specific field surveys of steep slopes in the Nehalem watershed would be required to determine the erosion potential (either landslide or surface erosion) and sediment delivery potential of particular areas. It is recommended that erosion potential surveys be conducted on a site-by-site basis during the normal application of timber harvest activities. Because of the very large areas involved, such surveys are impractical during coarse-scale analyses, such as the Nehalem watershed analysis.

8. ROAD RELATED SEDIMENT SOURCES

Erosion near streams and surrounding areas occurs through various natural and human-induced processes. The focus of this section is to identify portions of road networks that currently affect or are prone to affect stream channel morphology, fish habitat, and fish passage due to road position or delivery of fine sediment to streams. In particular, this section attempts to address the following ODF questions regarding road and trail conditions.

ODF Questions:

1. *What proportion of road length is within 100 feet of streams?*
2. *What proportion of road related drainage ditches are hydrologically connected to the stream network?*
3. *What roads are in critical locations?*
4. *What roads have road prism instability, including sidecast/fill landslides?*
5. *How many stream crossings are barriers to fish passage?*
6. *Are road washouts of stream crossing fills present in the project area?*
7. *Do recreation trails contribute to sediment or erosion problems?*
8. *What proportion of the project area is non-forested due to forest roads?*

8.1 METHODS

Three previously completed OWEB watershed assessments cover portions of the current Upper Nehalem Project Area: Nehalem River Watershed Assessment (Johnson and Maser 2000), Lower Columbia-Clatskanie Watershed Assessment (Rule 2001) and Young's Bay Watershed Assessment (E&S Water Chemistry Inc. and Young's Bay Watershed Council 2000). These documents provide additional descriptions of road location and condition within each watershed.

The ODF Roads Information Management System (RIMS) database was utilized in conjunction with available stream layers to address the questions provided. The RIMS data was collected in 2005 by ODF; surveys covered all accessible forest roads within the Upper Nehalem Project Area maintained by ODF.

For the purposes of this analysis, stream adjacent roads were defined as roads within 100 feet of a stream with an identifiable bed and banks. Stream adjacent roads were identified using RIMS critical road location and road crossing data. Critical road location types included streams

paralleling road segments within 100 feet and road segments identified to have diverted streamflow in a roadside drainage ditch. Culvert and bridge crossings of streams recorded during the RIMS field surveys and the length of stream adjacent road associated with each crossing was estimated at 250 feet. Total stream adjacent road length within the Project Area was calculated by adding the stream adjacent road lengths associated with stream crossings with stream adjacent road lengths from the critical road location data layer. Percent road length adjacent to streams was calculated using the total length of roads surveyed during 2005 RIMS surveys. Stream adjacent road lengths were calculated by management basin and 6th Field HUC.

Hydrological connectivity of road drainage systems to stream systems was verified during RIMS field surveys and included in the RIMS road drainage data layer. Road sections in this data layer were sorted based on hydrologic connectivity, and the associated road length was tallied according to Management Basin and 6th Field HUC. Road drainage conditions were assessed in the project area during the 2005 RIMS surveys using Attention Priority (AP) codes, which rate the road drainage condition on a scale of 1 to 5, with a rating of 1 indicating highest priority for maintenance attention. Road drainage AP codes are described below. The percent of road length in the project area by AP code rating was calculated using the RIMS road drainage layer. The roads drainage analyses were completed based on the total length of road surveyed in the 2005 RIMS field surveys.

<u>Road Drainage AP Codes</u>

> *AP Code 1* – Road surface drainage is not controlled; surface water is causing severe erosion of road prism and needs immediate attention, unsafe to drive.
>
> *AP Code 2* – Road surface drainage is not controlled; surface water is causing moderate erosion of road, needs attention in next dry period.
>
> *AP Code 3* – Road surface drainage is poorly controlled, potential to cause erosion of road prism or weakness in road surface, needs attention before next wet season.
>
> *AP Code 4* – Road surface is not draining fully, however impairment is minor and does affect water quality or need immediate attention.
>
> *AP Code 5* – Surface drainage is functioning perfectly.

Road locations in the Upper Nehalem Project Area with inherent resource risk were identified during RIMS field surveys, and classified by stream-related, slope-related, and non-critical risk categories. Critical road locations were mapped by location type and the percent length of roads

was calculated by critical location type using these data from the RIMS critical road location data layer. The RIMS critical locations are described below.

Stream-Related Critical Road Locations

Canyon fill. The road is in a steep, narrow canyon, with high cuts and fills crowding the stream in places.

Channel fill. Road is next to and sometimes crowding stream, however is in a generally stable location.

Stream in ditch. Stream has been diverted down a roadside ditch.

Stream parallel. Road generally parallel to stream and toe of fill averages within 100 feet of stream. No fill in channel.

Wetland adjacent. Road crosses a wetland.

Slope-Related Critical Road Locations

Sidecast/fill slides. Failures of both cut and steep sidecast slopes are present; difficult to stabilize road.

Fill slides. Sidecast slope failures are present along road segment, cutslope stable.

Deep Active Slide. Road prism has moved due to deep active slide.

Steep fill. Sidecast constructed road fill placed on natural slopes that are over 65 percent, with a resulting slope of over 75 percent. No significant slides are present.

Deep inactive slide. Road construction has cut toe of old, inactive slide.

Steep full-bench. Road constructed with full bench end haul (no fill) or effective pullback of roadside fill is apparent.

Non-Critical Road Locations

Non-critical. Any road not in one of the above locations. Slopes of road are stable and at least 100 feet from streams and do not cross wetlands, which is common for slopes less than 50 percent.

The stability of road prisms in the project area, including the presence of sidecast/fill and fill landslides was assessed using the RIMS road prism data layer. The percent length road located in sidecast/fill and fill slides was calculated based on the total length of forest roads surveyed. Road prism condition was assessed in the project area during the 2005 RIMS surveys using AP codes. The percent road length located in the project area by AP code rating was calculated using the RIMS road drainage data layer.

Road Prism AP Codes

AP Code 1 – Landslide involving most or all of road prism has closed road, geotechnical investigation and major reconstruction required to reopen road.

AP Code 2 – Arcuate cracks or other landslide has reduced road width; pullback and road widening may be necessary.

AP Code 3 – Road has serious surface erosion or minor cutback slump.

AP Code 4 – Minor surface erosion; bare soil slopes on a substantial minority of cutslope.

AP Code 5 – Road prism is vegetated, or rocked and is stable with little erosion.

The fish passage condition of stream crossings in the project area was summarized using RIMS stream crossings data. Stream crossings were surveyed for fish passage and were classified as adult barrier, juvenile barrier, or fully passable. Culvert passage condition and stream type data (i.e., known fish use, likely fish use, no fish use or unknown) at each crossing were summarized by management basin. Known fish presence determinations were based primarily on ODFW surveys or other direct observation. For streams in which fish presence has not been verified, presence was based on physical stream characteristics such as stream size and gradient. Fish presence will need to be validated in streams assessed to have likely and unknown fish presence.

Diversion and washout risk were evaluated during RIMS surveys and classified at each stream crossing as washed out or as high, moderate, or low risk of washout based on road and culvert conditions, including slope, culvert size, amount of road fill present, and presence of bank armoring. These two attributes were summarized using the stream crossings data layer.

Recreational hiking and all-terrain vehicle (ATV) trails are present within the project area but were not surveyed during 2005 RIMS surveys. Trail lengths and descriptions of locations by Management Basin and 6th Field HUC were completed using a data layer of the recreational trail distribution within the Project Area.

The non-forested area in the Upper Nehalem Project Area dedicated to roads (permanent non-forested) was calculated using measured road widths and lengths recorded for all surveyed road segments during 2005 RIMS surveys. Road width was obtained using sub-grade and cutslope widths. For the small proportion of forest roads not surveyed during the 2005 RIMS surveys, an average width was applied to the total length of unsurveyed roads obtained from the ODF GIS roads layer.

8.2 RESULTS

8.2.1 Stream Adjacent Roads

There are approximately 607 miles of active forest road managed by ODF within the project Area. Of this total length, approximately 53.8 miles (8.8%) are stream adjacent. The proportion of stream adjacent roads within the project area are presented by management basin and 6th field HUC in Tables 8-1 and 8-2, respectively.

Table 8-1. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by management basin.

Management Basin	Stream Type[1]	Stream Size	Road Length (mi)	Percentage of Total Road Length
Fishhawk	Fish	Large	0.1	0.2%
	Fish	Medium	0.2	0.6%
	Non-fish	Unknown	<0.1	0.2%
	Unknown	Unknown	1.0	3.0%
Total			***1.3***	***4.1%***
Northrup	Fish	Large	0.8	2.0%
	Unknown	Unknown	1.0	2.7%
Total			***1.8***	***5.6%***
Beneke	Fish	Medium	0.4	0.8%
	Fish	Unknown	0.1	0.2%
	Non-fish	Unknown	<0.1	0.1%
	Unknown	Unknown	3.7	8.0%
Total			***4.2***	***9.1%***
Lousignot	Fish	Large	<0.1	<0.1%
	Fish	Medium	0.2	0.9%
	Fish	Unknown	0.1	0.5%
	Non-fish	Unknown	0.6	2.3%
	Unknown	Unknown	1.2	4.5%
Total			***2.3***	***8.4%***

Table 8-1. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by management basin.

Management Basin	Stream Type[1]	Stream Size	Road Length (mi)	Percentage of Total Road Length
Hamilton	Fish	Large	0.8	2.1%
	Fish	Medium	0.1	0.4%
	Fish	Small	0.2	0.5%
	Fish	Unknown	0.7	1.8%
	Non-fish	Unknown	0.4	1.2%
	Unknown	Unknown	6.0	16.0%
Total			***8.2***	***22.0%***
Crawford	Fish	Medium	0.2	1.0%
	Unknown	Unknown	1.9	7.5%
Total			***2.1***	***8.3%***
Sager	Fish	Large	0.1	0.1%
	Fish	Medium	0.4	0.6%
	Fish	Unknown	0.1	0.2%
	Non-fish	Unknown	0.2	0.3%
	Unknown	Unknown	2.7	4.1%
Total			***3.5***	***5.3%***
Buster	Fish	Large	1.8	1.8%
	Fish	Medium	0.6	0.6%
	Fish	Small	<0.1	<0.1%
	Fish	Unknown	0.3	0.3%
	Non-fish	Unknown	0.5	0.4%
	Unknown	Unknown	4.9	4.7%
Total			***8.2***	***7.9%***
Quartz	Fish	Medium	0.3	0.6%
	Fish	Small	<0.1	0.1%
	Fish	Unknown	0.3	0.5%
	Non-fish	Unknown	0.5	1.0%
	Unknown	Unknown	3.1	6.1%
Total			***4.2***	***8.2%***
McGregor	Fish	Large	0.1	0.2%
	Fish	Medium	<0.1	0.1%
	Fish	Small	0.9	1.5%
	Non-fish	Medium	0.1	0.2%
	Non-fish	Small	3.2	5.4%
	Non-fish	Unknown	0.1	0.2%
	Unknown	Unknown	0.2	0.4%
Total			***4.7***	***8.0%***

Table 8-1. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by management basin.

Management Basin	Stream Type[1]	Stream Size	Road Length (mi)	Percentage of Total Road Length
Wheeler	Fish	Large	1.6	1.7%
	Fish	Medium	1.7	1.8%
	Fish	Small	1.6	1.7%
	Non-fish	Small	5.4	5.8%
	Unknown	Unknown	0.8	0.8%
Total			***11.0***	***11.9%***
Wilark	Fish	Medium	0.2	0.7%
	Fish	Small	1.5	5.3%
	Non-fish	Small	0.4	1.3%
	Unknown	Unknown	0.2	0.8%
Total			***2.3***	***8.1%***
Project Total			***53.8***	***8.8%***

1 Stream types include fish bearing (Fish), non-fish bearing (Non-Fish), and unknown fish presence (Unknown)

Table 8-2. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by 6th Field HUC[1].

Sixth Field HUC[1]	Stream Type[2]	Stream Size	Road Length (mi)	Percentage of Total Road Length in HUC
HUC 171002020101	Fish	Large	1.2	1.7%
	Fish	Medium	1.3	1.8%
	Fish	Small	1.4	1.9%
	Non-fish	Small	3.8	5.3%
	Unknown	Unknown	0.5	0.8%
Total			***8.2***	***11.6%***
HUC 171002020102	Fish	Large	0.1	0.5%
	Fish	Medium	0.1	0.3%
	Fish	Small	0.3	1.0%
	Non-fish	Small	1.0	3.2%
	Unknown	Unknown	0.2	0.8%
Total			***1.8***	***5.8%***
HUC 171002020103	Fish	Medium	<0.1	0.2%
	Fish	Small	0.1	0.6%
	Non-fish	Medium	0.1	0.6%
	Non-fish	Small	1.7	10.5%
	Unknown	Unknown	0.1	0.5%
Total			***1.9***	***12.3%***
HUC 171002020105	Fish	Large	0.4	0.9%
	Fish	Medium	0.6	1.3%
	Fish	Small	0.3	0.7%
	Fish	Unknown	0.1	0.2%
	Non-fish	Small	1.7	3.8%
	Non-fish	Unknown	0.1	0.2%
	Unknown	Unknown	1.5	3.4%
Total			***4.8***	***10.5%***
HUC 171002020106	Fish	Small	0.4	2.1%
	Non-fish	Small	0.4	2.0%
	Unknown	Unknown	0.3	1.3%
Total			***1.0***	***5.4%***
HUC 171002020107	Unknown	Unknown	0.3	6.1%
HUC 171002020203	Fish	Medium	0.2	1.1%
	Fish	Small	0.7	4.2%
	Non-fish	Small	0.3	1.7%
	Unknown	Unknown	0.2	1.4%

Table 8-2. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by 6th Field HUC[1].

Sixth Field HUC[1]	Stream Type[2]	Stream Size	Road Length (mi)	Percentage of Total Road Length in HUC
Total			***1.4***	***8.5%***
HUC 171002020205	Fish	Large	0.1	0.2%
	Fish	Medium	0.3	0.8%
	Non-fish	Unknown	<0.1	0.1%
	Unknown	Unknown	1.3	3.2%
Total			***1.8***	***4.4%***
HUC 171002020206	Fish	Medium	0.2	0.9%
	Fish	Unknown	0.1	0.6%
	Unknown	Unknown	0.6	2.7%
Total			***1.0***	***4.2%***
HUC 171002020208	Fish	Large	0.9	1.0%
	Fish	Medium	0.3	0.4%
	Fish	Unknown	<0.1	0.2%
	Non-fish	Unknown	0.7	0.9%
	Unknown	Unknown	2.6	3.2%
Total			***4.7***	***5.7%***
HUC 171002020301	Fish	Medium	0.2	0.9%
	Non-fish	Unknown	<0.1	0.2%
	Unknown	Unknown	1.5	5.3%
Total			***1.8***	***6.4%***
HUC 171002020302	Fish	Medium	0.4	0.7%
	Fish	Unknown	0.1	0.2%
	Non-fish	Unknown	<0.1	0.1%
	Unknown	Unknown	4.8	9.0%
Total			***5.3***	***9.9%***
HUC 171002020303	Fish	Large	0.8	2.2%
	Fish	Medium	0.1	0.4%
	Fish	Small	0.1	0.4%
	Fish	Unknown	0.6	1.7%
	Non-fish	Unknown	0.4	1.2%
	Unknown	Unknown	5.6	16.2%
Total			***7.7***	***22.1%***

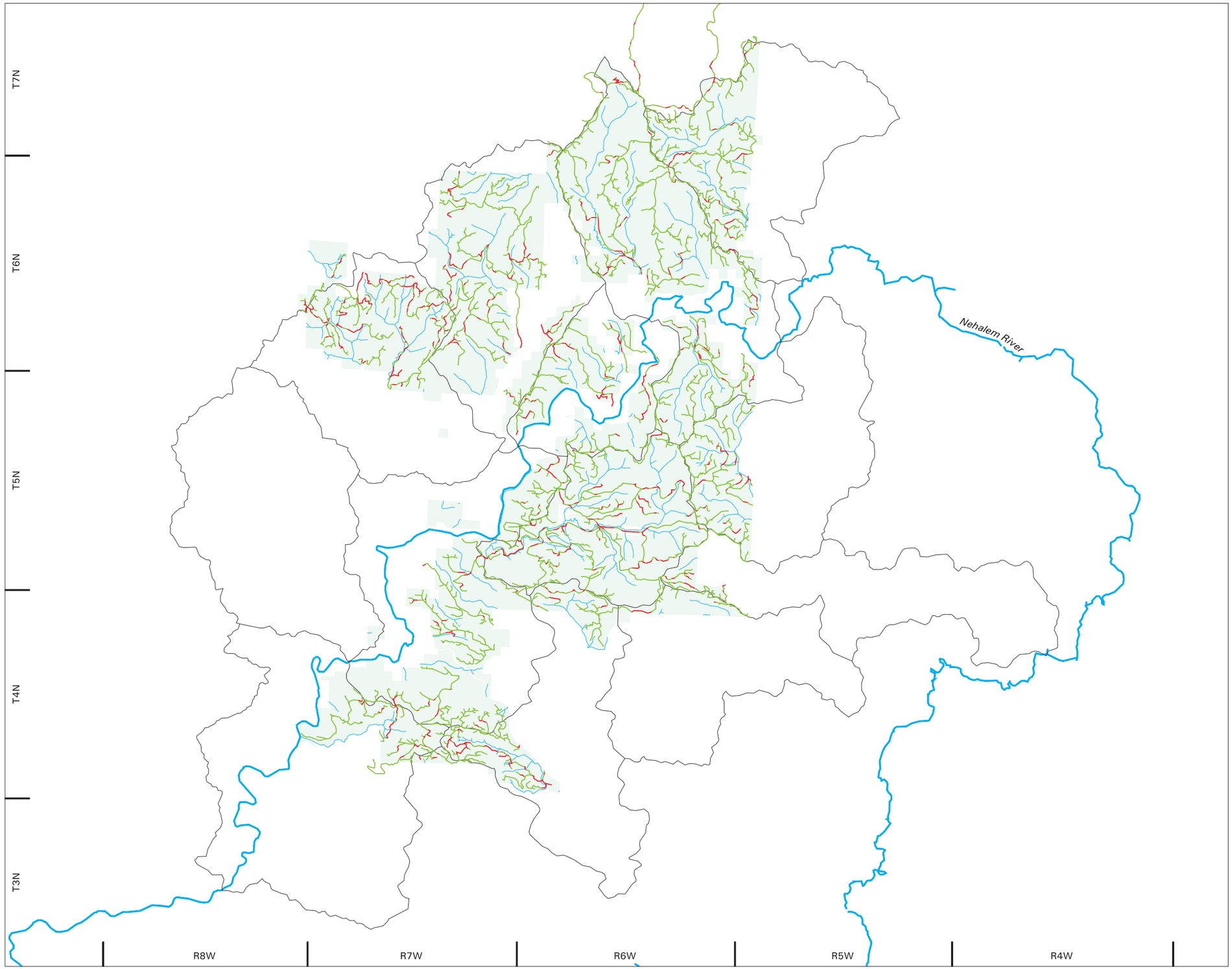
Table 8-2. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by 6th Field HUC[1].

Sixth Field HUC[1]	Stream Type[2]	Stream Size	Road Length (mi)	Percentage of Total Road Length in HUC
HUC 171002020304	Fish	Large	1.8	3.0%
	Fish	Medium	0.4	0.6%
	Fish	Small	<0.1	<0.1%
	Fish	Unknown	0.3	0.5%
	Non-fish	Unknown	0.5	0.7%
	Unknown	Unknown	2.8	4.7%
Total			***5.8***	***9.6%***
HUC 171002020305	Fish	Medium	0.3	0.5%
	Fish	Small	<0.1	0.1%
	Non-fish	Unknown	0.3	0.7%
	Unknown	Unknown	2.8	5.6%
Total			***3.4***	***7.0%***
HUC 171002020307	Fish	Medium	<0.1	0.3%
	Fish	Unknown	0.2	1.0%
	Non-fish	Unknown	0.1	0.9%
	Unknown	Unknown	1.0	6.6%
Total			***1.4***	***8.7%***
HUC 171002020402	Unknown	Unknown	0.2	6.9%
Clatskanie Watershed	Fish	Small	0.8	6.8%
	Non-Fish	Small	0.1	0.8%
Total			***0.9***	***7.7%***
Young's Bay Watershed	Fish	Small	<0.1	2.0%
	Fish	Unknown	0.1	3.2%
	Unknown	Unknown	0.3	13.2%
Total			***0.4***	***17.9%***
Project Total			***53.8***	***8.8%***

1 6th field HUC is a USGS Hydrologic Unit Code designating a subwatershed.
2 Stream types include fish bearing (Fish), non-fish bearing (Non-Fish), and unknown fish presence (Unknown)

8.2.2 Road Drainage

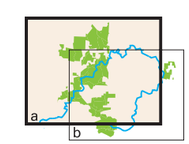
There are approximately 607 miles of forest road in the project area. Drainage for approximately 96 miles (15.8%) of forest road within the project area was assessed to have direct hydrologic connection to streams. Hydrologic connectivity of road drainage is summarized in Figure 8-1a,b



Legend

- Hydrologically Connected Road Segment
- Unconnected Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

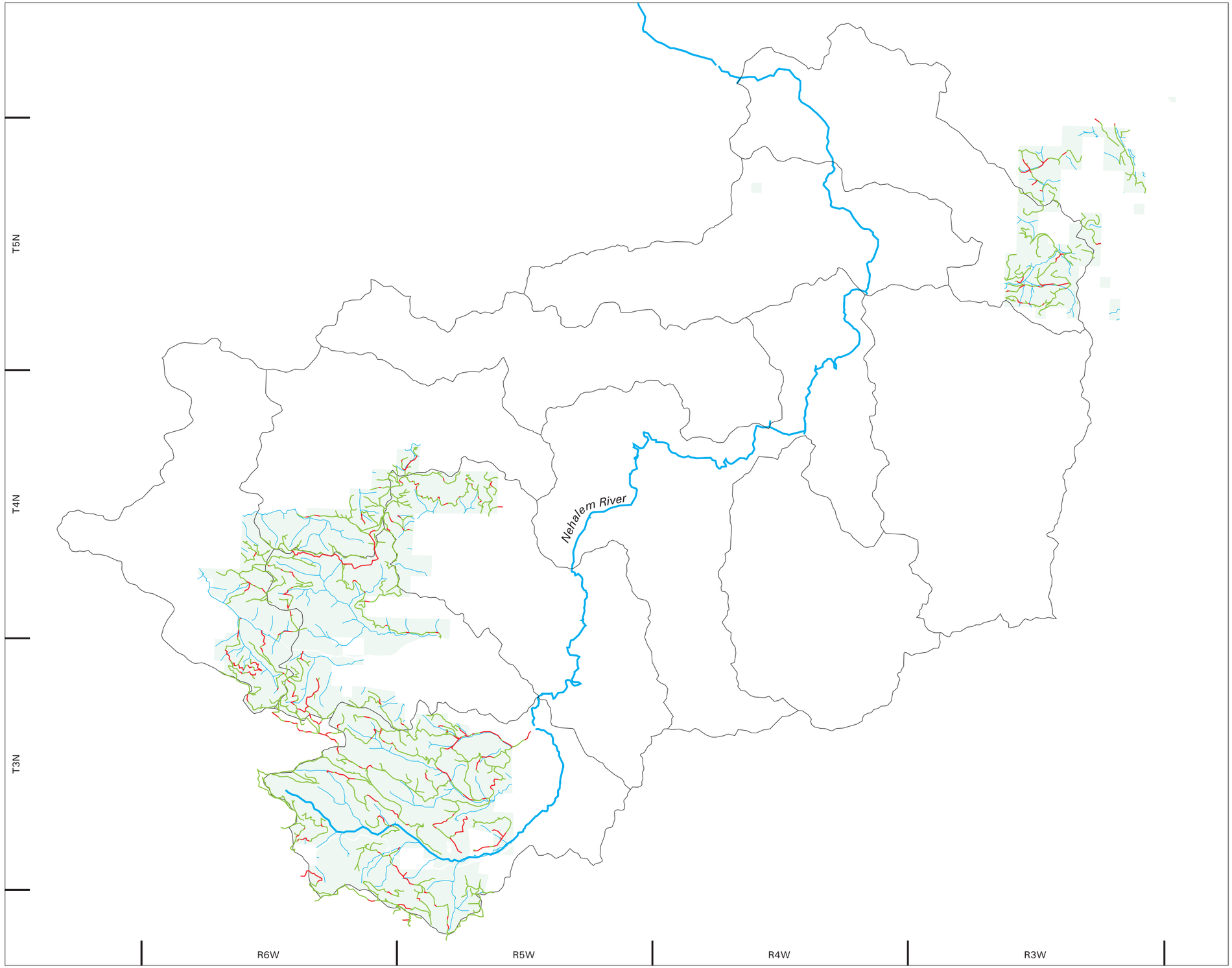
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-1(a)

Hydrologically Connected Road Drainage

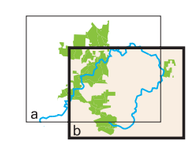
Astoria District



Legend

- Hydrologically Connected Road Segment
- Unconnected Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.3 Miles

0 2

Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-1(b)

Hydrologically Connected Road Drainage

Forest Grove District

and Tables 8-3 and 8-4. The majority (67.4%) of forest roads in the project area were identified to have drainage AP code 5, indicating perfectly functioning road drainage (Table 8-5).

Table 8-3. Length and percentage of forest roads on ODF lands in the Upper Nehalem Watershed Analysis area in which the drainage system is directly connected to streams, by management basin.

Management Basin	Road Length (mi)	Percentage of Total Road Length
Fishhawk	2.6	8.2%
Northrup	3.9	10.3%
Beneke	7.6	16.4%
Lousignot	2.6	9.5%
Hamilton	11.3	30.4%
Crawford	5.3	20.9%
Sager	8.0	12.1%
Buster	16.1	15.6%
Quartz	8.5	16.6%
McGregor	8.5	14.5%
Wheeler	18.2	19.6%
Wilark	3.4	11.9%
Project Area Total	***96.0***	***15.8%***

Table 8-4. Length and percentage of forest roads on ODF lands in the Upper Nehalem Watershed Analysis area in which the drainage system is directly connected to streams, by 6th Field HUC.[1]

Sixth Field HUC[1]	Road Length (mi)	Percentage of Total Road Length
HUC 171002020101	12.9	18.3%
HUC 171002020102	6.3	20.5%
HUC 171002020103	1.6	10.0%
HUC 171002020105	9.5	20.8%
HUC 171002020106	2.4	12.6%
HUC 171002020107	1.0	20.3%
HUC 171002020203	1.8	11.0%
HUC 171002020205	3.6	8.9%
HUC 171002020206	2.6	11.3%
HUC 171002020208	7.9	9.7%
HUC 171002020301	5.4	19.5%
HUC 171002020302	9.1	17.1%
HUC 171002020303	10.6	30.4%
HUC 171002020304	11.4	18.8%
HUC 171002020305	4.8	9.8%
HUC 171002020307	2.4	15.5%
HUC 171002020402	0.3	10.9%
Clatskanie Watershed	1.5	13.0%
Young's Bay Watershed	0.7	30.2%
Project Area Total	***96.0***	***15.8%***

1 Sixth field HUC is a USGS Hydrologic Unit Code designating a subwatershed.

Table 8-5. Length and percentage of road associated with each road drainage AP code in the Upper Nehalem Project Area.

Road Drainage AP Code	Road Length (Mi)	Percentage of Total Roads
AP Code 1	0.3	<0.1%
AP Code 2	2.0	0.3%
AP Code 3	10.5	1.6%
AP Code 4	203.7	30.7%
AP Code 5	448.0	67.4%

8.2.3 Critical Road Locations

Critical road locations identified within the project area included roads with sidecast/fill slides, fill slides, stream in ditch, stream parallel roads, wetland adjacent roads, roads with steep fill, and roads with steep full-bench. Canyon fill, channel fill, deep active slide and deep inactive slide road types were not observed in the project area. The total length of critical roads identified in the project area is 33.6 miles, or approximately 5.5 percent of the total road length (Table 8-6). The vast majority of roads (94.4%) in the project area were designated non-critical during 2005 RIMS surveys. The roads with the greatest length of road in critical location are BU Road in the Buster Management Basin, which has 1.75 miles of stream parallel road, and NLOU Road in the Wheeler Management Basin, with 1.36 miles of stream parallel and steep fill roads. The types and locations of critical roads within the Upper Nehalem project area are identified in Figure 8-2a,b.

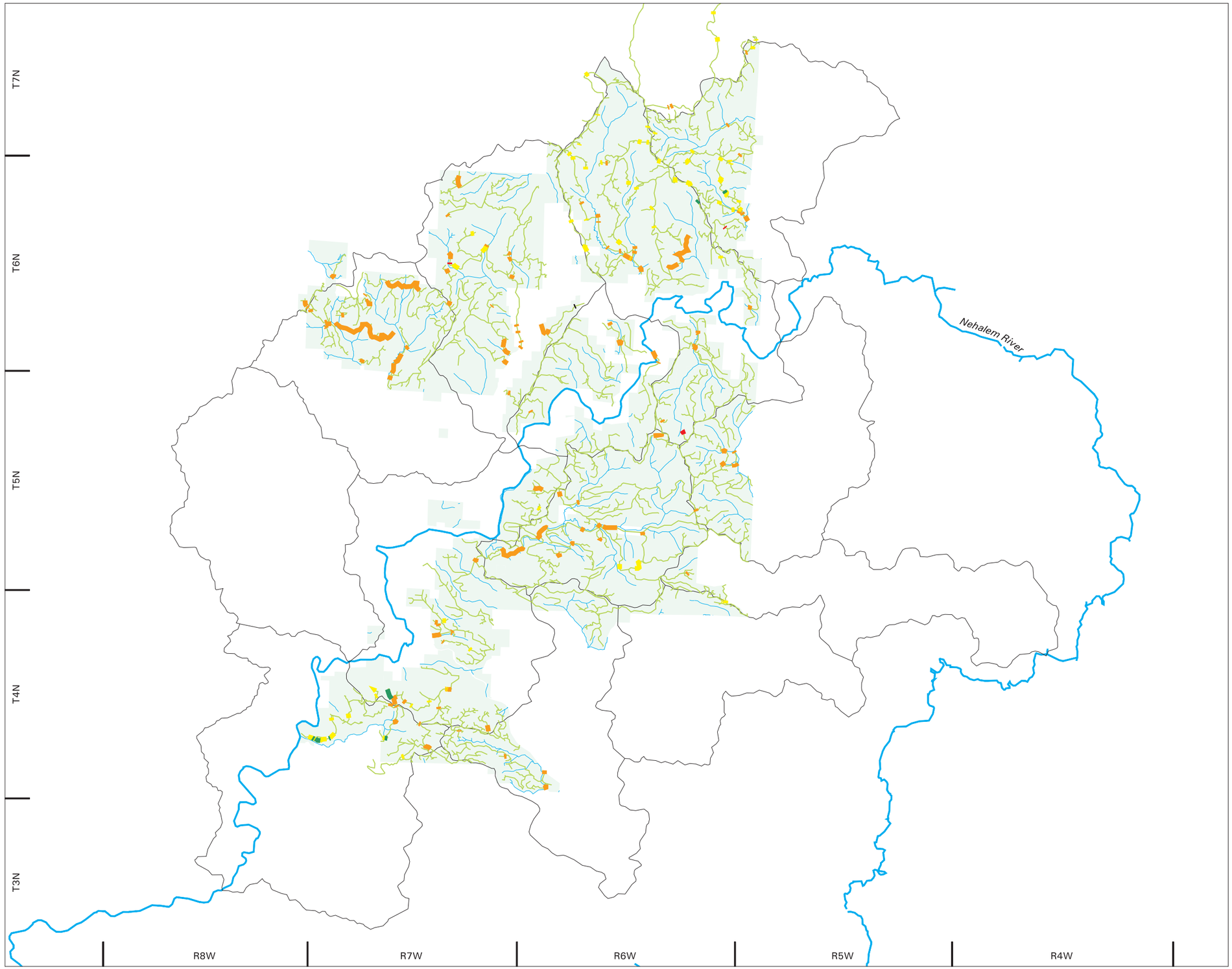
Table 8-6. Length and percentage of road associated with each critical and non-critical road location type in the Upper Nehalem Project Area.

Road Location Type	Road Length (Mi)	Percentage of Total Roads
Critical Roads		
Sidecast/Fill Slide	0.11	<0.1%
Fill Slide	0.16	<0.1%
Stream in ditch	0.01	<0.1%
Stream parallel[1]	25.12	4.1%
Wetland adjacent	0.09	<0.1%
Steep fill	7.16	1.2%
Steep full-bench	0.98	0.2%
Total Critical Roads	*33.6*	*5.5%*
Non-Critical Roads	573.3	94.4%

[1] Stream adjacent roads considered in Section 8.2.1 include mileage associated with stream parallel roads and stream crossings.

8.2.4 Road Prism Stability

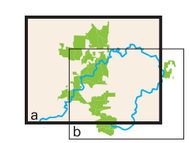
A total of five road sections in the Upper Nehalem Project Area, totaling approximately 0.26 mile, are located in sidecast/fill or fill slides (Table 8-7). Approximately 67 percent of road prisms in the project area were assessed to be stable, with a road prism AP Code 5, and an



Legend

- Cut/Fill Slide
- Fill Slide
- Stream in Ditch
- Stream Parallel
- Wetland
- Steep Fill
- Steep Full-Bench
- Non-Critical Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

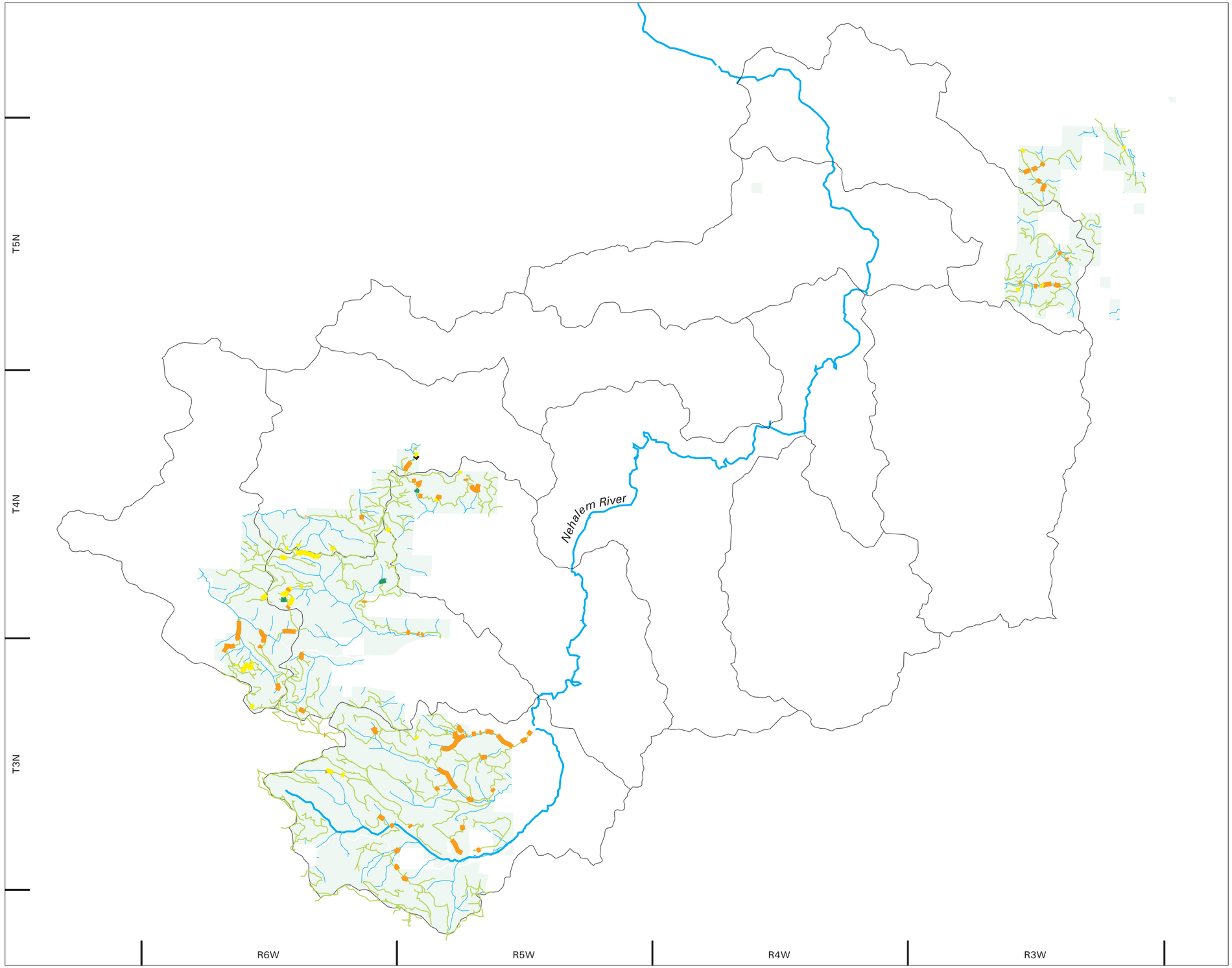
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-2(a)

Critical Road Types and Locations

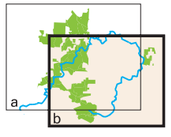
Astoria District



Legend

- Cut/Fill Slide
- Fill Slide
- Stream in Ditch
- Stream Parallel
- Wetland
- Steep Fill
- Steep Full-Bench
- Non-Critical Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.3 Miles

0 2

Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-2(b)

Critical Road Types and Locations

Forest Grove District

additional 30 percent was identified to have only minor bare soil exposure on the cutslope only (Table 8-8).

Table 8-7. Location and length of critical road sections in the Upper Nehalem Project Area with sidecast/fill and fill slide conditions.

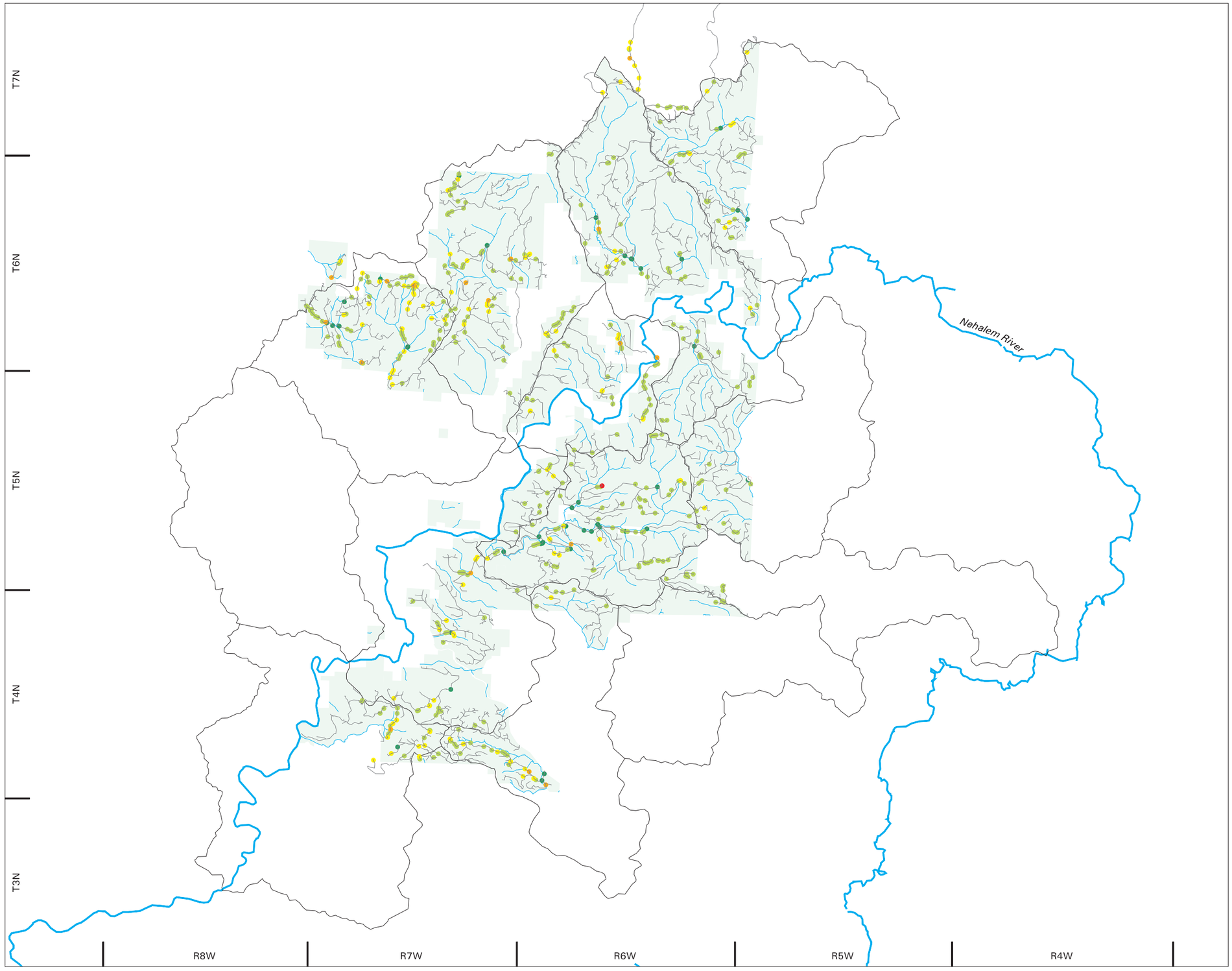
Management Basin	Road Name	Road Location (Road Mile)	Road Length (Mi)	Critical Road Type
McGregor	Lower Rock Creek	0.54	0.09	Sidecast/fill slide
Crawford	Crawford Ridge 14010	1.21	0.02	Sidecast/fill slide
Sager	East Sager Vacated 3	0.23	0.10	Fill slide
Beneke	Beneke Vacated 1	0.45	0.03	Fill slide
Lousignot	Vesper Spur 16850	0.08	0.02	Fill slide

Table 8-8. Length and percentage of road associated with each road prism stability AP code in the Upper Nehalem Project Area.

Road Drainage AP Code	Road Length (Mi)	Percentage of Total Roads
AP Code 1	n/a	n/a
AP Code 2	0.2	0.1%
AP Code 3	16.7	2.5%
AP Code 4	200.8	30.2%
AP Code 5	446.3	67.2%

8.2.5 Stream Crossings

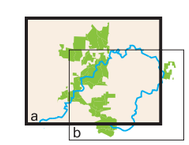
A total of 720 stream crossings were identified within the Upper Nehalem Project Area. Of this total, three stream crossings identified as barriers occur on known fish bearing streams, while 559 crossings were assessed to have no fish passage restriction. A summary of fish passage at stream crossings within the project area is provided in Figure 8-3a,b and Table 8-9.



Legend

- Known Fish Passage Barrier
- Likely Fish Passage Barrier
- Possible Fish Passage Barrier
- Known Fish Absence
- Full Fish Passage
- RIMS Road Network
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

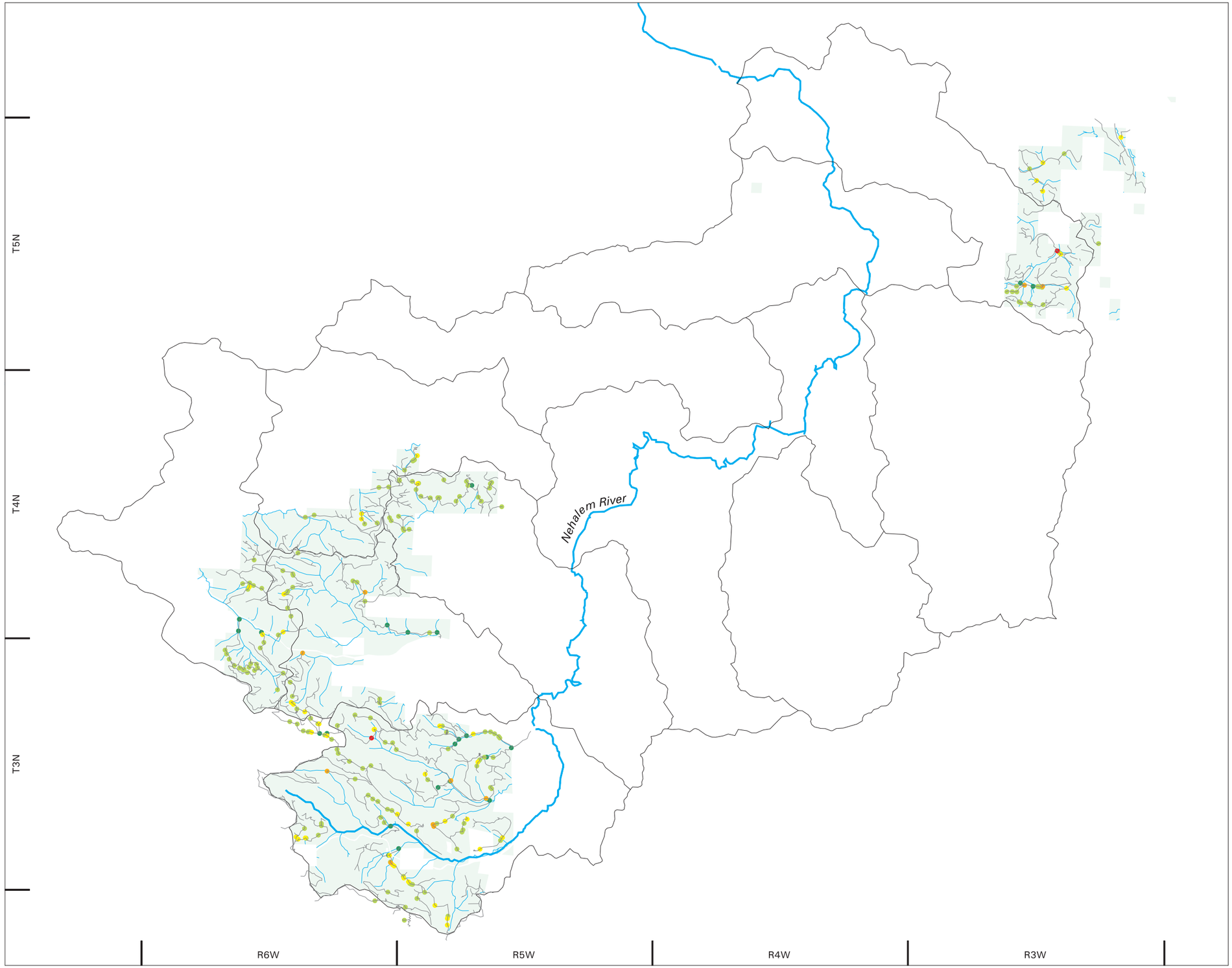
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-3(a)

Fish Passage Condition

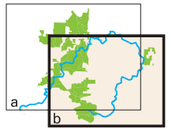
Astoria District



Legend

- Known Fish Passage Barrier
- Likely Fish Passage Barrier
- Possible Fish Passage Barrier
- Known Fish Absence
- Full Fish Passage
- RIMS Road Network
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.3 Miles

0 2

Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-3(b)

Fish Passage Condition

Forest Grove District

Table 8-9. Number and type of fish passage barriers at stream crossings within the project area by management basin.

Fish Presence Condition	Barrier Type[1]			
	Known Barriers	**Likely Barriers**	**Possible Barriers**	**No Passage Restriction[2]**
Fishhawk Mgt Basin				
Adult and Juvenile	0	0	1	2
Juvenile Only	0	0	4	-
No fish	-	-	-	13
Total	***0***	***0***	***5***	***15***
Northrup Mgt Basin				
Adult and Juvenile	0	0	1	5
Juvenile Only	0	1	3	-
No fish	-	-	-	15
Total	***0***	***1***	***4***	***20***
Beneke Mgt Basin				
Adult and Juvenile	0	0	4	2
Juvenile Only	0	3	8	-
No fish	-	-	-	42
Total	***0***	***3***	***12***	***44***
Lousignot Mgt Basin				
Adult and Juvenile	0	0	2	2
Juvenile Only	0	0	1	-
No fish	-	-	-	16
Total	***0***	***0***	***3***	***18***
Hamilton Mgt Basin				
Adult and Juvenile	0	4	10	7
Juvenile Only	0	1	13	-
No fish	-	-	-	50
Total	***0***	***5***	***23***	***57***
Crawford Mgt Basin				
Adult and Juvenile	0	1	5	0
Juvenile Only	0	0	5	-
No fish	-	-	-	22
Total	***0***	***1***	***10***	***22***
Sager Mgt Basin				
Adult and Juvenile	0	0	2	2
Juvenile Only	0	0	2	-
No fish	-	-	-	48
Total	***0***	***0***	***4***	***50***

Table 8-9. Number and type of fish passage barriers at stream crossings within the project area by management basin.

Fish Presence Condition	Barrier Type[1]			
	Known Barriers	**Likely Barriers**	**Possible Barriers**	**No Passage Restriction[2]**
Buster Mgt Basin				
Adult and Juvenile	0	1	10	16
Juvenile Only	1	1	5	-
No fish	-	-	-	100
Total	***1***	***2***	***15***	***116***
Quartz Mgt Basin				
Adult and Juvenile	0	1	4	5
Juvenile Only	0	2	14	-
No fish	-	-	-	41
Total	***0***	***3***	***18***	***46***
McGregor Mgt Basin				
Adult and Juvenile	0	0	5	4
Juvenile Only	0	1	2	-
No fish	-	-	-	55
Total	***0***	***1***	***7***	***59***
Wheeler Mgt Basin				
Adult and Juvenile	0	3	12	14
Juvenile Only	1	4	14	-
No fish	-	-	-	80
Total	***1***	***7***	***26***	***94***
Wilark Mgt Basin				
Adult and Juvenile	0	0	4	2
Juvenile Only	1	2	2	-
No fish	-	-	-	16
Total	***1***	***2***	***6***	***18***
Project Total	***3***	***25***	***133***	***559***

1 Known barriers represent barriers on known fish bearing streams.
Likely barriers represent barriers on likely fish bearing streams.
Possible barriers represent barriers on streams of unknown fish presence.
On streams with known fish absence, fish passage is not applicable

2 No passage restrictions represent crossings that do not impede fish movement, including crossings that allow full fish passage on known, likely, and unknown fish bearing streams and all crossings on streams with known fish absence.

Of the 720 stream crossings within the project area, eight were determined to be at high risk of washout while 484 were assessed to be at low risk of washout. No washouts were recorded at stream crossing assessed during RIMS surveys. A summary of washout risk at stream crossings within the project area is provided in Table 8-10.

Table 8-10. Diversion and washout risk ratings at road stream crossings on ODF lands in the Upper Nehalem watershed analysis area, by management basin.

	Diversion/Washout Risk			
Management Basin	**Low**	**Moderate**	**High**	**Total**
Fishhawk	19	1	0	20
Northrup	15	10	0	25
Beneke	39	19	1	59
Lousignot	14	6	1	21
Hamilton	50	34	1	85
Crawford	7	26	0	33
Sager	32	20	2	54
Buster	98	34	2	134
Quartz	54	13	0	67
McGregor	57	10	0	67
Wheeler	80	48	0	128
Wilark	19	7	1	27
Project Area Total	***484***	***228***	***8***	***720***

8.2.6 Recreational Trails

There were approximately 14.6 miles of recreational trails in the project area. Recreational trails on ODF lands included approximately 8.8 miles of ATV trails in Northrup and Fishhawk management basins and 5.8 miles of hiking trails in Quartz, McGregor, and Wheeler management basins. Based on mapped distributions, sections of ATV trail were adjacent to Northrup and Fishhawk creeks however information on trail condition and impact of the trail on adjacent streams were not available for this analysis. Sections of hiking trails also appeared to be stream adjacent, however the erosion related impacts of these portions of trails on adjacent streams were likely minimal and were not identified in this analysis.

8.2.7 Non-Forested Area Due to Roads

The total land area dedicated to roads (permanent non-forested) in the Upper Nehalem Project Area is 1,998 acres, or is approximately 2 percent of the total project area. The total non-forested area was calculated based on the total mileage of all active and inactive forest roads. The total length of active and inactive roads in the project area is 643 miles, which include approximately 36 miles of inactive or inaccessible roads that were not assessed during 2005 RIMS surveys.

8.3 SUMMARY

1. *What proportion of road length is within 100 feet of streams?*

   Of 607 total miles of forest road in the project area, 53.8 (8.8%) are steam adjacent.

2. *What proportion of road related drainage ditches are directly connected to the stream network?*

   Approximately 96 miles, or 15.8 percent, of the total road system has direct hydrological connection to the stream network.

3. *What roads are in critical locations?*

   A total of 33.6 miles, or 5.5 percent of forest roads are in critical locations. The roads with greatest in critical location are Buster Creek Road in the Buster Management Basin, which has 1.76 miles of stream parallel road, and North Lousignont Road in the Wheeler Management Basin, with 1.36 miles of stream parallel and steep fill roads.

4. *What roads have road prism instability, including sidecast/fill landslides?*

   No roads in the project area were identified to have prism AP Code 1. Two road sections are located on sidecast/fill slides: Lower Rock Creek Road and Crawford Ridge 14010. Three road sections are located on fill slides: East Sager Vacated 3, Beneke Vacated 1, and Vesper Spur 16850.

5. *How many stream crossings are barriers to fish passage?*

   A total of three stream crossings are barriers to juvenile fish and occur on known fish bearing streams.

6. *Are road washouts of stream crossing fills present in the project area?*

No washouts are present in the project area.

7. *Do recreation trails contribute to sediment or erosion problems?*

   The 14.6 miles of hiking and ATV trails in the project area likely to have minimal erosion related impacts.

8. *What proportion of the project area is non-forested due to forest roads?*

   The total land area dedicated to roads (permanent non-forested) is 1,998 acres, which is approximately 2 percent of the total project area.

8.4 CONFICENCE IN WORK PRODUCT

The analysis in this section was based predominantly on data recorded during the 2005 RIMS roads surveys of the Upper Nehalem Project Area. Data gathered during these surveys was considered to be preferable to GIS derived estimates based on the level of visual field verification of road and stream features inherent in the RIMS surveys. For this reason there is high confidence in the summaries of road locations and characteristics provided in this analysis.