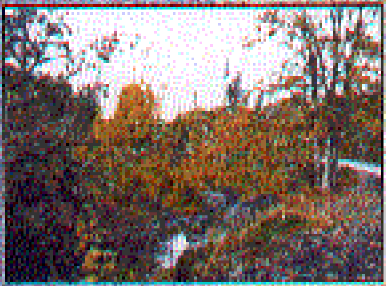
# Trail Creek Watershed Analysis



Bureau of Land Management
Medford District, Oregon
June 1999

Prepared by:

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# TRAIL CREEK WATERSHED ANALYSIS

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# TABLE OF CONTENTS

**APPENDICES**



## LIST OF TABLES

# 1.0 WATERSHED CHARACTERIZATION

This section provides a regional setting for the Trail Creek watershed and describes dominant human, physical, and biological features and functions that characterize it. This discussion provides a basis for the watershed analysis, providing a context for addressing ecosystem condition and function in the watershed.

## 1.1 Regional Setting

**Geographic Location and Population**

The Trail Creek fifth-field watershed is located in southwestern Oregon between Medford and Crater Lake National Park along the Rogue River within the Upper Rogue River Sub-basin (Figure 1-1). The watershed covers approximately 55 square miles within the sub-basin which covers about 1,618 square miles. The Trail Creek watershed is accessed by State Highway 227 from the Canyonville I-5 interchange to the northwest, by State Highway 62 from Medford to the southwest, or by the same route from Crater Lake to the northeast. The towns of Trail and Shady Cove (population approximately 2,379) are within or adjacent to the watershed. Most of the watershed is within Jackson County (population approximately 146,389), though the northern portion lies within Douglas County (population 94,649). The Trail Creek itself is situated north and west of the Rogue River and extends upslope to the divide with the South Umpqua River to the north (see Figure 1-2).

**Ownership and Land Use**

Forest and agricultural production represent the predominant land uses in the region. The Bureau of Land Management and Forest Service are the major federal land administrators in the region. Crater Lake National Park, administered by the National Park Service, is also within the region. The Army Corps of Engineers operates Lost Creek Reservoir east of Trail Creek watershed. The Trail Creek watershed is within the Butte Falls Resource Area of BLM's Medford District and within the Tiller District of the Umpqua National Forest.

The Rogue River National Forest is located east of the watershed. Several large private industrial forest land owners are also represented in the region. Agriculture operations are primarily restricted to the valley bottoms and include fruit and livestock production. Other significant products of the region include medical services, manufacturing, and tourism, which to some extent uses the recreational opportunities on public land and water.

**Physiography, Climate, and Drainage**

The Trail Creek watershed lies predominantly within the Western Cascade physiographic province as described by the Standards and Guidelines and Franklin and Dyrness (1973), though some of the lands in the southern portion of the watershed contain landscapes representative of the Klamath Mountains province. Southwestern Oregon has a Mediterranean climate characterized by wet, mild winters, hot, dry summers and a long frost-free period. Annual precipitation fluctuates widely averaging approximately 20" with average January temperatures about 38E and July temperatures averaging around 73E. This climate represents some of the hottest and driest conditions in the region. Lightning storms are common and contribute to extreme fire dangers throughout southwest Oregon. Drainages in these provinces flow to the Rogue River which in turn empties into the Pacific Ocean at Gold Beach.

**Vegetation and Habitat**

Major vegetational areas of the region include the Mixed Conifer and Rogue Valley Zones described by Franklin and Dyrness (1973). Douglas-fir, ponderosa pine, incense cedar, and white fir occur in the Mixed Conifer Zone. Grasslands, Oregon white oak woodlands, and coniferous stands of Douglas-fir represent the successional pattern in the Rogue Valley Zone though much of this zone is in agricultural production. These vegetational areas are entirely within the range of the northern spotted owl. Big game including Roosevelt elk and blacktail deer are also found throughout the region. Finally, extensive riparian areas and potential aquatic habitat conditions support anadromous and resident fisheries.

## 1.2 Human Use

**Ownership**

Major owners of land in the watershed include the federal government, corporations, and private individuals (shown on Figure 1-3). Federal land includes public lands managed by the Bureau of Land Management Medford District, and the Umpqua National Forest, managed by the Tiller Ranger District of U.S. Forest Service. Isolated parcels of land historically managed by the Prospect Ranger District of the Rogue River National Forest have recently been transferred to BLM administration. Land managed by the BLM in the watershed comprise approximately 14,640 acres within the watershed, representing the single largest ownership category. These parcels are not contiguous but instead are interspersed among privately held property in a semi-checkerboard pattern. Roughly 4,360 acres of the Umpqua National Forest is in a contiguous block in the northwestern part of the watershed.

Private industrial landowners include Boise Cascade Corporation and several smaller corporations. Boise Cascade property comprises the largest portion of the corporate holdings located in large blocks on the west half of the watershed. Other corporate lands are generally smaller, discontinuous parcels interspersed throughout the watershed. Collectively, this category occupies about 9,867 acres in the watershed.

According to Jackson County tax assessor records for 1997, there are approximately 250 non-corporate, private landowners in the Trail Creek watershed. Most of the residential development is within the small community of Trail, which is located at the southern boundary of the watershed at the confluence of Trail Creek and the Rogue River and along a corridor in the valley bottoms up the main stem and the west fork of Trail Creek.

There are seven primary county zoning designations within the Trail Creek watershed. Each of these designations are presented below with a brief description of the planning goals and land uses associated with them (Jackson County, 1996):

**Forest Resource (FR)**: This zoning district applies to both commercial forest land and woodland areas in private, small tract (20 to 40 acres) ownership. The primary use of these lands is or can be the production of forest products; however, they are also intended to protect and provide for compatible forest uses, fish and wildlife habitat, watershed and aquifer recharge areas, recreational opportunities, scenic attributes, ranching and grazing, and other natural resources. Within the watershed, FR lands are public lands managed by the BLM or Forest Service and Boise Cascade. The smaller, privately-owned woodland tracts also serve as a buffer between commercial forest lands and adjacent areas committed to higher density development.

**Woodland Resource (WR):** WR designated land is similar to FR-designated small tract woodlands described above. WR land includes smaller, privately held tracts where the production of timber and/or wood fiber may be a primary use. These lands typically serve as buffers between FR lands and residential or commercial developments. Lands in this category are recognized for the ecological and other natural resource characteristics. Properties within the WR zones are at least 20 acres or larger due to a county zoning restriction that existed prior to 1993. In 1993, the minimum parcel size in areas zoned WR was increased from 20 acres to 80 acres.

**Open Space Reserve (OSR):** Lands designated OSR are generally not suitable for development due to a broad range of factors such as high seasonal wildfire hazard, shallow and fragile soil, access limitations, etc. These lands may, however, be important in terms of their potential as aquifer recharge zones, fish and wildlife habitat, or perhaps scenic or recreational aspects.

**Exclusive Farm Use (EFU):** The EFU lands are areas where farm production exists or where the land is suitable for grazing, cultivation, or other farming activities. Properties within the

EFU zones are at least 20 acres or larger due to a county zoning restriction that existed prior to 1993.

**Farm Residential (F):** These lands generally include small "hobby" farms of 3 to 10 acres and are committed to rural homesite development.

**Rural Residential (RR)**: Generally located on lowland foothills, valley terrace, and valley floor areas, lands zoned RR are small tracts of 3 to 10 acres that are not used as hobby farms. The designation ensures that these lands are maintained in a rural land use pattern and they are typically located adjacent to Exclusive Farm Use or Woodland Resource zoned lands.

**Rural Service Commercial (RS)**: The rural service centers provide goods and services to rural populations. Typical business establishments may include grocery and video stores, limited business and professional offices such as insurance or real estate sales, laundromats, etc. Much of the community of Trail is zoned RS.

Figure 1-3 distinguishes between parcels less than 20 acres (roughly 1,237 acres) and parcels greater than 20 acres (about 4,970 acres).

## Land Use and Land Use Allocations

Figure 1-3 shows the distribution of land ownership and land use allocations for federally-managed lands within the Trail Creek watershed. Pursuant to the Medford District's Record of Decision and Resource Management Plan (RMP) and the Northwest Forest Plan. Land use allocations within the Trail Creek watershed consist of the following:

**Matrix - General Forest Management Areas**: The matrix within the watershed is divided into the Northern and Southern General Forest Management Areas for BLM Lands. These areas are managed to produce a sustainable supply of forest products in a manner that meets the needs of species and provides for ecological functions. Roughly 12,325 acres of matrix land is managed in this manner on BLM Land and all USFS Land within the watershed is allocated as matrix.

**Matrix - Connectivity Blocks**: The management objectives for connectivity blocks are to provide habitat and dispersal routes for a variety of organisms and maintain connectivity between late-successional reserves. Blocks may be comprised of contiguous or non-contiguous lands present throughout the watershed. Two blocks representing about 1,261 acres exist in the watershed.

**Unmapped Late Successional Reserves (LSRs):** These allocations offer late successional and old-growth conditions promoting old-growth species. Roughly 872 acres of this allocation are scattered within BLM Matrix allocations.

One additional land use allocation, Riparian Reserves, will be established within this watershed as part of this watershed analysis. Riparian Reserves are areas along streams, wetlands, ponds, and lakes where the conservation of aquatic and riparian-dependent terrestrial resources receive primary emphasis. These designations will replace existing designations and, as such, it will likely represent a significant land use allocation interspersed throughout the watershed.

Currently, predominant land use within the watershed consists of agricultural uses such as grazing and harvesting non-timber forest products; extraction of saleable minerals; recreation; rural residential; and rural commercial business. Historically, however, timber production has been a significant land use on public and private land. According to the Regional Economic Profile for Jackson County (Anderson, 1998), the availability of federal timber fell sharply between 1988 and 1992 in response to environmental regulations and sustained-yield policies. As a consequence, commercial logging in the Trail Creek watershed has dropped off significantly in the past decade on corporate and small privately held land. There has been no recent commercial logging on BLM lands in the watershed. Other timber-related management activities have been largely limited to commercial thinning on privately-owned timber lands and tree clearing for other agricultural uses. The most productive farm land in the Jackson County area lies along the Rogue River and its tributaries, including Trail Creek (Anderson, 1998). In the Trail Creek watershed, ranching is the predominant agricultural activity. There are four grazing allotments in the watershed (USDI BLM, 1998), although only three are currently in use.

Recreation in the watershed is generally limited to dispersed activities, such as hunting and primitive camping, that do not require developed facilities. However, rock climbing is growing in popularity in the southwest section of the watershed in an area known as the Rattlesnake Crags-Main Cliffs located up one of the lower tributaries to the west fork of Trail Creek. Established routes for climbers are present in the area, and access trails are being developed by users of the area.

Extraction of special forest products represents another significant use of the watershed. This includes the sale of pit-run rock and firewood cutting as well as bough cutting, mushroom harvesting, and burl wood and peeler log harvests. Collectively, those are common uses of the watershed.

Roadside dumping of domestic garbage and appliances is common in the watershed. This negative human use may be due to a lack of solid waste transfer stations or other waste management facilities and cost of waste disposal.

### 1.3 Physical Characteristics

**Geomorphology and Soils**

Elevations within the Trail Creek watershed range from a low of 1,436 feet at Trail where Trail Creek empties into the Rogue River, rising to 4,698 feet at Threehorn Mountain, located on the watersheds northern margin which forms part of the divide that separates the Roque and Umpqua river basins. Much of the northern divide and adjoining western and eastern margins of the watershed exceed an elevation of 4,000 feet. Oregon State highway 227 passes through the center of the basin and through the Rogue/Umpqua divide at an elevation of 3,300 feet.

The entire Trail Creek basin is formed from Tertiary (1.6 to 66 million years before present) Western Cascade volcaniclastic rocks originally deposited predominantly as flows and ash deposits on a nearly flat to gently sloping land-scape. Formations found in the watershed include basaltic and andesitic lava flows and flow breccias, including stratified and interbedded tuffaceous (ash) sediments and volcanic conglomerates, and ash-flow tuff, the latter found within the central portion of the West Fork basin (see Figure 1-4). The watershed has not been glaciated, and little structural deformation has occurred since deposition of the volcaniclastic flows. Although some minor faulting is evident in the watershed, the stream system has generally been free to downcut into and through the volcanic layers unhindered by structural controls, thus developing in a classic dendritic form, and with very few exceptions, developing a normal sequence of high gradient tributaries leading to progressively lower gradient and larger channels.

The Trail Creek watershed is characterized by rugged topography with irregular ridges and deep narrow valleys. Quaternary (1.6 million years ago to present) alluvial floodplain deposits occur along the lower reaches of the West Fork and Trail Creek. Gentle to moderate slopes predominate in the southern and lower elevations of the watershed, with slope steepness generally increasing with increasing elevation to the north, towards the watersheds margins. Internally within the watershed these conditions exist where sharp ridges occur between major tributaries where in some cases substantial flow-edge rock escarpments (cliffs) have formed. Steep slopes are also found where tributaries are deeply incised, forming inner gorges, although inner gorges are not a dominant feature.

The volcaniclastic parent materials within the watershed form a variety of soil series and soil characteristics. Shallow, stony soil tends to form on steep, south facing slopes. Most areas form deep to very deep cobbly to gravelly clay loam soil that range from well to poorly drained. A pervasive characteristic with management implications is the high clay content of the subsoil horizons: clay content typically ranges from 35 to 60 percent below a depth of approximately 6 to 12 inches.

Due to high clay content, drainage of some soils is described as poor, resulting in seasonally perched water tables.

**Precipitation and Hydrology**

Mean annual precipitation within the Trail Creek watershed averages approximately 40 inches. Annual precipitation is lowest near the Rogue River and the town of Trail, and generally increases to the north and with increasing elevation. Typical of the Mediterranean climate of southwestern Oregon and Washington, approximately 70 percent of annual precipitation in the watershed falls in the five months of November through March. Streamflow patterns reflect the distribution of precipitation. Streamflows begin to increase from their seasonal summertime lows in the fall, increasing rapidly during late fall and winter storm events.

Peak flows occur during the winter months. Most of the watershed is subject to periodic snowfall and subsequent total to partial snow melt during warm mid-winter rain-on-snow events, which are associated with nearly all major peak flows. Trail Creek is an ungaged watershed. However, representative gaging stations are located nearby on Elk Creek. The largest peak flow recorded near the mouth of Elk Creek during the period of record, 1947 through 1987, occurred in December 1964 at a flow of 19,200 cfs. Low flows occur during summer and early fall. Minimum flow recorded on the West Fork of Elk Creek reached 0.26 cfs in September 1981. Equivalent maximum and minimum flows at the mouth of Trail Creek are 7,940 and 1.0 cfs, respectively. For analysis purposes, seven sub-watersheds have been delineated in the watershed (see Figure 1-5).

**Soil Erosion and Mass Wasting Processes**

The soil erodibility "K" factor for soil found in the watershed in few cases reaches the criteria for moderate erodibility (K = 0.25 to 0.40), and then only for subsoil horizons. The Soil Survey of Jackson County (USDA SCS, 1993) describes this soil as having moderate to high erodibility. This soil is subject to erosion where exposed and compacted or puddled with associated destruction of internal macroporosity leading to surface runoff, and that delivery of sediment to streams is a concern, particularly on steep slopes. Again due to their high clay content, road surfaces have poor bearing strength when wet, and unsurfaced roads are subject to rutting, concentration of surface flows, and delivery of sediment to streams. Heavily used ground-based skid trails are subject to severe compaction, generation of surface flows, erosion, and attendant sediment delivery potential if poorly drained and located. Since few areas within the watershed have been harvested within the past five years, with no areas harvested in this period on BLM and Forest Service ownership, it is unlikely that sediment delivery associated with harvesting currently adds significant volumes of sediment to Trail Creek streams.

Deep-seated slumps and earthflows are common within the Trail Creek watershed, and again are associated with the clay rich soil formed from volcaniclastic parent materials that underlie the entire watershed. Ancient slump/earthflows occupy major areas of the moderate and low gradient slopes of the watershed, particularly in areas of weaker formations (flow breccias and ash tuffs). Although these forms of failure typically do not deliver large volumes of sediment to stream systems, and are not particularly sensitive to management activities, road construction or harvest activities on slump/earthflow formations are associated with local reactivation and acceleration of erosion processes.

Shallow-rapid forms of mass wasting (debris avalanches and debris flows) are much more sensitive to forest management activities and can have substantial effect on stream systems. However, relatively few debris avalanches were observed within the watershed, and no debris flows were observed to have occurred within the watershed's stream channels. Based on these observations, it is unlikely that mass wasting is a major source of accelerated sediment delivery within the Trail Creek watershed[1].

[1] This preliminary conclusion is reached based on detailed review of 1966, 1975, 1985, and 1996 ~ 1:12,000 scale aerial photos. A major storm and flood event occurred the winter of 1996/1997, and mass wasting associated with this event have been reported to the authors. Post-1996 photo failures will be observed during Current Conditions Inventory,

Nearly all of the Trail Creek watershed has been accessed for forest harvesting with roads during the past 60 years. Road density is relatively high. Stream crossings are numerous, and road mileage adjacent to streams are common. As a result, road systems are the dominant source of delivered sediment within the watershed.

**Stream Channels, Processes and Land Use Impacts**

Headwater and tributary streams typically have steep to moderate gradient and are highly confined within the Trail Creek watershed (Rosgen Aa, A, and B - Source and Transport reaches). The lower reaches of Trail Creek, including substantial length above the West Fork to Wall Creek and beyond, and the lower reaches of the West Fork below Walpole Creek have gradients below 2 or even 1%, but remain well-confined by bedrock. Defined as response reaches, these areas are expected to be particularly sensitive to wood and sediment input, or lack thereof. Shallow, straight, bedrock channels are the prevalent condition in the main fork and Wall Creek.

A defining characteristic of the Trail Creek watershed is that response reaches contain very little wood and coarse sediment, critical for formation of quality fisheries rearing and spawning habitat. Contributing to this condition, riparian forests adjacent to nearly the entire length of these reaches were removed in previous decades, and few mature trees remain. The 1964 flood is reported to have flushed wood and scoured cobble and gravel substrate from many stream channels in the Rogue River basin, including adjacent Elk Creek. In any event, large wood of sufficient size to remain within these channels will now be slow to develop within these mainstem channels.

Water temperatures are known to exceed the Oregon State Water Quality Standards criteria (Oregon Administrative Rules, 1998) for extended periods during summer months, at least within the lower reaches of the West Fork and Trail Creek (Boise Cascade Corp., 1998). Water temperatures exceed the Oregon State Water Quality Standards criteria for extended periods during summer months, at least within the lower reaches of the West Fork and Trail Creek (Boise Cascade Corp. (1998). Channels in these areas are highly exposed to solar radiation due to the sparseness of the adjacent riparian forest. Contributing natural factors to warm water temperature are low elevation and associated warm air temperature.

## 1.4 Biological Characteristics

Figure 1-6 presents preliminary vegetation classification in the Trail Creek watershed based on stand structure as a surrogate for seral stage development. Public and private land were classified using the Western Oregon Digital Image Product (WODIP). Field reconnaissance has been performed to develop and verify classification rules and to "spot check" individual classifications. Classified WODIP data have also been checked against the BLM's Forest Operations Inventory (FOI) to verify classifications on BLM land and to support interpretation of results. Based on this analysis, vegetation classification presented in Figure 1-6 is considered representative of the mixed, diverse stand structure/seral stage conditions that exist in the watershed. These conditions include:

**Non-Forest and Clearcuts –** These classifications are lumped given the limitations of WODIP to distinguish between these two classifications. Non-forest conditions include developed areas, agricultural land uses, barren grasslands or rock outcrops, and brush fields. Developed and agricultural conditions tend to coincide with small private land parcels described earlier. Rock outcrops, grasslands, and brush fields are distributed throughout the watershed on public and private land. Brush fields tend to be early successional stages of both hardwood and conifer stands whereas outcrops and grasslands will likely remain in their current condition. Finally, clearcuts tend to exist in regular shaped patterns on federal land and on private industrial ownerships. Overall, these

incorporated into the findings, and the Draft Characterization adjusted as warranted.

conditions represent hydrologically immature[2] conditions covering about 22% of the watershed.

**Hardwoods** – This vegetation type is represented by Oregon white oak woodlands at lower elevations and in riparian situations throughout the watershed. Stands of Pacific madrone and big leaf maple trees are also common at relatively higher elevations. Roughly 5% of this condition are scattered throughout the watershed in relatively small stands intermixed with conifer stands and non-forest conditions. Hardwood areas in this watershed are considered hydrologically intermediate.

**Conifer/Mixed –** This vegetation type is represented by mixed stands of Douglas-fir, ponderosa pine, incense cedar, and hardwoods which cover over two thirds of the watershed. These conditions exist in various size classes and densities predominantly in the upper elevations of the watershed, though they are also present in the lower elevations as later seral stages. WODIP supports size classifications of 0 to 10 inches Diameter at Breast Height (DBH), 10 to 20 inches, and 20 inches and above. Based on this size classification, conifer/mixed stands tend to be distributed in relatively contiguous even-aged blocks reflective of the disturbance history in the watershed. For purposes of determining hydrologic maturity, crown closure classifications of 0 to 70% and 70% and higher were made within these size classifications. Based on density, conifer/mixed stands tend to be more diverse, reflective of the variable regeneration success in the watershed. Species composition also tends to correlate with density where intolerant species (predominantly ponderosa pine) occurs in lower density situations and relatively shade tolerant species (predominantly Douglas-Fir) occurs in denser stands. Based on size, most (roughly 90%) of the conifer/mixed stands represent early to late seral stage conditions (see footnote below). Based on density, conifer/mixed stands are relatively split between intermediate and mature hydrologic conditions[3]. Dense, large tree stands exist on 2071 acres within the watershed, representing about 6% of the total land base.

It is noted that shelterwood silvicultural systems were used extensively on BLM land creating significant large tree (20" DBH and higher) conditions that are not captured by the WODIP imagery. This is significant in that a large proportion of stands classified as 0 to 20 inches will contain a large tree component providing late successional habitat conditions described in the Northwest Forest Plan and the Medford Resource Management Plan. It is assumed that this large tree component does not affect the hydrologic maturity of the stands.

Overall, timber harvests and wildfire have been the most significant disturbance factors in the watershed. Based on review of stand age data, timber harvests began in the watershed near the turn of the century and have more or less progressed on a constant basis over time. Harvest activity has dropped off dramatically on federal lands, however, in the past ten years. Even-aged management through clearcutting and shelterwood silvicultural systems have predominated. Commercial and pre-commercial thinning is also evident, though to a lesser extent. Wildfires are frequent, with about one incident per year occurring within the watershed. Aggressive fire suppression has limited wildfire spread, contributing to significant increase in fuel loadings, particularly in the rural wildland interface, increasing the likelihood of a significant disturbance.

**Habitat Features**

Wildlife habitat characteristics in the Trail Creek watershed have been influenced by logging, road construction, wild fire, wind, and residential development. Different logging practices on private and federally managed lands have resulted in

[2] Hydrologic maturity defined according to land use/cover types and descriptions developed by the Washington Forest Practices Board (1995):

Mature - Greater than 70% total crown closure and less than 75% of the crown in hardwoods or shrubs.

Intermediate - 10% to 70% total crown closure and less than 75% of the crown in hardwoods or shrubs.

Immature - Less than 10% total crown closure and/or greater than 75% of the crown in hardwoods or shrubs.

distinct habitat differences within the watershed depending on land ownership. Much of the federally managed land (BLM and Forest Service) in the watershed has been logged through a process known as "shelterwood harvesting", mostly during the 1960's. This selective method of logging removed large, mature trees, and associated large woody debris, but also left a substantial number of large trees. Selective removal of large trees resulted in relatively even spacing of old-growth Douglas-fir, with development of dense understory canopies of mid- or late-seral forest communities, dominated mostly by Douglas-fir and incense cedar. Late-successional and old-growth forests provide important nesting and foraging habitat for spotted owls, goshawk, and pileated wood peckers.

Logging on private land within the watershed has largely been done through clear-cut harvesting of relatively large blocks of all size classes of trees. Consequently, private lands are nearly devoid of large, old-growth trees. Most habitat on private lands consists of even-aged stands of Douglas-fir and incense cedar forests in varying stages of ecological development. Clear-cut areas have had forest regeneration supplemented by planting of seedlings. This practice has contributed to the even-aged, uniformly stocked character of most private forest lands in the watershed. Early-seral plant communities, following clear cutting, provide forage and browse for deer and elk. As saplings and seedlings mature and understory grasses and shrubs become less dense due to competition with overstory species, forage and browse production declines.

The uniformly high density of roads throughout the watershed has resulted from accessing and removing timber. High densities of roads in forested habitat tend to displace wildlife species, sensitive to human activities, from otherwise suitable habitat near roads. High road densities also allow high levels of human access that tend to reduce security of deer and elk during hunting season and increase mortality due to poaching.

The Oregon Department of Fish and Wildlife (ODFW) has established a goal for road density of 1.5 miles of road per square mile of habitat to reduce poaching and winter harassment of deer and elk.

Although most of the watershed is vegetated by mixed conifer forest, portions in lower elevation have remnant stands of Oregon white oak. These oak stands are often composed of large, relatively old trees with understory densities of shrubs and tree seedlings reflecting histories of the site. Frequent fires, prior to modern suppression efforts, tended to create relatively open savannah-like oak stands by killing competing woody plants, especially conifers, in the understory and allowing fire-resistant large oaks to survive. White oak communities provide unique habitat for woodpeckers, deer, wild turkey, small mammals, and reptiles.

Riparian habitats and wetlands are present along streams and at springs and seeps. Red alder, big-leaf maple, and deciduous shrubs are typical components of riparian communities. Conifer species are often interspersed among deciduous species along streams and usually become dominant on slopes adjacent to the floodplain. Riparian vegetation provides important habitat for passerine birds and provides important ecological benefits to aquatic ecosystems such as moderating water temperatures through shading, improving fish habitat (e.g., large woody debris), and contributing organic detritus to the invertebrate food chain.

Habitat connectivity is a management priority, especially in the northern one-third of the Trail Creek watershed. The upper one-third of the watershed abuts a large late successional reserve on the east in the Elk Creek watershed and another to the west at Goolaway/Snow Creek. There are also "connectivity blocks" in the watershed, that are retained as late-successional /old-growth refuges to provide habitat for breeding, feeding, dispersal, and movement of spotted owls and other species dependent on mature and old-growth forest. Designated connectivity blocks and other late-successional Douglas-fir stands provide potential linkages across portions of the landscape, both inside and outside the Trail Creek watershed, that have been clear cut, burned or rendered unsuitable for spotted owls and other late-successional species.

Common wildlife species in the watershed include black-tailed deer, Roosevelt elk, black bear, mountain lion, ruffed and blue grouse, wild turkey, mountain quail, red tree vole, and numerous other birds and small mammals. Black-tailed deer populations in the watershed are currently above benchmark population levels set by ODFW. About one-half of the watershed is winter range for deer. Deer wintering in the watershed migrate from north of Prospect and as far east as Crater Lake. Elk populations in the watershed are about 65 percent of the benchmark established by ODFW.

## Special-Status Species

Special-status species include plants and animals that are listed under the Endangered Species Act of 1973 as threatened or endangered or candidates for listing (see Appendix F). Species listed by BLM as "sensitive" or by the Oregon Natural Heritage Program as warranting special management considerations because of rarity or threats to population viability also have special status. Two species listed under the Endangered Species Act occurs in the Trail Creek watershed: spotted owl (threatened) and peregrine falcon (endangered). Other special-status wildlife species that are known to occur or for which there is suitable habitat in the watershed include: great gray owl, goshawk, acorn woodpecker, flammulated owl, Lewis' woodpecker, northern pygmy owl, saw-whet owl, olive sided flycatcher, pileated woodpecker, western bluebird, red tree vole, Yuma myotis, ringtail, western gray squirrel, clouded salamander, foothill yellow-legged frog, western toad, California mountain king snake, sharptail snake, and blue-gray tail-dropper slug.

Spotted owls nest in the watershed where mature and old-growth Douglas-fir stands provide habitat (i.e., large-diameter snags). Figures 1-6 and 1-7 shows areas in the watershed that appear to have sufficient large trees for spotted owl nesting and foraging. There are 17 historic spotted owl nesting sites and associated activity centers of which 10 have been active within at least one of the past three years (i.e., a 100-acre zone surrounding nest sites) in the watershed. There is one known nesting pair of peregrine falcons in the watershed and additional, suitable nesting habitat (i.e., large cliffs over 100 feet high). Peregrine falcon populations in Oregon have been steadily increasing from eight known nesting sites in 1988 to 42 known sites in 1997.

## Fisheries

Trail Creek and its tributaries provide spawning and rearing habitat for both anadromous and resident salmonids. There are approximately 25 miles of confirmed, fish-bearing streams in the watershed (Figure 1-7). Major resident spawning streams in the watershed are: Canyon, Paradise, Romine, Walpole, Wall, and Chicago Creeks, and the West Fork Trail Creek. Anadromous fish are coho salmon, and winter and summer steelhead. Resident fish include: cutthroat trout, Pacific lamprey, Klamath smallscale sucker, reticulated sculpin, and redside shiner.

Coho and steelhead move upstream from the Rogue River into smaller tributaries, such as the Trail Creek drainage, to spawn. Autumn stream flows, barriers to migration (e.g., waterfalls and woody debris), stream gradient, and availability of spawning gravels determine the spatial distribution of spawning in the drainage. The scarcity of suitable spawning gravel is a significant limiting factor for resident spawning in the watershed. Cutthroat and rainbow trout and other non-anadromous fish are more widely distributed throughout the drainage than are anadromous fish. Resident fish are often found above barriers that may periodically prevent anadromous fish from moving upstream to spawn.

## Noxious Weeds

Noxious weeds are invasive plants specified by law as being especially undesirable, troublesome, and difficult to control. Noxious weeds typically invade and proliferate on sites that have had the plant cover and soil removed or disturbed. Logged areas, road sides, utility corridors, abandoned fields, and heavily grazed sites are especially susceptible to noxious weed infestations. Noxious weeds in the watershed include: Canada thistle, St. John's wort, diffuse knapweed, and tansy ragwort. As dense overstory canopies of trees and shrubs become established on sites with weed infestations, shading and competition with woody plants, often, greatly reduced the density of several noxious weed species (yellow starthistle, scotch broom, purple loose strife). Most of the weeds found in this watershed, as well as District-wide, are found along road sides, where the seeds are transported by vehicles and control is difficult.

# 2.0 ISSUES AND KEY QUESTIONS

This section describes issues and questions identified through a scoping process that will be used to analyze ecosystem functions that are most relevant to management within the Trail Creek watershed. These will form the basis of the description of current and reference conditions presented in the next section.

## 2.1 Scoping Process

**Previous Consultations**

Scoping activities were conducted to identify the key issues and questions associated with the Trail Creek watershed. Some of the key issues and questions were previously developed by the BLM based on experience in the watershed, previous interactions with landowners and stakeholders in the watershed, and concerns identified by other groups or agencies. Results of scoping are presented in Section 2.2.

In June 1997, the Rogue Institute for Ecology and Economy conducted an outreach and education project on behalf of the Upper Rogue Watershed Council. The project was designed to identify the major concerns of local people related to watershed health; inform residents of the Watershed Council and its goals and activities; confirm the degree to which the action plan of the Watershed Council corresponds to local issues; and explore the development of projects of most interest to local residents (Preister, 1997). The project was conducted throughout the Upper Rogue watershed, including the Trail Creek watershed, as well as neighboring watersheds. A total of 160 people were interviewed during the effort. Comments or issues specific to, or that can be otherwise be applied to Trail Creek, are discussed in Section 2.2 below.

**Watershed Analysis Consultations**

Additional scoping was conducted at the onset of this watershed analysis to verify issues identified earlier and obtain recent input from landowners and/or stakeholders.

Notification efforts for public scoping consisted of the following:

- Advertisements placed in the Legal Notice sections of the *Upper Rogue Independent*, the *Rogue River Press*, and the *Medford Mail-Tribune;*
- Letters sent to individuals and organizations identified by BLM as either corporate or private landowners in the watershed or who are otherwise on the BLM's Environmental Assessment mailing list;
- Telephone calls to public agencies, advocacy groups and citizen councils, and individuals identified as having a potential interest in the watershed.

Comments, issues, and key questions elicited during these consultations are also presented in Section 2.2.

## 2.2 Scoping Results

**Issues Identified by the BLM**

A comprehensive set of key questions were identified by the BLM at the onset of this watershed analysis. Issues reflected in this list include:

- Human uses
- Soil and slope stability
- Terrestrial ecosystems - vegetation
- Terrestrial ecosystems - wildlife
- Riparian ecosystems
- Aquatic ecosystems - physical components
- Aquatic ecosystems - biological components
- Fire hazard and risk
- Opportunities for commodity extraction

Table 2-1 presents key questions associated with those issues and the section within this document that they are addressed.

**TABLE 2-1**

**Issues and Key Questions Identified by the BLM**

| Key Questions | Watershed Analysis Document Section(s) |
|---|---|
| **Human Uses** | |
| What are the major ways in which humans interact with the watershed? | Section 3.1 |
| What are the current human uses and trends of the watershed (economic, recreational, other)? | Section 3.1 |
| What is the current and potential role of the watershed in the local and regional economy? | Section 3.1 |
| Are there treaty or tribal rights in the watershed? | Section 3.1 |
| Who are the people most closely associated with and potentially concerned about the watershed? | Section 2.2 |
| What are the regional public concerns that are pertinent to the watershed (e.g., air quality, environmental degradation, commodity production, etc.)? | Section 2.2 |
| What are the public concerns specific or unique to this watershed? | Section 2.2 |
| What are the current conditions and trends of the relevant human uses in the watershed:<br>a. authorized and unauthorized uses<br>b. logging<br>c. special forest products<br>d. grazing/agriculture<br>e. minerals<br>f. recreation<br>g.cultural resources | Section 3.1 |
| Where are the primary locations for human use of the watershed? | Section 3.1 |
| What are the anticipated social or demographic changes that could affect ecosystem management? | Section 3.1 |
| What are the major historical human uses in the watershed, including tribal and other cultural uses? | Section 3.1 |
| What are the influences and relationships between human uses and other ecosystem processes in the watershed? | Section 4.0 |
| What human interactions have been and are currently beneficial to the ecosystem and can these be incorporated into current and future land management practices? | Section 4.0 |
| What human effects have fundamentally altered the ecosystem? | Section 4.0 |
| What changes in human interactions have taken place since historic contact and how has this affected the native ecosystem? | Section 4.1 |
| What are the causes of change between historical and current human uses? | Section 4.1 |
| **Soil and Slope Stability** | |
| What are the general topographic features found throughout the watershed? | Section 1.3 |
| What are the typical soil types associated with these topographic features or landforms? | Section 1.3 |
| What are the dominant soil types found throughout the watershed and where are they located? | Section 3.2 |
| What is the relative landslide potential (hazard) based on slope class, geology, soils and landform features? | Section 3.2 |
| What was the historic landslide magnitude/rate and what is the current magnitude/rate and expected trend of landslide events in the watershed? | Section 3.2 |

| | |
|---|---|
| What was the historic landslide distribution and what is the current landslide distribution? How is this distribution expected to change over time? | Section 3.2 |
| What is the road network and what are the maintenance classes of the roads identified? | Section 3.2 |
| What are the characteristics of the roads within each stratification unit according to drainage type, distance to streams, whether road drainage reaches stream, character of road cut, character of road ditch, cut and fill erodability classes, road surfacing material, length of flow along the bearing surface; number, type, and condition of stream crossings, and other characteristics that influence erosion rates and sediment delivery to streams? | Section 3.2 |
| What were the historic sources of non-point source sedimentation and what are the current sources of non-point sedimentation? What is/was the location and relative intensity of these sources? | Section 3.2 |
| What anthropogenic activities (i.e. roads and timber harvest methods) and natural processes affect/affected landslide initiation, rate, magnitude and delivery? | Section 3.2 |
| What are their dominant characteristics relative to response from management activities? (i.e. soil depth, clay content, amount of coarse fragments, erodability) | Section 3.2 |
| What soil types are at most risk for producing stream sediments from erosion and mass wasting and why? What management activities most contribute to this risk? | Section 3.2 |
| What is the relationship(s), adverse and beneficial between landslide events and surrounding ecosystems (e.g aquatic ecosystem)? | Section 4.4 |
| What are the influences and relationships between roads and other ecosystem processes and features in the watershed? | Section 4.4 |
| What road hazards exist in the watershed, and which hazards influence aquatic habitat? | Section 4.4 |
| Where are the locations, stratified by relative degree of magnitude (i.e.High, Mod, Low use supporting criteria), for non-point sources of sediment and their proximity/relationship to adjacent streams? | Section 4.4 |
| What soil types are at most risk to reducing soil productivity from management activities and why? What are the soil properties and the type of management activities that create this risk? | Section 4.4 |
| What is the relationship between non-point source sedimentation and fish species and their habitat? | Section 4.7 |
| **Terrestrial Ecosystems - Vegetation** | |
| What is the ownership pattern and distribution by acres and percent of ownership within the Trail Creek Watershed? | Section 1.2 |
| Within the Trail Creek Watershed, what seral stages(classes) are found? How many acres and percent of the seral stage is represented by each seral stage and land owner? | Section 3.5 |
| What is the relative abundance and distribution of non-native plants and noxious weeds? | Section 3.5 |
| What is the habitat distribution and character of non-native plants and noxious weeds? | Section 3.5 |
| What are the current habitat conditions and trends for non-native species and noxious weeds? | Section 3.5 |
| What is the current condition of forest disease and insect problems within the Trail Creek Watershed? | Section 3.5 |
| What is the projected forest disease and insect problems within the watershed? | Section 3.5 |
| What is the current condition of windthrow problems within the Trail Creek Watershed? | Section 3.5 |
| What is the projected windthrow problem within the watershed? | Section 3.5 |
| What was the historical level (app. 1900) of forest disease and insect problems within the watershed? | Section 3.5 |
| What was the historical level of windthrow within the watershed? | Section 3.5 |
| Have non-native species and noxious weeds changed the landscape pattern of native vegetation? | Section 4.3 |

| Terrestrial Ecosystems - Special Status Plants | |
|---|---|
| Describe any Special Status Plant Species that have been discovered within the watershed, their habitat, abundance and distribution. | Section 3.5 |
| Describe any Survey and Manage nonvascular plants discovered within the watershed, their habitat, abundance and distribution. | Section 3.5 |
| Describe the amount of Sensitive Plant surveys which have occurred in the watershed over the past 10 years. | Section 3.5 |
| Describe any Special Status Plant Species likely to occur within the watershed, and the likely habitat associated with the species. | Section 3.5 |
| Describe any Survey and Manage nonvascular plants likely to occur within the watershed, and the likely habitat associated with the species. | Section 3.5 |
| Describe any special habitats within the watershed (meadows, rock outcrop, riparian/aquatic) and their relative abundance. | Section 3.5 |
| **Terrestrial Ecosystems - Wildlife** | |
| Identify where is designated spotted owl Critical Habitat and list management options for CHU. | Section 3.5 |
| What is the distribution and number of acres of late-successional coniferous forest within the watershed? | Section 3.5 |
| What is the distribution and number of acres of old-growth coniferous habitat within the watershed. | Section 3.5 |
| Where are McKelvey I (nesting) and McKelvey 2 (foraging/roosting) habitat? How many acres and what's their arrangement across the landscape? | Section 3.5 |
| What is the level of survey for owls that has taken place? How many owl sites are there, and what is their breeding history since 1992? | Section 3.5 |
| Identify active spotted owl I00 acre cores within the corridor that could be maintained as larger deferrals. | Section 3.5 |
| What level of survey for red tree vole has occurred, and where have votes been located? | Section 3.5 |
| What level of survey for great gray owl (protection buffer species) has occurred, and where have they been located, both in current surveys, and historically? | Section 3.5 |
| What is the level of survey for peregrine falcon in the watershed? What occurrence is there? | Section 3.5 |
| How much likely cliff habitat occurs, and what threats are there (roads, climbers)? | Section 3.5 |
| What is the level of survey for bald eagle in the watershed? What occurrence is there? | Section 3.5 |
| What is the likelihood of bald eagle sites, how much suitable habitat is there? | Section 3.5 |
| What is the level of survey for northern goshawk in the watershed? What occurrence is there? | Section 3.5 |
| What is the quantity and distribution of suitable northern goshawk habitat (McKelvey)? | Section 3.5 |
| Are there any other special habitats including mine adits, caves, cliff and talus, wet meadows, or wetlands? | Section 3.5 |
| Where is designated deer winter range, or designated big game management area? | Section 3.5 |
| What is the status of any road closure areas (Jackson County Travel Management Area JACTMA)? | Section 3.5 |
| What is the trend of herds (ODFW info)? | Section 3.5 |
| What changes have occurred in owl habitat in the past 5-10 years? | Section 4,6 |
| How connected are retained and non-retained LS/OG stands within the watershed? | Section 4.6 |
| What is the probability for more undiscovered peregrine falcon sites, or potential for new sites in the next 5 years? | Section 4.6 |
| Identify corridor connecting two LSRs and likely stands to be maintained on longer rotation as stepping stones. | Section 4.6 |
| How can connectivity between isolated stands be improved through management of silvicultural efforts with specific regard to the species of Appendix F? | Section 4.6 |
| What stands will be retained to meet the 15% LS/OG retention standard under both contingencies of interpretation of that Standard and Guide. | Section 4.6 |

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|---|---|
| Where are there road closure opportunities (ties in with engineering RMOS)? | Section 4.6 |
| Are there any habitat improvement project opportunities? | Section 4.6 |
| **Riparian Ecosystems** | |
| Describe the amount of Riparian Reserves (based on a site tree of 180 feet) within the watershed. | Section 3.1 |
| Describe the following general features related to streams within the watershed:<br>a. Channel geomorphology<br>b. Channel substrate<br>c. Channel sinuosity.<br>d. Channel gradient.<br>e. Channel stability. | Section 3.4 |
| Describe all wetland areas and springs within the watershed and the following general features related to: size, location, connectedness to surface stream hydrology.<br>a. Where are the current unstable areas and potential unstable areas within the watershed?<br>b. How many miles of stream occur within unstable areas?<br>**c.** Where are the highly erodible soil types and what is the expected impacts to the riparian and aquatic ecosystems?<br>d. How many miles of stream occur on highly erodible soils? | Section 3.4 |
| Describe the following general features related to artificial structures within the watershed: Impoundments and hydrologic diversions (size, location, impact to stream hydrology). | Section 3.4 |
| Describe the general functioning condition of streams, number of miles of streams, and stream reaches within the watershed. | Section 3.4 |
| Describe the historical condition of headwater streams, wetland areas and springs as they relate to the above appropriate physical components. | Section 3.4 |
| Describe any large-scale events which may have shaped stream channel morphology within the watershed. | Section 3.4 |
| Describe the historic range of riparian zone as it relates to natural disturbance. | Section 3.4 |
| Describe the historic range of riparian zone as it relates to human disturbance. | Section 3.4 |
| Describe the following biological features related to riparian vegetation within the watershed:<br>a. Riparian vegetative species composition (overstory, understory, and ground level vegetation).<br>b. Riparian stand characteristics (number of canopy layers, canopy closure, canopy height, openings within the riparian zone.)<br>c. Coarse woody debris amount and distribution.<br>d. Wildlife species associated with Riparian Reserves (richness, abundance). | Section 3.6 |
| Describe any Special Status animal or plant species, or Survey and Manage Species likely to occur and benefit from Riparian Reserves in the watershed. | Section 3.6 |
| Describe any changes of the physical components from the historical condition resulting from natural disturbances. | Section 4.5 |
| Describe any anthropogenetic actions that have altered morphology, sinuosity, stability, area, and any other physical characteristics of headwater streams, wetlands, and springs. | Section 4.5 |
| Which streams, wetlands, and springs have been effected, where are they located, and to what extent? | Section 4.5 |
| Describe any streams that have been degraded by anthropogenic actions (locations, length, and degree of degradation). | Section 4.5 |
| Describe the following impacts to Riparian Reserves (riparian vegetation and stream bank stability):<br>a. Timber Harvesting<br>b. Road Construction<br>c. Cattle Grazing<br>d. Off-Road Vehicles<br>e. Recreation | Section 4.5 |

| Aquatic Ecosystems – Physical Components | |
|---|---|
| What is the current location and mileage of intermittent and perennial streams in the watershed? (Base intermittent stream classification on ROD definition.) | Section 3.3 |
| What is the relative drainage density in the watershed (mile of stream/square mile) by sub-watershed? | Section 3.3 |
| What is the current flow regime in the watershed? What factors influenced this regime? | Section 3.3 |
| What was the historic flow regime in the watershed? What factors influenced this regime? | Section 3.3 |
| What are the general channel classifications (i.e. transport and response reaches using Rosgen Level I classification) of fish-bearing and non-fish bearing streams based on most recent ODFW aquatic habitat inventory and BLM stream survey information? If information is unavailable then use aerial photo and topographic maps to arrive at a Rosgen Level I charmer type determination. Convert all ODFW stream reach data to Rosgen Level I classification. | Section 3.4 |
| What was the relative historic condition of these channels and what is the current condition and expected trend? | Section 3.4 |
| What is the current location and mileage of ephemeral, intermittent and perennial streams in the watershed? (Classification should be based on flow duration criteria. See Laurie Lindell, District Hydrologist for criteria.) | Section 3.4 |
| What would be the expected historic thermal regime in the watershed, and distribution of High, Mod and Low stream temperatures? | Section 3.6 |
| What is the current distribution of stream temperatures based on seven-day average maximums displayed in two degree interval classifications (where thermograph data is available)? | Section 3.6 |
| What is the current distribution of 303(d) Water Quality Limited Streams due to summer temperature in the watershed? | Section 3.6 |
| Are there warm or cold water source streams in the watershed? What is their location, relationship, and magnitude in influencing water temperatures (i.e. High, Mod, Low - use supporting criteria.)? | Section 3.6 |
| What are the potential sources of changes to base and peak flows? Where are these located in the watershed? What is their relative magnitude of influence over these changes? | Section 4.3 |
| What is the relationship between the historic and current thermal regime in the watershed and expected trend? | Section 4.3 |
| What is the role of these reaches in creating/maintaining/providing aquatic habitat for fish and non-fish species? (i.e. Why are they important (e.g. delivery of large wood and coarse sediment, productive flats?)) | Section 4.5 |
| What anthropogenic activities and natural disturbance events have affected these channels? Stratify by channel type. | Section 4.5 |
| What anthropogenic activities and natural processes affect the drainage pattern? | Section 4.5 |
| Is there a current limitation in the amount of available thermograph data to draw definitive conclusions about stream temperature in the watershed? | Section 4.5 |
| What are the anthropogenic activities and natural processes affecting this relationship and trend?. How have these activities and processes affected water temperature historically and currently? | Section 4.5 |
| What are the relationships between the flow regime, fish and fish habitat in the watershed? | Section 4.7 |
| What is the relationship between water temperature and fish species? | Section 4.7 |
| What areas are in need of restoration? (i.e. High, Mod, Low - use supporting criteria.) | Section 4.7 |
| Which streams that are not currently monitored should be monitored on a regular basis? | Section 4.7 |
| **Aquatic Ecosystems – Biological Components** | |
| Which fish species are found in the watershed and what are their general life history strategies and biological requirements? | Section 3.7 |

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|---|---|
| What is the current Endangered Species Act (ESA) status of fish species within the watershed? What is criteria used to define an anadromous fish species' status under ESA? | Section 3.7 |
| Based on past vegetation, climate, topographic and geographic conditions what would be the expected aquatic habitat condition/ quality be by sub-watershed? Display each sub-watershed based on habitat quality rating (i.e. High, Mod, Low and document supporting criteria). | Section 3.7 |
| What is the current trend in habitat quality and why? Display information by sub-watershed. | Section 3.7 |
| What is the estimated watershed capability for aquatic habitat quality (i.e. High, Mod, Low and document supporting criteria)? What is the estimated potential habitat quality (i.e. High, Mod, Low and document supporting criteria) | Section 3.7 |
| Which fish hatcheries are found in the Rogue Basin and where are they located? | Section 3.7 |
| What is the current distribution of fish species within the watershed? (e.g. map of fish distribution by species. May not be able to produce for non salmonids.) | Section 3.7 |
| What would be the expected historic escapement levels of anadromous salmonid species within the watershed? What is the current escapement level and trend of anadromous salmonid species within the watershed and how does this vary from historic levels? | Section 3.7 |
| What is the current freshwater production levels of anadromous salmonid species within the watershed? Classify as high, mod, low production by sub-watershed. Use ODFW 1995 weir trapping data to support. | Section 3.7 |
| What would be the expected relative freshwater production level of anadromous salmonid species based on current aquatic habitat, riparian vegetation, and terrestrial indicators (e.g. road densities and management history) | Section 3.7 |
| What would be the potential future freshwater production level of anadromous salnonid species based on current aquatic habitat, riparian vegetation, and terrestrial indicators (e.g. road densities and management history)? All production estimates should break down by life history stage. For example use the age class breakdowns for young of the year/ pre-smolts (0+) and smolts (1+). | Section 3.7 |
| Which fish hatcheries are found in the Rogue Basin and where are they located? Why and when were they established? | Section 3.7 |
| What are the current stocking locations? | Section 3.7 |
| What are the natural and human created barriers to fish migration and their location within the watershed? | Section 3.7 |
| What is the relative mileage of potential fish habitat, by species, above culverts that is not currently occupied by fish? | Section 3.7 |
| Are there any know locations of T&E or sensitive macroinvertebrates or aquatic mollusks in the watershed? Based on known habitat requirements, what are potential areas of high, moderate and low potential occurrence? | Section 3.7 |
| What is the expected historic distribution of fish species within the watershed? (e.g. map of fish distribution by species. May not be able to produce for non-salmonids.) | Section 3.7 |
| Based on historic vegetative, stream channel and aquatic habitat indicators what would be the expected historic freshwater production levels of anadromous salmonid species within the watershed? Classify as high, mod, low production by sub-watershed. Document supporting criteria. | Section 3.7 |
| Which fish species have been historically stocked in the watershed? What have been the stocking levels by year? Where have the stocking locations historically been? | Section 3.7 |
| What is the relative magnitude of individual passage barriers on fish distribution based on fish species, potential habitat above the barrier, and degree of obstruction to migration? Consider both adult an juvenile life stages. | Section 3.7 |
| What are the anthropogenic activities that have influenced the current habitat condition? | Section 4.0 |
| What natural processes or historic anthropogenic activities have influenced historic habitat conditions? Link with landslide/ mass wasting section. | Section 4.0 |

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| What anthropogenic activities or natural processes are influencing fish population trends relative to historic population numbers? | Section 4.0 |
| If stocking is occurring in the watershed should it continue? Why? If stocking is not occurring in the watershed should it be initiated? Why? | Section 4.0 |
| What functions do natural barriers perform in the overall maintenance of diverse aquatic habitats and species composition/evolution? | Section 4.0 |
| What locations, based on priority by species and abundance, are in need of restoration efforts? Display by high, mod, low and document supporting criteria | Section 4.0 |
| Where would the priority locations for fish stocking occur or be discontinued? Where would the priority locations for fish stocking occur? | Section 4.0 |
| **Fire Hazard and Risk** | |
| What risk is the current condition posing? | Section 3.5 |
| How has fire historically influenced this ecosystem? | Section 3.5 |
| What would be the effect of reintroducing fire into the ecosystem? | Section 4.0 |
| What is the feasibility of reintroducing fire into the ecosystem? | Section 4.0 |
| **Opportunities for Commodity Extraction** | |
| Where are there opportunities within the next 5-10 years for timber harvest activities and what are the recommended treatments? | Section 4.0 |
| What Special Forest Products (SPF) exist within the watershed and where are there opportunities for removal of these products? | Section 4.0 |

Consistent with the directives of the Federal Guide for Watershed Analysis (Regional Ecosystem Office, 1995), the key questions listed above were developed to help focus the Trail Creek Watershed analysis on the ecosystem elements and other watershed issues that are or may be influenced by management decisions. These questions represent core topic areas considered relevant to this particular watershed.

**Issues Identified by the Rogue Institute for Ecology and Economy**

Key questions identified during the Outreach and Education Project of the Upper Rogue Watershed Council (Preister, 1997) were summarized into four main issues (see Table 2-2). Questions that were identified as specific to Trail Creek for each of these topic areas are listed below each topic heading. It should be noted that many of the comments received during the project did not acknowledge specific geographical areas, but nonetheless may have come from residents in the Trail Creek Watershed who were commenting on conditions or issues observed in their area. These comments are therefore not reflected in the following list. However, the author of the project report did present a summary of the concerns of each community in the Upper Rogue Watershed. According to the report, Trail residents were quite concerned about trash problems in their area with accompanying pollution of local creeks, leaky septic tanks, the increase in population, four wheeling, and education [of watershed issues] in the schools. Many of the comments listed in the report reflect strong opinions about local forest

**TABLE 2-2**

**Key Questions Identified During the Outreach and Education Project of the Upper Rogue Watershed Council**

| Key Questions | Watershed Analysis Document Section(s) |
|---|---|
| **Human Uses and Aquatic Ecosystems - Physical Components** | |
| Does the water quality of Trail Creek have any potential effects on human health? | Section 4.0 |
| What are the current conditions of water quality due to unauthorized human uses? | Section 4.0 |

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|---|---|
| Will the quantity of groundwater be affected by development in the watershed? | Section 4.0 |
| **Terrestrial Ecosystems - Vegetation** | |
| What impact do the unharvested dead, dying, and blowdown trees have on the watershed? | Section 4.0 |
| **Terrestrial Ecosystems - Wildlife** | |
| What impact will hunting restrictions have on predator populations, such as cougars? | Section 4.0 |
| **Aquatic Ecosystems - Biological Components** | |
| What effects does erosion have on fish spawning? | Section 4.0 |
| What impacts does removing brush and other woody vegetation have on stream habitat? | Section 4.0 |
| How does water quality affect fish and other aquatic organisms? | Section 4.0 |

practices, particularly with respect to the impact of clear-cutting, management of dead and dying trees, the use of controlled burns, spraying, and road maintenance and access (Preister, 1997).

These questions indicate that Trail residents were largely concerned with human use impacts, particularly the effects of development in terms of water quality and habitat degradation.

**<u>Issued Identified During Watershed Analysis Consultations</u>**

No comments were received as the result of the advertisements; however, one comment (from a representative of the Tiller District of the U.S. Forest Service) was provided as the result of the individual letters that were mailed. The remaining comments were the result of telephone calls initiated during the watershed analysis. The key questions associates with these issues identified during the public scoping effort of the watershed analysis are summarized below.

Again, the comments received from those interviewed generally reflect some agreement that human impacts are of greatest concern. The two most prominent concerns noted during the interviews pertained to 1) water quantity in the watershed and the effects of over-appropriation of water on fish habitat; and 2) open dumping of garbage along the river banks. Other respondents noted access to public lands and the general effects of development on water quality.

**TABLE 2-3**

**Key Questions Identified During Watershed Analysis**

| Key Questions | Source for Identifying Issue | Watershed Analysis Document Sections(s) |
|---|---|---|
| **Human Uses** | | |
| What are the current conditions regarding unauthorized uses of the watershed? | Mr. Fred Fleetwood, Resident - Personal conversation 11/12/98;<br>Ms. Carol Fishman, Upper Rogue Watershed Association, Personal conversation, 11/13/98; | Section 3.1 |
| What are the regional public concerns regarding road access? | Mr. Ken Phippen -USFS Tiller Ranger District, Umpqua National Forest - Personal conversation, 11/10/98 | Section 3.1 |
| **Human Uses and Aquatic Ecosystems** | | |
| How does development along the streams impact water quality? | Mr. Bob Jones, Medford Water Commission - Personal conversation 11/12/98 | Section 4.0 |

| | | |
|---|---|---|
| How has trash dumping along stream banks affected the watershed? | Dr. Rose Marie Davis, Jackson County Soil and Water Conservation District - Personal conversation, 11/12/98 | Section 4.1 |
| What affect do water rights have on stream ecology (especially fish habitat)? | Mr. Mike Evenson, Oregon Fish & Wildlife - Personal conversation, 11/18/98; Dr. Rose Marie Davis, Jackson County Soil and Water Conservation District - Personal conversation, 11/12/98 | Section 4.1 |
| Describe the conflicts between management of grazing allotments and conformance to the NW Forest Management Plan. | Mr. Ken Phippen, USFS Tiller Ranger District, Umpqua National. Forest - Personal conversation 11/10/98 | Section 4.1 |
| **Riparian Ecosystems** | | |
| How has ditch effluent from stormwater runoff impact wetlands? | Ms. Bea Frederickson, Shady Cove Resident - Letter to Upper Rogue Watershed Association, 11/5/98 | Section 4.0 |
| Has logging high in the watershed impacted riparian areas? | Mr. Bob Jones, Medford Water Commission - Personal conversation, 11/12/98 | Section 4.0 |
| **Aquatic Ecosystems - Biological Components** | | |
| How do temperature increases impact fish habitat? | Mr. Fred Fleetwood, Resident - Personal conversation, 11/12/98; Mr. Bob Jones, Medford Water Commission - Personal conversation 11/12/98; Mr. Mike Evenson, Oregon Fish & Wildlife - Personal conversation, 11/18/98 | Section 4.0 |
| How does water quantity in terms of flow affect fish habitat, particularly coho salmon and steelhead trout? | Mr. Fred Fleetwood, Resident - Personal conversation, 11/12/98 Mr. Larry Menteer, Water Master, Oregon Water Resources Dept. - personal conversation, 11/12/98 | Section 4.0 |
| How does turbidity impact Trail Creek aquatic habitat? | Mr. Fred Fleetwood, Resident - Personal conversation, 11/12/98; Mr. Bob Jones, Medford Water Commission - Personal conversation, 11/12/98 | Section 4.0 |

# 3.0 CURRENT AND REFERENCE CONDITIONS

## 3.1 Human Use

**Reference Human Use Conditions**

Little historic information exists specifically for the Trail Creek watershed. However, relatively thorough historic information has been compiled for the adjoining Elk Creek watershed. Given the proximities of the two watersheds and their comparable physical and biological characteristics, it is assumed that valuable information could be derived from the Elk Creek record that will have relevance to the Trail Creek watershed. Consequently, the historic account of human activities in the Trail Creek watershed is in part from extrapolating the well-documented history of the adjoining Elk Creek watershed.

In employing this relationship, the following differences between the Elk Creek and Trail Creek watersheds are noted. The headwaters of Elk Creek are at approximately 5,500 feet above sea level and the pass is steep and rugged. Trail Creek watershed, on the other hand, is lower in elevation (the pass is only approximately 3,300 feet above sea level) and smaller in overall land area. As a consequence of this geography, Trail Creek was used as the main route over the Umpqua divide and has been comparatively well-traveled since the early to mid-19th century.

As another consequence of the difference in elevation, the flora and fauna of the upper reaches of the Trail Creek watershed are more comparable to those of the lower, or southern two-thirds of the land area within the Elk Creek watershed. As a whole, the land area within the Trail Creek watershed has been more accessible, and therefore underwent development earlier than Elk Creek watershed lands. Overall, these differences are accounted for in the following discussions.

***Native Americans***

Jeff LaLande, of the U.S. Forest Service (Rogue River National Forest) researched the history of human interaction with the Elk Creek watershed (LaLande, 1996). Based on LaLande's research, much can be extrapolated to include the Trail Creek watershed. For example, the first human beings arrive in southwestern Oregon may have done so approximately 13,000 to 10,000 years ago. Evidence of these "Paleo-Indians" has not been found in the Elk Creek or Trail Creek watershed, however, it is likely that these populations may have been present in the area. There have been extensive studies associated with the Lost Creek and Elk Creek dams done in the 1970's and 1980's. These studies indicate that initial occupation began about 5,000 years ago and intensified in the last 2,000 years (Winthrop, 1999).

Evidence in Elk Creek suggests that occupation was predominantly on the broad, wide alluvial terraces on the west side of that watershed and that travel out of the watershed by upland populations may have followed major ridges leading toward the Rogue-Umpqua Divide (LaLande, 1996). Occupation and migration patterns for Trail Creek watershed lands is likely very similar in nature, particularly due to its relatively better accessibility. It is noted that a number of sites have been recorded in the watershed relating to the Native American and early historic periods; however, many of these sites have been looted and severely damaged in recent years.

Early native populations relied on elk, deer, and other game and other forest-derived products (such as berries, roots, and nuts) for sustenance and likely took advantage of the Rogue River fishery. It is known that fire was used to drive game and to enhance the browse vegetation the animals fed on. Anthropogenic (human set) fires also served to create, maintain, or restore favorite plant-gathering areas, such as oak groves and meadows (LaLande, 1996).

According to LaLande, Native Americans set fires to preserve the California black oak component of the transition/mixed-conifer forest. The health and dominance of different types of vegetation on the lands within the watershed or Rogue River Valley were significantly influenced by the fire management techniques of indigenous populations.

For example, low intensity fire was used in oak groves to clear obstructions to seed and acorn gathering, and fire on lower elevation prairies was used to gather sunflower and tarweed seeds and maintain prairies. Other purposes for fire included communication and for driving deer into traps (Pullen, 1996). Effects of Native American fire use are discussed later in this section.

Indian populations were largely absent from southwest Oregon as a combined consequence of disease and warfare with the newly arriving Euro-Americans by the mid 19th century. The Rogue Indian Wars, which lasted from 1852 through 1856, ended with the removal of all local surviving Native Americans to distant reservations (Pullen, 1996). This resulted in the cessation of careful management of plant communities.

***Euro-Americans***

*Exploration and Early Use*

The first arrival of Euro-Americans to the Rogue River Valley and perhaps the vicinity of the Trail Creek watershed occurred in the early 1800s, when fur trappers traveled through the valley. Although pelt trading was responsible for bringing white explorers into the region, beaver populations along the Rogue were apparently not numerous enough to support prolonged fur trapping. It is likely that if early-day trapping did take place in the Elk Creek watershed (and presumably the adjacent Trail Creek watershed), that it may have been done with disregard to sustaining the beaver population, resulting in a substantial decrease in beaver numbers before settlement of the region occurred (LaLande, 1996). According to LaLande, the removal of beaver from the area, in addition to influencing settlement, may have also altered the characteristics of the streams by removing beaver-caused stream morphological features. Potential impacts are discussed later in this section.

*Settlement*

Though no mining is known to have occurred in the Trail Creek watershed, mining directly influenced the development of the region and thereby indirectly influenced the settlement of the watershed. The discovery of gold in the 1850s brought a number of settlers to the Upper Rogue region, although no mines were specifically identified within the Trail Creek watershed during this study. The Red Cloud Mine Road, shown on a map of the area printed in approximately 1932, takes off from the main stem of Trail Creek and heads northwest to the Red Cloud and Mammoth Load mines located in the adjoining watershed to the west. In <u>Yonder Hills: Persist, Trail, Etna</u> (Hegne, 1989), mention is made of the Umpqua Copper Mine, the Vickory Mine, and the Buzzard Mine; however, none of these are located in the Trail Creek watershed. Although it appears that mining has not been a significant human use of the watershed, nearby mining activities along the divide likely influenced the development of roads through the watershed.

The swelling population of the upper Rogue River Valley, in response to mining and homesteading, increased the demand for meat. Reliance on the watershed for agricultural purposes was documented in the early 1870s with hog ranching in the vicinity of Trail (Hegne, 1989). Between the 1870s and early 1900s, the dominant activities in the Trail Creek watershed were logging and ranching, and in 1889, Jackson County was ranked second only to Lane County, Oregon, in terms of swine production. By 1892, one rancher in the watershed began irrigating by digging a ditch from Trail Creek to land up the Canyon Creek drainage.

Homesteaders that arrived in the area in the late 1800s also used the watershed as a source of timber, and by the turn of the century, the area economy was based heavily on the timber industry. In many cases, people used homesteading to obtain land and then sold it to private lumber companies (LaLande, 1980). Other homesteaded lands were developed for housing and agriculture, predominantly limited to sites at lower elevations. In response to this development, services were established in the Trail Creek watershed, including a school district in 1879 and a post office in 1893 By the turn of the century, a sustained population had been established (Hegne, 1989).

Early logging methods involved using oxen and “booming” logs down the river to Gold Hill by chaining cut trees together and sliding them down the hill to the river. Several mills sprang up in the area. The Swingle Mill was located approximately six miles up Trail Creek; the Marcks Mill was a steam-driven mill about two miles up Trail Creek; the Adamson Mill was located in Trail; another mill was apparently located somewhere in the upper part of the watershed and may have been the Johnson or Lausmann Mill; the Jantzer Mill was located on the West Fork of Trail Creek; and the Al Hall Sawmill was located on the Rogue River just below Trail (Hegne, 1989). Most “timber claim” homesteaders left the area by 1920 due to the decreased market value of timber, and by then only two sawmills serviced the entire area. While logging dwindled, the watershed continued to be used for ranching (LaLande, 1980). Effects of these activities on resources in the watershed are discussed in later sections.

*Federal Land Management*

Federal management of lands in the watershed began shortly after the turn of the century through the U.S. Forest Service. Sheep and cattle grazing along the divide was fairly heavy from 1910 to the early 1930s, and grazing management became one of the important missions of the U.S. Forest Service for that area. In addition to private landowners, the federal government was also heavily involved in the logging industry in Trail Creek. Simultaneously, the U.S. Forest Service had embarked on a campaign to suppress fires. Federal land management activities were administered from a ranger station in Trail at the time (LaLande, 1980). Effects of these early land management practices and policies are discussed in later sections.

By 1932, a map of the area (Metsker’s Atlas of Jackson County) shows the familiar checkerboard pattern of private land and public, or government-owned land. This development pattern was a result of the Oregon & California Railroad (O & C) project in the 1860s. The federal government granted the O&C land to develop a railroad from Portland to California. The railroad was to sell the property to finance the project; however, over the years, disputes arose over how the railroad was using the land. Eventually, the federal government took back the unsold portion of the railroad land. Unfortunately, the counties (including Jackson County) relied heavily on property taxes paid by the O&C for revenue. The ensuing dispute between the counties and the federal government resulted in the O&C Lands Act of 1937, which enabled the counties to share the money the federal government earns when it cuts timber on those lands. Even though the railroad never went through the Trail Creek watershed, the reverting of O&C lands back to federal control were a catalyst for the formation of the BLM in 1946.

*Post World War II*

A resurgence in the local timber industry occurred during World War II, but then decreased substantially afterward in the early 1950s (LaLande, 1980). Private lands were almost exclusively tractor logged in the 1940s and 1950s. Cable yarding systems were used in the 1960s. The BLM used tractor logging methods, but steep lands were later logged by cable. In the 1970s and 1980s, all the downed woody material left behind from previous logging was removed and sold to chip markets (Welden, 1998). Effects of these activities on resources in the watershed are discussed in later sections.

Federal logging activities in the area were and remain an important part of the county’s economy. In the 1950s, the counties agreed to reinvest 25 percent of the O&C receipts into road building, reforestation, and other improvements on federal lands (Russell E. Getty, 1960 *in* Follansbee and Pollock, 1978). The importance of the O&C logging revenues was again demonstrated in the 1980s. Again, timber prices fell, and the resulting drop in O&C revenues brought the layoff of half the county’s employees during fiscal year 1983-84. In 1993, O&C money made up half of Jackson County government’s “general operating fund” (Jackson County, 1993).

***Transportation and Access***

Few improved roads existed in the watershed until the latter half of the 1900s. Historical information on roads indicate that a military road was surveyed as early as 1853. This road may have originally been a Native American trail that had gone north from Shady Cove, past Trail and across Trail Creek, and on up the watershed, eventually crossing Lewis and Elk Creeks (Hegne, 1989). The road is believed to have been connected to a military road that had gone to Fort Klamath. Consequently, the road in Trail Creek was perhaps used by settlers as a primary route across the divide (Carlton, 1960). Later, the Red Cloud Mine Road, which was still shown on Metsker's 1932 Jackson County Atlas map of the region, headed west off of the main stem of Trail Creek to the Red Cloud and Mammoth Load Mines.

Numerous trails are shown on Metsker's Atlas indicating increased access and use in the Trail Creek watershed through settlement and early federal land management. Most of the trails were high in the watershed, originating in the sub-watersheds and traversing along the ridges. The Chicago Trail, for example, was located on the west side of the watershed along Cleveland Ridge. The age and purpose of the trails is not documented; however, they may have been a result of work conducted by the Civilian Conservation Corps during the Depression. Such road and trail building was documented in the Elk Creek watershed and may have extended to the Trail Creek watershed. The trails may also have been related to earlier mining or grazing activities in the upper reaches of the watershed.

## Current Human Use Conditions

Dominant human activities within the Trail Creek watershed consist of rural residential development, silviculture and agriculture, light commercial development, use of roads for local and regional access, and recreation. The following discussion provides a detailed account of these activities by the federal government and private landowners in the watershed.

### *Riparian Reserves*

Figure 3-1 presents adjustments to BLM land use allocations for the addition of Riparian Reserves. This land use allocation has been established as part of this watershed analysis along streams, wetlands, and ponds where the conservation of riparian-dependent terrestrial resources receive primary emphasis. Interim guidelines for widths of Riparian Reserves are stated in the Record of Decision for the Medford District, Resource Management Plan. For purposes of this analysis, BLM has directed use of a 170 foot site tree.

Consequently, Riparian Reserves were established along fish-bearing streams at a total width of 680 feet and along non-fish bearing streams at a total width of 340 feet. Designation of fish-bearing streams will be discussed in detail in later sections. All streams meet the definition presented in the Record of Decision. Pursuant to the Northwest Forest Plan and the Medford District Resource Management Plan, the Riparian Reserve designation supersedes any previous land use designation.

The addition of the Riparian Reserve designation resulted in the adjustments to land use allocations presented in Table 3-1. Cumulatively, 3,182 acres, or 22 percent, of land that are managed by the BLM have been designated Riparian Reserve. Of these lands, approximately one quarter is located in the Lower West Fork of Trail Creek and approximately one quarter is located in the Upper East Fork. The remaining Riparian Reserve land is distributed over the Wall Creek and Chicago Creek tributaries and the lower reaches and Upper West Fork of Trail Creek.

In terms of management emphasis, most lands managed by the BLM (approximately 66 percent) are in the General Forest Management Area land use allocation. Timber production is the primary land management emphasis on these lands. Lands recently acquired from the Rogue National Forest not in Riparian Reserve are not currently designated but have been managed for timber production. Connectivity Blocks are also managed for timber production but receive additional habitat management consideration. When combined with Riparian Reserves, about 29 percent of the lands within BLM boundaries are managed for late successional species and/or riparian and aquatic habitat is the primary emphasis.

**TABLE 3-1**

**Acreages of BLM Land Use Allocations**

| Land Use Allocation | Acreage | Percentage |
|---|---|---|
| Matrix - Northern General Forest Management Area | 7545 | 52 |
| Matrix - Southern General Forest Management Area | 2050 | 14 |
| Matrix - Connectivity Block | 1067 | 7 |

| | | |
|---|---|---|
| Riparian Reserves | 3182 | 22 |
| Exchange Land | 796 | 5 |

***Transportation and Access***

The current transportation system provides the basis for most of the current human uses in the watershed. The watershed is most effectively accessed by ground transportation. State Highway 227 is the major arterial road running north-south through the watershed between the town of Trail and the Rogue-Umpqua divide. Several collector roads exist within the watershed providing access to each sub-watershed via roads following the major named drainages displayed in Figure 1-2. An extensive local road system also exists, providing access for residential properties, commodity extraction, and recreation, as well as for unauthorized uses.

Air transportation provides a secondary means to access the watershed, which is particularly important from the standpoint of fire suppression. Based on field reconnaissance, most of the watershed has suitable topography for the use of air attack resources and established helipad sites have been developed to support response, if needed. No fixed wing airstrips exist in the watershed. Overall, these systems are reflective of the historical uses in the watershed and have the ability to support current human uses as well as increased potential uses as demand warrants.

Approximately 190 miles of active roads exist within the Trail Creek watershed. This represents a road density of about 3.5 miles per square mile, more or less evenly distributed throughout each sub-watershed. Approximately half exist on BLM-administered lands such that the road density is slightly higher (about 4.1 miles per square mile) than on non-BLM administered lands (about 3.1 miles). It is noted that most of the non-BLM roads exist on private lands, of which most are gated, posted, or otherwise restricted. A significant abandoned or permanently closed road network also exists in the watershed (approximately 110 miles), most of which occur on non-BLM lands (about 85 miles). Only about 25 miles of abandoned or permanently closed roads exist on BLM-lands, meaning that of the historically constructed roads, about four-fifths are still open for public access. Further summaries related to road surfacing and traffic are presented in Section 3.2 within the context of road erosion. Overall, this road access reflects the historical use of the watershed for commodity extraction as well as the management of these roads amongst the different landowner categories.

***Housing and Human Occupation***

One of the primary uses of the Trail Creek watershed is to support human habitation and related commercial activities. Until the past two decades, the predominant human occupancy pattern has generally been static since the 1930s. Based on zoning maps, tax assessor records, and planning maps, the upper part of the drainage has been primarily used for resource extraction, with scattered small residential farming or ranching parcels. In the lower portion of the watershed, usage has been residential or small business with indications of some multi-family parcels. Based on taxable dwellings lists and a conversation with Connie Florry of Jackson County (1998), growth in the watershed was 43% from 1975 to 1985 and 49% from 1985 to 1995. Growth was primarily in the lower reaches of the watershed and along the Rogue River just below the watershed.

Typical development along the creeks in the watershed have been small “hobby” farms or small ranches. Irrigation of pastures by withdrawal of creek water has reduced the historical base flow of creeks in the watershed. Utilization of water rights associated with properties adjoining creeks in the watershed has also reduced total water quantity available in the watershed for other uses. This is not a major land use as any agriculture in the watershed is predominantly dry land.

Development of small farms and ranches potentially affects water quality in the Trail Creek watershed. Grazing and overgrazing of developed pastures increases soil erosion and degrades creek water quality. Development of timber resources may also have an effect on soil erosion properties and subsequent surface water quality. The Bureau of Land Management has classified most of the timber resources in the Trail Creek watershed as Category 4 – low intensity management. However, the tax structure of Jackson County promotes the use of these lands for the production of wood products, which may change the overall impact on the watershed from these activities.

***Timber Forest Products***

Currently, private industrial and the larger small private landowner categories are actively managed for timber product extraction. These lands are managed primarily under an even-aged silvicultural system consisting predominantly of clearcut methods. The current methods for timber extraction are conducted pursuant to Oregon Forest Practice Rules and reflect the historical evolution of logging practices described above. Currently, timber inventories on private lands represent young second growth stand conditions, most of which have not reached mature stand conditions. These vegetation patterns will be further described in Section 3.5.

Furthermore, as will be presented later, site productivity is relatively low in this watershed, further delaying the development of merchantable stands. Consequently, the opportunity for commodity extraction on private lands is significantly lower than was historically referenced above. It is noted that this situation can change due to factors such as mill demand and prices, but currently this does not appear to be the case. Therefore, there is and will likely be the level of harvesting that was historically experienced on these lands in the near future.

On BLM and USFS lands, there has been a dramatic downturn in the timber harvest levels since 1991 as a result of the court-ordered halt of federal timber harvest within the range of the northern spotted owl. As was noted earlier, approximately half of the BLM-administered lands are now designated in land use allocations where timber management is not a primary management emphasis. On these remaining lands, a significant merchantable timber base does exist where mature stand conditions predominate.

Most of these stands have been managed using shelterwood harvesting and most of these stands exhibit suitable understory regeneration. Consequently, the next forest management activity would be overstory removal. Secondarily, some stands have not had successful understory regeneration and there also do exist a significant number of dense, mature stands which have had no shelterwood entries. Discussion of these vegetation patterns will be described in greater detail in later sections. Overall, significant opportunity for forest product extraction does currently exist on BLM-administered lands, however, it is recognized that more than just timber availability factors into this type of recommendation, topics that will be addressed later in this document.

***Non-Timber Forest Products***

The predominant non-timber forest products in the Trail Creek watershed are firewood, madrone (for peelers), burl wood, and unmerchantable woody material extracted for chip markets and hog fuel. Other non-timber products include mushrooms, boughs for wreaths and other decorative uses, Christmas trees, mosses, and other greenery. Pit-run rock is sold from BLM-managed quarries for $0.50 per cubic yard. The rock is usually purchased by Shady Cove and Trail residents. Total receipts for these products are not available, as many of the products are collected from individuals who do not consistently obtain permits that would enable the BLM to track the value of these products.

***Current Agricultural Activities***

Grazing on public lands occurs on four grazing allotments in the Trail Creek watershed: Trail Creek, Clear Creek, Sugarloaf, and Longbranch. Of these, only the Trail Creek Allotment is located entirely within the watershed boundary. The Allotments are not heavily used. For example, according to data supplied by the BLM, only five cows graze the Trail Creek Allotment between April and November. Only 14 cows graze the Clear

Creek and Sugarloaf Allotments, which both extend into the Elk Creek watershed to the north. Clear Creek is grazed from May until the end of October each year and Sugarloaf is reportedly grazed only between the months of April and June. The Longbranch Allotment is vacant except for 320 acres in the southeast portion, which may handle 22 cows between April and May.

No cultivated lands or orchards were observed in the Trail Creek watershed. A combination of poor soil type, aspect, and slope prevent the land in the watershed from being useful for crop production. The watershed supports pasture land, some of which is irrigated but otherwise is predominantly dryland.

### *Commercial Uses*

The small community of Trail supports a handful of tourism-based businesses, including independent fishing and rafting guides, a convenience store and cafe, and boat rental facilities. The historic Rogue Elk Hotel is located in Trail, but is on Highway 62 just outside of the watershed boundary. Shady Cove, south of the watershed, has a more diverse service-based business community, including a gas station, health care clinic, bank, fishing and tackle store, small grocery store, and real estate offices. The businesses in Trail and Shady Cove generally serve local residents, although the tourist based businesses in these communities are in response to local attractions such as the Rogue River, Lost Creek Lake, and pass-through traffic en route to Crater Lake.

### *Recreation*

Opportunities for recreation in the Trail Creek watershed are limited due to the unavailability of developed facilities such as trails, picnic areas, and campgrounds. In addition, road closures and access restrictions on public lands is reducing the area available for dispersed recreation activities such as hunting, primitive camping, or biking. This condition has been the cause of recent friction between federal land managers and recreation users of the watershed. Trail Creek is also closed to fishing, further reducing the draw to the area for ancillary recreation purposes (such as camping and picnicking).

The Rattlesnake Crags-Main Cliffs area of the watershed, which is located on one of the lower tributaries to the West Fork of Trail Creek, has recently begun drawing rock climbing enthusiasts. Established routes for climbers are present on the cliffs, and access trails are being developed by users of the area. Technical information on the routes and access to the climbing area has been developed and is available at Medford area mountaineering stores. It could be anticipated that word of mouth will result in increased use of the area for climbing activities, enhancing the appeal of the watershed to local recreationists'.

### *Treaty/Tribal Rights*

There are no treaty or tribal rights established in the Trail Creek watershed (Winthrop, 1999). Attempts were made to interview the cultural resource coordinators for the Cow Creek Band of the Umpqua Indians, the Confederated Tribes of the Grand Ronde, and the Confederated Tribes of the Siletz to determine if there were any other specific Native American concerns associated with the Trail Creek watershed. There has not yet been a response as of this writing. In addition, the Confederated Tribes of the Grand Ronde, listed on a stakeholder list provided by the BLM, were notified in writing at the onset of this project to solicit comments for consideration during the watershed analysis; no response was received.

### *Unauthorized Uses*

Trash dumping is a significant problem in the watershed. During reconnaissance of the area, numerous dumping ground locations were observed, frequently adjacent to Trail Creek and its tributaries. The trash dumping problem was the most visible unauthorized use of the watershed, and may result from a variety of factors, including a lack of readily accessible transfer stations, the cost of garbage collection, or other sociological conditions. Dumping locations were prevalent in areas readily accessible from primary and secondary roadways in the watershed. The concern over the effects of trash dumping was voiced during personal conversations with individuals familiar with the watershed. Observed dumping locations appeared to be primarily comprised of domestic garbage and household appliances, although detailed inventory was not taken.

Illegal withdrawal of water from Trail Creek and its tributaries is apparently a known problem in the watershed, although apparently only a few specific instances have been documented and reported to the Jackson County Water Master. Individuals concerned with this issue voiced particular frustration at what they perceive as a lack of action on the part of enforcement agencies and the State Water Board. The Water Master reported that one or two instances of alleged illegal withdrawal of water have been checked out (Menteer, 1998). In general, the concern over illegal withdrawal of water and over appropriation of water rights is exacerbated by the seasonally-limited water availability.

## 3.2 Erosion Processes

Mass wasting, hillslope erosion, road erosion, and channel erosion are examined in this analysis. Relative importance and location of erosion processes are identified. Current conditions, trends of the dominant erosion processes, and management/human-related activity effects are evaluated in comparison to historical (reference) conditions to the degree possible from the historical aerial photography record and field observations made during this analysis.

**<u>Watershed Overview</u>**

The Trail Creek watershed is located in southwestern Oregon, north of Medford, in Jackson and Douglas Counties. Elevation in the watershed varies from 1,436 feet at the mouth of Trail Creek to 4,698 feet at Threehorn Mountain, located on the watershed's northern margin. Annual precipitation ranges from approximately 34 inches near the mouth of Trail Creek to approximately 52 inches at the northwestern watershed divide. Most of the precipitation in the watershed falls as rain, with little snow accumulation occurring below 3,000 feet. Above 3,000 feet, snow accumulations can be significant. Warm winter storms are common, and substantial snowmelt can occur. Most surface erosion occurs in the watershed during winter and spring months when approximately 70% of annual precipitation occurs.

The entire Trail Creek basin is formed from Tertiary (1.6 to 66 million years ago.) Western Cascade volcanoclastic rocks originally deposited predominantly as flows and ash deposits on a nearly flat to gently sloping landscape. Formations found in the watershed include basaltic and andesitic lava flows and flow breccias, including stratified and interbedded tuffaceous (ash) sediments and volcanic conglomerates, and ash-flow tuff, the latter found in the central portion of the West Fork sub-watershed. The watershed has not been glaciated, and little structural deformation has occurred since deposition of the volcanoclastic flows. Although some minor faulting is evident in the watershed, the stream system has generally been free to downcut into and through the volcanic layers unhindered by structural controls. A classic dendritic drainage system has formed, and with very few exceptions, developing a normal sequence of high gradient tributaries leading to progressively lower gradient and larger channels.

The Trail Creek watershed is characterized by rugged topography with irregular ridges and deep narrow valleys. Quaternary (1.6 million years ago to present) alluvial floodplain deposits occur along the lower reaches of the West Fork and Trail Creek. Gentle to moderate slopes predominate in the southern area (lower elevations) of the watershed, with slope gradient generally increasing with increasing elevation to the north, toward the watershed divide. Steep slopes occur along sharp ridges between major tributaries where in some cases substantial flow-edge rock escarpments (cliffs) have formed. Steep slopes are also associated with inner gorges that occur adjacent to many of the larger streams in the watershed, including portions of the East Fork, the West Fork above Chicago Creek, Canyon Creek, and an extensive length of Wall Creek.

The volcanoclastic parent materials in the watershed form a variety of soil series and soil characteristics. Shallow, stony soils tend to form on steep, south-facing slopes. Most areas form deep to very deep, cobbly to gravelly, clay loam soils that range from well to poorly drained. A pervasive characteristic with management implications is the high clay content of the subsoil horizons: clay content typically ranges from 35 to 60 percent below a depth of approximately 6 to 12 inches. Due to high clay content, drainage of some soils, particularly the Medco series, is described as poor, resulting in seasonally perched water tables. Alluvial formations and soils are confined primarily to the West Fork and main stem of Trail Creek. These areas are nearly flat and are comprised of stratified sands, gravels, and interbeds of finer textured layers. Erodibility of these materials is highly variable, they are generally well drained, and compactibility is less than that of the upland soils.

**Reference Conditions**

The reference condition for this watershed is fully-forested, subject to periodic severe wildfire that affected all or part of the watershed. Mass wasting during forested periods was generally associated with major storms and floods. Channel-scouring debris flows (debris torrents) undoubtedly occurred in steep first, second, and some third order channels, depositing coarse sediment and LWD into transport/response transitional areas. However, no debris torrents were observed to have occurred in the Trail Creek watershed during the photo record made available for this analysis (1966, 1969, 1975, 1985, and 1996). This suggests that debris torrents may never have been as frequent as is common for steeper and more failure-prone areas of the Oregon and Washington Cascades, Coast ranges, and Siskiyou Mountains.

Prior to disturbance of soils by road construction, logging, and forest conversion to non-forest land uses, surface erosion of well-forested areas rarely occurred in the watershed, with the possible exception of erosion that occurred immediately following severe wildfire. Thin and stony soils, which are often sparsely vegetated with hardwoods and grasses, may also have been subject to surface erosion. However, most natural erosion within the watershed likely occurred as mass wasting, soil creep, and related streambank and channel erosion, most of which is likely to have occurred during major flood events.

Many watershed analyses have concluded that historical logging practices have contributed large quantities of mass wasting and surface erosion sediment to streams. Steep slopes were commonly tractor logged downhill on excavated skid trails to log landings and road systems located adjacent to streams, and streams were not protected by streamside buffers. While these practices were used in some areas of Trail Creek, they do not appear to have been pervasive, and by 1966, evidence of such practices was not commonly evident from the aerial photography. Early logging and road management practices, followed by later periods of heavy road construction in the late 1950's, 1960's, and 1970's, almost certainly contributed larger quantities of hillslope and road surface erosion than currently occurs. However, the contrast in contributed sediment is not as great as has occurred in many other watersheds.

**Current Mass Wasting Conditions**

The landslide hazard assessment for the Trail Creek watershed was conducted according to the Washington State Manual for Watershed Analysis (Version 3.0, 1995). The primary objectives of this analysis are to identify the geomorphic circumstances where landslides are most likely to occur, to identify and map these locations, and to identify any management practices that contribute to the occurrence of landslides in the watershed.

Deep-seated slumps and earthflows are common in the Trail Creek watershed and are associated with the clay rich soils formed from volcanoclastic parent materials that underlie the entire watershed. Ancient slump/earthflows occupy major areas of the moderate and low gradient slopes of the watershed, particularly in areas of weaker formations (flow breccias and ash tuffs). Although these forms of failure typically do not deliver large volumes of sediment to stream systems and are not particularly sensitive to management activities, road construction or harvest activities on slump/earthflow formations are associated with local reactivation and acceleration of erosion processes.

Shallow-rapid forms of mass wasting (debris avalanches and debris flows) are much more sensitive to forest management activities and can have substantial effects on stream systems. However, relatively few debris avalanches were observed within the watershed, and no debris flows were observed to have occurred in the watershed's stream channels. As a result, although a moderate number of failures were observed, the quantity of sediment delivered to streams from mass wasting processes is relatively low.

### *Background*

Mass wasting is a major erosion process in many forested watersheds of the northwest. Three types of mass wasting contribute to stream habitat change: deep-seated slumps and earthflows, shallow planar failures (debris avalanches), and debris flows down stream channels, sometimes referred to as debris torrents. The most significant factors affecting slope stability are slope gradient and ground water, although additional factors such as composition, depth, and degree of weathering of parent materials, and micro-topographic features are also important.

Slumps and earthflows are typically triggered by the build-up of pore water pressure in mechanically weak, and often clay-rich, parent materials. Earthflows are commonly reported as significant processes in western Oregon, California, and Washington. Debris avalanches are most common on slopes steeper than 65% (Benda et al., 1997) and are primarily associated with two specific landforms: bedrock hollows (also referred to as swales or zero-order basins), and stream-adjacent inner gorges. Debris avalanches and debris torrents are the two forms most likely to be influenced by forest management activities (Ice, 1985). Debris torrents are the form of mass wasting most destructive to stream habitat (WFPB, 1995).

Roads are the predominant cause of increased rates of mass wasting associated with forest management, with acceleration factors due to roads commonly found to be in the range of ten to one hundred times greater for roads than for harvesting (Swanston and Swanson, 1976). Road fill failures, including fill failures associated with culvert blockages and diversions, are the predominant form of road-associated mass wasting.

Rates of debris avalanche on steep sites can be accelerated during the first 6 to 15 years following clearcut harvest due to loss of apparent soil cohesion attributed to root decay (Benda et al., 1997; Gray and Megahan, 1981). Rates of failure acceleration in clearcuts versus forest have been reported to range from 1.0 to 8.7 times.

### *Methods*

Aerial photo analysis and field investigations were used to analyze the hazard for mass wasting for the Trail Creek watershed. Four sets of aerial photographs were examined to identify landslide locations and the history of mass wasting in the watershed (1966/69, 1975, 1985, and 1996). Locations of landslides observed on the aerial photos were plotted on a watershed base map (Figure 3-2), and landslide features were recorded in a database (Appendix A, Table A-1).

Field investigations were also conducted. A number of the landslides identified from the aerial photos during this analysis were visited during these field investigations. Additional landslides located during the course of the field investigations were also recorded on the map and their characteristics recorded in the database. Physical characteristics of the landslides and local geomorphic circumstances were confirmed and/or recorded, as was any evidence of past management activities and their potential contribution to failure occurrence. All landslides were classified according to the conventions in the Manual.

***Landslide Inventory***

A total of 45 landslides were observed within the 55 $mi^2$ Trail Creek watershed, a density of 0.82 landslides per $mi^2$. The characteristics of each landslide observed are recorded in Table A-1 for sub-watersheds.[1] All of the landslides were considered to have originated, or at least to have been reactivated, relatively recently.

As shown in Table A-2, landslide types were nearly evenly split between small, deep-seated (SSD) failures and shallow rapid (SR) failures (debris avalanches). Nearly two-thirds of the failures were associated with roads that contributed to failure through undercutting and removal of lateral support or through failure of fill materials. No evidence of debris torrents was observed.

Volume of failures was estimated based on surface area of each area as estimated by size class from the aerial photos or as observed in the field, and by applying representative failure depth of 3 feet for shallow rapid failures, and 10 feet for deep forms of failure. Percentage of failure volume delivered to streams was also estimated from the photos or estimated in the field. Mass wasting sediment and delivery is summarized in Table 3-2. An estimated 2,400 tons of sediment was delivered to streams from the observed failures over approximately 35 years of photo record. This translates to about 1.3 tons/$mi^2$/year of delivered sediment, a rate which is an order of magnitude less than that from road surface erosion (see Road Erosion section below).

***Landslide Hazard Classes and Mass Wasting Management Units***

Standard Manual procedures call for classification of the watershed into Mass Wasting Management Units (MWMU). Each MWMU is classified as having high, medium, or low potential for mass wasting to deliver sediment to streams if a failure were to occur, and also rated for combined potential hazard of mass wasting and sediment delivery to streams.

[1] Seven logical divisions of the watershed were delineated and are referred to as sub-watersheds (Figure 1-5) for the hydrologic analysis. These same sub-watersheds were used to facilitate the mass wasting, surface erosion, and sediment budget analyses.

**TABLE 3-2**

**Mass Sediment and Delivery**

| Sub-watershed | Number of failures | Failure area (acres) | Failure volume (tons) | Delivered volume (tons) |
|---|---|---|---|---|
| Chicago Creek | 3 | 0.12 | 1,400 | 340 |
| Lower East Fork | 4 | 0.17 | 1,700 | 140 |
| Lower Trail Creek | 4 | 0.50 | 7,000 | 1,460 |
| Lower West Fork | 7 | 0.29 | 3,800 | 0 |
| Upper East Fork | 17 | 1.03 | 18,100 | 470 |
| Upper West Fork | 7 | 0.79 | 10,800 | 0 |
| Wall Creek | 3 | 0.12 | 2,700 | 0 |
| Total | 45 | 3.02 | 45,500 | 2,410 |

Forty-five landslides were observed to have occurred in the watershed (0.82 landslides per mi$^2$) since or shortly prior to 1966. Twenty-nine failures were associated with roads, eight failures were associated with harvest units, and eight failures were not associated with management (i.e., natural) (see Table A-2). This is a moderately low rate of mass wasting for watersheds west of the Cascades.

Four MWMU were defined and mapped based on observed landslide occurrence and associated geomorphic characteristics. Table 3-3 presents associated mass wasting management unit hazard ratings. Road-related sediment delivery hazard is rated high for one unit, moderate for two of the units, and low for one unit. Harvest-related sediment delivery hazard is rated moderate for two units, and low for two units.

*Mass Wasting Management Unit #1*

MWMU #1 occurs on gentle to moderately steep (~20 to 50%) slopes formed in deep soils from heterogeneous and stratified volcanic flow breccias, tuff, basalt and andesite, sediment, and from basaltic andesite flows. These areas are generally located downslope from steeper slopes formed from more competent basalt and andesite flows found near the watershed divide (see Table A-1 and Figure 3-3). Large, geologically ancient, deep-seated failures are inferred throughout the MWMU. Twenty-four road-associated failures occurred (0.99 failures/mi$^2$ in 30 years) within the unit (see Table A-2). Roads located in old earthflow toes, headwall source areas, and concave areas where water is concentrated contributed to several slump/earthflow (small, sporadic deep-seated) reactivation failures in the

**TABLE 3-3**

**Mass Wasting Management Unit Hazard Ratings**

| MWMU | Mass Wasting Potential | | Delivery Potential | | Hazard Rating | |
|---|---|---|---|---|---|---|
| | roads | harvest | roads | harvest | roads | harvest |
| 1 | M | M | M | L | M | L |
| 2 | H | M | H | M | H | M |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | M | M | M | M | M | M |
| 4 | L | L | L | L | L | L |

MWMU. Mass wasting potential and delivery potential are both rated moderate, yielding a moderate hazard for roads in the unit. Four failures were associated with harvesting within the unit (0.16 failures/$mi^2$ in 30 years); mass wasting potential for harvest is rated medium, but delivery potential is rated low, yielding a low overall hazard for harvest for this unit.

*Mass Wasting Management Unit #2*

MWMU #2 occurs on moderately steep (50 to 70%) and steep stream-adjacent and mid-slope areas formed from heterogeneous and stratified volcanic flow breccias, tuff, basalt and andesite, sediment. MWMU #2 areas are found downslope of more gently sloped and more slump-earthflow prone MWMU #1 areas, but also lie downslope of a MWMU #3 area in the northwestern portion of the watershed. Soil depth is shallow in rocky convex and planar areas, becoming deepest in many concave areas where colluvial materials have collected. Rock cliffs occur extensively as flow-edge benches in several areas of MWMU #2. Three failures, none of which were natural, were located within the unit. However, very few roads or harvest areas are located within the unit. Potential hazards were considered to be relatively high if the area were subject to road development. Sediment delivery hazard associated with roads is rated high because of the steep slopes common in the unit, and because the unit is generally located adjacent to streams where there is a relatively high hazard of sediment delivery. Mass wasting potential and delivery potential associated with harvest were considered to be lower than for roads, but moderate ratings were justified.

*Mass Wasting Management Unit #3*

MWMU #3 occurs on ridges and ridge-adjacent steep and moderately steep colluvial headwall basins formed from basalt, andesite, and breccia flows. These areas are found in the northern half of the watershed below the ridges that surround the watershed at higher elevations, where annual precipitation is generally greatest. Two road and two harvest-associated failures were located within this unit. Although the density of failures observed for this unit is relatively low (0.50 failures/$mi^2$ in 30 years), roads constructed on slopes steeper than 70% in this unit were considered to pose a moderate hazard of failure and sediment delivery. Harvest of concave headwalls and locations where water is concentrated on slopes steeper than 70% also poses moderate hazard of failure and sediment delivery.

*Mass Wasting Management Unit #4*

MWMU #4 is an extensive unit found in the southern part of the watershed that occurs on moderate to gentle slopes formed from heterogeneous and stratified volcanic flow breccias, tuff, basalt and andesite, sediment, and from basaltic andesite flows. While geologic materials of this unit are similar to those of MWMU #1, precipitation is typically 10 to 20 inches less, slump-earthflow topography is uncommon, and reactivation rarely observed. Five failures were located within this unit, with only two of these related to management; density of management associated failures is 0.11 failures/$mi^2$ in 30 years. Hazards for both roads and harvest are rated low.

### ***Confidence in Work Products***

Confidence in the work products for this analysis is moderately high. Four sets of aerial photographs were reviewed, coverage was complete, and quality of the photography quite good. Additional photography, particularly prior to 1964, would increase completeness of the inventory and provide additional historical perspective. Although mass failures could not always be detected in some areas due to presence of dense timber stands, additional failures were located and geomorphic relationships confirmed or established during the field investigations, including field inspection of approximately 80% of the road mileage in the watershed.

Mapping of mass wasting management units was completed at a reconnaissance level of precision from aerial photography, geologic maps, and topographic maps, and could be improved with additional study. However, the level of mapping detail and interpretation of processes is adequate to define the important mass wasting relationships in the watershed, particularly given the relatively few number of failures that deliver sediment to streams in the watershed. Confidence is high that this watershed has a moderate level of mass wasting activity and low to moderate sensitivity to management in most areas, and that high hazard areas have been identified.

**Current Hillslope Erosion Conditions**

The hillslope erosion analysis for the Trail Creek watershed was conducted in accordance with the Surface Erosion module in the Watershed Analysis Manual (Version 3.0, 1995) and is based on extensive field investigation and review of aerial photography.

Soil disturbance associated with forest harvesting can result in erosion and subsequent delivery of eroded materials (sediment) to streams. However, erosion and sediment delivery caused by harvesting only occurs where 1) soils are disturbed, 2) disturbed soils are subject to overland flow and particle detachment (erosion), and 3) eroded soil particles (sediment) are transported to streams without deposition onto the forest floor.

***Soil Erodibility***

The Natural Resources Conservation Service (NRCS) mapped the soils of the watershed on ortho-photography as part of the Jackson County Soil Survey (USDA SCS, 1993)[2]. The NRCS identified at least 16 different soil series and numerous series phases within the watershed. The most prevalent soil types in the watershed are the McMullin, McNull, and Medco series, which are described as shallow to moderately deep (12 to 40 inches in depth) and well drained.

Soil erodibility "K" factors for the soils found in the watershed fall almost entirely within the low (K < 0.25) and moderate (K = 0.25 to 0.40) erodibility classes (see Figure 3-4). The relatively low K factors indicate that these soils are generally not easily detached, or are moderately detachable. However, erodibility of some upland soils in the watershed is described by the county survey as moderate to high, these interpretations being largely a function of slope steepness (see Figure 3-6). Erosion potential considering K factor and slope was evaluated according to Table 3-4 (adapted from Manual Table B-1) and is displayed for the watershed in Figure 3-5.

[2] Soils in the northwestern part of the watershed within Douglas County and/or within the Umpqua National Forest have not been mapped by the NRCS.

### Hillslope Erosion and Delivery

Hillslope erosion and delivery was evaluated through a combination of aerial photo surveys and field observations. Although much of the forested area of the watershed has been harvested in the last 50-70 years, no harvest within the past five years (the period used in the standard methodology for assessing harvest-related erosion) has occurred on federal lands, and harvested acreage of private lands is not extensive.[3]

Examination of the most recent aerial photos (1996 color) revealed no evidence of substantial hillslope erosion associated with recent logging. Areas of relatively recent logging activity were examined during the course of mass wasting and road erosion field work. No evidence of substantial hillslope erosion and sediment delivery due to recent harvest activities was observed in these areas. Although there may be recently logged areas within the watershed that have eroded and delivered sediment to streams that were unobserved, unless Oregon Forest Practices Act stream buffer and timber harvest requirements were violated, it is highly unlikely that volume of sediment delivery is substantial within the Trail Creek sub-watersheds.[4]

### Hillslope Erosion Conclusions

Logging practices within the past five years have not contributed substantial amounts of delivered sediment to streams in the Trail Creek watershed (see Sediment Budget section below for additional discussion of delivered quantities). Delivery of eroded material due to harvest activities was not observed. The erosion potential ratings from existing soil surveys are heavily based on slope steepness although hillslope erosion associated with logging was not observed. The conclusion reached is that there is very little correlation

[3]Exact acreage recently harvested areas has not been measured. However, approximate percent watershed area recently harvested is estimated to be between zero and 10 percent.

[4]The Federal Guide notes that in general, any process that contributes less than one-tenth the sediment of another can be ignored (Regional Ecosystem Office, 1995, page EP-16). Surface erosion from roads, and perhaps even mass wasting, are believed to be far more important processes within Trail Creek, and to meet the can-be-ignored guidance.

**TABLE 3-4**

**Erodibility Ratings Based on K Factor and Slope**

| Slope | K < 0.25 | 0.25 < K < 0.40 | K > 0.40 |
|---|---|---|---|
| < 30% | Low | Low | Moderate |
| 30 – 65% | Low | High | High |
| > 65% | Moderate | High | High |

between NRCS hazard ratings and the occurrence of hillslope erosion under current conditions.

## Current Road Erosion Conditions

The road erosion and delivery analysis for the Trail Creek watershed was conducted in accordance with the Surface Erosion module in the Watershed Analysis Manual (Version 3.0, 1995) and is based on extensive field investigation and review of aerial photography.[5]

Many of the roads in the watershed are either paved or rock surfaced. Sections of paved road run directly adjacent to stream segments along the lower reaches of Trail Creek; sections of gravel road is also adjacent to West Fork Trail Creek. Much of the road mileage in forested portions of the watershed is rock surfaced, and many roads are gated, and therefore receive little traffic outside of periods of active harvest, which are limited to specific times and locations. Unsurfaced roads have poor bearing strength when wet, and are potentially subject to rutting, concentration of surface flows, and substantial delivery of sediment to streams.

### *Background*

While all roads generate erosion, only a portion of the road system actually delivers sediment to streams (Ketcheson and Megahan, 1996; Megahan and Ketcheson, 1996). Sediment is delivered to streams from forest roads in two ways: 1) "directly" via road ditches that drain directly into streams, and 2) "indirectly" via drainage structures where sediments are discharged onto forest slopes and where some portion of the sediment eventually reaches streams. In the case of direct delivery via road ditches, 100% of the eroded volume from the road cutslope, ditch, and portion of the road tread runoff contributing to the ditch is delivered to the stream system. In the case of indirect delivery, some or all of the sediment discharged from the road does not reach streams due to the filtering and sediment trapping effects of intervening buffer strips (Elliot et. al, 1997; Haupt, 1959; Ketcheson and Megahan, 1996; Megahan and Ketcheson, 1996; Packer, 1967).

### *Sediment Delivery Modeling*

The standard Watershed Analysis methodology for modeling erosion and sediment delivery rates from roads was applied, with some modification. Some of the standard assumptions are not appropriate for much of the road system in the Trail Creek watershed, and were adjusted for this Level 2 analysis.[6]

The primary variables that affect the road erosion and sediment delivery processes include traffic rates, surfacing materials, drainage design, and erodibility of soils based on the soil's geologic parent material. Coefficients for each of these primary factors vary relative to a standard

[5] Seven logical divisions of the watershed were delineated and are referred to as sub-watersheds (Figure 1-5) for the hydrologic analysis. These same sub-watersheds were used to facilitate the mass wasting, surface erosion, and sediment budget analyses.

[6] Level 2 analyses per Washington procedures are conducted by analysts with more advanced education and experience. Level 2 allows flexibility to modify standard observation and modeling procedures to provide improved assessment of key questions. Level 2 analyses per the Federal Guide (Regional Ecosystem Office, 1995) require more field observations and calculation of rates than does Level 1.

"Reference Road." The Reference Road is insloped with a ditch, has native surface road tread and ditch, cutslope gradient of 1:1, fillslope gradient of 1.5:1, sustained grade of 5-7 percent, and average cross drain spacing of 500 feet. The proportions of the total long-term average road erosion rates attributed to the components of the standard road prism are: road tread - 40%; cutslope/ditch - 40%; and fillslope - 20%. Standard coefficients for road tread surfacing, traffic use, and sediment delivery are presented below.

**Standard coefficients for the Road Tread Surfacing Factor are:**

| | |
|---|---|
| Native: | 1.0 |
| Gravel, 2-6" deep | 0.5 |
| Gravel, >6" deep | 0.2 |
| Dust oil: | 0.15 |
| Paved: | 0.03 |

**Standard coefficients for the Traffic Use Factor are:**

| | |
|---|---|
| Mainline (heavy truck traffic) | 20 |
| Active Secondary (moderate truck traffic) | 2 |
| Inactive Secondary (light traffic) | 1 |
| Abandoned (no traffic) | .02 |

**Standard Sediment Delivery coefficients are:**

| | |
|---|---|
| Direct Delivery | 1.0 |
| Roads within 200 feet of streams | 0.1 |
| Roads > 200 feet from streams | 0 |

Rather than sampling selected road segments and extrapolating the results to the entire road system in the watershed (as suggested in the manual), two types of potential delivery sites were evaluated throughout the watershed: 1) locations where road segments within 200 feet of a stream, and 2) locations where roads crossed streams. Nearly every segment within two hundred feet of streams was evaluated. Sediment delivery to stream crossing was evaluated at 11% of all crossings, and results extrapolated to the entire road system based on the total number of crossings. This improved procedure allows near complete verification of delivery from stream-adjacent road segments, and provides more accurate quantification of delivery from road crossings, which is where the majority of road sediment delivery occurs in most watersheds, and within the Trail Creek watershed.

Many road segments in the watershed do not fit the description of the "Reference Road;" this is particularly true for roads on the gentle slopes and valley bottoms of the lower elevations in the watershed. For many of the road segments in these areas, there are little or no cuts and fills, and in many cases roads were either crowned or outsloped without a ditch. Rather than apply the standard assumption coefficients for road tread, fill slopes, cuts and ditches to road segments where they were inappropriate, the appropriate weighting coefficient for each road prism was assigned proportional to the width of that component, i.e., the average widths of road tread, cutslope, and fillslope for each road segment were measured and coefficients for each component were assigned proportional to the percentage of area occupied by that component.[7]

The Watershed Analysis Manual provides standard coefficients for cutslope and fillslope vegetative cover and rock. Percent cutslope and fillslope cover for each road segment was estimated and the standard coefficients were applied in the modeling. The delivery coefficients were applied in the standard manner for each segment evaluated.

Table B-5 of the Watershed Analysis Manual provides Basic Erosion Rates (in tons/acre) for various geologic parent materials for application in the road modeling. The rates in the Manual Table vary from a low of 10 to a high of 110 tons/acre. All upland soils in the Trail Creek watershed are derived from volcanoclastic rocks that are highly weathered, which typically increases relative erodibility of parent materials. These soils also have very high clay content, which makes them more resistant to detachment. In consideration of these factors, and based on direct observation of material behavior in the watershed, basic erosion rates of 30 tons/acre for roads greater than two

[7] WWA has conducted several Level II road erosion analyses employing this modification of the standard procedure, including analyses which have been peer reviewed by authors of the standard Manual procedure and approved per Washington's rigorous review process.

years old, and 60 tons/acre for roads less than two years old were used (i.e., the “Moderate” Basic Erosion Rate from Table B-5 of the Manual). The standard modeling procedures were then applied to each road segment evaluated.

Detailed road erosion and sediment delivery spreadsheet calculations are shown in Table B-1 (Appendix B). Road types are mapped in Figure 3-7. The results for stream crossings were subtotaled for each road type, and an average delivery per crossing (in tons/year) was calculated for each road type. The number of stream crossings was then counted and tabulated by road type for each sub-watershed. Multiplying the average delivery per crossing for each road type by the number of crossings of that road type and then summing across all road types yields the total delivery from stream crossings in each sub-watershed (Table B-2, Appendix B). The sediment contributions from stream-adjacent road segments in each sub-watershed were then added to the sediment contributions calculated for crossings to arrive at a total road sediment delivery estimate for each sub-watershed.

Natural background rates of erosion were calculated for each sub-watershed using Standard Manual procedures (see Table B-3, Appendix B). Soil creep rates were determined on the basis of slope. A soil depth of 1 meter was used in all sub-watersheds. The total length of stream in the sub-watershed was first multiplied by 2 (two sides of the stream), then multiplied by the estimated soil depth and creep rate to yield an annual sediment volume. This annual sediment volume was then converted to an annual sediment yield and adjusted for the coarse fragment fraction to arrive at the annual fine sediment yield for each sub-watershed.

### *Road Erosion and Sediment Delivery Results and Conclusions*

The modeling and spreadsheet calculations reveal that road erosion and sediment delivery is a substantial contributor of fine sediment to streams in the Trail Creek watershed. The significance of road erosion and sediment delivery within each sub-watershed is shown in the last column of Table B-4, % Increase Factor (Appendix B). The road erosion increase factor for each sub-watershed is computed by dividing delivered road sediment by the natural background rate of erosion. Where the increase factor is less than 0.5, it receives a Low Hazard Rating, between 0.5 and 1.0 the hazard is Moderate, and when greater than 1.0 (road sediment exceeds natural sediment), the rating is High.

The road sediment increase factor exceeds 0.5 for all of the sub-watersheds except one (Upper West Fork); the increase factor ranges from 28% (in the Upper West Fork) to 101% (in the Upper East Fork). Five sub-watersheds (Chicago Creek, Lower West Fork, Wall Creek, Lower East Fork, Lower Trail Creek), as well as the entire watershed, therefore receive a hazard rating of Moderate. The Upper East Fork receives a hazard rating of High. The Upper West Fork receives a hazard rating of Low.

A number of factors contribute to the high road sediment delivery in the watershed: long contributing road lengths between cross drains, insloped or crowned road surfaces, unsurfaced or lightly surfaced roads, and relatively high road and stream densities. Potential actions to reduce road sediment delivery include addition of cross drains near stream crossings, rocking road surfaces near stream crossings, outsloping road surfaces, and installing gates or berms to reduce traffic.

### *Confidence in Work Products*

Road erosion and sediment delivery rates used in this analysis are based on the standard modeling approach. While simplifications, averages, and generalized coefficients are relied upon heavily within the methodology, the approach is basically sound and applies well to Trail Creek. Several Level II adjustments to the standard procedure were also applied to more realistically represent local road sediment delivery circumstances; consequently, confidence in the predicted quantity of total delivered road sediment is moderate. Furthermore, nearly 100% of all stream-adjacent road segments and 11% of all stream crossings were field inspected. Therefore, confidence is high that circumstances where roads have high sediment delivery potential were correctly identified, and that important cause and effect erosion and sediment delivery mechanisms were correctly identified.

The increase factors rely on estimates of natural background rates of erosion and also on the Basic Erosion Rates for roads. While the estimates for each of these rates was based on the standard manual methodology, the absolute accuracy of either method is unknown. Confidence in the estimates for the increase factors is no greater than moderate; however, confidence is moderately high that the relative importance of road erosion and delivery within each sub-watershed was correctly identified.

***BLM Road Inventory, Sediment Delivery Potential, and Maintenance Priorities***

In July and August, 1998, the BLM inventoried all roads on BLM ownership within the Trail Creek watershed. Numerous characteristics relating to road character, existing condition, and erosion were recorded in a database for 154 road segments, and 89.64 miles of road. Segment length varied from 0.05 to 2.96 miles, and averaged 0.58 miles. All roads are single lane, with 2.4 miles classed as arterial, 22.1 miles as collector, and the remaining 65.1 miles as “single lane”. Subgrade width varies from 12 to 17 feet and averages 14.7 feet. All but 9.5 miles of this road system are surfaced with crushed gravel, or are grid rolled with pit run rock.

Several features directly related to erosion and potential delivery of sediment to streams were recorded. 4.78 miles of road tread were found to be yielding; that is, the road tread was depressed where log truck tires had repeatedly passed over it, creating channels that potentially direct water to erosion-producing locations. 5.77 miles of the road tread were found to be eroding. Substantial ditch erosion was noted for several road segments. For characteristics relating to mass wasting, seven segments were found to have a major slide, with one segment having two slides. Several segments have cutslope failures. Only 0.05 miles of road were located within headwall topography, which is typically is high hazard for shallow planar forms of mass wasting. Twenty percent (18.2 miles) of the road system occurs near streams within 200 feet of streams, including mileage at stream crossings.

The detail provided by the BLM road inventory allows identification of those road segments most likely to deliver sediment to streams. For this watershed assessment, a sediment delivery potential index was developed from ten road characteristics that were considered to best indicate this potential. These characteristics are:

- % Road tread yield if ≥ 10% segment length
- % Road tread erosion if ≥ 5% segment length
- Cross drain outlets if rated poor
- % ditchline erosion if ≥ 10% segment length < 4" deep or ≥ 5% segment length 4 to 12" deep or > 0% >12" deep
- > 0 major slides
- > 0% headwall topography
- > 0 cutslope slides if > 45 cu. yds.
- > 2 cutslope slides if < 45 cu. yds.
- Cutbank erosion rated medium or high
- % segment length within 200 feet of streams

The Index of relative sediment delivery potential for each road segment was then computed as the total number of these factors that occurred multiplied by the percent segment length within 200 feet of streams. Index values computed in this manner varied from 0 to 500. Looking at the distribution of index scores, scores of < 20, 20 to 50, and > 50 were considered to best reflect low, moderate, and high potential for sediment delivery. Using this system, 21 road segments (10.88 miles) indicate high potential, 22 segments (17.73 miles indicate moderate potential, and 144 segments (61.03 miles) indicate low potential. Figure 3-8 provides a map of these low, moderate and high delivery potential locations (Table B-6; Appendix B).

**Sediment Budget**

The relative importance of four types of erosion processes was estimated for the Trail Creek watershed in relation to natural rates of erosion: mass wasting, hillslope erosion, road erosion, and stream channel erosion. Sediment delivery rates are summarized for each type by sub-watershed in Table 3-5. The natural rate of erosion of 1,187 tons/year for the Trail Creek watershed was calculated in the Road Erosion section of this report.

As discussed in the Hillslope Erosion section, accelerated delivery of sediment to streams from hillslope erosion associated with forest harvesting was not observed from units harvested within the past five years – the standard time frame for evaluation. Accordingly, delivered sediment due to hillslope erosion is considered to be negligible in the Trail Creek watershed for all sub-watersheds, as indicated in Table 3-5. Stream channels in the watershed were observed for several important processes and characteristics, including evidence of accelerated streambank and channel bed erosion. Channels in the headwaters and third order channels were found to be quite stable. Unstable banks in downstream locations within the alluvial formations adjacent to the West Fork and lower Trail Creek were observed at few locations. However, some degree of instability is expected for channels passing through alluvial deposits. It is inherently difficult to estimate an annual average quantity of streambank erosion, particularly when based on a limited number of observations. Because only limited streambank erosion was observed, which may not be measurably different from that which occurs in undisturbed conditions, accelerated stream channel erosion was considered to be negligible throughout the watershed for the current condition. However, road surface erosion and mass wasting within the watershed were found to be more substantial.

**TABLE 3-5**

**Sediment Budget**

| Sub-watershed | Natural erosion (tons/yr) | Mass wasting (tons/yr) | Harvest-related (tons/yr) | Road sediment (tons/yr) | Channel erosion (tons/yr) | Total sediment (tons/yr) | Increase over natural |
|---|---|---|---|---|---|---|---|
| Chicago Creek | 82 | 10 | N | 54 | N | 145 | 77% |
| Lower East Fork | 141 | 4 | N | 92 | N | 238 | 68% |
| Lower Trail Creek | 175 | 42 | N | 163 | N | 380 | 117% |
| Lower West Fork | 314 | 0 | N | 268 | N | 582 | 85% |
| Upper East Fork | 246 | 14 | N | 249 | N | 509 | 107% |
| Upper West Fork | 91 | 0 | N | 26 | N | 116 | 28% |
| Wall Creek | 138 | 0 | N | 93 | N | 231 | 67% |
| Total | 1,187 | 69 | 0 | 944 | 0 | 2,200 | 85% |

N - negligible amounts of sediment are delivered from channels and harvest units in comparison to other sources.

Table 3-5 shows that roads are the single greatest source of management-related delivered sediment in the watershed. For the Trail Creek watershed, road surface erosion alone increased sediment delivery by 80%, and exceeded 100% for the Upper East Fork sub-watershed. Mass wasting has been found to be the dominant source of natural and management-related sediment within many watersheds, but this is not the case for Trail Creek. As indicated in Table 3-5, mass wasting, including failures with no management association, added only 69 tons/yr – an increase of only 6% above natural. Increases in individual sub-watersheds were no more than 24% (Lower Trail Creek sub-watershed). While sediment contributed to streams from mass wasting in the watershed is not considered inconsequential, it is relatively small in comparison to surface erosion from roads.

## Culvert Sizing

Culvert diameters were measured at 17 locations. Culvert capacities were calculated based on Adams, et al. (1986) using a headwater depth of 1.0 diameter. Drainage area above each culvert location was measured from USGS topographic maps using a planimeter, and 100-year flood flows were calculated based on Adams et al. (1986). Two-year flows were also calculated based on standard USGS methods (Harris, et al. 1979) as a cross-check procedure, and were found to compare quite closely to the flows computed from Adams et al. (1986). Appendix Table B-5 summarizes the results of these calculations. On average, the 100-year flow is 3.5 times the culvert capacity. Table B-5 indicates that on average, the culverts sampled are sized for approximately the 2-year flow.

## Soil Productivity and Resiliency

Douglas-fir site index values are provided for each soil series mapped in the watershed (USDA SCS, 1993), as displayed in Figure 3-9. Productivity of the soils in the watershed is low to moderate, with King site classes ranging from 3 to 5. Acreage by site class is summarized for the watershed in Table 3-6. In general, site indices are lowest in the southern portions and lowest elevations of the watershed, although low site indices are also found throughout the watershed in areas of rock exposure and shallow soils with high rock content.

Shallow soils in the watershed are typically lithic (high stone content) and typically have moderate clay content. As a result, these soils may be less subject to compaction, rutting, and puddling than the deeper upland soils that characterize the more productive and forested areas of the watershed. Most of the deeper soils in the watershed have high clay content and are subject to the processes mentioned above. Of particular note are the Medco

**TABLE 3-6**

**Soil Timber Productivity**

| King Site Index | Acreage | Percentage |
|---|---|---|
| III | 5309 | 15 |
| IV | 10565 | 30 |
| V | 18302 | 52 |
| Unclassified * | 1130 | 3 |
| Total | 35306 | 100 |

* Unclassified due to lack of soil productivity information on some Forest Service lands.

soils; Medco variants are found throughout the watershed, particularly in the central and southern portions. Medco soils are high in clay content, and permeability is restricted by clay layers, leading to perched water tables persistent through the months of December to March. These properties cause Medco soils to be particularly susceptible to soil disturbance, rutting, and compaction during ground-based harvesting and site preparation activities if conducted during periods when soil moisture is greater than twenty-five percent.

Most of the watershed has been harvested at some time during the past 50 years. Some areas have been commercially thinned following earlier clearcut logging. Both logging and silvicultural practices have changed substantially between these entries. During the first entry, gentle and moderate slopes as steep as 50% were tractor logged on private lands within the watershed. Soil disturbance, removal of soil surface horizons, compaction, and subsequent erosion caused substantial loss of soil productivity, particularly where skid trails were excavated. Effects in these areas can be expected to persist for decades. Although these areas are recovering, impacts on the most heavily disturbed surfaces can be expected to persist for several more decades. Even on gently sloped areas where trails are not excavated, first-entry old-growth tractor logging typically resulted in deep soil disturbance and persistent loss of productivity. The percentage of the watershed affected by these first-entry tractor logging activities is unknown; however, the percentage of the area affected within tractor units has been reported to approximate 30 percent (Wooldridge, 1960).

Extensive first-entry cable logging occurred on the watershed's steeper slopes found throughout the watershed. Although some soil disturbance and compaction is known to be associated with cable logging, the percent area affected and degree of effect is far less than that caused by tractor logging.

Recent harvest activities in the watershed are not extensive. It is expected that cable and various types of mechanical logging will be used in many areas previously tractor logged. For instance, tractor logging of federal acreage is now typically restricted to slopes of less than 35 percent slope. Most trees logged in the future are expected to be substantially smaller than those logged previously, and soil disturbance due to soil gouging may be reduced. In addition, site preparation methods that disturb or severely burn the soil are now generally avoided. Although land management practices vary with ownership (i.e., federal vs. private), in general, soil compaction, disturbance, and erosion are expected to be decreased per unit area harvested, and effects are expected to be much less persistent than those associated with past practices.

## 3.3 Hydrologic Change

### Reference Conditions

The reference condition for this watershed is fully forested, interrupted by widespread severe wildfire at intervals of several decades to centuries. Wildfires may have caused partial water repellency of soils in severely burned areas for one to five years following fire. Overland flow in some areas of the watershed may have then occurred, causing elevated peak flows. Wildfire influenced rain-on-snow flood effects were minimal due to the low elevation of the watershed (see Current Conditions fully-clearcut results). In this analysis, snowmelt-associated floods are simulated based on the current condition of the watershed's vegetation in comparison to a hypothetical fully-forested reference condition.[8]

**Current Conditions**

This report presents the findings of a Hydrologic Conditions Assessment for the Trail Creek watershed conducted according to the Washington Forest Practices Board Standard Methodology for Conducting Watershed Analysis, Version 3.0 (WFPB, 1995). The purpose of the Hydrologic Conditions Assessment is to evaluate the effects of forest cover removal on peak flows in the watershed.

This analysis includes discussion of the following topics: summary of current watershed conditions, review of large peak flows and low flows, modeling of peak flow increases caused by mid-winter rain-on-snow (ROS) events, hazard calls, conclusions, and confidence in work products.

***Overview***

The fundamental underlying assumption of the Washington hydrologic analysis procedure (WFPB, 1995) is that the greatest likelihood of cumulative changes in forest hydrologic processes is due to increases in peak flows attributable to the influence of timber harvest on snow accumulation and melt rates during rain-on-snow (ROS) events. The WFPB methodology predicts changes in peak flow magnitude. Changes in peak flow frequency and duration are not explicitly addressed. However, it is inferred that where substantial increases in peak flow magnitude occur, corresponding increases in peak flow frequency and duration are also likely to occur.

The WAR analysis provides a means of estimating the magnitude of changes in water available for runoff (WAR) that are likely to be produced by rain-on-snow conditions for various levels of hydrologic maturity and for various flood recurrence intervals. For this analysis, we applied the basic Manual procedure using local climatic data to estimate values for the processes which generate WAR, including storm rainfall, snow accumulation, and snow melt. WAR estimates were then used to estimate peak flows.

We modeled a range of conditions under which ROS-generated WAR might occur. Each scenario represents a particular combination of three conditions: precipitation amount, storm type, and the hydrologic maturity of vegetation in the drainage. Precipitation amounts used in this assessment are the 24-hour totals for the 2, 5, 10, and 100-year return intervals. Two storm intensities were considered: an "average" storm, representing a typical ROS event; and an "unusual" storm, representing a less frequent, more intense event. Three vegetation cover conditions were considered: "fully-forested," representing the reference conditions; the "current" condition, representing the present day distribution and composition of land use and cover types; and "clearcut," representing removal of all forest canopy cover.

Estimation of the WAR requires addition of the estimated 24-hour snowmelt to the 24-hour precipitation amount for a given return interval. The snowmelt was determined by simulating a 24-hour storm event occurring over a modeled snowpack, taking into consideration the effects of forest cover on snow accumulation and wind speed. Snow accumulates to greater depth in open forests than it does under dense canopy cover, and snow melts faster in open forests during ROS conditions due to greater wind speeds over the snowpack.

Flood frequency analysis is a method of estimating flood magnitudes at selected recurrence intervals.

[8] Non-forest areas (rock, meadows, etc.) and areas permanently converted to non-forest use, such as agricultural lands, were held constant within this analysis for both the reference and current conditions: only private lands adjacent to Trail Creek, the East Fork and West Fork of Trail Creek may have been converted. Moreover, irrespective of conversion, these low elevation lands occur solely within the "lowland" hydrologic response zone, and there is no modeled peak flow response due to forest removal within this zone.

Regional flood frequency relationships have been developed by the USGS for western Oregon, which relate streamflow for various recurrence intervals to drainage basin characteristics. These flood discharge estimates are baseline flood magnitudes, to which we must add the additional flood volume predicted to occur as a result of the melted snow component of WAR during ROS conditions. To do this, we followed standard Manual procedures to develop regression equations which correlate peak flows, as predicted by the USGS regional equations, to 24-hour storm precipitation. Finally, peak flows for each forest cover and meteorologic scenario were estimated by substituting the 24-hour WAR values (in place of precipitation) into these regression equations.

### *Current Watershed Conditions*

The Trail Creek watershed was divided into 7 sub-watersheds[9] (Figure 1-5) for the purposes of this hydrologic assessment. These sub-watersheds allow examination of the potential effects of vegetative manipulation in different areas of the watershed which vary in precipitation and temperature characteristics, and also allow examination of effects as they accumulate in a downstream direction. Current vegetation conditions in the watershed are shown in Figure 1-6. Descriptions of each map unit can be found in Section 1.4. Table C-1 (Appendix C) summarizes vegetation condition by rain-on-snow potential zone by sub-watershed, and a summary of this information for the entire watershed is presented in Figure C-1 (Appendix C).

### *Streamflow and Climatic Records*

Streamflow data is not reported for any locations within the Trail Creek watershed, however, a stream gauge is located near the mouth of Elk Creek, the drainage immediately to the east of Trail Creek.[10] The highest flow of record at the Elk Creek gauge occurred in December, 1964; other large peak flows at this station occurred in December, 1945; January, 1953; December, 1955; January, 1974; and January, 1997. Mean daily discharge tends to be highest in the months of January and February. The lowest flow recorded for the Elk Creek stream gauge occurred in the month of September. Mean daily discharge tends to be lowest in the months of August and September (Moffatt et al., 1990). Mean annual flow, peak flows, and low flows in Trail Creek are likely to be proportionately similar to those reported for Elk Creek. Trail Creek below the West Fork has been reported to go completely dry in some areas, at least in part due to water withdrawals for rural residential domestic and minor agricultural uses, which increases water temperatures and limits fish production. (Evenson, 1998; Menteer, 1998).

### *Rain-on-Snow Modeling*

The standard methodology (WFPB, 1995) was used to model the effects of forest cover removal on peak flows during mid-winter rain-on-snow events. The reference condition for this analysis is the “fully forested” condition.

For more information on the model, its assumptions, and its input parameters, the reader is referred to WFPB (1995).

### *Model inputs*

Vegetation conditions were modeled using vegetative seral stage information shown in Figure 1-6. These vegetation condition categories were grouped into three Hydrologic Condition categories (mature, intermediate, immature) based on their ability to intercept snow and reduce wind at the snow surface. For each Hydrologic Condition category, a forest canopy cover factor ($F_c$) was assigned according to the standard methodology (see Table 3-7).

For “usual” winter conditions, the Manual suggests

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[9] Seven logical divisions of the watershed were delineated and are referred to as sub-watersheds (Figure 1-5) for the hydrologic analysis. These same sub-watersheds were used to facilitate the mass wasting, surface erosion, and sediment budget analyses.

[10] Two other gauges are located within the Elk Creek drainage, but their periods of record are too short for meaningful comparisons.

using the wind speed that is exceeded 50% of the time, as recorded at representative weather stations in the area during mid-winter storms. A value of 4.5 m/s was used in this analysis. For the "unusual" modeled condition, a value of 6.8 m/s was used, representing the 16% exceedance value. These values were developed by Boise Cascade (1998) based on extensive analysis of local data. We confirmed that these wind speeds were reasonable for this analysis by comparing them to regional wind speed values reported by WFPB (1995), where wind speed for nearly all western and eastern Washington weather stations analyzed were less than those used in this analysis for Trail Creek, resulting in conservatively high estimation of snow melt (WFPB Figures C-6a and C-6b).

The regional temperature lapse rate equation reported in the Elk Creek watershed analysis (Boise Cascade Corp., 1998) was also used for this analysis. This relationship was used to calculate a storm temperature for each precipitation zone. For the "unusual" modeled condition, one standard error (assumed to be 2ºC) was added to the modeled temperature for each precipitation zone:

**TABLE 3-7**

**Hydrologic Condition Classes and Forest Canopy Densities Assigned for Each Mapped Vegetation Cover Type**

| Vegetation Cover Type | Hydrologic Condition | Modeled Canopy Density, Fc |
|---|---|---|
| Conifer, > 70% crown closure | Mature | 0.85 |
| Conifer, 10-70% crown closure | Intermediate | 0.4 |
| Conifer, < 10% crown closure | Immature | 0.05 |
| Hardwood | Immature | 0.05 |
| Non-forest | Immature | 0.05 |

Average storm:T (EC) = 12.9 – 0.003 E

Unusual storm:T (EC) = 14.9 – 0.003 E

(E = elevation in meters)

Rain-on-snow potential zones were determined by elevation based on the general procedures of Brunengo et al. (1992), consistent with information obtained from the Elk Creek watershed analysis (Boise Cascade Corp., 1998); these zones are shown in Figure 3-10.

The NOAA Atlas (Miller et al., 1973) was used to determine the 24-hour precipitation intensity for various recurrence intervals for the watershed (see Table C-2).

Average January snowpack data was obtained for a total of 13 snow survey sites. This data was then used in a linear regression to obtain snow water equivalent (SWE) as a function of elevation (see Figure C-2). For "unusual" conditions, one standard error of the estimate was added to the calculated SWE.

To translate Water Available for Runoff (WAR) in the model to a resultant discharge, the standard methodology was used. This approach requires calculation of flood magnitudes of various return intervals for each sub-watershed (see Table C-3, derived from Harris, et al., 1979). A linear regression was then run for flood magnitude versus 24-hour precipitation of the corresponding recurrence interval (see Table C-4). This same input versus output relationship was then used to translate the "enhanced" WAR (from rain-on-snow) into streamflow. The USGS predictions of discharges for each sub-watershed are summarized in Appendix C.

### *Results*

The results for the ROS model simulation are presented in Table C-5 (Appendix C). The first portion of each table deals with predictions of Water Available for Runoff (WAR) for each recurrence interval for each sub-watershed. The data are summarized for a fully forested condition, the current condition, and for a completely clearcut condition. In the lower part of each table, predicted discharges for each recurrence interval are calculated for each sub-watershed. As with WAR, the discharge calculations are presented for the fully forested, current, and fully clearcut condition. Percentage increase calculations above a fully forested condition are shown for the current condition and the fully clearcut condition.

In this simulation, three sub-watersheds (Lower East Fork, Lower Trail Creek, and Lower West Fork) did not generate WAR values in excess of the 24-hour precipitation for the average storm scenario. This resulted because these sub-watersheds include very little area in the ROS elevation zone; therefore, within the simulation, there is no snow to be melted from the Lowland and Rain Dominated zones, irrespective of forest vegetative condition.

Four sub-watersheds generated WAR in excess of the 24-hour precipitation; these were higher elevation sub-watersheds with at least some area in the rain-on-snow zone: Chicago Creek, Upper East Fork, Upper West Fork, and Wall Creek.

The predicted increases in peak flows for the current condition ranged from 0% to 1.8% for the average storm (Table 3-8), and from 1.4% to 8.1% for the unusual storm. With regard to the fully clearcut condition, predicted increases in discharge ranged from 0% to 6.1% for the average storm, and 4.1% to 25.2% for the unusual storm. The most responsive sub-watershed was Wall Creek; this is to be expected, since it has the highest percentage of its area within the higher elevation rain-on-snow precipitation zone.

### *Hazard Calls*

The Washington Watershed analysis methodology assumes that there are no adverse effects associated with peak flow increases of up to 10%. This assumption is made because of the inherent error in the modeling, and because changes in peak flows less than 10% are typically below the detection limits using standard stream gauging techniques. All sub-watersheds in the Trail Creek watershed, as well as the entire watershed as a whole, have predicted increases in peak flows of less than 10% for both the average and unusual storm simulations. Therefore, all sub-watersheds have been assigned a low sensitivity to peak flow increases.

### *Conclusions and Discussion*

Simulation of mid-winter rain-on-snow conditions for the Trail Creek watershed reveals that current rain-on-snow flood magnitudes are not substantially different than the reference condition. Sub-watersheds with the highest percentage of area in the ROS zone were predicted to be most sensitive, but no substantial effects were indicated by the simulation results for current conditions. For the average and unusual storm scenarios, current vegetation conditions produced relatively small increases in peak flows. Proportionately small sub-watershed area that is in a hydrologically immature condition, and small area in the ROS zone, explains the current condition response.

Amount, timing, and delivery of water, sediment, and wood from the forested parts of this watershed are not changed appreciably from the reference conditions due to forest harvest effects on peak flows.[11] Compaction of road surfaces generates overland flow of water, and surface runoff from roads can change the normal flowpaths of forest slope runoff to some degree; however, it is unlikely that these effects on peak flows in the Trail Creek watershed are large enough to affect stream processes because of the limited length of road that discharges water to the stream network (see Erosion section, Roads section). Substantial removal of forest vegetation has occurred in riparian areas adjacent to most of the major tributaries in the watershed, particularly at lower elevations and along the main stem of Trail Creek and the West Fork. Deforestation of these riparian areas can be expected to have major effects on routing of water, sediment, and wood in these streams.

Low flow volume and total water yield in streams draining the forested portions of the watershed (where unaffected by water withdrawals) are likely to exceed quantities that would be produced in the theoretical fully-forested condition. All studies of forested watersheds have demonstrated small increases in low flows and water yield due to removal of vegetation, with only two exceptions that are relevant to the watershed. Decreased low flows have been observed for several years following clearcutting of riparian areas followed by dense regrowth of riparian hardwoods, and decreased low flows have been recorded following old-growth harvest in watersheds subject to heavy fog and low cloud cover, conditions not common to the Trail Creek watershed.

Water withdrawals for domestic use and limited pasture irrigation uses occur along the main stem of Trail Creek and the West Fork, and low flows may be critically low in some years. Withdrawals are pumped from the streams; there are no known surface flow diversions.

One approximately two-acre impoundment, previously used as a sawmill log pond, is located

[11] Substantial changes in delivery of sediment and wood have occurred due to other mechanisms, including effects from roads and riparian management practices.

**TABLE 3-8**

**Predicted Increases in Peak Flows Under Current Vegetative Conditions**

| Sub-Watershed | 2-year | | 5-year | | 10-year | | 100-year | |
|---|---|---|---|---|---|---|---|---|
| | average | unusual | average | unusual | average | unusual | average | unusual |
| Chicago Creek | 1.0% | 8.1% | 0.8% | 6.4% | 0.6% | 5.5% | 0.4% | 3.3% |
| Lower East Fork | 0.0% | 3.9% | 0.0% | 3.0% | 0.0% | 2.5% | 0.0% | 1.4% |
| Lower Trail Creek | 0.0% | 4.3% | 0.0% | 3.3% | 0.0% | 2.7% | 0.0% | 1.6% |
| Lower West Fork | 0.1% | 5.7% | 0.0% | 4.3% | 0.0% | 3.6% | 0.0% | 2.1% |
| Upper East Fork | 1.6% | 6.9% | 1.2% | 5.4% | 1.0% | 4.6% | 0.5% | 2.8% |
| Upper West Fork | 1.8% | 6.4% | 1.3% | 5.0% | 1.1% | 4.3% | 0.6% | 2.6% |
| Wall Creek | 1.8% | 7.6% | 1.4% | 6.0% | 1.1% | 5.1% | 0.7% | 3.1% |
| Total | 0.9% | 6.6% | 0.7% | 5.0% | 0.6% | 4.2% | 0.3% | 2.4% |

adjacent to the West Fork, but it is unlikely that the pond currently affects streamflows measurably. Numerous small ponds of much less than one acre are scattered throughout the watershed, as are a few areas labeled as marshes. No other wetlands are noted on the USGS maps, and only small isolated wet areas were observed during the field work for this analysis. Even within Riparian Reserve areas, wet areas are limited: headwater channels and adjacent slopes are typically steep, and mainstem channels are well entrenched in most areas Changes in ponds and wetlands from the reference condition are unknown.

Hot springs or other sources of geothermal water with potential to affect stream temperatures are not known to occur within the watershed. Eight springs, four of which are named, are shown within the watershed on the USGS 1:24,000 scale topographic maps. Three are shown as feeding perennial streams, three feed intermittent streams, and two appear to be isolated from the stream network. Although some of these springs are named, evidently all of them are small; Streamflow becomes quite low in the West Branch and Trail Creek during the late summer and early fall, and water temperatures are warm evidencing no affect of springs within the watershed.

***Confidence in Work Products***

Caution should be used with regard to the results of the peak flow analysis. The sensitivity of the modeling results to input parameters and the assumptions inherent in the modeling do not lend themselves to a high degree of confidence in the absolute magnitude of the predictions. However, the model does provide a means of assessing the relative potential for forest cover removal to increase peak flows in the watershed in comparison to the fully-forested reference conditions.

## 3.4 Stream Channels

The issues and key questions identified by the BLM for riparian and aquatic conditions are comprehensively addressed within this analysis through description and discussion of the physical processes that impact riparian zones and stream channels in the watershed, and through discussion of existing conditions within channels. Some issues identified as riparian and aquatic were more logically addressed within the hydrology and erosion sections, and were included there. The following discussion is focused on water, coarse and fine sediment, wood, and heat “inputs” to the stream system. Stream channel response and condition is then interpreted in relation to natural and reference processes and conditions. Interpretations, hypotheses, and conclusions are based on observation of slope and stream conditions and processes by WWA, and upon information extracted from Oregon Department of Fish and Wildlife (ODFW) and BLM stream surveys. Stream temperature interpretations (Figure 3-11) are based on thermograph data collected within the watershed and on a canopy-elevation-stream temperature regression model developed from Elk and Trail Creek data by Boise Cascade Corporation.

There are no reports or data that define the reference condition for streams within the Trail Creek watershed. However, general conditions and changes in conditions in Western Cascades stream systems associated with various land management practices are known, and some of these effects can be reasonably inferred for Trail Creek. However, the reader is cautioned that these interpretations of reference stream conditions are inferred for Trail Creek, and are not known to be true.

Many streams within forested west coast watersheds had higher density of large woody debris (LWD) than is found under current conditions (Bisson et al. 1987; Harmon et al. 1986). LWD has commonly decreased due to removal of riparian trees via timber harvest and land use conversion, and due to removal during log drives and use of streams as log transport systems (Bisson et al. 1987). Riparian harvest has occurred along most of the fish-bearing channels of Trail Creek, and to a lessor degree, many of the headwater channels. Forests along extensive reaches of Trail Creek and the lower reaches of the West and East Forks appear to have been converted from forest to non-forest vegetation and land uses. The large mainstem channels of Trail Creek 1964 (Lower Trail, East Fork and West Fork) appear to have been scoured by large flood events, such as occurred in 1964, and gravel and cobble substrate are uncommon. These substrate materials may have been highly associated with large accumulations of LWD, and well-developed mid-channel and channel margin gravel bars may have been common. Large LWD accumulations (log jams) were commonly removed in western streams to facilitate log transport, and there is at least one account that Trail Creek was used for "log booming" (Hegne, 1989). Gravel bars may have been washed away during subsequent floods. These gravel bars may have been vegetated with various brush and tree species which provided much more shade to these reaches than occurs today, and as a result, water temperatures may have been lower. Also associated with channel scouring event may have been widening of the stream wetted area, and channels themselves may have widened to some degree if streambanks were eroded in association with these other changes. Currently, channels are stable throughout the system, but main channels in the reference condition may actually have been somewhat less stable if LWD and gravel bars caused channel shifting. LWD and substrate associated pools may also have been more common than occur today. Channel meander, and gradient have been reported to have been altered in many western streams due to past land management effects, but such effects are not evident in the Trail Creek watershed.

There are no reports documenting reference conditions within the headwater channels of Trail Creek. However, there is evidence from existing data that current conditions within headwater channels are less altered from reference conditions than may be true for the main channels within the watershed. Whereas many main channels appear to have been scoured by floods, contributing to low quantities of LWD and gravel-cobble substrate, scoured headwater tributaries are not evident within the BLM database and were not observed during field reconnaissance for this analysis. Furthermore, no debris torrents were observed to have occurred from the aerial topography dating to 1966.

The remainder of this discussion focuses on current conditions, but continues to provide inference of changes from reference conditions.

Human disturbances that have degraded Riparian Reserves include timber harvesting, roads, and grazing within the reserves. Grazing within the watershed has been high within the watershed in previous years (see Section 3.1, Human Uses), but grazing is currently limited in area and intensity, and no substantial impacts due to grazing are noted in the ODFW stream surveys or were observed during the field work for this analysis. Timber harvest within riparian areas was extensive, including clearcutting without buffers in some cases. No harvest has occurred in Riparian Reserves on federal land in the Trail Creek watershed within the past several years. Road mileage within riparian areas is extensive on both federal and other ownerships within the watershed. Approximately 19.70 miles of road were identified within BLM Riparian Reserves within the watershed. No impacts due to off road vehicles, grazing, or recreational uses were noted in the ODFW stream surveys or were observed during the field work for this analysis, although isolated impacts may occur. Impacts along Trail Creek due to rural development are common, and to a lessor degree occur along the East Fork, West Fork and the larger tributaries to them at the lower elevations.

As noted in the Characterization, the Trail Creek stream system has developed in a typical dendritic pattern, with steep headwater channels leading to larger and more gently sloped channels at the lower elevations.

The headwater tributaries of Trail Creek typically form on moderately steep mountain slopes. The BLM collected extensive data for headwater streams in 1998. Numerous characteristics were recorded for 252 non-fish bearing stream reaches. From these data, general physical characteristics of these channels can be determined.

Headwater channels are typically small and steep: Bankfull width and depth average 3.9 and 0.6 feet, respectfully, and channel gradient averages 30 percent. They are well constrained, bounded typically by moderately steep sideslopes (34 % average), and adjacent riparian areas are relatively narrrow, averaging 23 feet on each side of the ordinary high water mark. Substrate varies widely in characteristics, but in general, a variety of substrate particle sizes is found. Mean percent substrate composition within the headwater streams inventoried is: 9.9 % bedrock; 18.3 % boulder; 16.5 % cobble; 15.5 % gravel; 18.1 % sand, and 21.6 % silt. Sand and silt substrate total 39.7%, which may be higher than reference conditions due to sediment delivery from roads and harvest, but this is not known.

Headwater channels are typically stable to moderately stable: The BLM data classifies 52% of the reaches as having good stability, 40% as fair, and 8% poor. No beaver dams were noted within the inventory. Density of riparian canopy ranges from 0 to 90%, and averages 64%. Canopy density measured from the stream or stream shade is not reported. Large woody debris (LWD) density per unit channel width[12] averages 0.088 pieces 6 to 16 inches in diameter, 0.026 pieces 16.1 to 24 inches in diameter, 0.011 pieces 24.1 to 36 inches in diameter, and 0.003 pieces 24.1 to 36 inches in diameter, for a total of 0.128 pieces per unit channel width, which is considered to be relatively low density for westside streams.

Downstream third and fourth order tributaries typically have formed inner gorges, where slopes are often oversteepened immediately adjacent to the channels. Pronounced inner gorges are found on the East Fork for 2,000 feet above its confluence with Wall Creek and extensively near its headwaters, extensively along Wall Creek and Canyon Creek, and along the West Fork, mainly above its confluence with Chicago Creek. Some inner gorge areas, with the best example being along the lower reaches of Wall Creek, are barren of soil with massive bedrock exposed and bordering the stream for twenty feet or more above the streambed. Landslides (type and size not identified) adjacent to channels in these areas were noted in 1996 ODFW stream reach surveys. Channel gradient classes are summarized consistent with Rosgen Level 1 classification in Table 3-9.[13]

Relatively narrow (less than 1,000 feet wide) and shallow alluvial terraces border most of lower Trail

[12]Many stream characteristics are commonly standardized by expressing them in quantities per unit stream width: For LWD for instance, LWD piece count is computed as the number of pieces that occur in a distance measured parallel with the channel for a distance equal to the channels width.

[13] ODFW habitat survey reaches were converted to Rosgen classes (Rosgen, 1994). However, ODFW surveyed reaches were quite long without reach breaks, often covering two or more Rosgen reaches. Figure 3-12 displays Rosgen classes based on original classification from topographic maps, aerial photos, and field observation.

Creek and most of the West Fork below Chicago Creek. However, very little channel meandering and alluvial bank cutting is evident. Even within these alluvial formations, channel sinuosity is low (typically less than 1.2). Trail Creek below the West Fork, and extensive areas of the West and East Forks, Wall Creek, and lesser tributaries have cut to the underlying bedrock, and bedrock and rock dominated soils adjoin many stream reaches

**TABLE 3-9**

**Stream Mileage by Rosgen Classification**

| Sub-watershed | Aa (>10%) | A (4-10%) | B (2-4%) | C (<2%) | Total |
|---|---|---|---|---|---|
| Chicago Creek | 20.9 | 1.9 | 0.0 | 0.0 | 22.8 |
| Lower East Fork | 38.8 | 1.6 | 0.4 | 3.2 | 43.9 |
| Lower Trail Creek | 52.4 | 6.2 | 0.6 | 2.8 | 61.9 |
| Lower West Fork | 92.1 | 10.5 | 2.5 | 2.7 | 107.8 |
| Upper East Fork | 58.5 | 2.2 | 1.4 | 0.0 | 62.1 |
| Upper West Fork | 21.4 | 1.8 | 0.8 | 0.0 | 24.0 |
| Wall Creek | 31.7 | 6.1 | 1.2 | 0.0 | 39.0 |
| Total | 315.7 | 30.2 | 6.8 | 8.7 | 361.5 |

in these systems. Lower Trail Creek is wide and shallow, and bedrock and boulder substrate is dominant, with relatively low area of cobble, gravel, or finer materials. This same condition persists upstream in most tributaries. Channels are highly stable throughout the watershed. Percent organics, silt, and sand within riffle substrate is highly variable, ranging from low to high in the Trail Creek system (ODFW, 1996). As noted in the Erosion Processes section of this analysis, road systems are likely to have been the predominant source of management-related fine sediment in the watershed.

As indicated by the previous discussion, streambanks are typically stable along Trail Creek and the lower reaches of the main tributaries due to the dominance of rock or well vegetated streambanks. Fully developed soils often adjoin streams higher in these systems, and we did observe a few instances of bank cutting. However, we did not observe instances of bank cutting that we considered to be out of the ordinary, and percent eroding streambank reported in the ODFW survey data was also low, typically less than 5%, with one reach average of 10%. In the Erosion Processes section of this analysis, extensive areas of Mass Wasting Management Unit (MWMU) #1 are mapped adjacent to stream channels. Slump-earthflow forms of slope failure are a common and natural process within this unit, and some degree of channel bank cutting may occur in association with major flood events at the toes of slump-earthflow formations (unmapped). Miles of stream within MWMU rated with moderate or high mass wasting potential are summarized in Table 3-10.

The ODFW surveyed a total of 14 stream reaches in June, July, and August, 1996, incorporating multiple stream transect data surveyed by the BLM into their summary reach reports. The main stem of Trail Creek was surveyed in six long reaches from its mouth to its headwaters. In additional, three reaches of Canyon Creek, a tributary of Canyon Creek, one reach of Deadhorse Creek, one reach of Clear Creek, and two reaches of Wall Creek were surveyed. These stream survey data were summarized for all measures used by ODFW as habitat benchmarks to provide evaluation of general functioning condition of streams within the watershed (see Appendix D). Measures rating high, moderate, or low in the ODFW system were assigned numeric ratings of 3, 2, and 1, respectively. Measures rated were averaged to provide a high, moderate, or low functional rating for the stream reaches evaluated. Average scores of < 1.5, 1.5 to 2.5, and > 2.5 received ratings of low, moderate, and high, respectively.[14]

Trail Creek functional condition scores ranged from 1.4 to 1.9; low to moderately low habitat quality

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[14] Percent stream canopy closure and/or shade could not be interpreted directly from the ODFW data sheets. However, as described in the Riparian Resources section, we evaluated canopy closure directly and evaluated maximum 7-day average water temperatures. Shade was nearly always found to be low, and temperatures to exceed the Oregon 7-day average maximum water temperature standard of 64 degrees F. In addition, low flows have been observed to limit fish production. Shade, temperature and flow limitations are not reflected in the ODFW ratings as reported in Appendix D. The reader is cautioned to consider these factors in addition to the ODFW Appendix D scores.

**TABLE 3-10**

**Stream Length by Mass Wasting Management Unit**

| Mass Wasting Management Unit | Hazard Rating (roads/harvest) | Stream Length (miles) |
|---|---|---|
| MWMU #1 | M/L | 163.8 |
| MWMU #2 | H/M | 21.0 |
| MWMU #3 | M/M | 42.1 |
| MWMU #4 | L/L | 134.6 |

Consideration of critical low flows and high stream temperatures may cause summer rearing habitat suitability to be substantially poorer than even these scores indicate. Low instream LWD in the lower five reaches of Trail Creek were the principal cause for low habitat quality.[15] Limited area of gravel was also found in three of the six reaches evaluated. High percent fine sediment was found in reaches 4 and 6. Low pool area was noted in reach 2. In addition, we found low LWD recruitment potential and high stream temperatures for reaches 1 through 3.

Functional condition scores of the eight tributary reaches evaluated ranged from 1.2 to 2.0. Low instream LWD and riparian large conifers (see footnote), and low pool frequency and depth, were the principal causes for poor habitat scores. Percent gravel area was moderate, and percent fine sediment in riffle habitat was not found to be high in the reaches evaluated. However, riffle habitat was low in most reaches, and completely absent in others, but percent riffle area is not listed by ODFW as a habitat benchmark.

Headwater streams on BLM lands appear to be comparable with typical reference conditions in the following ways: harvesting has depleted LWD recruitment potential of some streams, and may have contributed to depleted instream LWD of some. Debris torrents down tributaries have not been a cause of riffle and gravel depletion; depletion of LWD may have contributed to loss of gravel substrate, but there are no data or direct observations to support this hypothesis. Relatively high input of fine sediment from roads in several sub-watersheds may have contributed to observed levels of fines in riffle substrate, but reference levels of fines in these small headwater channels is unknown. Historically, harvesting has reduced shade levels well below the high shade level normal for small headwater tributaries. However, shade typically re-establishes itself rapidly on small streams, and we observed high shade levels for the upstream reaches of all fish-bearing streams, the limits of our formal shade evaluation.

One large-scale event is likely to have altered stream morphology within Trail Creek and the lower reaches of its major tributaries. The 1964 flood, the flood of record for most streams in the area, is known to have scoured large woody debris and channel substrate from many streams in the area (Boise Cascade Corp., 1998). It has been inferred that severely depleted instream LWD, coupled with low LWD recruitment potential, leads to depleted gravel and spawning habitat. Mass wasting and bank erosion sources of coarse gravel are limited in the watershed, as are future LWD sources, particularly along Trail Creek below the West Fork. Major channel-affecting disturbances other than the 1964 flood were not noted during this analysis.

## 3.5 Terrestrial Resources

Key issues addressed in this section include reference and current conditions in the following areas: of vegetation patterns, special status plants, noxious weeds, fire hazard, and wildlife.

### <u>Reference Vegetation Conditions</u>

Prior to the settlement of the region by non-native Americans (prior to 1850), fire was the major disturbance factor affecting vegetation patterns. Wildfires in the mixed evergreen forests of southern Oregon and northern California occurred at frequencies of 5 to 25 years. This regime of frequent, low-intensity fires promoted "open-grown"

[15] Low ratings for riparian conifers were also scored for nearly all reaches evaluated by the ODFW. However, it may be that an expectation of no less than 150 conifers >20 inches DBH and 75 conifers >35 inches DBH is not appropriate for the Trail Creek ecotype.

forests of ponderosa pine and Douglas-fir. Historically, because of their adaptations to fire, fire has allowed these species to dominate sites where they are the potential climax (USDA FS, 1998). One notable exception is that during pre-settlement, Native Americans used fire on a much more frequent basis to maintain grasslands and oak woodlands in the major river valleys. During the settlement period (1850-1900), fires occurred in the region more frequently, but were even smaller and lower in severity than during the pre-settlement period (Franklin and Dyrness, 1973).

Figure 3-13 presents general vegetation existing in the Trail Creek watershed around the turn of the century. This vegetation pattern reflects the fire regime discussed above as well as the emergence of land conversion as a disturbance factor in the watershed. According to this data set, the watershed was predominantly forested with merchantable timber covering approximately 31,000 acres. Moderate stocking (10 to 25 MBF) tended to occur at the higher elevations while lower stocking (5 to 10 MBF) occurred at lower elevations. Based on current stand ages of relic forest islands characterized within the BLM's Forest Operations Inventory, it is reasonable to assume that stand ages of merchantable timber were in the 80 to 200 year old range (i.e., mature). Non-timbered land (totaling about 4,300 acres) occurred primarily at lower elevations, resulting from the conversion to agricultural land uses, though some upper elevation non-timber land is recorded, most likely as the result of fire in the upper watershed. Overall, this historic vegetation pattern provides evidence of the early stages of the conversion of the Trail Creek watershed to agricultural and timber production land uses beginning at the turn of the century.

After the turn of the century, wildfire occurred and timber harvesting activities increased and together represented the major vegetation disturbance factors in the watershed. Other disturbance factors such as windthrow, insect infestations, and disease appear to be insignificant, historically. Figure 3-14 presents general vegetation existing in the Trail Creek watershed around 1936. The emergence of a significant second growth component is evident, with about 3,800 acres of reforested land since settlement, and an additional 1,200 acres is identified as recently deforested due to wildfire. Presumably, the majority of this second growth is represented primarily by logging activity in the lower portions of the watershed and then by patch burns that occurred in the upper elevations. Nevertheless, mature and old-growth stands still cover most of the watershed, totaling approximately 28,700 acres in 1936. Overall, the timber base comprised the major vegetation category in the watershed in 1936, though the vegetation pattern demonstrates a sustained reduction and fragmentation of older forested land during the early part of this century.

**Current Vegetation Conditions**

The vegetation pattern first presented in Section 1.4 and Figure 1-6 represents the current conditions in the Trail Creek watershed. Vegetation seral stage categories depicted on this figure reflect classifications that could be reliably interpreted from the available WODIP database. These classifications have been field verified and are thought to provide the most comprehensive representation for purpose of providing comparable descriptions of vegetation patterns throughout the watershed. Classifications described in Section 1.4 and presented in Figure 1-6 are prepared primarily to characterize the hydrologic maturity of the watershed and provide an indicator of seral stage for assessing the terrestrial ecosystem. Based on field verification efforts, this classification is also found to provide a comparable, reliable basis from which the effects of management activities can be interpreted. Refinements to this classification are presented later in this section as a means to address wildlife habitat characteristics.

Since 1936, timber harvesting and land conversion activities have been the dominant vegetation disturbance factors. Wildland fire is known to have occurred in the watershed and is evidenced throughout the watershed. However, through successful fire suppression, wildfire has not occurred at catastrophic levels and has not altered the landscape to the extent of logging and land conversion for residential and agricultural purposes. Timber harvesting has focused primarily on mature and old-growth stands, further reducing this component to about 2,500 acres located primarily in the upper elevations of the watershed. Even-aged silvicultural methods have predominated on Private Industrial and Forest Service lands, fragmenting seral stage conditions within these ownerships. Shelterwood silvicultural methods were used extensively on BLM lands and a significant large tree component exists on approximately 9,000 acres of lands otherwise interpreted as early or mid to late seral stages. Otherwise, a significant, even-aged, second growth component exists in the watershed on about 13,800 acres making this the most prevalent vegetation condition in the watershed. The remainder of the watershed is in a non-forest or hardwood situation covering approximately 10,000 acres. Because of the limitations of the WODIP data, the non-forest designation includes clearcuts as well as barren lands and agricultural and rural residential land uses.

Table 3-11 summarizes current vegetation classifications by ownership categories that were presented in Section 1.2. The Small Landowner category combines large and small parcel sizes as presented earlier as well as county and state rights-of-way. With a few notable exceptions, the percent allocation of the seral stage categories more or less reflects the percentages of the various ownership categories. This further supports observations as ro the mixed, diverse nature of vegetation patterns in the watershed. It is noted that BLM lands harbor the majority of mature and old-growth stand conditions in the watershed. When combined with the large tree component resulting from shelterwood operations, this results in up to one-third of the watershed providing late successional habitat conditions described in the Northwest Forest Plan and the Medford Resource Management Plan. It is also noted that non-forest seral stage conditions occur disproportionately higher within the Small Landowner category reflecting the amount of land conversion that has taken place for rural residential and agricultural land uses. Finally, it should also be noted that dense, small conifer/mixed stands occur at higher levels on USFS lands posing a potentially higher fire hazard. Overall, this vegetation pattern reflects the ecology, disturbance history, and management objectives for these ownerships.

Figure 3-15 and Table 3-12 provide some details regarding forest stand structure on BLM-administered lands as characterized by the Forest Operations Inventory. Most importantly, it provides greater detail for interpretation and management of stand conditions on a land use allocation basis. This summary does not include lands recently acquired by the BLM for administration purposes from the Rogue River National Forest. As with the seral stage stand conditions reported above, stand size classes are more or less distributed proportionally, reflecting the relative percentages of land use allocations within BLM-administered lands. Overall, this representation also depicts the mixed nature of vegetation in the watershed.

**TABLE 3-11**

**Acreages of Current Vegetation Seral Stage by Ownership Category**

| Seral Stage | Total Acres | BLM | | USFS | | Private Industrial | | Small Private & Rights-of-Way | |
|---|---|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | Acres | % | Acres | % |
| Non-Forest and Clearcuts | 7811 | 3172 | 41 | 794 | 10 | 1397 | 18 | 2448 | 31 |
| Hardwood | 2188 | 880 | 40 | 235 | 11 | 725 | 33 | 348 | 16 |
| Conifer/Mixed, 0-10" DBH, 0-69% Crown | 6935 | 2856 | 41 | 675 | 10 | 2418 | 35 | 986 | 14 |
| Conifer/Mixed, 0-10" DBH, 70+% Crown | 4982 | 2091 | 42 | 1110 | 22 | 1430 | 29 | 351 | 7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Conifer/Mixed, 10-20" DBH, 0-69% Crown | 6665 | 2564 | 38 | 700 | 11 | 2390 | 36 | 1011 | 15 |
| Conifer/Mixed, 10-20" DBH, 70%+ Crown | 4220 | 1535 | 36 | 505 | 12 | 1712 | 41 | 468 | 11 |
| Conifer/Mixed, 21+" DBH, 0-69% Crown | 432 | 321 | 74 | 54 | 13 | 41 | 9 | 16 | 4 |
| Conifer/Mixed, 21+" DBH, 70+% Crown | 2072 | 1221 | 59 | 279 | 13 | 434 | 21 | 138 | 7 |
| Total | 35306 | 14640 | 41 | 4352 | 12 | 10547 | 30 | 5767 | 17 |

**TABLE 3-12**

**Acreages of BLM Stand Size Classes by BLM Land Use Allocation**

| Stand Size | Total Acres | Matrix – NGFMA | | Matrix –SGFMA | | Matrix – Connectivity Blocks | | Riparian Reserves | |
|---|---|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | Acres | % | Acres | % |
| Non-Forest | 326 | 203 | 62 | 13 | 4 | 47 | 14 | 63 | 20 |
| Seedling / Sapling | 2371 | 1318 | 56 | 374 | 16 | 216 | 9 | 463 | 20 |
| Pole Timber | 1398 | 802 | 57 | 212 | 15 | 33 | 2 | 351 | 26 |
| Small Sawtimber | 2268 | 1371 | 60 | 321 | 14 | 87 | 4 | 489 | 22 |
| Large Sawtimber | 7224 | 3851 | 53 | 1130 | 16 | 684 | 9 | 1559 | 22 |
| Total | 13587 | 7545 | 56 | 2050 | 15 | 1067 | 8 | 2925 | 21 |

Figure 3-16 displays the primary Timber Productivity Capability Classifications (TPCCs) for the BLM-administered lands, excluding lands recently acquired from the Rogue River National Forest. As was noted in previous sections, soil productivity in this watershed is relatively low for timber production. TPCC further depict extensive timber productivity limitations due to fragile soil and/or reforestation problems. Fragile problems indicate where productivity may be reduced due to soil erosion, mass wasting, nutrient deficiencies, and/or moisture limitations. Reforestation problems indicate where factors such as frost pockets, exposure, and/or brush competition limit the ability of the site to achieve minimum stocking levels. Consequently, both conditions require additional operational considerations above and beyond standard practices in harvesting and reforestation of these sites (USDI BLM, 1986). Overall, these limiting factors have and will continue to influence vegetation patterns resulting from timber harvests, land conversions, and wildfires.

Little, if any, disturbance due to windthrow, disease, or insect infestation has occurred in the watershed to the extent that it affects vegetation patterns. Based on field reconnaissance of ridges and other areas prone to windthrow, no catastrophic windstorms have been observed to have influenced the watershed. Dwarf mistletoe (*Arceuthobium* spp.) are commonly found parasitizing conifers and hardwoods within the watershed, particularly at the lower elevations. While these infestations do not cause mortality, they further reduce tree growth. Likewise, diseases such as root rots and insects such as beetles are known to occur in the watershed, usually in denser, moisture-stressed stands. Again, however, there is no evidence from field reconnaissance or stand records in the BLM's Forest Operations Inventory to suggest these disturbance factors have directly or indirectly influenced vegetation patterns.

**Reference Fire Hazard Conditions**

As presented earlier, fire was the major disturbance factor affecting vegetation patterns in the watershed. Wildfires in the mixed evergreen forests of southern Oregon and northern California occurred at frequencies of 5 to 25 years. Naturally occurring fires were ignited primarily by lightning sources, which can strike more or less randomly, regardless of elevation. Hot, dry climatic conditions are common in the region, further increasing the chances of ignition and spread. During pre-settlement, Native Americans also used fire on a much more frequent basis to maintain grasslands and oak woodlands in the major river valleys. These fires were generally of relatively low to moderate intensity and limited extent, burning in mosaic patterns. Because of this fire cycle, fuel loads were maintained at relatively low levels. Furthermore, understory and ground fuels were typically consumed, thereby reducing the probability of crown fires. Because of these frequent, minor reductions in fuel profiles, the potential for large scale catastrophic events was greatly reduced. Overall, this process maintained a more or less stable ecosystem dominated by fire tolerant species such as Douglas-fir, ponderosa pine, and Oregon white oak.

Since the turn of the century, fire suppression in the watershed has interrupted this fire cycle and the result has been a progressive increase in fuel profiles. Both ground fuels and ladder fuels have increased in the absence of frequent, low intensity fires. As a result of timbering activity, there has also been a progressive increase of young, even-aged stands with dense regeneration and brush. Coincidently, the use of pre-commercial, commercial thinning, and other land conversion practices have further increased fuel profiles. Consequently, over time, fire hazard has increased to the extent that there has been an ever escalating threat of infrequent, high intensity, stand replacement fires. These changes in conditions over time have also increased risks to improvements, habitat, air quality, and soils, as well as economic impacts and safety hazards to suppression crews and the public. Overall, this trend has resulted in a less stable ecosystem more susceptible to catastrophic events.

**Current Fire Hazard Conditions**

Figure 3-17 displays recent fire occurrences in the watershed since 1983. Of a total of nine incidents, lightning accounted for only two of these fires, while human activities, including camp fires, smoking, prescribed burns, and equipment use, accounted for the remainder. Both lightning strikes ignited fires in the summer months, while other fires were discovered in spring, summer, and fall. Most of these fires were limited in size (less than 1 acre), and only two, the Pilot Fire of 1984 and the Board Mountain fire in 1987, produced notable disturbances (approximately 6 and 80 acres, respectively). Though fairly well distributed throughout the watershed, most of these fires occurred in areas with relatively higher fire hazards either due to fuel, slope, and/or aspect. Overall, these observations indicate the potential for relatively frequent, periodic ignition sources and conditions conducive to fires warranting suppression in the watershed.

Figure 3-18 displays current fuel profiles as expressed by data available in the WODIP and Forest Operations Inventory databases. Because of the inability to reliably separate non-forest conditions in the WODIP database, this classification represents several fire behavior fuel models (1, 2, 3, and 5) as described by Anderson (1982). Hardwoods represent fuel model 9 and the conifer/mixed category represents most timber fuel groups (6, 8, and 10) which all pose relatively the same hazard. Fuel model 4 is represented by the closed plantation category and is specific to small (less than 10" DBH), dense (60% crown closure or greater) conifer/mixed stands occurring below 3,500 feet elevation. Fuel models 11 and 12 are expressed as pre-commercial thins recorded in the BLM's Forest Operations Inventory. Combined, fuel models 4, 11, and 12 represent the greatest fuel hazard, of which about 7,800 acres (or about 20% of the total watershed) occurs scattered throughout the watershed.

Slope and aspect are two additional factors which affect fire hazard ratings. Figure 3-19 displays current fire hazard ratings as a function of fuels, slope, and aspect according to criteria supplied by the BLM (Dinwiddie, 1999). Roughly a third of the watershed (about 12,350 acres) is rated as a high fire hazard. These occur predominantly on steeper, south facing slopes where, because of these immutable extremes, fuel models appear to be a relatively insignificant factor. Pre-commercial thinnings and closed plantation conditions become a significant contributing factor in these high hazard areas on the cooler east and west aspects and/or moderate slopes. Moderate hazard ratings occur on over half of the watershed (about 20,200 acres). This rating appears to be more or less equally driven by slope, aspect, and fuel hazards but predominates on the cooler aspects and flatter slopes. Low fire hazards are confined to a small portion of the watershed (about 2,700 acres) primarily on northern facing aspects. Overall, the moderate to high fire hazard conditions reflect the natural affinity of the landscape to fire susceptibility as well as the continued build-up of high hazard fuels in the watershed since the turn of the century. Most notably, these conditions occur in Rural Interface Areas, thereby putting improvements and public safety at risk.

**Reference Noxious Weed Conditions**

There are no data for the presence of noxious weeds in the watershed at the turn of the century, however, based on regional patterns, it is unlikely that noxious weeds were present in large numbers in 1900. It is reasonable to assume that as the watershed was timbered and settled, invasion and proliferation began to occur as soil was removed and/or disturbed. It is likely that seeds were transported into the watershed by wildlife, livestock, and equipment. In most areas of the Northwest, noxious weed populations have proliferated as such conditions and land use increased primarily in logged areas, road sides, utility corridors, abandoned fields, and heavily grazed sites.

**Current Noxious Weed Conditions**

Figure 3-20 displays recorded noxious weed locations in the watershed. These observations indicate that the extent of these infestations are limited to travel corridors. Observations made during field reconnaissance indicate the road side distribution is considerably more extensive, particularly on roads with frequent traffic. Records or observations of noxious weeds establishing populations beyond road side conditions on BLM lands is limited. The potential exists, however, for invasion of harvest units and rangelands, particularly in the event of extensive ground disturbance. Noxious weeds noted to be common in the watershed include: Canada thistle, scotch broom, tansy ragwort, yellow starthistle, St. John's wort, diffuse knapweed, and purple loosestrife. Overall, these noxious weeds have the effect of displacing native species and natural plant succession and in some instances pose a health hazard to livestock.

As an indication of the potential extent of noxious weed infestations, approximately 190 miles of roads are open to traffic within the watershed. These roads are distributed relatively evenly between BLM and non-BLM lands. An additional 110 miles of abandoned and/or closed roads exist, extending the potential road network to about 300 miles. Additionally, non-forest and open early seral stand conditions occur on about 7,250 acres of private lands and 7,600 acres of federal land under current conditions. Overall, this road network and vegetation/land use pattern represents considerable potential for noxious weed infestations, the extent of which can be and has been mitigated through prevention, reclamation, natural succession, and vegetation management techniques.

## Reference Sensitive Plant Conditions

Data are not available for presence and distribution of historic sensitive plants in the watershed.

## Current Sensitive Plant Conditions

Comprehensive botanical surveys have not been conducted on all lands in the watershed; however, 1,698 acres of BLM lands have been searched for sensitive species and their habitat. All BLM-managed lands will be managed for conservation and protection of federally listed and candidate species, state-listed species, and BLM sensitive species. Special-status state and federal plants will be managed to prevent increased threats, leading to reclassification based on more restrictive distribution or threats to population viability. Nine species of special status plants have been documented to occur in the watershed (Table 3-13). Appendix E includes a BLM list of those species potentially occurring in the watershed.

**TABLE 3-13**

**Sensitive Species Identified in the Watershed**

| Species | Number of Sites | Status |
|---|---|---|
| *Allotropa virgata* | 6 | Survey and Manage |
| *Cypripedium montanu* | 4 | Survey and Manage |
| *Geranium oreganum* | 1 | Bureau Tracking Species; ONHP Lists 3&4 |
| *Iliamna latibracteata* | 1 | Bureau Assessment Species; ONHP List 2 |
| *Perideridia howellii* | 1 | Bureau Watch Species; ONHP List 4 |
| *Rosa spithamea spithamea* | 3 | Bureau Watch Species; ONHP List 4 |
| *Sidalcea malvaeflora ssp. Asprella* | 1 | Bureau Watch Species; ONHP List 4 |

| | | |
|---|---|---|
| *Pseudocyphellaria anomala* | 1 | Survey Strategy 4 |
| *Sarcosoma mexicana* | 6 | Protection Buffer Species |

Habitats for both known and potential special status plant species tend to be in mature and old-growth forested stands. Many species also favor moist conditions found on north facing slopes, upper elevations, and/or in riparian areas. Figure 1-6 and Table 3-11 depicts those mature and old-growth stand conditions as they occur throughout the watershed. Roughly 2,054 acres, or about 7 percent, of the watershed has this forest condition, most of which occurs on BLM and USFS lands. The majority of this acreage is found on the eastern boundary of the watershed predominantly on north-facing slopes at upper elevations.

Riparian areas and riparian stand conditions will be discussed in detail in a later section. Generally, stand conditions along streams within in the watershed are characterized by relatively mixed species and size composition and open canopies. Large trees and/or dense canopy conditions tend to be limited to the upper reaches throughout the watershed. Again, as with mature and old-growth stands, these conditions tend to be limited to BLM and USFS lands.

Other special habitats in the watershed for which special status plants have an affinity are meadows and rock outcrops. Because of limitations with the WODIP database, distinction of these cover types is not reliable on a watershed-wide basis. However, it is known that significant rock outcrops and balds exist along the west facing ridgetops on the eastern drainages of both Trail Creek and West Fork Trail Creek. Occurrence of these conditions on BLM land is more reliably interpreted by the Forest Operations Inventory presented in Figure 3-15 and summarized in Table 3-12. Only 326 acres, or roughly 2 percent of inventoried lands, have these non-forest conditions which are more or less proportionally distributed amongst land use allocations. Overall, existing habitat for special status species known to occur in the watershed and those potentially occurring in the watershed is limited.

**Wildlife Species**

The Trail Creek watershed provides habitat for a diversity of wildlife. Wildlife addressed in this report include: species listed as threatened and endangered under the Endangered Species Act of 1973; species identified by BLM as "survey and manage species" and sensitive species; and recreationally important species such as Roosevelt elk, black-tailed deer, and cougar. Appendix F lists special status animals with potential to occur in the watershed and their habitat associations.

**Reference Wildlife Habitat Conditions**

Reference conditions for habitat in the watershed in 1936 are depicted on Figure 3-14. Although timber harvesting and other activities in the watershed began earlier, 1936 was chosen to represent reference conditions because vegetation data for forest composition in 1936 are available and can be compared to current forest conditions. Although maps and data are available forest composition in 1900 (see Figure 3-13), it is presented for only non-forested, low-stocked, and moderately stocked stands. This stand stratification is not useful for making wildlife habitat interpretations. Wildlife habitat features of concern are related to tree size and density of overstory canopies.

Forest composition in 1936 included 16,169 acres (46 percent of watershed) of old-growth; 12,590 acres of large timber (36 percent of watershed); 2,588 acres of seedlings and saplings (7 percent of watershed); 1,523 acres of hardwood (4 percent of watershed); 1,151 acres of deforested burns (3 percent of watershed); and 81 acres of non-forest. Of the old-growth forest present in the watershed in 1936, about 7,761 acres were on BLM lands (48 percent). The most significant change, from a wildlife perspective, in forest composition between 1936 and the present has been a decrease in mature/old-growth forest from 16,169 acres to 2,504 acres today.

It appears that trends for wildlife habitat differ in the watershed based on land ownership. On private lands, timber harvesting will likely continue at regular rotation intervals. Habitat on BLM lands will likely be managed to maintain wildlife populations at current or increased levels. Existing policies and regulations specify that viability of wildlife populations not be jeopardized by federal actions.

Most likely, trends for habitat quality will vary depending on management designations. Matrix lands will likely be managed for timber production;

whereas, lands designated for preservation of late-seral vegetation and to provide connectivity for wildlife (e.g, Riparian Reserves, spotted owl core areas, and LSRs) will have increased amounts of late-seral habitat, snags, and downed woody debris. Over time, as mature seral stages age, numbers of large trees, snags, and down woody material will increase, leading to more high-quality habitat for old-growth and cavity-associated species.

**Current Wildlife Habitat Conditions**

Mature and old-growth forest are seasonally critical to Roosevelt elk, black-tailed deer, spotted owls, pileated woodpeckers, Vaux's swift, goshawk, great gray owls, and other species because of structure, thermal characteristics, nesting/denning sites, production of forage, and security. Mature and old-growth forests have the highest densities of large snags, important habitat for birds, bats, and small mammals. Woodpeckers are an especially important group that depends on snags and large trees. Cavities at the base of snags also provide dens for black bears, porcupines, and bobcats.

There are currently about 2,504 acres of old-growth forests (i.e., trees with diameters of 21 inches or greater) on all forested lands of the watershed (see Table 3-11. Old-growth on BLM land is 1,542 acres (about 62 percent of all old- growth). Old-growth comprises 13 percent (333 acres) of Forest Service land and 25 percent (629 acres) of private land.

The dominant historical influence on wildlife and wildlife habitat in the watershed has been timber extraction. Clearcut and shelterwood harvesting has largely determined the age of forest stands and ecological characteristics (e.g., canopy closure, canopy complexity, production of understory shrubs and herbaceous species, interspersion of habitat, size of habitat patches, tree size, density of snags, density of downed woody material, and road density). In general, most wildlife species find primary breeding habitat in grass-forb or shrub stages of ecological succession (less than 15-20 years old) or in large saw timber or old-growth (Raphael, 1990). Closed-canopy sapling and pole stands support the fewest species and the lowest density of species.

***Snags***

The RMP specifies that sufficient numbers of snags be retained for nesting of at least 40 percent of populations of cavity-nesting species. Data does not appear to be available for snag densities on lands within the watershed; however, it is likely that snag densities were higher in 1936 than today because there are more snags in old-growth stands.

***Habitat Connectivity***

Interspersion and connectivity of habitats are factors that affect the degree of genetic exchange among populations and utilization of suitable habitats. Ideally, spatially isolated patches of optimum habitat need to be linked with suitable habitats to allow adequate dispersal of species across the landscape. To enhance connectivity of habitat, some BLM lands have received special management status. Land management designations that help compensate for extensive removal of mature and old-growth forest by providing dispersal and connectivity linkages include: Riparian Reserves, Late-successional reserves, Connectivity Blocks, Areas of Critical Environmental Concern, and Research Natural Areas. Late-successional Reserves, managed to enhance older seral characteristics, have been established on the east side of the watershed (Elk Creek LSR #224) and 8 miles to the west at Goolaway/Snow Creek (#223). Approximately 4,249 acres (Connectivity Blocks and Riparian Reserves) are managed to enhance habitat connectivity for species associated with mature and old-growth forest communities (Figure 3-1).

Riparian Reserves enhance habitat connectivity, especially for relatively mobile species (e.g., spotted owls and other birds, elk, and deer) whose habitat has been fragmented by logging. Figure 3-1 shows lands designated as Riparian Reserves. Approximately 3,182 acres of BLM land is allocated to this land status. Portions of Riparian Reserves were logged prior to implementation of the Northwest Forest Plan in 1994, but they will be maintained to enhance older seral stage conditions. Using classifications from the BLM Forest Operations Inventory, stand composition within inventoried BLM lands in Riparian Reserves: 2 percent non-forest, 16 percent seedling/sapling, 12 percent pole timber (5 to 11" DBH), 17 percent small sawtimber (11 to 21" DBH), and 53 percent large sawtimber (over 21" DBH).

***Road Density***

A significant feature of timber harvesting in the watershed has been construction of roads. Roads directly destroy habitat and render adjacent habitat less suitable for species and individuals that are displaced by vehicular traffic and other human activities. Roads reduce habitat effectiveness by increasing ecotones (i.e., edge areas between habitats) and can inhibit movement of some species among patches of habitat. Increasing ecotones and reducing the size of forest patches adversely affects "core species" (e.g., spotted owl) that require large blocks of intact habitat; whereas, some species such as deer, elk, and bear often benefit from ecotones because of increased habitat diversity.

There are 189 miles of active roads in the watershed with 90 miles on BLM and 99 on private and U.S. Forest Service lands. In addition, a total of about 107 miles of abandoned or permanently closed roads exist in the watershed. Active road density within the watershed is about 3.4 miles of road per square mile. Active road density on BLM lands is 4 miles per square mile. The road density goal within the watershed is 1.5 miles per square mile for BLM lands. From a wildlife perspective, reducing road density, especially on big game winter range to 1.5 miles per section would be desirable, however, other multiple use objectives such as rapid access for fire suppression, tree planting, and timber harvest conflict with reducing road density in many areas

**Reference Peregrine Falcon Conditions**

There are no long-term data for occurrence, abundance, and distribution of peregrine falcons in the watershed. However, the current presence of a breeding pair in the watershed, and suitable nesting habitat (cliffs over 70 feet high), indicates that falcons were probably historic residents. Peregrine falcons typically re-use historic nest sites and tend to re-occupy nest sites even after not nesting in an area for many years. Features such as degree of shading, minimal human disturbance, protection from predators, and adequate prey base are important factors in selection of nesting locations.

Peregrine falcon populations are increasing in Oregon and the United States. They have recolonized historic nest sites in Oregon, with an increase from 8 known nest sites in 1988 to 42 active nests in 1997. The U.S. Fish and Wildlife Service formally proposed to delist the peregrine on August 26, 1998. Delisting would remove the peregrine's protected status under the Endangered Species Act of 1973; however, this species would continue to be protected under the Migratory Bird Treaty Act.

**Existing Peregrine Falcon Conditions**

One pair of peregrine falcons, discovered in 1998, is known to nest in the watershed. This pair produced one young in 1998. Data does not appear to be available for identifying important foraging areas for this pair of birds. It is likely that the nesting peregrines prey on passerine birds in the watershed. Peregrines prey on pigeons and other passerine birds that become vulnerable when they fly over the forest canopy, clearcuts, or meadows. Peregines prey on birds that are not protected by dense surrounding vegetation.

In addition to the cliff with the known nest, there are three other large cliff complexes (over 100 feet high) and three rock outcrops (over 70 feet high) in the watershed that may have suitable nest sites for peregrines. Although detailed surveys have not been conducted for potential nesting cliffs (a helicopter survey was done in 1997), prey base, and foraging areas, it appears that there is potential habitat for at least one more nesting pair.

Currently, a potential threat to the peregrines nesting in the watershed is rock climbers who are attracted to the nesting cliff and other rock faces in the watershed for recreational climbing. Although some rock climbers take precautions to avoid disturbing nesting birds, others may not be aware that approaching the nest could lead to abandonment of eggs or young.

**Reference Bald Eagle Conditions**

There are no historic records of bald eagle use of the watershed for nesting, foraging, roosting, or as seasonal transients. Typically, bald eagles in the Northwest nest close to productive prey bases (e.g., fish and waterfowl), often near rivers and lakes. Wintering bald eagles also seek open water where prey is accessible or carrion from livestock or wildlife is present on a regular basis. Wintering eagles also roost communally, usually in large conifers, within several miles of foraging areas. Populations of bald eagles in the Northwest and the United States as a whole have increased to the point where the U.S. Fish and Wildlife Service has proposed delisting the species.

**Current Bald Eagle Conditions**

Although formal bald eagle surveys have not been done in the watershed, biologists working in the watershed for more than 20 years have never reported observing eagles roosting, nesting, or foraging. Occasionally, wintering bald eagles may be transient visitors to the watershed where they may be attracted to road kills or rabbits. The nearest bald eagle nest is five miles from the Trail Creek watershed.

There are no large ponds or reservoirs in the watershed that provide habitat for fish and waterfowl, attractive prey for bald eagles. Trail Creek and large tributaries support fisheries, including anadromous salmonids, that could provide a food source for wintering eagles.

The lower reaches of Trail Creek and the Rogue River may become occupied by nesting or wintering eagles as eagle populations throughout the Northwest continue to expand. However, high levels of human activity along the lower reaches of Trail Creek and the adjacent Rogue River may discourage nesting. The lack of a reliable and plentiful prey base also limits the nesting pairs in the watershed.

**Reference Conditions for Northern Spotted Owls**

Data for tree size and density in 1900 is not adequate to interpret habitat quality for spotted owl nesting, foraging, or roosting. However, data for forest conditions in 1936 indicate that, for the watershed as a whole, there were about 16,169 acres (46 percent of the total acreage of the watershed) of old-growth Douglas-fir forest that probably provided suitable nesting, roosting, and foraging habitat for spotted owls. Based on this, the density of spotted owls was probably higher in 1936 than today.

**Current Conditions for Northern Spotted Owls**

Approximately, 90 percent of the watershed has been intensively surveyed for spotted owls as part of an Oregon State University demographic study from 1990 through 1996. Monitoring of historic owl sites was continued through 1998 by BLM and Boise Cascade Corporation. Much of the following interpretations are based on these surveys.

Typical spotted owl habitat in the Northwest consists of Douglas-fir forests (some stands being older than 200 years) with abundant snags and downed logs. Spotted owls prefer large trees for nesting, where nests are in cavities, mistletoe platforms, or on large limbs. Mature and old-growth forests may support higher densities of favored spotted owl prey (e.g., flying squirrels and wood rats).

There are 17 known historic spotted owl activity centers in the watershed, with 6 active in 1998. A detailed listing of their reproductive status is in Appendix G. An activity center is defined in the Northwest Forest Plan as a 100-acre area of concentrated activity of a pair of owls or a territorial single owl. Four young were produced each summer from 1996 through 1998. Numerous spotted owls have been banded in the watershed over the past decade. Many have died or moved from the watershed. Of the 13 adult spotted owls detected in the watershed in 1998, 10 had colored bands from previous years survey and marking studies. Long-term spotted owl surveys, including banding, in the watershed has established an excellent data base for monitoring various aspects of spotted owl ecology and demography. There are probably several undetected, unpaired adult spotted owls (i.e., floaters) in the watershed.

Of the 17 known activity centers, 11 are on BLM lands, 3 are on Forest Service lands, and 3 are on private lands. Of the activity centers on BLM lands, 3 are centered in Riparian Reserves, one is in a connectivity block, 3 are on NGFMA land, 3 are on SGFMA land, and one is on exchange land.

Boundaries of activity centers are occasionally "fine-tuned", but they are managed to provide long-term habitat for breeding and dispersal of spotted owls and for other plants and animals associated with late seral forest communities. Although the 100-acre designation for activity centers encompasses known or potential breeding habitat for spotted owls, this protected area is not sufficient to maintain successful reproduction if the activity center is surrounded by unsuitable habitat. Suitable spotted owl nesting, roosting habitat has declined over the past decade, and the numbers of spotted owl sites have declined. Most suitable nesting habitat is on BLM land.

Generally, optimum spotted owl nesting habitat (McKelvey I) is composed of trees larger than 21 inches in diameter with canopy closure greater than 60 percent. Roosting and foraging habitat (McKelvey II) typically tends to be less diverse structurally (i.e., single-story canopy) with smaller trees (i.e., 11 to 20 inches diameter), with canopy ranging from 40-60 percent. Dispersal habitat includes conifer forests with trees less than 11 inches in diameter. These stand conditions are depicted in Figure 3-22.

Within the watershed, there are 1,981 acres of optimum spotted owl habitat (i.e., trees larger than 21 inches in diameter with greater than 60 percent canopy cover) and 1,095 acres with large trees (21+ inch DBH, canopy cover 40-60 percent). On BLM lands in the watershed, there are 1,451 acres of optimum spotted owl habitat (21+ DBH and greater than 60 percent canopy closure) and 90 acres with large trees (21+ DBH, canopy closure 40-60 percent).

To determine amounts of suitable nesting, roosting, foraging, and dispersal habitat, forest canopy features within a 1.2 mile radius of spotted owl activity centers were tabulated for active owl sites on BLM lands (Appendix G). Based on an analysis of forest seral components, optimum nesting habitat (21+ DBH with canopy closure of 60-100 percent) composes from 5-13 percent of land within 1.2-mile zones around these sites (see Table 3-14).

Spotted owl habitat in the watershed also has been mapped using the McKelvey criteria. Zones (1.2-mile radius) around owl activity centers were evaluated for habitat composition. Because nesting habitat may be the most critical factor in determining spotted owl distribution and population levels, acreage of suitable nesting habitat in zones surrounding activity centers was tabulated for habitat classified by McKelvey habitat criteria and for seral vegetation components (see Table 3-15). Because zones for these owl sites may encompass both BLM and USFS lands, the "suitable classification" used on USFS lands to designate nesting and roosting/foraging habitat is reported.

Comparison of spotted owl nesting habitat based on seral vegetation with nesting habitat based on McKelvey criteria indicates that there is some agreement between the two methods. Based on forest seral vegetation, suitable nesting habitat around activity centers ranges from 152 to 366 acres. Based on the McKelvey criteria, suitable nesting habitat around activity centers ranges from <1 to 547 acres. When compared with habitat occurrence at other sites this tabulation also indicates that most suitable nesting habitat is associated with owl habitat units 1823, 3394, 2219, and 2625. Site 4027 is anomalous in that it exhibits relatively lower amounts of suitable habitat, regardless of the measurement method.

The U.S. Fish and Wildlife Service has designated spotted owl critical habitat, pursuant to the Endangered Species Act of 1973 (Federal Register, 1992, vol. 57:10, p. 1796) (Figure 3-23), however, this land use designation was not carried forward in the Northwest Forest Plan. Clarifications related to this designation can be found in Appendix G. There are about 4,936 acres of critical habitat designated within the watershed. Of designated critical habitat, about 28 percent is nesting habitat (BLM Classification), 34 percent is unsuitable habitat, and about 38 percent does not fall into one of the previous categories.

**TABLE 3-14**

**Comparison of Nesting, Roosting, and Foraging Habitat Associated with Active Northern Spotted Owl Centers on BLM Lands**

| Owl Master Site Number | 21"+ DBH 60%+ Canopy | McKelvey I (BLM Class) | McKelvey II (BLM Class) | Suitable (USFS Class) |
|---|---|---|---|---|
| 3394 | 159 | 547 | 396 | 2 |
| 2219 | 366 | 425 | 367 | 447 |
| 2625 | 347 | 203 | 271 | 554 |
| 4027 | 152 | <1 | 615 | N/A |

**Reference Red Tree Vole Conditions**

There are no data for abundance and distribution of red tree voles in the watershed in 1900 or 1936. However, preferred habitat for red tree voles (i.e., mature/old-growth forest) was more abundant in 1936 than today.

**Current Red Tree Vole Conditions**

Red tree voles live almost exclusively in canopies of Douglas-fir, about 100 years and older. The species is significantly more abundant in mature to late-successional forests, but can inhabit stands as young as 40 years old. This vole feeds primarily on Douglas-fir needles, and builds nests with needles, lichens, and other organic material. Surveys conducted in the watershed in 1998 indicate that populations of red tree voles are dense. Preferred habitat (mature/old-growth forest) is present on 7,224 acres of BLM lands within the watershed. Although red tree voles are more abundant in mature/old-growth forest, they also occupy younger Douglas-fir stands.

**Reference Northern Goshawk Conditions**

Northern goshawks are forest hawks that nest in old-growth stands for forage and prey (e.g., small mammals and passerine birds). They prefer forests with relatively open understories and clearcuts. In 1936, habitat for nesting was more abundant than today, consequently, there may have been more goshawks in the watershed.

**Current Northern Goshawk Conditions**

No surveys for goshawk have been conducted in the watershed and no sightings have been reported. However, surveys will be started in 1999. Goshawks may be present in the watershed, nesting in old-growth and late-seral stands, often in spotted owl core areas. Late successional reserves, riparian areas, connectivity blocks, and spotted owl core areas (all on federal lands) would be the most likely sites for goshawk nests. Foraging area (i.e., open forest and clearcuts) are abundant, but nesting habitat is limited on private lands within the watershed. Densities in the watershed and other watersheds in the area are low and will remain low with future management of both private and federal lands.

**Reference Great Gray Owl Conditions**

There is no information pertaining to great gray owl abundance in the watershed in 1900. Suitable habitat for great gray owls appears to have been present in 1900 for foraging (recent clearcuts and plantations, less than 10 years old, and meadows) and nesting (mature/old-growth forest, within 1,000 feet of forest openings).

**Current Great Gray Owl Conditions**

Surveys for great gray owls were conducted in the watershed in 1998 on six sections in the watershed, but none were detected. Although no great gray owls have been documented for the watershed, suitable habitat appears to be present for foraging and nesting throughout the watershed. These owls utilize abandoned hawk or raven nests, natural depressions on broken-top snags, or natural platforms of mistletoe for nest sites. The need for suitable foraging meadows or young clearcuts restricts population densities and range expansion. Pocket gophers and other small mammals are primary prey of great gray owls.

**Reference Salamander Conditions**

There is no data for occurrence and distribution of salamanders in the watershed in 1900 or 1936.

However, species found in the Medford District (i.e., Del Norte salamander and Siskiyou Mountain salamander) may have been present, although the closest known location for these species is more than 25 miles from the watershed. Many salamanders are associated with mature and old-growth forest and most lay eggs in quiet water of seeps or ponds. Extensive logging in the watershed may have adversely affected breeding habitat by removing shade and increasing runoff which would deposit silt in seeps and ponds and remove aquatic vegetation.

**Current Salamander Conditions**

Although extensive surveys have not been conducted in the watershed, ten small ponds or pump chances were surveyed for amphibian presence in 1994 through 1996. No survey and manage salamander species were found; however, other amphibian species documented were rough-skinned newt, tree frog, Pacific giant salamander, and bullfrog. Suitable habitat for salamanders may be present in old-growth forest and associated wetlands and talus slopes.

**Reference Mollusk Conditions**

There is no data for occurrence or distribution of mollusks in the watershed in 1900.

**Current Mollusk Conditions**

No mollusk surveys have been done in the watershed, but they will be initiated in the fall of 1999. Tail-dropper slugs and several other Survey and Manage species could occur in the watershed.

**Reference Wild Turkey Conditions**

There were no wild turkey in the watershed in 1936. Wild turkeys were introduced into the watershed in the late 1970s and early 1980s by the ODFW.

**Current Wild Turkey Conditions**

Since introduction in the watershed, wild turkeys have spread throughout the watershed. Their numbers have increased to levels that allow hunting. Wild turkeys utilize a variety of habitats for foraging and nest on the ground or on piles of woody debris. When not incubating eggs, turkeys roost in trees at night.

**Reference Roosevelt Elk Conditions**

Although most wildlife populations generally reflect availability and quality of habitat, hunting can also influence game animal populations. Elk populations in the watershed in 1936 probably were similar to current levels. Elk habitat in 1936 appears to have been excellent for Roosevelt elk, with relatively large amounts of old-growth forest for thermal and winter cover and younger seral stages for foraging.

**Current Roosevelt Elk Conditions**

Population estimates are not available for the watershed, but the Oregon Department of Fish and Wildlife (ODFW) has conducted surveys of wildlife management units that include the watershed. The watershed straddles portions of ODFW's Dixon and Evans Creek Management Units. Populations in wildlife management units that include the watershed are about 65 percent of desired number of elk. The desired sex ratio of 10 bulls per 100 cows has been met or exceeded over the past three years.

Habitat quality for elk is determined by relative amounts and spacing of foraging areas, thermal/hiding cover, and density of roads. Important foraging habitat components include meadows and recent clear-cuts (less than 20 years old) for foraging, and closed canopy mid/late and mature/old-growth for cover.

Road densities within the watershed are 3.4 miles of road per square mile of habitat. This density exceeds the desired density of 1.5 miles per square mile of habitat. Of the 189 miles of active roads in the watershed, 90 miles are on BLM land. Road closure and abandonment has eliminated motor vehicle traffic on 107 miles of road in the watershed (21 miles on BLM land and 86 miles on non-BLM lands).

In 1995, ODFW, in cooperation with BLM, Army Corps of Engineers, and Boise Cascade Corporation implemented the Jackson Access Cooperative Travel Management Area (JACTMA). The plan, providing seasonal road closure in the southwestern part of the watershed, was implemented to increase wildlife habitat effectiveness, improve wildlife protection, and enhance other watershed values. There is no designated elk winter range in the watershed. The plan is controversial because it is perceived by some users of BLM lands as an inappropriate limitation on access and use of federal lands. Some members of the public view restrictions on vehicular access as unduly restricting access to areas used for hunting, wood gathering, driving for recreation, and other forms of forest use.

**Reference Black-tailed Deer Conditions**

Habitat conditions in the watershed for black-tailed deer differed most between 1936 and the present in amounts of optimum thermal/hiding cover (mature/old-growth forest with dense canopy closure). There were about 16,169 acres of old-growth in 1936 (6,117 acres on BLM lands). Currently, there about 3,076 acres of old-growth (i.e., 21+ inch DBH, 40-100 percent canopy closure) in the watershed with about 50 percent (1,541 acres) on BLM lands.

**Current Black-tailed Deer Populations**

Wildlife management units that include the Trail Creek watershed currently have black-tailed deer populations above desired management levels. The sex ratio goal of 20 bucks per 100 does has probably not been attained for the watershed.

Studies initiated by the Oregon Department of Fish and Wildlife in 1995 indicate that deer migrate from long distances to winter in the watershed. Approximately 18,205 acres of the watershed are utilized by wintering black-tailed deer (Figure 3-24). Deer winter at lower elevations where snow does not become too deep, but also utilize old-growth stands at higher elevations. Mature and old-growth forest communities often accumulate less snow on the ground and produce lichens, which fall from tree trunks and branches, providing important winter food for deer. Like elk, black-tailed deer forage in clear-cuts less than 20 years old and seek cover in late seral forests

Although data are not available to determine acreage of prime foraging area (i.e., young clear-cuts), non-forested areas of the watershed (urban/residential, rock, meadow, brush fields, and clear-cuts) comprise about 7,811 acres of the watershed (3,172 acres on BLM lands). Generally, non-forested areas in the northern one-third of the watershed provide summer-fall foraging opportunities for deer, whereas areas in the southern portion of the watershed, below the snow line, are important foraging areas for wintering deer.

**Reference Mountain Lion Conditions**

There are no data for abundance and distribution of mountain lions in the watershed in 1936.

**Existing Mountain Lion Conditions**

Mountain lion numbers throughout the western United States, including the Trail Creek watershed, have been increasing in recent years, probably because deer (lion's favored prey) have been increasing. Mountain lion populations are thought to reach their highest densities in lower elevation forested areas, on the western slopes of the Cascade Range (Lost Creek Watershed Analysis) (USDI BLM, 1997). There are no estimates for mountain lion density in the watershed but the density is probably equal to or greater than the average Oregon density of 7.5-7.8 lions per 100 square miles of habitat. There are about 55 square miles of habitat within the watershed. Therefore, the watershed would likely have the potential to support 4 or 5 lions.

**Reference Conditions for Black Bear**

Like elk and deer, there is no data for the watershed in 1900 or 1936 that indicates abundance or distribution of black bears. Habitat conditions were favorable for black bear, but hunting and predator control activities in the early part of the century may have reduced numbers of black bears.

Black bears are omnivores that are able to utilize a variety of habitats. Consequently, changes in forest composition over the past century have had little affect on food and habitat quality for bear populations in the watershed.

**Existing Conditions for Black Bear**

Currently, black bear population numbers are at historic highs in Oregon and the watershed. Restrictions on hunting (e.g., use of hounds) have probably been factors in population increases. Habitat in the watershed appears to be excellent for black bears. The mix of seral vegetation provides abundant food for bears. High populations of deer may provide a protein source for bears (fawns and winter-killed deer).

**Bat Reference Conditions**

There are no data for occurrence or distribution of bats in the watershed in 1936. Bat species preferring habitat with large trees and snags probably would have been more abundant in 1936 than today because more old-growth forest existed. Bat species that utilize man-made structures (e.g., abandoned buildings, bridges, barns) may have had less roosting habitat in 1936. Bat species roosting in caves and rock crevices probably would have had similar populations in 1936 as today.

**Current Bat Conditions**

Most bat species in the Pacific Northwest roost and hibernate in protected sites (e.g., abandoned buildings, mine adits, caves, crevices, snags, and tree bark) and forage over water, vegetated areas, and urban/suburban areas where high densities of insects are present. Bat species likely to be present in the watershed are species that use forest habitats for roosting, breeding, and foraging (e.g., silver-haired bat, hoary bat, long-eared myotis, long-legged myotis, and big brown bat). There are also substantial amounts of cliff habitat in the western portion of the watershed that may provide habitats for bats that favor rock crevices for roosting, breeding, and hibernating (e.g., Townsend's big-eared bat). There are no known mine adits or deep caves for Townsend's big-eared bat maternity colonies.

Bat studies in the watershed appear to be limited to one site at Romine Creek where a mist net was placed at a pump chance in 1995. Species detected were long-legged myotis, silver-haired bat, and big brown bat.

**Reference Macroinvertebrate Conditions**

No data is available on macroinvertebrates in 1936, however aquatic habitat conditions may have been of higher quality because of lower road densities and less timber harvesting than today. Both roads and timber harvest, especially near perennial streams, can increase suspended and deposited sediment. Sediment can degrade habitat for aquatic insects, mollusks and other invertebrates by clogging interstitial spaces in gravel substrates. Sediment can also physically abrade gills and other organs in aquatic species.

**Current Macroinvertebrate Conditions**

Macroinvertebrate surveys were conducted in the watershed in 1994 by Aquatic Biology Associates, Inc. (1994). These studies detected no sensitive, threatened, or endangered macroinvertebrates. The studies found that there is moderate abundance and richness in erosional habitats, but high abundance and diversity in detritus habitats. Species indicative of very high temperatures and degraded habitat were not present.

## 3.6 Riparian Resources

Key issues addressed in this section include reference and current conditions for the following analyses: riparian vegetation, large woody debris recruitment, and stream shading.

**Reference Riparian Vegetation Conditions**

Based on vegetation patterns presented in Figure 3-13, lower stream reaches were predominantly timberless at the turn of the century. These stand conditions most likely resulted from fire, land conversion activities related to settlement, and log driving and likely extended to the streams. Presettlement vegetation along these streams may have included more large trees, primarily ponderosa pine and Oregon white oak, though maintained at relatively low densities by fires ignited by Native Americans. Similar conditions were described for the Elk Creek watershed (USDI BLM, 1997) and by regional studies of historic riparian vegetation (LaLande, 1995; Pullen, 1996). Gallery forests, characterized by cottonwood, ash, and alder, typically occurred along lower elevation drainages prone to frequent flooding and shallow groundwater conditions. Given observations about reference conditions for stream geomorphology, flood frequency, depositional patterns, and groundwater and impacts of water withdrawals, conditions suitable for these hardwood species was likely limited, much as it is currently.

Using information presented in Figure 3-13, vegetation depicted at lower and mid-elevations in the watershed were likely low stocking (5 to 10 MMBF) composed primarily of ponderosa pine and Douglas-fir. Moderately stocked stands of Douglas-fir and ponderosa pine likely occurred at the upper elevations, including headwater regions. Given the fire history in the region, it is likely that understory and brush density in these stands was significantly lower than current conditions.

By 1936, timbering activity increased in the watershed, further reducing riparian vegetation in the watershed (see Figure 3-14). This activity occurred primarily at lower and mid-elevations and entailed harvesting and tractor logging methods that likely cleared riparian vegetation with no buffer areas. This most probably reduced the extent of functioning riparian vegetation to the upper elevations and headwaters areas. Several deforesting fires have occurred, primarily in headwater sites, likely removing vegetation from riparian areas as well. Overall, these interpretations are based on the best available information, and while considered adequate for characterizing upland vegetation, the reader is cautioned as to their representativeness for riparian vegetation.

**Current Riparian Vegetation Conditions**

Figure 1-6 presents current vegetation seral stages in the watershed classified from existing WODIP data. This classification includes coverage of riparian areas and provides the best available comprehensive inventory of stand conditions along stream channels throughout the watershed. Table 3-15 summarizes these current vegetation categories by ownership category in terms of stream mileage. With a few notable exceptions, the percent allocation of the seral stage categories more or less reflects the percentages of the various ownership categories. A key exception is that USFS streams are not recorded at the same density as streams on BLM and private lands. Consequently, this summaries for this ownership category are under-represented; however, this table presents the best possible depiction of stand structure. Overall, this summary indicates that the mixed, diverse vegetation patterns in the watershed area applies to the stream network.

Watershed-wide, a very small proportion of streams (about 4%) in the watershed are covered with mature and old-growth stand conditions. The majority of these streams occur on BLM lands. It is anticipated that, due to shelterwood harvesting, a greater large tree component exists on BLM lands that is not represented in this table. Based on this assumption, it is possible that up to one-quarter of these streams have large tree cover. Conversely, it is also noted that the non-forest seral stage condition occurs disproportionately higher within the small landowner category reflecting the amount of land conversion that has taken place for rural residential and agricultural land uses. Overall, these vegetation patterns reflect that about 75% of the streams in the watershed are lacking and/or deficient in mature stand structure development.

At the stand level, Figure 3-15 and Table 3-12 provide some details regarding forest stand structure within Riparian Reserves on BLM-administered lands as characterized by the Forest Operations Inventory. Of the 2,925 acres of inventoried Riparian Reserves, over half (about 53 percent) is classified as large sawtimber (21" DBH and above). However, in these large sawtimber stands, only about 90 acres (roughly 3 percent of the class) is characterized as well stocked (70% canopy cover and greater). The remaining large sawtimber stands are poorly (10 to 40% canopy) or moderately (40 to 70%) stocked. Small sawtimber stands (11 to 21" DBH) make up roughly 17 percent of Riparian Reserves, while seedling and sapling stands and pole timber (5 to 11" DBH) stands comprise 16 percent and 12 percent, respectively. Non-forest conditions (meadows, rock outcrops, etc...) make up only 2 percent of Riparian Reserves. Overall, these findings are consistent with the results presented above.

***BLM Riparian Survey Results***

The BLM collected extensive data for headwater streams in 1998. Numerous characteristics were recorded for approximately 250 non-fish bearing stream reaches. This survey was limited to streams

**TABLE 3-15**

**Stream Miles of Current Vegetation Seral Stage by Ownership Category**

| Seral Stage | Total Miles | BLM | | USFS | | Private Industrial | | Small Private & Rights-of-Way | |
|---|---|---|---|---|---|---|---|---|---|
| | | Miles | % | Miles | % | Miles | % | Miles | % |
| Non-Forest and Clearcuts | 51.6 | 15.5 | 30 | 0.7 | 1 | 9.6 | 19 | 25.8 | 50 |
| Hardwood | 16.9 | 6.7 | 40 | 0.8 | 5 | 6.7 | 40 | 2.7 | 16 |
| Conifer/Mixed, 0-10" DBH, 0-69% Crown | 38.3 | 13.7 | 36 | 1.3 | 3 | 16.4 | 43 | 6.9 | 18 |
| Conifer/Mixed, 0-10" DBH, 70+% Crown | 24.6 | 15.3 | 62 | 4.0 | 16 | 4.5 | 19 | 0.8 | 3 |
| Conifer/Mixed, 10-20" DBH, 0-69% Crown | 40.8 | 14.2 | 35 | 1.5 | 4 | 17.2 | 42 | 7.9 | 19 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Conifer/Mixed, 10-20" DBH, 70%+ Crown | 20.3 | 7.7 | 38 | 1.4 | 7 | 8.9 | 44 | 2.3 | 11 |
| Conifer/Mixed, 21+" DBH, 0-69% Crown | 2.0 | 1.7 | 85 | 0.2 | 10 | 0.1 | 3 | <0.1 | 2 |
| Conifer/Mixed, 21+" DBH, 70+% Crown | 6.9 | 4.8 | 70 | 0.6 | 9 | 1.1 | 15 | 0.4 | 6 |
| Total | 201.3 | 79.5 | 39 | 8.9 | <0.1 | 64.6 | 32 | 46.7 | 23 |

in the Upper East Fork Trail Creek and Wall Creek sub-watersheds. From these data, general biological characteristics of these riparian areas can be determined.

Douglas-fir occurs as the dominant overstory species in roughly half (about 47 percent) of the inventoried reaches. Big leaf maple is the primary overstory species in about 13 percent of the reaches, while white fir and Oregon white oak dominate about 8 percent of these stream zones, respectively. The remaining inventoried streams (about 25 percent) are composed of miscellaneous species including incense cedar, ponderosa pine, red alder, manzanita, tan oak and madrone. Generally, all these species occur in some mixture in these stands along with other typically understory species including hazel, dogwood, vine maple, oceanspray, and mockorange. Ground cover in these riparian areas is similarly diverse including grasses, sedges, mosses, ferns, thimbleberry, blackberry, Oregon grape, horsetail, hedgehog dogtail, snowberry, and whipple vine. As presented in previous sections, these riparian areas also contain and/or have the potential to be likely habitats for several vascular and non-vascular special status plant species.

A total of about 38.5 miles of stream were inventoried in these two sub-watersheds. About two-thirds of these streams are intermittent and one-third were recorded as perennial. Primary functioning class was also recorded as a means to prioritize streams for restoration. Roughly half were classified as "properly functioning" (about 48 percent) and half (about 50 percent) as "functioning at risk". Only about 2 percent were observed to be non-functioning according to BLM classification rules. In presenting these results, however, the reader is cautioned that these findings can not be extrapolated to other sub-watersheds.

**LWD Recruitment Assessment Methods**

The riparian zone is the primary source area for large woody debris (LWD). Large woody debris, including tree boles, root wads and large branches, is an important structural component of stream systems (Harmon et. al., 1986; Bisson et. al., 1987). Assessment methods were performed according to the Washington State Forest Practices Board (WFPB) Manual: Standard Methodology for Conducting Watershed Analysis (Version 3.0, 1995). Near-term LWD recruitment potential was derived for current stand characteristics within 100 feet of each bank of the fish-bearing streams, consistent with standard manual procedures.

Approximately 28 miles of streams within the Trail Creek watershed are fish-bearing and were assessed for LWD recruitment potential. Most fish-bearing streams are located on private lands (21.57 miles) versus federal lands (about 6.34 miles). Fish-bearing streams on private lands tend to be located at lower elevations in the southern part of the watershed. Federal fish-bearing streams occur at mid elevations before stream gradients and flows become limiting factors. A detailed discussion of aquatic habitat and fisheries associated with these streams is presented below.

**TABLE 3-16**

**Coding System for Large Woody Debris**

| High Recruitment Potential | Moderate Recruitment Potential | Low Recruitment Potential |
|---|---|---|
| CMD | CMS | CSS |
| CLD | CLS | CSD |

| | | |
|---|---|---|
| MLD | HMD | HSS |
| MMD | HLD | HSD |
| | MLS | HLS |
| | MMS | HMS |
| | | MSS |
| | | MSD |

First Letter Indicates Species, Second is Age/Size and Third is Density
Species Key: C = Conifer; H = Hardwood; M = Mixed
Size Key: S = Small (DBH < 12"); M = Medium (DBH 12-20"); L = Large (> 20" DBH)
Density Key: D = Dense (< one third bare ground); S = Sparse (> one third bare ground)

All fish-bearing streams were viewed by a trained air photo interpreter using May and June 1995 color stereo pair aerial photographs (1:12,000 scale) to determine near-term LWD recruitment potential. The following riparian stand characteristics were interpreted from aerial photographs: species composition, tree size, and stand density. Table 3-16 summarizes the coding system used to determine High, Moderate and Low recruitment potential for LWD.

***Deviation from Standard Methods***

Segments were evaluated in increments of 1000 to 1500 feet, which deviates from the 2000-foot segment described in the manual. Given the large amount of managed forest and private land, smaller segments represent more accurately the variation of riparian vegetation.

***Riparian Patterns and Processes***

Flows of sediment, water, wood, and energy into and out of the riparian zone are controlled by climatic, geologic, topographic, vegetative, and management-related activities. Tree species composition, growth, and stand density within the riparian zone are influenced by many factors, including moisture, light, soils, geomorphology, and disturbance patterns. In areas where disturbance (either natural or man-made) has occurred within the riparian zone, deciduous tree species are dominated by Oregon white oak (*Quercus kelloggii*), big-leaf maple (*Acer macrophyllum*) and willow (*Salix spp*.). Conifers in the riparian zones are dominated by Douglas-fir (*Pseudotsuga menziessi*) and ponderosa pine (*Pinus ponderosa*).

**<u>Reference LWD Conditions</u>**

Historic information from the 1900s (see Figure 3-13) indicated that most of the watershed, including tributaries, was forested. A significant amount of timberless area did exist, however, in the lower watershed extending almost half way up the West and East Forks of Trail Creek. Information from 1936 (see Figure 3-14) identified the emergence of timber and land conversion activities extending the extent of open conditions somewhat further up the watershed. Compared to current conditions (Figure 1-6), the amount of forested land along the stream network in 1900 and 1936 appears to be higher. Therefore, the amount of woody material available for LWD recruitment was historically higher along the upper reaches of both forks of Trail Creek and their tributaries. Although it is apparent that trees have been removed from riparian areas of Lower Trail Creek and major tributaries, density of the forest in these areas may never have been high, and current LWD recruitment potential may not be substantially less in these areas compared to reference conditions.

***Disturbance Patterns***

Timber harvest, agricultural practices, and natural disturbances, such as fire, floods, or mass wasting, alter riparian vegetation. Removal of riparian vegetation influences both large woody debris recruitment and shading. Floods that carry debris torrents have impacted the riparian zones to a greater extent than fire or large-scale mass wasting. No signs of recent debris torrents in this watershed were evident during the field reconnaissance. In many locations throughout the watershed, timber harvest practices included cutting trees in riparian zones; this is evident on aerial photographs. On private lands, Oregon Department of Forestry requirements for maintaining LWD recruitment potential have increased substantially in recent years. On federal lands, requirements for maintaining LWD recruitment potential are substantial. Establishment of Riparian Reserves will eventually allow continued and future LWD development within the riparian zones.

***Large Wood Recruitment Mechanisms***

The delivery of large wood into streams is affected by many factors, including tree species and age classes, soil stability, channel configuration, and harvest history (Bisson et.al., 1987). Recruitment of LWD can occur from chronic, episodic, or human-caused mechanisms (Steinblums, 1977). Chronic inputs include trees or groups of trees that enter the stream channel naturally, from mortality or bank undercutting. Episodic inputs include blowdown or breakage, mass wasting from upslope areas, or debris torrents. Human-caused inputs include large-diameter slash from timber harvests. In the Trail Creek watershed, LWD will be introduced to the stream systems primarily from the riparian zones; mass wasting does not contribute substantial amounts of instream LWD in this watershed.

## Current LWD Conditions

Recruitment from second-growth stands generally begins 60 years after harvest or disturbance, with increasing rates thereafter (Grette, 1985; Heimann, 1988). The greatest potential for recruitment of woody debris is from coniferous stands due to their longevity and stability after death. However, deciduous hardwood species can provide woody debris and influence other riparian functions such as bank stability, shade, and undercut bank potential.

***Near-Term LWD Recruitment Potential***

Tables 3-17 and 3-18 list the riparian stand conditions and associated miles of low, moderate, and high recruitment potential for LWD on federal and private lands, respectively. Figure 3-25 indicates the locations of LWD recruitment potential. As Table 3-18 indicates, approximately 78% of the streams on federal lands have high or moderate LWD recruitment potential. Conversely, Table 3-19 indicates about 80% of fish-bearing streams on private lands have low LWD recruitment potential. Combined, this indicates that about one-third of fish-bearing streams have viable near-term LWD recruitment potential. Overall, this reflects the ownership pattern and forest vegetation conditions in the lower part of the watershed.

***Near-Term LWD Potential (Low)***

Areas in the Trail Creek watershed classified as having "Low" near-term LWD recruitment potential were identified as follows:

- Hardwood Small Sparse
- Hardwood Small Dense
- Hardwood Medium Sparse
- Mixed Small Sparse
- Mixed Small Dense
- Conifer Small Dense

Small diameter, sparse, hardwood and mixed stands make up roughly 38% of the total riparian areas along fish-bearing streams. The majority of these stands are Oregon white oak with ponderosa pine and big-leaf maple along both forks of Trail Creek. The remainder of riparian stand conditions represent relatively denser and/or larger tree conditions that are found further up these main drainages and their tributaries and in areas where the transition from non-forest conditions to historic timber harvesting has taken place. These stands comprise approximately 29 % of the riparian areas along fish-bearing streams. Overall, low LWD recruitment conditions reflect over two-thirds of the fish-bearing streams in the watershed.

**TABLE 3-17**

**Near Term LWD Recruitment Potential - Federal Lands**

| Riparian Stand Condition | Near Term Recruitment Potential | Miles of Stream | Percent of Total |
|---|---|---|---|
| Hardwood Small Sparse | Low | 1.17 | 18.45 |
| Hardwood Small Dense | Low | 0.08 | 1.26 |
| Hardwood Medium Sparse | Low | 0.07 | 1.10 |
| Mixed Small Sparse | Low | 0.06 | 0.95 |
| Mixed Medium Sparse | Moderate | 0.55 | 8.67 |
| Mixed Medium Dense | High | 2.28 | 35.96 |
| Mixed Large Dense | High | 1.00 | 15.77 |
| Conifer Large Dense | High | 1.13 | 17.82 |
| Total (both sides of the stream) | | 6.34 | 100.00 |

**TABLE 3-18**

**Near Term LWD Recruitment Potential - Private Lands**

| Riparian Stand Condition | Near Term Recruitment Potential | Miles of Stream | Percent of Total |
|---|---|---|---|
| Hardwood Small Sparse | Low | 6.65 | 30.83 |
| Hardwood Small Dense | Low | 5.02 | 23.27 |
| Mixed Small Sparse | Low | 2.78 | 12.89 |
| Mixed Small Dense | Low | 0.92 | 4.26 |
| Conifer Small Dense | Low | 0.77 | 3.57 |
| Hardwood Medium Sparse | Low | 1.10 | 5.10 |
| Mixed Medium Sparse | Moderate | 0.22 | 1.02 |
| Mixed Medium Dense | High | 4.11 | 19.05 |
| Total (both sides of the stream) | | 21.57 | 100.00 |

***Near-Term LWD Potential (Moderate and High)***

Areas in the Trail Creek watershed classified as having "Moderate" or “High” near-term LWD recruitment potential were identified as follows:

- Mixed Medium Sparse
- Mixed Medium Dense
- Mixed Large Dense
- Conifer Large Dense

Mixed Medium Dense stands account for the majority of this classification, representing about 23% of riparian zones of the watershed. These dense stands of mixed timber are present throughout the watershed, primarily in actively managed forest lands. Douglas-fir, ponderosa pine, and big-leaf maple make up the majority of these stands, along with some Oregon white oak. The remainder of this classification is represented by both larger, dense stands and medium, sparse stands, representing about 10% of the riparian areas along fish-bearing streams. Overall, this classification reflects about one-third of the riparian condition, occurring in the upper stretches of fish-bearing streams, and more or less evenly split between private and federal lands.

**<u>Stream Shade Assessment Methods</u>**

Stream temperatures are affected by stream and basin characteristics, including shading, depth of flow, length of exposed reach, interchange of flows with near-channel water, and groundwater inflow. Tributaries of cooler water also play a role in moderating summertime maximum temperatures on larger streams (McSwain, 1987; Holaday, 1993). Air temperatures generally increase with decreasing elevation, likewise stream temperatures also increase with decreasing elevation, causing streams lower in the basin to be warmer than higher streams.

Shade provided by riparian vegetation performs an important function for forest streams by maintaining optimal water temperatures for salmonids. Riparian shade can therefore be used to assess water quality in absence of actual stream temperature data. Assessment methods were performed in accordance with the WFPB Standard Methodology for Conducting Watershed Analysis (Version 3.0, 1995). The assessment was completed using stereo pair 1:12,000 color aerial photographs. All fish-bearing streams were assessed.

***Deviation from Standard Methods***

Segments were evaluated in increments of 1000 to

1500 feet, which deviates from the 2000 foot segment described in the manual. Given the large amount of managed forest, agricultural use, and private land, these smaller segments represent more accurately variation within the riparian zone.

## Reference Stream Shade Conditions

Stream shade patterns roughly correlate with LWD recruitment potential patterns, since both measures are dependent on riparian stand conditions. Consequently, much of the same discussion regarding reference LWD conditions applies. Historic information from the 1900s (see Figure 3-13) indicated that most of the watershed, including tributaries, was forested. A significant amount of timberless area did exist, however, in the lower watershed extending almost half way up the West and East Forks of Trail Creek. Information from 1936 (see Figure 3-14) identified the emergence of timber and land conversion activities extending the extent of open conditions somewhat further up the watershed. Compared to current conditions (Figure 1-6), the amount of forested land along the stream network in 1900 and 1936 appears to be higher. Therefore, shade was historically higher along the upper reaches of both forks of Trail Creek and their tributaries. In the lower portions of the drainage, however, stream shade may have been comparable to present conditions.

## Current Stream Shade Conditions

Tables 3-19 and 3-20 list the miles of stream at various shading levels within the riparian zones on federal and private lands, respectively. Figure 3-26 identifies where these areas are found within the watershed. The effect of stream shade on stream temperatures was evaluated (see Temperature discussion below) and indicated that almost all of the stream miles in the Trail Creek watershed have a high shade hazard, that is, the existing shade levels are less than that required to maintain stream temperatures below the 64 degrees F Oregon standard. This is largely a reflection of the relatively low amounts of adequate shade in the lower portions of the watershed. Only 5.86 miles (or 21%) of the fish-bearing streams currently provide 80% shade cover or greater. Overall, this finding indicates a shade-deficient condition predominates, however, it must be noted that the effect of this condition on stream temperatures must be supported by actual temperature monitoring data.

**TABLE 3-19**

**Stream Shading - Federal Lands**

| Minimum Shade Category (%) | Mileage |
|---|---|
| 10 | 0.16 |
| 20 | 0.65 |
| 30 | 0.93 |
| 40 | 0.14 |
| 60 | 0.22 |
| 70 | 2.78 |
| 80 | 1.46 |
| Total | 6.34 |

**TABLE 3-20**

**Stream Shading - Private Lands**

| Minimum Shade Category (%) | Mileage |
|---|---|
| 5 | 0.66 |
| 10 | 1.79 |
| 20 | 4.12 |
| 30 | 4.25 |
| 40 | 1.98 |
| 50 | 0.95 |
| 60 | 2.07 |
| 70 | 1.35 |
| 80 | 4.40 |
| Total | 21.57 |

Most of the Trail Creek watershed has high shade hazard due to the length of streams that pass through low elevation, non-forested areas. Shade recovery has the potential to occur in the forested reaches of the tributaries and along the main forks of Trail Creek. Riparian restoration efforts have been initiated by at least one private industrial landowner. The establishment of Riparian Reserves on federal lands in the upper reaches of the tributaries also raises the potential for shade improvement, albeit on a relatively smaller proportion of fish-bearing streams. Nevertheless, the remaining land uses and vegetation patterns indicate limited potential for the establishment of timber that could eventually provide additional shade to the stream.

**Temperature**

During 1996 and 1997, temperature monitoring was conducted at 21 sites in the Trail Creek and Elk Creek watersheds (Boise Cascade Corp., 1998). Data on elevation, shade, aspect, channel slope, width, and depth were also collected at each site. Data from additional USFS and USGS monitoring sites were also included for a total of 27 sites. Using this information, a linear regression model was developed, which predicts maximum water temperature as a function of elevation and shade level:

$$T = 95.1 - 0.0108\,E - 0.0756\,C$$

T = seven-day maximum temperature (ºF)
E = elevation (ft)
C = canopy shade level (%)

The results of this regression are illustrated in Table F-1 (Appendix H).

The monitoring results indicate that summer maximum water temperatures naturally exceed the Oregon 64 degrees F standard in many streams. Furthermore, the regression model predicts that the 64 degrees F standard cannot be achieved at elevations below 2,000 feet even with 100% shade, a level of shading which is seldom, if ever, achievable at the lower elevations in the Trail Creek watershed. Conversely, the model indicates that the 64 degrees F standard is likely to be met at elevations above 3,400 feet regardless of stream shade levels. In the Trail Creek watershed, all fish-bearing streams lie below 3,400 feet, and most are below 2,600 feet.

## 3.7 Aquatic Resources

**Reference Fisheries Conditions**

There appears to be little historic data (1900 or 1936) for the Trail Creek portion of the Rogue River watershed that indicates relative numbers and distribution of anadromous and resident fish species. However, data for the Rogue River, collected at Gold Rey Dam (located about 25 miles downstream from Trail Creek), documents numbers of anadromous fish that have migrated upstream in the Rogue River over the period 1942 to 1995 (Figure 3-27).

Migratory fish species that have historically spawned in the Rogue River and/or tributaries include spring chinook, fall chinook, summer steelhead, winter steelhead, coho salmon, Pacific lamprey, and Klamath small-scale sucker. Chinook salmon spawn primarily in the mainstem of the Rogue River, while coho and steelhead spawn mostly in tributaries such as Trail Creek and smaller headwater streams.

Over the period 1940 to 1995, spring chinook have been the most abundant anadromous species recorded at Gold Rey Dam, Cole Rivers and Applegate facilities, followed in abundance by winter and summer steelhead, fall chinook, and coho. Although all of these anadromous species are present in the Rogue River upstream and downstream of the confluence of Trail Creek, only steelhead and coho appear to have historically used Trail Creek for spawning. Cutthroat trout were probably the most abundant resident salmonid in upper reaches of tributaries. Other species present in the drainage in 1900 included sculpin, shiners, dace species, and Klamath small-scale suckers.

Except where limited by barriers, fish distribution in the watershed under reference conditions was more or less the same as today. However, numbers of fish and life stages supported were probably higher prior to aquatic habitat degradation and limits to migration resulting from extensive logging, road construction, and dam construction on the Rogue River drainage.

## <u>Current Fishery Conditions</u>

Resident fish in the Trail Creek watershed include cutthroat trout, rainbow trout, sculpins, red-side shiner, dace, bluegill, and Klamath small-scale sucker. Migratory fish that spawn and rear in the watershed are summer steelhead, winter steelhead, and coho salmon (Satterthwaite et al., 1996), Pacific lamprey and Klamath small-scale sucker. Cutthroat are most abundant in small headwater tributaries, where they are the dominant fish species.

### *Fish Distribution*

Fish distribution in the watershed was determined from file data compiled by BLM (GIS Hydrography Layer), unpublished file data collected from field studies conducted by BLM and ODFW in 1998, and a published report by Satterthwaite et al. (1996). Cutthroat trout are the most widely distributed salmonid in the watershed, occupying small, steep-gradient headwater streams as well as larger tributaries and the mainstem of Trail Creek. Cutthroat are resident fish and often occupy habitat that is upstream from barriers that inhibit movement of migratory fish. The presence of cutthroats above barriers indicates their presence in the watershed prior to establishment of barriers. Because they occupy the headwater streams year-round (i.e., do not migrate from the ocean or larger streams in the Rogue River watershed), they do not need to periodically negotiate barriers to spawn.

Resident cutthroats are native to the Pacific slope and spawn in small well-aerated streams (mainly in tributary streams) between February and May when water temperatures are around 50 degrees F. Some cutthroats may also be sea-run fish. No studies have been conducted that would discriminate between resident and sea-run cutthroats. Sea-run cutthroats migrate downstream to the ocean from March-June.

Coho are present in the mainstem of Trail Creek, most of the West Fork and lower reaches of major tributaries (i.e., Canyon Creek, Romine Creek, and Wall Creek). Coho migrate into Trail Creek from the Rogue River from November through January. Optimum temperatures for spawning and egg incubation are 50-55 degrees F. Optimum rearing temperatures are from about 53-57 degrees F.

Both summer and winter steelhead migrate into the Rogue River drainages. The relative numbers of summer versus winter steelhead that enter Trail Creek is not known. Steelhead are nearly as widely distributed in the watershed as cutthroat trout. It has been documented that they spawn in Canyon, Romine, Chicago, and Wall creek and the in the upper reaches of the West Fork (Satterthwaite et al., 1996). There is no data to indicate if they also spawn in the mainstem of Trail Creek or the West Fork downstream from the confluence with Chicago Creek.

Summer steelhead migrate into fresh water from April -November and spawn from February to June when water temperatures are from 50-55 degrees F. Winter steelhead migrate into fresh water from November - June and spawn from February to June. Both summer and winter strains migrate downstream from March-June.

Fish count data (Figure 3-27) collected at Gold Rey Dam, indicates that the most abundant anadromous fish that migrates upstream in the Rogue River is spring chinook. Although chinook (both spring and fall chinook) are present in the Rogue River, there is no data to indicate that they enter the Trail Creek watershed.

Although habitat for coho, steelhead, and cutthroat overlap in Trail Creek, they do show preferences in spawning and rearing habitat based on stream flows, substrates, and habitat type. Coho prefer low-gradient streams (slope less than 3 percent) with abundant pool habitat and larger substrate particles (Armantrout, 1995). Steelhead spawn in lower gradient streams (slopes less than 6 percent) but prefer faster flows and smaller substrate particle size. Cutthroat trout occur throughout the watershed, but extend into upper, high-gradient stream reaches (slopes less than 17 percent) with perennial flow and abundant pools.

Presence of anadromous fish in portions of watersheds is also correlated with the drainage area of the stream. Armantrout (1995) found that streams with coho generally have drainage areas larger than 472 acres. Streams with steelhead typically have drainage areas larger than 236 acres, while streams with cutthroats have drainage areas larger than 142 acres.

Coho salmon are listed as threatened under the Endangered Species Act by the NMFS on June 6, 1997. The Klamath Mountain Province steelhead is currently, a "candidate at risk species". Although Chinook salmon have not been reported from the Trail Creek watershed, they are present in the Rogue River. This species was proposed for listing as "threatened" under the Endangered Species Act; however, a determination was made by NMFS in March of 1999 to exclude the Southern Oregon chinook runs from listing at this time.

### Fish Hatcheries and Stocking

There are two fish hatcheries in the Rogue River watershed, Cole Rivers Hatchery and Butte Falls Hatchery. The Butte Falls Hatchery propagates fish for stocking only into standing water and does stock any streams in the Rogue River watershed (Adar, 1999). The Cole Rivers Hatchery propagates and releases summer steelhead, winter steelhead, spring chinook, and coho into the Rogue River. The Cole Rivers Hatchery does not stock fish in the Trail Creek watershed (Otto, 1999).

The collection ponds at Applegate capture adult winter steelhead. Eggs from these fish are reared at the Cole Rivers Hatchery for release into the Rogue River.

Data for numbers and species of salmonids migrating upstream in the Rogue River, collected at Gold Rey Dam since 1942, shows that the fish numbers for all species have increased since construction of the Cole Rivers hatchery in 1975. This hatchery was constructed to mitigate losses of anadromous fish habitat above Lost Creek Dam.

Numbers of coho, chinook, and steelhead that migrate past Gold Rey Dam have increased since 1975 (Figure 3-27). This increase may be attributable to the release of fish propagated at the Cole Rivers Hatchery; however, it may also be due to other factors. Data collected at Gold Rey Dam shows an increase of spring chinook, fall chinook, coho, summer steelhead, and winter steelhead since 1975. Because the Cole Rivers Hatchery does not propagate fall chinook, the increases in fall chinook, recorded at Gold Rey Dam after 1975, cannot be a result of propagation and release of fish from Cole Rivers Hatchery. The increase in fall chinook since 1975 seems to be in proportion to increases in numbers of other anadromous fish. Although numbers of anadromous fish migrating in the Rogue River vary yearly, there appears to be a trend of increasing fish numbers since 1975 that cannot be attributed, solely, to the Cole Rivers Hatchery.

### Anadromous Fish Escapement Levels

Escapement refers to adult fish that "escape" fishing gear to migrate upstream to spawning areas (Bell 1984). Although numbers of fish that migrate past the Gold Rey Dam are known, there is no data that indicate how many of these fish that enter Trail Creek. Numbers of coho and steelhead in portions of the Trail Creek watershed were recorded for only one year (Satterthwaite et al., 1996). Due to yearly variation in numbers that pass Gold Rey Dam and enter Trail Creek, it is not known how closely numbers of fish recorded by Satterthwaite et al. (1996), represent yearly averages or population ranges. With only one year of data it is not possible to analyze if there is a statistical relationship between numbers fish that pass Gold Rey Dam and numbers of fish that enter Trail Creek.

***Fish Habitat Values***

Fishery habitat values for streams in the watershed are correlated with features such as: temperature, frequency, depth, and gradient of pools; width/depth ratio, particle size, substrate geology, and gradient of riffles; amounts of gravel; amounts of large woody debris in streams; and large trees within 30 meters of the channel. In general, streams in the watershed have favorable ratings for pool areas, active channel widths per pool, and amounts of bank erosion. Based on physical characteristics, habitat values in the Trail Creek watershed are sub-optimal due to limited amounts of spawning gravel and large amounts of fine sediment in spawning gravel. Sub-optimal amounts of large woody debris (Figure 3-25) in and adjacent to the stream channel, insufficient shade (Figure 3-26), and high water temperatures (Figure 3-12) significantly limit habitat quality in the watershed.

Aquatic habitat in the lower portions of West Fork Trail Creek also has insufficient stream flow during most summers (Satterthwaite et al., 1996). Cessation of flow probably affects both resident and anadromous fish movement within the system, restricting available habitat for all age classes during the summer months.

Although there is little fishery data for the mainstem of Trail Creek and the West Fork, these large streams do not appear to have suitable spawning and rearing habitat for salmonids. Low amounts of spawning gravel and high summer water temperatures appear to be important habitat deficiencies. Low amounts of shading at lower elevations of the watershed (Figure 3-26) allow water temperatures to exceed 64 degrees, the ODEQ standard.

Although studies have been conducted in 1971 and 1998 by the ODFW to characterize substrate particle size, there appears to be no substrate data at known spawning sites for resident and migratory fish. The 1971 file data indicates that for nearly all surveyed portions of Trail Creek, spawning gravel is limited or not present. The 1998 data provides particle-size distribution for substrates of various reaches surveyed, but does not indicate which stream reaches appear to be suitable for spawning. Surveys of spawning gravel locations and amounts within the watershed at locations of spawning redds would provide critical information in determining if spawning habitat is limiting salmonid fish populations in the watershed.

It is possible that availability of spawning substrate varies depending on flood frequency and magnitude in the watershed. During large floods, gravel can be removed by scouring and transported downstream, especially where gravel overlays bed rock. The dynamics of gravel movement and recruitment in the watershed may be important in determining spawning potential of salmonids.

Based on studies in 1995, most salmon and trout spawn in the tributaries of Trail Creek and West Fork Trail Creek (Satterthwaite et al. 1996). Data do not appear to be available for spawning in the mainstem of Trail Creek.

Tributaries that provide spawning habitat for coho salmon are: Canyon Creek, West Fork Trail Creek above the confluence with Chicago Creek, Romine Creek, and Wall Creek. In 1995 (Satterthwaite et al., 1996), Canyon Creek produced about 19,000 coho fry per kilometer of habitat and Wall Creek and West Fork produced an average of 2,114 coho fry per kilometer of habitat.

Young salmon (coho and unknown salmon species) were also captured in Chicago Creek and Romine Creek, but data for spawning habitat in these streams is not presented in Satterthwaite et al. (1996). Based on the amount of spawning habitat available, yearly production of coho fry is estimated to be: Canyon Creek 9,960 fry (0.51 kilometers of spawning habitat), Wall Creek 2,960 fry (1.40 kilometers of spawning habitat), and West Fork 2,156 fry (1.02 kilometers of spawning habitat). Table 3-21 presents numbers of migrant fish captured in the Trail Creek watershed in 1995.

Trout production data for streams in the watershed (Table 3-21) indicates that the most productive streams for migrant rainbow (i.e., steelhead) and cutthroat, in decreasing order of productivity are: Wall Creek, West Fork, Canyon Creek, Romine Creek, and Chicago Creek. Suitable spawning habitat for trout in these streams (Satterthwaite et al., 1996) is: 1.13 kilometers for Canyon Creek, 0.81 kilometers for Romine Creek, 1.50 kilometers for Chicago Creek, 2.63 kilometers for Wall Creek, and 1.95 kilometers for West Fork.

**TABLE 3-21**

**Number of Migrant Juvenile Salmonids Caught in Weir Traps in 1995**

| Stream | Unknown Salmonid Age 0+ | Trout Age 0+ | Coho Salmon Age 0+ | Coho Salmon Age 1+ | Cutthroat Trout Age 1+ | Steelhead Trout Age 1+ |
|---|---|---|---|---|---|---|
| Canyon Creek | 10,164 | 2,172 | 9,158 | 3 | 46 | 7 |
| Romine Creek | 53 | 1,582 | 7 | 1 | 16 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Chicago Creek | 657 | 858 | 0 | 0 | 77 | 4 |
| West Fork | 3,045 | 6,890 | 2,566 | 2 | 37 | 25 |
| Wall Creek | 332 | 10,615 | 54 | 0 | 20 | 12 |

Although limited data (Satterthwaite et al., 1996) is available for anadromous and migrant salmonid species, there appears to be no data available for relative numbers of resident salmonids. Stream surveys conducted by Oregon Department of Fish and Wildlife (1998) collected information for presence or absence of fish species in various reaches of Trail Creek and tributaries, but did not differentiate between resident and migrant fish. This data along with data presented by Satterthwaite et al. (1996) was used to construct Figure 3-28. Table 3-22 shows the miles of stream in the watershed that provide habitat for salmonid fishes. Mileage presented in Table 3-22 includes reaches of stream that may only be used for migration (i.e., mainstems of Trail Creek) and may not provide suitable spawning habitat for resident and anadromous fishes.

***Passage Barriers***

Barriers to upstream movement of fish in the watershed include cascades, high-gradient stream reaches, waterfalls, log jams, and improperly sized and installed culverts. Fish barriers in the watershed are shown on Figure 3-28. Seasonal effects on fish movement due to barriers may be complete or seasonal obstruction of upstream migration of either adults or juveniles. Based on reviews of data compiled in 1971 and 1998 by ODFW and Satterthwaite et al. (1996), Figure 3-28 was constructed. In many cases, the data did not adequately describe the nature of barriers (e.g., type, height, location of pools relative to the barrier).

Generally, waterfalls higher than 12 feet are barriers to upstream fish movement. Waterfalls also isolate fish above falls (e.g., resident cutthroat trout) from anadromous fish downstream from waterfalls. This separation prevents competition between resident fish above barriers with migratory fish and may lead to genetic isolation of fish stocks above barriers.

Potential un-occupied fisheries habitat appears to be present above barriers (i.e., perennial streams above barriers) in the upper West Fork (2.4 miles of stream, all on federal lands), Canyon Creek (1.04 miles of stream, 0.78 miles on BLM lands), and a tributary of Wall Creek ( 1.06 of stream, 0.45 on BLM lands) (Figure 3-28).

**TABLE 3-22**

**Salmonid Species Occurrence**

| Species | Total Miles | Miles Federal | % of Total | Miles Private | % of Total |
|---|---|---|---|---|---|
| CO/SH/RB/CT | 16.36 | 2.38 | 15 | 13.98 | 85 |
| SH/RB/CT | 7.07 | 2.07 | 29 | 5.00 | 71 |
| CT | 4.48 | 1.89 | 42 | 2.59 | 58 |
| Total | 27.91 | 6.34 | 23 | 21.57 | 77 |

Species Codes: CO - Coho; SH - Steelhead; RB - Rainbow; CT - Cutthroat.

# 4.0 SYNTHESIS, INTERPRETATION, AND RECOMMENDATIONS

The purpose of this section is to compare current and reference conditions, explain significant trends and their causes, identify the capability of the system to achieve relevant key management plan objectives, and identify management recommendations that are responsive to those watershed processes identified in this analysis. This discussion summarizes trends observed in the Trail Creek watershed in terms of direct and indirect impacts and their causes in terms of disturbance factors and predisposing factors. The comparison of the current and reference conditions is used as a basis for these determinations, as well as the processes involved, and is described in detail in the following discussion. This discussion also addresses conditions determining relative significance of trends in the watershed and measures that could mitigate, enhance, or restore these conditions. Presented in the form of management recommendations, this discussion also summarizes these policies and activities on a resource management basis.

## 4.1 Human Use

Overall, human uses are the major disturbance factors affecting the Trail Creek watershed physical and biological systems. As such, they are the cause of many of the direct and indirect impacts depicted in this section. Naturally occurring disturbances such as storms and wildfire have also had a significant influence on the physical and biological attributes of the watershed; however, as has been presented in previous sections, their impact has become relatively insignificant. Consequently, this synthesis and interpretation focuses on the major changes and future trends in human use that will be presented in this section. This will form the basis for subsequent sections that address processes and the various impacts arising from human use, the relative significance of human use in these processes and impacts, and management recommendations for mitigating, enhancing, or restoring results of human use.

Comparing current conditions to reference conditions, Native American use and occupation in the Trail Creek watershed has been virtually eliminated and Euro-American use has been on an ever increasing trend. Native American use described in Section 3.0 was historically limited to hunting and gathering and associated vegetation manipulation. There was likely limited occupation of the watershed. With no treaty or tribal rights, there is no expectation that Native American use of the watershed will become significant within the watershed. Attempts to consult with tribes in the region were unsuccessful.

Euro-American use has increased significantly, first through settlement and grazing and timbering, then through increased rural residential development. Development patterns indicate that these uses began at lower elevations and continued up the major drainages (West Fork Trail Creek and East Fork Trail Creek) and transportation routes (current State Highway 227) as space and resources were utilized. Federal land management historically promoted grazing and timber uses, whereas private land management stressed grazing and timber uses. Residential development occurred on smaller parcels. All lands have had road development that has increased as resource use increased. Early use of major drainages for log drives decreased as this road system developed.

Timber harvesting has been the major extractive human use in the Trail Creek watershed. Logging began at lower elevations on private lands prior to the turn of the century. Products fed several mills in the watershed and mills downstream on the Rogue River. Expansion of timbering activity into higher elevations continued on both private and federal lands until the 1920's when markets became depressed. World War II sparked a resurgent demand and there is evidence of extensive logging in the watershed from the 1940s through the 1970s. On BLM-administered lands, this included extensive yarding of unmerchantable material for chip markets. Due to both decreased inventory and decreased markets, logging activity began to decline during the 1980s. On BLM and USFS lands, there has also been a dramatic downturn in the timber harvest levels as a result of the court-ordered halt of federal timber harvest within the range of the northern spotted owl.

This watershed analysis will identify opportunities for future harvest activity; however, because of limited inventory and environmental concerns, it is unlikely that volumes will return to historic levels. Second growth stand conditions on private industrial lands have likely not reached economic maturity under current markets. A significant amount of small private land parcels are not managed for timber production as the primary land use. Timber harvesting on federal lands has become restricted. Consequently, whereas over 90 percent of the watershed has been logged since the turn of the century, timber harvest activity will most probably occur at significantly lower levels in the future.

Land development, road building, and fire suppression are three additional major human use activities that occur in the Trail Creek watershed with significant impacts to resources. Small private land ownership has grown to about 16 percent of the total watershed area. Rural residential development, with associated small-scale agriculture, is the primary human use. Projected population trends for the area and county zoning within the watershed suggest that this use trend will continue. Road development in the watershed has grown to over 190 miles of active roads. This represents a density of about 3.5 miles per square mile. Overall density is unlikely to increase, though a shift in density from federal lands to private lands may occur as a result of increased private land development. Wildland fire cycles have been interrupted resulting in a less stable ecosystem more susceptible to catastrophic events. This trend is likely to continue; however, fuel and fire hazard management activities may be implemented reducing risks to firefighters, public safety, and natural resources.

Other traditional and unauthorized human uses in the Trail Creek watershed have been of limited scope and/or impact in the watershed. Grazing use on federal lands has decreased significantly from historic levels. Permitted use on the four current BLM grazing allotments is unlikely to increase. The major non-timber forest product on federal lands in the watershed has been firewood cutting for personal use. This has decreased significantly from historic levels and under current federal land management, would be limited or more heavily regulated in the future. Precommercial thinning programs have treated about 950 acres of BLM-administered lands since the 1980s. They and will continue at more or less present levels. The major recreational use of the watershed has been hunting. Levels of have been closely tied to road access and will likely remain so. Recreational climbing activity is noted in isolated locations; however, no survey data exists to establish any trends. Other uses in the watershed include illegal water withdrawals, trash dumping, and looting of archeological sites, all of which are known to occur, but at undocumented levels and impacts to the environment. Individually and cumulatively, the influence of these activities is relatively limited.

## 4.2 Vegetation

Prior to disturbance by timber harvests, land development, road building, and fire suppression, fire was the major disturbance factor affecting vegetation patterns. This included both frequent, low-intensity wildfires and anthropogenic fires ignited by Native Americans for vegetation management. The naturally occurring fire regime promoted “open-grown” forests favoring ponderosa pine, Douglas-fir, and oak woodlands. Periodic fires maintained a mosaic of stand conditions by controlling understory and ground fuels and by promoting grasses. Except in extreme climatic, topographic, and fuel conditions, stand clearing events were rare.

Timber harvesting and fire suppression in the Trail Creek watershed have dramatically changed forest stand conditions compared to pre-settlement times. In many instances, the relatively poor site quality found throughout the watershed has exacerbated the magnitude of these impacts. The current condition is characterized by second growth stand conditions with mixed overstory species, sizes and densities, dense understories and/or brush cover, and relatively high ground fuel loads. This condition is found on about 27,190 acres of BLM, USFS, and private industrial lands (about 77% or total area in the watershed) whose land management practices have dictated specific stand structures described earlier in Section 3.0. Conditions on private lands would most likely persist; however, changes in federal land management resulting from the Northwest Forest Plan would favor trends to reference conditions.

Land development activities have occurred primarily on about 5,770 acres of small private landowner parcels representing about 16 percent of the Trail Creek watershed. About two-thirds of this acreage has been converted from forest lands to predominantly non-forest conditions characterized by residential areas, small agricultural operations, and brushfields. Dense ladder fuel and high ground fuel conditions persist here, as well, also as a result of fire suppression activities. Land development is likely to increase within this land ownership category, primarily along major access roads and drainages in the watershed, and with it will likely come the same changes in vegetation structures.

Road construction has been extensive in the Trail Creek watershed. In addition to the approximately 190 miles of active roads in the watershed, about 110 miles of abandoned or permanently closed roads are found throughout the watershed. Road development has occurred on all land ownership categories. Vegetation conditions can be characterized by minimal vegetative cover and noxious weed invasions. As noted above, future trends for road construction will likely be limited to those associated with land development and there could be a reduction in road density on federal lands through implementation of land management programs.

Overall, the absence or exclusion of human use has been limited to a very small portion of the watershed where there has been no apparent timber harvest, land conversion, or road building, and fire suppression effects have not been significant. Roughly 2,050 acres of old-growth stand conditions exist on cooler, moister, upper elevation, north facing slopes where conditions likely are reflective of reference conditions. It should be noted, however, that because of their topographic position, these stands are not predisposed to fire. Consequently, they do not represent reference conditions as they likely existed over most of the watershed. Most of these stands exist on BLM and USFS lands and will likely be conserved. Other vegetation conditions relatively unaffected by human use include meadows and rock outcrops which occur in limited acreage throughout the Trail Creek watershed.

Trends in vegetation conditions within riparian areas tend to reflect the general trends described above; however, specific distinctions can be made. First, whereas upland sites tended to be timbered at the turn of the century, lower-elevation stream reaches were predominantly timberless. Contributing factors included naturally dry sites, fires ignited naturally and by Native Americans, land conversion activities related to settlement, and log driving. Secondly, effects of early logging practices appear to have been more severe in riparian areas than in upland sites. By 1936, tractor logging without buffers further reduced riparian vegetation in the watershed. Finally, whereas vegetative cover along streams in headwater areas closely resembles adjacent upland vegetation, riparian stand condition along the major fish-bearing streams appears to be significantly lower. Over two-thirds of the fish-bearing streams in the watershed appear to be lacking and/or deficient in mature riparian area stand structure. About 90 percent of this condition occurs on private lands.

Presettlement vegetation along these streams may have included more large trees, primarily ponderosa pine and Oregon white oak, though maintained at relatively low densities by fires ignited by Native Americans. Similar conditions were described for the Elk Creek watershed (USDI BLM, 1997) and by regional studies of historic riparian vegetation (LaLande, 1995; Pullen, 1996). Gallery forests, characterized by cottonwood, ash, and alder, typically occurred along lower elevation drainages prone to frequent flooding and shallow groundwater conditions. Given observations about reference conditions for stream geomorphology, flood frequency, depositional patterns, and groundwater and impacts of water withdrawals, conditions suitable for these hardwood species was likely limited, much as it is currently.

Overall, changes in forest stand structure have profoundly impacted physical, biological, and social processes in the Trail Creek watershed. These changes have directly affected peak flows, soils, hillslope erosion processes, large woody debris recruitment, and stream shade. These, in turn, have had indirect impacts on soil productivity and resiliency, stream sedimentation, stream temperature, and overall aquatic habitat quality. These impacts, and recommendations for mitigating effects of these impacts, will be discussed in detail in the following sections on Hydrologic Processes, Erosion Processes, Riparian and Stream Processes, and Aquatic Habitat.

In addition to effects on aquatic habitat, changes in vegetation have had direct biological effects on old-growth habitat, stand structure, early seral habitat, understory/brush densities, wildlife, habitat connectivity, coarse woody material, and snag habitat. Impacts on sensitive plant and wildlife populations have resulted. Recommendations for addressing these impacts are addressed in the Terrestrial Habitat section.

Socially, the most significant impacts of vegetation processes and current conditions in the watershed are decreased timber stand productivity, increased fire hazard conditions, and potential for increased noxious weeds infestations, recommendations for which are addressed here. Each of these impacts indirectly affects the value of natural resources in the watershed and poses further risk to watershed processes, resources, and public safety. Opportunities for economic development and use of natural resources in the watershed will be discussed in conjunction with these recommendations. Furthermore, suggested locations for application of these recommendations will be presented addressing specific habitat and species objectives.

***Recommendations***

Objective: The following recommendations address RMP objectives for matrix land use allocations, forest health, timber resources, and roads/access as implemented through timber stand improvement activities.

The following prescriptions would be applied either during timber harvest activities or non-commercial timber stand improvement projects. Many vegetation management activities also have direct applicability to RMP objectives for terrestrial and aquatic habitat. As such, they will be integrated into later discussions. In making these recommendations, it is noted that the capability of the forest land in the Trail Creek watershed to meet RMP objectives is limited by current vegetation conditions and low site productivity factors. Factors such as operability constraints, access, and markets are less of a concern. Therefore, the following recommendations are responsive to current conditions and stress those that are likely to significantly increase the overall growth, quality, and vigor of BLM-administered stands:

- Consider selection or group selection harvesting in moderately and well stocked large sawtimber stands and appropriate site preparation treatments to create openings and suitable seed beds promoting the establishment and growth of mixed conifer species. Based on the BLM Forest Operations Inventory, about 3,570 acres of this stand condition exists on BLM-administered land, 2,000 acres of which occurs on matrix land use allocations.

- Consider hardwood density management and thinning from below to improve large tree growth within all sawtimber stands. BLM Forest Operations Inventory does not readily support determination of stand locations and acreage that could potentially benefit from this treatment; however, field reconnaissance indicates that these conditions are common, though intermittent, throughout about 9,490 acres of small and large sawtimber stands, about 7,440 acres of which occurs on matrix land use allocations.

- Consider overstory removal harvests on BLM lands where prepatory and seed tree harvests have been successful in promoting regeneration of commercial species of adequate size and density where brush competition and hardwood competition will not become a problem upon stand release. These stand conditions tend to exist on at least 5,020 acres of matrix land use allocations expressed as poorly to moderately stock sawtimber stands in the BLM Forest Operations Inventory.

- Consider use of regeneration harvests on BLM lands where prepatory and seed tree harvests have not been successful in promoting regeneration of commercial species of adequate size and density. Regeneration harvest prescriptions would require aggressive site preparation and brush control to ensure adequate regeneration. These conditions exist within the 5,020 acres of sawtimber stands presented above.

- Consider commercial thinning harvests on BLM lands in well stocked pole and small sawtimber stands. This stand condition is very limited and fragmented within BLM-administered lands, represented by only about 250 acres scattered throughout the Trail Creek watershed.

- Consider precommercial thinning and chemical and mechanical brush control to release commercial tree regeneration in all seedling/sapling stands. At least 2,370 acres exist on BLM-administered lands, 1,900 acres of which occurs on matrix land use allocations. To date, the BLM has already completed about 950 acres of precommercial thinning in these areas.

- Consider the use of intensive chemical, mechanical, and biological measures to convert dense brush fields in which desired hardwood and/or conifer regeneration is inadequate and unlikely to improve. Non-stocked and poorly stocked seedling/sapling and pole stand conditions exist on up to about 1,050 acres on BLM-administered land.

- Consider the use of prescribed fire and mechanical methods to decrease under brush and understory regeneration in conifer stands and oak woodlands. Fuel loading tends to be high throughout the Trail Creek watershed and since these activities would be carried out in potentially high hazard conditions, pre-burn planning would be necessary to mitigate potential risks and hazards from these activities.

In implementation, several factors would need to be considered. Suitable stands and total acreage available would require further site assessment of habitat constraints, operability constraints, hardwood and brush competition, fuel conditions, and regeneration success. Preliminary determinations can be supported by information provided above. Further reductions in available acreage could also occur due to fragmentation of available acreage due to revised land use allocations making some areas uneconomical to harvest. In fact, the BLM should consider restratification of stand conditions in response to revised land use allocation delineations. Finally, all prescriptions would be subject to overriding resource management priorities (e.g., terrestrial and aquatic habitat) presented in the Resource Management Plan.

Overall, whereas these recommendations indicate opportunities for timber stand improvement and associated economic benefits, actual area available for implementation of these recommendations would be moderated by other resource management concerns. Conversely, the need for fire hazard reduction and terrestrial and aquatic habitat improvement could present opportunity for these timber stand improvement recommendations and associated economic benefits. As such, timber stand improvement prescriptions should be coordinated with other resource specialists to identify conflicts and develop opportunities.

In addition to timber stand improvement, the following recommendation should also be placed on road access in consideration of supporting these activities:

- Maintain adequate access routes for forest product extraction associated with timber stand improvements. An extensive road network exists within the Trail Creek watershed; however, road closure activities could indirectly reduce economic feasibility of timber stand improvement activities.

In implementation, road closure plans should be coordinated between timber management and resource specialists for which road management applies, as well.

Objective: The following recommendations address RMP objectives for forest health, timber resources, roads/access, rural interface areas, and fire management as implemented through fire hazard reduction activities.

Recommended prescriptions could be applied either concurrent with other management activities or expressly as fire hazard treatments. As with timber stand improvement recommendations, many fire use activities also have direct applicability to aquatic and terrestrial habitat improvement and, as such, will be incorporated later in this section. In making these recommendations, it is noted that much of the area within the Trail Creek watershed is predisposed to high fire hazard due to hot, dry climatic conditions and steep, southern exposures. In many instances, these conditions alone will make any given site considered high hazard under the criteria used in Section 3.0. Consequently, the following recommendations stress overall strategies that will most significantly reduce fire hazard:

- Decrease canopy closures in dense, pole sized conifer conditions below 3,500 feet elevation to 60% or less. According to the WODIP database, about 6,850 acres of this vegetation condition exists in the lower watershed, about half of which occurs scattered throughout BLM-administered land. This represents about 20 percent of the watershed and about 25 percent of the BLM acreage. Both timber stand improvement and treatments specific to fuel management would apply as would treatment of activity fuels would, as discussed below.

- Decrease ladder fuels in forest stands by cutting dense patches of suppressed tree regeneration and shrubs species. Neither the BLM Forest Operations Inventory nor the WODIP database readily supports determination of stand locations and acreage that could potentially benefit from this treatment; however, field reconnaissance indicates that these conditions are common, though intermittent, throughout all forested stand conditions in the watershed.

- Decrease ground fuels in both commercial and noncommercial timber stands. Both mechanical methods and fire use should be considered in implementation. Again, existing data do not support determination of treatment locations although they commonly occur throughout the watershed.

- Decrease activity fuels associated with timber harvests and timber stand improvement activities. This can be accomplished both through prescriptive actions that limit or eliminate fuel loads and/or through activity scheduling that limits the total amount of acres that would be in a high fuel hazard condition.

- Appropriate tactics used in fuel hazard reduction would be developed on a prescription basis and could include, but not be limited to: mechanical reduction, underburning, slash and burning, lop and scatter, handpile and burning. Prescriptions would also address site assessments of habitat considerations, operability constraints, fuel conditions, and other environmental concerns.

In implementation, several factors would need to be considered. Priority for fire hazard reduction would likely focus on rural interface areas depicted in Figure 3-19; however, it is noted that BLM-administered lands are limited within these areas. To address this, cooperative fire hazard reduction efforts should be explored by the BLM. Opportunities for timber stand improvement, terrestrial habitat improvement, and aquatic habitat improvement could be created and used to promote fire hazard reduction efforts. Conversely, habitat concerns may override concerns for fire hazard reduction. Overall, the potential risk to public safety may outweigh all other concerns. In any case, fire management efforts would need to be coordinated with other resource specialists.

In addition to fuel hazard reduction, the following recommendation should also be placed on road access:

- Maintain adequate access routes for fire suppression activities associated with safety and resource protection. An extensive road network exists within the Trail Creek watershed; however, road closure activities or traffic restrictions could indirectly place public safety and resources potentially at risk.

In implementation, road closure plans should be coordinated between fire management and resource specialists for which road management applies, as well.

Objective: The following recommendations directly address RMP objectives for forest health, timber resources, roads/access, fire management, and noxious weeds as implemented through noxious weed control activities.

Specifically, the following prescriptions are for controlling existing infestations and discouraging the spread of non-native and noxious weeds throughout the watershed. Recommendations tend to be specific to this one resource issue. Much of the area is predisposed to noxious weed problems due to overall low site quality and the extensive road system that exists. The following recommendations are therefore responsive to existing conditions and stress those that address existing problems, those with the potential to increase, and prevention actions:

- Consider maintaining relatively higher shade levels along roads and rights-of-way within the watershed to reduce the competitive advantage of shade intolerant weed species.

- Consider use of chemical treatments in dense, roadside noxious weed infestations. Activities would be performed pursuant to the BLM's programmatic noxious weed control program. Existing noxious weed inventories identify existing infestations; however, field reconnaissance indicates the problem is more widespread and extends to abandoned and permanently closed roads, particularly at lower elevations.

- Consider the use of sterile and/or competitive grasses on disturbed sites to prevent encroachment of noxious weeds. Use of native grass seeds should also be considered in instances where noxious weeds have not yet become established. Active and non-active roads should be considered in this recommendation, as should early seral stage vegetation conditions, both extensive in the watershed.

- Prevention activities should be emphasized, including: minimization of ground disturbance, where possible; use of native, non-invasive, or non-persistent species in reclamation; and, equipment decontamination, applied in all activities. This recommendation should be implemented through standard operating procedures.

- Consider aggressive post-harvest prescriptions to control noxious weed infestation of harvested lands and adjoining lands and roads. Any of the prescriptions outlined above would be considered under such a strategy.

Potential for noxious weed infestation exists throughout the watershed; however, several factors should be considered to prioritize efforts. Because weeds can occur most anywhere, control efforts should focus on those situations where disturbance will persist and/or provide pathways for further spread; i.e., all roads and land conversion activities within the watershed. Potential for invasion from timber harvesting and fire are short-lived and grazing is limited on BLM lands. BLM lands do not have land conversion issues; however, invasion from private lands is a concern. The one element that they have the potential to control effectively is roads. Detailed weed inventories were not included in the BLM Road Inventory and other inventory efforts where limited to BLM roads, however. Consequently, additional surveys may be needed to better assess infestation potential from non-BLM lands in order to better prioritize BLM control efforts. Overall, because roads are integral to other issues, these activities would need to be coordinated.

### 4.3 Hydrologic Change

Potential effects of human uses on low flows, water yield, and peak flows were examined. Effects of forest cover removal on rain-on-snow (ROS) peak flows in the watershed were assessed with the Washington Forest Practices Board Standard Methodology for Conducting Watershed Analysis, Version 3.0 (WFPB, 1995).

The predicted increases in peak flows for the current condition ranged from 0% to 1.8% for "average" return interval storm conditions (Table 3-8), and from 1.4% to 8.1% for conditions during severely warm and windy conditions. Wall Creek was found to be the most responsive sub-watershed because it has the highest percentage of its area within the higher elevation rain-on-snow precipitation zone. Conversely, the Lower East Fork, Lower Trail Creek, and Lower West Fork sub-watersheds were found to be least responsive.

These results indicate that current rain-on-snow flood magnitudes are not substantially different than the reference condition. Sub-watersheds with the highest percentage of area in the ROS zone (elevation 3,600 to 4,800 feet) were predicted to be most sensitive, but no substantial effects were indicated by the simulation results for current conditions. Current vegetation conditions produce relatively small increases in peak flows. Proportionately small area that is in a hydrologically immature condition, and small area in the ROS zone, explains this limited response. Amount, timing, and delivery of water, sediment, and wood from the forested parts of this watershed are not changed appreciably from the reference conditions due to forest harvest effects on peak flows. Effects will remain inconsequential unless large areas of forest are harvested or burned in the near future. Effects of future harvesting, prescribed fire, or potential wildfire scenarios can be examined using the peak flow modeling approach developed for Trail Creek and its sub-watersheds. The procedure is recommended if effects of harvest or fire need to be examined in detail for future management alternatives analysis.

Roads can change the normal flowpaths of forest slope runoff through two mechanisms. Compaction of soil results in lower infiltration capacity and increased overland flow (Reid and Dunne, 1984; Luce and Cundy, 1994), and shallow subsurface flow can be intercepted by road cutslopes and converted to surface runoff (Burroughs et al., 1972; Megahan, 1972; King and Tennyson, 1984). However, roads have been found to increase flows in some studies and watersheds (King and Tennyson, 1984; Jones and Grant, 1996; Harr et al., 1975), to decrease flows in other watersheds (King and Tennyson, 1984), and to have no effect upon peak flows in yet other studies and watersheds (Rothacher, 1970; 1973; Ziemer,1981; Wright et al.,1990; King and Tennyson, 1984; Thomas and Megahan, 1998). However, to the degree that roads have any effect on peak flows, potential effects are most likely related to the total distance of road length that discharges water directly into the stream network via road ditches. Reduction of road length directly discharging to streams is recommended for the Trail Creek road system as a means of cost-effectively reducing sediment delivery. To the degree that this recommendation is employed to reduce sediment delivery, potential for road effects upon water delivery and peak flows will also be reduced.

Substantial removal of forest vegetation has occurred in riparian areas adjacent to most of the major tributaries in the watershed, particularly at lower elevations and along the main stem of Trail Creek and the West Fork. Deforestation of these riparian areas can be expected to have major effects on routing of water, sediment, and wood in these streams. Reforestation of these areas is encouraged, and through time, could be expected to reverse adverse effects. However, BLM ownership adjacent to these stream reaches is limited, and treatment of private lands will be necessary to achieve substantial results.

Low flow volume and total water yield in streams draining the forested portions of the watershed (where unaffected by water withdrawals) may exceed quantities that would be produced in the theoretical fully-forested condition. However, water withdrawals for domestic use and limited pasture irrigation uses occur along the main stem of Trail Creek and the West Fork, and low flows may be critically low in some years.

The following recommendations address hydrology objectives listed in the BLM Resource Management Plan and the Aquatic Conservation Strategy.

***Recommendations***

Objective: Maintain and enhance instream flows to create and sustain riparian, aquatic, and wetland habitats and to retain sediment, nutrient, and wood routing. Protect the timing, magnitude, duration, and spatial distribution of peak, high, and low flows (Aquatic Conservation Strategy Objective (ACSO) #6).

- If future management alternatives or projects are extensive and therefore may have potential for increasing peak flows above acceptable limits, consider additional analysis consistent with the procedures used within this watershed analysis to define acceptable sub-watershed canopy removal and stand treatment limits. Consider these limits in relation to future potential effects of wildfire and stand treatment needs.

- Allow for 100-year runoff events, including associated bedload and debris, when installing new stream crossing structures and for existing stream crossing structures that pose substantial risk to Riparian Reserves.

- Reduce fire hazard throughout the watershed, including upland and Riparian Reserve areas, as necessary to prevent catastrophic wildfire and attendant damage to soils, streams, and aquatic and riparian habitat.

- Attempt to increase summer flows by encouraging compliance with State regulations and permit limitations for water withdrawals from surface waters.

Objective: Maintain and enhance natural channel stability by allowing streams to develop a stable dimension, pattern, and profile. Allow the natural dynamic actions of streams to connect with their floodplain.

- Evaluate roads that are adjacent to stream channels using the 1998 BLM road inventory for Trail Creek (Table B-6, Appendix B) and consider decommissioning, obliteration, or rerouting to restore the floodplain.

- Promote growth of forests with species composition suited for the site within Riparian Reserves, using silvicultural methods if necessary to reach late-successional characteristics (where capable) for future LWD recruitment. Refer to Figures 3-25 and 3-26 to help identify highest priority areas for reestablishment of LWD recruitment potential and stream shade.

Objective: Maintain and enhance the physical integrity of the aquatic system, including stream banks and bottom configurations (ACSO #3).

- Reduce stream width-to-depth ratios in the Lower West Fork and the East Fork, and other appropriate stream reaches, while maintaining a stable dimension, pattern, and profile for promoting point and side bar development through reestablishment of riparian vegetation and by adding boulders and stable LWD.

## 4.4 Erosion Processes

Prior to disturbance of soils by road construction, logging, and non-forest land uses, surface erosion rarely occurred in the watershed, with the possible exception of erosion that occurred immediately following severe wildfire, and in thin, stony and sparsely vegetated soils. However, most natural erosion likely occurred as mass wasting, soil creep, and related streambank and channel erosion, most of which is likely to have occurred during major floods.

Many watershed analyses have concluded that historical logging practices contributed large quantities of mass wasting and surface erosion sediment to streams. Steep slopes were commonly tractor logged downhill on excavated skid trails to log landings and road systems located adjacent to streams, and streams were not protected by streamside buffers. Although these practices do not appear to have been pervasive in Trail Creek, early logging and road management practices, followed by periods of heavy road construction, likely contributed larger quantities of hillslope and road surface erosion than currently occurs.

## Sediment Budget

The relative importance of four types of erosion processes was estimated for the Trail Creek watershed in relation to natural rates of erosion: mass wasting, hillslope erosion, road erosion, and stream channel erosion. Sediment delivery rates are summarized for each type by sub-watershed in Table 3-5.

Quantity of sediment delivered to streams due to hillslope erosion was found to be negligible in the Trail Creek watershed for all sub-watersheds. Channels in the headwaters and third order channels were found to be quite stable, and only relatively minor streambank erosion was noted in the larger downstream channels: Accelerated stream channel erosion was considered to be negligible throughout he watershed for the current condition. However, road surface erosion and mass wasting within the watershed were found to be substantial.

While a dominant source of natural and management-related sediment within many watersheds, Table 3-5 shows that mass wasting, including failures with no management association, added only 69 tons/yr to streams within the Trail Creek watershed– an increase of only 6% above natural. Increases in individual sub-watersheds were no more than 24% (Lower Trail Creek sub-watershed). While sediment contributed to streams from mass wasting in the watershed is not considered inconsequential, it is relatively small in comparison to surface erosion from roads.

Table 3-5 shows that roads are the single greatest source of management-related delivered sediment in the watershed. For the entire Trail Creek watershed, road surface erosion alone increased sediment delivery by 80%, and exceeded 100% for the Lower Trail Creek and Upper East Fork sub-watersheds.

Potential actions to reduce road sediment delivery include addition of cross drains near stream crossings, surfacing roads with rock near stream crossings, outsloping road surfaces, and installing gates or berms to reduce traffic.

## Mass Wasting

Mass wasting during reference conditions within the watershed occurred during major storms and floods, and may also have occurred following major wildfires. Channel-scouring debris flows (debris torrents) undoubtedly occurred in steep channels, but no channel-scouring debris torrents were observed from the 30-year photo record, indicating that debris torrents may never have been frequent in this watershed.

Deep-seated slumps and earthflows in the Trail Creek watershed are relatively common and are associated with the prevalent clay rich soils formed from volcanic parent materials. Although these forms of failure are not particularly sensitive to management activities, road construction or harvest activities on slump/earthflow formations are associated with local landslide reactivation. Shallow-rapid forms of mass wasting (debris avalanches and debris flows) are much more sensitive to forest management activities and can have substantial effects on stream systems. However, relatively few shallow-rapid failures and no debris flows in stream channels were observed.

Roads are the predominant cause of increased rates of mass wasting associated with forest management, with acceleration factors due to roads commonly found to be in the range of ten to one hundred times greater for roads than for harvesting (Swanston and Swanson, 1976). In the Trail Creek watershed, nearly two-thirds of all failures observed from the aerial photos and field reconnaissance were associated with roads (29 of 45 failures observed)[1].

### *Recommendations*

Four Mass Wasting Management Units (MWMU)

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[1]Only seven “failures” are recorded within the BLM 1998 road inventory for roads on BLM lands. Higher number of failures recorded by WWA reflects survey of all roads irrespective of ownership, and observation of old failures from aerial photos, many of which may no longer be active or apparent.

were defined and mapped for the Trail Creek watershed. Recommendations for minimizing minimize mass wasting impacts from roads and harvest are provided for each MWMU. One general recommendation applies to all MWMUs:

- Use the 1998 BLM road inventory, and any subsequent updates, to identify existing roads with mass wasting potential, and develop site-specific mitigation plans to reduce hazards to streams where they occur.

MWMU #1 occurs on gentle to moderately steep (~20 to 50%) slopes formed in deep volcanic soils. Twenty-four road-associated failures occurred (0.99 failures/mi$^2$ in 30 years) within MWMU#1 (see Table A-2). Roads located in old earthflow toes, headwall source areas, and concave areas where water is concentrated contributed to several slump/earthflow (small, sporadic deep-seated) reactivation failures, and sediment delivery hazard is moderate. Four harvest-associated failures were located within the unit (0.16 failures/mi$^2$ in 30 years); mass wasting potential for harvest is rated medium, but delivery potential is rated low, yielding a low sediment delivery hazard. Observed rate of failure within MWMU#1 is relatively low, and may represent only minimal acceleration above natural rates of landslide sediment delivery rates.

- Avoid new roads in old earthflow toes, headwall source areas, and concave areas where water is concentrated.

- Minimize failures along existing roads primarily by improving road drainage. Road closure and obliteration may be necessary where indicated by specific field inspection and determination.

- Avoid regeneration harvest units on 50% or steeper slopes in this MWMU. Note that this may further reduce the low rate of failure observed, but may have only minimal ecological significance or benefit related to mass wasting processes and sediment delivery to streams.

MWMU #2 occurs on moderately steep (50 to 70%) and steep stream-adjacent and mid-slope areas formed from volcanic flows and interbedded sediments. Soil depth is shallow in rocky convex and planar areas, becoming deep in concave areas. Although only three failures were located within the unit, very few roads or harvest areas occur. Risk of failure and sediment delivery associated with roads is high. Mass wasting potential and sediment delivery potential associated with harvest is moderate.

- New roads within the unit should generally be avoided. Construction of new road should require site-specific review by a geotechnical engineer, geomorphologist, or hydrologist with extensive experience with roads and mass wasting processes.

- Regeneration forms of harvesting should be avoided in areas of the unit exceeding 60% slope or in stream-adjacent locations.

MWMU #3 occurs on ridges and ridge-adjacent steep and moderately steep colluvial headwall basins formed from volcanic flows. Two road and two harvest-associated failures were located within this unit. Density of failures observed for this unit is relatively low (0.50 failures/mi$^2$ in 30 years), but road construction on slopes steeper than 70% in this unit can contribute to failure occurrence. Harvest of concave headwalls and locations where water is concentrated on slopes steeper than 70% also poses moderate hazard of failure and sediment delivery, and should be avoided.

- Avoid road construction on slopes steeper than 70%. Construction of new road should require site-specific review by a geotechnical engineer, geomorphologist, or hydrologist with extensive experience with roads and mass wasting processes.

MWMU #4 is mapped in the southern part of the watershed on moderate to gentle slopes formed from volcanic flows and in areas of relatively low mean annual precipitation. Slump-earthflow topography is uncommon, and only five failures were located within this unit, with only two of these related to management; density of management associated failures is low at 0.11 failures/mi$^2$ in 30 years. Hazards for both roads and harvest are rated low.

- Standard management practices are adequate to prevent failures within this unit, although any steep (>60%) or steep inner gorge inclusions should be treated carefully, and road construction and harvest restrictions may be advisable in these areas as prescribed on a site-specific basis.

**Hillslope Erosion**

Soil disturbance associated with forest harvesting can result in erosion and delivery of sediment to streams. However, sediment delivery only occurs where 1) soils are disturbed, 2) disturbed soils are subject to overland flow and particle detachment (erosion), and 3) eroded soil particles (sediment) are transported to streams without deposition onto the forest floor. Although much of the forested area of the watershed has been harvested in the last 50-70 years, no harvest within the past five years has occurred on federal lands, and harvested acreage of private lands is not extensive. No evidence of substantial hillslope erosion and sediment delivery due to recent harvest activities was observed in the areas observed during this analysis. When compared to natural rates of erosion, and when compared to sediment delivery from roads and mass wasting, surface erosion from harvesting is inconsequential within the Trail Creek watershed. This observation is consistent with watershed analyses conducted in Washington, Idaho, and Oregon, where nearly all analyses have revealed that sediment delivered to streams from harvesting conducted in compliance with state forest practices rules is insignificant (McGreer et al., 1998).

**Road Erosion**

Roads contribute moderately large quantities of fine sediment to streams in the Trail Creek watershed. The road sediment increase factor, computed by dividing the quantity of delivered sediment from roads by the natural rate of erosion, exceeds 50% for all seven of the sub-watersheds except one (Upper West Fork); the increase factor ranges from 28% (in the Upper West Fork) to 101% (in the Upper East Fork). Five sub-watersheds (Chicago Creek, Lower West Fork, Wall Creek, Lower East Fork, Lower Trail Creek), as well as the entire watershed, are considered to have “Moderate” delivered road sediment quantity and hazard (50 to 100% increase). The Upper East Fork is rated High (greater than 100% increase), and the Upper West Fork is rated Low (less than 50% increase). Factors contributing to road sediment delivery in the watershed include long contributing road lengths between cross drains, unsurfaced or lightly surfaced roads, and relatively high road and stream densities.

The 1998 BLM inventory of roads identifies a number of characteristics relating to erosion and sediment delivery for 154 road segments and 90 miles of road on BLM ownership. Based on this detailed inventory, an index was developed by WWA that identifies the road segments most likely to deliver sediment to streams. Based on the distribution of index scores, sediment delivery potential was rated high for 21 road segments (10.88 miles), moderate for 22 segments (17.73 miles), and Low for 144 segments (61.03 miles). Figure 3-8 provides a map of these low, moderate and high delivery potential locations. The inventory and ratings can be used to prioritize further examination and treatment or closure of road segments.

Culvert diameters, a factor related to road erosion and impacts upon stream channels, were measured at 17 locations within the watershed, and compared to return interval capacities based on procedures provided by Adams et al. (1986), an adaptation of standard USGS methodology for small drainages. Using these procedures, culverts appear to be undersized within the watershed. (See Appendix Table B-5). On average, the 100-year flow is 3.5 times the culvert capacity, and the culverts sampled are sized for only the 2-year flow. This is a surprising result, and while it may indicate error in the method as specifically applicable to Trail Creek, it does appear highly likely that existing culverts have insufficient capacity to pass 100-year flows. Depending on specific road crossing and culvert characteristics, hazards of failure and downstream damage may be substantial at some locations. A more comprehensive inventory of existing culvert capacity, hazard of insufficient hydraulic capacity, and hazards at the crossings and to downstream channels is recommended. Fish passage conditions can also be inventoried during such a review.

The following recommendations address surface erosion and mass wasting objectives, and transportation system objectives that relate to erosion processes and protection of riparian and aquatic areas, that are listed in the BLM Resource Management Plan and the Aquatic Conservation Strategy:

***Recommendations***

Objective: Maintain and enhance the sediment regime under which the aquatic ecosystem evolved (ACSO #5), and improve, maintain, or restore federal road systems with an emphasis on adequate drainage and surfacing.

- Use the BLM Trail Creek road inventory to identify road segments that cause concentrated flow and downslope gullying. If sediment from gullies reaches streams, consider control treatments including addition of drainage structures and energy dissipation/erosion control treatments.
- Maintain the transportation system to minimize sediment delivery to streams.
- Prioritize sediment delivery reduction efforts, both surface erosion and mass wasting, by sub-watershed according to Table 3-5 Sediment Budget, in consideration of individual reduction opportunities determined through use of BLM road inventory Table B-6, Appendix B, Figure 3-8, Appendix Table B-1, and through site-specific review.
- Consider monitoring the effectiveness of road sediment delivery reduction efforts by remodeling sediment delivery of treated road segments.
- Decrease the direct delivery distance of road ditches (currently averaging 570 feet). Delivery distance of treated road segments should approximate 100 feet.
- Add rock surfacing near stream crossings and to stream-adjacent road sediments that add large amounts of sediment to streams. See Table B-6 Appendix B, Figure 3-8, Appendix Table B-1, and apply site-specific review.
- Adopt the road management recommendations specific to each of the four Mass Wasting Management Units mapped within the watershed.
- Reconstruct, stabilize, reroute, close, obliterate, or decommission roads and landings that pose substantial risk to Riparian Reserves.
- Use the BLM Trail Creek Road Inventory to identify road segments within Riparian Reserves, and to determine risk.
- Design new stream crossing structures to accommodate 100-year runoff events. See Adams et al. (1986) for recommended culvert sizing procedures.
- Reconstruct existing stream crossing structures that pose substantial risk to downstream channels and fisheries resources. See Table B-5 for a list of culverts now known to be incapable of passing 100-year flows, determine if these culverts pose substantial risks, and perform similar determinations for all other stream crossing structures within the watershed.
- Provide for fish passage at all potential fish bearing stream crossings; wherever possible, maintain a natural stream bed.

Objective: Protect active and potentially active landslides and severely eroding areas.

- Prioritize watershed restoration projects in areas where roads accelerate landslide and erosion that deliver sediment to streams.
- Use the BLM Trail Creek road inventory Table B-6, Mass Wasting Appendix Table A-1, Figures 3-2 (Landslide Inventory Map) and 3-3 (Mass Wasting Management Unit Map) to identify road segments with existing and

potential landslides that have or may in the future deliver sediment to streams.

- Designate Riparian Reserves to include active and potentially active landslides.

- Adopt mass wasting management recommendations for harvest units within each of the four mass wasting management units mapped within the watershed.

**Soil Productivity and Resiliency**

Productivity in the watershed is low to moderate, and is generally lowest in the southern portions and lowest elevations of the watershed, and in areas of shallow soils with high rock content. Most deep soils in the watershed have high clay content and are subject to compaction, rutting, puddling and surface erosion. Shallow lithic soils, may erode if protective vegetation is removed.

Most of the watershed has been harvested, and many areas were tractor logged causing substantial loss of soil productivity, particularly where skid trails were excavated. Reduced soil productivity of skid trails has been reported to range from 5 to 50 percent (Adams and Froelich, 1984). Effects can persist for decades. Even on gentle slopes, old-growth tractor logging causes persistent loss of productivity. The percentage of the watershed affected by first-entry tractor logging activities is unknown; however, affected area may approximate 30 percent (Wooldridge, 1960; Dyrness, 1965 ).

Extensive first-entry cable logging occurred on the watershed's steeper slopes. Although some soil disturbance and compaction is associated with cable logging, only 5 to 9 percent of the cable-logged area may have been affected (Wooldridge, 1960; Dyrness, 1965).

Recent harvest activities in the watershed are not extensive, and cable and of mechanical logging were used in many areas previously tractor logged. Tractor logging of federal lands is restricted to gentle slopes, and disturbance during site preparation is now avoided. Although management practices vary with ownership (i.e., federal vs. private), less area is expected to be adversely affected, and effects are expected to be less persistent, due to future harvest activities than are associated with historic practices.

Roads occupy approximately 4 percent of the watershed. Although roads are necessary for provision of goods and services, road surfaces do not, or at best only partially, contribute to vegetative productivity and attendant benefits. Road density within many areas of the watershed are relatively high. This watershed analysis can be used to help assess future road transportation system needs, and to identify specific road segments that may be high priority for maintenance and or road closure. Several specific road segments that are known or suspected of posing high surface or mass erosion sediment delivery potential to streams are noted in Table B-6**,** Appendix B , and are addressed in the Recommendations section of this report.

Mass wasting, particularly shallow planar forms of failure, substantially reduce productivity of areas impacted. However, failures observed from the aerial photos through approximately 30 years occupy only an estimated 3 acres of the 35,305 acre watershed.

Objectives and recommendations appropriate for the Trail Creek watershed that preserve and restore soil productivity include those which address mass wasting and soil erosion processes as previously listed, and an objective and recommendation that address effects of fire:

***Recommendations***

Objective: Minimize the effects of fire on soils.

- Avoid intense wildfire and intense prescribed burning.

- Avoid soil disturbance during ground-based skidding. Prohibit bladed skid trails with rare exceptions allowed only where unavoidable.

- Use designated skid trails to minimize compacted area.

- Design silvicultural treatments to meet the RMP coarse wood requirements.

## 4.5 Riparian and Stream Processes

**Stream Shade**

Shade provided by riparian vegetation is essential for maintenance of cool stream temperatures. Riparian shade in combination with additional factors can be used to assess water temperatures throughout watershed stream systems if local relationships are defined. Stream shade and water temperature relationships were determined in accordance with the WFPB Standard Methodology for Conducting Watershed Analysis (Version 3.0, 1995) using stereo pair 1:12,000 color aerial photographs. All fish-bearing streams were assessed.

Stream shade roughly correlates with LWD recruitment potential because both measures are dependent on riparian stand conditions. Consequently, much of the same discussion regarding reference LWD conditions applies. Historic information from the 1900s (see Figure 3-13) indicated that most of the watershed, including tributaries, was forested. A significant amount of timberless area did exist, however, in the lower watershed extending almost half way up the West and East Forks of Trail Creek. Information from 1936 (see Figure 3-14) reveals that timber and land conversion extended open conditions somewhat further up the watershed. Historically, both forks of Trail Creek along their upper reaches, and their tributaries, were more heavily shaded than they are currently. In the lower portions of the drainage, however, the effect of current stream shade on stream temperatures appears to be comparable to historic conditions.

During 1996 and 1997, temperature monitoring was conducted at 21 sites in the Trail Creek and Elk Creek watersheds. Seven-day maximum temperature (ºF) exceeded the Oregon standard of 64 ºF at five monitoring stations located within the Trail Creek watershed. Seven-day maximum daily temperatures near the mouth of the West Fork and Trail Creek reach 80.3 and 83.5 ºF, respectively (Figure 3-11).

A linear regression model was developed from the 1996 and 1997 data which allows prediction of maximum water temperature as a function of elevation and shade at any location within the watershed (Boise Cascade Corp., 1998):

$$T = 95.1 - 0.0108\,E - 0.0756\,C$$

T = seven-day maximum temperature (ºF)
E = elevation (ft)
C = canopy shade level (%)

The model predicts that the 64 degrees F standard cannot be achieved at elevations below 2,000 feet even with 100% shade. Conversely, the model indicates that the 64 degrees F standard is likely to be met at elevations above 3,400 feet regardless of stream shade levels. In the Trail Creek watershed, all fish-bearing streams lie below 3,400 feet, and most are below 2,600 feet. At extreme low flows, water withdrawals may have a relatively small impact on maximum temperatures. Given the conditions in lower Trail Creek watershed, it is reasonable to conclude that increased flow would not cause recovery of these streams to below the 64 degrees F standard.

***Recommendations***

Objective: Maintain and enhance water quality necessary to support healthy riparian, aquatic and wetland ecosystems (ACSO #4).

- Attempt to increase summer flows by encouraging compliance with State regulations and permit limitations for water withdrawals from surface waters.
- Reduce summer stream temperatures by planting or maintaining native species in riparian areas where shade, LWD and tree density is low, temperatures are high, and where shade can accomplish temperature recovery.
- Consider reaches within the West and East Forks and their fish-bearing tributaries as highest priority for stream temperature

recovery.

- Reduce stream width-to-depth ratios, add instream cover, and create habitat diversity in the Lower West Fork and the East Fork, and other appropriate stream reaches, by placing flow-diversion boulders and logs.

- Continuously monitor stream temperatures from May 1 through November 1 for no less than five years at no less than five key locations to verify trends and to further calibrate the temperature prediction model used in this watershed analysis: Lower Trail Creek near mouth; Lower West Fork near mouth; Lower East Fork near mouth; East and West Forks near midpoints between headwaters and mouths and not within 1,000 feet downstream of any major tributaries.

- Follow Washington Ambient Monitoring Program protocols.

**LWD Recruitment**

LWD is introduced to Trail Creek stream systems primarily from the riparian zones; mass wasting does not contribute substantial amounts of instream LWD due the low number of source and runout acres affected by the process.

Approximately 28 miles of streams within the Trail Creek watershed are fish-bearing and were assessed for LWD recruitment potential according to the Washington State Forest Practices Board procedure (WFPB, 1995). Using this approach, about three quarters of the streams on federal lands currently have high or moderate LWD recruitment potential. Conversely, about 80% of fish-bearing streams on private lands, predominantly the larger and more mainstem streams found at lower elevations, have low LWD recruitment potential. Combined, this indicates that only about one-third of fish-bearing streams have moderate to high near-term LWD recruitment potential.

As indicated by the aerial photos reviewed, historic timber harvest practices included cutting trees in riparian zones adjacent to many fish-bearing stream reaches within the watershed. Forest Practices and riparian management on private lands are now regulated by the Oregon Department of Forestry, and requirements for maintaining LWD recruitment potential have increased substantially in recent years. On federal lands, requirements for maintaining LWD recruitment potential are substantial. These private and public land riparian management requirements are expected to increases future LWD recruitment potential for forest lands. Riparian management of private lands used for purposes other than commercial forestry remain unregulated, and potential for development of stands and LWD recruitment potential is unknown adjacent to these areas. Non-forest land uses are common adjacent to Lower Trail Creek, Lower East Fork, and Lower West Fork. Conditions and effects within stream channels related to LWD are discussed in the Stream Channels section of this chapter.

**Stream Channels**

Interpretations of channel processes and conditions is based on observation of slope and stream conditions and processes by WWA, and upon information extracted from Oregon Department of Fish and Wildlife (ODFW) and BLM stream surveys. There are no reports that define the reference condition for streams within the Trail Creek watershed. However, some effects of historic management practices can be reasonably inferred for Trail Creek from historic accounts and from the aerial photographic record.

Riparian harvest has occurred along most of the fish-bearing channels and some headwater channels. Extensive reaches of Trail Creek and the lower reaches of the West and East Forks appear to have been converted from forest to non-forest vegetation and land uses. The large mainstem channels of Trail Creek (Lower Trail, East Fork and West Fork) appear to have been scoured by large flood events, such as occurred in 1964. Channels were not scoured during the 1996 and 1997 floods. Gravel and cobble substrate are uncommon, and may have been lost due to earlier removal of LWD to facilitate log transport. Gravel bars may have been washed away, and channels may have become wider during subsequent floods. These gravel bars may have been vegetated, providing more stream shade to these reaches than occurs today, and water temperatures may have been lower. Currently, channels are stable throughout the system, but main channels in the reference condition may have been somewhat less stable if LWD and gravel bars caused channel shifting. LWD and substrate associated pools may also have been more common than occur today.

Existing data indicate that current headwater channel conditions are less altered from reference conditions than may be true for the main channels within the watershed. Whereas many main channels appear to have been scoured by floods, scoured headwater tributaries are not evident.

Human disturbances that have degraded Riparian Reserves include timber harvesting, roads, and grazing. Grazing, historically heavy, is currently limited, and no substantial impacts currently occur. Timber harvest within riparian areas was historically extensive, but no harvest has occurred in Riparian Reserves within the past several years. Road mileage within riparian areas is extensive on both federal and other ownerships. Impacts along Trail Creek due to rural development are common, and to a lessor degree occur along the East Fork, West Fork and the larger tributaries to them at the lower elevations.

1998 BLM headwater non-fish bearing stream survey data indicate general physical characteristics of these channels. Headwater channels are typically narrow, steep, and well constrained by moderately steep sideslopes, and are stable to moderately stable. Riparian areas are typically narrow with canopy density highly variable, but averaging 64%. Substrate particle sizes are diverse. Percent sand and silt substrate (40%) may be higher than reference conditions due to sediment delivery from roads and harvest, but this is not known. Canopy density measured from the stream or stream shade is not reported. Large woody debris (LWD) density is relatively low for western Cascade streams.

Downstream third and fourth order tributaries upstream of Lower West Fork and Lower East Fork typically have formed inner gorges with oversteepened slopes and bedrock exposures commonly adjacent to the channels. Landslides (type and size not identified) adjacent to channels in these areas were noted in 1996 ODFW stream reach surveys.

Relatively narrow (less than 1,000 feet wide) and shallow alluvial terraces border most of lower Trail Creek and most of the West Fork below Chicago Creek. The mainstem of Trail Creek is wide and shallow, and bedrock and boulder substrate is dominant, with relatively low area of cobble, gravel, or finer materials. The channel is entrenched, is disconnected from its floodplain, and has unusually low sinuosity for its low-gradient alluvial valley setting. Very little channel meandering and alluvial bank cutting is evident currently. These conditions may be the result of land-clearing and bottomland reclamation for pasture, road building on the floodplain, riparian logging practices and use of Trail Creek for log transport. Other potential causes of this condition include removal of LWD and beaver from the stream system, and subsequent scour of LWD and gravel from the lower system by flood events, particularly the 1964 flood.

Channels remain highly stable throughout the watershed, and percent area of gravel substrate remains relatively low. Percent organics, silt, and sand within riffle substrate is highly variable, ranging from low to high in the Trail Creek system (ODFW, 1996). As noted in the Erosion Processes section of this analysis, road systems are likely to have been the predominant source of management-related fine sediment in the watershed.

Using a scoring index developed for this analysis to evaluate the 1996 ODFW stream survey data, functional condition of channel habitat measured in the Trail Creek watershed is low to moderately low. Conditions contributing to poor habitat of mainstem channels include low instream LWD , limited area of gravel, limited area of pools, and high percent fine sediment in spawning gravels. Critically low flows and high stream temperatures, not measured by the ODFW or included in our index, may cause summer rearing habitat suitability to be substantially poorer than even these scores indicate.

Habitat quality of tributary reaches evaluated by the ODFW also rated low to moderately low. Low instream LWD and riparian large conifers, and low pool frequency and depth, were the principal causes for poor habitat scores. Percent gravel area was moderate, and percent fine sediment in riffle habitat was not found to be high in the reaches evaluated. However, area of riffle habitat was low in most reaches, and completely absent in others, but percent riffle area is not listed by ODFW as a habitat benchmark.

Headwater stream condition on BLM lands compares to reference conditions in the following ways: harvesting has depleted LWD recruitment potential and instream LWD of some streams; Debris torrents down tributaries have not been a cause of riffle and gravel depletion; depletion of LWD *may* have contributed to loss of gravel substrate; Relatively high input of fine sediment from roads in several sub-watersheds may have contributed to observed levels of fines in riffle substrate; Historically, harvesting removed shade from small headwater tributaries, but the upstream reaches of all fish-bearing streams evaluated during this analysis are currently well shaded.

The 1964 flood, the flood of record for most streams in the area, is known to have scoured large woody debris and channel substrate from many streams in the area, including the adjacent Elk Creek watershed (Boise Cascade Corp., 1998), and this may also have occurred in the Mainstem channels of Trail Creek. Mass wasting and bank erosion sources of coarse gravel are limited in the watershed, as are future LWD sources, particularly along Trail Creek below the West Fork. Major channel-affecting disturbances other than the 1964 flood were not noted during this analysis.

Degraded conditions in Trail Creek streams, the most severe occurring in the main fish-bearing channels, appear to be primarily related to a history of direct channel disturbance and management practices within riparian areas that have lead to depletion of LWD followed by loss of gravel substrate and habitat diversity elements. Because there are few landslides within the watershed, nearly all instream LWD originates from the near-stream (within a horizontal distance of less one site potential tree-height) area. The recommendations that follow address this conclusion.

***Recommendations***

- Encourage long-term development of LWD within all stream channels within federal ownership by managing riparian vegetation to encourage development of large trees consistent with natural stand density and species composition, both conifer and hardwood.
- Consider careful engineered placement of LWD in select sections of the West and East Forks, and major tributaries to them where existing LWD quantity and function are low.
- In concert with assessment of road abandonment and transportation system assessment, consider as a high priority abandonment and rehabilitation to forested conditions roads within one site potential tree-height equivalent of stream channels, particularly fish-bearing stream channels.

### 4.6 Terrestrial Habitat

As with vegetation patterns, fire was the major disturbance factor affecting terrestrial habitat prior to settlement of the watershed. Forest composition was composed of predominantly large trees in “open-grown”, “park-like” stands. Frequent, low-intensity wildfires would have maintained low understory and brush densities and would have maintained a relatively diverse tree size structure. Fire-adapted tree species, (e.g., ponderosa pine and Douglas-fir) were climax species in these communities. Overall, these conditions were extensive within the Trail Creek watershed and tended to favor plant and wildlife species dependent on such old-growth conditions. Though stand structures were likely diverse, habitat connectivity was relatively intact and road densities virtually non-existent. Stand structures were likely diverse and, although no data exists on dead wood, it is likely that snag and large coarse woody material densities were higher than current conditions. Populations of species dependent on these stand conditions (e.g., Roosevelt elk, black-tailed deer, spotted owls, goshawk, and great gray owls) and dead wood components (e.g., birds, bats, small mammals, and many non-vascular plant species) were, therefore, also likely higher than current levels.

The dominant historical influence on terrestrial habitat and terrestrial plant and wildlife populations in the watershed has been timber extraction. Clearcut and shelterwood harvesting has largely determined the age of forest stands and ecological characteristics. It should be noted that the aggressive extraction of downed woody material associated with these activities has had significant impact, as well. The current condition is characterized by second growth stand conditions with dense understories and brush and very little standing or downed dead woody material. This condition is found scattered on about 21,830 acres of BLM, USFS, and private industrial land in the watershed (about 62 percent of the total watershed area). These conditions directly affect lowered habitat connectivity, structural deficiencies (e.g., canopy closure, canopy complexity, understory shrubs, and herbaceous species), and lower availability of dead wood habitat (e.g., snags and coarse woody material). Although diverse and mixed, the stand conditions that persist on these lands (e.g., second-growth conifer stands) support the fewest species and lowest density of species compared to late and early seral stand conditions.

Land development and road building activities have also been significant influences on the watershed, though the magnitude of their impact has been lower than timber harvesting. About two-thirds of the 5,770 acres of small private landowner parcels have been converted from forest lands to non-forest conditions. Most of this activity has occurred at lower elevations along the major stream drainages. Impacts on connectivity, habitat quality, and displacement of wildlife species have been significant outcomes of this land use. The higher road densities that have resulted from timber and land development activities have had similar impacts on connectivity and have also resulted in a general decrease in habitat availability within and adjacent to road corridors. The extent of these impacts on the wildlife populations occurring in Trail Creek watershed is species-dependent, resulting in displacement of species favoring large, intact habitats (e.g., spotted owl, goshawk, and great gray owl) and favoring those who benefit from habitat diversity and open corridors (e.g., deer, elk, and bear).

Fire suppression activities have generally resulted in high fuel loading conditions throughout the Trail Creek watershed that, when considered along with climatic and topographic factors, place almost all of the area into a moderate or high fire hazard condition. The potential for catastrophic fire is great and extensive, the results of which could be devastating to terrestrial habitat and populations. Specifically, high-intensity fires could result in loss of large trees, snags, and coarse woody material, all limited habitat components within the watershed. Conversely, stand-clearing fires would create early seral conditions; however, because of reduced soil productivity and associated problems, this habitat would be of lower quality than if early seral habitat were maintained through less destructive means. In either case, habitat connectivity would be affected via habitat loss and lowered habitat quality. Consequently, whereas the loss of these resources has not occurred, the potential risk for their loss is great and, as such, recommendations for reducing this risk should be considered. Left untreated, this risk will tend to increase on all lands.

Overall, reference habitat conditions are currently very limited within the Trail Creek watershed; however, potential for habitat improvement exists on most forest lands. About 2,050 acres of undisturbed, old-growth habitat exists on cooler, moister upper elevation, north facing slopes, most of which occurs on federal lands. The greatest potential for development of old-growth habitat likewise exists on federal lands where large trees do exist, though at lower densities than old-growth situations. Meadows and rock outcrops are even more limited, scattered throughout the watershed. Finally, though preliminary BLM surveys indicate significant portions of riparian areas are "properly functioning", very little reflects reference conditions. Riparian habitat conditions tend to be even more impacted within private ownerships.

Recommendations for addressing impacts of these human use activities will focus on the following strategy components: resource protection; reference habitat, old-growth habitat; early seral habitat; and, riparian habitat. Many of these recommendations directly incorporate selected recommendations provided by BLM biologists (see Appendix I). Many of the recommendations will reference those already presented for timber stand improvement and fire hazard reduction. As such, recommendations for terrestrial habitat pose can present opportunities for these other activities, as well. Such comprehensive recommendations, and where they may occur, will be incorporated into the following discussion.

***Recommendations***

Objective: Previous recommendations for fuel hazard reduction are herein emphasized for directly addressing ACS and RMP objectives for Riparian Reserves, late-successional reserves, matrix lands, wildlife habitat, special status species, roads/access, and fire management as they relate to resource protection.

Whereas fire hazard reduction measures presented earlier generally addressed resource protection, specific terrestrial habitat values that need be protected include: connectivity, large trees, snags, and coarse woody material. Although these values tend to occur on federal lands, the potential risk to these resources can occur from fire hazard conditions that occur throughout the Trail Creek watershed. Capabilities of the watershed to achieve resource protection objectives through fire hazard reduction were presented earlier. Consequently, the following terrestrial habitat conditions need to be addressed in fuel hazard reduction planning:

- Fire hazard reduction should directly reduce risk to existing old-growth habitat conditions. These tend to exist on about 2,050 acres of dense, large tree stands occurring on cooler, moister upper elevation north facing sites, most of which are on federal lands.

- Fire hazard reduction should directly reduce risk to stands containing large trees with the potential for development of late seral stage characteristics. These conditions tend to exist on about 9,000 acres of BLM-administered lands that are otherwise interpreted as early or mid to late seral stages.

- Fire hazard reduction should directly reduce risk to Riparian Reserves, about 3,180 acres of which exist on BLM-administered lands including, in part, large tree stand conditions described above.

- In the use of prescribed fire to reduce fuel loading, mitigation measures should be implemented to limit fire intensity, thereby reducing the risk of snag and coarse woody debris consumption.

As discussed earlier, appropriate tactics used in fuel hazard reduction would be developed on a prescription basis and could include, but not be limited to: mechanical reduction, underburning, slash and burning, lop and scatter, handpile and burning. Prescriptions would also address site assessments of habitat considerations, operability constraints, fuel conditions, and other environmental concerns.

In addition to fuel hazard reduction, the following recommendation should also be placed on road access:

- Maintain adequate access routes for fire suppression activities associated with terrestrial habitat. An extensive road network exists within the Trail Creek watershed; however, road closure activities or travel restrictions could indirectly place terrestrial habitat resources potentially at risk.

In implementation, road closure plans should be coordinated between fire management and terrestrial habitat resource specialists. This consultation would extend to other resource specialists for which road management applies, as well.

Objective: The following recommendations directly address RMP objectives for Riparian Reserves, late-successional reserves, matrix lands, wildlife habitat, and special status species through activities designed to promote reference habitat conditions and associated special status plant and wildlife species.

In implementation, these recommendations provide both landscape level strategies and operational recommendations for re-establishing and "open-grown", "park-like" stand structures. Practically, the capability of the Trail Creek watershed to achieve these objectives is limited by current vegetation deficiencies that can be overcome in the long-term. Consequently, the following recommendations focus on general strategies that the BLM can integrate into all management recommendations:

- Consider promoting conifer stand development at upper elevations such that stand conditions more closely reflect reference conditions. Most of the silvicultural recommendations presented above would apply. Additionally, tree planting may be needed in instances where existing regeneration is inadequate.

- Consider promoting oak woodland development at lower elevations such that stand conditions more closely reflect reference conditions. Silvicultural recommendations for brush control and brushfield conversion would apply, as would use of prescribed fire. Additionally, mechanical methods to reduce the conifer component and to promote hardwood regeneration (e.g., coppicing) could be used, where appropriate.

- Consider aggressive control of dense understory brush component components in all riparian stands. This can be accomplished through hardwood density control, thinning from below, mechanical and chemical brush control, precommercial thinning, and use of prescribed fire. Because fire activities would be carried out in potentially high hazard conditions, pre-burn planning would be necessary to mitigate potential risks and hazards from the latter.

- Consider using prescribed fire on a periodic basis (5 to 25 years) to maintain reference habitat conditions once they are established by measures outlined above. This can be used in conjunction with mechanical methods in order to control both understory brush and regeneration densities.

Overall, these recommendations indicate opportunities for reference habitat development that could present opportunities for timber stand improvement and associated economic benefits, as well. Conversely, the need for reference habitat development could be prescribed at the expense of timber stand improvement and other resource management opportunities. As such, reference habitat recommendations should be coordinated with other resource specialists to identify conflicts and develop opportunities.

Objective: The following recommendations directly address ACS and RMP objectives for Riparian Reserves, late-successional reserves, matrix lands, wildlife habitat, special status species, and roads/access in activities designed to promote old-growth habitat and associated species (e.g., northern spotted owls, red tree voles, northern goshawk, great gray owls, salamanders, big game, and special status plant species).

In implementation, they provide both landscape level strategies and operational recommendations for addressing the following specific old-growth habitat issues: connectivity, stand structure, snags, and coarse woody material. Practically, the capability of the Trail Creek watershed to achieve these objectives is limited by private land use practices, current habitat deficiencies, overall low site productivity, the need for access within the watershed, and current population levels. Some limitations can be overcome in the long-term (e.g., vegetation conditions); however, some will persist as a permanent component of the watershed. Consequently, the following recommendations focus on those which the BLM can implement and realize some improvements:

- Manage existing old-growth stands wherever they exist to provide adequate habitat for old-growth dependent species, connectivity, and to contribute to the 15% late-successional requirement on federal forest lands. According to WODIP data, these stand conditions tend to exist on about 2,050 acres of dense, large tree stands occurring on cooler, moister upper elevation north facing sites, about 1,500 of which occurs on federal lands. Since these conditions exist in conjunction with minor components of small trees and/or low canopy covers, acres retained under this designation would likely be higher via unit delineations. Overall, this would represent about 10 percent of federal lands. The remainder of late-successional stand conditions would have to be developed through resource management activities.

C Consider promoting late seral stage stand development at upper elevations where there are a) existing large tree components to provide some of the habitat structure, b) need for creating late-successional habitat connectivity, and c) existing blocks of late-successional habitat. Field reconnaissance and further analysis would be required to identify where these conditions area met. Whereas lower elevation BLM stands also have significant large tree components as a result of shelterwood activities, the need to create habitat connectivity is not as great; however, promotion of late seral stage development at lower elevations should not be discounted in activity planning.

Silvicultural recommendations for hardwood density control, thinning from below, and brush control would apply. This activity would a) promote growth of existing large trees, b) encourage growth and recruitment of large trees from the understory, and c) create an open understory that is conducive to foraging and that reduces the fire hazard within the stand.

C Follow RMP guidelines for tree retention and downed woody material retention to promote snag and coarse woody material development, respectively. These measures would be implemented in conjunction with timber harvest activities on BLM-administered lands throughout the watershed. In implementation, consideration should be given to deferring creation of downed woody material to standing tree retention. Whereas it is recognized that both snags and coarse woody material are deficient throughout the watershed, it is recognized that large trees are a limited resource within the watershed and of more. Consequently, it is concluded that it is best to opt for natural development of snags and coarse woody material where possible.

C Consider road closures and/or traffic restrictions at upper elevations within and adjacent to late-successional retention areas and areas where late-successional habitat structure is to be developed. This closure strategy would further improve connectivity for old-growth dependent species.

Overall, these recommendations indicate opportunities for old-growth habitat improvement that could present opportunities for timber stand improvement and associated economic benefits, as well. Conversely, the need for old-growth habitat retention and/or improvement could be prescribed at the expense of timber stand improvement and other resource management opportunities. Similar conflicts and opportunities would be associated with road management issues, as well. As such, old-growth habitat recommendations should be coordinated with other resource specialists to identify conflicts and develop opportunities.

Objective: The following recommendations directly address RMP objectives for Riparian Reserves, late-successional reserves, matrix lands, wildlife habitat, special status species, and roads/access in activities designed to promote early seral habitat and associated species (e.g., big game and special status plant species).

In implementation, these recommendations provide both landscape level strategies and operational recommendations for developing early seral stage habitat. Practically, the capability of the Trail Creek watershed to achieve this objective is limited by private land use practices and federal land management policies to promote late-successional habitat. Consequently, the following recommendations focus on those which the BLM can implement and minimize such conflicts:

- Consider developing early seral stage stand conditions at lower elevations where there are existing vegetation conditions conducive to cultural treatments creating early seral stage conditions. This could include operations in large tree stands where late-successional habitat connectivity is not an overriding issue. Silvicultural recommendations for regeneration harvests and brushland conversion would provide the best opportunities for creation of early seral conditions.

- Consider the use of prescribed fire to maintain oak woodlands and native grasslands. Native grassland communities are very limited, representing only about 325 acres on BLM lands. Hardwood conditions are scattered on over 880 acres; however, acreage for which this prescription would apply is likely less.

Overall, these recommendations indicate opportunities for early seral development that could present opportunities for timber stand improvement and associated economic benefits, as well. Conversely, the need for early seral stage development could be prescribed at the expense of timber stand improvement and other resource management opportunities. As such, early seral stage habitat recommendations should be coordinated with other resource specialists to identify conflicts and develop opportunities.

Objective: The following recommendations directly address ACS and RMP objectives for Riparian Reserves, wildlife habitat, special status species, and roads/access in activities designed to promote riparian habitat and associated special status plant and wildlife species.

In implementation, they provide both landscape level strategies and operational recommendations for addressing the following specific riparian habitat issues: connectivity, and stand structure. Recommendations for improving riparian conditions as they relate to aquatic habitat will be discussed in other sections. Similar to old-growth, the capability of the Trail Creek watershed to achieve these objectives is limited by private land use practices, current habitat deficiencies, overall low site productivity, limited channel deposition, low flow, and the need for access within the watershed. Some limitations can be overcome in the long-term (e.g., vegetation conditions); however, some will persist as a permanent component of the watershed. Consequently, the following recommendations focus on those which the BLM can implement and realize some improvements:

- Manage Riparian Reserves according to guidelines presented in the Resource Management Plan and the Aquatic Conservation strategy. Consider extending these measures to lower-order streams in an order to further improve connectivity and to mitigate indirect downstream impacts. As stated in Section 3.0, about 3,180 acres of Riparian Reserve are designated on BLM-administered lands.

- Special consideration should be given to developing reference habitat conditions within riparian management areas. Riparian areas tend to be the preferred habitat of many wildlife and special status plant species and, as such, could realize the greatest potential gains from developing these conditions. Specifically, the following recommendations should be emphasized: development of conifer stand development at upper elevations; development of oak woodlands at lower elevations; aggressive control of dense understory components; and the use of prescribed fire on a periodic basis (5 to 25 years).

- Consider development of hardwood riparian habitat (e.g., cottonwood, ash, and alder) where stream flow, flood frequency, and floodplain deposition support the ecological needs of these species. Current conditions limit the extent of riparian areas meeting these criteria in the watershed, most of which tends to be at lower elevations on private lands.

- Special emphasis should be placed on following guidelines for survey and manage species within riparian areas. These habitats tend to support most special status plant species described in Section 3.0. As such, they should receive higher attention in BLM land administration and clearance activities.

- Consider road closures and/or traffic restrictions within and adjacent to Riparian Reserves to further improve connectivity.

As with other terrestrial habitat recommendations, riparian habitat recommendations could present opportunities for timber stand improvement and associated economic benefits, as well. Conversely, the need for riparian habitat improvement could be prescribed at the expense of timber stand improvement and other resource management opportunities. As such, riparian habitat recommendations should be coordinated with other resource specialists to identify conflicts and develop opportunities.

## 4.7 Aquatic Habitat

The dominant disturbance factors affecting aquatic habitat quality in the Trail Creek watershed have been land development, timber harvest activity, and road building. These activities have had direct effects on vegetation, hydrologic change, and erosion processes described above. In turn, these processes have affected the following key aquatic habitat quality components: stream sedimentation, stream shade, large woody debris, and stream channel conditions. Trends in these individual components and recommendations for improving them have been discussed in previous sections.

This section presents comprehensive recommendations for improving aquatic habitat and fisheries populations in the Trail Creek watershed in terms of the following strategies: resource protection; aquatic habitat restoration and improvement; and, fish population restoration and improvement. These recommendations are premised on trends in fish populations, discussed in Section 3.7, which indicate that, except where limited by barriers, fish distribution in the watershed under reference conditions was more or less the same as today; however, numbers of fish were probably higher prior to aquatic habitat degradation due to the disturbance factors listed above and dam construction on the Rogue River drainage.

***Recommendations***

Objective: The following recommendations for fuel hazard reduction are herein emphasized for directly addressing ACS and RMP objectives for water and soil, fisheries habitat, roads/access, and fire management as they relate to resource protection.

Whereas fire hazard reduction measures presented earlier generally addressed resource protection, specific aquatic habitat values that need be protected include: flows, sedimentation, and stream shade. Although these values tend to occur in association with stream zones, the potential risk to these resources can occur from fire hazard conditions that occur throughout the Trail Creek watershed. Capabilities of the watershed to achieve resource protection objectives through fire hazard reduction were presented earlier. Consequently, the following aquatic habitat conditions need to be addressed in fuel hazard reduction planning:

- Fire hazard reduction should directly reduce risk to areas with high percentages of drainage area in the ROS zone (elevation 3,600 to 4,800 feet). These are areas where hydrologic change is most responsive to changes in canopy cover that would result from catastrophic wildfire.

- Fire hazard reduction should directly reduce risk to areas predisposed to mass wasting and hillslope erosion that are capable of discharging sediment to streams. Table 3-5 provides an indication of those sub-watersheds in which high sediment potential exists.

- Fire hazard reduction should directly reduce risk to Riparian Reserves, about 3,180 acres of which exist on BLM-administered lands, of critical value in routing of stream flow and stream shade.

As discussed earlier, appropriate tactics used in fuel hazard reduction would be developed on a prescription basis and could include, but not be limited to: underburning, slash and burning, lop and scatter, handpile and burning. Prescriptions would also address site assessments of habitat considerations, operability constraints, fuel conditions, and other environmental concerns.

In addition to fuel hazard reduction, the following recommendation should also be placed on road access:

- Maintain adequate access routes for fire suppression activities associated with aquatic habitat. An extensive road network exists within the Trail Creek watershed; however, road closure activities or traffic restrictions could indirectly place aquatic habitat resources potentially at risk.

In implementation, road closure plans should be coordinated between fire management and aquatic habitat personnel. This consultation would extend to other resource specialists for which road management applies.

Objective: The following recommendations directly address ACS and RMP objectives for fisheries habitat for aquatic habitat restoration and improvement.

In implementation, they provide both landscape level strategies and operational recommendations for addressing the following specific aquatic habitat issues: stream flows, sedimentation, stream shade and temperatures, large woody debris, and substrate materials. Practically, the capability of the Trail Creek watershed to achieve is limited by private land use practices, hydrologic responsiveness, current habitat deficiencies, and existing stream geomorphology. Some limitations can be overcome in the long-term (e.g., vegetation conditions); however, some will persist as a permanent component of the watershed. Consequently, the following recommendations focus on those which the BLM can implement and realize some improvements:

- Generally, existing fisheries data is incomplete or inconclusive regarding the following information: existing flow and temperature regimes are not known for the majority of streams; and substrate, embededdness, and pool/riffle/run complexes are not known for many streams. These are key issues that need to be addressed before implementing the recommendations outlined below. Of key concern are whether streams are in a condition for which habitat restoration and improvement would result in any benefits.

- As recommended in the terrestrial habitat section, protection of existing old-growth stands should be considered wherever they exist on BLM lands. These stand conditions tend to exist on about 2,050 acres of dense, large tree stands occurring on cooler, moister upper elevation north facing sites, about 1,500 of which is on federal lands, much of which within riparian areas. Their retention will help moderate stream flows, sedimentation, and temperatures and provide large woody debris, as well as help the BLM meet their 15 percent late-successional stand retention requirements.

- As recommended in the terrestrial habitat section, manage Riparian Reserves according to guidelines presented in the Resource Management Plan and the Aquatic Conservation strategy and also consider extending these measures to lower-order streams. Key benefits to aquatic habitat would be moderated flows, sedimentation, and temperatures.

- As recommended in the terrestrial habitat section, promote late seral stage stand development at upper elevations where there is existing large tree components to provide some of the habitat structure. This measure would also help moderate stream flows, sedimentation, and temperature as well as develop large woody debris recruitment potential when applied near streams. Silvicultural prescriptions outlined above would apply here as well. Special consideration should be given to maintaining these stand conditions at upper elevations where drainages are most responsive to canopy cover for hydrologic change and most susceptible to sediment delivery from mass wasting and roads.

- As recommended in the terrestrial habitat section, special consideration should be given to developing reference habitat conditions within riparian management areas. Reference conditions would provide needed aquatic habitat components such as moderated flows, decrease sedimentation, and stream temperatures as well as large woody debris recruitment potential. Specifically, the following recommendations should be emphasized: development of conifer stand development at upper elevations; development of oak woodlands at lower elevations; aggressive control of dense understory components; and the use of prescribed fire on a periodic basis (5 to 25 years).

C As recommended in the terrestrial habitat section, consider development of hardwood riparian habitat (e.g., cottonwood, ash, and alder) where stream flow, flood frequency, and floodplain deposition support the ecological needs of these species. Current conditions limit the extent of riparian areas meeting these criteria in the watershed, most of which tends to be at lower elevations on private lands.

C Consider developing associations with landowners in the watershed to develop solutions to potential impacts from water withdrawals. Potential activities could include reallocation of water rights and enforcement to reduce unauthorized withdrawals.

C Implement stream restoration projects within the current extent of fish-bearing streams where they meet the following criteria: 1) one or more improvable habitat components (e.g., temperature, large woody debris, or substrate) are currently limiting to aquatic habitat quality; 2) predisposing factors (e.g., hydrologic responsiveness, sedimentation, flows and geomorphology) will allow for aquatic habitat improvement; and 3) habitat improvements can practically be realized and persist over time. Generally, the ability of fish-bearing streams in the Trail Creek watershed to meet these criteria decreases with elevation and it is concluded that there is little chance of meeting these criteria within the main stem of Trail Creek. Consequently, the BLM should consider reaches of the West and East Forks of Trail Creek and their tributaries for locating such stream restoration projects. Because much of the fish-bearing streams meeting these criteria would occur within private lands, the BLM will have to actively cooperate with landowners in order to meet these objectives.

C As presented in previous sections, consider recommendations addressing instream flows, physical integrity of streams, mass wasting, road erosion, stream shade, and LWD as they specifically relate to aquatic habitat restoration and improvement.

As with other habitat recommendations, aquatic habitat recommendations could present opportunities for timber stand improvement and associated economic benefits, as well. Conversely, the need for aquatic habitat could be prescribed at the expense of timber stand improvement and other resource management opportunities. As such, aquatic habitat recommendations should be coordinated with other resource specialists.

Objective: The following recommendations directly address ACS and RMP objectives for fish habitat as implemented through fish population restoration and improvement projects.

In implementation, they provide both landscape level strategies and operational recommendations for addressing the following specific fish population issues: migration barriers and fish stocks. Practically, the capability of the Trail Creek watershed to achieve these objectives throughout the Trail Creek watershed are limited by the aquatic habitat quality concerns that have been discussed throughout this section. Some limitations can be overcome in the long-term (e.g., vegetation conditions); however, some will persist as a permanent component of the watershed. Consequently, the following recommendations focus on those which the BLM can implement and realize some improvements:

C Generally, existing fisheries data is incomplete or inconclusive regarding the following information: presence and absence of fish species is not observed for many streams; fish populations are not estimated for many streams; barrier surveys are not complete for many streams; and genetic composition is not known for all streams. These are key issues that need to be addressed before implementing the recommendations outlined in this document. Of key concern are 1) the responsiveness of fish populations in the drainages of the Trail Creek watershed to habitat conditions, and 2) the extent to which genetic mixing could be a concern.

- Consider barrier removals/improvements where there is the potential for extending fish-bearing streams in situations meeting the following criteria: 1) genetic mixing of populations is not a concern; 2) sufficient flows exist to sustain desired fish species and/or life stages; and 3) riparian habitat and stream geomorphology will support establishment and/or persistence of aquatic habitat components (e.g., stream shade, large woody debris, and substrate). Permanent and ephemeral natural barriers, man-made barriers, and beaver dams would all be considered. Given current knowledge of fish distribution, it is concluded that the most potential for extension of populations probably exists for cutthroat and rainbow trout. In most cases, anadromous fish populations have extended themselves as far as they could in the Trail Creek watershed drainage system and are therefore likely to benefit from these measures only in certain instances.

Overall, these fish population improvement and restoration recommendations offer limited opportunity for associated timber stand improvements and associated economic benefits. However, consideration to aquatic habitat improvement and restoration recommendations in timber stand improvement and other resource management activities should be made in order to increase the probability of success for fish population activities. As such, fish population recommendations should be coordinated.

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# APPENDIX A

# MASS WASTING

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 33013101<br>1966 photo 6-12-27 | 4 | SR | q | <500 | 0 | none | 30-50% | concave | L | |
| 33011701<br>1966 photo 6-12-30 | 1 | SR | q | <500 | <50% | none | <30% | concave | B | |
| 33011702<br>1966 photo 6-12-30 | 1 | SR | q | <500 | <50% | none | <30% | concave | B | |
| 32012001<br>1966 photo 6-12-37 | 1 | SR | p | <500 | 50-90% | clearcut | 30-50% | planar | P | |
| 33023601<br>1966 photo 6-10-35 | 4 | SR | q | 500-2000 | <50% | none | 30-50% | planar | P | |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge
P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data



| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 32012801<br><br>1969 photo<br>23-21B-12 | 1 | SR | q | <500 | 0 | clearcut | <30% | concave | L | |
| 33022401<br><br>1969 photo<br>23-19B-16 | 4 | SR | q | <500 | 0 | road? | <30% | convex | L | |
| 32012701<br><br>1975 photo<br>13-73-19 | 3 | SR | q | <500 | 0 | none | 50-70% | concave | H | field observation indicates that this is <u>not</u> a failure |
| 33021201<br><br>1975 photo<br>15-70-18 | 1 | SR | p | <500 | 0 | road fill | 30-50% | concave | R? | |
| 33022402<br><br>1969 photo<br>23-19B-16 | 2 | SR | p | <500 | 0 | skid trail | 50-70% | convex | P | |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
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Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 32023501<br><br>1975 photo<br>15-68-21 | 1 | SR | d | 500-2000 | 0 | none | 30-50% | concave | B? | slide existed prior to the road |
| 33020401<br><br>1975 photo<br>15-67-28 | 3 | SR | d | <500 | <50% | clearcut | 30-50% | planar | P | |
| 33012101<br><br>1975 photo<br>13-72-14 | 4 | SR | p | <500 | 0 | none | <30% | concave | L | |
| 32012101<br><br>1985 photo<br>12-57A-22 | 3 | SR | d | <500 | 0 | road fill | 30-50% | convex | P | |
| 33021101<br><br>1975 photo<br>15-68-18 | 1 | SR | d | <500 | 100% | road fill | <30% | convex | L | |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge
P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 32023502<br><br>1996 photo 3-18 | 1 | SR | d | 500-2000 | 0 | none | 30-50% | planar | P | |
| 32013101 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |
| 33010501 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |
| 33010801 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |
| 32012901 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge
P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 32012902 | 1 | SSD | d | <500 | 0 | road | 30-50% | concave | L? | field observation |
| 32012903 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |
| 32012802 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |
| 32012102 | 1 | SR | d | <500 | 0 | road cut | 30-50% | planar | P | field observation |
| 32012002 | 3 | SR | p | <500 | 0 | harvest | 30-50% | convex | P | field observation; visible on 1996 photos |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge

P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 32013301 | 1 | SR | d | <500 | 0 | road cut | 30-50% | planar | P | field observation |
| 32013302 | 1 | SSD | d | 500-2000 | 0 | road | <30% | convex | L? | field observation |
| 33020901 | 3 | SSD | d | <500 | 0 | road cut | <30% | concave | L? | field observation |
| 33020101 | 1 | SSD | d | <500 | 0 | road | <30% | concave | L? | field observation |
| 33021501 | 1 | SSD | d | <500 | 0 | road | <30% | planar | L | field observation |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge

P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 33013102 | 4 | SSD | d | 500-2000 | <50% | road fill | 30-50% | planar | P | field observation |
| 33012901 | 2 | SR | d | <500 | 0 | road cut | 30-50% | planar | P | field observation |
| 33010901 | 1 | SSD | d | <500 | 0 | road cut | 30-50% | concave | H | field observation |
| 32013303 | 1 | SR | d | <500 | 100% | none | 50-70% | concave | G | field observation |
| 32013304 | 1 | SSD | d | <500 | 0 | clearcut | 30-50% | concave | B | field observation |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge

P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 32012103 | 1 | SSD | d | <500 | 0 | road cut | <30% | concave | B | field observation |
| 32012104 | 1 | SSD | d | 500-2000 | 0 | clearcut | 30-50% | planar | B | field observation |
| 32012904 | 1 | SSD | d | <500 | 0 | road cut | 30-50% | concave | B | field observation; numerous road slumps |
| 32023503 | 1 | SSD | d | <500 | 0 | road cut | 30-50% | concave | B | field observation |
| 32013001 | 1 | SSD | d | <500 | 0 | road fill | 30-50% | concave | B | field observation |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge

P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 33020102 | 1 | SSD | d | 500-2000 | 0 | road | 30-50% | concave | B | field observation |
| 33020103 | 1 | SSD | d | <500 | 0 | road cut | <30% | concave | B | field observation |
| 33020104 | 1 | SSD | d | <500 | 0 | road cut | <30% | concave | B | field observation |
| 34010601 | 2 | SSD | p | <500 | 0 | harvest | >70% | planar | H | field observation |
| 33021502 | 1 | SSD | d | <500 | 0 | road fill | <30% | concave | B | field observation |

**SR** - shallow, rapid failure
**DT** - debris torrent
**LPD** - large, persistent, deep-seated failure
**SSD** - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge
P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-1. Landslide Inventory Data

| Landslide ID (T, R, S, #) | MWMU | Landslide Process (SR, DT, LPD, SSD) | Certainty (definite, probable, questionable) | Size (sq.yd.) | Delivery | Associated Land Use | Slope Gradient | Slope Shape | Landform * | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 33021503 | 1 | SSD | d | <500 | 0 | road fill | <30% | concave | B | field observation |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

SR - shallow, rapid failure
DT - debris torrent
LPD - large, persistent, deep-seated failure
SSD - small, sporadic, deep-seated failure

* H - headwall, scarp, or steep hollow
L - low gradient smooth or hummocky slope
R - ridgetop or upland bench
I - inner gorge
P - steep planar or convex slope
B - undifferentiated bench or deep-seated landslide
V - valley alluvium

Table A-2. Mass Wasting Summary

MWMU #1

| Activity | Mass Wasting Feature: Shallow rapid failure | Large persistent deep-seated | Small sporadic deep-seated | Debris torrent | Total |
|---|---|---|---|---|---|
| Clearcut< 20 years | 2 | 0 | 2 | 0 | 4 |
| Road | 4 | 0 | 20 | 0 | 24 |
| Mature forest | 5 | 0 | 0 | 0 | 5 |
| Total | 11 | 0 | 22 | 0 | 33 |

MWMU #2

| Activity | Mass Wasting Feature: Shallow rapid failure | Large persistent deep-seated | Small sporadic deep-seated | Debris torrent | Total |
|---|---|---|---|---|---|
| Clearcut< 20 years | 1 | 0 | 1 | 0 | 2 |
| Road | 1 | 0 | 0 | 0 | 1 |
| Mature forest | 0 | 0 | 0 | 0 | 0 |
| Total | 2 | 0 | 1 | 0 | 3 |

MWMU #3

| Activity | Mass Wasting Feature: Shallow rapid failure | Large persistent deep-seated | Small sporadic deep-seated | Debris torrent | Total |
|---|---|---|---|---|---|
| Clearcut< 20 years | 2 | 0 | 0 | 0 | 2 |
| Road | 1 | 0 | 1 | 0 | 2 |
| Mature forest | 0 | 0 | 0 | 0 | 0 |
| Total | 3 | 0 | 1 | 0 | 4 |

MWMU #4

| Activity | Mass Wasting Feature: Shallow rapid failure | Large persistent deep-seated | Small sporadic deep-seated | Debris torrent | Total |
|---|---|---|---|---|---|
| Clearcut< 20 years | 0 | 0 | 0 | 0 | 0 |
| Road | 1 | 0 | 1 | 0 | 2 |
| Mature forest | 3 | 0 | 0 | 0 | 3 |
| Total | 4 | 0 | 1 | 0 | 5 |

# APPENDIX B

# ROADS

Table A-2. Mass Wasting Summary

Trail Creek watershed

| Activity | Mass Wasting Feature: Shallow rapid failure | Large persistent deep-seated | Small sporadic deep-seated | Debris torrent | Total |
|---|---|---|---|---|---|
| Clearcut< 20 years | 5 | 0 | 3 | 0 | 8 |
| Road | 7 | 0 | 22 | 0 | 29 |
| Mature forest | 8 | 0 | 0 | 0 | 8 |
| Total | 20 | 0 | 25 | 0 | 45 |

Table B-1. (continued) **Watershed** Trail Creek

Stream Crossings

| X-ing ID # (T, R, S, #) | ROAD TYPE | TREAD WIDTH (ft) | CUT WIDTH (ft) | FILL WIDTH (ft) | ROAD LENGTH (ft) | ROAD AGE | CUT VEG. % | FILL VEG % | TREAD DELIVERY TO DITCH | BASIC RATE | CUT VEG. FACTOR | CUT DELIVERY | FILL VEG FACTOR | FILL DELIVERY | TREAD SURFACE FACTOR | TREAD TRAFFIC FACTOR | TRD/TRAF RATE (tons/ac) | TREAD TO DITCH | TREAD OVER FILL | TOTAL SEDIMENT DELIVERY | COM-MENT? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33010501 | NI | 12 | 4 | 0 | 250 | O | 70 | 0 | 50% | 30 | 0.37 | 0.25 | 1 | 0.00 | 1 | 1 | 30.0 | 1.03 | 0.10 | 1.4 | |
| 33010502 | NI | 12 | 3 | 3 | 100 | O | 70 | 80 | 0% | 30 | 0.37 | 0.08 | 0.18 | 0.00 | 1 | 1 | 30.0 | 0.00 | 0.08 | 0.2 | |
| 33010503 | NI | 12 | 4 | 4 | 500 | O | 70 | 80 | 80% | 30 | 0.37 | 0.51 | 0.18 | 0.02 | 1 | 1 | 30.0 | 3.31 | 0.08 | 3.9 | |
| 32012901 | NI | 16 | 4 | 4 | 450 | O | 80 | 80 | 80% | 30 | 0.18 | 0.22 | 0.18 | 0.02 | 1 | 1 | 30.0 | 3.97 | 0.10 | 4.3 | |
| 32012101 | NI | 12 | 4 | 6 | 450 | O | 80 | 80 | 50% | 30 | 0.18 | 0.22 | 0.18 | 0.03 | 1 | 1 | 30.0 | 1.86 | 0.19 | 2.3 | |
| 32012801 | NI | 12 | 8 | 12 | 400 | O | 30 | 70 | 0% | 30 | 0.53 | 1.17 | 0.37 | 0.12 | 1 | 1 | 30.0 | 0.00 | 0.33 | 1.6 | |
| 32012102 | NI | 14 | 12 | 10 | 900 | O | 20 | 80 | 0% | 30 | 0.63 | 4.69 | 0.18 | 0.11 | 1 | 1 | 30.0 | 0.00 | 0.87 | 5.7 | |
| 32013303 | NI | 12 | 14 | 10 | 1,000 | O | 30 | 80 | 50% | 30 | 0.53 | 5.11 | 0.18 | 0.12 | 1 | 1 | 30.0 | 4.13 | 0.41 | 9.8 | |
| 33020901 | NI | 14 | 6 | 10 | 1,300 | O | 50 | 80 | 80% | 30 | 0.37 | 1.99 | 0.18 | 0.16 | 1 | 1 | 30.0 | 10.03 | 0.25 | 12.4 | |
| Average | NI | 13 | 7 | 7 | 594 | | 56 | 70 | 43% | | | 1.58 | | 0.07 | | | | 2.70 | 0.27 | 4.8 | |

Road Sediment Calculations **Watershed** Trail Creek

Stream Crossings

| X-ing ID # (T, R, S, #) | ROAD TYPE | TREAD WIDTH (ft) | CUT WIDTH (ft) | FILL WIDTH (ft) | ROAD LENGTH (ft) | ROAD AGE | CUT VEG % | FILL VEG. % | TREAD DELIVERY TO DITCH | BASIC RATE | CUT VEG FACTOR | CUT DELIVERY | FILL VEG FACTOR | FILL DELIVERY | TREAD SURFACE FACTOR | TREAD TRAFFIC FACTOR | TRD/TRAF RATE (tons/ac) | TREAD TO DITCH | TREAD OVER FILL | TOTAL SEDIMENT DELIVERY | COM-MENT? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | NA | 13 | 7 | 7 | 594 | O | 56 | 70 | 43% | 30 | 0.37 | 0.99 | 0.37 | 0.10 | 1 | 0.05 | 1.5 | 0.11 | 0.01 | 1.2 | |

**Comments:**

33010901 ~30-70' from stream.

33011701 ~30-100' from stream.

33012001 ~30-100' from stream.

33021001 ~30-50' from stream, frequent water bars recently installed

33011903 ~40-70' from stream

33012902 ~40-100' from stream.

33013401 ~50-75' from stream.

33012802 ~10-20' from stream.

33012803 ~30-50' from stream.

33013301 ~30-50' from stream.

33013302 ~30' from stream.

33013401 ~30-50' from stream.

33010804 Bridge.

33012901 Bridge.

33010801 Bridge.

33011901 Bridge.

33010502 No pipe; stream runs across road

## Table B-1. Road Sediment Calculations

**Watershed** Trail Creek

**Road Segments**

| SEGMENT ID # (T, R, S, #) | ROAD TYPE | TREAD WIDTH (ft) | CUT WIDTH (ft) | FILL WIDTH (ft) | ROAD LENGTH (ft) | ROAD AGE | CUT VEG. % | FILL VEG % | DELIVERY TO STREAM | BASIC RATE | CUT VEG FACTOR | CUT DELIVERY | FILL VEG FACTOR | FILL DELIVERY | TREAD SURFACE FACTOR | TREAD TRAFFIC FACTOR | TREAD DELIVERY | TOTAL SEDIMENT DELIVERY | SUB-WATER-SHED | COM-MENT? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33010901 | NI | 12 | 4 | 4 | 1,750 | O | 80 | 80 | 10% | 30 | 0.18 | 0.09 | 0.18 | 0.09 | 1 | 1 | 1.45 | 1.6 | UEF | * |
| 33011701 | PS | 40 | 3 | 4 | 6,500 | O | 70 | 70 | 10% | 30 | 0.37 | 0.50 | 0.37 | 0.66 | 0.03 | 2 | 1.07 | 2.2 | LEF | * |
| 33012001 | PS | 40 | 4 | 6 | 4,000 | O | 70 | 70 | 10% | 30 | 0.37 | 0.41 | 0.37 | 0.61 | 0.03 | 2 | 0.66 | 1.7 | LEF | * |
| 33021001 | NI | 14 | 4 | 6 | 1,500 | N | 70 | 80 | 10% | 60 | 0.37 | 0.31 | 0.18 | 0.22 | 1 | 1 | 2.89 | 3.4 | CC | * |
| 33011903 | 2I | 18 | 5 | 3 | 500 | O | 80 | 80 | 10% | 30 | 0.18 | 0.03 | 0.18 | 0.02 | 0.5 | 1 | 0.31 | 0.4 | LWF | * |
| 33012902 | PS | 40 | 6 | 6 | 1,000 | O | 50 | 80 | 10% | 30 | 0.37 | 0.15 | 0.18 | 0.07 | 0.03 | 2 | 0.17 | 0.4 | LEF | * |
| 33013401 | 2I | 14 | 6 | 8 | 1,500 | O | 50 | 80 | 10% | 30 | 0.37 | 0.23 | 0.18 | 0.15 | 0.5 | 1 | 0.72 | 1.1 | LT | * |
| 33012602 | 2I | 12 | 0 | 3 | 500 | O | 0 | 80 | 10% | 30 | 1 | 0.00 | 0.18 | 0.02 | 0.5 | 1 | 0.21 | 0.2 | LT | * |
| 33012803 | PS | 40 | 0 | 4 | 1,500 | O | 0 | 80 | 10% | 30 | 1 | 0.00 | 0.18 | 0.07 | 0.03 | 2 | 0.25 | 0.3 | LT | * |
| 33013301 | PS | 40 | 0 | 4 | 1,500 | O | 0 | 80 | 10% | 30 | 1 | 0.00 | 0.18 | 0.07 | 0.03 | 2 | 0.25 | 0.3 | LT | * |
| 33013302 | PS | 40 | 0 | 6 | 500 | O | 0 | 80 | 10% | 30 | 1 | 0.00 | 0.18 | 0.04 | 0.03 | 2 | 0.08 | 0.1 | LT | * |
| 33013401 | PS | 40 | 8 | 10 | 1,000 | O | 50 | 80 | 10% | 30 | 0.37 | 0.20 | 0.18 | 0.12 | 0.03 | 2 | 0.17 | 0.5 | LT | * |
| Total | segments | | | | 21,750 | | | | | | | 1.91 | | 2.15 | | | 8.22 | 12.3 | | |

## Road Sediment Calculations

**Watershed** Trail Creek

**Stream Crossings**

| X-ing ID # (T, R, S, #) | ROAD TYPE | TREAD WIDTH (ft) | CUT WIDTH (ft) | FILL WIDTH (ft) | ROAD LENGTH (ft) | ROAD AGE | CUT VEG. % | FILL VEG % | TREAD DELIVERY TO DITCH | BASIC RATE | CUT VEG FACTOR | CUT DELIVERY | FILL VEG FACTOR | FILL DELIVERY | TREAD SURFACE FACTOR | TREAD TRAFFIC FACTOR | TRD/TRAF RATE (tons/ac) | TREAD TO DITCH | TREAD OVER FILL | TOTAL SEDIMENT DELIVERY | COM-MENT? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32023601 | PS | 40 | 20 | 10 | 350 | O | 20 | 80 | 80% | 30 | 0.63 | 3.04 | 0.18 | 0.04 | 0.03 | 2 | 1.8 | 0.46 | 0.01 | 3.8 | |
| 33010601 | PS | 40 | 0 | 8 | 250 | O | 0 | 60 | 50% | 30 | 1 | 0.00 | 0.37 | 0.05 | 0.03 | 2 | 1.8 | 0.21 | 0.02 | 0.3 | |
| 33010602 | PS | 40 | 10 | 3 | 350 | O | 20 | 50 | 50% | 30 | 0.63 | 1.52 | 0.37 | 0.03 | 0.03 | 2 | 1.8 | 0.29 | 0.03 | 1.9 | |
| 33010803 | PS | 40 | 4 | 6 | 500 | O | 50 | 80 | 100% | 30 | 0.37 | 0.51 | 0.18 | 0.04 | 0.03 | 2 | 1.8 | 0.83 | 0.00 | 1.4 | |
| 33010804 | PS | 34 | 6 | 2 | 150 | O | 50 | 70 | 50% | 30 | 0.37 | 0.23 | 0.37 | 0.01 | 0.03 | 2 | 1.8 | 0.11 | 0.01 | 0.4 | * |
| 33012901 | PS | 35 | 0 | 6 | 1,200 | O | 0 | 80 | 50% | 30 | 1 | 0.00 | 0.18 | 0.09 | 0.03 | 2 | 1.8 | 0.87 | 0.09 | 1.0 | * |
| Average | PS | | | | 467 | | | | | | | 0.88 | | 0.04 | | | | 0.46 | 0.03 | 1.4 | |

Table B-2. Road Sediment Calculations

Sub-watershed: Upper West Fork

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 0 | 1.4 | 0.0 |
| Heavy gravel | 0 | 1.3 | 0.0 |
| Graveled | 3 | 2.8 | 8.4 |
| Native surface | 0 | 4.6 | 0.0 |
| Abandoned | 14 | 1.2 | 17.1 |
| Stream-adjacent | | | 0.0 |
| Total | 17 | | 25.5 |

Sub-watershed: Chicago Creek

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 0 | 1.4 | 0.0 |
| Heavy gravel | 0 | 1.3 | 0.0 |
| Graveled | 9 | 2.8 | 25.2 |
| Native surface | 3 | 4.6 | 13.9 |
| Abandoned | 9 | 1.2 | 11.0 |
| Stream-adjacent | | | 3.4 |
| Total | 21 | | 53.5 |

Table B-2. (continued)

Sub-watershed: Lower West Fork

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 2 | 1.4 | 2.8 |
| Heavy gravel | 4 | 1.3 | 5.3 |
| Graveled | 30 | 2.8 | 84.0 |
| Native surface | 21 | 4.6 | 97.0 |
| Abandoned | 64 | 1.2 | 78.2 |
| Stream-adjacent | | | 0.4 |
| Total | 121 | | 267.8 |

Sub-watershed: Upper East Fork

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 2 | 1.4 | 2.8 |
| Heavy gravel | 5 | 1.3 | 6.6 |
| Graveled | 8 | 2.8 | 22.4 |
| Native surface | 44 | 4.6 | 203.3 |
| Abandoned | 10 | 1.2 | 12.2 |
| Stream-adjacent | | | 1.6 |
| Total | 69 | | 249.0 |

Table B-2. (continued)

Sub-watershed: Wall Creek

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 8 | 1.4 | 11.3 |
| Heavy gravel | 0 | 1.3 | 0.0 |
| Graveled | 3 | 2.8 | 8.4 |
| Native surface | 9 | 4.6 | 41.6 |
| Abandoned | 26 | 1.2 | 31.8 |
| Stream-adjacent | | | 0.0 |
| Total | 46 | | 93.0 |

Sub-watershed: Lower East Fork

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 15 | 1.4 | 21.2 |
| Heavy gravel | 2 | 1.3 | 2.7 |
| Graveled | 0 | 2.8 | 0.0 |
| Native surface | 11 | 4.6 | 50.8 |
| Abandoned | 11 | 1.2 | 13.4 |
| Stream-adjacent | | | 4.3 |
| Total | 39 | | 92.4 |

Table B-2. (continued)

Sub-watershed: Lower Trail Creek

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 8 | 1.4 | 11.3 |
| Heavy gravel | 1 | 1.3 | 1.3 |
| Graveled | 24 | 2.8 | 67.2 |
| Native surface | 15 | 4.6 | 69.3 |
| Abandoned | 9 | 1.2 | 11.0 |
| Stream-adjacent | | | 2.6 |
| Total | 57 | | 162.7 |

Sub-watershed: Trail Creek Watershed

| Road Type | Number of stream crossings | Delivery per X-ing (tons/yr) | Total delivery (tons/yr) |
|---|---|---|---|
| Paved | 35 | 1.4 | 49.4 |
| Heavy gravel | 12 | 1.3 | 15.9 |
| Graveled | 77 | 2.8 | 215.7 |
| Native surface | 103 | 4.6 | 475.9 |
| Abandoned | 143 | 1.2 | 174.7 |
| Stream-adjacent | | | 12.3 |
| Total | 370 | | 943.9 |

Table B-3. Natural Background Erosion Rates

Trail Creek Watershed

| Sub-watershed | Area (acres) | Stream length (m) | Creep rate (m/yr) | Soil Depth (m) | Sediment volume ($m^3$/yr) | % Coarse fragment | Fine sediment (tonnes/yr) | Fine sediment (tons/yr) | Sediment yield (tons/$mi^2$/yr) | Stream density (mi/$mi^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| Upper West Fork | 3,669 | 19,596 | 0.0020 | 1.0 | 78 | 30% | 82 | 91 | 15.8 | 2.1 |
| Chicago Creek | 1,857 | 17,787 | 0.0020 | 1.0 | 71 | 30% | 75 | 82 | 28.3 | 3.8 |
| Lower West Fork | 8,767 | 90,713 | 0.0015 | 1.0 | 272 | 30% | 286 | 314 | 22.9 | 4.1 |
| Upper East Fork | 5,585 | 53,248 | 0.0020 | 1.0 | 213 | 30% | 224 | 246 | 28.2 | 3.8 |
| Wall Creek | 5,730 | 39,766 | 0.0015 | 1.0 | 119 | 30% | 125 | 138 | 15.4 | 2.8 |
| Lower East Fork | 4,193 | 40,773 | 0.0015 | 1.0 | 122 | 30% | 128 | 141 | 21.6 | 3.9 |
| Lower Trail Creek | 5,504 | 50,546 | 0.0015 | 1.0 | 152 | 30% | 159 | 175 | 20.4 | 3.7 |
| Total | 35,305 | 312,429 | | | 1,028 | | 1,079 | 1,187 | 21.5 | 3.5 |

Table B-4. Road Erosion Summary

Trail Creek Watershed

| Sub-watershed | Area (acres) | Road length (miles) | Road density ($mi/mi^2$) | Road sediment (tons/yr) | Road sediment ($tons/mi^2/yr$) | Natural sediment (tons/yr) | Natural sediment ($tons/mi^2/yr$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| Upper West Fork | 3,669 | 24.0 | 4.2 | 25.5 | 4.4 | 91 | 15.8 | 28% |
| Chicago Creek | 1,857 | 18.3 | 6.3 | 53.5 | 18.4 | 82 | 28.3 | 65% |
| Subtotal | 5,526 | 42.3 | | 79.0 | 9.1 | 173 | 20.0 | 46% |
| Lower West Fork | 8,767 | 78.0 | 5.7 | 267.8 | 19.5 | 314 | 22.9 | 85% |
| Subtotal | 14,293 | 120.3 | | 346.8 | 15.5 | 487 | 21.8 | 71% |
| Upper East Fork | 5,585 | 52.1 | 6.0 | 249.0 | 28.5 | 246 | 28.2 | 101% |
| Wall Creek | 5,730 | 56.1 | 6.3 | 93.0 | 10.4 | 138 | 15.4 | 68% |
| Subtotal | 11,315 | 108.2 | | 342.0 | 19.3 | 384 | 21.7 | 89% |
| Lower East Fork | 4,193 | 28.0 | 4.3 | 92.4 | 14.1 | 141 | 21.6 | 65% |
| Subtotal | 15,508 | 136.2 | | 434.4 | 17.9 | 525 | 21.7 | 83% |
| Subtotal - WF/EF | 29,801 | 256.5 | | 781.2 | 16.8 | 1,012 | 21.7 | 77% |
| Lower Trail Creek | 5,504 | 45.6 | 5.3 | 162.7 | 18.9 | 175 | 20.4 | 93% |
| Total | 35,305 | 302.1 | 5.5 | 943.9 | 17.1 | 1,187 | 21.5 | 80% |

Table B-5. Culvert Sizing Calculations

| Culvert location (T, R, S, #) | Culvert diameter (in) | Culvert capacity (cfs) | Drainage area ($mi^2$) | 100-year flood (cfs) | Flood/ capacity ratio | 2-year flood (cfs) | Flood/ capacity ratio |
|---|---|---|---|---|---|---|---|
| 32012103 | 24 | 11 | 0.11 | 37 | 326% | 11 | 96% |
| 32012801 | 48 | 66 | 0.23 | 67 | 102% | 20 | 31% |
| 32012802 | 36 | 32 | 0.29 | 80 | 253% | 24 | 77% |
| 32012803 | 36 | 32 | 0.31 | 85 | 269% | 26 | 83% |
| 32012901 | 24 | 11 | 0.35 | 93 | 828% | 29 | 255% |
| 32013301 | 36 | 32 | 0.62 | 150 | 473% | 47 | 149% |
| 32013302 | 36 | 32 | 0.34 | 91 | 288% | 28 | 88% |
| 32023601 | 72 | 185 | 2.86 | 523 | 283% | 175 | 95% |
| 33010503 | 48 | 66 | 1.01 | 222 | 338% | 71 | 108% |
| 33011902 | 60 | 116 | 1.24 | 264 | 227% | 85 | 73% |
| 33013101 | 48 | 66 | 0.96 | 214 | 325% | 69 | 104% |
| 33013102 | 48 | 66 | 1.15 | 247 | 376% | 80 | 121% |
| 33020101 | 30 | 20 | 0.17 | 53 | 265% | 16 | 79% |
| 33021302 | 30 | 20 | 0.39 | 102 | 513% | 32 | 159% |
| 33021303 | 36 | 32 | 0.26 | 73 | 231% | 22 | 70% |
| 33022301 | 36 | 32 | 0.17 | 52 | 164% | 16 | 49% |
| 34010601 | 36 | 32 | 1.15 | 248 | 786% | 80 | 254% |
| | | | | average | 356% | average | 111% |

Table B-6: 1998 ROAD INVENTORIES BUTTE FALLS RA, MEDFORD D.O.

| DATE | SURVEYORS | CMPT NAME | WTSHD NAME | ROAD # | ROAD NAME | SEGMENT | CONTROL | LENGTH | CLASS | WIDTH |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.1 | CABIN CANYON | A1 | BLM | 0.31 | SC | 16 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | **33S-1-29.1** | CABIN CANYON | A2 | BLM | 1.09 | SL | 16 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.1 | CABIN CANYON | A3 | BLM | 0.48 | SL | 17 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.1 | CABIN CANYON | A3 | BLM | 0.48 | SL | 17 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.1 | CABIN CANYON | A4 | BLM | 1.28 | SL | 17 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | **33S-1-29.1** | CABIN CANYON | B | BLM | 2.07 | SL | 17 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.04 | BOARD EAST TS SP | N/A | BLM | 0.54 | SL | 17 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31.4 | OLD RD. # '34-1-3D | A | BLM | 0.41 | SL | 14 |
| 7/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | **33S-1-31.1** | LOWER SPUR LEFT | N/A | BLM | 0.46 | SL | 17 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31.3 | SPRING SPUR | N/A | BLM | 0.19 | SL | 17 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | **33S-1-32** | CABIN CANYON MN SP LEFT | A | BLM | 1.55 | SL | 17 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-32 | CABIN CANYON MN SP LEFT | B | **AC** | 0.12 | SL | 14 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.8 | STAMP SP | N/A | BLM | 0.11 | SL | 14 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.1 | BOARD MTN. SP | A | BLM | 0.17 | SL | 14 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.1 | BOARD MTN SP | B | BLM | 0.07 | SL | 14 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31 | CABIN SP BOARD MTN TIE | A | BLM | 0.64 | SC | 17 |
| 7/7/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31 | CABIN SP BOARD MTN TIE | B | BLM | 1.59 | SC | 17 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-19.1 | BOARD MTN | A | BLM | 2.96 | SL | 16 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-19.1 | BOARD MTN | B | BLM | 1.14 | SL | 16 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-19.1 | BOARD MTN | C | BLM | 0.37 | SL | 14 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.7 | SEC 25 CABIN SP | N/A | BLM | 0.4 | SL | 14 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.6 | ROCKY VIEW SP | N/A | BLM | 0.33 | SL | 17 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.5 | ROCKY VIEW SP | N/A | BLM | 0.42 | SL | 17 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.4 | ROCKY VIEW SP | N/A | BLM | 0.28 | SL | 17 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.3 | ROCKY VIEW SP | N/A | BLM | 0.7 | SL | 17 |
| 7/8/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25.2 | ROCKY VIEW SP | N/A | BLM | 1.04 | SC | 17 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.2 | BOARD EAST TS SP | N/A | BLM | 0.11 | SL | 17 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31.2 | MOBIL YARDER SPUR | N/A | BLM | 0.33 | SL | 17 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.2 | TRAIL CK LOWER SP RT | A | BLM | 0.99 | SL | 14 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.2 | TRAIL CK LOWER SP RT | B | BLM | 0.13 | SL | 14 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29.2 | TRAIL CK LOWER SP RT | C | BLM | 0.27 | SL | 14 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-5 | DWINNEL ROAD | A | BLM | 0.1 | SL | 16 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-5 | DWINNEL ROAD-EM ST | B | BLM | 0.83 | SL | 16 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-5 | DWINNEL ROAD | C | BLM | 1.38 | SL | 16 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-5 | DWINNEL ROAD | D | BLM | 0.3 | SL | 16 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-5 | DWINNEL ROAD | E | BLM | 0.6 | SL | 16 |
| 7/9/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-7.2 | OLD BEN EXTENSION | N/A | BLM | 0.26 | SL | 16 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3.1 | CHICAGO CK | A | BLM | 1.13 | SL | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3.2 | SNOW SPRINGS SP | N/A | BLM | 0.56 | SL | 16 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3.3 | SNOW SPRINGS SP | N/A | BLM | 0.23 | SL | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3.4 | SNOW SPRINGS SP | N/A | BLM | 0.6 | SL | 17 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29 | BRANCH TRAIL CK | A | BLM | 1.35 | **SA** | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29 | BRANCH TRAIL CK | B | BLM | 0.59 | **SA** | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29 | BRANCH TRAIL CK | C | BLM | 0.25 | SC | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29 | BRANCH TRAIL CK | D | BLM | 1.3 | SC | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29 | BRANCH TRAIL CK | E | BLM | 0.76 | SC | 17 |
| 7/13/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-29 | BRANCH TRAIL CK | F | BLM | 1.92 | SC | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-15.2 | WALPOLE CK SP | A | BLM | 0.18 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-15.2 | WALPOLE CK SP | B | BLM | 1.16 | SL | 14 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-15.1 | WALPOLE CK MN SP | A | BLM | 0.37 | SL | 14 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-15 | WALPOLE CK S SP SPEC 15 | N/A | BLM | 1.38 | SL | 14 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3.6 | LITTLE CHICAGO | N/A | BLM | 0.21 | SL | 16 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3 | CHICAGO CABIN EMST | N/A | BLM | 0.78 | SL | 14 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-12 | HARDWAY ML | A1 | BLM | 0.83 | SC | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-12 | HARDWAY ML | A2 | BLM | 0.25 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-12 | HARDWAY ML | B1 | BLM | 0.61 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-12 | HARDWAY ML | B2 | BLM | 1.14 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-1 | HARDWAY SPUR | N/A | BLM | 0.19 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-12.1 | HARDWAY SPUR | A | BLM | 0.14 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-12.1 | HARDWAY SPUR | B | BLM | 0.94 | SL | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-13 | WALPOLE CK ML | A | BLM | 0.88 | SC | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-13 | WALPOLE CK ML | B | BLM | 1.52 | SC | 17 |
| 7/14/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-13 | WALPOLE CK ML | C | BLM | 0.69 | SL | 17 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-13.1 | WALPOLE | A1 | BLM | 0.76 | SC | 17 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-13.1 | WALPOLE | A2 | BLM | 1.8 | SC | 17 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-13.1 | WALPOLE | B | BLM | 0.06 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-13.1 | WALPOLE | C | BLM | 0.1 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.6 | WALLOW SP | N/A | BLM | 0.22 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.4 | ROMINE CK CENTER | A | BLM | 0.75 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.4 | ROMINE CK CENTER | B | BLM | 0.08 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.7 | ROBERTS | N/A | BLM | 0.03 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.5 | WALPOLE CK SEC 23 SE SP | A | BLM | 0.2 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.2 | ROMINE CK S SP | A | BLM | 0.19 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.3 | ROMINE CK OAK SP | N/A | BLM | 0.2 | SL | 17 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-2-23 | WALPOLE SEC 23 SP | N/A | BLM | 0.42 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-1-7 | OLD BEN TS SPUR | N/A | BLM | 0.74 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-1-8.1 | DWINNEL RD ESMT | N/A | BLM | 1.32 | SL | 14 |
| 7/15/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 33S-1-5.2 | OLD BEN QUARRY ROAD | N/A | BLM | 0.42 | SL | 12 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 34S-2-1 | RT FK LONG BRANCH | A | BLM | 0.63 | SL | 17 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 34S-2-1 | RT FK LONG BRANCH | B | BLM | 0.7 | SL | 17 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.4 | BOARD EAST TS SP | N/A | BLM | 0.55 | SL | 17 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.5 | BOARDEAST SP | A | BLM | 0.19 | SL | 14 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.6 | BOARD EAST TS SP | N/A | BLM | 0.69 | SL | 17 |
| 7/16/98 | CC,NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-5.4 | WALL CREEK | A | BLM | 1.46 | SL | 14 |
| 7/16/98 | CC,NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-5.4 | WALL CREEK | B | BLM | 0.69 | SL | 14 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 32S-1-31 | BEAVER SPRINGS | N/A | BLM | 0.61 | SL | 14 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 32S-1-31.1 | BEAVER SPRINGS | N/A | BLM | 0.31 | SL | 14 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 32S-1-31.2 | BEAVER SPRINGS SP | N/A | BLM | 0.4 | SL | 14 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 32S-1-31.3 | BEAVER SPRINGS SP | A | BLM | 0.32 | SL | 14 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 32S-1-31.3 | BEAVER SPRINGS SP | B | BLM | 0.29 | SL | 14 |
| 7/16/98 | CC,NW | WEST TRAIL CK | TRAIL CK | 32S-1-31.4 | BEAVER SPRINGS | N/A | BLM | 0.41 | SL | 14 |
| 7/16/98 | CC,NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.1 | UPPER TRAIL CK ML | A | BLM | 0.46 | **SA** | 14 |
| 7/16/98 | CC,NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.1 | UPPER TRAIL CK ML | B | BLM | 1.22 | SC | 14 |
| 7/21/98 | NW, KV | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.1 | UPPER TRAIL CK ML | C | BLM | 2.27 | SC | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-16 | SHED RIDGE | N/A | BLM | 0.62 | SL | 16 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.2 | SHED CAMP ML | A | BLM | 2.33 | SC | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.2 | SHED CAMP ML | B | BLM | 2.24 | SC | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.2 | SHED CAMP ML | C | BLM | 0.47 | SC | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.3 | LOWER SP RT | N/A | BLM | 0.45 | SL | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-29.4 | NW SP | N/A | BLM | 0.26 | SL | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-29.5 | LUMBER MILLS R/W | N/A | BLM | 0.37 | SL | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-20 | PNWB MICRO SITE | N/A | BLM | 0.8 | SL | 14 |
| 7/28/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-29.3 | SNOWMOBILE CONNECT | N/A | BLM | 0.69 | SL | 14 |
| 7/29/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-16 | SHED RIDGE | N/A | BLM | 0.75 | SL | 16 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21.4 | GIBRALTER SP | A | BLM | 0.51 | SL | 14 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21.4 | GIBRALTER SP | B | BLM | 0.1 | SL | 16 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21.3 | SHED CAMP SP LT | N/A | BLM | 1.03 | SL | 14 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-29.2 | NE SHED CAMP SP | N/A | BLM | 1.18 | SL | 12 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21 | SHED CAMP | N/A | BLM | 0.57 | SL | 13 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21.1 | SHED CAMP ADVERSE SP | N/A | BLM | 0.42 | SL | 14 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21.2 | SHED CAMP SW BK SP | N/A | BLM | 0.17 | SL | 14 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-21.5 | UPPER TRAIL CK SP | N/A | BLM | 1.16 | SL | 17 |
| 7/29/98 | CC | **EAST TRAIL CK** | TRAIL CK | 32S-1-28 | TRAIL CK QUARRY | N/A | BLM | 0.38 | SL | 16 |
| 7/30/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-9 | T00THACHER CREEK | N/A | BLM | 0.46 | SL | 17 |
| 7/30/98 | CC, NW | WEST TRAIL CK | TRAIL CK | CLEVELAND RIDGE SP | | N/A | BLM | 0.61 | SL | 14 |
| 7/30/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-9.3 | STUB SPUR RT | A | BLM | 0.27 | SL | 16 |
| 7/30/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-9.3 | CLEVELAND RIDGE | B | BLM | 1.05 | SL | 16 |
| 8/3/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-29 | SE SEC 29 UPPER TRAIL SP | N/A | BLM | 0.28 | SL | 14 |
| 8/3/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-24.2 | PARADISE SP | A | **PRIVATE** | 0.04 | SL | 12 |
| 8/3/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-24.2 | PARADISE SP | B | BLM | 0.34 | SL | 12 |
| 8/3/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.1 | WALPOLE SEC 23 SHORT SF | N/A | BLM | 0.1 | SL | 17 |
| 8/3/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.5 | WALPOLE SE SP | B | BLM | 0.17 | SL | 14 |
| 8/3/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.8 | RIDGE SP | N/A | BLM | 0.1 | SL | 14 |
| 8/3/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-23.2 | ROMINE CK S SP | B | BLM | 0.17 | SL | 14 |
| 8/4/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-15.1 | WALPOLE CK MN SP | A | BLM | 0.9 | SL | 14 |
| 8/4/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-15.1 | WALPOLE CK MN SP | B | BLM | 0.62 | SL | 17 |
| 8/4/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-3.5 | SNOW SPRINGS SP | N/A | BLM | 0.28 | SL | 17 |
| 8/4/98 | | | | 33S-1-18.1 | N/A | N/A | BLM | 0.11 | SL | 14 |
| 8/4/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-18 | W BR TIMBER CK | N/A | BLM | 0.57 | SL | 14 |
| 8/4/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25 | BOARD MTN TRESPASS | A | BLM | 0.35 | SL | 14 |
| 8/4/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-2-25 | BOARD MTN TRESPASS | B | BLM | 0.4 | SL | 14 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8/5/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.5 | BOARDEAST SP | A | BLM | 0.19 | SL | 14 |
| 8/5/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.5 | BOARDEAST SP | B | BLM | 0.12 | SL | 14 |
| 8/5/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-10.4 | HUNGRY SPOT LOWER BUCI | N/A | BLM | 0.4 | SL | 14 |
| 8/5/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-10.1 | BUCK WILLY A SPUR | N/A | BLM | 0.41 | SL | 14 |
| 8/5/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-10.3 | HUNGRY SPOT UPPER BUCI | N/A | BLM | 0.28 | SL | 14 |
| 8/5/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 33S-1-10.2 | BUCK WILL B SPUR | N/A | BLM | 0.77 | SL | 14 |
| 8/5/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-29.1 | SOUTH SP | N/A | BLM | 0.22 | SL | 14 |
| 8/5/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-2.1 | OLD BEN TS SP | N/A | BLM | 0.22 | SL | 17 |
| 8/5/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 34S-2-1.1 | BOARD EAST TS SP | N/A | BLM | 0.19 | SL | 14 |
| 8/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 32S-1-30.2 | BEAVER SPRINGS | N/A | BLM | 0.13 | SL | 14 |
| 8/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 32S-1-30.1 | BEAVER SPRINGS | N/A | BLM | 0.05 | SL | 14 |
| 8/6/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.4 | UP TRAILHD ESMT | A | BLM | 0.26 | SL | 14 |
| 8/6/98 | CC, NW | | TRAIL CK | | | | | | | |
| 8/6/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.5 | UP TRAILHD ESMT | B | NON-EX | 0.26 | SL | 17 |
| 8/6/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33.5 | UP TRAILHD ESMT | C | BLM | 0.12 | SL | 14 |
| 8/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31.4 | OLD ROAD # 34-1-30 | A | BLM | 0.45 | SL | 14 |
| 8/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31.4 | USFS #620110 OLD #34-1-30 | B | BLM | 0.25 | SL | 14 |
| 8/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-31.4 | OLD ROAD # 34-1-30 | C | BLM | 0.63 | SL | 14 |
| 8/6/98 | CC, NW | **EAST TRAIL CK** | TRAIL CK | 32S-1-33 | WALL CK ELDERMILL | A | BLM | 0 | SL | 17 |
| 8/6/98 | CC, NW | WEST TRAIL CK | TRAIL CK | 33S-1-32 | CABIN CYN MN SP LEFT | C | **AGREE CO.** | 0.42 | SL | 14 |
| | | | | | | | | 89.64 | | 2267 |

| | | condition | | | | | | ROAD GRD (%seg) | | | X-DRAIN | DTCHLN ERSN (%depth) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRISM | SURF TYPE | %YIELD | yieldmi | %EROD | erodmi | %STABLE | stabmi | %<8 | %8-12 | %>12 | OUTLET | %<4" | %4-12" | %>12" | NONE |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.31 | 15 | 75 | 10 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.09 | 50 | 40 | 10 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.48 | 10 | 90 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.48 | 10 | 90 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.28 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | **10** | 0.207 | **40** | 0.828 | 50 | 1.04 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | 0 | 0.000 | 0 | 0.000 | 100 | 0.54 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | **10** | 0.041 | **35** | 0.144 | 55 | 0.23 | 30 | 40 | 30 | N/A | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.46 | 90 | 10 | 0 | GOOD | **10** | 0 | 0 | 90 |
| FLAT | CRU | **25** | 0.048 | **10** | 0.019 | 65 | 0.12 | 80 | 20 | 0 | N/A | **10** | 0 | 0 | 90 |
| DIT | CRU | 0 | 0.000 | **30** | 0.465 | 70 | 1.09 | 55 | 40 | 5 | GOOD | 5 | 0 | 0 | 95 |
| DIT | CRU | 0 | 0.000 | **5** | 0.006 | 95 | 0.11 | 50 | 50 | 0 | GOOD | 0 | 0 | 0 | 100 |
| OUT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.11 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.17 | 75 | 25 | 0 | FAIR | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.07 | 0 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.64 | 60 | 40 | 0 | GOOD | 5 | **10** | 0 | 85 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.59 | 65 | 35 | 0 | FAIR | 5 | 0 | 0 | 95 |
| DIT | CRU | 0 | 0.000 | **5** | 0.148 | 95 | 2.81 | 60 | 30 | 10 | GOOD | **10** | **20** | **5** | 65 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.14 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.37 | 95 | 5 | 0 | FAIR | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.40 | 10 | 90 | 0 | G00D | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.33 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.42 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | **5** | 0.014 | 95 | 0.27 | 100 | 0 | 0 | GOOD | 5 | 0 | 0 | 95 |
| DIT | *GRR* | 0 | 0.000 | **10** | 0.070 | 90 | 0.63 | 50 | 50 | 0 | GOOD | 0-5 | 0 | 0 | 0 |
| DIT | *GRR* | 0 | 0.000 | **5** | 0.052 | 95 | 0.99 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.11 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | **5** | 0.017 | 95 | 0.31 | 25 | 75 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.99 | 10 | 85 | 5 | GOOD | 5 | 0 | 0 | 95 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.13 | 10 | 50 | 40 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.27 | 10 | 35 | 55 | GOOD | 5 | **5** | 0 | 90 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.10 | 50 | 50 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | **5** | 0.042 | 95 | 0.79 | 40 | 60 | 0 | GOOD | 5 | 0-5 | 0 | 90-95 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.38 | 35 | 60 | 5 | GOOD | 0-5 | 0 | 0 | 95 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.30 | 65 | 35 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.60 | 85 | 15 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.26 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRR | 0 | 0.000 | 0 | 0.000 | 100 | 1.13 | 75 | 20 | 5 | FAIR | **10** | 0 | 0 | 90 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.56 | 85 | 15 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.23 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | **10** | 0.060 | **40** | 0.240 | 50 | 0.30 | 45 | 40 | 15 | GOOD | 0 | 0 | 0 | 100 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.35 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.59 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.25 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.30 | 10 | 60 | 30 | GOOD | 25 | 0 | 0 | 75 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.76 | 10 | 70 | 20 | GOOD | 90 | 0 | 0 | 10 |
| DIT | CRU | 5 | 0.096 | 0 | 0.000 | 95 | 1.82 | 10 | 70 | 20 | FAIR | 50 | 0 | 0 | 50 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.18 | 50 | 50 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.16 | 25 | 75 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.37 | 35 | 65 | 0 | GOOD | 0-5 | 0 | 0 | 95 |
| DIT | CRU | 0-1 | 0.000 | 0 | 0.000 | 100 | 1.38 | 55 | 40 | 5 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.21 | 85 | 15 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0-1 | 0.000 | 0 | 0.000 | 100 | 0.78 | 75 | 20 | 5 | GOOD | 15 | 0 | 0 | 85 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.83 | 30 | 70 | 0 | GOOD | 5 | 0 | 0 | 95 |
| DIT | GRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.25 | 80 | 20 | 0 | GOOD | 50 | 0 | 0 | 50 |
| DIT | GRR | 0 | 0.000 | 5 | 0.031 | 95 | 0.58 | 85 | 15 | 0 | GOOD | 10 | 0 | 0 | 90 |
| DIT | GRR | 5 | 0.057 | 10 | 0.114 | 85 | 0.97 | 60 | 40 | 0 | GOOD | 25 | 5 | 0 | 70 |
| FLAT | NAT | 95 | 0.181 | 0 | 0.000 | 5 | 0.01 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.14 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.94 | 70 | 30 | 0 | GOOD | 15 | 0 | 0 | 85 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.88 | 65 | 35 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.52 | 55 | 45 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.69 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.76 | 60 | 40 | 0 | GOOD | 5 | 0 | 0 | 95 |
| DIT | CRU | 0-2 | 0.000 | 0 | 0.000 | 98 | 1.76 | 25 | 40 | 35 | GOOD | 5 | 1 | 0 | 94 |
| DIT | NAT | 100 | 0.060 | 0 | 0.000 | 0 | 0.00 | 100 | 0 | 0 | GOOD | 35 | 0 | 0 | 65 |
| DIT | NAT | 50 | 0.050 | 50 | 0.050 | 0 | 0.00 | 55 | 45 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 80 | 0.176 | 0 | 0.000 | 20 | 0.04 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | CRU | 10 | 0.075 | 0 | 0.000 | 90 | 0.68 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | NAT | 25 | 0.020 | 25 | 0.020 | 50 | 0.04 | 25 | 75 | 0 | N/A | 25 | 50 | 0 | 25 |
| N/A | NAT | 0 | 0.000 | 0 | 0.000 | 0 | 0.00 | 0 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.20 | 60 | 40 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 15 | 0.029 | 0 | 0.000 | 85 | 0.16 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0-5 | 0.000 | 0 | 0.000 | 95-100 | 0.00 | 60 | 10 | 30 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 5 | 0.021 | 0 | 0.000 | 95 | 0.40 | 75 | 25 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.74 | 100 | 0 | 0 | FAIR | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.32 | 50 | 35 | 15 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 10 | 0.042 | 90 | 0.38 | 70 | 30 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 25 | 0.158 | 75 | 0.47 | 60 | 25 | 15 | GOOD | 5 | 0 | 0 | 95 |
| DIT | GRR | 15 | 0.105 | 20 | 0.140 | 65 | 0.46 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.55 | 50 | 25 | 25 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 0 | 0.000 | 20 | 0.038 | 80 | 0.15 | 100 | 0 | 0 | GOOD | 10 | 0 | 0 | 90 |
| DIT | GRR | 5 | 0.035 | 10-15 | 0.000 | 85 | 0.59 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 10 | 0.146 | 15 | 0.219 | 75 | 1.10 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 5 | 0.035 | 5 | 0.035 | 90 | 0.62 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | GRR | 5 | 0.031 | 25 | 0.153 | 70 | 0.43 | 65 | 20 | 15 | GOOD | 5 | 0 | 0 | 95 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIT | *GRR* | 5 | 0.016 | **30** | 0.093 | 65 | 0.20 | 60 | 10 | 30 | GOOD | 0 | 0 | **10** | 90 |
| DIT | *GRR* | 0 | 0.000 | **5** | 0.020 | 95 | 0.38 | 80 | 10 | 10 | GOOD | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 5 | 0.016 | **30** | 0.096 | 65 | 0.21 | 20 | 80 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | **5** | 0.015 | 95 | 0.28 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0 | 0.000 | **5** | 0.021 | 95 | 0.39 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.46 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.22 | 40 | 40 | 20 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | **5** | **0.114** | 95 | 2.16 | 70 | 25 | 5 | GOOD | 5-10 | 0 | 0 | 90-95 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.62 | 90 | 10 | 0 | POOR | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 2.33 | 40 | 50 | 10 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 2.24 | 40 | 40 | 20 | FAIR | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.47 | 60 | 40 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.45 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRR | 0 | 0.000 | 0 | 0.000 | 100 | 0.26 | 50 | 50 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | **100** | 0.370 | **100** | **0.370** | 0 | 0.00 | 70 | 30 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | *GRR* | 0-5 | 0.000 | **5** | **0.040** | 90 | 0.72 | 40-45 | 50 | 5-10 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | **1** | **0.007** | 99 | 0.68 | 85 | 15 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.75 | 50 | 30 | 20 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.51 | 45 | 50 | 5 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.10 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.03 | 90 | 10 | 0 | GOOD | 5 | 0 | 0 | 95 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 1.18 | 95 | 5 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.57 | 90 | 10 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.42 | 75 | 15 | 10 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.17 | 100 | 0 | 0 | FAIR | 0 | 0 | 0 | 100 |
| DIT | NAT | 0 | 0.000 | 0 | 0.000 | 100 | 1.16 | 85 | 15 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | 0-1 | 0.000 | **1** | **0.004** | 98 | 0.37 | 50 | 20 | 30 | N/A | 0 | 0 | 0 | 100 |
| INSLOPED | NAT | 5-10 | 0.000 | 0 | 0.000 | 90 | 0.41 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| DIT/INSLOP | CRU | **30** | 0.183 | **50** | 0.305 | 20 | 0.12 | 25 | 65 | 10 | GOOD | 5 | **5** | 0 | 90 |
| INSLOP | *GRR* | 0 | 0.000 | 0 | 0.000 | 100 | 0.27 | 20 | 80 | 0 | GOOD | 0 | 0 | 0 | 100 |
| INSLOP | NAT | **65** | 0.683 | **15** | 0.158 | 20 | 0.21 | 100 | 0 | 0 | FAIR | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | 0 | 0.000 | **10** | **0.028** | 90 | 0.25 | 60 | 40 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | 0 | 0.000 | 0 | 0.000 | 100 | 0.04 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| INSLOPED | NAT | **10** | 0.034 | **20** | 0.068 | 70 | 0.24 | 80 | 10 | 10 | N/A | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | **20** | 0.020 | **20** | 0.020 | 60 | 0.06 | 50 | 0 | 50 | GOOD | 0 | 0 | 0 | 100 |
| DIT/FLAT | NAT | **10** | 0.017 | 0 | 0.000 | 90 | 0.15 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | 5 | 0.005 | **10** | 0.010 | 85 | 0.09 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| FLAT | NAT | **50** | 0.085 | **50** | 0.085 | 50 | 0.09 | 5 | 10 | 85 | GOOD | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | **10** | 0.090 | 95 | 0.86 | 85 | 15 | 0 | GOOD | **15** | 0 | 0 | 85 |
| DIT | CRU | 0 | 0.000 | **10** | 0.062 | 95 | 0.59 | 35 | 55 | 10 | GOOD | 0-5 | 0 | 0 | 95 |
| DIT/INSLOP | CRU | **10** | 0.028 | 0 | 0.000 | 90 | 0.25 | 50 | 50 | 0 | GOOD | 0-5 | 0 | 0 | 95 |
| N/A | NAT | 0 | 0.000 | 0 | 0.000 | 100 | 0.11 | 20 | 70 | 10 | N/A | 0 | 0 | 0 | 100 |
| OUTSLOP | NAT | 5 | 0.029 | **50** | 0.285 | 45 | 0.26 | 65 | 20 | 15 | N/A | 0 | 0 | 0 | 100 |
| FLAT | NAT | **10** | 0.035 | **15** | 0.053 | 75 | 0.26 | 85 | 15 | 0 | N/A | 0 | 0 | 0 | 100 |
| FLAT | NAT | 5 | 0.020 | **10** | 0.040 | 85 | 0.34 | 90 | 10 | 0 | N/A | 0 | 0 | 0 | 100 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIT | *GRR* | 0 | 0.000 | **20** | 0.038 | 80 | 0.15 | 100 | 0 | 0 | GOOD | **10** | 0 | 0 | 90 |
| DIT/FLAT | NAT | **40** | 0.048 | **40** | 0.048 | 20 | 0.02 | 80 | 20 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT/INSLOP | NAT | **10** | 0.040 | **20** | **0.080** | 70 | 0.28 | 70 | 30 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | 5 | 0.021 | **5** | **0.021** | 90 | 0.37 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | **10** | 0.028 | 0 | 0.000 | 90 | 0.25 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| FLAT | NAT | **60** | 0.462 | **25** | **0.193** | 15 | 0.12 | 55 | 30 | 15 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | *GRR* | 0 | 0.000 | **10** | **0.022** | 90 | 0.20 | 75 | 20 | 5 | GOOD | 0 | 0 | 0 | 100 |
| DIT | NAT | **10** | 0.022 | 0 | 0.000 | 90 | 0.20 | 85 | 10 | 5 | N/A | 0 | 0 | 0 | 100 |
| INSLOPED | NAT/GRR | 0 | 0.000 | **15** | 0.029 | 85 | 0.16 | 40 | 25 | 35 | N/A | 0 | 0 | 0 | 100 |
| FLAT | NAT | 0 | 0.000 | 0 | 0.000 | 100 | 0.13 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| FLAT | NAT | 0 | 0.000 | 0 | 0.000 | 100 | 0.05 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| DIT | CRU | 0 | 0.000 | 0 | 0.000 | 100 | 0.26 | 80 | 20 | 0 | GOOD | 0 | 0 | 0 | 100 |
| | | | 0.000 | | 0.000 | | 0.00 | | | | | | | | |
| FLAT | NAT | **40** | 0.104 | **20** | **0.052** | 40 | 0.10 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | 0 | 0.000 | **70** | 0.084 | 30 | 0.04 | 90 | 10 | 0 | N/A | 0 | 0 | **30** | 70 |
| DIT | *GRR* | **50** | 0.225 | **5** | 0.023 | 45 | 0.20 | 100 | 0 | 0 | N/A | **10** | 0 | 0 | 90 |
| FLAT | *GRR* | **60** | 0.150 | **30** | 0.075 | 10 | 0.03 | 100 | 0 | 0 | GOOD | 0 | 0 | 0 | 100 |
| FLAT | NAT | **90** | 0.567 | **70** | 0.441 | 5 | 0.03 | 100 | 0 | 0 | N/A | 0 | 0 | 0 | 100 |
| N/A | NAT | 0 | 0.000 | 0 | 0.000 | 0 | 0.00 | 0 | 0 | 0 | N/A | 0 | 0 | 0 | **0** |
| DIT | CRU | **10** | 0.042 | **20** | 0.084 | 70 | 0.29 | 70 | 30 | 0 | GOOD | 0 | 0 | 0 | 100 |
| | | | | | | | 79.23 | | | | | | | | |
| | | 1200 | 4.718 | | 6.211 | | | | | | | | | | |

STABILITY | CUT BANK SLIDES | CUT BANK HT

| SLIDES | #SPRINGS | #SEEPS | %HDWL TOPC | #<45yd3 | #>45 | %CUTBNK RVL | %CTBNK NOVEG | %CTBNK F/ROCK | %<10' | %10'-20' | %>20' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 90 | 75 | 20 | 5 |
| 0 | 0 | 0 | 0 | 2 | 0 | 0 | 20 | 25 | 15 | 60 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 30 | 20 | 80 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30-40 | 30 | 20 | 80 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 5 | 30 | 30-35 | 50 | 35 | 15 |
| 0 | 1 | 0 | 5 | 2 | 0 | 5 | 50 | 90 | 60 | 30 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 70 | 90 | 80 | 20 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95 | 5 | 0 |
| 1 | 0 | 0 | 0 | 2 | 1 | 0 | 40-50 | 40-50 | 45 | 10 | 45 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 10 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 3 | 0 | 0 | 15 | 25 | 40 | 50 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15-20 | 0 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 70 | 30 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 5 | 20 | 50 | 80 | 20 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0-5 | 30 | 40 | 60 | 35 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5-10 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 15 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 3 | 0 | 0 | 40 | 50 | 75 | 20 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 40 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0-5 | 10 | 30 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 40 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 25 | 15 | 30 | 65 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 10 | 10 | 90 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 10 | 50 | 50 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 25 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 | 0 | 5 | 35 | 50 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 35 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 50 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 20 | 95 | 5 | 0 |
| 1 | 0 | 2 | 0 | 1 | 1 | 5 | 35 | 25 | 75 | 25 | 0 |
| 0 | 0 | 1 | 0 | 4 | 0 | 0 | 60 | 20 | 65 | 30 | 5 |
| 0 | 0 | 0 | 0 | 4 | 0 | 60 | 55 | 40 | 90 | 10 | 0 |
| 0 | 0 | 1 | 0 | 7 | 0 | 40 | 60 | 65 | 90 | 10 | 0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 2 | 0 | 0 | 25 | 25 | 70 | 30 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 15 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 15 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 10 | 90 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 15 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 15-20 | 45 | 45 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 25 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 40 | 90 | 10 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 40 | 5-10 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 25 | 5-10 | 80 | 15 | 5 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 30 | 5 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0-5 | 40 | 25 | 80 | 15 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0-5 | 20 | 20 | 75 | 25 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 10 | 100 | 0 | 0 |
| 0 | 0 | 2 | 0 | 0 | 0 | 0 | 20 | 15-20 | 80 | 20 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 5 | 20 | 35 | 80 | 15 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 10 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 40 | 20 | 75 | 20 | 5 |
| 0 | 0 | 0 | 0 | 2 | 0 | 0 | 25 | 40 | 75 | 20 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15-20 | 10 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 10 | 10 | 95 | 5 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 | 10 | 90 | 10 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 5 | 15 | 10 | 85 | 10 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0-5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 | 15 | 20 | 100 | 0 | 0 |
| 0 | 0 | 2 | 0 | 3 | 0 | 5 | 15 | 20 | 75 | 15 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 100 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 10 | 5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 5-10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 15 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0-5 | 25 | 20 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 30 | 40 | 50 | 40 | 10 |
| 0 | 0 | 0 | 0 | 1 | 0 | 20 | 35 | 45 | 55 | 25 | 20 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 20 | 10-15 | 100 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 10-15 | 5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 20 | 40 | 70 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10-15 | 5-10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 20 | 35 | 30-35 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 10 | 10 | 20 | 75 | 15 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5-10 | 10 | 10 | 85 | 15 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 | 15 | 70 | 25 | 5 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 10 | 15 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 30 | 10 | 80 | 15 | 5 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 25 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 20 | 80 | 15 | 5 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0-5 | 25 | 35 | 70-75 | 20-25 | 5-10 |
| **2** | 0 | **6** | 0 | 0 | 0 | 5-10 | 25 | 75 | 55 | 35 | 10 |
| 0 | 0 | **1** | 0 | 0 | 0 | 0 | 60 | 85 | 100 | 0 | 0 |
| 0 | 0 | **1** | 0 | 1 | 0 | **15** | 50 | 50 | 40 | 30 | 30 |
| 0 | 0 | **1** | 0 | 0 | **2** | **15** | 40 | 65 | 55 | 35 | 10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 35 | 40 | 90 | 10 | 0 |
| **1** | 0 | **1** | 0 | 1 | **2** | 0 | 40 | 65 | 50 | 30 | 30 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 25 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 15 | 100 | 0 | 0 |
| 0 | 0 | **1** | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | **25** | 50 | 80 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 2 | 0 | 5-10 | 65 | 90 | 35 | 50 | 15 |
| 0 | 0 | 0 | 0 | 0 | 0 | **10-15** | 100 | 100 | 0 | 10 | 90 |
| 0 | 0 | **1** | 0 | 2 | 0 | 0 | 20 | 40 | 85 | 15 | 0 |
| 0 | 0 | **5** | 0 | 0 | 0 | 0 | 20 | 25 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0-5 | 35 | 75 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 5 | 35 | 90 | 65 | 25 | 10 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 10 | 25 | 80 | 10 | 10 |
| 0 | 0 | **1** | 0 | **8** | 0 | 0 | 40 | 40 | 20 | 0 | 0-5 |
| 0 | 0 | 0 | 0 | 0 | 0 | **25** | 45 | 100 | 40 | 15 | 45 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5-10 | 0 | 60 | 25 | 15 |
| 0 | 0 | **1** | 0 | 1 | 0 | 0 | 80 | 25 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 | 35 | 50-60 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 | 45 | 75 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 40 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 30 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 60 | 100 | 0 | 0 |
| **1** | 0 | **1** | 0 | 1 | 0 | 0 | 45 | 10 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 70 | 20 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 50 | 10 | 60 | 40 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 45 | 25 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | **25** | 45 | 50 | 10 | 90 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0-10 | 0-10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 5-10 | 100 | 0 | 0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10-15 | 5-10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | **50** | 60 | 70 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 10 | 30 | 25 | 95 | 5 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 30 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | **5** | 0 | **50** | 45 | 75 | 20 | 50 | 30 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 30 | 20 | 90 | 10 | 0 |
| 0 | 0 | **1** | 0 | 0 | 0 | **20** | 20 | 40 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 90 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 35 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 20 | 90 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 10 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 25 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 0 | 0 |
| 0 | 0 | **2** | 0 | 0 | 0 | 0 | 10 | 50 | 100 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 10 | 50 | 100 | 50 | 40 | 10 |

## LOCATION

| #FILLSLP | FLS.SLP N | CTSLP ERSN | SLP ST | ERODABILITY | %RD PRL RIP | %UP SLOPE | %MIDSLP | %LWR SLP | #fact | miles | Hazard |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0-5 | LOW | 0 | LOW | 0 | 0 | 0 | 100 | | 0.31 | 0 |
| 0 | 5 | **MED** | 0 | LOW | **10** | 0 | 0 | 100 | 1 | 1.09 | 10 |
| 0 | 5 | LOW | 0 | LOW | 0 | 0 | 90 | 10 | | 0.48 | 0 |
| 0 | 5 | LOW | 0 | LOW | 0 | 0 | 90 | 10 | | 0.48 | 0 |
| 0 | 10 | LOW | 0 | LOW | **5** | 0 | 90 | 10 | 0 | 1.28 | 0 |
| 0 | 10 | LOW | 0 | LOW | **10** | 0 | 100 | 0 | 3 | **2.07** | **30** |
| 0 | 5 | LOW | 0 | MED | 0 | 0 | 10 | 90 | | 0.54 | 0 |
| 0 | 5-10 | LOW | 0 | MED | 0 | 100 | 0 | 0 | | 0.41 | 0 |
| 0 | 5-10 | LOW | 0 | MED | **10** | 0 | 0 | 100 | 3 | **0.46** | **30** |
| 0 | **20** | LOW | 0 | MED | 0 | 100 | 0 | 0 | | 0.19 | 0 |
| **1** | 0-5 | LOW-MED | 0 | MED | **5** | 50 | 50 | 0 | 5 | **1.55** | **25** |
| 0 | 0 | LOW | 0 | LOW | 0 | 80 | 20 | 0 | | 0.12 | 0 |
| 0 | 0-5 | LOW | 0 | LOW-MED | 0 | 100 | 0 | 0 | | 0.11 | 0 |
| 0 | 0-5 | LOW | 0 | LOW-MED | 0 | 100 | 0 | 0 | | 0.17 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.07 | 0 |
| 0 | 0-5 | LOW | 0 | MED | **90** | 75 | 25 | 0 | 1 | 0.64 | **90** |
| 0 | 0-5 | LOW | 0 | MED | **80** | 90 | 10 | 0 | 0 | 1.59 | 0 |
| **1** | 0-5 | LOW | 0 | MED | **5** | 0 | 50 | 50 | 2 | 2.96 | 10 |
| 0 | 0 | LOW | 0 | LOW | **5** | 90 | **10** | 0 | 0 | 1.14 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.37 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.4 | 0 |
| 0 | 0 | LOW | 0 | LOW | **5** | 100 | 0 | 0 | 0 | 0.33 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | **5** | 100 | 0 | 0 | 0 | 0.42 | 0 |
| 0 | 5 | LOW-MED | 0 | MED | 0 | 90 | 10 | 0 | | 0.28 | 0 |
| 0 | 0 | **MED** | 0 | MED | 0 | 80 | 20 | 0 | | 0.7 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 50 | 50 | 0 | | 1.04 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.11 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | **50** | 0 | 100 | 0 | 1 | **0.33** | **50** |
| 0 | 0-5 | LOW-MED | 0 | LOW-MED | **10** | 0 | 70 | 30 | 0 | 0.99 | 0 |
| 0 | 0 | LOW-MED | 0 | LOW-MED | **95** | 0 | 100 | 0 | 0 | 0.13 | 0 |
| **1** | 5 | LOW | 0 | LOW | **5** | 30 | 70 | 0 | 1 | 0.27 | 5 |
| 0 | 5 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.1 | 0 |
| **1** | 5-10 | LOW | 0 | MED | 0 | 20 | 80 | 0 | | 0.83 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | **5** | 90 | 10 | 0 | 0 | 1.38 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.3 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.6 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.26 | 0 |
| 0 | 0-5 | **MED** | 0 | MED | 0 | 60 | 40 | 0 | | 1.13 | 0 |
| 0 | 0-5 | **MED** | 0 | MED | **10** | 80 | 20 | 0 | 3 | **0.56** | **30** |
| 0 | 5 | LOW | 0 | MED | **20** | 100 | 0 | 0 | 2 | **0.23** | **40** |
| 0 | 5 | LOW | 0 | MED | **100** | 100 | 0 | 0 | 5 | 0.6 | **500** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 5 | LOW | 0 | MED | 100 | 0 | 0 | 100 | 0 | 1.35 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 100 | 0 | 0 | 100 | 0 | 0.59 | 0 |
| 0 | 5 | LOW | 0 | LOW | 100 | 0 | 40 | 60 | 0 | 0.25 | 0 |
| 0 | 5-10 | LOW | 0 | LOW | 35 | 40 | 60 | 0 | 1 | 1.3 | 35 |
| 0 | 0-5 | LOW | 0 | LOW | 10 | 50 | 50 | 0 | 1 | 0.76 | 10 |
| 0 | 0-5 | LOW | 0 | LOW | 0 | 80 | 20 | 0 | | 1.92 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 100 | 90 | 10 | 0 | 0 | 0.18 | 0 |
| 1 | 0-5 | LOW | 0 | LOW | 0 | 60 | 40 | 0 | | 1.16 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 25 | 70 | 30 | 0 | 1 | 0.37 | 25 |
| 0 | 0-5 | LOW | 1 | MED | 5-10 | 20 | 30 | 0 | 1 | 1.38 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.21 | 0 |
| 0 | 0 | LOW | 0 | MED | 0 | 10 | 90 | 0 | | 0.78 | 0 |
| 1 | 0 | LOW | 0 | MED | 15 | 0 | 100 | 0 | 1 | 0.83 | 15 |
| 0 | 0-5 | LOW | 0 | MED | 0 | 0 | 100 | 0 | | 0.25 | 0 |
| 1 | 0-5 | LOW | 0 | LOW | 20 | 10 | 90 | 0 | 4 | 0.61 | 80 |
| 2 | 0-5 | LOW | 0 | HIGH | 5 | 70 | 30 | 0 | 5 | 1.14 | 25 |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.19 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.14 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 15 | 60 | 40 | 0 | 2 | 0.94 | 30 |
| 0 | 0-5 | LOW | 0 | LOW | 95 | 60 | 40 | 0 | 0 | 0.88 | 0 |
| 0 | 0-5 | LOW | 0 | LOW-MED | 20 | 90 | 10 | 0 | 0 | 1.52 | 0 |
| 1 | 0 | LOW | 0 | LOW | 70 | 90 | 10 | 0 | 2 | 0.69 | 140 |
| 0 | 0-5 | LOW | 0 | LOW | 90 | 0 | 20 | 80 | 1 | 0.76 | 90 |
| 0 | 0-5 | LOW | 0 | LOW | 5 | 60 | 40 | 0 | 1 | 1.8 | 5 |
| 0 | 0 | LOW | 0 | MED | 85 | 100 | 0 | 0 | 2 | 0.06 | 170 |
| 0 | 0 | LOW | 0 | HIGH | 15 | 100 | 0 | 0 | 2 | 0.1 | 30 |
| 0 | 0-5 | LOW | 0 | LOW | 65 | 100 | 0 | 0 | 1 | 0.22 | 65 |
| 0 | 0-5 | LOW | 0 | MED | 20 | 0 | 100 | 0 | 3 | 0.75 | 60 |
| 0 | 0 | MED | 0 | MED | 5 | 0 | 100 | 0 | 5 | 0.08 | 25 |
| 0 | 0 | N/A | 0 | N/A | N/A | 0 | 100 | 0 | | 0.03 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.2 | 0 |
| 0 | 0 | LOW | 0 | LOW | 40 | 0 | 100 | 0 | 1 | 0.19 | 40 |
| 0 | 0 | LOW | 0 | LOW | 10 | 0 | 100 | 0 | 0 | 0.2 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 90 | 0 | 100 | 0 | 0 | 0.42 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.74 | 0 |
| 0 | 0-5 | LOW | 0 | MED DG | 50 | 0 | 100 | 0 | 0 | 1.32 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 60 | 0 | 40 | 60 | 2 | 0.42 | 120 |
| 0 | 0-5 | LOW | 0 | LOW | 65 | 10 | 90 | 0 | 1 | 0.63 | 65 |
| 0 | 5 | LOW | 0 | LOW-MED | 0 | 70 | 30 | 0 | | 0.7 | 0 |
| 0 | 10 | LOW | 0 | LOW-MED | 10 | 0 | 100 | 0 | 2 | 0.55 | 20 |
| 0 | 0 | LOW | 0 | MED | 100 | 0 | 100 | 0 | 2 | 0.19 | 200 |
| 0 | 0-5 | LOW | 0 | MED | 20 | 75 | 25 | 0 | 2 | 0.69 | 40 |
| 1 | 0 | LOW | 0 | LOW | 15 | 0 | 70 | 30 | 3 | 1.46 | 45 |
| 0 | 0 | LOW | 0 | LOW | 0 | 5 | 95 | 0 | | 0.69 | 0 |
| 1 | 0-5 | LOW | 0 | LOW-MED | 5 | 25 | 75 | 0 | 3 | 0.61 | 15 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | LOW | 0 | LOW | **100** | 15 | 85 | 0 | 3 | 0.31 | **300** |
| 0 | 0 | LOW | 0 | LOW-MED | **15** | 75 | 25 | 0 | 2 | 0.4 | 30 |
| 0 | 0 | LOW | 0 | LOW | **10** | 0 | 10 | 90 | 2 | 0.32 | 20 |
| 0 | 0 | LOW | 0 | LOW | **0-5** | 0 | 10 | 90 | 2 | 0.29 | 0 |
| 0 | 0 | LOW | 0 | MED | 0 | 30 | 70 | 0 | | 0.41 | 0 |
| 0 | 0 | LOW | 0 | LOW | **5** | 0 | 100 | 0 | 0 | 0.46 | 0 |
| 0 | 0-5 | LOW | 0 | MED | **40** | 65 | 35 | 0 | 0 | 1.22 | 0 |
| 0 | 0-5 | LOW | 0 | LOW-MED | **10** | 15 | 85 | 0 | 3 | **2.27** | **30** |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.62 | 0 |
| 0 | 0 | LOW | 0 | LOW | **20** | 70 | 30 | 0 | 2 | **2.33** | **40** |
| 0 | 0 | LOW | 0 | LOW | **45** | 90 | 10 | 0 | 3 | 2.24 | **135** |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.47 | 0 |
| 1 | 0-5 | **MED** | 0 | MED | **30** | 0 | 90 | 10 | 4 | 0.45 | **120** |
| 0 | 0 | LOW | 0 | LOW | **10** | 100 | 0 | 0 | 0 | 0.26 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.37 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.8 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.69 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.75 | 0 |
| 0 | 0 | LOW | 0 | LOW | **10** | 0 | 100 | 0 | 0 | 0.51 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | **10** | 0 | 100 | 0 | 1 | 0.1 | 10 |
| 0 | 0 | LOW | 0 | LOW | **10** | 10 | 90 | 0 | 1 | 1.03 | 10 |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 1.18 | 0 |
| 0 | 0 | LOW | 0 | LOW | **50** | 40 | 60 | 0 | 0 | 0.57 | 0 |
| 0 | 0 | LOW | 0 | LOW | **20** | 0 | 100 | 0 | 0 | 0.42 | 0 |
| 0 | 0-5 | LOW | 0 | LOW | **50** | 0 | 100 | 0 | 0 | 0.17 | 0 |
| LOW | 0 | LOW | 0 | LOW | **10** | 40 | 60 | 0 | 2 | **1.16** | **20** |
| 0 | 5-10 | LOW | 0 | LOW | **25** | 0 | 100 | 0 | 3 | 0.38 | **75** |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.46 | 0 |
| 0 | 0 | LOW | 0 | LOW | **5** | 40 | 60 | 0 | 3 | 0.61 | 15 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.27 | 0 |
| 0 | 0 | LOW | 0 | LOW | **5** | 100 | 0 | 0 | 2 | 1.05 | 10 |
| 0 | 0 | LOW | 0 | LOW | **20** | 80 | 20 | 0 | 2 | **0.28** | **40** |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.04 | 0 |
| 0 | 0 | LOW | 0 | LOW | **40** | 20 | 80 | 0 | 2 | 0.34 | **80** |
| 0 | 0 | LOW | 0 | LOW | **100** | 10 | 90 | 0 | 2 | 0.1 | **200** |
| **1** | 0 | **MED** | 0 | MED | 0 | 90 | 10 | 0 | | 0.17 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 100 | 0 | 0 | | 0.1 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 0 | 100 | 0 | | 0.17 | 0 |
| 9 | 0 | **MED** | 0 | HIGH | **10-15** | 0 | 100 | 0 | 2 | 0.9 | 0 |
| 1 | 0 | LOW | 0 | MED | **0-5** | 60 | 40 | 0 | 3 | 0.62 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 25 | 75 | 0 | | 0.28 | 0 |
| 0 | 0 | LOW | 0 | LOW | **25** | 0 | 100 | 0 | 0 | 0.11 | 0 |
| 0 | 0 | LOW | 0 | LOW | **20** | 50 | 50 | 0 | 2 | **0.57** | **40** |
| 0 | 0 | LOW | 0 | LOW-MED | 0 | 15 | 85 | 0 | | 0.35 | 0 |
| 0 | 0 | LOW | 0 | LOW | **5** | 20 | 80 | 0 | 1 | 0.4 | **5** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | LOW | 0 | MED | **100** | 0 | 100 | 0 | 2 | 0.19 | **200** |
| 0 | 0 | LOW | 0 | DG | **20** | 100 | 0 | 0 | 2 | **0.12** | **40** |
| 0 | 0 | LOW | 0 | MED | 0 | 35 | 65 | 0 | | 0.4 | 0 |
| **1** | 0 | LOW | 0 | LOW | **90** | 70 | 30 | 0 | **1** | 0.41 | **90** |
| 0 | 0 | **MED** | 0 | MED | **5** | 100 | 0 | 0 | 3 | 0.28 | 15 |
| 0 | 0 | LOW | 0 | LOW | **80** | 70 | 30 | 0 | 2 | 0.77 | **160** |
| 0 | 0 | LOW | 0 | LOW | 0 | 80 | 20 | 0 | | 0.22 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 80 | 20 | 0 | | 0.22 | 0 |
| 0 | 0 | LOW | 0 | LOW | 0 | 40 | 60 | 0 | | 0.19 | 0 |
| 0 | 0 | LOW | 0 | LOW | **100** | 0 | 100 | 0 | 0 | 0.13 | 0 |
| 0 | 0 | LOW | 0 | LOW | **0-5** | 0 | 100 | 0 | 0 | 0.05 | 0 |
| 0 | 0 | LOW | 0 | LOW | **10** | 0 | 100 | 0 | 0 | 0.26 | 0 |
| | | | | | | | | | 2 | | 0 |
| 0 | 0 | LOW | 0 | MED | **10-15** | 0 | 40 | 60 | 3 | 0.26 | 0 |
| 0 | 0 | LOW | 0 | MED | **100** | 0 | 40 | 60 | 2 | 0.12 | **200** |
| 0 | 0 | LOW | 0 | LOW | **5** | 100 | 0 | 0 | 2 | 0.45 | **10** |
| 0 | 0 | LOW | 0 | LOW | **5** | 100 | 0 | 0 | 2 | 0.25 | **10** |
| 0 | 0 | LOW | 0 | MED | **10** | 100 | 0 | 0 | 2 | **0.63** | **20** |
| 0 | 0 | N/A | 0 | N/A | 0 | 0 | 0 | 0 | | 0 | 0 |
| 0 | 0 | LOW | 0 | LOW | **10** | 20 | 80 | 0 | 2 | 0.42 | 20 |

| BLOCKS |
|---|
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| M.P. 0.05 GUARDRAIL |
| M.P. 0.19 BRUSH |
| NONE |
| M.P. 2.06 LOG |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| M.P. 0.05 STEEL |
| M.P. 1.06 STEEL |
| M.P.1.18 GUARDRAIL |
| M.P. 0.79 STEEL |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| 1.13 EARTH |
| NONE |
| NONE |
| NONE |

NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
M.P. 0.37 EARTH
NONE
M.P. 0.22 EARTH WATER BAR
M.P. 0.03 GUARDRAIL
NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
M.P. 3.09 SINK, POSSIBLE SLIDE
NONE
NONE
M.P. 2.70 LOG
NONE
NONE
NONE
NONE
0.03 ROCKS
M.P. 0.20 LOG AND EARTH
M.P. 0.19 LOG & EARTH
NONE
NONE
M.P. 0.74 EARTH
NONE
NONE
NONE
NONE
NONE
NONE
NONE
M.P. 0.02 STEEL
NONE
NONE

M.P. 0.31 LOG & EARTH
NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
M.P. 0.45 MAJOR SLIDE/ FILL SLOPE I
NONE
M.P. 0.13 LOG
M.P. 0.07 STEEL
M.P. O.09 TREE
NONE
NONE
NONE
NONE
M.P. 0.34 ROAD WASHED OUT
NONE
NONE
NONE
NONE
NONE
M.P. 0.46 GUARDRAIL
NONE
M.P. 0.03 STEEL
NONE
M.P. 0.01 LOG & EARTH
M.P. 0.01 LOG & EARTH
SEE NARRATIVE
M.P. 0.01 LOG
M.P. 0.20 ROCK
M.P. 0.01 LOG & EARTH
SEE NARRATIVE
M.P. 0.36 LOG
M.P. 1.00 EARTH
M.P. 0.07 STEEL
NONE
M.P. O.01 LOG & EARTH
M.P. 0.10 LARGE WATER BAR
SEE NARRATIVE

NONE
NONE
NONE
SEE NARRATIVE
NONE
SEE NARRATIVE
M.P. 0.07 LOG & EARTH
SEE NARRATIVE
0.00 LOG
NONE
NONE
M.P. 0.26 STEEL

M.P. 0.52 LOG & EARTH
M.P. 0.52 LOG & EARTH
NONE
NONE
NONE
SEE NARRATIVE
NONE

| NARRATIVE |
|---|
| NONE |
| NONE |
| NONE |
| NONE |
| SEEP AT M.P. 2.51 RIGHT SIDE ON CUT BANK; ROCK QUARRY |
| SPRING AT 0.98 |
| NONE |
| NEEDS BRUSHING, NO CULVERTS |
| **ROAD BLOCKED BY A MAJOR CUT-BANK SLIDE AT 0.46** |
| **POSSIBLE DECOMISHINING, OVERGROWN BY CONIFER TREES, BRUSH IN ROAD, RECOMMEND WATER BAR AND BLOCK, NO CULVERTS** |
| NONE |
| NONE |
| **NO CULVERTS** |
| **CULVERT AT M.P. 0.12 OUTLET IS CLOGGED** |
| **NO CULVERTS** |
| NONE |
| **CULVERT INLET AT M.P. 1.11 AND 1.19 NEEDS CLEANING** |
| **OVERGROWN,M.P.1.15 ON ROAD, NEED HYDRO SEEDING IN GRANETICS, OLD COACH AT .12, 0.10 CULVERT INLET WAS CLOGGED** |
| NONE |
| **M.P. 4.12 CULVERT IS PLUGGED** |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| NONE |
| **OVERGROWN, NEEDS BRUSHING, ALMOST NATURAL, NO CULVERTS** |
| NONE |
| NONE |
| NONE |
| NONE |
| M.P. 0.03 GARBAGE |
| M.P. O.26 ROCK QUARRY |
| NONE |
| NONE |
| NEEDS BRUSHING |
| NEEDS BRUSHING |
| **M.P. 0.07 CULVERT OUTLET IS PINCHED CLOSED, 0.77 SINK HOLE IN MIDDLE OF ROAD. 1.13 ROAD ENDS. PART OF SEG A & ALL OF SEG B. ARE OVERGF** |
| NONE |
| **AT ONE TIME THE ROAD COULD HAVE BEEN DITCED BUT DUE TO SOME CUT BANK SLIDES IT APPEARS TO NOW BE FLAT.** |
| NONE |

NONE
NONE
NONE
NONE
NONE
NONE
NONE
NONE
**SEG. B IS BLOCKED**
POND AT M.P. 0.55
NONE
SOME CUTBANK AREAS MAY NEED HYDRO-SEEDING
NONE
NONE
**M.P.1.40 POND, CLOGGED PIPE, WET AREA AT M.P. 1.48**
**m.P. 1.91 AND 1.95 WATER DIPS WERE ALMOST LIKE SINKING, ERODING, DITCHES OR DIPS CAUSED BY A MAJOR SLIDE.**
**NO CULVERTS, POORLY DRAINED, 4-10" RUTS, PSSIBLE DECOM.**
NONE
M.P. 0.04 SMALL FALLEN TREE IN ROAD
NONE
NONE
**ROAD WAS BLOCKED AND UNABLE TO CONTINUE, COULD BE A SLIDE AND OR FILL SLOPE FAILURE AND EROSION**
NONE
NONE
NONE
NONE
NONE
NONE
NONE
BLOCKED BY ROCK QUARRY NO EVIDENCE OF A ROAD
SEG. B IS BLOCKED
SEG B IS BLOCKED
ROAD IS OVERGROWN WITH GRASS
NEEDS BRUSHING IF GOING TO BE USED
WATER BAR BLOCK AT 0.74, NEEDS BRUSHING IF GOING TO BE USED
M.P. 0.49 OVERHEAD HAZARD
NONE
NONE
NONE
NONE
**SEG B IS BLOCKED, 'ROAD EROSION AT M.P. 0.13, CULVERT RECOMMENDED OR A BETTER DITCH**
NONE
**M.P. 0.58 MAJOR FILL SLOPE FAILURE/SLIDE; ROAD HEAVILY VEG.; NEVER USED; SOME PLACES ROAD IS DITCHED, YET IN MOST IT ISN'T.**
SEVERAL WATER DIPS
**M.P. 0.46 EITHER EROSION OR DIP "FILL SLOPE FAILURE"**

**ROAD PROBABLY BLOCKED DUE TO SEVERE DITCHLINE EROSION**
NONE
NONE
NONE
**M.P. 0.30 WATER DIP DUE TO A SINK AND TRUCK RUTS**
NONE
M.P. 1.98 TREE FALLEN OVER ABOVE
NONE
NONE
M.P. 1.62 QUARRY
**M.P. 4.36 QUARRY; SEVERAL PIPES ARE BURIED**
NONE
**M.P. 0.45 SLIDE HAS WASHED OUT ROAD**
M.P. 0.04 QUARRY
**IF THE ROAD WASN'T ERODING, IT WAS YIELDING. THIS ROAD COULD ALMOST BE NATURAL. NO CULVERTS**
GATE IS BANGED UP AND BARELY HANGING OFF IT'S HINGES
POND AT M.P. 0.48
NONE
NONE
NONE
NONE
**ROAD IS WASHED OUT**
NONE
NONE
NONE
NONE
**NO CULVERTS**
NEEDS BRUSHING; ROAD BLOCKED GOING INTO USFS LAND
**M.P. 0.19 SEEP CAUSED A SLIDE**
NONE
**YIELDING DUE TO HEAVY TRACTOR OR VEHICLE USAGE**
UNABLE TO DRIVE; 0.11-0.15 & 0.24-0.27 NUMEROUS FALLEN TREES
UNABLE TO DRIVE; 0.02 FALLEN TREES
**UNABLE TO DRIVE; M.P. CREEK DIP; 0.20, 0.23, 0.26, 0.29 0.32 WATER BARS; 0.25 & 0.29 FALLEN TREES; 0.34 EROSIONS COULD HAVE CONTINUED BUT VE**
**UNABLE TO DRIVE; M.P. '0.04 ROAD IS EXTREMLY STEEP, 0.07 SMALL TREE IN ROAD & FALLEN TREES.**
**UNABLE TO DRIVE; 'M.P. 0.25 SMALL TREES GROWING; 0.29 FILL SLOPE FAILURE; 0.35 LOG BLOCK; 0.36 WET AREA; 0.37 MAJOR SLIDE, NO DESTINCTIVE**
UNABLE TO DRIVE; 'M.P. O.02 TREE STUMPS BLOCKING ROAD; 0.06 SMALL TREES GROWING, LARGE FALLEN TREE; 0.07 FALLEN BURNT TREE; 0.08 SMALL
UNABLE TO DRIVE; 'M.P. 0.23, 0.34, 0.35, 0.36 FALLEN TREES; 0.31 ROCK BLOCK; 0.23 ON, TREES ARE GROWING IN THE ROAD
**M.P. 0.36 FILL SLOPE FAILURE/ EROSION; 0.37, 0.39, 0.41, 0.73, 0.81, 0.88 BIG FILL SLOPE FAILURE; 0.74 ROAD IS WASHED OUT/ UNABLE TO DRIVE**
**UNABLE TO DRIVE; M.P. 0.99 FILL SLOPE FAILURE**
M.P. 0.27 FALLEN LOG; BOULDERS FALLING INTO ROAD
NOT FUNCTIONING AS A ROAD; THERE IS NO DESTINCTIVE INDICATION OF A ROAD
M.P. 0.02-0.03, 0.06 BUSHES; 0.02, 0.45 WATER DIP; 0.06 ROAD IS BASICALLY A TRAIL; 0.29 RUN OFF DITCH IN ROAD; 0.33,0.57 FALLEN & GROWING TREES; 0
**UNABLE TO DRIVE; M.P. 0.15 & 0.22 DRIED CREEK ERODING RD.; 0.17 TREES GROWING IN ROAD; 0.17 BUSHES; 0.22 FALLEN TREE; 0.28 TREE BLOCKING F**
**M.P. 0.43 DRIED CREEK BED IN ROAD; 0.47 TREES; 0.52 CLEARING WITH TREES GROWING IN ROAD; 0.53 LOG BLOCK; 0.55 CUT TREES IN ROAD FROM CLE**

NONE

**M.P. 0.22 ROAD EROSION; CULVERT NEEDED OR A BETTER DITCH; 0.26 HEAVY ROAD EROSION**

**UNABLE TO DRIVE, LARGE AMOUNTS OF EROSION; 0.05 & 0.16 SMALL TREES GROWING; 0.11 LARGE FALLEN TREES; 0.14 FALLEN TREE; 0.17 HARD TO D**

UNABLE TO DRIVE; M.P. 0.37 SMALL TREES GROWING IN ROAD; 0.02 FALLEN LOG CAN'T PASS; NEEDS BRUSHING

OVERGROWN; 0.10 & 0.16 SLIDE; 0.21 ROCK QUARRY

**UNABLE TO DRIVE; M.P. 0.01 MAJOR ROAD EROSION, DITCH NEEDED; 0.17 & 0.51 FALLEN TREE; 0.41 OVER GROWN TREES HANGING DOWN**

UNABLE TO DRIVE; M.P. 0.05 TREE IN ROAD; 0.19 LOG IN ROAD; 0.20 WET AREA

UNABLE TO DRIVE; OVERGROWN; M.P. 0.01 TREE FALLEN OVER; 0.07 SMALL TREE GROWING; O.09 COMPLETELY OVERGROWN WITH LARGE TREES

UNABLE TO DRIVE; OVERGROWN; M.P. 0.01 FALLEN TREE; 0.02 SMALL TREES GROWING; 0.11 SMALL TREE GROWING; 0.15-0.17 SMALL TREES GROWING

**UNABLE TO DRIVE; M.P. O.OO DITCHLINE EROSION FROM MAIN HIGHWAY ON ROAD; 0.01 TREES; 0.01, 0.02, 0.12 FALLEN TREES; GIG TREES GROWING IN**

UNABLE TO DRIVE; M.P. 0.01 BUSHES IN ROAD; 0.02 LOG; 0.03 BIG BUSHES; HEAVILY OVERGROWN; BARRICADE OF BUSHES THAT ARE IMPOSSIBLE TO WA

PRIVATE GATE AT M.P. 0.26

ON PRIVATE LAND

**UNABLE TO DRIVE; DITCHLINE EROSION HAS WASHED OUT ROAD AT BEGINING; M.P. 0.06, 0.07, 0.11 FALLEN TREES; 0.12 TREE GROWING; ROAD CONT. C**

**VEHICLE CAME THROUGH ROAD WHEN IT WAS MUDDY LEAVING SEVERE RUTS IN A PORTION OF THIS SEG. NO CULVERTS**

**LOTS OF DEEP RUTS**

**M.P. 0.80 SPRING CAUSING WATER TO RUN DOWN ROAD/ ALSO A PUMP CHANCE; M.P. 0.80-0.86 WET AREA OR SPRING IS CAUSING THE WATER TO EROD**

UNABLE TO DRIVE; BLOCKED BY A PRIVATE FENCE; IT IS DIFFICULT TO DETERMINE WHICH ROAD COULD BE CONNECTING TO A BLM ROAD.

SEG. B NEEDS TO BE CHANGED TO AGREEMENT CO.

# APPENDIX C

# HYDROLOGY

Table C-1. Acreage by Precipitation Zone and Cover Type - Current Conditions

Chicago Creek sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 126 | 466 | 102 | 694 |
| intermediate | 114 | 571 | 99 | 784 |
| immature | 19 | 100 | 13 | 132 |
| non-forested | 18 | 168 | 61 | 247 |
| Total | 277 | 1,305 | 275 | 1,857 |

Lower East Fork sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 532 | 654 | 12 | 1,198 |
| intermediate | 1,103 | 626 | 2 | 1,731 |
| immature | 183 | 101 | 1 | 285 |
| non-forested | 777 | 189 | 13 | 979 |
| Total | 2,595 | 1,570 | 28 | 4,193 |

Lower Trail Creek sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 308 | 470 | 0 | 778 |
| intermediate | 1,250 | 966 | 1 | 2,217 |
| immature | 195 | 114 | 0 | 309 |
| non-forested | 1,755 | 445 | 0 | 2,200 |
| Total | 3,508 | 1,995 | 1 | 5,504 |

Lower West Fork sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 1,015 | 1,285 | 17 | 2,317 |
| intermediate | 2,026 | 2,001 | 19 | 4,046 |
| immature | 336 | 241 | 3 | 580 |
| non-forested | 1,134 | 668 | 22 | 1,824 |
| Total | 4,511 | 4,195 | 61 | 8,767 |

Table C-1. (continued)

Upper East Fork sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 191 | 1,583 | 467 | 2,241 |
| intermediate | 346 | 1,116 | 390 | 1,852 |
| immature | 77 | 236 | 91 | 404 |
| non-forested | 245 | 526 | 317 | 1,088 |
| Total | 859 | 3,461 | 1,265 | 5,585 |

Upper West Fork sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 170 | 1,164 | 398 | 1,732 |
| intermediate | 204 | 622 | 337 | 1,163 |
| immature | 38 | 124 | 54 | 216 |
| non-forested | 55 | 328 | 175 | 558 |
| Total | 467 | 2,238 | 964 | 3,669 |

Wall Creek sub-watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 296 | 1,376 | 642 | 2,314 |
| intermediate | 300 | 1,343 | 520 | 2,163 |
| immature | 47 | 200 | 89 | 336 |
| non-forested | 81 | 565 | 271 | 917 |
| Total | 724 | 3,484 | 1,522 | 5,730 |

Trail Creek Watershed

| Maturity Class | Precipitation Zone | | | Total |
|---|---|---|---|---|
| | Lowland | Rain | R-O-S | |
| mature | 2,638 | 6,998 | 1,638 | 11,274 |
| intermediate | 5,343 | 7,245 | 1,368 | 13,956 |
| immature | 895 | 1,116 | 251 | 2,262 |
| non-forested | 4,065 | 2,889 | 859 | 7,813 |
| Total | 12,941 | 18,248 | 4,116 | 35,305 |

Table C-2. 24-hour Precipitation

| Recurrence interval (yrs) | 24-hour precipitation (in) |
|---|---|
| 2 | 2.6 |
| 5 | 3.6 |
| 10 | 4.5 |
| 100 | 8.2 |

Table C-3. USGS Streamflow Relationships

| Recurrence interval (yrs) | Streamflow (cfs) |
|---|---|
| 2 | $24.2\ A^{0.86}\ I^{1.15}\ (S+1)^{-1.16}$ |
| 5 | $36.0\ A^{0.88}\ I^{1.15}\ (S+1)^{-1.25}$ |
| 10 | $44.8\ A^{0.88}\ I^{1.14}\ (S+1)^{-1.28}$ |
| 100 | $77.3\ A^{0.90}\ I^{1.08}\ (S+1)^{-1.34}$ |

A = drainage area ($mi^2$)
I = 24-hour precipitation for 2-year recurrence interval (in)
S = proportion of drainage area occupied by lakes and ponds

Table C-4. Streamflow vs. 24-hour Precipitation Regression Relationships

| Sub-watershed | Streamflow relationship |
|---|---|
| Chicago Creek | $Q_r = 66.4\ P_r + 30$ |
| Lower East Fork | $Q_r = 141\ P_r + 43$ |
| Lower Trail Creek | $Q_r = 181\ P_r + 47$ |
| Lower West Fork | $Q_r = 277\ P_r + 51$ |
| Upper East Fork | $Q_r = 183\ P_r + 47$ |
| Upper West Fork | $Q_r = 124\ P_r + 41$ |
| Wall Creek | $Q_r = 187\ P_r + 47$ |
| Trail Creek Watershed | $Q_r = 997\ P_r - 31$ |

$Q_r$ = streamflow for return period of r years (cfs)
$P_r$ = 24-hour precipitation for return period of r years (in)

**Figure C-1. Acreage by Precipitation Zone and Cover Type, Current Conditions - Trail Creek Watershed**

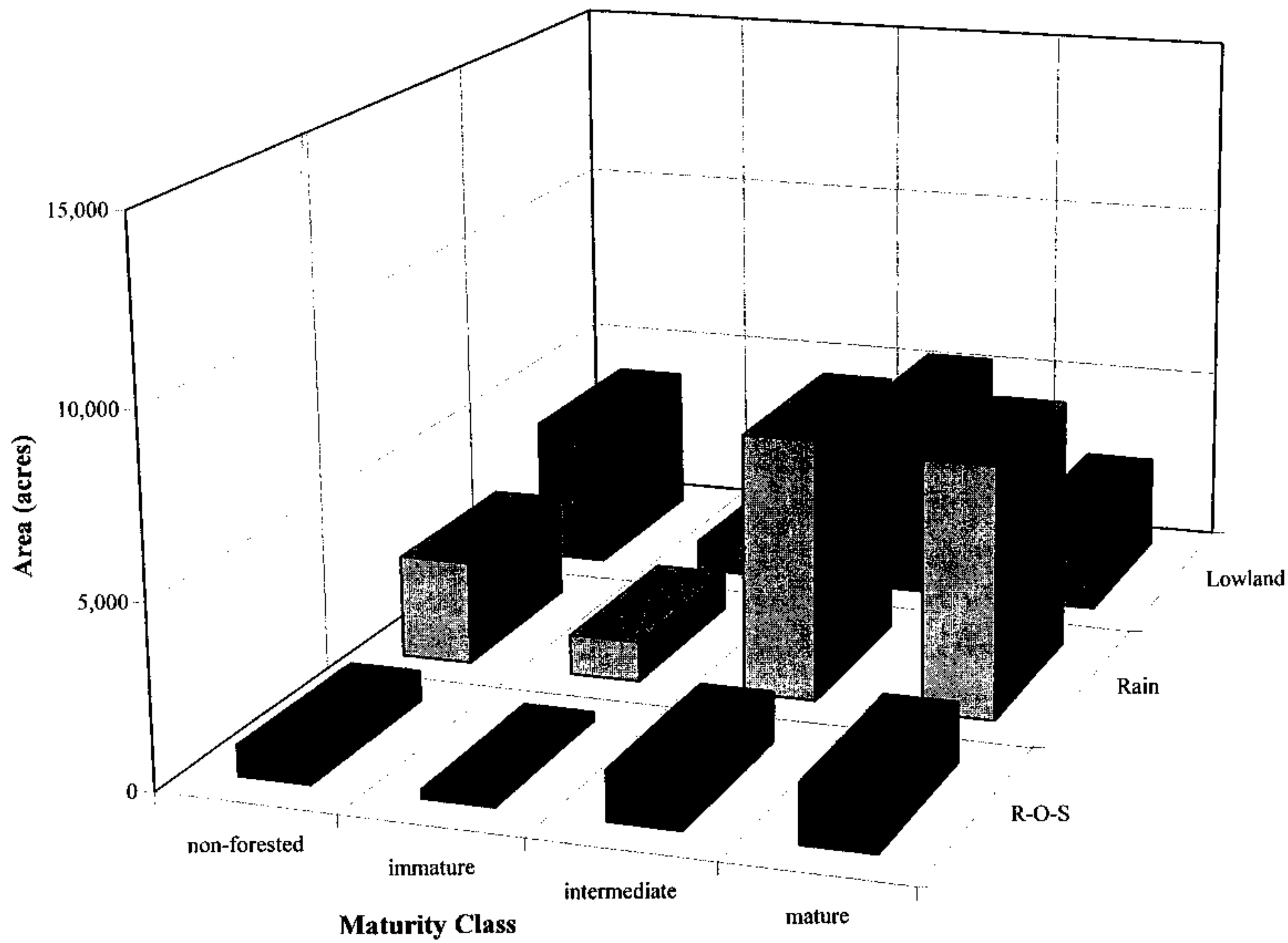

Table C-2. 24-hour Precipitation

| Recurrence interval (yrs) | 24-hour precipitation (in) |
|---|---|
| 2 | 2.6 |
| 5 | 3.6 |
| 10 | 4.5 |
| 100 | 8.2 |

Table C-3. USGS Streamflow Relationships

| Recurrence interval (yrs) | Streamflow (cfs) |
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| 2 | $24.2\ A^{0.86}\ I^{1.15}$ |
| 5 | $36.0\ A^{0.88}\ I^{1.15}$ |
| 10 | $44.8\ A^{0.88}\ I^{1.14}$ |
| 100 | $77.3\ A^{0.90}\ I^{1.08}$ |

A = drainage area ($mi^2$)
I = 24-hour precipitation for 2-year recurrence interval (in)

Table C-4. Streamflow vs. 24-hour Precipitation Regression Relationships

| Sub-watershed | Streamflow relationship |
|---|---|
| Chicago Creek | $Q_r = 66.4\ P_r + 30$ |
| Lower East Fork | $Q_r = 141\ P_r + 43$ |
| Lower Trail Creek | $Q_r = 181\ P_r + 47$ |
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| Upper West Fork | $Q_r = 124\ P_r + 41$ |
| Wall Creek | $Q_r = 187\ P_r + 47$ |
| Trail Creek Watershed | $Q_r = 997\ P_r - 31$ |

$Q_r$ = streamflow for return period of r years (cfs)
$P_r$ = 24-hour precipitation for return period of r years (in)

## Figure C-2. January 1 Snow-Water Equivalent

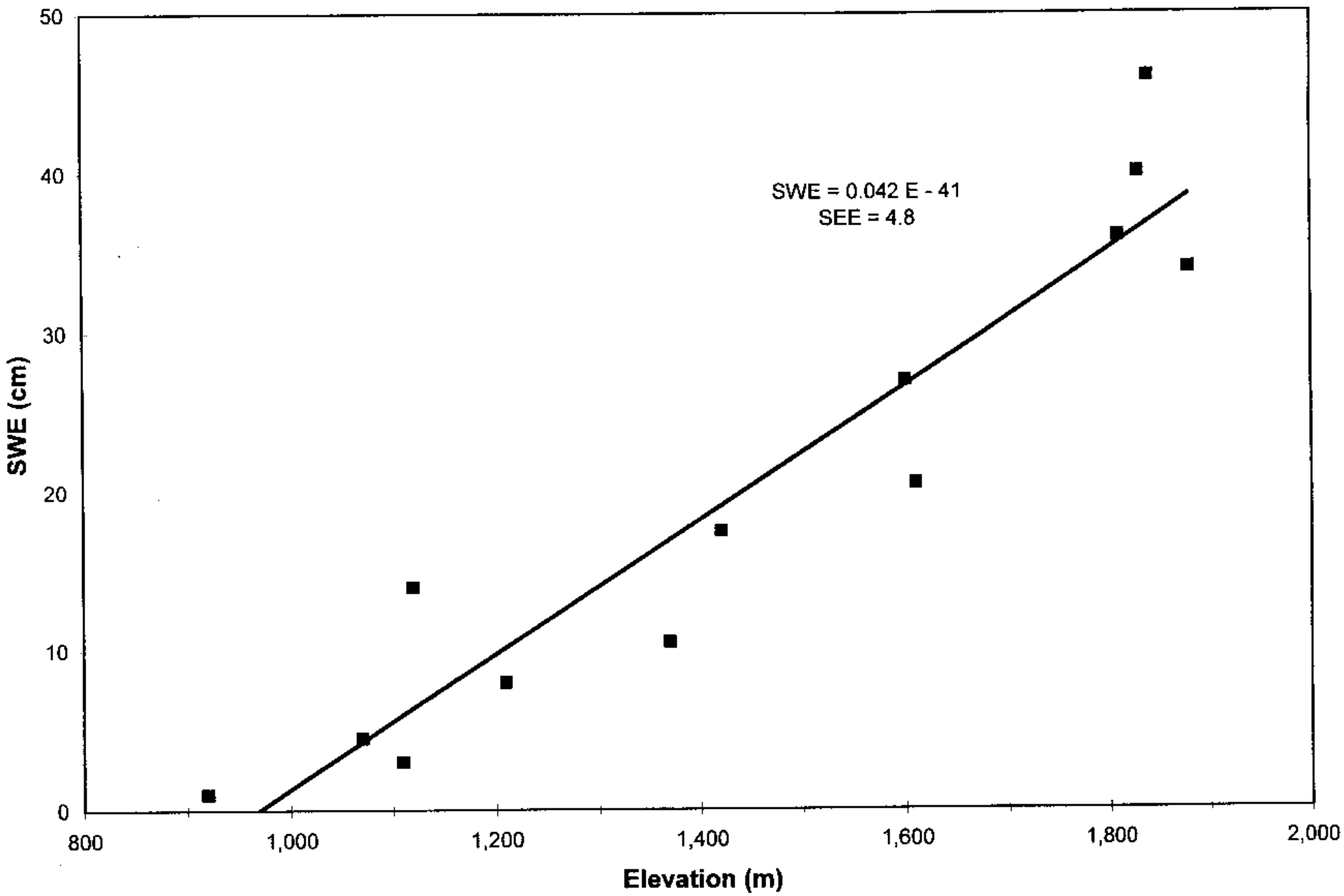


**Table C-5. Chicago Creek**

## Summary of Water Available for Runoff (WAR)

| | | WAR (in) | | |
|---|---|---|---|---|
| Recurrence interval (yr) | Storm intensity | Fully-forested | Current condition | Fully-clearcut |
| 2 | Average | 2.78 | 2.81 | 2.88 |
| 2 | Unusual | 3.61 | 3.94 | 4.59 |
| 5 | Average | 3.86 | 3.90 | 3.96 |
| 5 | Unusual | 4.69 | 5.02 | 5.67 |
| 10 | Average | 4.74 | 4.78 | 4.85 |
| 10 | Unusual | 5.58 | 5.91 | 6.56 |
| 100 | Average | 8.55 | 8.58 | 8.65 |
| 100 | Unusual | 9.40 | 9.72 | 10.38 |

## Summary of Peak Discharge Estimates

| | | Discharge (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Recurrence interval (yr) | Storm intensity | USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
| 2 | Average | 178 | 257 | 214 | 216 | 1.0% | 221 | 3.2% |
| 2 | Unusual | | | 269 | 291 | 8.1% | 334 | 24.2% |
| 5 | Average | 271 | 387 | 286 | 288 | 0.8% | 293 | 2.4% |
| 5 | Unusual | | | 341 | 363 | 6.4% | 406 | 19.1% |
| 10 | Average | 334 | 481 | 345 | 347 | 0.6% | 351 | 2.0% |
| 10 | Unusual | | | 400 | 422 | 5.5% | 465 | 16.3% |
| 100 | Average | 556 | 840 | 597 | 599 | 0.4% | 604 | 1.1% |
| 100 | Unusual | | | 653 | 675 | 3.3% | 718 | 10.0% |

**Table C-5. Lower East Fork Trail Creek**

## Summary of Water Available for Runoff (WAR)

| Recurrence interval (yr) | Storm intensity | WAR (in) Fully-forested | Current condition | Fully-clearcut |
|---|---|---|---|---|
| 2 | Average | 2.57 | 2.57 | 2.57 |
| 2 | Unusual | 2.96 | 3.09 | 3.39 |
| 5 | Average | 3.63 | 3.63 | 3.64 |
| 5 | Unusual | 4.02 | 4.15 | 4.45 |
| 10 | Average | 4.50 | 4.50 | 4.50 |
| 10 | Unusual | 4.89 | 5.02 | 5.32 |
| 100 | Average | 8.24 | 8.24 | 8.25 |
| 100 | Unusual | 8.63 | 8.76 | 9.06 |

## Summary of Peak Discharge Estimates

| Recurrence interval (yr) | Storm intensity | Discharge (cfs) USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
|---|---|---|---|---|---|---|---|---|
| 2 | Average | 359 | 517 | 404 | 404 | 0.0% | 405 | 0.1% |
| 2 | Unusual | | | 458 | 476 | 3.9% | 519 | 13.2% |
| 5 | Average | 555 | 793 | 554 | 554 | 0.0% | 554 | 0.1% |
| 5 | Unusual | | | 608 | 626 | 3.0% | 669 | 10.0% |
| 10 | Average | 684 | 985 | 675 | 675 | 0.0% | 676 | 0.1% |
| 10 | Unusual | | | 730 | 748 | 2.5% | 790 | 8.3% |
| 100 | Average | 1,158 | 1,748 | 1,201 | 1,202 | 0.0% | 1,202 | 0.0% |
| 100 | Unusual | | | 1,256 | 1,274 | 1.4% | 1,317 | 4.8% |

## Table C-5. Lower Trail Creek

### Summary of Water Available for Runoff (WAR)

| | | WAR (in) | | |
|---|---|---|---|---|
| Recurrence interval (yr) | Storm intensity | Fully-forested | Current condition | Fully-clearcut |
| 2 | Average | 2.56 | 2.56 | 2.56 |
| 2 | Unusual | 2.98 | 3.12 | 3.34 |
| 5 | Average | 3.62 | 3.62 | 3.62 |
| 5 | Unusual | 4.04 | 4.18 | 4.40 |
| 10 | Average | 4.49 | 4.49 | 4.49 |
| 10 | Unusual | 4.91 | 5.05 | 5.27 |
| 100 | Average | 8.23 | 8.23 | 8.23 |
| 100 | Unusual | 8.65 | 8.79 | 9.01 |

### Summary of Peak Discharge Estimates

| | | Discharge (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Recurrence interval (yr) | Storm intensity | USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
| 2 | Average | 454 | 653 | 509 | 509 | 0.0% | 509 | 0.0% |
| 2 | Unusual | [redacted] | | 584 | 609 | 4.3% | 650 | 11.3% |
| 5 | Average | 705 | 1,008 | 701 | 701 | 0.0% | 701 | 0.0% |
| 5 | Unusual | [redacted] | | 776 | 801 | 3.3% | 842 | 8.5% |
| 10 | Average | 869 | 1,251 | 857 | 857 | 0.0% | 857 | 0.0% |
| 10 | Unusual | [redacted] | | 932 | 958 | 2.7% | 998 | 7.1% |
| 100 | Average | 1,479 | 2,233 | 1,532 | 1,532 | 0.0% | 1,532 | 0.0% |
| 100 | Unusual | [redacted] | | 1,608 | 1,633 | 1.6% | 1,673 | 4.1% |

## Table C-5. Lower West Fork Trail Creek

### Summary of Water Available for Runoff (WAR)

| Recurrence interval (yr) | Storm intensity | WAR (in) Fully-forested | Current condition | Fully-clearcut |
|---|---|---|---|---|
| 2 | Average | 2.57 | 2.57 | 2.57 |
| 2 | Unusual | 3.09 | 3.27 | 3.61 |
| 5 | Average | 3.63 | 3.64 | 3.64 |
| 5 | Unusual | 4.15 | 4.34 | 4.68 |
| 10 | Average | 4.50 | 4.50 | 4.50 |
| 10 | Unusual | 5.02 | 5.20 | 5.54 |
| 100 | Average | 8.24 | 8.25 | 8.25 |
| 100 | Unusual | 8.76 | 8.95 | 9.29 |

### Summary of Peak Discharge Estimates

| Recurrence interval (yr) | Storm intensity | Discharge (cfs) USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
|---|---|---|---|---|---|---|---|---|
| 2 | Average | 677 | 975 | 763 | 763 | 0.1% | 764 | 0.1% |
| 2 | Unusual | | | 906 | 957 | 5.7% | 1,052 | 16.1% |
| 5 | Average | 1,061 | 1,518 | 1,057 | 1,058 | 0.0% | 1,059 | 0.1% |
| 5 | Unusual | | | 1,201 | 1,252 | 4.3% | 1,347 | 12.2% |
| 10 | Average | 1,308 | 1,884 | 1,298 | 1,298 | 0.0% | 1,299 | 0.1% |
| 10 | Unusual | | | 1,441 | 1,492 | 3.6% | 1,587 | 10.1% |
| 100 | Average | 2,249 | 3,395 | 2,335 | 2,335 | 0.0% | 2,336 | 0.0% |
| 100 | Unusual | | | 2,478 | 2,529 | 2.1% | 2,624 | 5.9% |

## Table C-5. Upper East Fork Trail Creek

### Summary of Water Available for Runoff (WAR)

| Recurrence interval (yr) | Storm intensity | WAR (in) Fully-forested | Current condition | Fully-clearcut |
|---|---|---|---|---|
| 2 | Average | 2.90 | 2.95 | 3.06 |
| 2 | Unusual | 3.73 | 4.00 | 4.68 |
| 5 | Average | 4.00 | 4.04 | 4.15 |
| 5 | Unusual | 4.82 | 5.10 | 5.78 |
| 10 | Average | 4.88 | 4.93 | 5.03 |
| 10 | Unusual | 5.72 | 5.99 | 6.67 |
| 100 | Average | 8.72 | 8.77 | 8.87 |
| 100 | Unusual | 9.58 | 9.85 | 10.53 |

### Summary of Peak Discharge Estimates

| | | Discharge (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Recurrence interval (yr) | Storm intensity | USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
| 2 | Average | 459 | 662 | 578 | 588 | 1.6% | 606 | 4.8% |
| 2 | Unusual | [redacted] | | 729 | 779 | 6.9% | 904 | 24.0% |
| 5 | Average | 714 | 1,021 | 778 | 787 | 1.2% | 806 | 3.5% |
| 5 | Unusual | [redacted] | | 929 | 980 | 5.4% | 1,104 | 18.8% |
| 10 | Average | 880 | 1,267 | 941 | 950 | 1.0% | 968 | 2.9% |
| 10 | Unusual | [redacted] | | 1,093 | 1,143 | 4.6% | 1,268 | 16.0% |
| 100 | Average | 1,499 | 2,263 | 1,643 | 1,652 | 0.5% | 1,670 | 1.7% |
| 100 | Unusual | [redacted] | | 1,799 | 1,849 | 2.8% | 1,974 | 9.7% |

## Table C-5. Upper West Fork Trail Creek

### Summary of Water Available for Runoff (WAR)

| Recurrence interval (yr) | Storm intensity | WAR (in) Fully-forested | Current condition | Fully-clearcut |
|---|---|---|---|---|
| 2 | Average | 2.94 | 3.00 | 3.14 |
| 2 | Unusual | 3.76 | 4.03 | 4.79 |
| 5 | Average | 4.04 | 4.10 | 4.23 |
| 5 | Unusual | 4.87 | 5.13 | 5.89 |
| 10 | Average | 4.93 | 4.99 | 5.12 |
| 10 | Unusual | 5.76 | 6.03 | 6.79 |
| 100 | Average | 8.78 | 8.84 | 8.98 |
| 100 | Unusual | 9.64 | 9.90 | 10.67 |

### Summary of Peak Discharge Estimates

| Recurrence interval (yr) | Storm intensity | Discharge (cfs) USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
|---|---|---|---|---|---|---|---|---|
| 2 | Average | 320 | 461 | 407 | 414 | 1.8% | 430 | 5.8% |
| 2 | Unusual | | | 508 | 541 | 6.4% | 636 | 25.0% |
| 5 | Average | 493 | 705 | 543 | 550 | 1.3% | 566 | 4.4% |
| 5 | Unusual | | | 645 | 678 | 5.0% | 773 | 19.7% |
| 10 | Average | 608 | 875 | 654 | 661 | 1.1% | 677 | 3.6% |
| 10 | Unusual | | | 757 | 790 | 4.3% | 884 | 16.8% |
| 100 | Average | 1,027 | 1,550 | 1,132 | 1,140 | 0.6% | 1,156 | 2.1% |
| 100 | Unusual | | | 1,239 | 1,272 | 2.6% | 1,366 | 10.3% |

## Table C-5. Wall Creek

### Summary of Water Available for Runoff (WAR)

| Recurrence interval (yr) | Storm intensity | WAR (in) Fully-forested | Current condition | Fully-clearcut |
|---|---|---|---|---|
| 2 | Average | 2.95 | 3.01 | 3.14 |
| 2 | Unusual | 3.78 | 4.08 | 4.79 |
| 5 | Average | 4.04 | 4.10 | 4.24 |
| 5 | Unusual | 4.88 | 5.19 | 5.90 |
| 10 | Average | 4.94 | 4.99 | 5.13 |
| 10 | Unusual | 5.78 | 6.08 | 6.79 |
| 100 | Average | 8.79 | 8.85 | 8.98 |
| 100 | Unusual | 9.66 | 9.96 | 10.67 |

### Summary of Peak Discharge Estimates

| | | Discharge (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Recurrence interval (yr) | Storm intensity | USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
| 2 | Average | 470 | 676 | 599 | 611 | 1.8% | 636 | 6.1% |
| 2 | Unusual | | | 755 | 812 | 7.6% | 945 | 25.2% |
| 5 | Average | 730 | 1,044 | 805 | 816 | 1.4% | 841 | 4.5% |
| 5 | Unusual | | | 962 | 1,019 | 6.0% | 1,152 | 19.8% |
| 10 | Average | 900 | 1,296 | 972 | 983 | 1.1% | 1,008 | 3.7% |
| 10 | Unusual | | | 1,130 | 1,187 | 5.1% | 1,320 | 16.8% |
| 100 | Average | 1,533 | 2,316 | 1,694 | 1,705 | 0.7% | 1,730 | 2.1% |
| 100 | Unusual | | | 1,857 | 1,914 | 3.1% | 2,047 | 10.2% |

## Table C-5. Trail Creek Watershed

### Summary of Water Available for Runoff (WAR)

| Recurrence interval (yr) | Storm intensity | WAR (in) Fully-forested | WAR (in) Current condition | WAR (in) Fully-clearcut |
|---|---|---|---|---|
| 2 | Average | 2.73 | 2.76 | 2.81 |
| 2 | Unusual | 3.37 | 3.59 | 4.08 |
| 5 | Average | 3.81 | 3.84 | 3.89 |
| 5 | Unusual | 4.45 | 4.67 | 5.16 |
| 10 | Average | 4.69 | 4.71 | 4.77 |
| 10 | Unusual | 5.33 | 5.55 | 6.04 |
| 100 | Average | 8.48 | 8.50 | 8.56 |
| 100 | Unusual | 9.13 | 9.35 | 9.84 |

### Summary of Peak Discharge Estimates

| Recurrence interval (yr) | Storm intensity | Discharge (cfs) USGS equation | USGS + 1 S.E. | Fully-forested | Current cond. | % inc. | Fully-clearcut | % inc. |
|---|---|---|---|---|---|---|---|---|
| 2 | Average | 2,244 | 3,231 | 2,693 | 2,718 | 0.9% | 2,774 | 3.0% |
| 2 | Unusual | [redacted] | | 3,323 | 3,543 | 6.6% | 4,034 | 21.4% |
| 5 | Average | 3,616 | 5,171 | 3,766 | 3,792 | 0.7% | 3,848 | 2.2% |
| 5 | Unusual | [redacted] | | 4,400 | 4,620 | 5.0% | 5,110 | 16.2% |
| 10 | Average | 4,458 | 6,420 | 4,641 | 4,666 | 0.6% | 4,722 | 1.8% |
| 10 | Unusual | [redacted] | | 5,277 | 5,497 | 4.2% | 5,987 | 13.5% |
| 100 | Average | 7,878 | 11,895 | 8,418 | 8,443 | 0.3% | 8,500 | 1.0% |
| 100 | Unusual | [redacted] | | 9,065 | 9,285 | 2.4% | 9,775 | 7.8% |

# APPENDIX D

# CHANNELS

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Canyon Creek    Reach: #1

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 13.7 | M 2 |
| CW/Pool | >20 | 5-8 | 15.2 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.6 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 15.7 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 19 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 15 | M 2 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | --- | --- |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 2.6 | L 1 |
| Volume / 100m stream length | <20 | >30 | 6 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 0.8 | L 1 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 0 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | **18** |
| Average Score* | | | | M 1.5 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Canyon Creek    Reach: #2

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 12 | M 2 |
| CW/Pool | >20 | 5-8 | 15.2 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.6 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 14.3 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 27 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 25 | M 2 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 6 | L 1 |
| Volume / 100m stream length | <20 | >30 | 24 | M 2 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 2.4 | M 2 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 81 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 30 | L 1 |
| **Total Score** | | | | 20 |
| Average Score* | | | | M 1.7 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Canyon Creek Tributary    Reach: T335 R1W S31SE

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 7 | L 1 |
| CW/Pool | >20 | 5-8 | 18 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.48 | L 1 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | NP | NP |
| Gravel (% Area) | <15 | ≥35 | NP | NP |
| Silt-Sand-Organics (% Area) | >15 | <8 | NP | NP |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 7 | L 1 |
| Volume / 100m stream length | <20 | >30 | 33 | H 3 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 2.8 | M 2 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 0 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | **13** |
| Average Score* | | | | L 1.4 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Dead Horse Creek Reach: #1

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 8 | L 1 |
| CW/Pool | >20 | 5-8 | 9 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.8 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 22 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 5 | L 1 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 0 | H 3 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 8 | L 1 |
| Volume / 100m stream length | <20 | >30 | 24 | M 2 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 1.7 | M 2 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 20 | --- |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | --- |
| **Total Score** | | | | **17** |
| Average Score* | | | | M 1.7 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Trail Creek Reach: #1

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 5.0 | H 3 |
| CW/Pool | >20 | 5-8 | 8.4 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | 1.1 | H 3 |
| >3% slope or (>7m width) | <0.5 | >1.0 | --- | --- |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 17.8 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 16 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | --- | --- |
| Channel Gradient <1.5% | >25 | <12 | 24 | M 2 |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 0.3 | L 1 |
| Volume / 100m stream length | <20 | >30 | 0.5 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 0 | L 1 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 0 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | **20** |
| Average Score* | | | | M 1.7 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Trail Creek Reach: #2

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 4 | L 1 |
| CW/Pool | >20 | 5-8 | 9.2 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | 1.3 | H 3 |
| >3% slope or (>7m width) | <0.5 | >1.0 | --- | --- |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 17.6 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 18 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | --- | --- |
| Channel Gradient <1.5% | >25 | <12 | 17 | M 2 |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 0.4 | L 1 |
| Volume / 100m stream length | <20 | >30 | 1.7 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 0.1 | L 1 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 0 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | **18** |
| Average Score* | | | | M 1.5 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Trail Creek Reach: #3

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 2.6 | M 2 |
| CW/Pool | >20 | 5-8 | 9.2 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | 0.9 | H 3 |
| >3% slope or (>7m width) | <0.5 | >1.0 | --- | --- |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 15.3 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 12 | L 1 |
| Silt-Sand-Organics (% Area) | >15 | <8 | --- | --- |
| Channel Gradient <1.5% | >25 | <12 | 18 | M 2 |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 0.1 | L 1 |
| Volume / 100m stream length | <20 | >30 | 0.2 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 0 | L 1 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 0 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | **18** |
| Average Score* | | | | M 1.5 |

*Scoring:
<1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Trail Creek    Reach: #4

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 19 | M 2 |
| CW/Pool | >20 | 5-8 | 8.8 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.9 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 14.5 | H 3 |
| Gravel (% Area) | <15 | ≥35 | 14 | L 1 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 18 | L 1 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 2.3 | L 1 |
| Volume / 100m stream length | <20 | >30 | 4.9 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 0.5 | L 1 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 15 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | 17 |
| Average Score* | | | | L 1.4 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Trail Creek    Reach: #5

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 15 | M 2 |
| CW/Pool | >20 | 5-8 | 8.7 | H 3 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.8 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 14.4 | H 3 |
| Gravel (% Area) | <15 | ≥35 | 18 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 9 | M 2 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 7.1 | L 1 |
| Volume / 100m stream length | <20 | >30 | 29.1 | M 2 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 2.8 | M 2 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 61 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 24 | L 1 |
| **Total Score** | | | | **22** |
| Average Score* | | | | M 1.8 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Trail Creek     Reach: #6

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 13 | M 2 |
| CW/Pool | >20 | 5-8 | 11.5 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.8 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 13.3 | H 3 |
| Gravel (% Area) | <15 | ≥35 | 22 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 21 | L 1 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 11.1 | M 2 |
| Volume / 100m stream length | <20 | >30 | 47.7 | H 3 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 4.5 | H 3 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 85 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 12 | L 1 |
| **Total Score** | | | | **23** |
| Average Score* | | | | M 1.9 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Wall Creek    Reach: #1

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 27 | M 2 |
| CW/Pool | >20 | 5-8 | 5.7 | H 3 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.8 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0.2 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | 18.7 | M 2 |
| Gravel (% Area) | <15 | ≥35 | 19 | M 2 |
| Silt-Sand-Organics (% Area) | >15 | <8 | 12 | M 2 |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 5.1 | L 1 |
| Volume / 100m stream length | <20 | >30 | 14.7 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 1.6 | M 2 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 43 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 12 | L 1 |
| **Total Score** | | | | **22** |
| Average Score* | | | | M 1.7 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided

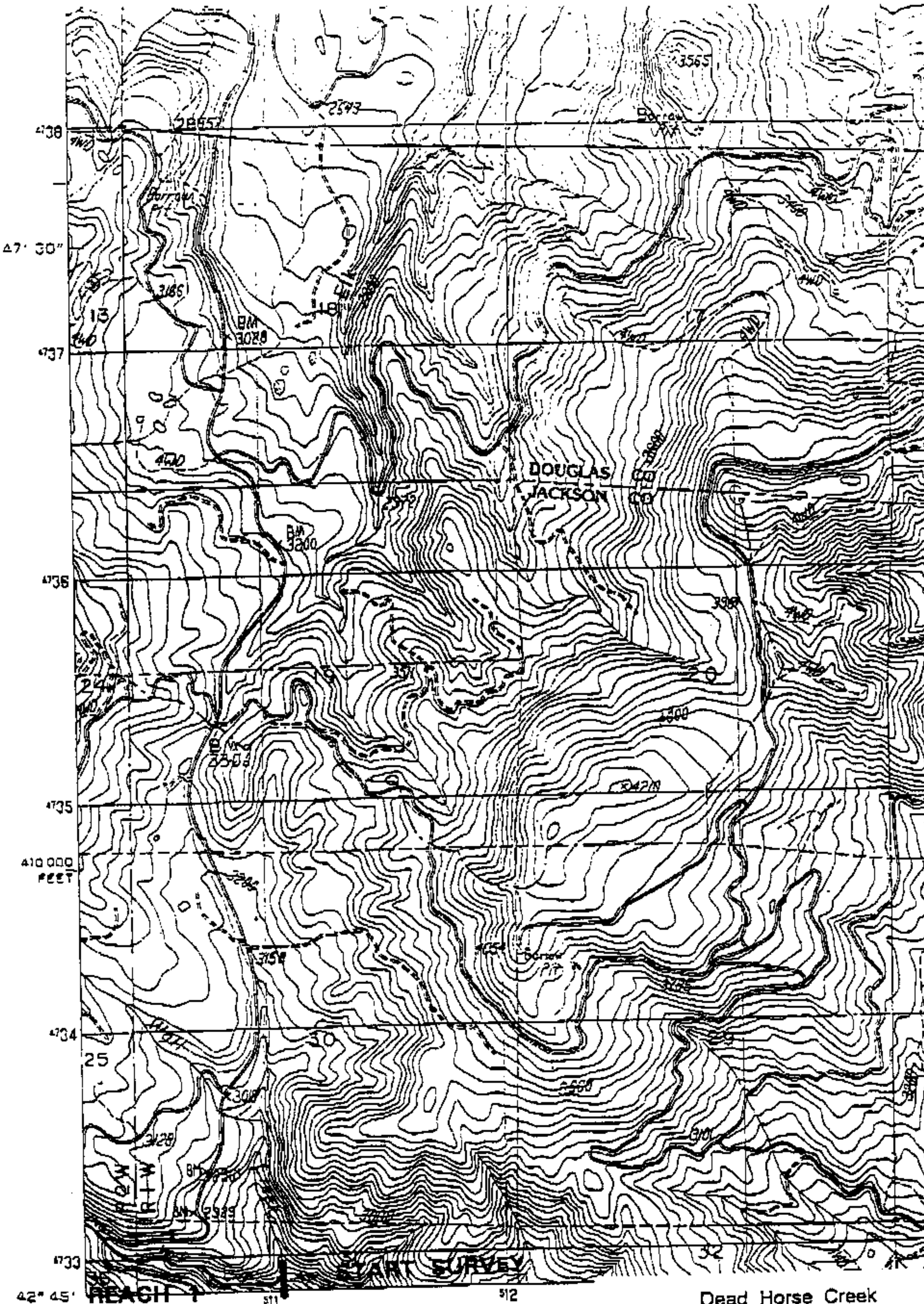
Table D-1: ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks

Stream: Wall Creek    Reach: #2

| | UNDESIR. | DESIR. | OBSERVED | RATING |
|---|---|---|---|---|
| POOLS | | | | |
| %Pool area | <10 | >35 | 9.3 | L 1 |
| CW/Pool | >20 | 5-8 | 12.4 | M 2 |
| Residual Pool Depth- | | | | |
| <3% slope or (<7m width) | <0.2 | >0.5 | --- | --- |
| >3% slope or (>7m width) | <0.5 | >1.0 | 0.6 | M 2 |
| Wood complexity >3 km | <1.0 | >2.5 | 0 | L 1 |
| RIFFLES | | | | |
| Width/Depth | >30 | <15 | NP | --- |
| Gravel (% Area) | <15 | ≥35 | NP | --- |
| Silt-Sand-Organics (% Area) | >15 | <8 | NP | --- |
| Channel Gradient <1.5% | >25 | <12 | --- | --- |
| SHADE | | | | |
| Stream Width <12 meters | <60 | >70 | NP | NP |
| Stream Width >12 meters | <50 | >60 | --- | --- |
| LARGE WOODY DEBRIS-(15cm X 3m minimum piece size) | | | | |
| Pieces / 100m stream length | <10 | >20 | 5.9 | L 1 |
| Volume / 100m stream length | <20 | >30 | 17.7 | L 1 |
| "Key" Pieces (>60cm dia. & ≥10m long)/100m | <1 | >3 | 1.6 | M 2 |
| RIPARIAN CONIFERS* (30m from both sides channel) | | | | |
| Number >20in dbh/ 1000 ft Stream | <150 | >300 | 61 | L 1 |
| Number >35in dbh/ 1000 ft Stream | <75 | >200 | 0 | L 1 |
| **Total Score** | | | | **12** |
| Average Score* | | | | L 1.3 |

*Scoring: <1.5, low
>1.5 < 2.5, moderate
>2.5, high

NP-Not Provided



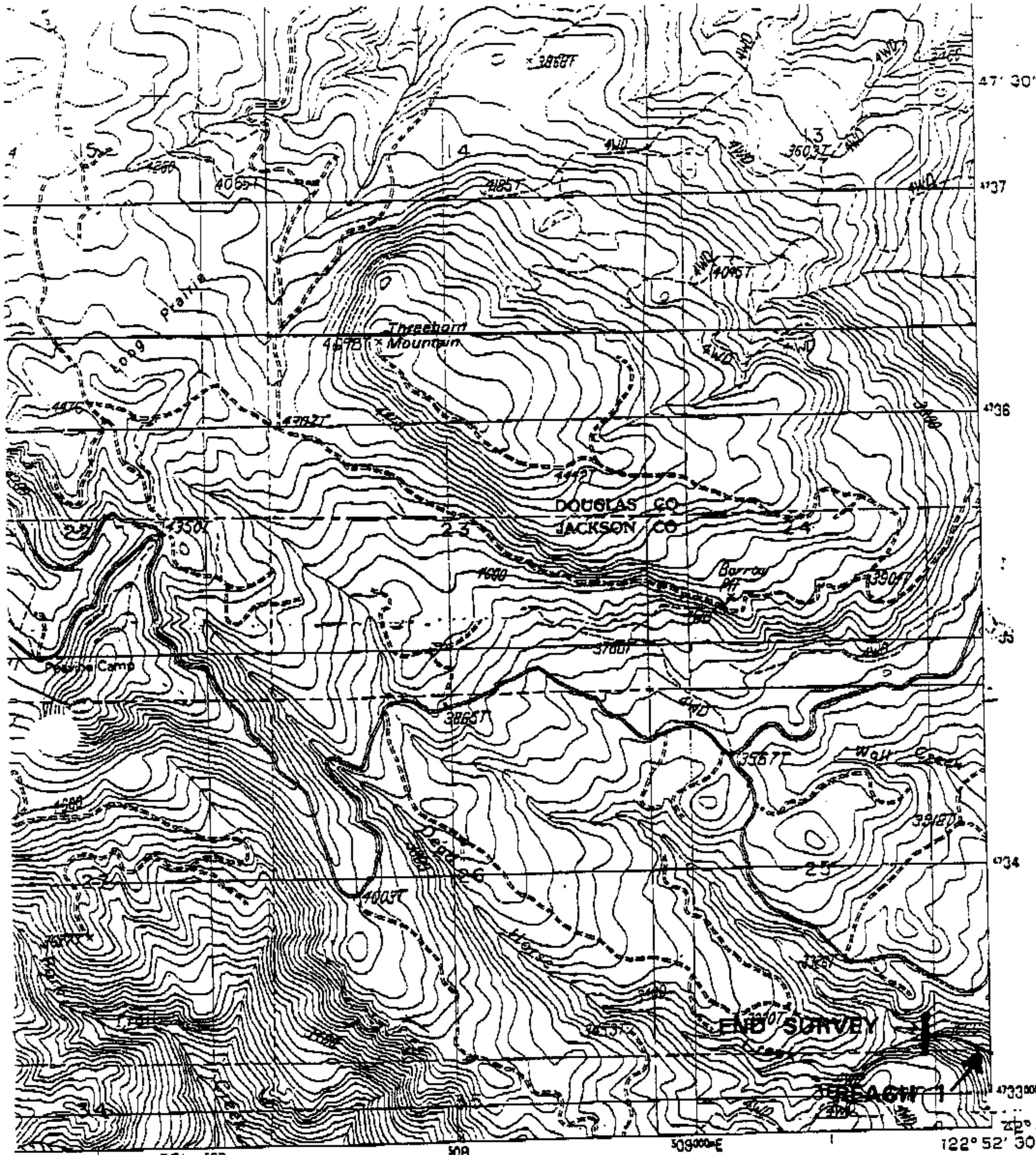

Dead Horse Creek

Rogue River Basin

U.S.G.S.: Ragsdale Butte

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .......... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN .......... 1980 AND 1983
FIELD CHECKED .......... 1984 MAP EDITED .......... 1989
PROJECTION .......... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .......... ZONE 10
10,000-FOOT STATE GRID TICKS .......... OREGON, SOUTH ZONE
UTM GRID DECLINATION .......... 2°26' EAST

1000




INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1990

2000

100 5000 10 000


QUADRANGLE LOCATION

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 1 Mile<br>2 Tiller<br>3 Pickett Butte |
| 4 | | 5 | 4 Cedar Springs Mountain<br>5 Ragsdale Butte<br>6 Skeleton Mountain |
| 6 | 7 | 8 | 7 Cleveland Ridge<br>8 Trail |

Dead Horse Creek

Rogue River Basin

U.S.G.S.: Richter Mountain

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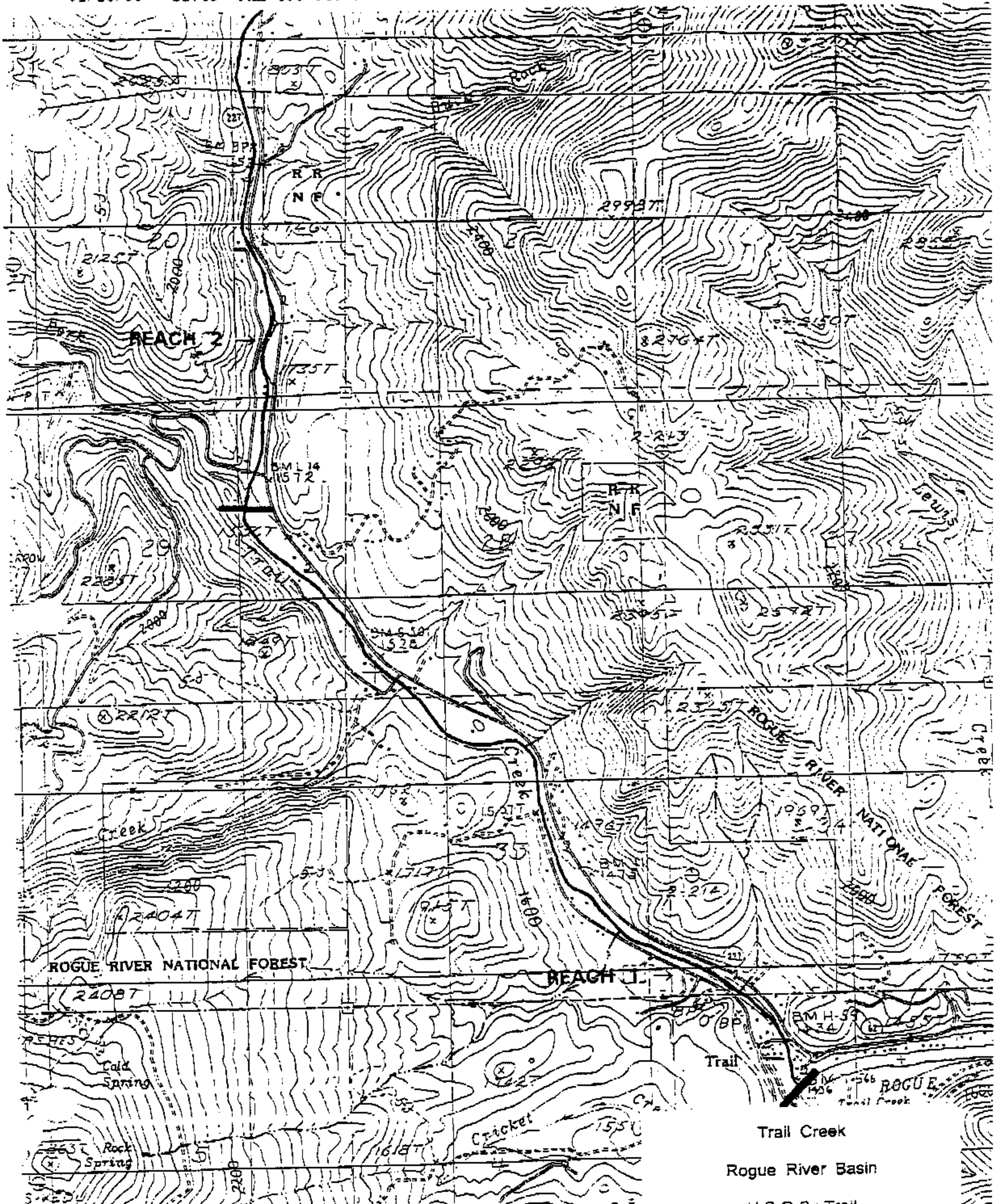
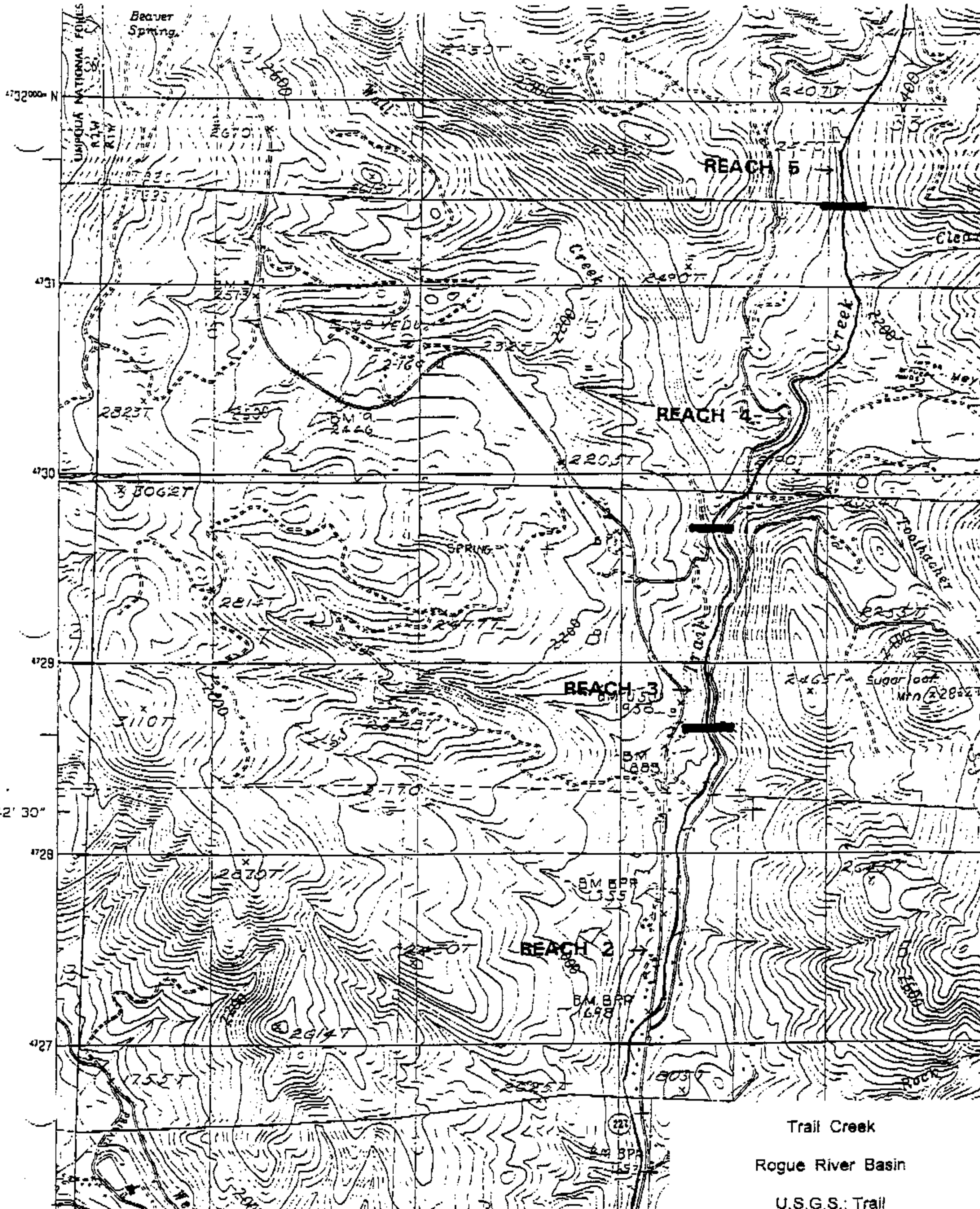
RICHTER MOUNTAIN, OREGON
PROVISIONAL EDITION 1989

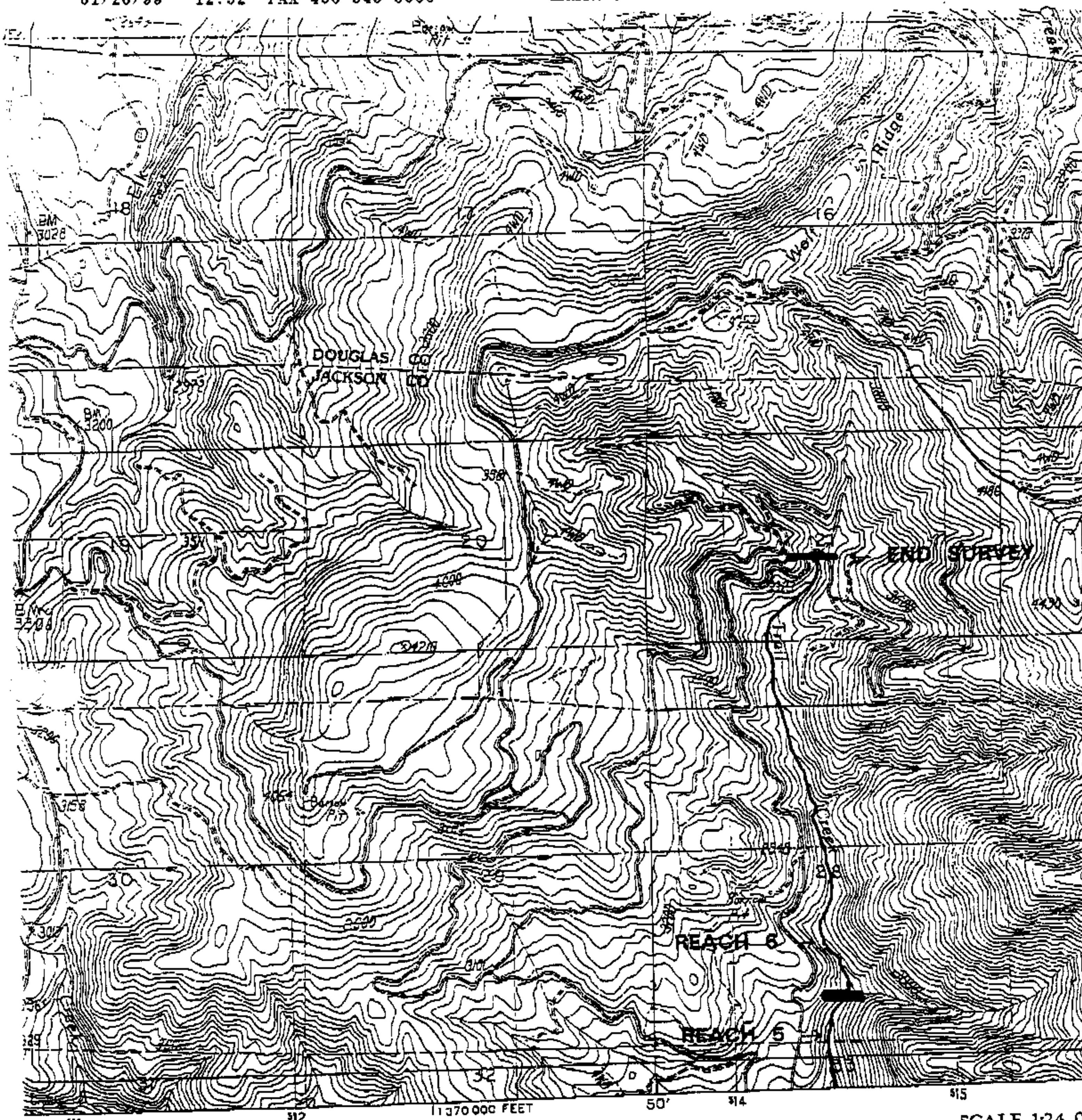

REACH 2
R R
N F
REACH 1
ROGUE RIVER NATIONAL FOREST
ROGUE RIVER NATIONAL FOREST
Creek
Trail
Lewis
Cold Spring
Rock Spring
Cricket
ROGUE
Trail Creek
Rogue River Basin




Trail Creek

Rogue River Basin

U.S.G.S.: Trail




SCALE 1:24 00

KILOMETERS
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IE UNITED STATES GEOLOGICAL SURVEY
........ USGS, NOS/NOAA
AL PHOTOGRAPHS TAKEN ........ 1980 AND 1983
... 1984 MAP EDITED ........ 1989
........ LAMBERT CONFORMAL CONIC
ER ANSVERSE MERCATOR ....... ZONE 10
E C ICKS ........ OREGON, SOUTH ZONE
........ 0°08' EAST
DECLINATION ........ 18° EAST
..... NATIONAL GEODETIC VERTICAL DATUM OF 1929
........ 1927 NORTH AMERICAN DATUM
redicted North American Datum of 1983,
m lines as shown by dashed corner ticks

PROVISIONAL MAP
Produced from original manuscript drawings. Infor-

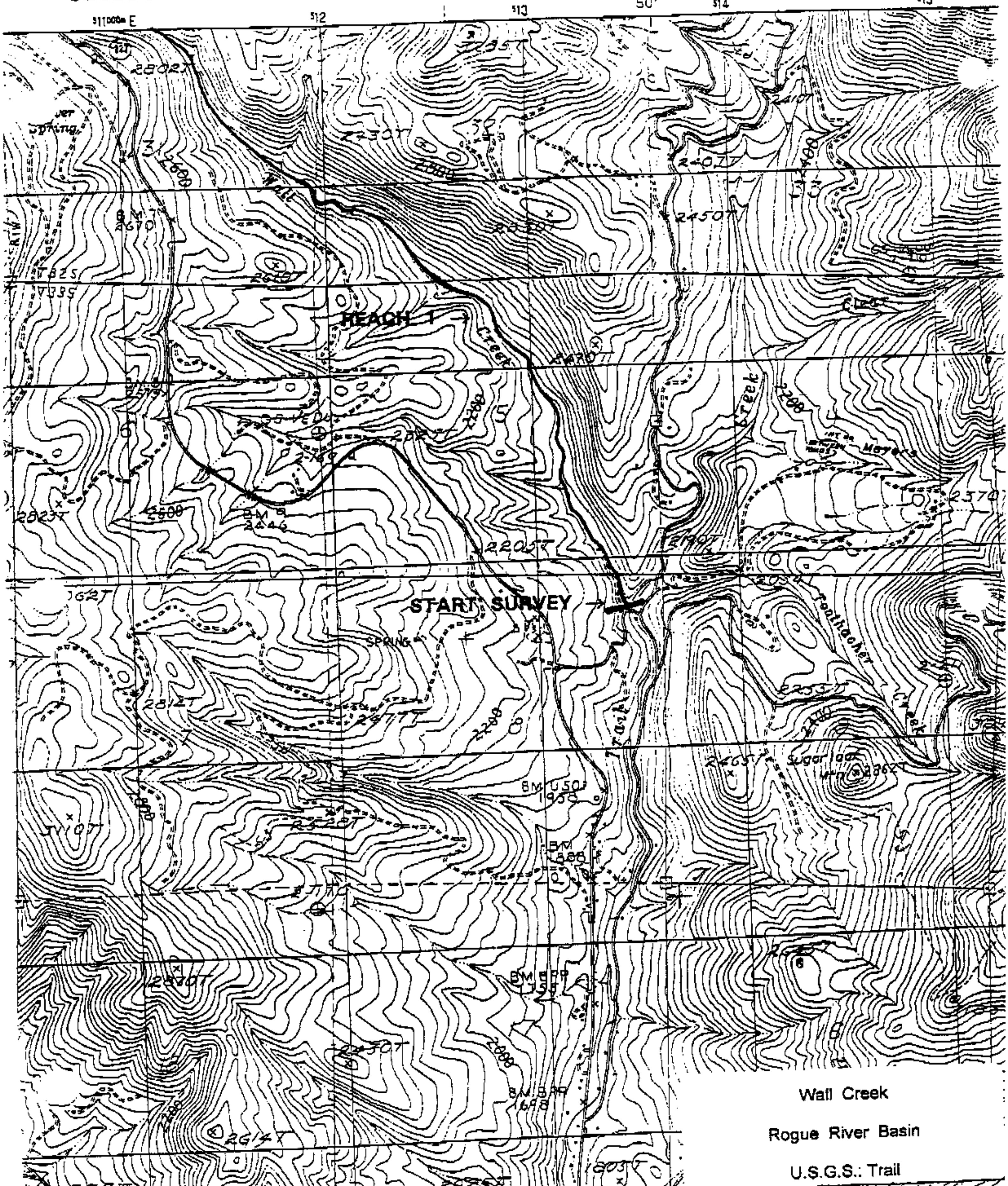
Trail Creek

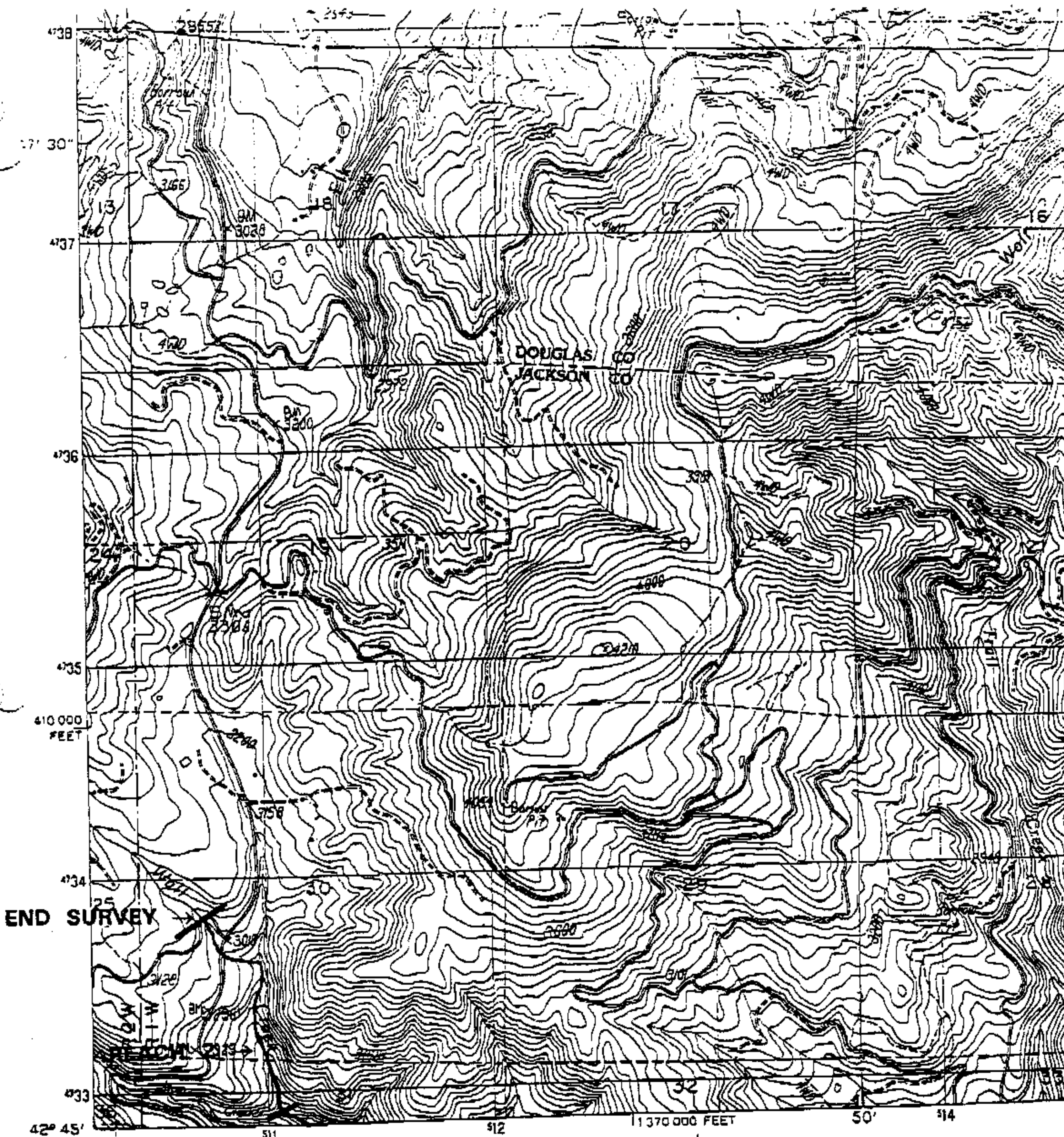
Rogue River Basin

U.S.G.S.: Ragsale Butte

THIS MAP COMPLIES WITH NATIONAL MA
BY U.S. GEOLOGICAL SURVEY.

GEOLOGICAL SURVEY






PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .................................... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN .......... 1980 AND 1983
FIELD CHECKED ........ 1984 MAP EDITED .............. 1989
PROJECTION ................................ LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ......... ZONE 10
10,000-FOOT STATE GRID TICKS ........... OREGON, SOUTH ZONE
UTM GRID DECLINATION ........................... 0°08' EAST
1989 MAGNETIC NORTH DECLINATION ..................... 18° EAST
VERTICAL DATUM ........... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM ..................... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (21 meters north and 95 meters east)

NORTH

PROVISIONAL
Produced from manuscript drawing

Wall Creek

Rogue River Basin

# APPENDIX E

# POTENTIAL SENSITIVE PLANT SPECIES

## HABITAT DESCRIPTION OF SURVEY & MANAGE FUNGI, LICHENS & BRYOPHYTES THAT POTENTIALLY OCCUR IN TRAIL CREEK WATERSHED

List of Survey and Manage (S&M) Species and Protection Buffer (PB) Species by survey category and plant community. Included is a brief description of habitat and known sites in southwest Oregon.

### LICHENS

**Oak Woodland Plant Community**

*Bryoria tortuosa* (1,3) - on bark or wood of hardwood or conifers, semi-open conifer stands at low elevation transitional areas between wet coastal forests and drier inland forests. Found in Bieber-Wasson (Little Butte Watershed), Grants Pass and Applegate Valley.

**Conifer and Conifer/Hardwood Mature-Old Growth Forest Stands**

*Dendriscocaulon intriculatum* (1,3) - found in Bieber-Wasson (Little Butte Watershed) and Grants Pass RA on Black oak, at edge of mixed conifer, mature stand

*Lobaria hallii* (1,3) - found in Bieber-Wasson/Double Salt (Little Butte Watershed) and Lower Big Butte Watershed; on hardwoods, usually Quercus garryana, in low to mid-elevation riparian forests

*Bryoria subcana* (1,3) - within 50 kms of coast, bark & wood of conifers, *Picea, Abies* & wetter *PSME* forests

**Mature-Old Growth Forest Stands:**

*Hypogymnia duplicata* (1,2,3) - epiphytic in moist old-growth mountain hemlock/Pacific silver fir forests, old growth western hemlock forests, old-growth douglas fir or noble fir forests (Oregon sites), 1100-5500 ft. elev.

*Nephroma occultum* (1,3) - old-growth PSME - western hemlock stands, most frequent in mid to upper canopy

*Pannaria rubiginosa* (1,3) - bark & wood of conifers & hardwoods, moist lowland habitats; coastal thickets of old shrubs

*Pilophorus nigricaulis* (1,3) - on rock, cool, moist, rocky slopes, often north-facing, usually in open but where sheltered by surrounding topo, such as steep narrow valleys

*Pseudocyphyellaria rainierensis* (1,2,3) - mesic to moist old growth forests in Western hemlock or lower Silver fir zones, may be on Douglas fir, Pacific silver fir, western hemlock, subalpine fir, Pacific yew, Sitka spruce, western redcedar, bigleaf maple, vine maple, red alder cascara, chinquapin, black cottonwood, 330-4000 ft.

*Tholuma dissimilis* (1,3) - conifer twigs, exposed subalpine ridges and peaks, occasionally at low

*Tholuma dissimilis* (1,3) - conifer twigs, exposed subalpine ridges and peaks, occasionally at low to mid-elevations in cool moist sites. Known from Crater Lake N.P.

## BRYOPHYTES

**(Riparian, north-facing, moist, or mature/old-growth sites)**

*Brotherella roelii* (PB, 1,3) - cool to moist mixed deciduous and conifer forests, usually at low elevations along valley floors

*Buxbaumia viridis* (PB) - dense, shady, humid coniferous forests, with logs & stumps in advanced stages of decay. Found in Bieber-Wasson (Little Butte Watershed)

*Encalypta brevicolla* var. *crumiana* (1,3) - on soil in shaded crevices in igneous rocks, along ridgetops subject to frequent fog penetration

*Plagiochila satoi* (1,3) - lower elevation riparian forests, on cliffs, rocks, bark

*Ptilidium californicum* (1,2, PB) - mid-elevation forests, mature-old growth; at base of standing trees or recently fallen logs. Found in Bieber-Wasson (Little Butte Watershed)

*Rhizomnium nudum* (PB) - mid-high elevation forests, moist organic soil

*Schistostega pennata* (PB) - known site at Diamond Lake; dark, dense forests, on damp rock, soil, decaying wood, in dark places

*Tetraphis geniculata* (1,3, PB) - well-rotted stumps and logs or rocks, shaded, humid locations at low to mid-elevations

*Tritomaria excectiformis* (1,2) - mixed coniferous forests, 3200-5100 ft. elev., on peaty or humic soil or rotting wood, creek banks

*Ulota meglospora* (PB) - on conifers & hardwoods, lowlands to montane, old growth forests; maples, alders, tanoak, douglas fir, oceanspray, elderberry. Found in Glendale RA.

## FUNGI

*Cantharelles formosa* (1,3) - widespread in disturbed sites in mature conifer forests

*Bondarzewia montana (mesenterica)* (1,2,3) - on or around conifer trees or stumps (*PIPO* in BFRA) in coniferous forests

*Aleuria rhenana* (PB) - on ground or moss in well-developed conifer litter in late-successional conifer forests, sea level to treeline

*Otidea leporina* (PB) - under hardwoods and conifers, widely distributed, winter and spring

*Otidea smithii* (PB) - under conifers, fall and winter

*Polyozellus multiplex* (PB) - known from Ore. Cascades, on ground under conifers (usually spruce and fir)

*Sarcosoma mexicana* (PB) - found in Bieber-Wasson (Little Butte Watershed) and Lost Creek Watershed, Butte Falls RA, saprophyte on decayed wood and soil in coniferous woods, higher elevations, spring.

*Ramaria cyaneigranosa* (1,3) - known from Butte Falls RA, on ground in mature mixed conifer stand

**OTHER FUNGI SPECIES DISCOVERED IN SOUTHWEST OREGON:**

*Choiromyces alveolatus* (1,3) -old growth *Abies* or *Tsuga mertensiana* or mid-high elevations, late winter, spring, early summer

*Gastroboletus subalpinus* (1,3) - 4500 ft - timberline, *Pinaceae*, spring to summer

*Helvella compressa* (1,3) - found in Butte Falls RA, associated with late successional forests, under redwood, oak, pines; late summer and fall

*Helvella elastica* (1,3) - associated with late-successional forests, but also found in a variety of deciduous and coniferous woods

*Martellia fragrans* (1,3) - truffle, upper elevation *Abies* forests, mature and old growth with *Abies* component and coarse woody debris

*Mycena monticola* (1,3) - 3500-4500 ft. elev., conifer forest, on beds of pine needles,

*Neournula pouchetii* (1,3) - saprophytic in conifer litter, late-successional stands, *Tsuga* or *Thuja* associated, spring-early summer

*Nivatogastrium nubigenum* (1,3) - truffle, inhabits dead mountain conifers, assoc. with *Abies* and *Pinus contorta*, spring

*Nivatogastrium nubigenum* (1,3) - dead mountain conifers, especially *Abies* and *Pinus contorta*, spring

*Plectania milleri* (1,3) - saprophytic on conifer duff, in spring, adjacent to snow melt

*Ramaria rubrivanescens* (1,3) - on ground in forest of western hemlock, fall

## SURVEY AND MANAGE SPECIES KNOWN TO OCCUR
## BUTTE FALLS RESOURCE AREA

| **LICHENS** | **SURVEY STATUS** |
|---|---|
| Bryoria subcana ? | 1,3 |
| Bryoria tortuosa | 1,3 |
| Calicium viride | 4 |
| Collema nigrescens | 4 |
| Dendriscocaulon intricatulum | 1,3 |
| Leptogium saturninum | 4 |
| Lobaria hallii | 1,3 |
| Lobaria pulmonaria | 4 |
| Nephroma helveticum | 4 |
| Nephroma resupinatum | 4 |
| Peltigera collina | 4 |
| Pseudocyphellaria anomala | 4 |
| Pseudocyphellaria anthrapsis | 4 |
| Sticta fulginosa | 4 |

| **MOSSES** | **SURVEY STATUS** |
|---|---|
| Antitrichia curtipendula | 4 |
| Buxbaumia viridis | PB |

| *FUNGI* | **SURVEY STATUS** |
|---|---|
| 1. Bondarzewia mesenterica | 1,2,3 |
| 2. Cantharellus formosus | 1,3 |
| 3. Clavariadelphus ligula | 3,4 |
| 4. Clavariadelphus pistilaris | 3,4 |
| 5. Clavariadelphus truncatus | 3,4 |
| 6. Clavulina cristata | 3,4 |
| 7. Gomphus floccocus | 3 |
| 8. Mycena lilacifolia | 3 |
| 9. Phlogiotis helvelloides | 3,4 |
| 10. Ramaria cyaneigranosa | 1,3 |
| 11. Sparassis crispa | 3 |

## SURVEY AND MANAGE SPECIES AND PROTECTION BUFFER SPECIES REQUIRING SURVEY

## LICHENS

| SPECIES | SURVEY STATUS | HABITAT | SUBSTRATE | KNOWN RANGE |
|---|---|---|---|---|
| *Hypogymnia duplicata* | 2 | Moist sites, maritime and old-growth TSHE, PSME, Pacific silver or noble fir forests, from Alaska to Mendocina CA. | epiphyte--tree branches & boles, moss-covered rock outcrops? | Potential habitat; Throughout PNW but almost always west. Of Cascades. Known site in Roseburg |
| *Lobaria linita* | 2 | var linita: Temperate mature/old growth Doug fir forests, elev., oak forest w/rock outcrops | epiphyte--lower boles, branches, trunks of conifers, deciduous trees, shrubs; moss-covered rocks in cool, shaded humid micro-sites | Potential habitat; only 2 known sites in north Ore. Cascades |
| | | var tenuior: Alpine Meadows | soil surface | Potential habitat; only 2 known sites in north Ore. Cascades |
| *Psudeocyphellaria rainierensis* | 2 | mesic to moist old growth PSME/TSHE forests w/ cool, humid micro-climate, in Ore. not restricted to interior or old growth forests, 1600-2950 ft. elevation | epiphyte--PSME, TSHE, Pacific silver fir, TABR, western redcedar, Sitka spruce, red alder, chinquapin, big-leaf maple, vine maple, black cottonwood, canopy litterfall low to mid-canopy | Potential habitat; Western Cascades south to Roseburg |

## BRYOPHYTES

| SPECIES | HABITAT | SUBSTRATE | RANGE |
|---|---|---|---|
| **LIVERWORTS** | | | |
| *Diplophyllum plicatum* | cool, humid patches; moist north-facing cliffs, shaded cliff crevices in riparian areas, soil of upturned roots | decayed wood, down logs, trunks of PSME, TABR, Sitka spruce; mineral soil, rock | Not suspected for this area, OR-no. coast, |
| *Kurzia makinoana* | shaded, moist sites, bogs, <3000 ft. | rocky cliffs & ledges, soil banks & cuts, decayed wood, rarely base of trees | Not suspected for southern Cascades, no known OR sites, potential habitat |
| *Marsupella emarginata var. aquatica* | aquatic, swift-flowing water at high elevations | submerged rocks in cold perennial streams | central Cascades (Lane Co. only known OR site), potential habitat |
| *Tritomaria exsectiformis* | dry to moist, partially shaded sites | soil or litter, soil in rock crevices | central Cascades farthest south?, potential habitat |
| **MOSSES** | | | |
| *Brotherella roellii* | cool to moist mixed deciduous & conifer forests, low elev., along valley margins, stream terraces, slopes, swampy floodplains | rotten logs, stumps, bases of trees;<br>big leaf maple, red alder | potential habitat; Pacific northwest |
| *Buxbaumia viridis* | dense, shady & humid coniferous forests, low elev to subalpine | rotten logs, peaty soil & humus | potential habitat |
| *Rhizomnium nudum* | middle to high elev. forests | moist but not wet organic soil; sometimes among rocks, on rotten logs, or along streams | potential habitat |
| *Tetraphis geniculata* | cool, shaded, humid locations at low to middle elev., especially on stream terraces & floodplains | Well-rotted stumps, logs, rarely on rocks | **not susepcted in southern OR** |

| | | | |
|---|---|---|---|
| *Ulota meglospora* | lowlands to submontane | epiphytic on conifers & hardwoods, esp. maples, alder, tanoak, PSME, HODI; trunks & branches, esp. toward tips | potential habitat; known site in sw OR |

**FUNGI**

| SPECIES | HABITAT | SUBSTRATE | RANGE |
|---|---|---|---|
| *Aleuria (Sowerbyella) rhenana* | mixed conifer or HW/con forests, low to mid-elev. | duff or humus | potential habitat |
| *Bridgeoporus (Oxyporus) nobilissimus* | Abies procera & A. Amabilis forests, mesic to wet microsites, old growth, mtn. tops, ridges, west-north aspects | grows on collar or root crowns of >43" ABPR or ABAM live or dead standing trees, snags, stumps | **unlikely in BFRA because of habitat**, OR & WA Cascades, Olympic Mtns.,OR Coast Mtns? |
| *Bondarzewia montana* | late-successional conifer forests | conifer snags, stumps | known in RRNF, potential habitat |
| *Otidea leporina* | conifer forests, not restricted to old-growth | terrestrial, under conifers & hardwoods | known site in Josephine Co., potential habitat |
| *Otidea onotica* | conifer forests | duff or moss, bare ground under conifers & hardwood | known sites in Josephine Co. & RRNF; potential habitat |
| *Otidea smithii* | conifer forests | under conifers on duff, esp. PSME & Quercus | potential habitat |
| *Polyozellus multiplex* | late successional, mid-elev., montane conifer forests | ectomycorrhiza with Abies sp. roots | potential habitat |
| *Sarcosoma mexicana* | old growth forests | rotting wood, duff under conifers | known from BFRA |

BUTTE FALLS RESOURCE AREA
SPECIAL STATUS SPECIES OCCURRENCE

PROJECT NAME Trail Creek Watershed Analysis (Sept 98)

| U.S. FISH & WILDLIFE T&E SPECIES | | | | | |
|---|---|---|---|---|---|
| SPECIES | STATUS | RANGE (Y/N) | P/A | HABITAT QUALITY | LEVEL OF SURVEY |
| Peregrine falcon | FE, SE, 1 | Y | P | High | Medium |
| Bald eagle | FT, ST, 1 | Y | A | Low | Medium |
| Northern spotted owl | FT, ST, 1 | Y | P | Medium | Thorough |
| Vernal pool fairy shrimp | FT | Y | A | Low | None |

| STATE, BUREAU, ONHP, SPECIES of CONCERN | | | | | |
|---|---|---|---|---|---|
| SPECIES | STATUS | RANGE (Y/N) | P/A | HABITAT QUALITY | LEVEL OF SURVEY |
| Cascade frog | SoC, SV, BS, 3 | N | A | Low | Limited |
| Clouded salamander | SU, BS, 3 | Y | S | Medium | None |
| Foothill yellow legged frog | SoC, SV, BS, 3 | Y | S | Medium | None |
| No. red legged frog | SoC, SU, BS, 3 | Y | A | Low | None |
| Tailed Frog | SoC, SV, BS, 3 | Y | U | Low | None |
| Western pond turtle | SoC, SC,BS, 2 | Y | A | Low | Limited |
| Western toad | SV, 3 | Y | S | Low | Limited |
| California mt. kingsnake | SV, AS, 3 | Y | P | Low | None |
| Common kingsnake | SV, AS, 3 | Y | U | Low | None |
| Sharptail snake | SV, AS, 4 | Y | S | Low | None |
| Acorn woodpecker | SU, 3 | Y | S | Medium | None |
| Black backed woodpecker | SC, AS, 4 | Y | U | Medium | None |
| Flammulated owl | SC, AS, 4 | Y | S | Low | None |
| Great gray owl | SV, AS, SM, 4 | Y | P | Medium | Medium |
| Greater sandhill crane | SV, 4 | N | A | Low | None |
| Lewis' woodpecker | SC, AS, 3 | Y | S | Low | None |
| Northern goshawk | SoC, SC, BS, 3 | Y | S | Meduim | Limited |

| SPECIES | STATUS | RANGE (Y/N) | P/A | HABITAT QUALITY | LEVEL OF SURVEY |
|---|---|---|---|---|---|
| Northern pygmy owl | 4 | Y | S | Medium | Limited |
| Northern saw whet owl | AS | Y | P | Medium | Incidental |
| Olive sided flycatcher | SV, 3 | Y | S | Medium | None |
| Pileated woodpecker | SV, AS, 4 | Y | P | High | Incidental |
| Three-toed woodpecker | SC, AS, 4 | N | A | Low | None |
| Tricolored blackbird | SoC, SP, 2 | N | A | Low | None |
| Western Bluebird | SV, 4 | Y | S | Medium | None |
| White headed woodpecker | SC, 3 | N | A | Low | None |
| American martin | SV, 3 | Y | U | Low | None |
| Fisher | SoC,BS,SC,2 | Y | U | Low | None |
| Fringed myotis | SoC, SV, BS, 3 | Y | U | Medium | None |
| Long eared myotis | SoC,BS, SU, 4 | Y | U | Medium | None |
| Long legged myotis | SoC,BS, SU, 3 | Y | U | Medium | None |
| Pallid bat | SV, 3 | Y | U | Medium | None |
| Red tree vole | SoC, SM | Y | P | High | Medium |
| Ringtail | SU, 3 | Y | S | Low | None |
| Silver haired bat | SU, 3 | Y | U | Low | None |
| Townsend's big eared bat | SoC,SC,BS, SM, 2 | Y | U | Low | None |
| Yuma myotis | SoC, BS, 4 | Y | S | Low | None |
| Western gray squirrel | SU, 3 | Y | P | High | Incidental |
| Oregon Shoulderband | SM | U | U | Medium | None |
| Oregon Megomphix | SM | U | U | Medium | None |
| Crater Lake tightcoil | SM | U | U | Low | None |
| Blue-grey tail-dropper | SM | Y | P | Medium | None |
| Papillose tail-dropper | SM | Y | U | Medium | None |
| Burnell's False Water Penny Beetle | SoC, BS, 4 | U | U | Low | None |
| Denning's Agapetus caddisfly | SoC, BS, 3 | U | U | Low | None |
| Green springs Mt. faurlan caddisfly | SoC, BS, 3 | U | U | Low | None |

| SPECIES | STATUS | RANGE (Y/N) | P/A | HABITAT QUALITY | LEVEL OF SURVEY |
|---|---|---|---|---|---|
| Schuh's homoplectran caddisfly | SoC, BS, 3 | U | U | Medium | None |
| Siskiyou caddisfly | SoC, BS, 3 | U | U | Low | None |
| Siskiyou chloealtis grasshopper | SoC, BS, 3 | U | U | Low | None |
| Mardon skipper butterfly | BS, 2 | U | U | Low | None |
| Franklin's bumblebee | SoC, BS | U | U | Low | None |

Status:
FE - USFW Endangered - in danger of extinction throughout a significant portion of its range
FT - USFW Threatened - likely to become endangered species within the foreseeable future
SoC- Taxa whose conservation status is of cocern to the USFW (many previously known as category 2 candidates), but for which further informaiton is needed.
SE - State Endangered - in danger of extinction in the state of Oregon
ST - State Threatened - listed as likely to become endangered by the state of Oregon
SC - State Critical - listing is pending, or appropriate, if immediate conservation action not taken
SV - State Vulnerable - listing not imminent, and can be avoided through continued or expanded use of adequate protective measures and monitoring
SP - State Peripheral or naturally rare - populations at the edge of their geographic range, or historically low numbers due to limiting factors
SU - State Unknown - status unclear, insufficient information to document decline or vulnerability
SM - Survey & Manage - Forest plan ROD directs protection of known sites and/or survey for new sites
BS - Bureau Sensitive (BLM) - eligible for addition to Federal Notice of Review, and known in advance of official publication. Generally these species are restricted in range and have natural or human caused threats to their survival.
AS - Assessment Species (BLM) - not presently eligible for official federal or state status, but of concern which may at a minimum need protection or mitigation in BLM activities.

1 - Oregon Natural Heritage Rank, threatened with extinction throughout its range
2 - Oregon Natural Heritage Rank, threatened with extinction in the state of Oregon
3 - Oregon Natural Heritage Rank, more information is needed before status can be determined, but may be threatened or endangered in Oregon or throughout range
4 - Oregon Natural Heritage Rank, of conservation concern. May be rare, but are currently secure. May be declining in numbers or habitat but still too common to be considered as threatened or endangered. May need monitoring.

P/A Presence:
P - Present
S - Suspected
U - Uncertain
A - Absent

Habitat quality:
H - High
M - Medium
L - Low
A - Absent

T - Possibly transitory

# APPENDIX G

# NORTHERN SPOTTED OWL SITES AND CRITICAL HABITAT DESIGNATIONS

Spotted Owl sites in the Trail Creek Watershed Analysis vicinity.
Reproductive status by year, updated through September 1998.

| Site no. | Site name | Last yr active | Last yr young | 93 | 94 | 95 | 96 | 97 | 98 |
|---|---|---|---|---|---|---|---|---|---|
| 403 | Snowshoe Spring usfs | 96 | 94 | NR | R1 | R0 | SM | -- | N0 |
| 410 | West Fork Trail usfs | 98 | 98 | SM | NO | -- | -- | -- | R2 |
| 409 | Long Prairie usfs | 98 | 94 | NR | R2 | NR | -- | -- | UN |
| 3394 | Off The Wall | 98 | 98 | SM | UN | NO | R2 | NR | R1 |
| 1832 | Trail Creek | 88 | -- | NO | NO | NO | NO | NO | NO |
| 1823 | Trailhead | 87 | -- | NO | NO | NO | NO | NO | NO |
| 2625 | Toothacher | 98 | 97 | UN | R1 | UN | RO | R2 | NR |
| 0926 | Walpole | 94 | -- | SM | SM | NO | NO | NO | NO |
| 1949 | Millcat Trail | 96 | 89 | UN | NO | NO | SM | NO | NO |
| 4027 | Paradise Creek | 98 | 98 | UN | R1 | UN | R1 | R2 | R1 |
| 2630 | Paradise East | 93 | -- | SM | NO | NO | NO | -- | SM |
| 2629 | Upper Canyon Creek | 97 | -- | SM | NO | SM | NO | SM | NO |
| 4381 | Canyon Creek | 95 | -- | -- | -- | SM | -- | -- | -- |
| 2219 | Clear Creek usfs | 98 | 96 | UN | NR | NR | R1 | -- | NR |
| 1822 | Romine pvt | 93 | -- | SM | NO | NO | NO | -- | -- |
| 3395 | Wally Rollo pvt | 93 | -- | SM | NO | NO | -- | SM | NO |
| 3396 | East Chicago pvt | 93 | -- | SM | NO | NO | -- | NO | NO |

Legend:

UN Reproduction unknown for year, adults present.
-- No survey or information, or site not located yet.
NR Pair present, but not reproductive for year.
R1 Pair reproductive, followed by number of young.
NO No response, site presumed not occupied.
SM Single male.
SF Single female.

Wildlife Appendix : Clarification on Critical Habitat Designation

The following are quotes from the Federal Register notice (43 pages) of the designation of Critical Habitat Units for the northern spotted owl. This information is the only guidance statement available from US Fish & Wildlife Service on how these lands should be managed, and it preceeds the NW Forest Plan by two years. Federal Register, 50 CFR Part 17, Vol 57 No 10, Wed Jan 15 1992, pages 1796 - 1838.

Pg 1796. " Critical habitat is defined ... as the specific areas ... on which are found those physical and biological features (i) essential to the conservation of the species, and (ii) that may require special management considerations or protection."

" ... critical habitat serves to preserve options for a species eventual recovery. Critical habitat helps focus conservation activities by identifying areas that contain essential habitat features (primary constituent elements) regardless of whether or not they are currently occupied by the listed species ..." "Aside from the added protection provided under Section 7, the Act does not provide other forms of protection to lands designated as critical habitat."

Pg 1797. "Specific management recommendations for critical habitat are more appropriately addressed in recovery plans, management plans, and through section 7 consultation." Primary Constituent Elements: "Such physical and biological features ... include, but are not limited to, the following: - Space for individual and population growth, and for normal behavior; - Food, water, or other nutritional or physiological requirements: - Cover or shelter; - Sites for breeding, reproduction, rearing of offspring; and - Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species."

Pg 1803. "The Service's primary objective in designating critical habitat was to identify existing spotted owl habitat and to highlight specific areas where management considerations should be given highest priority to manage habitat." "... the Service relied upon the following principles: - Develop and maintain large contiguous blocks of habitat to support multiple reproducing pairs of owls; - Minimize fragmentation and edge effect to improve habitat quality. - Minimize distance to facilitate dispersal among blocks of breeding habitat; and - Maintain range-wide distribution of habitat to facilitate recovery."

"The definition of 'suitable habitat' was generally equivalent to the structure of Douglas-fir stands 80 or more years of age (with adjustments for local variation or condition)." "Critical habitat units minimize distance between adjacent units, thereby facilitating dispersal and linkage."

Pg 1804. "Since critical habitat designation is not a management plan, there was not a limitation on the size of the area added to any HCA ... . Primary consideration was given to existing suitable habitat and known pairs of spotted owls, particularly where the Service felt that additional protection should be considered and would enhance the existing HCA."

Pg 1805 "Although the designation of critical habitat emphasizes the importance of maintaining suitable habitat for all four constituent habitat elements, nesting and roosting habitat should be emphasized to improve opportunities for successful linkage." "Not all suitable nesting and roosting habitat was included in critical habitat."

Pg 1806. "The emphasis for future management will be on maintaining or developing habitat that has the characteristics of suitable nesting and roosting habitat and to avoid or reduce the adverse effects of current management practices." "The Service analyzed the economic effects of the ... proposal to designate critical habitat."

Pg 1809. " The revised proposed rule for the designation of critical habitat ... published on August 13 1991 ... encompased a total of approximately 8.2 million acres." " As a result of the exclusion process, the Service is designating approximately 1.4 million acres less ..." "The final rule ... encompassing a total of nearly 6.9 million acres ... 62 percent of the total originally identified in the May 6 proposal." 1.2 million acres of Bureau land.

Pg 1801. "State, private, tribal, and other non-Federal lands are not designated as critical habitat even if they are physically situated within the boundaries of critical habitat units."

Pg 1822. "Section 7 prohibitions against the destruction or adverse modification of critical habitat apply to actions that would impair survival and recovery of the listed species, thus providing a regulatory means of ensuring that Federal actions within critical habitat are considered in relation to the goals and recommendations of a recovery plan. As a result of the link between critical habitat and recovery, the prohibition against destruction or adverse modification of the critical habitat should provide for the protection of the critical habitat's ability to contribute fully to the species' recovery."

# APPENDIX H

# STREAM TEMPERATURE MATRIX

Table F-1 Predicted Stream Temperatures

| Elevation (ft) | 1600 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3200 | 3400 | 3600 | 3800 | 4000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canopy (%) | | | | | | | | | | | | | |
| 0 | 78 | 76 | 74 | 71 | 69 | 67 | 65 | 63 | 61 | 58 | 56 | 54 | 52 |
| 5 | 77 | 75 | 73 | 71 | 69 | 67 | 64 | 62 | 60 | 58 | 56 | 54 | 52 |
| 10 | 77 | 75 | 73 | 71 | 68 | 66 | 64 | 62 | 60 | 58 | 55 | 53 | 51 |
| 20 | 76 | 74 | 72 | 70 | 68 | 66 | 63 | 61 | 59 | 57 | 55 | 53 | 50 |
| 30 | 76 | 73 | 71 | 69 | 67 | 65 | 63 | 60 | 58 | 56 | 54 | 52 | 50 |
| 40 | 75 | 73 | 70 | 68 | 66 | 64 | 62 | 60 | 58 | 55 | 53 | 51 | 49 |
| 50 | 74 | 72 | 70 | 68 | 65 | 63 | 61 | 59 | 57 | 55 | 52 | 50 | 48 |
| 60 | 73 | 71 | 69 | 67 | 65 | 62 | 60 | 58 | 56 | 54 | 52 | 50 | 47 |
| 70 | 73 | 70 | 68 | 66 | 64 | 62 | 60 | 57 | 55 | 53 | 51 | 49 | 47 |
| 80 | 72 | 70 | 67 | 65 | 63 | 61 | 59 | 57 | 54 | 52 | 50 | 48 | 46 |
| 90 | 71 | 69 | 67 | 65 | 62 | 60 | 58 | 56 | 54 | 52 | 49 | 47 | 45 |
| 100 | 70 | 68 | 66 | 64 | 62 | 59 | 57 | 55 | 53 | 51 | 49 | 47 | 44 |

Wildlife Report for the Trail Creek Watershed Analysis

Jim Harper, Wildlife Biologist, Butte Falls Resource Area, 2 October 98 - DRAFT

Wildlife biologists consulted for this report included Linda Hale (Medford BLM), John Thiebes (Medford District ODFW), Simon Wray (Medford District ODFW), Jim Goode (Prospect RD, Rogue River National Forest), Kevin Sands (Tiller Ranger District, Umpqua National Forest).

A table depicting all the special status and sensitive terrestrial species thought to occur in the resource area is attached. The table shows what status list the species may be on, whether presence has been documented, what is the habitat quality available on a gross scale, and what level of survey has been performed in the watershed. The table is accompanied by a brief description of typical habitat for these species.

LISTED SPECIES

Peregrine Falcon

There is one known nesting pair within the compartment. Discovered in 1998, they produced two young. This area had been checked on a helicopter survey in May 1997 with no detection of peregrines. There are three other large cliff complexes (over 100 ft tall) in the watershed, and at least an additional three outcrops of 70 ft height (thought to be the minimum needed for nesting). Some of these cliffs are on private timberland. Peregrines are recolonizing cliffs in Oregon, with an increase from 8 known sites in 1988 to 42 active (of 61 known) sites (43 young) in 1997. There is potential habitat for at least one more nesting pair in the watershed. The US Fish & Wildlife Service (USFWS) on August 26th announced a proposal to delist the peregrine falcon, with the public comment period closing November 23 1998.

There are two main potential land use conflicts: timber sales and recreational climbers. Protocol visits (two visits in the spring, minimum four hours duration each ) need to be made by experienced observers to cliffs within a mile and a half of proposed sale units to detect presence of new birds. Establishment of primary and secondary protection zones, with appropriate seasonal restrictions, can then minimize noise disturbance to nest cliffs during timber sale operations or other ground disturbing activities. The other concern is recreational rock climbing. Climbers searching for new rocks to explore can inadvertantly cause nest abandonment by disturbing adult birds. Conversely, responsible climbers can be a source of information to detect new sites if they are aware of what peregrines look like, and know enough to back off once a bird is disturbed.

Other resident pairs of falcons in SW Oregon are thought to be year-round residents (vs migratory), but will tolerate disturbance such as climbing or timber sale noise from mid August through mid January outside of the nesting season (February through July). A site-specific management plan for the resident pair should be drafted within the next two years.

Agencies do not have the resources to survey each cliff each year, but potential nesting cliffs would be surveyed during planning for any nearby timber sales regardless of whether the species is delisted.

## Bald Eagle

There are no records of bald eagle sightings in the watershed. There are no large ponds or reservoirs, and the major forks of Trail Creek don't flow much water in the summer to support a fish prey base. The SE corner of the watershed abuts the Rogue River at the community of Trail, and eagles could be expected to occasionally roost or pass through or winter in this area, but habitat quality and likelihood of use are low.

Bald eagles have increased in Oregon from 39 occupied and successful nests in 1978 to 178 nests (276 young) in 1997. There is very low probability of eagles nesting in the watershed in the future unless a large reservoir were constructed, or unless the nest tree was near the Rogue River at Trail. The nearest nest is five miles from the watershed. The bald eagle has been proposed for delisting.

## Northern Spotted Owl

Surveys: Approximately 90% of the watershed was intensively surveyed for owls as part of an Oregon State University (OSU) demographic study from 1990 through 1996. Ten of the 13 known adult adult owls are color banded (plastic leg band) to facilitate long term monitoring of their site fidelity and reproductive success. Monitoring of individual historic sites was continued through 1998 by BLM and Boise Cascade. Of 17 historic sites, 7 were active in 1998 (see attached table listing specific site information). Four young were produced in each of the past three summers. There are potentially several undetected floater adults who are unpaired and move about the watershed in the nesting season.

Critical Habitat: The northeast corner and east fringe of the watershed is designated Critical Habitat for the spotted owl, intended to provide additional connectivity across the landscape. Critical Habitat was designated (see Appendix map) by US Fish & Wildlife Service (USFWS) on 15 Jan 1992 (Federal Register vol 57, no.10, pg1796) but this land use designation was not carried forward in the Northwest Forest Plan (NFP). There are 4,957 federal acres of this Critical Habitat Unit (CHU # O-17) within the watershed, while most of the CHU is east within the large LSR. No non-federal land was designated as Critical Habitat. An attachment provides quotes from the Federal Register designation, but the mandate to provide extra protection for owls in critical habitat has not been strong.

Connectivity:

The east side of the watershed abuts the Elk Creek Late Successional Reserve (LSR #224), where management activities are intended to enhance older seral characteristics to provide habitat for a variety of species.   Eight miles to the west is LSR #223 at Goolaway/Snow Creek.  The NW Forest Plan provides for connectivity across matrix lands via 100 acre owl cores and by riparian reserves, and by connectivity blocks.  I recommend two steps to maintain additional stepping stones of habitat a corridor along the northern third of the watershed  between the large LSRs.  Firstly, leave another 50 to 80 acres of older habitat adjacent to the productive 100 acre owl cores (Off The Wall, West Fork Trail, Long Prairie) to maintain successful nesting.  Also leave older seral stepping stone "nodes" of 40 to 80 acres each in Tiller sections 34 and 35, and BLM sections 1, 3, 28, 29, 31, 32, 33.  Some of these sections are also critical habitat.  Sections 31 and 3 also happen to be RMP designated (pg 189) and NFP designated (pg C-42) " connectivity blocks", where management is required to maintain 25% of the block in a late-successional condition.  Stands providing the extra connectivity would be managed on a long rotation, with individual stands being rotated over time.  Connectivity would benefit an array of plant and animal species.  Harvest of older stands on all ownerships in the past two decades has resulted in increasing fragmentation of suitable owl habitat.

USFWS Consultation:  Programmatic consultation packages for the Rogue Basin (Medford BLM, Rogue River National Forest, Siskiyou National Forest) for years 1997-1998, and for years 1999-2000 (biological opinion dated 18 September 1998) provided Endangered Species Act formal consultation compliance with USFWS for proposed land management activities in those years.  As long as threshold levels of disturbance are not exceeded, the programmatic package covers most anticipated land management activites within the watershed.  BO 1-7-96-F-392 covers actions other than timber sales through 2005.

Suitable Habitat:  Suitable spotted owl habitat was classified in 1995-96 by aerial photo interpretation, and entered on a GIS overlay (see appendix map).  There are 13,586 BLM acres in the 35,306 acre watershed.  McKelvey 1 habitat provides suitable nesting, with a current 1,820 acres on BLM. McKelvey 2 habitat provides suitable roosting/foraging , with a current 3,715 acres on BLM. This suitable owl habitat totals 40.7% of the BLM acreage, or 15.7% of the total compartment.   There is additional suitable habitat on USFS lands, and a small amount on private ownership.  There is ample dispersal habitat in 40-60 year old stands across the watershed.  There are no sold-but-unlogged sales on federal land within.

Owl Core Protection: Historic owl sites on federally managed lands have received a 100 acre LSR core area, where the only projected harvest would be felling (but not removal) of danger trees along roadways.  Boundaries of these cores are occasionally adjusted, but the cores are to be maintained long-term to provide refugia and dispersal for a variety of older seral preferring wildlife and plants. According to the NFP the cores must be maintained, even if the site burns or the owls disappear. Under the Oregon Forest Practices Act, owl sites on private lands are to receive a 70 acre core.  This core can be logged if it is demonstrated that the owls have been absent for 3 years.  A 100 acre core surrounded by nonsuitable habitat is not considered sufficient to maintain successful reproduction.  Any new owl sites discovered after 1994 (includes the Canyon Creek site) will not receive a 100 acre core.

Other Listed Species

Vernal Pool Fairy Shrimp - First identified in spring 1998 on the Table Rocks and Agate Desert near Medford. No vernal pool habitat (perched water table) has been located in the watershed.

Marbled Murrelet - The watershed is more than 75 miles inland, and in the Rogue Basin there have been no detections further than 35 miles inland.

SURVEY AND MANAGE (NFP pg C-4)

Red Tree Vole

Surveys in the northern third of the compartment were begun in September 1998. Vole nest detections thus far are dense. Surveys will continue through October, and be continued in fall 1999 before any ground-disturbing activites commence.

Great Gray Owl (protection buffer species)

The first year (of two scheduled) of six protocol surveys were run on 15 routes on BLM in April through June 1998. Thus far there have been detections in three areas. More routes are to be added in 1999. Tiller Ranger District had an additional detection in the northern portion.

Great Grays seem to select open stands or recently cut areas for foraging, as well as meadows. Nesting habitat can be a variety of timber stands, as long as it's near (within 1,000 ft) of the foraging area. Nests have been found on the Medford District in previously partial cut stands. Great Grays are more difficult to detect than spotted owls, and Grays could nest throughout the watershed. Current guidance (NFP pg C-21 ) establishes a 1/4 mile protection zone around known nest sites (an "unmapped LSR"). ROD mitigation (pg. 47) includes providing a 300 foot no-cut buffer around meadows and natural openings. However, the owls often shift core areas in subsequent years.

Salamanders

Survey and Manage (S & M) salamander species found on the Medford District include the Siskiyou Mountain salamander and the Del Norte salamander. Neither have ever been detected within 25 miles of the watershed, so protocol surveys are not mandated. Ten small ponds or pump chances were surveyed for amphibian presence in 1994 through 1996. No sensitive or S&M species were detected. Species identified included rough skinned newt, tree frog, Pacific giant salamander, and bullfrog.

Molluscs

There have been no mollusc surveys performed yet. Surveys here are currently scheduled to begin in

Spring of 2000. We would expect to find the taildropper slugs in forested habitats throughout the watershed, and potentially several of the other S & M snails.

Bats

Surveys for S&M bats are not yet mandated, and protocols have not been finalized. One pump chance at Romine Creek was mist netted in August 1995. Species detected included the long-legged myotis, silver-haired bat, and the big brown bat. No old mine adits or caves have been identified nearby. There are probably numerous bat roosts in cracks and crevises of the many cliffs.

GAME SPECIES

This description is from a conversation with John Thiebes (Oregon Dept. of Fish & Wildlife) on 24 Sept 98. The watershed is bisected by the Tiller-Trail Highway 227, with the east portion comprising about 5% of ODFWs Dixon Unit (#22), and the west portion comprising about 10% of the Evans Creek Unit (#29).

Roosevelt Elk

Evans Creek Unit - Current population is at 65% of benchmark target of 900 animals. The goal sex ratio is 10 bulls per 100 cows. Current level is 14 for the past three years (95, 96, 97). For the Dixon Unit, benchmark target was not available. The target sex ratio is 10 bulls, with the current three year average at 11.

There have been no special hunts, none are anticipated, and no antlerless hunting, and no limit on the number of tags for deer or elk. No hazing or kill permits (to chase animals away from croplands) have been issued in the watershed in recent years. ODFW has one helicopter survey route that covers a quarter of the watershed that is flown in February.

Black-tailed Deer

Evans Creek Unit - Are currently above the benchmark goal of 9,600 animals. The sex ratio goal is 20 bucks per 100 does, with current levels at 22 for the past three years. But in the Trail Creek subunit, the ratio is probably below target. The benchmark goal was not available for the Dixon Unit. Target ratio is 25 bucks per 100 does, with a current three year average of 22. Currently there are 900 doe tags available.

ODFW began the South Cascades Black-tailed Deer Study in 1995, radio tagging deer to follow their movements and survival. This is the last year for adding newly tagged individuals, that will be monitored for another three years. Telemetry has shown that deer from north of Prospect and as far east as Crater Lake Park funnel into the south Trail Creek area to winter.

About half the watershed is considered to be deer winter range (see Appendix map). Mitigation on winter range (RMP pg. 2-33) includes closing roads, maintaining 20% of the area in thermal cover (70% canopy closure, 40 ft tall), and limiting disturbance activities from 15 November to 1 April.

JACTMA Road Restrictions

Hunting pressure is average, and poaching pressure is above average. ODFWs goal for road density here is 1.5 miles of open road per square mile to reduce poaching and winter harassment. In 1995, ODFW, in cooperation with BLM, US Army Corps of Engineers, and Boise Cascade, implemented the Jackson Access Cooperative Travel Management Area (JACTMA). The plan provides seasonal closure of roads in three comparments. The southern six sections (36, 31, 32, 1, 6, 5) of the watershed are within the Boswell Mountain compartment (see Appendix map). Some roads remain open, and most lower standard roads are closed by a "green dot" system from 15 November thruouh 1 April.

Objectives of the restrictions are to 1) assure continued hunter and angler access, 2) increase wildlife habitat effectiveness, 3) reduce soil erosion, road maintenance, vandalism, forest fires, timber theft, and garbage dumping, 4) improve wildlife protection, 5) promote watershed health, 6) increase quality hunting opportunities. The plan includes the employment of a state police trooper to enforce the restrictions. A segment of the local population remains strongly opposed to any limits on road use

Other Game

Bear and cougar numbers are at all time high numbers. ODFW estimates that bear density is over one animal per square mile. There is an ongoing cougar research project just north on Tiller Ranger District. With the ban on hunting using dogs, bear and cougar populations will continue to increase.

For game birds, the state runs one grouse & quail route each July. Populations are stable. Wild turkey numbers are increasing.

OTHER WILDLIFE

Raptors - Northern Goshawk surveys will begin in summer 1999. There are no known nesting pairs, but they probably occur. The RMP (pg 57) says to "protect all nest sites", with current guidance (IM-OR-98-12) to maintain a 30 acre core area and an additional 400 acre post fledging family area (PFFA) comprised of the best available habitat. On 23 June 98, USFWS denied a petition to list the goshawk as a T&E species. The nearest osprey nests is a mile outside the watershed and along the Rogue River. No golden eagles, prairie falcons, coopers hawks have been recorded, but they could nest here.

Furbearers such as fisher, martin, ringtail may occur sparsely. Fishers were introduced into the Prospect area several decades ago, and now a telemetry and remote camera monitoring project is studying these species just east of the watershed. Lynx, wolverine, wolf are other species of concern which have never been documented near the watershed.

## SPECIAL HABITATS

As mentioned in the peregrine discussion, there are more large (over 50 ft tall) cliffs in this watershed than in the rest of the resource area. There is also more talus habitat than elsewhere. There are no mine adits (bat habitat) or caves, but there could be caves at the base of cliffs. Recreational rock climbing is increasing.

Other than pump chances, there are no large ponds or reservoirs. There is a millpond at the old Wilson mill along Trail Creek, and a helipond at Cold Creek (T33S-R1W-S32-SW)

There are large grassy rocky meadows in the eastern portion. Under RMP direction (pg 54) and ROD direction (pg.47), these are to receive a 300 foot no-cut buffer to benefit protection buffer species such as Great Gray Owls.

Oak woodlands in lower elevations provide unique habitat for woodpeckers, turkey, deer, small mammals, and reptiles. RMP direction (ROD pg 46 ) is to utilize prescribed fire to maintain habitat condition within the white oak woodland communities. One ongoing project is at Cold Springs (T34S-R1W-S5). There are numerous other areas where potential projects could be undertaken. In some areas, patches of dense wedgeleaf or conifer encroachment is reducing oak habitat.

Spotted Owl sites in the Trail Creek Watershed Analysis vicinity.

Reproductive status by year, updated through September 1998.

| Site no. | Site name | Last yr active | Last yr young | 93 | 94 | 95 | 96 | 97 | 98 |
|---|---|---|---|---|---|---|---|---|---|
| 403 | Snowshoe Spring usfs | 96 | 94 | NR | R1 | R0 | SM | -- | N0 |
| 410 | West Fork Trail usfs | 98 | 98 | SM | NO | -- | -- | -- | R2 |
| 409 | Long Prairie usfs | 98 | 94 | NR | R2 | NR | -- | -- | UN |
| 3394 | Off The Wall | 98 | 98 | SM | UN | NO | R2 | NR | R1 |
| 1832 | Trail Creek | 88 | -- | NO | NO | NO | NO | NO | NO |
| 1823 | Trailhead | 87 | -- | NO | NO | NO | NO | NO | NO |
| 2625 | Toothacher | 98 | 97 | UN | R1 | UN | RO | R2 | NR |
| 0926 | Walpole | 94 | -- | SM | SM | NO | NO | NO | NO |
| 1949 | Millcat Trail | 96 | 89 | UN | NO | NO | SM | NO | NO |
| 4027 | Paradise Creek | 98 | 98 | UN | R1 | UN | R1 | R2 | R1 |
| 2630 | Paradise East | 93 | -- | SM | NO | NO | NO | -- | SM |
| 2629 | Upper Canyon Creek | 97 | -- | SM | NO | SM | NO | SM | NO |
| 4381 | Canyon Creek | 95 | -- | -- | -- | SM | -- | -- | -- |
| 2219 | Clear Creek usfs | 98 | 96 | UN | NR | NR | R1 | -- | NR |
| 1822 | Romine pvt | 93 | -- | SM | NO | NO | NO | -- | -- |
| 3395 | Wally Rollo pvt | 93 | -- | SM | NO | NO | -- | SM | NO |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3396 | East Chicago pvt | 93 | -- | SM | NO | NO | -- | NO | NO |

Legend:

| | |
|---|---|
| UN | Reproduction unknown for year, adults present. |
| -- | No survey or information, or site not located yet. |
| NR | Pair present, but not reproductive for year. |
| R1 | Pair reproductive, followed by number of young. |
| NO | No response, site presumed not occupied. |
| SM | Single male. |
| SF | Single female. |

Wildlife Appendix : Clarification on Critical Habitat Designation

The following are quotes from the Federal Register notice (43 pages) of the designation of Critical Habitat Units for the northern spotted owl. This information is the only guidance statement available from US Fish & Wildlife Service on how these lands should be managed, and it preceeds the NW Forest Plan by two years. Federal Register, 50 CFR Part 17, Vol 57 No 10, Wed Jan 15 1992, pages 1796 - 1838.

Pg 1796. " Critical habitat is defined ... as the specific areas ... on which are found those physical and biological features (i) essential to the conservation of the species, and (ii) that may require special management considerations or protection."

" ... critical habitat serves to preserve options for a species eventual recovery. Critical habitat helps focus conservation activities by identifying areas that contain essential habitat features (primary constituent elements) regardless of whether or not they are currently occupied by the listed species ..." "Aside from the added protection provided under Section 7, the Act does not provide other forms of protection to lands designated as critical habitat."

Pg 1797. "Specific management recommendations for critical habitat are more appropriately addressed in recovery plans, management plans, and through section 7 consultation." Primary Constituent Elements: "Such physical and biological features ... include, but are not limited to, the following: - Space for individual and population growth, and for normal behavior; - Food, water, or other nutritional or physiological requirements: - Cover or shelter; - Sites for breeding, reproduction, rearing of offspring; and - Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species."

Pg 1803. "The Service's primary objective in designating critical habitat was to identify existing spotted owl habitat and to highlight specific areas where management considerations should be given highest priority to manage habitat." "... the Service relied upon the following principles: - Develop and maintain large contiguous blocks of habitat to support multiple reproducing pairs of owls; - Minimize fragmentation and edge effect to improve habitat quality. - Minimize distance to facilitate dispersal among blocks of breeding habitat; and - Maintain range-wide distribution of habitat to facilitate recovery."

"The definition of 'suitable habitat' was generally equivalent to the structure of Douglas-fir stands 80 or more years of age (with adjustments for local variation or condition)." "Critical habitat units minimize distance between adjacent units, thereby facilitating dispersal and linkage."

Pg 1804. "Since critical habitat designation is not a management plan, there was not a limitation on the size of the area added to any HCA ... . Primary consideration was given to existing suitable habitat and known pairs of spotted owls, particularly where the Service felt that additional protection should be considered and would enhance the existing HCA."

Pg 1805 “Although the designation of critical habitat emphasizes the importance of maintaining suitable habitat for all four constituent habitat elements, nesting and roosting habitat should be emphasized to improve opportunities for successful linkage.” “Not all suitable nesting and roosting habitat was included in critical habitat.”

Pg 1806. “The emphasis for future management will be on maintaining or developing habitat that has the characteristics of suitable nesting and roosting habitat and to avoid or reduce the adverse effects of current management practices.” “The Service analyzed the economic effects of the ... proposal to designate critical habitat.”

Pg 1809. “ The revised proposed rule for the designation of critical habitat ... published on August 13 1991 ... encompased a total of approximately 8.2 million acres.” “ As a result of the exclusion process, the Service is designating approximately 1.4 million acres less ...” “The final rule ... encompassing a total of nearly 6.9 million acres ... 62 percent of the total originally identified in the May 6 proposal.” 1.2 million acres of Bureau land.

Pg 1801. “State, private, tribal, and other non-Federal lands are not designated as critical habitat even if they are physically situated within the boundaries of critical habitat units.”

Pg 1822. “Section 7 prohibitions against the destruction or adverse modification of critical habitat apply to actions that would impair survival and recovery of the listed species, thus providing a regulatory means of ensuring that Federal actions within critical habitat are considered in relation to the goals and recommendations of a recovery plan. As a result of the link between critical habitat and recovery, the prohibition against destruction or adverse modification of the critical habitat should provide for the protection of the critical habitat’s ability to contribute fully to the species’ recovery.”