CHAPTER 1: EROSION

CHARACTERIZATION

The locations of dominant erosion processes correspond to geologic features. See "The Geological basis for the Erosional Patterns in the Subwatershed" in the Erosion Appendix. Also, see Map EROD-1: Predicted and Confirmed Landslide Distribution, which is modified from the geology map published by Baldwin (1961). The erosion processes are discussed in detail in *Slope Stability in Road Construction* (Burroughs *et. al.* 1976).

Table EROD-1: Dominant Erosion Processes and Their Locations Within the Subwatershed

Erosion Processes	Location
Debris avalanches and debris torrents (photo figures 3 & 5)	Most commonly occur in the Bateman Formation and in the Elkton member immediately below the contact with the Bateman Formation, and on steep north facing slopes. They also occur in both the Tyee Formation and the Elkton member on steep slopes above the outside bends of the Umpqua River.
Recent deep-seated failures: rotational slumps and earthflows (photo figure 4)	Most common in the Elkton member. The soil associations, as mapped by Townsend *et. al.* (1977), that include Apt soils (mapping code 50) are risk areas. Map EROD- 2 is the soils map for this area from that inventory.
Ancient deep-seated slumps	Located on the Elkton member and areas previously mapped as Quaternary landslide debris (Baldwin 1961). The largest concentrations are on long, gentle to moderate south-facing slopes north of the Umpqua River, Hedden Creek and north of Hedden Bluff (see Map EROD- 1). Within these large features, small debris avalanches on the scarp, and small deep-seated failures elsewhere (particularly on the slump's toe) occasionally occur.
Chronic erosion processes (photo figures 8, 9, 10, 16 & 19)	Soil creep occurs to a greater or lesser degree throughout the subwatershed. Fine sediment bleeding into streams occurs where streams pass through deep-seated failures. Surface erosion is associated with unvegetated cuts, fills, ditches, dirt road surfaces, and where activities expose bare soil.

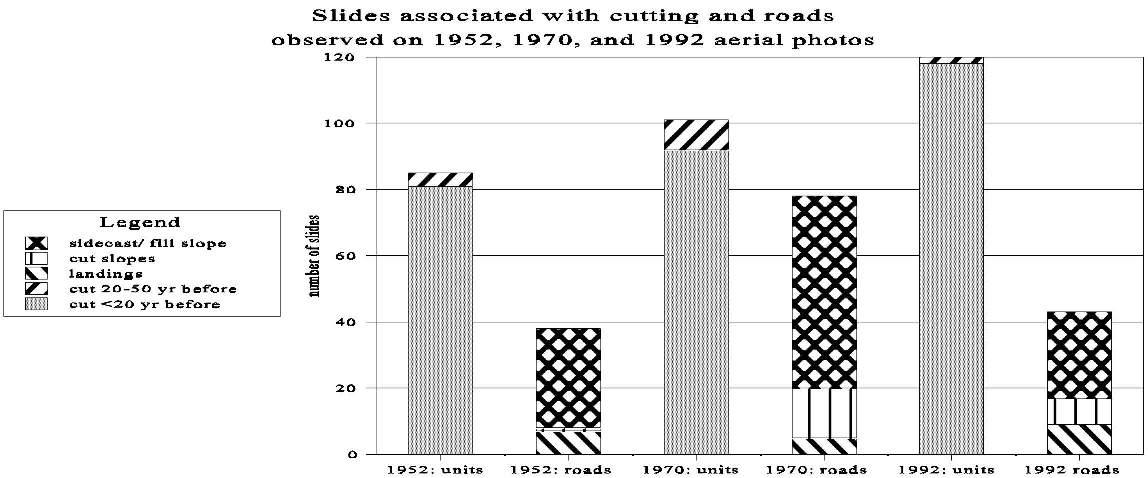
Table EROD-2: Relative Rate of Landsliding by Geological Formation and the Percent of Those Slides Delivering Sediments to Streams Based on the 1952, 1970 and 1992 Aerial Photos

	Bateman	Tyee	Elkton	Qal	Qt	Ql	Total
Total Slides	**191**	**37**	**252**	**4**	**6**	**5**	**495**
Acres	3978	2776	15586	2889	605	3200	29034
Slides/100 acres	4.8	1.3	1.6	0.1	1	0.2	1.7
% Delivering Sediment to Streams	**60.2%**	**43.2%**	**35.3%**	**50.0%**	**66.7%**	**0.0%**	**45.7%**

CURRENT CONDITIONS

The aerial photo landslide inventory showed an increase in the number of slides originating inside clearcut units from 1952 to 1992. The number of slides per 100 acres of management affected area was not determined due to time constraints. The severity of cutting and yarding impacts on a site-by-site basis subjectively appears to have decreased over time, due to the decreased use of cat logging and ground leading, and a corresponding increase in partial and whole-log suspension. Therefore, the increase in number of slides originating inside cutting units is likely to be a function of an increased rate of cutting over time.

The logging road construction on steep ground began in the 1950s, and the rate of construction peaked during the 1970s. The highest number of road-associated slides was observed on the 1970 photos. The



Graph Erod 1

percent of large (1,000 to 5,000 square yards) road-associated slides decreased from 1952 to 1970 and again from 1970 to 1992 possibly reflecting improvements in road construction methods (see Tables, E-9, E-10, E-11, and Graph E-2 in the Erosion Processes Appendix).

Landslides associated with fires that had burned 20 to 50 years before each flight date have declined: 12 in 1952; 5 in 1970; none in 1992. This is due to the near exclusion of fire as a disturbance agent during the last 50 years. Landslides in stands more than 50 years old have varied with 3 in 1952, 11 in 1970, and 7 in 1992. Aerial photo slide counts for stands more than 20 years old will under-represent the true number of slides due to the difficulty of seeing through a closed forest canopy.

Large, ancient, deep-seated failures move very slowly down hill, disturbing (even altering) drainage patterns and causing road-cuts to slump into ditches and road grades to change. Road-cuts across the toe of these deep-seated failures can reinitiate the movement of those features by removing the natural buttressing formally provided by the excavated material.

See Landslide History in the Erosion Appendix for an expanded discussion and analysis on landslide patterns. That part of the appendix is based on the Mass Wasting Module - level one assessment described in the Standard Methodology for Conducting Watershed Analysis, ver. 1.10 (Washington Forest Practice Board 1992).

Based on the assumptions and predictive model in the Surface Erosion: Roads Module, described in the Standard Methodology for Conducting Watershed Analysis, ver. 1.10 (Washington Forest Practice Board 1992), the three variables that most effect sediment deliveries in this watershed are the type of road surface, the amount of road use, and timely vs. delayed road maintenance.

Variation in vegetation cover on cut-slopes was also a factor encountered in this subwatershed. However, based on the module assumptions, lack of vegetation on the cut slopes was a distant fourth in terms of the amount of sediment potentially delivered to streams. See the Surface Erosion Evaluation section in the Erosion Appendix for expanded discussion. Appendix Table E-1 in the Erosion Appendix summarizes the surface erosion evaluation findings by road.

The risk of road-surface erosion contributing sediment to a stream is related to the road's proximity to the stream (Washington Forest Practice Board 1992). Ridge-top roads and roads on benches away from streams are unlikely to contribute sediment to streams, whereas stream-side roads, and roads that cross draws, do have the potential to add sediment to streams. The road surface evaluation results show most of the BLM roads in this subwatershed to present a low sediment hazard, particularly under the current management with its system of reserves. The mid-slope roads at stream crossings and streamside gravel roads can present a sediment hazard under heavy road use conditions. Private roads were not evaluated and the reader is cautioned not to extrapolate observations from BLM roads to private roads. The differences between BLM and private roads that influence the potential for contributing sediment are differences in maintenance practices, relative densities of roads close to streams, surface types, density of points where roads cross streams, and the harvest level, which affects log and dump truck traffic levels. Map EROD- 6: Intersection of Roads and Streams, illustrates relative stream crossing and road densities across the subwatershed. Each dot on that map is the point where a road crosses a stream. The density of stream crossings is greatest on private land at the lower elevations.

The relative benefits of different treatment options for reducing road surface related erosion are illustrated by starting with a hypothetical mid-slope road segment that intersects a stream and is characterized as in-sloped, the cutslope supports 50% vegetation cover, the fill slope supports 100% vegetation cover, and the road has a 4" to 6" deep rocked surface. The following table shows how various road improvements affect sediment production.

Table EROD-3: Tons of Sediment/ Acre of Road/ Year Predicted for Different Management Scenarios

	administrative use only		1 to 4 log trucks/day		>4 log trucks/day	
	tons/ac of rd/yr	hazard rating	tons/ac of rd/yr	hazard rating	tons/ac of rd/yr	hazard rating
As described	11	Low	27.8	Low	216.8	High
Increase cut slope vegetation to 80%+ only	9	Low	25.8	Low	214.8	High
Change to an out slope road, no other changes	9.9	Low	25	Low	195.1	High
Increase rock depth to > 6 inches only	8.9	Low	23.6	Low	127.6	Medium
Increase rock depth to > 6 inches; outslope; increase vegetation on cut to > 80%	6.9	Low	15.3	Low	109.8	Medium
Increase cut slope vegetation to 80%+ and pave the road surface	5.1	Low	6.4	Low	20.8	Low

Table EROD-4: Known and Suspected Management-Related or Accelerated Erosion Inside the Subwatershed

Condition / Situation	Comments
Slumps and Slides Associated with Roads	Sawyer Ck. is cutting the toe of a slump in sect. 5, T.23S., R.8W. Slump is further destabilized by the 22-8-29.2 road. Cut bank failure recently put soil into the ditch. The Nov. 18, 1996 storm caused additional failure. (Photo figures 12 & 13)
	Hedden Ck. Rd. requires above normal maintenance effort because of slides and rock falls where there are 30 to 40 ft. high cut banks.
	Gould Creek Rd. (22-08-22) has a slumping problem in the area where it crosses from sect. 22 to sect. 27 (Dennis Graham per. com.)
	The Nov. 18, 1996 storm precipitated numerous other slumps and slides on the Sawyer Ck. Rd. and other roads in the Sawyer Creek area. Hedden Ck. Rd. in T.23S., R.8W., section 3 closed by slides as a result of the same storm.
	Blocked culverts and filled ditches on unmaintained/ infrequently maintained roads can cause water to flow across the road onto a fill causing failure (photo figure 7).
Landing Failure Causing Debris Avalanche	2 failures and 1 landing with potential to fail noted, all on private land.
Eroding Running Surface on the Dirt Segments of 23-8-12.0 & 23-8-16.0	Observed gully formation on road surface, also small cut and fill failures. The segments visited do not appear to contribute sediment to any stream.
Eroding running surface on gravel roads, and plugged culverts that are attributable to insufficient or deferred ditch line maintenance	Noted almost exclusively on roads used for administrative access, and infrequently used roads, for example the 23-8-23.2 road. There are several other spur roads, both BLM & private, that show some surface erosion. Flat road surface (not crowned nor outsloped) is a contributing factor on some roads. (Photo figure 8)
In-unit slope failures, not road related	Scattered examples seen in October 1996. After the Nov. 18, 1996 storm, numerous in unit slope failures noted primarily in units on the Elkton geologic member. Slope gradient is a good predictor of risk in that most slides occur on land >65% slopes. Slope failures also associated with convergent topographic features, which concentrate water. (Photo figure 11)

REFERENCE CONDITIONS

The historical erosion processes are debris avalanches, debris torrents, earth flows, deep-seated failures (rotational slumps), soil creep and chronic bleeding of fine sediments into streams that pass through deep-seated slumps. Peak erosion periods were associated with high intensity storms. These historical erosion processes occurred in the same locations noted in the erosion characterization section.

Table EROD-5: Past Management-Related or Accelerated Erosion in the Subwatershed

condition/ situation	comments
Slumps activated as result of roads	Major failures on the lower part of Hedden Ck. Rd. (Sect. 35, T.22S., R.8W. and sect. 3, T.23S., R.8W., Will. Mer.) forced the rerouting of that road. All attempts to stabilize the original road failed. (Terry Evans, per. com.). BLM relinquished the easement for the by passed slide-prone segments of the Hedden Ck. Rd. in sections 34 and 35 (Dennis Graham, per. com.).
Sidecast road construction	Sidecast road construction on the Luchsinger Ck. and Hedden Ck. Roads resulted in considerable soil displacement and subsequent slope failures. Sidecasting was standard practice used to build nearly all roads before 1970. Practice was phased out on steep ground during the 1970s and 1980s.
Common practices in this and other subwatersheds before the 1970s that have since decreased due to changes in regulations and policies (a partial list)	-Leaving landing debris overhangs that could fail resulting in debris avalanches -Dirt roads -Widely spaced ditch relief culverts -Stream crossing culverts were designed to pass 25 year storm events -Ditches on actively used roads were regularly graded removing ditch line vegetation. -Cat trails close to and crossing streams -Ground lead logging, on steep ground
In-unit slope failures, not road related	Slope gradient is a good predictor of risk in that most slides occur on land >65% slopes. Slope failures are also associated with convergent topographic features, which concentrate water.

Extremely large but infrequent erosional episodes were associated with major earthquakes, causing large deep-seated slumps (Lloyd Fritz per. com.), and large stand replacement fires. Surface erosion peaks in the first winter following the fire. The risk for earth flows, debris avalanches/ torrents peaks about 5 years after the event and taper off until about 15 years after the fire. The mass failure pattern corresponds to loss of root strength following vegetation mortality and subsequent reoccupation of the site by regeneration (Swanson *et. al*. 1982; Swanston and Swanson 1976).

Under undisturbed conditions, overland flow of water, even during heavy rainstorms, is rare in the Coast Range. The vegetation canopy, duff and litter layers, and the topsoil's naturally high infiltration rates all contribute to minimizing surface runoff (Craig Garland per. com.)

SYNTHESIS & INTERPRETATION

Changes between historical and current erosion processes: The most significant human-caused changes between historical and current erosion processes are not unique to this subwatershed. The Oregon Forest Practices Act was passed in 1971, and revisions over the years have resulted in incremental improvements in road construction methods, and stream and riparian vegetation protection on private land. Federal land management practices have also changed over the years, resulting in reduced soil erosion and subsequent sediment entering streams. See the Erosion Appendix for a list of changes since 1969 that affected the entire Coos Bay District.

Several main access routes in this subwatershed are water grade roads. These roads, depending on surface type, maintenance, and distance from the stream, can be chronic sediment sources. They affect the volume and timing of landslides that reach the stream, both as interceptors of upland slides and as slide initiation points. Roads built close to streams can also confine channels, and reduce the area in riparian vegetation. All these make stream side roads candidates for possible closure. However, reciprocal right-of-way agreements will make it difficult to close some streamside main haul roads. See North Coquille Watershed Analysis (USDI 1995), Section VIII. Road Access (Issue #8) for discussion on reciprocal right-of-way agreements. This may limit management options for many of these roads to engineering and maintenance solutions.

Late-Successional Reserves and Riparian Reserves designated by the ROD-RMP (USDI 1995) will reduce the area available for timber harvest and, therefore, reduce the number of in-unit slides. Vegetated Riparian Reserves filter chronic sediment delivery and will either intercept or modify the composition of in-unit slides that would otherwise reach streams. Less logging translates to reduced road construction. Reduced construction, application of best management practices, and improved construction standards and maintenance have already reduced both the number and average size of slides associated with roads. High densities of relief culverts appear to be an effective technique for keeping ditch water out of streams, thereby reducing chronic sediment delivery to streams.

Between the stand age distribution on all lands, and the system of reserves on Federal land, there will be few periods of heavy log truck traffic for a decade or more inside this subwatershed (Paul Fontaine, and Brian Thauland per. com.). Most logging traffic will be associated with commercial thinning and density management; these sales are unlikely to generate more than 4 truck loads per day. However, it is plausible that 2 or more sales could together result in more than 4 trucks per day using the same haul road for short periods. The most heavily used main haul roads under BLM control (Sawyer Ck. Road, Smith Ridge Road and Waggoner Ck. Road) are all paved. Considering the relative amount of sediment delivered from a paved surface verses a gravel surface with > 6 inches of rock, an investment in additional paving is not justified where road use is less than 4 log trucks per day. Dollars for paving should go to other subwatersheds where there is greater activity. However, if conditions change or future analysis predicts an increase of hauling to > 4 trucks/ day on a given segment of water grade or mid-slope road, paving would be justified because it will cut sediment production by 90 tons/ acre of road/ year, compared to a road with > 6 inch thick rock surface.

Much of the gentle ground in this subwatershed (excluding flood plains and terraces) are old slumps. Finding stable ground for end haul sites, in compliance with Best Management Practices (Appendix D, USDI 1995), will be difficult in this subwatershed.

Influences and Relationships Between Erosion Processes and Other Ecosystem Processes: The background rate of sediment entering the streams in the Elkton member is higher than in the rest of the Tyee Formation or the Bateman Formation. The Elkton member has more siltstone, which weathers into clay and silt more readily than does sandstone. The Elkton member has more deep-seated failures, resulting in a higher proportion of inner-gorge failures and chronic bleeding of fine sediments into the streams.

The mechanism predisposing a site to slope failure (following denuding by either fire or cutting), is the loss of root strength. Soil saturation is often the immediate slide-triggering mechanism. The interaction of fire and intense storm events, and their influence on the frequency and timing of landslides is not unique to this subwatershed. See the Erosion Appendix for an expanded discussion.

Some streamside flats may be slide deposits rather than a product of alluvial deposition. Locations of landslide created flats are stream junctions, and places in the Elkton member where streams have cut the toe of the slope causing large deep-seated failures.

Right-of-way brushing can expose bare soil to erosion where scotch broom has shaded out herbaceous ground cover on road cuts, fills, and ditches.

Increasing vegetation cover to more than 80% on cuts, fills and ditch lines will help reduce overall sediment production. However, increasing vegetation cover will not have as significant of an impact on sediment production as maintaining/ improving the running surface and controlling road use during extremely wet periods. The most significant opportunity for increasing vegetation cover is on the cut slope.

REFERENCES

Baldwin, E.M. 1961. *Geologic Map of the Lower Umpqua River Area, OR: USGS Oil and Gas Investigations Map OM-204*.

Burroughs, E.R.; Chalfant, G.R.; Townsend, M.A. 1976. *Slope Stability in Road Construction - A Guide to the Construction of Stable Roads in Western Oregon and Northern California*. BLM, Ore. State Office. Portland, OR. 102 pp.

Evans, Terry. Forester, Umpqua Resource Area, Coos Bay District-BLM.

Fontaine, Paul. Forester, Umpqua Resource Area, Coos Bay District-BLM.

Garland, Craig. Former Soil Scientist for the Coos Bay District-BLM, now retired.

Fritz, Lloyd. former Geologist for Coos Bay District-BLM, now retired.

Graham, Dennis. Engineer, Umpqua Resource Area, Coos Bay District-BLM.

Swanston, D.N.; Swanson, F.J. 1976. *Timber Harvesting, Mass Erosion, and Steepland Forest Geomorphology in the Pacific Northwest* in Geomorphology and Engineering. D.R. Coates, ed. Dowden, Hutchinson & Ross, Inc. Stroudsburg, PA. pp 199-221.

Swanson, F.J.; Fredriksen, R.L.; McCorison. 1982. *Material Transfer in a Western Oregon Forested Watershed*. in Analysis of Coniferous Forest Ecosystems in the Western United States. US/IBP Synthesis Series 14. R.L. Edmonds, ed. Dowden, Hutchinson & Ross, Inc. Stroudsburg, PA. pp 233-266.

Thauland, Brian. Engineer, Umpqua Resource Area, Coos Bay District-BLM.

Townsend, M.A.; Pomerening, J.A.; & Thomas, B.R. 1977. *Soil Inventory of the Coos Bay District*. USDI, Coos Bay Dist.-BLM, Coos Bay, OR. 259 pp. plus maps.

USDA unpublished data. Soil Survey of Douglas County. USDA Soil Conservation Service.

USDI. 1986. *Timber Production Capability Classification, Handbook 5251-1*, BLM Manual Supplement, Coos Bay Dist. Edition, May 1986, Ore. State Office, Portland OR. 46 pp.
USDI. 1995. *Coos Bay District Record of Decision and Resource Management Plan, May 1995.* Coos Bay Dist.-BLM, North Bend, OR. 99 pp. plus appendices and maps.
USDI BLM-Tioga Res. Area. 1995. North Coquille Watershed Analysis First Iteration. Unpublished Document on file at the Coos Bay Dist. Office, North Bend, OR.
Washington Forest Practice Board.1992. *Standard Methodology for Conducting Watershed Analysis Under Chapter 222-22 WAC*- ver. 1.10 Oct 1992.

CHAPTER 2: HYDROLOGY

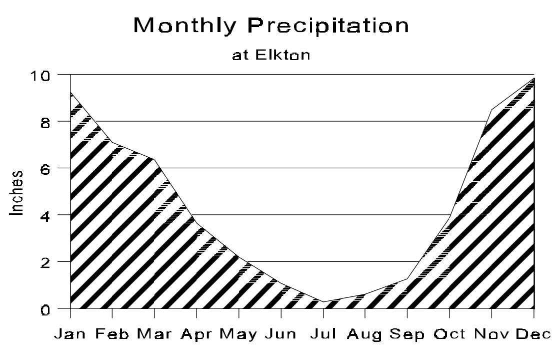
CHARACTERIZATION

The hydrology of the subwatershed is driven by precipitation in the form of rain. The subwatershed does occasionally receive snow, but the quantity and duration of the snow do not normally produce rain-on-snow events. The peak flows, low flows, annual flows and groundwater levels are all dependent on the amount, intensity and distribution of rainfall as well as the basin geology and geomorphology. The close correlation between precipitation and runoff indicates that this system rapidly translates rainfall into runoff due to: a high drainage density, low bedrock permeability, coarse textured, shallow soils, high precipitation, and steep slopes.

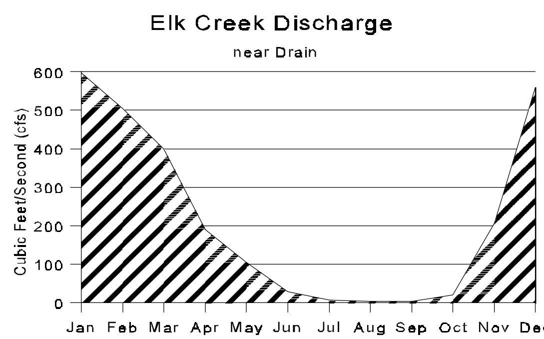
CURRENT CONDITIONS

The average annual precipitation ranges from 50 inches in the lower elevations to 70 inches at the higher elevations. This precipitation produces an average runoff of 2.1 cfs/sq. mile/day or approximately 30 inches annually. Graphs HYD-1 and HYD-2 illustrate that the precipitation pattern and the distribution of annual runoff is directly related. Thus, the peak flows are observed during the winter months and low flows in the summer.

Graph HYD-1

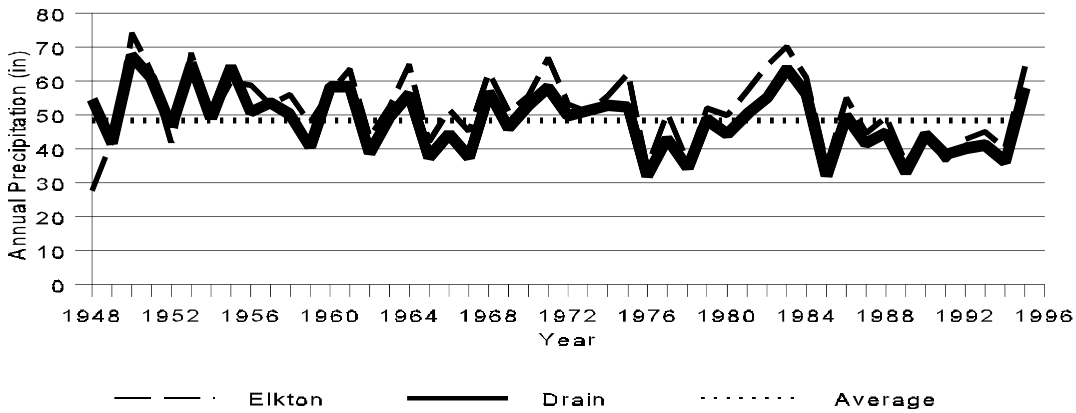


Graph HYD-2



Since the seasonal rainfall pattern is consistent through time, the major factor controlling runoff is the amount of annual rainfall. Graph HYD-3 shows the year to year variation of precipitation. The 1950's and early 1980's were wetter than average, and the mid-1980's to 1994 were below average. Starting in 1995, this pattern has begun to change, with above-average precipitation falling throughout 1996 and into 1997.

Graph HYD-3: Annual Precipitation at Elkton and Drain



HISTORIC CONDITIONS

The nearest U.S. Geologic Survey (USGS) gaging station with a long period of record (1905 - present) is located on the Umpqua River near Elkton. Some peak discharge data was also collected at Sawyer Creek, Elk Creek, and Bear Creek. Precipitation records have also been maintained at Elkton and Drain from 1903 to present. Copies of these records are on file with the Area Hydrologist.

SYNTHESIS AND INTERPRETATION

Evaluating changes between historical and current hydrologic conditions is difficult because of the numerous factors involved and the high degree of natural variability. There is an implied assumption that management activities will change the hydrology of the watershed. However, determining at what level management activities become a problem, strictly from a hydrology standpoint, is difficult. The following are guidelines that were developed through research and are generally accepted.

- 20-30% of the subwatershed must be harvested (in clear cut condition) before a change in streamflow can be detected (Bosch and Hewlett 1982)
- Roads must cover 8-15% of the subwatershed area before changes in streamflow conditions become apparent (Harr 1976; Keppeler and Ziemer 1990).

Again, it should be noted that these are general guidelines that provide one way to evaluate the cumulative effects on hydrology. Table HYD-4 lists the level of roading and 0-30 year old stands in the subwatershed, and may be used to help guide management and prioritize restoration efforts.

Table HYD 4: Acres of Roads and 0-30 Year-Old Stands in Subwatershed by Drainage

Drainage	Total Acres	Ttl Acres Occupied by Roads (%)	BLM Acres by Drainage (%)	BLM Acres 0-30 yr. (%)
Sawyer Ferry	9871	472 (5)	579 (6)	448 (81)
Sawyer Creek	5566	166 (3)	2642 (47)	1667 (66)
Fitzpatrick	2595	55 (2)	1143 (44)	570 (51)
Umpqua Big	5671	228 (4)	303 (5)	157 (54)
Mehl Creek	5822	144 (3)	2584 (44)	1302 (53)

The above listed timber harvest thresholds have been exceeded in all of the drainages, but the specific effects on the hydrology have not been evaluated. It is important to note that the BLM administration is limited in these drainages and most of the timber harvest was completed prior to the Coos Bay District RMP (USDI 1995). The future management on BLM administered lands will be conducted in accordance with the ROD-RMP (USDI 1995) and is strongly tied to the land use allocation.

REFERENCES

Bosch, J.M. and J.D. Hewlett. 1982. *A Review of Catchment Experiments to Determine the Effect of Vegetation Changes on Water Yield and Evapotranspiration*. Journal of Hydrology 55: 3-23.

Harr, R. D. 1976. *Hydrology of Small Forest Streams in Western Oregon*. USDA FS Gen Tech Rpt PNW-55. Denver Service Center, Denver, CO.

Keppeler, E.T. and R.R. Ziemer. 1990. *Logging Effects on Streamflow: Water Yield & Summer Low Flows at Caspar Creek in Northwest California*. Water Resources Research 26(7): 1669-1679.

USDI. 1995. *Coos Bay District Record of Decision and Resource Management Plan, May 1995.* Coos Bay Dist.-BLM, North Bend, OR. 99 pp. plus appendices and maps.

CHAPTER 3: VEGETATION

CHARACTERIZATION

The plant communities in the subwatershed are described by Franklin and Dyrness (1973), and include the *Tsuga heterophylla* zones on the mountain slopes (pages 70-88) and a mix of "interior" valley communities (pages 110-129) occupying the valley bottom and foothills near the Umpqua River. The interior valley communities include *Quercus* woodland, conifer forest, riparian communities, and grasslands. Vegetation on the valley bottom and valley side hills is highly modified by a long history of human use. The most important stand replacement process occurring today is timber harvest and subsequent reforestation.

For general discussions on processes affecting stand structure and landscape patterns see:

- Franklin and Dyrness (1973), and Hemstrom and Logan (1986) for plant succession.
- Averill et al (1995) for an overview on disturbance.
- Oliver and Larson (1990) for vegetation competition and stand dynamics.
- Agee (1993) for fire as a disturbance process.
- Agee (1993) pp. 9, Smith (1962) pp. 413-414, 422, & 499, and Oliver and Larson (1990) pp. 100-106 for wind as a disturbance process.

CURRENT CONDITIONS

Current vegetation patterns are a result of management decisions, harvest practices (along with associated road building), and land ownership.

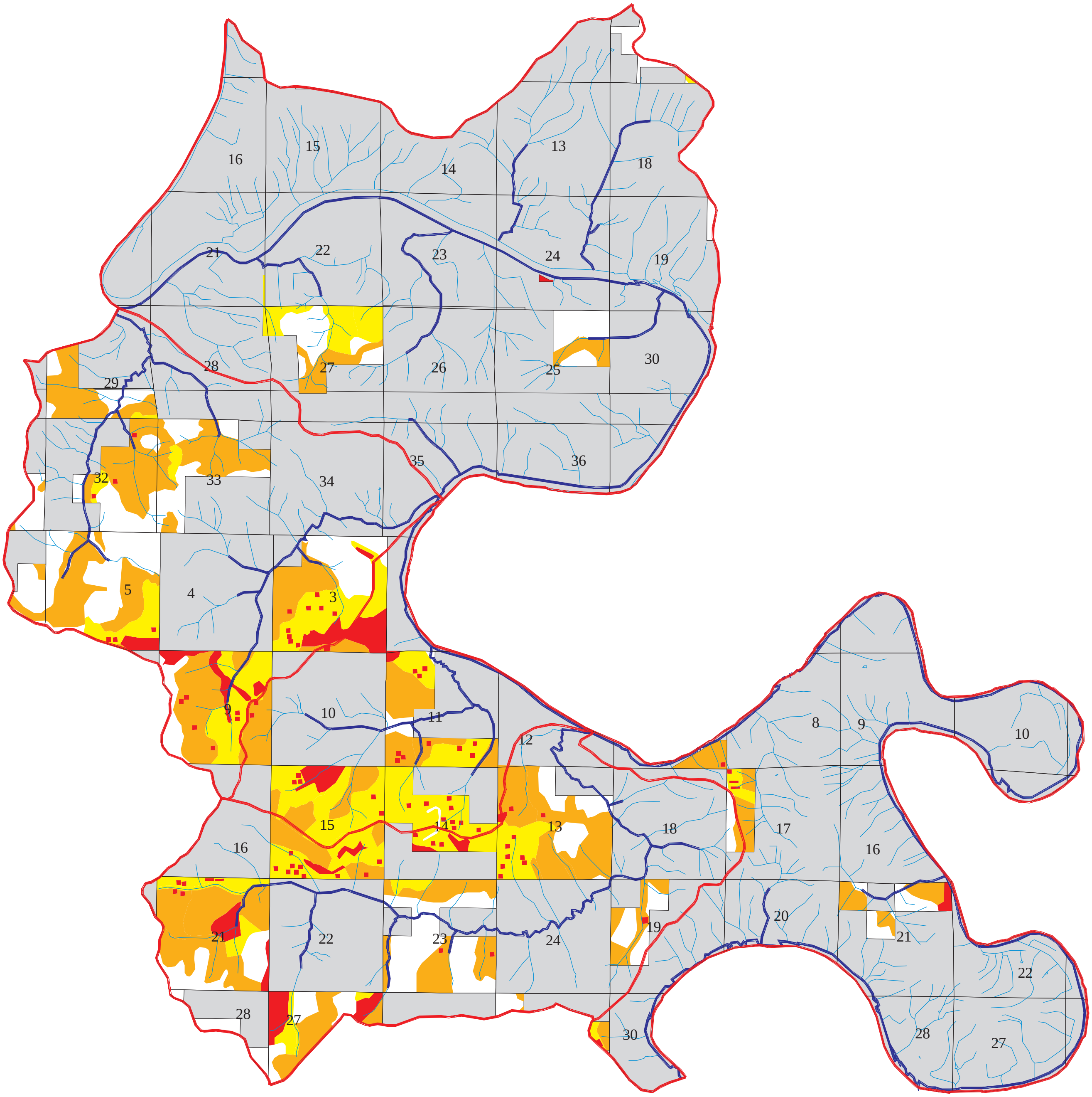
Table VEG-1: Current Land Use Allocation Acres on BLM

Land Use Allocation	Acres (From GIS Data)	Percent of Land Base
Connectivity	206 acres	3%
General Forest Management Area	1,447 acres	20%
Late-Successional Reserve	4,992 acres	69%
Marbled Murrelet Reserve	601 acres	8%
Total	**7,246 acres**	**100%**

See Map VEG-1: Current Land Use Allocations.

MAP EROD-3 TPCC Fragile and Administratively Withdrawn Acres on BLM Lands

UPPER MIDDLE UMPQUA SUBWATERSHED



MAP FEATURES

FGNW or Rock Outcrop	*Non-fragile BLM Lands*
FGPR Lands	*USDA Forest Service Lands*
FGR1	*State, Private or Other Lands*
FGR2	*Fish-bearing Stream*

Scale 1: 89027

0.5 0 0.5 1 miles

0.5 0 0.5 1 1.5 km

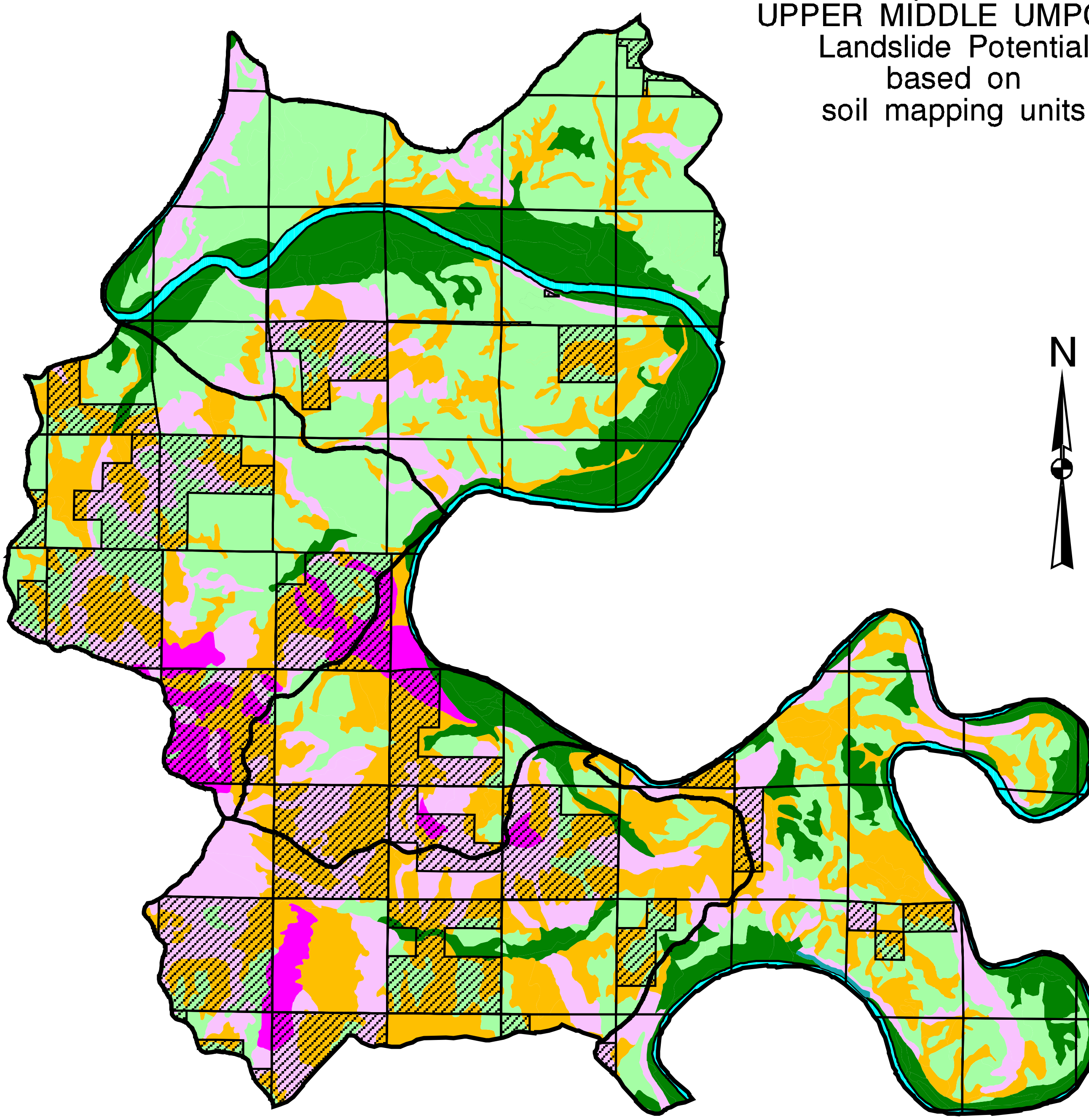
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data

N

Note: Some map features shown in the legend may not appear in the mapped area.

award 10/10/97 /nfs/or4003/usr10/umpqua/wsa/up_mid_ump/fnl_tpc.aml

Map Erod-4
UPPER MIDDLE UMPQUA
Landslide Potential based on soil mapping units

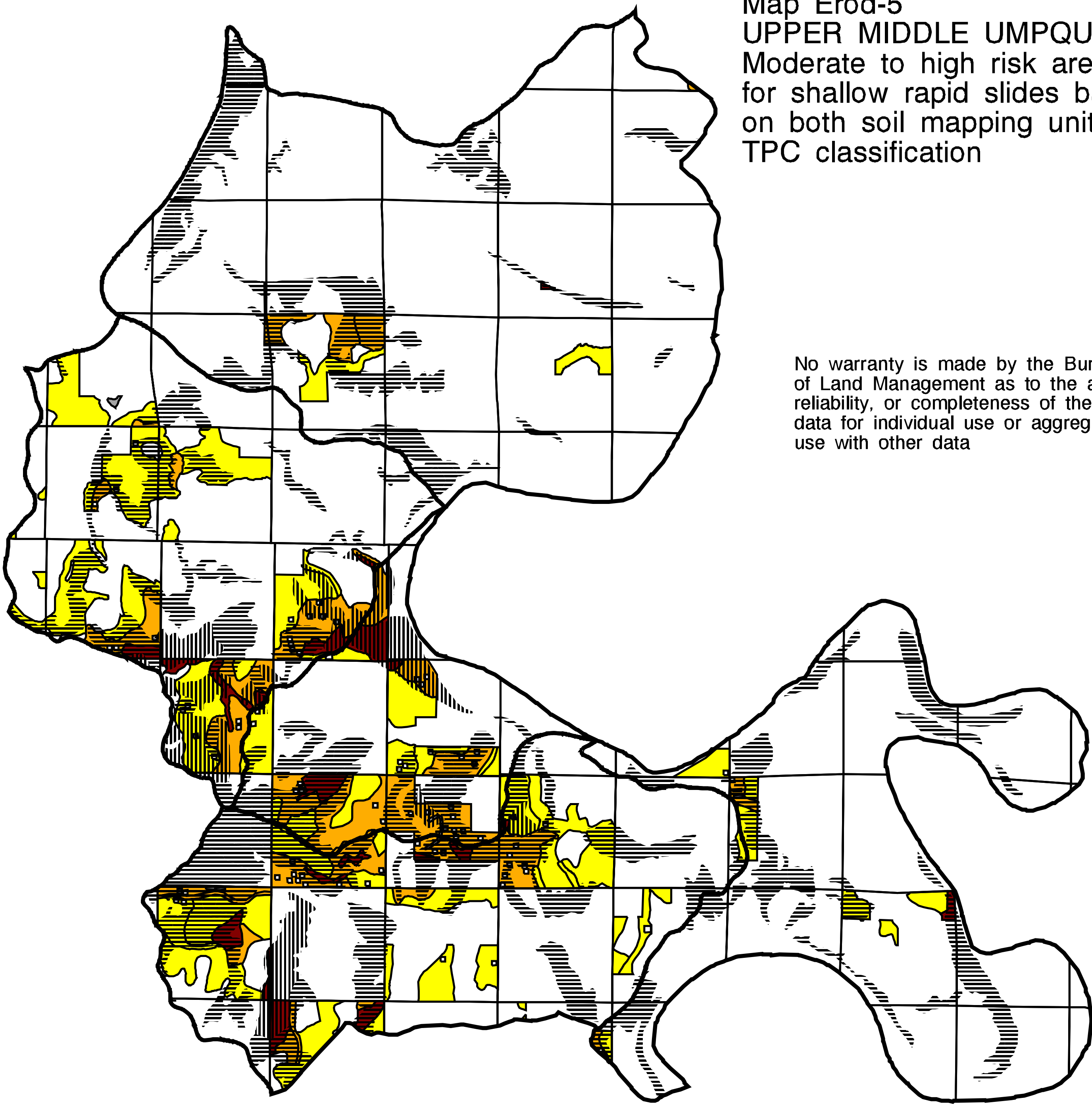


1 0 1 Miles

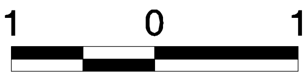
Landslide Hazard Potential Classification:

- no hazard
- low potential for shallow rapid slides
- mix of low and moderate shallow rapid slide potential
- mix of moderate and high shallow rapid slide potential
- high shallow rapid slide potential
- not apply/ unclassified
- BLM land
- Drainage Boundaries

Map Erod-5
UPPER MIDDLE UMPQUA
Moderate to high risk areas for shallow rapid slides based on both soil mapping units and TPC classification



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data



Landslide potential based on soil mapping units

- mix of moderate to high potential for shallow rapid slides
- high potential for shallow rapid slides

Fragility classification for BLM land in the TPCC

- FGNW
- FGR1
- FGR2
- NF

- Drainage boundaries

Note: Landslide potential, based on soil mapping units, applies to all land inside the watershed analysis area. Fragility classification from TPCC applies to BLM land only

MAP EROD −6 Intersections of Roads and Streams

UPPER MIDDLE UMPQUA SUBWATERSHED

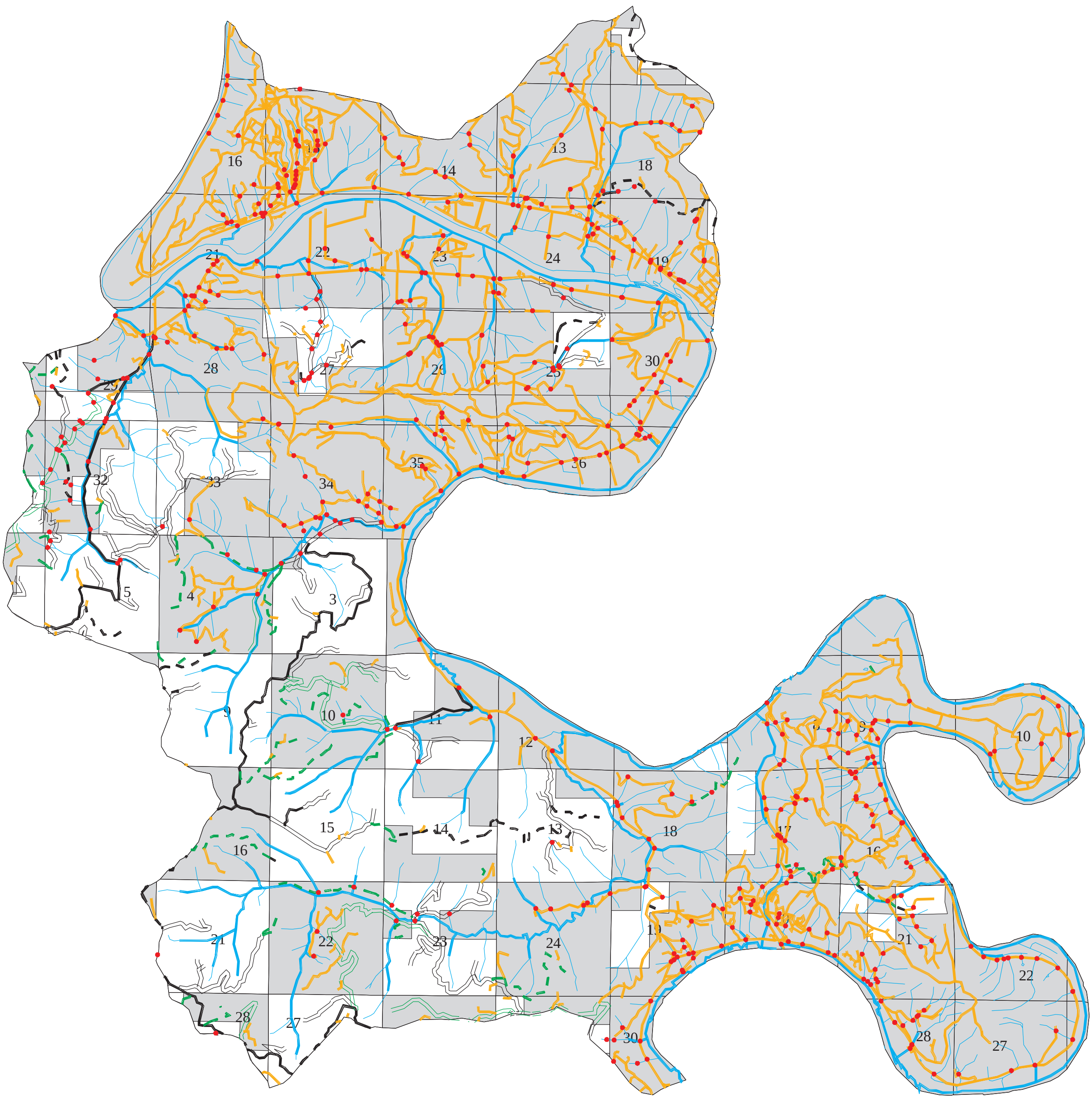


TABLE OF CONTENTS
EROSION PROCESSES APPENDICES

EROSION PROCESSES APPENDIX

Geology of the Upper Middle Umpqua

The following description is taken from Baldwin (1961). The formation names are updated reflecting more recent literature (Niem and Niem 1990). Bateman Formation (called "Coaledo Formation(?)" by Baldwin) - Very thick bedded sandstone, and minor amounts of siltstone in the upper part, underlies the highland area between Old Blue, Rainy Peak, and Soup Mountain. This unit is nearly horizontal, whereas dips of 10° to 15° are common in the underlying Elkton siltstone member of the Tyee. The lowermost sandstone is 40 to 50 feet thick and is composed of poorly sorted crossbedded sandstone with small pebbles of chert, quartz, and basalt. Bedding in this lower unit is indistinct, but higher in the section the bedding is better defined. The upper part of the Bateman contains a few thin beds of tuffaceous sandstone, bony coal, and carbonaceous shale with abundant fossil leaves. Except for the less distinct bedding, much of this sequence resembles the sandstone of the Tyee Formation. The coaly beds are well exposed at the pass between Mehl and Little Camp Creeks.

The Elkton siltstone member is predominantly siltstone sequence in the upper part of the Tyee Formation. The Elkton siltstone member is more clayey than the underlying lower part of the Tyee Formation or the overlying Bateman Formation, even though it contains an appreciable amount of thin-bedded sandstone. This lithologic difference is reflected topographically by rounded slopes, which contrast with steeper slopes and more prominent outcrops of sandstone units.

The Tyee Formation consists of rhythmically and massively bedded sandstone and intercalated sandy siltstone.

Other geologic features in the subwatershed are:

- Quaternary alluvium: Unconsolidated silt, sand, and gravel.
- Quaternary alluvium on terraces - Semiconsolidated and partially weathered silt, sand and gravel.
- Landslide debris - Landslides are particularly common in areas where the interbedded sandstone and siltstone of the Tyee Formation form dip slopes. Upon weathering, the siltstone becomes unctuous[1] and large blocks of sandstone move valleyward, gliding on siltstone beds.

The Geological Basis for the Erosional Patterns in the Subwatershed: Debris avalanches and debris torrents most often occur on moderate and steep areas in the Tyee and Bateman Formations, particularly near contacts with other formations, and on headwalls and around cliffs. Debris avalanches and torrents are less likely to occur in Elkton member. Most of those that do occur originate near the contacts with adjacent formations and on steep north facing slopes.

The massive sandstone beds in the Bateman and Tyee are the cliff forming areas within those formations. The Elkton member has thinner beds with more siltstone than sandstone, and does not readily form cliffs. As a result the slopes are more gradual and soils are more deeply developed. The Elkton does have cliffs but they are not a dominant feature.

Deep-seated slumps are most common on the Elkton siltstone member of the Tyee Formation. Ancient earthquakes may have caused the large old slumps. These features are composed of unconsolidated, structurally weak colluvial soils. Within these larger features, smaller failures, such as rotational

[1] Unctuous (Ŭngk' chooəs) *adj.* of the nature of or characteristic of an ointment: oily; greasy

slumping, cut slope failures, and intergorge failures are activated by streams cutting the toe of the slope, and road construction that either loads the head of the slope or cuts the toe. Ground water seepage contributes to slope instability. Streams readily cut down through the deep unconsolidated soils in the slumps creating trenches. Streams undercut the slopes inside these trenches causing intergorge failures. The soils in these slumps are high in clay and are a chronic source of fines that enter the streams as suspended sediments.

Siltstone weathers more readily to clay than does sandstone, therefore chronic input of suspended sediments into the streams is higher on the Elkton member than from the rest of the Tyee Formation or the Bateman. The Tyee and Bateman sandstones are high in feldspar. Feldspar weathers relatively fast. Consequently, gravel derived from those sandstones decomposes relatively fast to sand.

Land in the Sawyer Ferry Drainage dips to the south resulting in the steepest land facing generally north gentle to moderate sloped ground facing south. In Mehl Creek and Umpqua Big Bend Drainages, the land dips to the west resulting in the steepest land generally facing east. The steepest ground in Fitzpatrick Creek tends to be on the north and east facing slopes.

Introduction to the Array of Assessment Tools Used

Map Erod 3: Timber Production Capability Classification (TPCC), and Map Erod 4: Landslide Potential Based Soil Mapping Units were created and confidence described as part of the initial characterization. The landslide history and surface erosion sections were completed later in the watershed analysis process. A Rotational Slumping/ Earthflow Potential Map Based on Soil Mapping Units was attempted but was not successful as a predictive tool, and therefore that product was not included in this analysis.

Timber Production Capability Classification (TPCC)

The TPC classification for BLM land was done in 1986 and 1987 following the protocol given in the *Timber Production Capability Classification, Handbook 5251-1*, BLM Manual Supplement, Coos Bay District Edition, May 1986 (USDI. 1986).

Apndx Table E-1: TPCC Slope Gradient Classification Criteria Used by Coos Bay District in 1986/87

	Not Fragile	FGR1	FGR2	FGNW
TPCC MAP UNIT over all characteristics				
slope - ave. for unit	0-60%	50-70%	70-80%+	mostly 80%+
dissection - ave. for unit	low	low-mod.	mod.-high	high- very high
soils*	57,10,14,63	63,57,66,64,166	64,564,66,63,R	564,64,R,66,63
soil depth	deep & moderately deep	shallow to deep	shallow to moderately deep & skeletal	shallow & skeletal
rockland/ % rock outcrop	0-5%	0-10%	5-20%	10-30%
HEADWALLS (upper 1st order draws)				
channel gradient	10-35%	35-60%	60-80%	80+
channel adjacent slopes	10-60%	50-70%	60-80%+	80%+
shape of headwall draw	-----	smooth "U" shape	"V" shaped	"V" shaped
dissection density	low	low to moderate	moderate to high	very high
soils*	57,10,14,63	63,57,66,64,166	64,564,66,63,R	564,64,R,66,63
instability indicators	none to few	few	common	many, including active failure

	Not Fragile	FGR1	FGR2	FGNW
STREAM ADJACENT SLOPES outside headwall areas				
channel gradient	<20%	10-35%	35-60%	50-70%
slope	10-60%	50-70%	70-80%	mostly 80%
dissection density	low	low to moderate	moderate to high	very high
soils*	57,10,14,63	63,57,66,64,166	64,564,66,63,R	564,64,R,66,63
instability indicators	none to few	few	common	many, including active failure
MANAGEMENT CONCERNS (generalization)				
landslide risk	none to low	low to moderate	high	High to very high
surface erosion risk	low to moderate	moderate to high	high to very high	high to very high
burn hazard to the soil	low	moderate	high to very high	high to very high

* soil mapping unit codes from Townsend et. al. (1977)

Apndx Table E-2: BLM Acres by TPCC Classification

TPC Classification	acres
Fragile gradient not suitable (FGNW)	390
Fragile gradient restricted 2 (FGR2)	1,643
Fragile gradient restricted 1 (FGR1)	3,044
BLM land classified as fragile gradient	5,077
BLM land not classified as fragile gradient	2,083
total BLM land	7,160

Private land (and therefore excluded from TPCC data base) in the subwatershed	22364

Confidence in work products: The overall confidence in this product is moderately high. The TPCC data set was developed using aerial photos, local knowledge, and ground truthing. The limitations of TPCC maps are:

- Field checking was done at the rate of a square mile/ day. That was usually only enough time to make one pass out across a section and back.
- The data was transferred from the aerial photos to base maps without benefit of cartographic tools for removing photo distortion.
- TPCC was done only on BLM land.
- The TPCC was designed to address timber production and site productivity issues, not risks to aquatic and hydrologic issues.

Landslide Potential Based on Soil Mapping Units

The soils in the Upper Middle Umpqua Subwatershed were classified, as to their landslide potential, based on soil mapping done by the USDA Soils Conservation Service (Unpublished data, copy on file at the Coos Bay District Office). In previous watershed analyses (Sandy Creek, Middle Creek, and Paradise Creek), landslide potential maps were compared to landslide histories covering the same areas (USDI 1995a, 1995b, & 1995c). The ability of the landslide potential maps to predict corresponded favorably to the observed pattern of landslides found in the landslide histories.

Apndx Table E-3: Acres by Landslide Potential Based on Soil Mapping Units

Landslide potential class	stratification criteria	code	acres
High	Shallow to moderately deep gravelly soils on 80%+ slopes.	high	1,008
Mix of moderateand high	Moderately deep to deep gravelly and nongravelly soils on 60% to 80% slopes.	M-H	5,493
mix of moderate and low	Deep to moderately deep soils on 35% to 60% slopes	L-M	8,186
Low	Deep soils on gentle slopes (10% to 35%).	low	9,783
None	Deep soils on level to gently sloping terraces and flood plans.	none	4,089
not apply or no data		n/a	19
water		W	955

The "mix of moderate and high" and the "mix of low and moderate" classes are necessary because of two artifacts of soil mapping. Some soil mapping units cover a broad range of slopes with the soils on the steeper ground having a higher potential for sliding than similar soils on less steep ground. Other mapping units are assemblages of diverse soils found intermixed on complex topography. In this case quite different soils with respect to slope, depth, and composition are included in the same mapping unit. That was necessary because the mapping scale was too small to allow drawing separate polygons for each separate soil type. See Apndx Table E-4 for the landslide hazard rating assigned to each soil mapping unit.

Confidence in work products: The overall confidence in this product is moderate. Map Erod 4: Landslide Potential Based on Soil Mapping Units compares favorably to the TPCC provided one considers that the slope breaks used by the SCS when mapping soils do not match those used to map TPCC. The landslide potential map is less reliable than the TPCC for assessing landslide hazard on BLM land. However, unlike the TPCC, the landslide potential map does cover all of the land inside the subwatershed, and is sufficiently reliable to provide an overview of landslide hazard in the subwatershed. The map is not suitable for indicating site specific landslide hazard without benefit of a site visit.

The weaknesses of the landslide potential map are the inability to fully separate areas of different hazard potential in the "mix of moderate and high" (M-H), and the "mix of low and moderate" (L-M) classes, which is described above. The map is based on soil mapping units and is therefore an adaptation of a data set to purposes other than the original intentions for collecting that data.

Apndx Table E-4: Soils in the Upper Middle Umpqua Subwatershed

soil mapping unit (USDA unpublished data) code	name	acres	landslide hazard	rotational slump & earthflow haz.
25A	Evans loam 0-3% slope	520	none	none
27A	Chapman-Chehalis complex 0-3% slope	682	none	none
33C	Meda loam 2-20% slope	35	none	none
35A	Newberg fine sandy loam 0-3% slope	86	none	none
40A	Riverwash	5	none	none
45A	Newberg loamy sand 0-3% slope	10	none	none
61A	Roseburg loam 0-3% slope	209	none	none
65A	Brand silty clay loam 0-3% slope	18	none	none
66A	Waldo silty clay loam 0-3% slope	32	none	none
68C	Dupee silty clay loam 3-12% slope	101	none	none

soil mapping unit (USDA unpublished data) code	name	acres	landslide hazard	rotational slump & earthflow haz.
68D	Dupee silty clay loam 12-30% slope	33	none	low
69A	Coburg silty clay, flooded 0-3% slope	95	none	low
70A	Coburg silty clay 0-5% slope	104	none	none
71A	Silbold fine sandy loam 0-5% slope	193	none	none
72A	Redbell silt loam 0-5% slope	273	none	none
78C	Bickford silt loam 3-12% slope	92	none	none
81A	Conser silty clay loam 0-3% slope	162	none	none
85A	Malabon silty clay loam 0-3% slope	3	none	none
86A	Malabon silty clay loam, flooded, 0-3% slope	341	none	none
99C	Stockel fine sandy loam 3-12% slope	35	none	none
106C	Veneta loam 0-12% slope	126	none	none
115D	Pengra silt loam 2-20% slope	6	none	L-M
120E	Nonpareil loam 12-30% slope	7	none	none
120F	Nonpareil loam 30-60% slope	42	none	none
125F	Nonpareil-Oakland complex 30-60% slope	12	low	low
131C	Oakland silt loam 3-12% slope	7	none	none
131F	Oakland silt loam 30-60% slope	19	low	L-M
136F	Dickerson-Rock outcrop complex 30-90% slope	8	L-M	L-M
140E	Oakland-Sutherlin complex 12-30% slope	35	low	L-M
141E	Oakland-Dupee complex 12-30% slope	59	low	L-M
148D	Panther silty clay loam 4-20% slope	9	low	high
175C	Sutherlin silt loam 3-12% slope	58	none	none
175D	Sutherlin silt loam 12-20% slope	16	low	L-M
180D	Speaker loam 2-20% slope	50	low	low
180E	Speaker loam 20-30% slope	9	low	low
180F	Speaker loam 30-60% slope	104	L-M	L-M
188F	Speaker-Nonpareil complex 30-60% slope	17	L-M	L-M
188G	Littlesand-Nonpareil complex 60-90% slope	43	M-H	M-H
200C	Bellpine silt loam 3-12% slope	18	none	none
200E	Bellpine silt loam 12-30% slope	37	low	L-M
209C	Windygap silt loam 2-12% slope	458	none	low
209E	Windygap silt loam 12-30% slope	640	low	low
209F	Windygap silt loam 30-60% slope	19	L-M	M-H
211E	Windygap-Bellpine complex 12-30% slope	865	low	L-M
212F	Bellpine-Windygap complex 30-60% slope	577	L-M	M-H
222F	Rock outcrop	19	N/A	N/A
225C	Bateman silt loam 3-12% slope	276	none	none
225E	Bateman silt loam 12-30% slope	2,534	low	L-M
225F	Bateman silt loam 30-60% slope	1,480	L-M	medium
233F	Atring-Larmine complex 30-60% slope	14	L-M	none
233G	Atring-Larmine complex 60-90% slope	622	M-H	none
235F	Atring gravelly loam 30-60% slope	101	L-M	none
235G	Atring gravelly loam 60-90% slope	594	M-H	none
237F	Atring-Larmine-Rock outcrop complex 30-60% slope	5	L-M	none
237G	Atring-Larmine-Rock outcrop complex 60-90% slope	621	M-H	none
240F	Digger-Bohannon complex 30-60% slope	137	L-M	none
240G	Digger-Bohannon-Umpcoos complex 60-90% slope	1,965	M-H	none
270E	Rosehaven loam 12-30% slope	145	low	low
270F	Rosehaven loam 30-60% slope	576	L-M	L-M
275E	Rosehaven-Atring complex 12-30% slope	99	low	low
275F	Rosehaven-Atring complex 30-60% slope	1,661	L-M	L-M
275G	Littlesand-Rosehaven-Atring complex 60-90% slope	446	M-H	?
280C	Rosehaven loam 3-12% slope	48	none	none
305E	Honygrove gravelly clay loam 3-30% slope	2,883	low	L-M
305F	Honygrove gravelly clay loam 30-60% slope	65	L-M	M-H
310E	Honeygrove-Peavine complex 3-30% slope	407	low	L-M
310F	Honeygrove-Peavine complex 30-60% slope	89	M-H	M-H
311E	Preacher-Bohannon complex 3-30% slope	293	low	low
311F	Preacher-Bohannon complex 30-60% slope	1,504	L-M	L-M
325E	Orford gravelly silt loam 3-30% slope	643	low	L-M

soil mapping unit (USDA unpublished data) code	name	acres	landslide hazard	rotational slump & earthflow haz.
325F	Orford gravelly silt loam 30-60% slope	13	L-M	M-H
335G	Preacher loam 50-75% slope	510	M-H	M-H
370E	Fernhaven gravelly loam 3-30% slope	91	low	low
370F	Fernhaven gravelly loam 30-50% slope	34	L-M	L-M
375F	Fernhaven-Digger complex 30-60% slope	99	L-M	L-M
376G	Digger-Preacher complex 60-90% slope	570	M-H	M-H
437G	Digger-Umpcoos-Rock outcrop complex 60-90% slope	1,008	high	none
555E	Absaquil-Honeygrove-McDuff complex 3-30% slope	938	low	L-M
555F	McDuff-Absaquil-Honeygrove complex 30-60% slope	1,771	L-M	M-H
1125G	Nonpareil loam 60-90% slope	32	M-H	
Pt	Pits	4	none	none
W	water	955	N/A	N/A

Landslide History

The landslide history of this subwatershed was developed using the Mass Wasting Module - level one assessment described in the Standard Methodology for Conducting Watershed Analysis ver. 1.10 (Washington Forest Practice Board 1992). Due to time constraints, only the 1952, 1970 and 1992 aerial photos were used. All three sets are 1:12000 scale. Landslide locations were drawn on 7.5 minute quad maps and are on file at the Coos Bay District Office. This map was compared with Map Erod 3: TPCC. and Map Erod 4: Landslide Potential Based on Soil Mapping Units. The results of that comparison are shown on Map Erod 1: Predicted and Confirmed Landslide Distribution.

Large deep-seated ancient slumps: Twenty-seven large slumps are noted in the landslide history and are shown on Map Erod 1. These ancient slumps are on the Elkton member or were previously identified as Quaternary landslide debris by Baldwin (1961). The obvious ancient slumps are on south facing gentle to moderate slopes and are mostly farmed or private forests. The ancient slumps on other aspects are less obvious and for now are viewed as suspected ancient slumps pending review by more qualified investigators. Most of these suspected large deep-seated ancient slumps are covered by forest and in complex topography. The largest clustering of suspected slumps is in the Sawyer Creek subdrainage between the 22-8-29.2 and 22-8-29.1 roads in sections 29 and 32, and in the NW portion of section 5. Deep-seated slope failures, following the November 18, 1996 storm, lend support to that suspension. These include a failing cut slope on the 22-8-29.2 road, which is the toe of a 1.5 acre slump feature inside a 12 acre suspected ancient slump feature.

Rock falls: A large rock fall area and associated talus slope, next to the Umpqua River, is located in section 9, T.23S., R.7W. Will. Mer. A second rock fall area is in the headwaters of Mehl Creek in section 27, T.23S., R.8W., Will. Mer.

Shallow rapid slides: A comparison of the landslide history with the soil mapping unit based Map Erod 4: Landslide Potential Map, showed slides typically occur on the moderate and steep slopes. Slides on the Elkton member are concentrated on moderate to steep north facing slopes and near the contact with the Bateman Formation. Slides on both the Bateman and the Tyee Formations are on the moderate to steep slopes. Since most of the Bateman Formation has either moderate or steep slopes, slides occur thoughout that formation. The Tyee Formation exhibits a wide range slopes with most of the steep slopes associated with the outside bends of the Umpqua River. Therefore, the slides on the Tyee Formation in this subwatershed are concentrated above those river bends[2]. Quaternary terrace and alluvium are low risk areas for landsliding except where streams have cut gorges, which are subject to small earthflows and slumps. Those streamside slides have a 50% or greater probability of delivering sediment to the stream. Recent slides in the Quaternary landslide debris areas are concentrated on the slump scarps. More slides were observed on the Elkton member (Apndx Table E-6) however, the Bateman Formation produced more slides per 110 acres than any other area in the subwatershed (Apndx Table E-13). Slides originated in units cut within the previous 20 years constituted 58.8% of the observed events, and 21.4% of the slides were associated with roads (Apndx Table E-8).

[2] If only that portion of the Tyee Formation in the northwest corner of the subwatershed is considered (which is almost entirely steeper than 50%) the resulting figures are 19 slides / (330 ac)(100) = 5.8 landslides/ 100 acres

Discussion on Apndx Table E-11, and Apndx Graph E-2: On all 3 of the aerial photo flights examined, over 70% of the slides in clear cuts are less than 500 square yards in size. There is no obvious pattern of change in the size of slides originating inside clear cuts over time. The percent of road associated slides greater than 1,000 square yards in size has decreased over time.

Discussion on Apndx Table E-12: Most of the slides originating on convex slopes are on the Elkton geologic member. This is consistent with the observation that most earthflows and slumps in this subwatershed are in the Elkton geologic member. The pattern of failures originating on convex and straight slopes in the Quaternary formations is expected given most of the slides in those areas are either intergorge or slump scarp failures.

Additional discussions and summary of observations are in the Current Conditions section under Erosion Processes.

Notes on the tables and graphs: Unless otherwise noted, the following tables and graphs are based on observations made on the 1952, 1970 and 1992 aerial photos. The total number of slides on Apndx Tables E-9, E-10, and E-11 is greater than 495 because those tables reflect situations where multiple slides over several years occurred at the same location. The following tables and graphs do not include the data on the large ancient deep-seated failures or large rock falls.

Apndx Table E-5: Landslide Origin & Sediment Delivery to Streams by Slope Position & Shape

	Upper Slope	Midslope	Lower Slope	Totals
Concave no delivery	24	18	13	55
Concave sediment delivered	41	45	12	98
Convex no delivery	26	27	5	58
Convex sediment delivered	8	7	8	23
Straight no delivery	84	57	15	156
Straight sediment delivered	43	37	23	103
Totals (excludes 2 large intergorge failures recorded on the Umpqua River that do not meet the sort criteria)	226	191	76	493

Apndx Graph E-1

Apndx Table E-6: Total Number of Landslides by Drainage & Geology

	Bateman Formation	Tyee Formation	Elkton member	Qal	Qt	Ql	total
Fitzpatrick	41		16				57
Mehl	93		33				126
Sawyer Ck. (Sawyer Ck. subdrainage)	2		67	1	1		71
Sawyer Ck. (Hedden Ck. subdrainage	55		17			4	76
Sawyers Ferry (north of the Umpqua)		19	38				57
Sawyers Ferry (south of the Umpqua)			65	2	4		71
Umpqua Big Bend		19	16		2		37
total	191	38	252	3	7	4	495

Apndx Table E-7: Landslides Delivering Sediment to Streams by Geology & Drainage

	Bateman Formation	Tyee Formation	Elkton member	Qal	Qt	Ql	total
Fitzpatrick	21		5				26
Mehl	61		14				75
Sawyer Ck. (Sawyer Ck. subdrainage)	2		24				26
Sawyer Ck. (Hedden Ck. subdrainage	31		3				34
Sawyers Ferry (north of the Umpqua)		10	21				31
Sawyers Ferry (south of the Umpqua)			21	2	3		26
Umpqua Big Bend		6	1		1		8
total	115	16	89	2	4	0	226

Apndx Table E-8: Total Number of Slides by Activity at Point of Slide Origin

activity/ condition at the origin of slide	Sediment delivered		Total
	no	yes	
Agriculture	10	5	15
cut 20-50 years before photo	5	2	7
cut within 20 years of photo	178	113	291
partial cut or open stand	1	1	2
landing failure	6	15	21
road side cast/ fill failure	39	67	106
road cut failure	15	0	15
fire 20-50 years before photo	4	12	16
undisturbed/ fire more than 50 yrs. before photo/ fire no date	11	7	18
20-50 yr. old stand (fire? cut? other?)	2	0	2
large intergorge failure on the Umpqua River	0	2	2
Total	271	224	495

Apndx Table E-9: Slides by Size Class, Activity at Origin & Sediment Delivery on the 1992 Aerial Photos

activity/ condition at the origin of slide observed on the 1992 photos	slide size class and sediment delivery to streams										
	very small: <100 yd^2		small: 100-500 yd^2		medium: 500-1000 yd^2		large: 1000-5000 yd^2		very large: >5000 yd^2		total
	yes	no	yes	no	yes	no	yes	no	yes	no	
Agriculture			1								1
cut 20-50 years before photo *			1	1							2
cut within 20 years of photo	4	26	19	44	16	5	2	1	1		118
partial cut or open stand											
landing failure		1		1	3		4				9
road side cast/ fill failure	1	4	5	4	6	3	2		1		26
road cut failure		4		4							8
fire 20-50 years before photo											
undisturbed/ fire > than 50 yrs. before photo/ fire no estimated date **			2	1	1	1	2				7
20-50 yr. old stand (fire? cut? other?)											
very large intergorge failure on the Umpqua River											
Total	5	35	28	55	26	9	10	1	2		171

* Slides counted as CC <20 when initially seen in earlier photos are included in the 20 to 50 yr. group when still visible in later photos.
** Slides first seen in earlier photos in areas burned < 50 years before that are still visible in this flight are included in the undisturbed/ fire > 50 group.

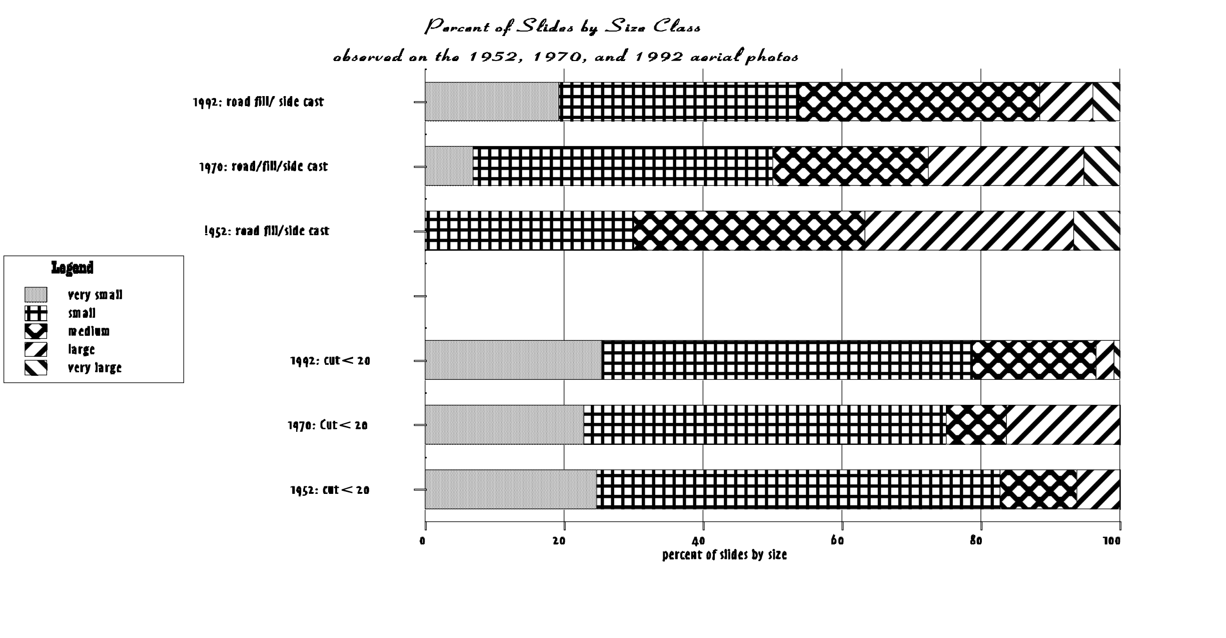
Apndx Table E-10: Slides by Size Class, Activity at Origin & Sediment Delivery on the 1970 Aerial Photos

activity/ condition at the origin of slide observed on the 1970 photos	slide size class and sediment delivery to streams										
	very small: <100 yd^2		small: 100-500 yd^2		medium: 500-1000 yd^2		large: 1000-5000 yd^2		very large: >5000 yd^2		total
	yes	no	yes	no	yes	no	yes	no	yes	no	
Agriculture	1	4	1	3	1						10
cut 20-50 years before photo *		1	1	3	3	1					9
cut within 20 years of photo	6	15	24	24	6	2	11	4			92
partial cut or open stand											
landing failure				2	1	1	1				5
road side cast/ fill failure	1	3	9	16	10	3	11	2	3		58
road cut failure		2		3	10						15
fire 20-50 years before photo	2		2		1						5
undisturbed/ fire more than 50 yrs. before photo **	1		2	3		1	2	1	1		11
20-50 yr. old stand (fire? cut? other?)				1	2						3
very large intergorge failure on the Umpqua River									2		2
Total	11	25	39	55	34	8	25	7	6		210

* Slides counted as CC <20 when initially seen in earlier photos are included in the 20 to 50 yr. group when still visible in later photos.
** Slides first seen in earlier photos in areas burned < 50 years before that are still visible in this flight are included in the undisturbed/ fire > 50 group.

Apndx Table E-11: Slides by Size Class, Activity at Origin & Sediment Delivery on the 1952 Aerial Photos

activity/ condition at the origin of slide observed on the 1952 photos	slide size class and sediment delivery to streams										
	very small: <100 yd^2		small: 100-500 yd^2		medium: 500-1000 yd^2		large: 1000-5000 yd^2		very large: >5000 yd^2		total
	yes	no	yes	no	yes	no	yes	no	yes	no	
Agriculture	2		1	3							6
cut 20-50 years before photo		2	2								4
cut within 20 years of photo	3	17	12	35	4	5	5				81
partial cut or open stand				1			1				2
landing failure					2	1	3		1		7
road side cast/ fill failure			6	3	9	1	7	2	2		30
road cut failure		1									1
fire 20-50 years before photo	1	2		3	4		2				12
undisturbed/ fire more than 50 yrs. before photo				1		2					3
20-50 yr. old stand (fire? cut? other?)											
very large intergorge failure on the Umpqua River											
Total	6	22	21	46	19	9	18	2	3		146



Apndx Graph E-2

Apndx Table E-12: Number of Slides by Geology and by Slope Shape and Position

	Bateman	Tyee	Elkton	Qal	Qt	Ql	total
convex upper	3	1	30				34
convex middle	6	4	19		2	3	34
convex lower	6	1	6				13
subtotal convex all	**15**	**6**	**55**		**2**	**3**	**81**
concave upper	46	4	14	1			65
concave middle	32	7	24	0			63
concave lower	3	4	18	0			25
subtotal concave all	**81**	**15**	**56**	**1**			**153**
straight upper	57	5	64		1		127
straight middle	29	5	59			1	94
straight lower	9	7	18		4		38
subtotal straight all	**95**	**17**	**141**		**5**	**1**	**259**
large intergorge failure				2			2
total	**191**	**38**	**252**	**3**	**7**	**4**	**495**

Apndx Table E-13: Relative Rate of Landsliding by Geological Formation and the Percent of Those Slides Delivering Sediment to Streams (Expanded Table)

	Bateman	Tyee	Elkton	Qal	Qt	Ql	total
acres	3978	2776	15586	2889	605	3200	29034
total slides	**191**	**37**	**252**	**4**	**6**	**5**	**495**
slides/ acre	0.048	0.013	0.016	0.001	0.01	0.002	0.017
slides/100 acres	4.8	1.3	1.6	0.1	1	0.2	1.7
slides delivering sediment	**115**	**16**	**89**	**2**	**4**	**0**	**226**
slides delivering/ acre	0.029	0.006	0.006	0.001	0.007	0	0.008
slides delivering/ 100 acres	2.9	0.6	0.6	0.1	0.7	0	0.8
percent slides delivering sediment to streams	**60.20%**	**43.20%**	**35.30%**	**50.00%**	**66.70%**	**0.00%**	**45.70%**

Confidence in work products: The level of confidence in the data obtained from the 1952 aerial photos is moderate, and moderately high for data based on the 1970 and 1992 aerial photos. The 1952 photos are copies made from prints held by Archives and not from negatives. Consequently these photos are more contrasty and less clear than aerial photos produced by contact printing from the original negative. Distinguishing slides on the 1952 photos was also complicated by the high level of disturbance associated with ground lead logging.

Sources of error in data from all three flights:

- Stump holes/ root wads caused by blowdown can be mistaken for very small slides.
- Separating road associated landslides and fresh sidecasting, seen on aerial photos, was both difficult and somewhat arbitrary. Lighter color slides on top of sidecast, and landslides associated with

roads that are not newly constructed were counted. Sidecast that reached a draw was counted as a slide because of its potential to affect downstream values. Sidecasting that did not reach a draw was not counted.

- Slope estimates made from the aerial photos were inconsistent and therefore not analyzed.
- Field checking showed that many slides classified as "shallow rapid" are really earth flows, particularly on the Elkton member. Therefore that data was not analyzed.

There is a very good correlation between the landslide history map and the Map Erod 4: Landslide Potential Map Base on Soils. Differences between the two were usually due to the lack of a ground exposing disturbance. The TPCC predicted potential for slides on some land that was not steep enough to be identified as moderate or high risk for shallow rapid sliding based on soil mapping units. Those sites however did exhibit some shallow rapid slides and earthflows.

The landslide history process resulted in a more complete view of the extent of large ancient slumping than was previously available using data on hand. Additional large ancient slumps are suspected in the sawyer Creek Drainage in sections 29 and 32, T.22S., R.8W. and in section 5, T.23S., R.8W., Will. Mer.

Surface Erosion Evaluation

The potential for road prism surface erosion contributing sediment to streams was evaluated using the field procedures described in the Surface Erosion: Roads Module - level 1 assessment in the Standard Methodology for Conducting Watershed Analysis ver. 1.10 (Washington Forest Practices Board 1992). The following assumptions were used to select road segments for evaluation:

- Road surface erosion occurs everywhere. However, excluding special problem areas -
  - Road surface erosion results in sediment entering streams at stream crossings. This is defined by the distance from the stream to the nearest ditch relief culvert or to the nearest grade break that affects the direction water flows in the ditch, whichever is first.
  - Roads within 200 feet and parallel to streams potentially can contribute sediment to that stream.
- Surface erosion from ridge-top roads are not considered to contribute sediment to streams. (This should not be confused with the potential for sediment delivery through landsliding.)

Using these assumptions, only water-grade roads within 200 feet of a stream and midslope roads that cross streams were included in the evaluation. We focused this evaluation on BLM controlled roads and on other roads crossing BLM land. We also observed conditions on other private roads however, most of those observations were incidental to travel to and from destinations on BLM land. Time constraints prevented us from visiting all of the midslope and water grade BLM roads.

The results of the surface erosion evaluation are summarized by road in Apndx Table E-14. Based on the assumptions and predictive model in the Surface Erosion: Roads Module, the three variables that affect sediment delivery in this watershed are:

- The type of road surface.
- The amount of road use.
- Timely versus delayed road maintenance.

Vegetation cover was also a frequently encountered variable, which based on the module assumptions, was a distant fourth in terms of the amount of sediment potentially delivered to streams.

Apndx Table E-14: Sediment Hazard Summarized by Road

Road	Surface Type	Segments Visited	Sediment Hazard by Type of Use		
			Admin. traffic	1 to 4 log trucks/day	> 4 log trucks/day
Sawyer Creek					
^22-8-29.2	BST	from 22-8-29.1 junction to slide near 23-8-5.1 rd.	Low	Low	Low
^23-8-5.0	> 6" rock	between junctions with 22-8-33.1 and 22-8-29.2	Low	Low	Medium
^23-8-5.3	> 6" rock	all	Low	Low	Medium
Gould Creek					
^22-8-22.8	> 6" rock	from center section 27 to north boundary of the section	Low	Low	Medium
^22-8-27.2	dirt	all	Low	Medium	High
Grubbe Creek					
^22-8-24.0	> 6" rock	from center section 25 to spur to the west near the section's north boundary	Low	Low	Medium
Hedden Creek					
^23-8-3.0	BST	W1/2 of the SE of section 3	Low	Low	Low
^22-8-34.0	> 6" rock	NW of the NW section 3	Low	Low	Medium
Fitzpatrick					
^23-8-11.0	BST	County road to culvert crossing Fitzpatrick Ck.	Low	Low	Low
^23-8-10.0	> 6" rock	from 23-8-11.0 rd. to section line	Low	Low	Medium
Mehl Creek					
^23-8-23.6	> 6" rock	from 23-8-25.0 junction to north boundary of section 23	Low	Low	Medium
^23-8-36.2	worn surfaces est 4 to 6 " rock	from 23-8-23.6 junction to west section line	Low	Low	High
^23-8-21.2/21.3	>6 " rock	23-8-21.2 to junction with -21.3 & -21.3 to end	Low	Low	Medium

Vegetation in the ditch lines reduces the erosion occurring in the ditch and filter the surface erosion material from other parts of the road prism that may enter the ditch. Consequently, the sediment model probably over estimates sediment production because model does not consider vegetation cover in the ditch line. The model can only accommodate natural surface and armored ditches.

The following observations were made while doing the surface erosion evaluation:

Most ditches on BLM roads either ran clear water, slightly milky water, or had no observable flow of water. The ditches are well vegetated. We observed sediment accumulation in the ditches only where:

- The ditch intercepted an (assumed) intermittent stream with a defined channel and no culvert at the point of interception. (One case observed.)
- Below and downstream from a spring located on a cut slope. (One case observed.) There was no defined channel between the spring and the ditch.
- Slides came down onto the road.
- Cut bank failures deposited soil directly into the ditch line. (Several locations)

A high density of ditch relief culverts along much of the Cedar Creek Road was so effective at draining water that many segments had no standing water visible in ditch. This observation stands out because it had rained hard for several days before we evaluated that road and was raining the entire day of the evaluation. The use of high densities of culverts seems an effective way of keeping ditch water from entering streams where roads cross drainages.

One evaluation criterion, in the DNR methodology, is the amount of vegetation on road cuts and fills. The more vegetation cover, the lower the predicted sediment delivery. All of the fills are well vegetated. Cut slopes are well vegetated where the cut slope angle was less than or equal to 1:1 (estimated not measured). Bare ground was on the steeper cut slopes.

Lack of maintenance on private roads and unused BLM spurs allowed bank slough to fill ditches. That resulted in the following problems:

- Ditch water eroding the slough material and picking up sediment
- Ditch water kicked out across the road. In one case, on a private road, that water is eroding the fill.
- Ditch water kicked out on to the running surface is eroding that surface.

Hedden Ck. Road was closed by slides so only apart of it was evaluated. Based on what we could visit, observations by other people and the history of that road, Hedden Ck. Road is particularly prone to landsliding and thus requires above average maintenance.

Confidence in work products: The level of confidence in the data is moderately high for the roads evaluated. The observations can be extrapolated to other maintained BLM road segments in the subwatershed with a moderate level of confidence. We have no sense if the absolute sediment production rates are accurate but we are comfortable with the relative rankings of "low," "moderate" and "high" hazard. Extrapolating to private road segments can be done only with extreme caution because:

- Ditch relief culverts are farther apart on private land.
- Maintenance practices on private roads appear less aggressive than on BLM roads.
- GIS data depicting the intersection of the road theme with the hydro theme show far more places where private roads cross streams than BLM roads (see Map Erod 6: Intersections of Roads and Streams). This is due to the higher private road density on the lower slopes where there are more streams. This suggests there are more opportunities for sediment delivery from road surfaces in those areas than exist on BLM administered land.

Road Construction History

The 1952 flight line map showed only a few roads in the subwatershed They included Henderer, Mehl Ck., Joe Hooker and Bullock County Roads, and Highways 38 and 138. The main forest access roads were: Luchsinger Road 22-9-18.0; Bridge Road 22-8-29.1; the upper end of Hedden Ck. Road - 20-8-3.0; 22-8-34.0 road; and Upper Mehl Ridge Road 23-8-16.0. The 1952 aerial photos show numerous farm roads and logging roads mostly in the Sawyers Ferry Drainage. Of those roads, the Luchsinger Creek Road was the most ambitious. Luchsinger Ck. Road was built shortly before the 1952 photos were taken and was the first major haul to enter the Bateman Formation part of the subwatershed.

The 1952 photos show cat logging in the Sawyer Ferry Drainage. Cat trails were close to and crossing streams suggesting that surface erosion from cat trails was a significant source of sediment then. Cat logging was also visible in the 1970 photos as were many abandoned cat trails.

The 1970 aerial photos show the transition from sidecast to full bench construction in difficult terrain. Hedden Creek Road was being built in 1970 using conventional sidecast construction. However, the level of soil displacement was less than that associated with Luchsinger Ck. Road. The Waggoner Ck. Road was completed by the time the 1970 photos were taken and must have been full bench construction as suggested by how little sidecast or landsliding was associated with that road. Road construction probably peaked in the 1970s and has tapered off since.

Changes in Federal Land Management Practices over Time

The following changes resulted in a decrease of soil erosion and subsequent sediment entering the streams:

- NEPA passed in 1969 resulting in increased environmental awareness
- Shift from sidecast to full bench road construction started in the 1970s.
- Also in the 1970s, better equipment and aerial systems allowed for full log suspension when logging fragile ground.
- The 1975 TPCC was the first formal stratification of BLM land based on slope stability. Very fragile land was removed from the timber base. Recommendations restricting road construction and logging methods were applied to other fragile lands.
- District soils inventory, with management recommendations, was published in 1977 (Townsend *et. al.* 1977)
- The 1983 MFP required stream buffers on third order and larger streams (USDI 1983).
- The 1987 TPCC revision (USDI, 1986) resulted in more land removed from the timber base due to slope fragility.
- The Aquatic Conservation Strategy put forth by FEMAT (1993), and incorporated into planning and decision documents (USDA; USDI 1994, USDI 1995).
- Best Management Practices are required under the Resource Management Plan (USDI 1995).

The Interaction of Fire and Soil Saturation, and their Effects on Landslide Frequency and Timing

The mechanism predisposing a site to slope failure, following denuding by either fire or cutting, is the loss of root strength. The time of lowest root strength begins about 5 years after the disturbance when the previous stand's roots decay. The period ends about 15 years after the stand replacing event when the replacement stand starts to fully reoccupy the soil with new roots. Whether a particular site slides during the 5 to 15 year low root strength window depends on if there is a storm of sufficient intensity during that time to full saturate the soil. Using the fully forested state as the reference, then one can argue there are more slides on denuded sites than on forested sites all other factors being equal. But if one looks at periods sufficiently long to include both stand replacing fire, and low to moderate severity stand modifying fires, then landslides have to be viewed as a normal site response to disturbance. The differences between the wild and managed landscapes, with respect to landslides, then become:

- a function of frequency disturbance and whether the disturbances are regularly spaced (matching the rotation age) or irregularly spaced (as a function of drought and wet weather cycles).
- Disturbance severity (stand replacement fire/ clearcutting; shelterwood cuts or thinning/ moderate severity fire).
- Whether course woody debris is a component of/ redistributed by slides.

References

Baldwin, E.M. 1961. *Geologic Map of the Lower Umpqua River Area, Oregon: U SGS Oil and Gas Investigations Map OM-204*.

FEMAT, 1993. *Forest Ecosystem Management: An Ecological, Economic and Social Assessment*. Portland, OR.

Niem, A.R.; Niem, W.A., 1990. *Geology and Oil, Gas, and Coal Resources, Southern Tyee Basin, Southern Coast Range, Oregon*: Department of Geology and Mineral Industries. Open File Report 0-89-3.

Townsend, M.A.; Pomerening, J.A.; & Thomas, B.R. 1977. *Soil Inventory of the Coos Bay District*. USDI BLM, Coos Bay Dist, Coos Bay, OR. 259 pp. plus maps.
USDA unpublished data. Soil Survey of Douglas County. USDA Soil Conservation Service.
USDA; USDI. 1994. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl*. Portland, OR.
USDI. 1983. South Coast - *Curry Coos Bay District Timber Management Plan Record of Decision, Apr 28, 1983*. BLM-USDI, Coos Bay Dist, Coos Bay, OR. 42 pp.
USDI. 1986. *Timber Production Capability Classification, Handbook 5251-1*, BLM Manual Supplement, Coos Bay Dist Edition, May 1986, Ore. State Office, Portland, OR. 46 pp.
USDI. 1995. *Coos Bay District Record of Decision and Resource Management Plan, May 1995.* Coos Bay Dist BLM, North Bend, OR. 99 pp. plus appendices and maps.
Washington Forest Practice Board, 1992, *Standard Methodology for Conducting Watershed Analysis Under Chapter 222-22 WAC*- ver. 1.10 Oct 1992.