Soil and Water Resources Technical Memorandum

Tamarack Quarry Expansion Environmental Impact Statement

for

USDA Forest Service
Mt. Hood National Forest

March 2004

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USDA Forest Service
16400 Champion Way
Sandy, Oregon 97055

Prepared by
Todd Reinwald
Soil Scientist
PO Box 381
Rhododendron, OR 97049

Reviewed by

David Evans and Associates, Inc.
2100 SW River Parkway
Portland, Oregon 97201

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GLOSSARY

Accelerated erosion	Rates of erosion that are much greater than normal, natural rates; primarily as a result of some disturbance, often human induced.
Alluvium	Material transported and deposited by a stream or river, usually a coarse deposit composed of sand and rock.
Available runoff	Total precipitation less evapotranspiration and infiltration. The amount of water not lost to infiltration into the soil, or uptake and transpiration by plants, or evaporation.
Catchment	A 7th field hydrologic unit or drainage nested within a larger 6th field subwatershed. For example, the Mud Creek catchment is one of the smaller drainages that comprise the larger West and East Forks of the Salmon River 6th field subwatershed.
Disturbance regime	Natural pattern of periodic disturbances, such as fire or flood, followed by a period of recovery from the disturbance, such as regrowth of a forest after fire.
Effective ground cover	A continuous cover of organic material, such as plants or plant residues, like litter or duff, that protects soil materials from erosional forces.
Ephemeral stream	A stream, or stream segment that only flows seasonally during most years. Stream flow that only lasts for a brief period during a water year, the remainder of the year it is absent.
Glacial till	Unstratified glacial drift deposited directly by ice and consisting of clay, sand, gravel, and boulders intermingled in any proportion.
Gully/rill erosion	The dislodgement of soil particles by a concentrated flow of water.
Igneous rock	Rock that has formed by the cooling and consolidation of viscous rock, or magma.
Intermittent stream	A stream that flows only at certain times of the year when it receives water from other streams or from surface sources such as melting snow.
Mass wasting	The dislodgment and downhill transport of soil and rock materials under the influence of gravity. Many classifications of mass movement are identified, including soil creep, debris slides, rotational slides or slumps, and rock slides.
Seep	A site where groundwater is present at the surface.
Soil creep	The slow, downslope movement of weathered rock fragments and soil.
Stream order	The hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Two first-order streams flow together to form a second-order stream, two second-order streams flow together to form a third-order stream, and so on.

Subwatershed	A 6th field hydrologic unit or drainage nested within a larger, 5th field hydrologic unit known as a watershed. For example: The West and East Forks of the Salmon River is just one of many 6th field hydrologic units or subwatersheds that comprise the larger Salmon River Watershed.
Surface erosion	Wearing away of the earth's surface by water, ice, wind, or other natural agents under natural environmental conditions of climate, vegetation, and landscape, undisturbed by human influences.
Watershed	The region draining a river, river system, or body of water.

1 INTRODUCTION

Interpretations and descriptions contained in this memorandum rely heavily on local information derived from the Mt. Hood Soil Resource Inventory (Howes 1979) and the Salmon River Watershed Analysis (USFS 1995). These sources were used along with topographic maps and aerial photographs of the project area, field notes, meetings with agency specialists, and various other related reports and directives to characterize local conditions and support analysis conducted for predicting environmental consequences of the proposed actions.

The project area that this memorandum addresses includes the main Tamarack Quarry site and proposed expansion area, as well as the primary haul route (Forest Roads 2656 and 2656-955) connecting the site with U.S. Highway 26. Figure 1 shows the project vicinity, and Figure 2 shows the existing quarry and proposed expansion areas for the alternatives under consideration. For a description of the project area, see Chapter 1 of the Draft Environmental Impact Statement (DEIS). Actions addressed here include those associated with the proposed expansion of the quarry site. Additionally, operational actions such as blasting, rock crushing, and material hauling are considered.

2 AFFECTED ENVIRONMENT

2.1 RELIEF

The project area lies within the High Cascade Physiographic Province described by Franklin and Dyrness (1969). Locally, landforms where the project area is located, such as Mud Creek Ridge, the Mud Creek valley, and Summit Meadows, are typical of features associated with the High Cascade Province. Mud Creek Ridge is typified by rolling mountainous terrain of modest elevation (less than 5,000 feet). Its side slopes are moderately steep to steep, and primarily uniform (or in places concave) in shape. The valley of Mud Creek is U-shaped, and along with Summit Meadows is about one-quarter to one-half mile wide. Valley relief is primarily gentle and slopes are mild. The quarry site is located on the lower third of the western side of Mud Creek Ridge, while the haul route leads from there down to the valley bottom, then past Summit Meadows and up to the base of Mt. Hood at U.S. Highway 26. Slopes around the quarry site naturally range between about 20 and 50 percent, while those directly at the quarry range from nearly level to very steep, in places being nearly vertical. In comparison, slopes crossed by the haul route usually do not exceed 30 percent.

2.2 WATERSHEDS AND STREAMS

The project area lies mostly within the 4,394-acre 7th field hydrologic unit identified as the Mud Creek catchment. A much smaller portion of the project area is within the 6th field hydrologic unit identified as the West and East Forks of the Salmon River subwatershed. Both of these hydrologic units are contained within the upper portion of the 73,240-acre 5th field watershed of the Salmon River, a tributary to the Sandy River, which flows into the Columbia River (USFS 1995).

Two perennial streams are near the project area and haul route. The first is Mud Creek, the only named stream near the project site, which issues from Trillium Lake. The other is an unnamed stream originating from Summit Meadows. Both are headwater tributaries to the Salmon River. Additionally, there are a number of small, unnamed, seasonally flowing, intermittent streams that originate from the west slope of Mud Creek Ridge and are tributary to Mud Creek or Trillium Lake. Most cross beneath the haul route, though one in particular is very near to the southern bounds of the quarry site.

Mud Creek is a small, perennially flowing, somewhat confined, gently meandering, second-order stream that issues from Trillium Lake reservoir. Its mid- and upper reaches parallel portions of the haul route. Although both the lake and creek are nearby, they are not directly adjacent to or in contact with either the quarry site or the haul route. The shortest distance between the quarry site and Mud Creek is roughly 0.4 mile. Reaches of Mud Creek that parallel the haul route have low, indistinct stream banks thickly covered by aquatic grasses, brush, and woody debris. The channel is about three to four feet wide, and mostly a low- to moderate-gradient, riffle-pool type of stream sequence.

The unnamed perennial stream originates from Summit Meadows and crosses beneath the haul route near where it intersects with Forest Road 2656-131, about one-half mile south of U.S. Highway 26. Its features are very similar to those of Mud Creek, and it is associated with an adjacent wetland corridor that connects to a complex of wetlands known as Red Top and Salmon River Meadows downstream.

Between the Trillium Lake Campground and the quarry site are about ten very small, first-order ephemeral streams that cross beneath the haul route. Their hillslope sources are small springs and seeps replenished by snowmelt-charged groundwater and runoff. In the spring and early summer they are freshets that are dry by mid- to late summer. Their lower reaches are moderate- to high-gradient, cascading step/pool stream types. However, much of their upper reaches are overgrown and indistinct, with an intermittent and discontinuous channel, and predominantly subsurface flow. Evidence of annual surface scour in the upper reaches of these small streams is often lacking.

One of these very small streams is in close proximity to the quarry site. It originates about 250 feet south of the lower pit of the quarry from a small, seasonally ponded seep in a broad shallow swale. The upper reaches are mostly subsurface flow, interspersed periodically with small, pools and wallows that dry up in the summer. These features are disconnected on the surface, and lack a continuous channel between them. About one-eighth mile downhill, this water source emerges to the surface as a continuous feature just above where it flows beneath Forest Road 2656. It then flows to Mud Creek in a shallow; 2- to 3-foot-wide, indistinct channel lined with dense forest vegetation and filled with an abundance of downed woody debris.

Figure 1. Vicinity

Figure 2. Alternatives Under Consideration

2.3 STREAMFLOW AND THE HYDROLOGIC REGIME

The Salmon River Watershed Analysis indicates that average precipitation in the Mud Creek catchment ranges between about 65 and 70 inches annually (USFS 1995). The greatest amount falls in the period between November and January, and the least amount in July and August. During most years a winter snowpack accumulates in the drainage, providing water storage over the winter and supplementing surface flow and groundwater recharge in the spring and summer (USFS 1995).

The hydrologic regime of the upper Salmon River, including the 7^{th}-field Mud Creek catchment, is a snow- and rain-dominated system. Flows are usually lowest in the late summer and fall, then they typically increase in late fall and stay steady through the wet winter months until early spring. In spring, flows steadily rise again and peak during periods of high snowmelt, then they gradually diminish in late spring and early summer as the snowpack melts (USFS 1995).

Typically, normal peak flows are associated with the spring runoff. However, large magnitude runoff or flood events often result when periodic rain-on-snow events occur, usually during the wet winter months. The project area is within the upper range of the transient snow zone, where heavy intense rains can fall on accumulations of snow in the mountains. Such occurrences have resulted in the largest runoff and flood events recorded in the western Cascades (USFS 1995). In regions where episodes of rain-on-snow periodically occur, both natural and human disturbances can have a considerable effect on peak flows, increasing the susceptibility of a watershed to flood events (Harr et al. 1975).

In western Oregon, natural disturbances capable of denuding the forest canopy over a large area, such as wildfire, have been shown to hasten the timing and accentuate the magnitude of peak flows, particularly those resulting from high precipitation and rain-on-snow events. A portion of the western half of the Mud Creek catchment was burned in the early 1940s, and the forest canopy was mostly destroyed over a large area (USFS 1995).

The loss of the forest canopy would have diminished its moderating effects on interception of snow and rainfall, snow accumulation, snow melt, evapotranspiration, and runoff until a protective cover of vegetation returned. For a time, peak flows may have been elevated in Mud Creek as an indirect result of wildfire, leading to excessive stream bank erosion, channel scour, and downcutting. Unstable banks along the lower reaches of Mud Creek near its confluence with the Salmon River suggest that a considerable degree of stream erosion had occurred in the past, which could be attributable, in part, to elevated peak flows resulting from high intensity wildfire (USFS 1995). At present, however, effects to Mud Creek from past wildfire seem to have diminished greatly since the area has recovered, and a protective forest canopy has returned to the once burned over areas.

Human disturbance can also affect peak flows. Road surfaces and clearcut timber harvest can be primary disturbances that adversely affect the timing and magnitude of peak flows (Harr et al. 1975). As with natural disturbances, of particular concern are effects of human disturbance on peak flows generated by high precipitation and rain-on-snow events that can increase flooding potential. According to the Salmon River Watershed Analysis (USFS 1995), peak flows have been elevated in the Mud Creek catchment as a result of human disturbance, primarily attributable to the presence of roads. While past clearcut timber harvest and historic wildfire have been influences, their effect is thought to be diminishing as forest vegetation and a canopy continue to develop.

Base flows in the perennial stream reaches near the project area occur in late summer and fall, long after the contributing snow pack has diminished. In the Mud Creek catchment, groundwater recharged annually with snow melt maintains base flows. The nearly level wetlands on the north end of Trillium Lake and along Mud Creek retain groundwater later into the season than surrounding hillsides, and these wetlands provide available water that support summer flows. The Salmon River Watershed Analysis (1995) indicates that, for reasons that are uncertain, base flows (particularly in the upper portion of the watershed) have been slowly declining since the early 1950s. Climatic factors, human disturbance, or a combination of both may play a role, but the connection is unclear. The reservoir at Trillium Lake, however, stores water that can be available for release to maintain base flow in Mud Creek. Its influence serves to moderate variations in flow from year to year. Likewise, Summit Meadows, which is seasonally ponded in spring and perennially saturated close to the surface year-round, ensures base flow for the unnamed, perennial tributary to the Salmon River.

All of the streams near the quarry site and haul route can be considered relatively small in length, width, and average discharge. Although their contributing areas include the surrounding hill slopes, where a snowpack accumulates annually and rain-on-snow events periodically occur, these streams have a low sediment transport capability, even during flood events. This is primarily attributable to the low gradient and gentle relief of the valley bottom, the attenuating effect of wetlands and Trillium Lake, groundwater storage, and porous upland soils. Therefore, fluvial erosion is not considered to be a primary, naturally occurring, sediment-producing and transport mechanism for the Mud Creek catchment.

2.4 SOILS AND EROSION

Upland soils around the project area are dominated by moderately deep, gravelly sandy-loams and silt loams that have formed in colluvium of glacial till. They are cold, well-drained soils that support conifer plant associations typical of the Pacific Silver Fir Zone described by Franklin and Dyrness (1969). Limitations associated with the properties of these soil types include difficulties with regeneration due to heavy brush competition and severity of slope. Even though these soils are somewhat resilient to disturbance and possess a good infiltration capacity, they exhibit a moderate surface erosion potential, due primarily to slope.

Soil characteristics around the quarry site and along portions of the haul route are similar, but the quarry site itself is underlain directly by igneous rock, where in places, soils are very shallow or wholly lacking (Howes 1979). Drilling records indicate that samples collected from several old test borings at the site were andesite, and that at a depth of about 60 to 80 feet materials became decomposed and highly weathered. Records also indicated that there were no noteworthy groundwater sources encountered (Deroo pers. comm. 2003).

Several soil types are associated with valley bottom settings around the project area. Most of those directly adjacent to the haul route are cold, deep, loamy sands and silt loams that have formed in glacial till and that tend to be either well drained or somewhat poorly drained. There are also wet meadow soils and poorly drained forested bottom lands that occur along the haul route, mainly between Trillium Lake and Summit Meadows. These soils have a high water detention potential and exhibit a low surface erosion potential. Limitations associated with these soils include permanent or seasonal inundation, and permanent or seasonal high water tables. Wet soil types are considered sensitive to ground disturbing activities (Howes 1979).

The natural erosion regime associated with the Mud Creek catchment where the project is located is primarily related to periodic disturbance. Since landforms in the vicinity are mostly stable and fluvial processes are relatively slight, mass wasting and stream-related erosion are not dominant, sediment-producing mechanisms. Additionally, porous upland soils with good infiltration capacity, along with the attenuating effects of valley bottom soils to store water and a ubiquitous cover of litter and forest vegetation, combine to limit the effects of runoff and raindrop splatter that induce surface erosion. Rather, it is probable that the highest rates of naturally occurring erosion were temporarily provoked when a disturbance such as intense wildfire caused bare soil to be exposed to erosive forces. Accelerated rates of surface erosion could have occurred for a time afterward until a protective cover of vegetation was reestablished. Most prone would have been upland soil types on moderately steep to steep slopes, which exhibit a moderate to high surface erosion potential when they are bare and devoid of cover. Other more minor forms of erosion exist. Slow-acting soil creep and periodic rock fall probably play a negligible role in the natural erosion regime, only occurring where rock outcrops, steep slopes, and areas where high water tables occur on steep slopes. Under natural conditions, areas in the vicinity of the quarry site and haul route were not generally subjected to intense rates of surface erosion or large quantities of sediment production.

Human disturbance, however, has exposed surface soils to erosive forces in the project vicinity. The Salmon River Watershed Analysis (1995) indicates that this is attributed mostly to the presence of roads, and estimates that road related sediment delivered to water bodies in the Mud Creek catchment could potentially amount to 160 tons annually.

Of particular concern are road segments composed of dirt or gravel surfacing. In the Mud Creek catchment, the greatest potential for road-generated sediment to be delivered to a water body is where gravel and dirt roads cross over streams – for example, where Forest Road 2656-309 crosses Mud Creek, which is one-quarter mile west of the quarry site (USFS 1995).

Where road segments are near a water body, such as a stream crossing, sediment delivery potential is high. Along the haul route, streams pass under the road in about a dozen locations. However, the haul route consists of asphalt surfacing where it crosses streams. So, except where there are bare-cut banks and ditch lines, sediment generated from the haul route is very slight when compared to that which is potentially produced from roads with dirt or gravel surfacing.

Road sanding during winter months can be another potential source of sediment delivery to streams. Highway 26 is the nearest road to the Mud Creek catchment that is sanded. However, because there are no above-ground flow routes that directly connect the highway with water bodies in the Mud Creek catchment there is little potential for sanding materials to be delivered from the highway to any of the water bodies near to the haul route or quarry site. The haul route is closed in winter and is not sanded.

Areas in the catchment where timber harvest activities occurred in the past are considered to contribute less sediment than roads (USFS 1995). Currently there are no harvest operations occurring in the catchment, and all of the areas that have been previously logged are young plantations where a protective ground cover has established. Except for the remaining roads, any adverse impacts related to accelerated rates of erosion caused by timber harvest activities are diminishing.

At the quarry site, signs of accelerated surface erosion are evident. It is a large, poorly vegetated open area consisting of an upper and lower pit where rock materials have been extracted and sorted into a wide variety of sizes for various purposes. Much of the rock that was originally quarried was crushed into material of pit run, gravel, and sand size for road construction and highway sanding projects. Copious amounts of unconsolidated sand and fine soil material are scattered loosely throughout the site, or have been arranged into piles and berms for storage. In places, some of the fine fraction materials have been mobilized and transported via concentrated runoff from water bars and hardened driving surfaces to a broad, shallow headwater swale on the south side of the quarry site.

Large, deep deposits of fine material can be readily observed in and around the margins of the broad shallow swale adjacent to the south side of the quarry site. Given the extent of these deposits, runoff from the site and the resultant sediment transport appears to have been occurring seasonally for many years. Large openings in the forest, such as that offered by the quarry site, are capable of accumulating a snowpack deeper than normal. In the spring, these exposed openings tend to melt earlier and faster than areas under the shade of a forest canopy. The combination of a deeper snow pack with an earlier and faster melt rate in the spring potentially increases runoff and erosive energy. The snow that accumulates in the quarry every winter melts every spring, and the runoff erodes loose, fine material located directly in the flow routes. Some efforts have been undertaken in the past, with limited success, to control erosion at the quarry site. Currently, erosion control structures at the site are in relatively poor condition and marginally effective, presumably due to vandalism, off road vehicle use, the seasonal snowpack, and infrequent maintenance.

Sediment deposited to the swale from the quarry site does not appear to have undergone considerable transport farther downhill. The majority of spring runoff in the broad swale appears to be subsurface flow, as there are only several places where signs of water at the surface are apparent and there is no continuous channel extending downhill. Thus, the current potential for the sediment deposited in the swale to be transported to a perennial water body such as Mud Creek, one- quarter mile downhill, is very low. These deposits, however, have been encroaching upon a seep located in the bottom of the broad swale about 250 feet from the south edge of the lower pit of the quarry site, a condition that could be judged as inconsistent with standard and guideline FW-084 in the Mt. Hood National Forest's Land and Resource Management Plan.

2.5 WATER QUALITY

The single beneficial use listed by the Oregon Department of Environmental Quality (DEQ) for the Sandy River Basin that applies to water bodies that are in direct contact with the project area is categorized as resident fish and aquatic life. Beneficial uses applicable to other notable water bodies nearby, particularly Trillium Lake include boating, fishing, and water contact recreation (OAR, chapter 340-410). There are no streams or stream segments in the Mud Creek catchment and project area included on the DEQ 2002 303(d) list of water quality-impaired water bodies (DEQ 2003) for the applicable beneficial uses.

While there are no known temperature concerns for streams flowing near the haul route or quarry site, the Salmon River Watershed Analysis (1995) identifies increased water temperature as a potential concern for nearby Mud Creek, despite the high-quality sources of cold water from springs and wetlands in the area. Data obtained from continuous monitoring conducted in 2002 and 2003 detected temperatures downstream from Trillium Lake that for several periods during the summer exceeded 64º Fahrenheit, the standard for the 7 day average maximum water temperature established by DEQ for the Sandy River subbasin. The cause was attributed to the capability of the surface area of Trillium Lake to intercept solar radiation, along with stream side shade conditions at the time, and discharge sun-warmed waters to Mud Creek.

The Salmon River Watershed Analysis (1995) also noted the potential for fine sediment to be delivered to streams from certain road segments in the Mud Creek catchment.

Notable increases of fine sediment can have deleterious effects upon the quality and quantity of aquatic habitat. Low-gradient stream reaches such as those of Mud Creek below Trillium Lake were noted as being susceptible sites where fine sediment could potentially accumulate, causing undesirable effects to the quality of pool habitat. Of particular concern were contributing road segments with gravel or dirt surfaces near a water body. Segments of the haul route cross a number of streams, but since the haul route is surfaced with asphalt, the potential for large quantities of sediment to be delivered from its surfaces to streams is low. The potential for sediment to be delivered to a stream from the quarry site is also low, partly due to its distance from the nearest perennial stream, but also because there is no continuous channel nearby that connects surface flow directly with water bodies downstream.

2.6 WETLANDS AND FLOODPLAINS

Several wetlands in the valley bottom are near the haul route. They are palustrine types as defined by Cowardin (1979), and consist primarily of a combination of emergent, shrub-scrub, and forested classes. Most notable is a complex of wetlands associated with Summit Meadows. These wetlands are connected with Red Top Meadows, which in turn are connected to Salmon River Meadows. Although the haul route is somewhat removed from, and not directly adjacent to, Summit, Red Top, or Salmon River Meadows, it does cross through a wetland corridor that connects with them near the junction with Forest Road 2656-131, about one-half mile south of U.S. Highway 26. The haul route also crosses through a number of wet forest bottom lands between Trillium Lake Campground and the quarry site. There are no wetlands directly adjacent to the quarry site.

There are no jurisdictional, 100-year floodplains recognized by the Federal Emergency Management Agency or Army Corps of Engineers in the project area.

2.7 PERTINENT AGENCY DIRECTIVES

The Salmon River Watershed Analysis (1995) identifies land use allocations within the Mud Creek catchment designated by the Mt. Hood National Forest Land and Resource Management Plan (LRMP) (USFS 1990) and the Northwest Forest Plan (NWFP) (1994). Those that apply to the project area include B2 Scenic Viewshed and C1 Timber Emphasis. Standards and Guidelines associated with these designations direct strategic and project-level planning, as well as land uses within their bounds. In addition to these directives, others to be considered in context of the activities and operations proposed in this DEIS include those listed as Forestwide Standards and Guidelines in the LRMP for water, soil, and riparian resources, as well as transportation and access and travel management, and minerals management.

Forestwide Standards and Guidelines (S&Gs) to be considered in relation to the proposed activities include those for minimizing or preventing undesirable impacts to water, soil, and riparian resources that could result from the use and maintenance of the transportation system (haul route) and the activities for expanding the quarry site. Those for consideration that most apply to the proposed activities include the following S&Gs (paraphrased):

- FW-025/026 Achieving effective ground cover
- FW-027 Removal and sale of topsoil
- FW-059 Implementation of individual Best Management Practices
- FW-060 Preventing the degradation of water quality and natural drainage
- FW-063/064 Watershed impact areas should not exceed 15 percent
- FW-066 Cumulative effects analysis
- FW-075/076 Protection from chemical and hazardous materials
- FW-084 Preventing sediment delivery to riparian areas
- FW-398 Administration of minerals on sale or permit basis in accordance with 36 CFR 228, subpart C
- FW-416 Design standards for proposed road reconstruction
- FW-422/423/424 Minimizing impacts to soil and water resources
- FW-427 Minimizing disturbance to natural drainage patterns

(Note: there are a number of water, soil, and riparian Forestwide S&Gs that are the same or very similar between resource areas. For the sake of brevity and to minimize redundancy, some were omitted from this list.)

3 ENVIRONMENTAL CONSEQUENCES

3.1 INTRODUCTION / ANALYSIS METHODOLOGY

A qualitative method was used to analyze the effects of the proposed alternatives. This method was employed for several reasons. Because watershed and soil resources were not topics identified as significant issues during the scoping process, a more stringent, quantitative detailed analysis was not deemed necessary. Secondly, because the haul route is not proposed to change beyond existing conditions and its use would not necessitate ground-disturbing activities, an in-depth and detailed analysis would probably not reveal distinct, measurable differences between the alternatives. Additionally, direct hydrologic pathways and links between streams or water sources is lacking, and there are no continuous channels that come in contact with, or are near the expanded quarry site in any of the alternatives. As a result, detailed, in-depth analysis would also probably result in very little or no measurable distinctions between the alternatives.

Standard practices and procedures for analyzing particular impacts to soil and water resources were considered as an approach for identifying simple cause-and-effect relationships between proposed activities and the natural conditions and physical characteristics of the project area. Cause and effect relationships were considered in the context of standard procedures defined in the U.S. Environmental Protection Agency's publication, *An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources (A Procedural Handbook)* (EPA 1980). The primary items considered for concluding effects were the footprint areas of ground disturbing activities. Secondary items included activities not considered ground disturbing.

3.2 HYDROLOGY, STREAMFLOW, AND CHANNELS

3.2.1 Effects Common to All Alternatives

Expansion of the quarry site for all alternatives can be considered a created opening. The removal of forest vegetation can effectively reduce interception and transpiration and increase snow accumulation, thereby increasing the amount of net precipitation available for runoff. These effects can alter the hydrograph and have been shown to hasten the timing and accentuate the magnitude of peak flows, particularly those resulting from high precipitation and rain-on-snow events (Harr et al. 1975).

Likewise, expansion as well as operations at the quarry site would create heavily compacted and hardened surfaces, where the capability for infiltration and water transmissivity into underlying materials is greatly diminished, which would also increase the amount of precipitation available for runoff.

As an indirect result, elevated peak flows resulting from created openings and hardened surfaces can lead to excessive stream bank erosion, channel scour, and downcutting; particularly if sensitive streambanks similar to those noted along the lower reaches of Mud Creek are present. For small watersheds in the western Cascades within the transient snow zone, such as the Mud Creek catchment, effects of created openings begin to become pronounced when the amount of area consisting of a well developed, hydrologically mature forest canopy (represented here as forest stands older than about 15 to 30 years of age), is decreased by about 20 percent (Bosch and Hewlett 1982, USFS 1990). The extent that hydrologic conditions are altered depends upon the amount of area in a hydrologically immature status.

The primary difference between the alternatives is the comparative size of the opening that would be created as a result of the quarry expansion, and the expanded size and extent of hardened surfaces. The haul route and its footprint are the same for all of the alternatives. Its location, design, and materials would remain as is for all of the alternatives. There are no proposed improvements, upgrades, reconstruction, or other actions associated with the haul route that would necessitate ground-disturbing activities. Hence, there are no additional impacts predicted to streams or channels as a direct or indirect consequence of its physical presence and location. Existing effects to streams and channels are attributable to current uses, and would not be expected to increase or decrease for any of the alternatives.

Under each of the alternatives, the closest water body to the quarry site would be a small, seasonally wet seep located roughly 250 feet to the south, in a broad swale.

3.2.2 Effects Common to Action Alternatives 1 and 2

The size of the created opening that would result from expansion of the quarry site in Alternatives 1 and 2 would be 70 and 50 acres, respectively. Created openings of this size in a small forested watershed are considered rather large. In the western Cascades, openings of this size would tend to receive appreciably more rainfall because there would be very little loss due to interception by a forest canopy. An accumulation of a snowpack notably deeper than that of surrounding forested areas could be expected. In the spring, snow that had accumulated in the opening could melt earlier and faster than normal. Hardened surfaces at the site would limit the amount of precipitation and snowmelt that could infiltrate into the ground. Combined, these factors could cause a noticeable increase in available runoff from the quarry site.

Depending upon the degree of incline, arrangement, and distribution of hardened surfaces at the site, available runoff could become concentrated and directed in various flow routes. If a substantial proportion of the available runoff were directed off-site toward the broad swale south of the project area, then a notable increase could occur in the amount of water that is normally contributed to its contributing area.

As an indirect result, what would normally be subsurface interflow in the swale could become surface flow during periods of high antecedent soil moisture. Recurrence of such conditions over the span of numerous seasons might induce channel-forming processes. Small connected channel segments could begin to develop, altering the hydrology of the swale and its current capacity to store and retain moisture. Existing seeps and vernal pools would possibly disappear as a consequence, and the ability of the swale to store and retain sediment reversed.

The effects of openings in forested areas of the region can also influence base flows. Increases in the amount of precipitation available as runoff, particularly spring snow melt, can result in elevated inputs to groundwater via infiltration into the soil complex. Given the large opening that would result from quarry expansion, there is a potential for intercepted precipitation at the quarry site to become stored groundwater available as localized contributions supporting base flow. Localized contributions at the catchment scale, however, would have little effect on base flows, including their magnitude and duration.

The duration of hydrologic effects at the site-specific scale attributable to the large quarry site in Alternatives 1 and 2 might last as long as the presence of the created opening and hardened surfaces persist. If left unmitigated, effects could persist for many decades until a hydrologically mature canopy becomes developed over most of the quarry site, and the extent of hardened surfaces sufficiently reduced.

3.2.3 Alternative 1 (Proposed Action)

As a direct consequence of implementing Alternative 1, a non-forest patch approximately 70 acres in size would be created due to quarry expansion, a 48-acre increase above the size of the existing quarry. The opening would comprise about 1.6 percent of Mud Creek's total catchment area. Additionally, ground-disturbing activities associated with quarry expansion and operations could be expected to expand the amount of heavily compacted surface area at the site by nearly three times its current size.

The maximum opening size expected as a result of quarry expansion under Alternative 1 would decrease the amount of area in a hydrologically mature condition in the Mud Creek catchment by about 1.1 percent. The potential effect of a created opening of this size upon the hydrograph is considered to be low at the catchment scale (7^{th} field hydrologic unit). Considering the slightly elevated peak flow estimates for the existing condition, and the moderately small percentage of the catchment converted to an opening in this alternative, the potential for notable alterations to the magnitude, timing, and duration of peak flows attributable to quarry expansion would be low and likely undetectable. Hence, the potential for undesirable channel effects such as excessive channel scour and bank erosion to Mud Creek, including its lower sensitive reaches, is expected to be low.

At the site-specific scale, hydrologic effects resulting from this alternative could be noticeable, as discussed above under 3.2.2, Effects Common to Alternatives 1 and 2.

3.2.4 Alternative 2

As a direct consequence of implementing Alternative 2, a non-forest patch approximately 50 acres in size would be created due to quarry expansion, a 28-acre increase above the size of the existing site. The opening would comprise about 1.1 percent of Mud Creek's total catchment area. Additionally, ground-disturbing activities associated with quarry expansion and operations could be expected to expand the amount of heavily compacted surface area at the site by approximately two times its current size.

The maximum opening size expected as a result of quarry expansion under Alternative 2 would decrease the amount of area in a hydrologically mature condition in the Mud Creek catchment by about 0.6 percent. The potential effect of a created opening of this size upon the hydrograph is considered to be low at the catchment scale. Considering the slightly elevated peak flow estimates for the existing condition, and the somewhat small percentage of the catchment converted to an opening in this alternative, the potential for notable alterations to the magnitude, timing, and duration of peak flows attributable to quarry expansion would be low and undetectable. Thus, the potential for undesirable channel effects such as excessive channel scour and bank erosion to Mud Creek, including its lower sensitive reaches is expected to be minimal.

At the site-specific scale, hydrologic effects resulting from this alternative could be noticeable, as discussed above under 3.2.2, Effects Common to Alternatives 1 and 2.

3.2.5 Alternative 3 (No Action)

As a direct consequence of the No Action Alternative, a non-forest patch approximately 29 acres in size would be created due to quarry expansion, a 7-acre increase above the size of the existing site. The opening would comprise about 0.6 percent of Mud Creek's total catchment area. Additionally, ground-disturbing activities associated with quarry expansion and operations could be expected to expand the amount of heavily compacted surface area at the site by approximately one-third.

The maximum opening size expected as a result of quarry expansion under the No Action Alternative would decrease the amount of area in a hydrologically mature condition in the Mud Creek catchment by less than 0.2 percent. The potential effect of a created opening of such small size upon the hydrograph and peak flows is considered to be negligible at the catchment scale. Thus, undesirable effects such as excessive channel scour and bank erosion to Mud Creek, including its lower sensitive reaches would not be expected.

At the site-specific scale, the created opening at the quarry site would tend to accumulate a deeper-than-normal snowpack. In the spring, the snow covering the exposed opening could melt earlier and faster than areas under the shade of a forest canopy. Hardened surfaces at the site would limit the amount of snow melt that could infiltrate into the ground. Combined, these factors would cause an increase in available runoff from the quarry site. However, since there are no continuous surface flow-routes directly connecting the quarry site with a stream, noticeable effects to channels resulting from elevated runoff would not be expected. Instead, available runoff would infiltrate into the ground soon after leaving the quarry site.

The duration of hydrologic effects at the site-specific scale attributable to the quarry site could be expected to last as long as the presence of the created opening and hardened surfaces persists. Although overall hydrologic effects are considered slight compared to Alternatives 1 and 2, they would remain until a hydrologically mature canopy becomes developed over most of the quarry site, and the area of hardened surfaces sufficiently reduced. At the catchment scale, the effects attributable to the quarry site, which are considered to be negligible, would diminish even further over time. As re-growth in clearcut areas continued to develop, the amount of hydrologically mature stands would increase in the catchment (assuming no future, widespread clear cut harvest).

3.2.6 Mitigation

Under both of the action alternatives, detailed excavation and reclamation plans would be developed throughout the course of operations and expansion. At the minimum these should identify measures for yearly runoff and sediment control, including the placement of runoff control structures at the quarry site that are resistant to vandalism and off road vehicle use (e.g., rock check dams, retention berms, drainage ditch lines, waterbars, infiltration drains, shallow evaporation basins).

3.3 SOILS AND EROSION

3.3.1 Effects Common to All Alternatives

The haul route and its footprint are the same for all of the alternatives. Its location, design, and materials would remain as is for all of the alternatives. There are no proposed improvements, upgrades, reconstruction, or other actions associated with the route that would necessitate ground disturbing activities. Hence, there are no additional impacts predicted to occur to soil resources underlying the haul route as a direct or indirect consequence of its physical presence and location. Existing effects to soil resources are attributable to current uses, and would not be expected to increase or decrease for any of the alternatives.

3.3.2 Effects Common to Action Alternatives 1 and 2

Where road segments come near to a water body, such as a crossing over a stream, the potential for sediment delivery can be high, particularly if they are gravel or dirt roads. Along the haul route, there are about a dozen locations where streams pass under the road. However, because the haul route consists of asphalt surfacing, except where there are bare cut banks or ditch lines, sediment generated from the haul route would typically be considered very light.

Under Alternatives 1 and 2, however, there would be a substantial increase above the No Action Alternative in the amount of traffic using the haul route, attributable directly to periodic intensive hauling, which would occur during the non-winter months as needed. Recurring periods of heavy traffic, especially with heavy trucks and equipment, can have deleterious effects upon roads, gradually breaking them down and dislodging and pulverizing materials from their surfaces.

Because Alternatives 1 and 2 forecast more periods of intense haul using heavy trucks, there is a higher potential for these alternatives to generate sediment by traffic from the haul route than would be generated by the No Action Alternative. Likewise, since the haul route crosses a number of small channels of both perennially and seasonally flowing streams, there is greater potential for a portion of haul-related sediment to enter water. Despite these factors, the increase in the amount of related sediment that could be available to enter streams is concluded to be slight.

Typically, gradual and incremental wear on asphalt surfaces from heavy traffic is indiscernible on a near-term basis. Except where there are weak spots, such as pot holes or ruts, pavement deterioration is generally considered to be relatively slow. Periods of elevated traffic on the haul route would occur intermittently over the life of the project, but in between there would be long periods when no quarry-related traffic would occur. During winters, for example, the haul route would be entirely closed to traffic. Additionally, gradual wear would be distributed over the entire haul route, not just close to a water body. Also, routine maintenance would occur under the action alternatives for regularly repairing any damage that might arise. Hence, periodic extensive haul is not expected to cause an excessive amount of pavement degradation that would lead to the production of an appreciable amount of fine sediment potentially deliverable to a water body.

Under both Alternatives 1 and 2, detailed excavation and reclamation plans would be developed throughout the course of operations and expansion. Since activities proposed in the action alternatives are expected to occur more often than those which currently occur under the existing Special Use permit (No Action), it can be assumed that activities prescribed by excavation and reclamation plans would also occur more regularly.

At the minimum, excavation and reclamation plans developed under Alternatives 1 and 2 should contain standard operating procedures to prevent accelerated erosion and contain sediment. Implementation of these measures would occur by far more frequently than the existing level of effort. Therefore, it is concluded that erosion and sediment control measures implemented under Alternatives 1 and 2 could result in a considerable decrease of sediment transport off site compared to the No Action Alternative.

3.3.3 Alternative 1

As a direct consequence of implementing Alternative 1, adverse impacts to soil resources could be expected over the greatest amount of area in relation to Alternatives 2 and 3. The maximum limits of the quarry site proposed for Alternative 1 provide a footprint size of approximately 70 acres. Proposed expansion of the quarry site to that size could be expected to result in ground-disturbing activities occurring across 48 acres in addition to the existing 22-acre site.

As a result of expansion, which would primarily occur outward from the east and north bounds of the site, the soil mantle and forest cover would be removed from most of the quarry area. Activities and use at the quarry would increase dramatically, including the use of heavy equipment, machinery, and vehicles, causing further ground disturbance that could be expected to render surfaces across much of the site heavily compacted and in a hardened state. Expansion and operations at the quarry site could result in a nearly three-fold increase in the amount of area exposed and heavily compacted.

Due to the comparative size of the expanded quarry site under this alternative, which could substantially increase the amount of available runoff and sediment, the potential for sediment delivery off site is very high. Fully expanded, the 70-acre quarry site would mostly be bare and void of a vegetative cover. Any exposed soil, sand, and fine aggregate materials at the site could be subjected to erosive forces from wet season rains, spring snowmelt, and concentrated runoff. Proposed expansion in this alternative would expose the greatest total area to erosive forces, and enlarge the amount of hardened surfaces extensively, thereby increasing the potential for accelerated surface erosion and sediment delivery offsite. This could result in the need for a substantially greater effort to minimize accelerated erosion and contain sediment compared to the No Action Alternative.

Removal of the soil mantle, in conjunction with an enlargement of compacted surfaces, would relate to a loss of inherent long-term site productivity over the 70-acre expanded quarry site, equal to a three-fold increase in the amount of affected area compared to the No Action Alternative. Soil conditions would be severely diminished, making the site incapable of supporting forest vegetation for decades**.** Conversion of the site to a non-productive status would add 48 acres to the amount of area currently in a non-productive condition in the project vicinity and Mud Creek catchment (i.e., many of the existing road segments).

The conditions described for this alternative could be expected to continue as long as the quarry site persists. Reclamation could eventually restore some of the area to a productive status, but the productive capacity could be expected to remain below natural levels across the 70-acre site over the long term.

3.3.4 Alternative 2

As a direct consequence of implementing Alternative 2, adverse impacts to soil resources could be expected to be somewhat greater than the No Action Alternative, but markedly less than Alternative 1. The maximum limits of the quarry site proposed for Alternative 2 provides a footprint size of approximately 50 acres. Proposed expansion of the quarry site to that size would result in ground-disturbing activities occurring across 28 acres in addition to the existing 22-acre site.

As a result of expansion, which would primarily occur outward from the east and north bounds of the site, the soil mantle and forest cover would be removed from most of the quarry area. Activities and use at the quarry would increase considerably, including the use of heavy equipment, machinery, and vehicles, causing further ground disturbance that would render surfaces across much of the site heavily compacted and in a hardened state. Expansion and operations at the quarry site could result in an approximately two-fold increase in the amount of area exposed and heavily compacted.

Due to the comparative size of the expanded quarry site, which could distinctly increase the amount of available runoff and sediment, the potential for sediment delivery off site is high under Alternative 2. Fully expanded, the 50-acre quarry site would mostly be bare and without vegetative cover. Any exposed soil, sand, and fine aggregate materials at the site would be subjected to erosive forces from wet season rains, spring snowmelt, and concentrated runoff. Proposed expansion in this alternative would notably increase the total area exposed to erosive forces, and enlarge the amount of hardened surfaces appreciably, thereby increasing the potential for accelerated surface erosion and sediment delivery offsite. This could result in the need for a substantially greater effort to minimize accelerated erosion and contain sediment compared to the No Action Alternative.

Removal of the soil mantle in conjunction with an enlargement of compacted surfaces would result in a loss of long-term site productivity over the 50-acre expanded quarry site, equating to an approximately two-fold increase in the amount of affected area compared to the No Action Alternative. Soil conditions would be severely diminished, making the site incapable of supporting forest vegetation for decades. Conversion of the site to a non-productive status would add 28 acres to the amount of area currently in a non-productive condition in the project vicinity and Mud Creek catchment.

The conditions described for Alternative 2 could be expected to continue as long as the quarry site persists. Reclamation could eventually restore some of the area into a productive status, but the productive capacity could be expected to remain below natural levels over the long term across the 50-acre quarry site.

3.3.5 No Action Alternative

As a direct consequence of implementing the No Action Alternative, adverse impacts to soil resources would be less than those for Alternatives 1 and 2. The maximum limits of the quarry site proposed for the No Action Alternative provides a footprint size of approximately 29 acres. Proposed expansion of the quarry site to that size could be expected to result in ground-disturbing activities occurring across 7 acres in addition to the existing 22-acre quarry.

As a result of quarry expansion, which would occur primarily outward from the east bounds of the site, the soil mantle and forest cover would be removed from most of the quarry area. Activities and use at the quarry could increase somewhat, and include the use of heavy equipment, machinery, and vehicles, causing some additional ground disturbance, which could render some of the surfaces across the expanded portions of the site heavily compacted. Expansion and operations at the quarry site would increase the amount of area exposed and heavily compacted by approximately one-third.

Currently, the quarry site is exposed and poorly vegetated, and contains a large source of unprotected sediment. Its compacted surfaces are prone to concentrating runoff in the spring or during heavy precipitation events. As evidence, sediment deposits are readily observable in the broad swale immediately south of the project area and can easily be traced directly to the quarry site. Transport of sediment off site from the quarry appears to have been occurring for many seasons, primarily from snowmelt runoff. Expanding the quarry site by 7 acres could increase somewhat the amount of available runoff and sediment. The potential for off-site sediment transport would remain moderate to high under the No Action Alternative.

The absence of a soil mantle, in conjunction with the presence of compacted surfaces at the site, relates to a loss of inherent long-term site productivity over an estimated 29 acres. Expansion of the quarry site could increase the amount of affected by approximately one-third over the existing condition. Soil conditions at the quarry would remain severely diminished, making the site incapable of supporting forest vegetation for decades. Conversion of the site to a non productive status would cumulatively add 7 acres to the amount of area currently in a non productive status in the surrounding vicinity and Mud Creek catchment.

The conditions described for the No Action Alternative could be expected to persist at the quarry site for the long term. Reclamation would not occur until extraction of rock materials was complete. Even though reclamation would be aimed at restoring the site back to a vegetated status, it would not fully restore productivity to a pre disturbance capacity. Current practices to reduce elevated rates of erosion and contain levels of sediment under the No Action Alternative would continue to be minimally effective. Existing erosion control structures are only marginally functional. Despite their presence, it is evident that sediment generated from quarry surfaces has moved offsite, particularly on the south side of the quarry. Due to the poor condition of existing erosion control structures, it is presumed that maintenance intervals are sporadic.

3.3.6 Mitigation

Under both of the Action Alternatives, detailed excavation and reclamation plans would be developed and approved by the FS throughout the course of operations and expansion. At the minimum these should identify measures for annual erosion and runoff control, and sediment containment, including the following provisions.

1. Place and arrange stock piled soil, rock, or waste materials away from drainage and runoff pathways.

2. Prior to ceasing operations each year (i.e., before heavy snow closes the haul route), for the entire length of FS road 2656-955, as well as the first 0.1-mile segment of FS road 2656-903, and the intersecting segments of FS road 2656: install appropriately spaced structures to drain and dissipate concentrated runoff from road treads and ditch lines (e.g., culverts, waterbars, dry trenches below cross drain outlets, inboard drainage to ditch lines, check dams, etc.).

3. Place runoff control structures at the southern edge of the quarry site that are resistant to vandalism and off-road vehicle use (e.g., constructed benches, rock check dams and filters, rock containment berms, waterbars, infiltration drains, shallow evaporation basins, etc.).

4. Suspend operations, including haul, during excessively wet and high runoff events as determined by the Forest Service Road Manager.

5. Establish an effective ground cover over reclaimed and stock piled soils, including the use of seasonally rigorous species adapted to the site and capable of rebound from seasonal snowpack (e.g., prolific pioneer species enhanced by disturbance, such as long-stolon sedge and pearly everlasting).

Additionally, specific mitigation measures pertaining to stockpiled soil materials could greatly enhance reclamation efforts at the quarry site. During quarry expansion, removal of the soil mantle would entail scraping it nearly down to underlying rock, then stockpiling it on site for subsequent reclamation purposes. In the process surface and subsurface soil horizons would become mixed, altering several natural physical properties such as structure, porosity, and the distribution and arrangement of organic matter. Soil amendments could greatly enhance altered physical conditions by improving the nutrient status of stockpiled soils. Soil amendments used at the site should be approved by a FS botanist.

To reclaim and restore stockpiled soil materials to their inherent productive capability, measures beyond those typical of standard operating procedures could be necessary. These include not only seasonal applications of special soil amendments to enhance nutrient status and increase the content of organic matter, but also efforts to keep the bulk density of materials within a certain range after they are redistributed. Excessively compacted conditions should be avoided as should excessively loose conditions. In a moist state, soil materials should be somewhat firm, but not overly so.

3.4 WATER QUALITY

3.4.1 Effects Common to All Alternatives

Heavy equipment and machinery that would be used in quarry and haul activities require the use of a variety of petroleum based fluids such as fuel, oil, and hydraulic fluid. These fluids would primarily be stored within the reservoirs and tanks of individual equipment and machinery, as well as in the tanks of service trucks. During operations, there would always be a possibility for accidents or breakdowns to potentially result in excessive leaks or spills.

Along the haul route, there would be some potential for a spill to enter a water body. If a spill were to occur, its potential to affect a water body would depend on its proximity and deliverable distance to it. The potential would be greatest during times when haul traffic is the highest. During most of the year, however, traffic would be low or non-existent, so the potential would be negligible. At the quarry site the potential for a spill to enter a water body and adversely effect water quality would be low too, because the nearest source is a small seasonal seep about 250 feet to the south of the project area, and it has no continuous channel that connects to a tributary downstream.

3.4.2 Effects Common to Action Alternatives (1 and 2)

Large, open, compacted surfaces located in the western Cascades would be capable of intercepting appreciable amounts of annual precipitation, potentially resulting in a noticeable increase in available runoff from the site. Runoff intercepted by hardened surfaces, such as roads, can be routed toward a water source. Roads, for example, can be links between sediment sources and streams, functioning as direct pathways for sediment to be delivered to water, potentially having an effect on water quality.

The quarry site in Alternatives 1 and 2 would be rather large (70 and 50 acres respectively), and a considerable portion of its surface would be hardened and heavily compacted. Available runoff originating from its surface during rain events or spring snow melt could be intercepted by the access road (Forest Road 2656-955). The access road, however, is not directly linked to any streams. Thus, sediment generated from the large quarry sites that are proposed in Alternatives 1 and 2 would not be expected to be routed to a stream. Of notable interest is Mud Creek, located about 0.4 miles to the west. There is no known direct or indirect link via road surfaces between the quarry site and Mud Creek. The potential for sediment generated from the quarry site to adversely affect the water quality of Mud Creek is considered low.

Because Alternatives 1 and 2 forecast more periods of intense haul using heavy trucks, there is a higher potential for these alternatives to generate sediment from traffic use beyond that generated by the No Action Alternative. Since the haul route crosses a number of small perennial and seasonal streams, the potential for a portion of haul-related sediment to enter water is somewhat greater. The amount of generated sediment that might be delivered to streams and adversely affect water quality, however, is expected to be slight because intense haul would occur only intermittently during non-winter months throughout the course of the permit, and would not be expected to be prolonged over a long time frame. Hence, degradation of asphalt surfaces attributable to intense haul over the haul route would not be excessive.

3.4.3 No Action Alternative

The Salmon River Watershed Analysis (1995) indicated a distinct potential for fine sediment to be delivered to streams from certain road segments in the Mud Creek catchment. Contributing road segments of particular concern were those with gravel or dirt surfaces near to, or crossing, a water body. Segments of the haul route cross a number of streams, but because it is surfaced with asphalt, its tread is not prone to generate sediment. Despite several short segments of the haul route where there are small bare-cut banks and ditch lines, the potential for plentiful quantities of sediment to be produced and delivered to a water body from its surfaces and adversely affect water quality is very low.

In general, traffic levels expected under the No Action Alternative would be relatively low, including times when material haul from the quarry site would occur. Under the No

Action Alternative, the potential for sediment from the quarry site to be delivered to a stream and adversely impact water quality is also low, primarily because no water body is directly connected to the quarry site. The nearest water body is a small, seasonally wet seep about 250 feet south of the project area, and it does not have a continuous channel directly connected with tributaries, or ultimately to Mud Creek downstream.

3.4.4 Mitigation

For all alternatives, excavation and reclamation plans would be developed that would contain provisions for erosion control and sediment containment and would be intended to minimize the effects of project related erosion to water quality (for additional detail regarding prescribed erosion control, see listed items in 3.3.6, Mitigation for soils and erosion).

Spill plans would be required as a condition of the special use permit. These plans would include provisions for containment and treatment of fluids in the event of a spill. At the minimum they would require rock filter berms to be located around above-ground storage tanks to contain potential spills, impervious filter materials beneath storage tanks to prevent petroleum based products from contaminating the site, and supplies of absorbent materials stored on-site or within close proximity to the haul route and quarry so that a certain level of immediate action can occur to prevent fluids from entering water bodies. Plans would primarily address petroleum-based fluids such as fuel, oil, and hydraulic fluid.

3.5 WETLANDS

3.5.1 Effects Common to All Alternatives

None of the alternatives propose ground-disturbing activities within or near known wetlands. No direct impacts to wetlands are anticipated as a result of quarry expansion and operations. Wetlands in the catchment are located primarily in the valley bottom, and are far removed from the quarry site. There are no known pathways, such as roads or streams that directly link the quarry site to wetlands. Existing effects to wetlands are attributable to current uses, and would not be expected to increase or decrease for any of the alternatives.

Along the haul route, there would be some potential for a spill to enter a wetland. If a spill were to occur, the potential for it to affect a wetland would depend on its proximity and deliverable distance to it. The potential would be greatest during times when haul traffic is the highest. During most of the year, however, traffic would be low or non-existent, so the potential would be low.

3.5.2 Effects Common to Action Alternatives (1 and 2)

Because Alternatives 1 and 2 forecast more periods of intense haul using heavy trucks, there is a higher potential for the action alternatives to generate sediment from traffic use than would be generated by the No Action Alternative. Since the haul route crosses a number of wet valley bottom areas, the potential for a portion of haul-related sediment to be delivered to a wetland is somewhat elevated. However, the amount of generated sediment that could be delivered to a wetland, potentially resulting in an adverse affect, is expected to be slight because intense haul would occur only intermittently during non-winter months throughout the course of the permit, and would not be expected to be prolonged over a long time frame. Hence, degradation of asphalt surfaces attributable to intense haul over the haul route would not be excessive.

3.5.3 Mitigation

Spill plans would be required as a condition of the special use permit. These plans would include provisions for containment of fluids in the event of a spill, and would require that at the minimum rock filter berms be constructed around above-ground storage tanks to contain potential spills, impervious filter cloth be installed beneath storage tanks to prevent petroleum based products from contaminating the site, and that supplies of absorbent materials be kept on-site or within close proximity to the haul route and quarry so that a certain level of immediate action can occur to prevent fluids from entering water bodies. Plans would primarily address petroleum-based fluids such as fuel, oil, and hydraulic fluid.

4 UNAVOIDABLE ADVERSE IMPACTS

Removal and stockpiling of soil resources for quarry expansion would adversely impact soils and soil productivity. Reclamation would ameliorate the condition to a degree, but soil properties would be drastically altered and nutrient status and water holding capacity diminished for the long-term.

5 SHORT-TERM IMPACTS VERSUS LONG-TERM PRODUCTIVITY

In the short term, adverse impacts to soil resources would result in a loss of long-term site productivity. The site would be converted to a non-forest condition. Reclamation efforts would not restore the capability of the entire site to support dense stands of conifers. The natural capability and productivity of the site would be diminished for the long term.

6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Expansion of the quarry site would considerably alter the natural topography of areas to the east and north of the existing site. Excavation of rock and stockpiling of soil materials would result in large quantities of materials being removed from the site. Reclamation plans would not intend to restore the site to a near natural condition, but rather would be aimed at minimizing surface erosion and establishing effective ground cover. Due to expansion and excavation, the site would not be expected to become a densely stocked stand of mature conifers in the foreseeable future. Open areas lacking trees would remain features of the site for the long-term.

7 CUMULATIVE EFFECTS

When analyzing cumulative effects to soil and water resources; past, future, and reasonably foreseeable activities are considered within the context of a discrete land unit. In this case the land unit to consider for cumulative effects to soil and water resources is primarily the Mud Creek catchment, although the next higher level land unit, the Upper Salmon River Subwatershed is also considered. Future and foreseeable actions other than the proposed actions that are scheduled to occur in the Mud Creek catchment include the Salmonberry #5 commercial thinning EA, the Timberline Express Lift EIS, the Timberline fuels reduction EIS, and the Trails Master Plan for the Mt Hood area EA. Past activities include previous clearcuts, fire, road construction, and recreation development.

7.1 HYDROLOGY

At the catchment scale, the cumulative effects to peak flows attributable to the quarry site are considered to be low because such a relatively small area would be affected (<2%). Effects would diminish even further over time as regrowth continues to develop a forest canopy in once cut-over areas, gradually increasing the amount of area in a hydrologically mature condition in the Mud Creek catchment (assuming no future, widespread clearcut harvest).

The Salmon River Watershed Analysis concluded that in 1995 the forest canopy in the Mud Creek catchment functioned at 89 percent of a mature hydrologic condition. At that time, created openings in the form of roads and young, previously clearcut stands had accounted for an estimated 11 percent decrease from a hydrologically mature condition. It was further concluded that as a result of these conditions, there was a slight increase in the potential for adverse effects to occur as a consequence of elevated peak flows predicted for the 2+ recurrence storm interval. Such an increase is considered to be very low and probably undetectable.

Recent analysis conducted by the Forest Service using the methodology known as the Aggregate Recovery Percentage (ARP) estimated that currently, slightly less than 9 percent of the area in the Upper Salmon River 6th-field subwatershed is in a hydrologically disturbed status (Parker pers. comm.. 2004). Reiterating the analysis to determine the effect of cumulative actions, it was estimated that minor increases to ARP values would result, amounting to 9.0 and 8.9 respectively for Alternatives 1 and 2. These represent increases of less than 1 percent in the amount of area in the subwatershed considered hydrologically disturbed. The opening that would be created as a result of quarry expansion would not cause ARP values to become appreciably elevated, for, in either action Alternative. Cumulative watershed effects would stay well below the limits set forth by forestwide standard and guideline FW-064, which establishes a maximum acceptable limit of less than 35 percent. As such, the potential for adverse cumulative effects to peak flows in the catchment to result from past, present, and future actions is considered negligible.

7.2 SOILS

Past actions that have caused adverse impacts to soil resources within the Mud Creek catchment include timber harvest (including road construction and use), some minor rock quarrying, and recreation development. Current and future actions that could affect soil resources include those listed as cumulative actions above. Combined, these actions will result in the cumulative accrual of detrimental soil conditions in the Mud Creek catchment.

Detrimental soil conditions could be expected to increase in the Mud Creek catchment incrementally over time, particularly with repeated harvest entry where ground-based harvest systems would be employed. Impacts would be isolated to harvest units and minimized to the extent possible by implementing best management practices (BMPs) and related rehabilitation efforts.

Sediment-related impacts attributable to current and foreseeable actions in the Mud Creek catchment would be minimal due to the implementation of BMPs and Northwest Forest Plan standards and guidelines requiring Riparian Reserve buffers that prevent indirect effects to soil and water resources from accelerated erosion. Additionally, the implementation of BMPs such as erosion control, along with restoration projects in the catchment would minimize accelerated erosion from isolated sites. Overall, accelerated erosion and sedimentation resulting from cumulative actions would increase only slightly over the entire area of the Mud Creek catchment.

The presence and use of roads would continue to seasonably contribute fine sediment to water sources within the Mud Creek catchment. Related sediment delivery would be minimized at very local sites, particularly at road crossings with gravel or native surfacing. Periodic increases could be expected temporarily in response to periods of heavy traffic and use such as log and material haul, summer recreational traffic as well as during peak runoff events. Overall, however, road-related erosion is not expected to increase or decrease markedly over the long term.

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