SE GROUP

TECHNICAL MEMORANDUM

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TO:	White Pass MDP FEIS Project File
FROM:	Travis Spikes
CC:	SE GROUP Project Files
DATE:	November 11, 2004 [Updated January 17, 2007]
RE:	White Pass MDP FEIS Flow Model Technical Report

This memorandum addresses the stream flows of the Upper Tieton River and Upper Clear Fork Cowlitz watersheds within the White Pass MDP project area. This analysis was developed to identify the potential to changes in stream flow associated with vegetation clearing resulting from the construction of ski area facilities proposed under the alternatives evaluated in the FEIS.

1.0 AFFECTED ENVIRONMENT

1.1 FLOW REGIME

As described in Section 3.1 of the FEIS, average annual precipitation at White Pass is 79.6 inches. The average snowpack between January and March is 37.6 inches, measured as a snow water equivalent. The snowpack at White Pass typically forms in mid-October and persists until late June or early July. Average annual snowfall within the White Pass Study Area is 350 inches (GoSki 2004 [www.goski.com]). Average annual temperatures within the White Pass Study Area are 35.8 degrees Fahrenheit during the period of record from 1989 through 2003. Temperatures range from average highs of 51.2 degrees Fahrenheit in August to average lows of 24.2 degrees Fahrenheit in February.

There are no stream gauges present within the White Pass Study Area or in the immediate vicinity to provide general stream flow characteristics. The closest stream gauge to White Pass that is located on an unregulated river is Station 14226500 on the Cowlitz River near Packwood. This station is located approximately 17 River Miles (RM) downstream of White Pass. Due to the distance from White Pass and the influence of downstream sub-basins, the data can not be directly used to characterize flow conditions in the streams within the White Pass Study Area.

The alpine weather cycles and associated stream flow responses that are characteristic of the hydrologic processes at White Pass are described as follows. Stream discharge increases in perennial stream channels as autumn rains fill the storage capacity of the soil. However, the greatest stream flows and most rapid increases in discharge are not controlled by rain alone, but also by rates of snow accumulation and snowmelt (i.e., rain-on-snow events). This is most prevalent in late October to mid-December, when frontal storms deliver warm rain and winds after the snowpack begins to develop. During these rain-on-snow events, all of the snowpack can melt during one storm event and contribute directly to very large peak flow events. The variability in the amount of stream flow begins to stabilize in the winter due to colder temperatures. Low winter flows are sustained by melt generated by ground heat, and by alternating freezing and thawing at the snowpack surface. Large and sustained peak flows occur during the spring and early summer when warm air temperatures cause the melt-off of the winter snowpack. The ephemeral stream channels in the White Pass Study Area typically go dry shortly after the spring melt is completed (refer to Figure 3-14 of the FEIS). The intermittent stream channels in the White Pass Study Area typically go dry later in the year, as shallow groundwater storage decreases later on in the summer (refer to Figure 3-14 of the FEIS). The stream channels located in the lower elevation portions of the White Pass Study Area are generally perennial; with larger contributing areas to sustain base flows and significant groundwater discharge from slope wetlands (refer to Figure 3-14 of the FEIS).

1.2 WATER USE

The White Pass Company has diverted for domestic use and fire control a small portion of source waters of Millridge Creek. During the 1996-97 season (Dec. 20 to March 16), the average peak weekend and holiday water use was 9,195 gallons (5 percent of capacity) per day for 1,870 skier visits or an average 4.92 gallons per skier visit. The highest visitor day use on record (2,949 skier visitors), 12,561 gallons were used (4.26 gal/visitor day) (refer to Section 3.13 – Utilities and Infrastructure). The dominant non-consumptive water use of Millridge Creek in the White Pass Study Area and downstream is the maintenance of cold water biota. Additional uses are for irrigation and recreation. Fish beneficial uses are discussed in Section 3.4 of the FEIS.

1.3 FLOW MODEL

It is well documented that removal of forest cover and creation of new impervious surfaces in a watershed increases available surface and shallow subsurface water, and can alter the flow regime of a watershed (Dunne, T. and L. B. Leopold 1978; Naiman, R.J. and R. E. Bilby 1998). The dominant type of land cover change that affects surface runoff generation and stream flow conditions is large-scale timber harvest, which increases residual soil moisture due to the excess water that would normally be used by trees through evapo-transpiration. The increased soil moisture promotes quicker development of surface water during rainstorms and additional shallow subsurface flow to streams in the treated area, especially in riparian areas adjacent to streams (Keppeler 1998). Research indicates that timber harvest in small watersheds (60-300 acres) can increase annual water yield by as much as 26 to 43 percent in completely clear-cut watersheds and can increase annual water yield in partially cut watersheds by 3 to 15 percent (Harr et al. 1979; Harr et al. 1982; Keppeler 1998). The construction of impervious surfaces (e.g., roads and parking lots) can also significantly increase stream flow by preventing rainfall from percolating into the soil, creating stormwater runoff that can contribute surface flow directly to streams (Wright et al. 1990). According to research by Ziemer (1981), newly constructed roads occupying five percent of a watershed did not result in a detectable change in base flow or peak flow. However, a separate study conducted in the Alsea watershed concluded that new roads occupying 12 percent of a watershed resulted in increases in peak flow of roughly 19 percent (Harr et al. 1975).

Many of the publicly available stream flow models are not suited for estimating potential changes in stream flow due to land cover alterations because they do not have an adjustable and/or accurate land cover variable in their algorithms (e.g., USGS Regional Equations, Index Flood Method). The stream flow models that do allow accurate adjustment of land cover are designed for flood control, stormwater routing, and agricultural purposes (e.g., HEC-1, HEC-RAS, HEC-HMS, StormCAD, BASIN, AGNPS) and are either not designed to accurately predict stream flow in watersheds with significant snow accumulation and melt or do not predict changes in stream flow at specific flow events. Since the existing publicly available stream flow models do not provide accurate stream flow predictions for alpine environments, a custom stream flow model was created to estimate the potential changes in stream flow conditions as a result of land cover changes from the Proposed Action in the Upper Clear Fork Cowlitz River and Upper Tieton River watersheds.

The geographic scope of the analysis for this custom flow model is larger than the White Pass Study Area because accurate flow modeling requires inclusion of the entire contributing area to the streams analyzed. Therefore, the scope of this analysis includes the White Pass Study Area, as well as lands to the north and east of the White Pass Study Area extending outward to the nearest drainage divide for the streams analyzed (refer to Figure 3-12 of the FEIS). This geographic area would be hereafter referred to as the Flow Model Analysis Area. The Upper Clear Fork Cowlitz watershed portion of the White Pass Study Area is approximately 1,460 acres in size and the Upper Tieton watershed covers approximately 535 acres of land. The model measures changes in flows at the mouth of the model area, which is at the inlet to Leech Lake for the Upper Tieton River and at the mouth of an unnamed tributary to Millridge Creek above Knuppenberg Lake for the Upper Clear Fork Cowlitz River.

The custom flow model was developed by first performing a thorough review of published literature in order to establish relationships between the size and type of watershed treatments (e.g., clear-cutting, road construction) and the measured effects on various stream flow parameters. Out of the 17 studies reviewed, seven were selected to be included in this model because they were conducted locally in Washington and Oregon, and typically involved watersheds with similar characteristics to the two analysis watersheds for this FEIS. For the purposes of this analysis, the existing and proposed stream flow conditions were calculated and presented as average 7-day low flow (low flow) and the 2-year peak flow (peak flow). These specific flow conditions were selected for analysis because, according to published literature, these are the flow conditions most likely to be affected by land cover changes from the implementation of activities such as those in the Action Alternatives (Beschta et al. 2000; Burton 1997; Keppeler 1998; Hicks et al. 1991).

Once the two flow rates to be modeled were selected, the data contained in the seven selected studies was synthesized for each of the two flow rates for this analysis. The synthesized data was then plotted on a X, Y scatter plot and trend lines were fit to the data with the percentage of the watershed treated on the X axis, and the percent change in the specific flow rate on the Y axis (refer to Illustrations 1 and 2). The most representative study for each flow (e.g., low flow or peak flow) was chosen based on the characteristics of the watersheds in the study, the location of the trend line relative to the trend lines from other studies, and the fit of the trend line to the data in the study. Once a trend line was selected for each flow rate, an equation was developed to describe the line so that the percent change in flow rate (discharge) could be calculated under any treatment scenario.

Illustration 1:
Changes to 7-Day Low Flow Discharge Due to Watershed Treatments

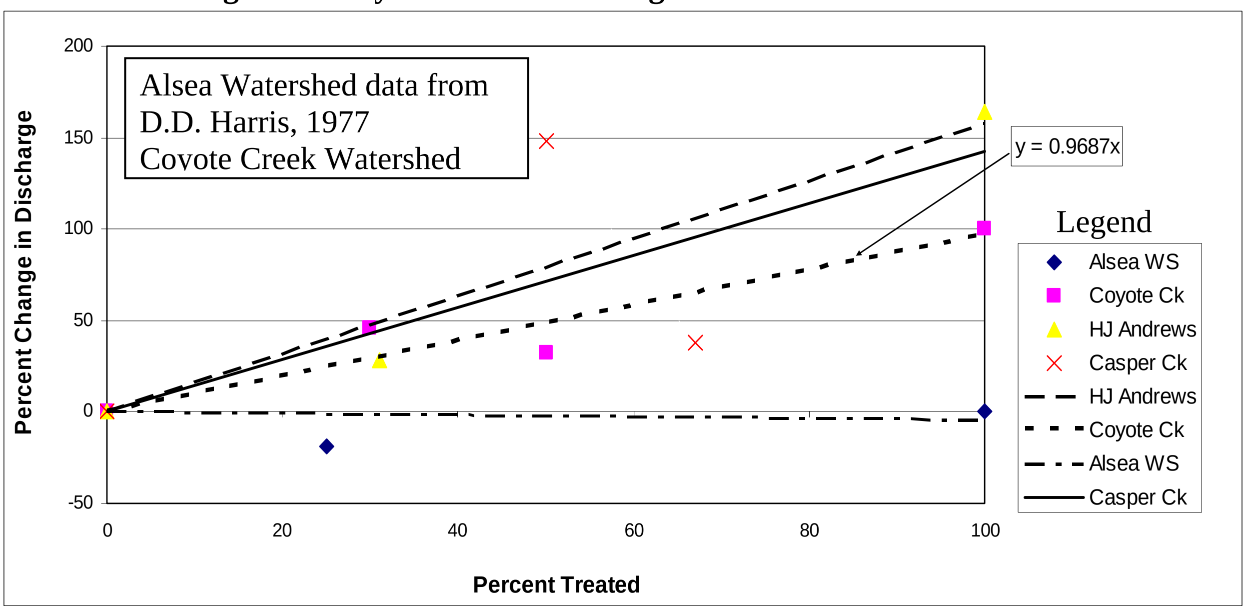
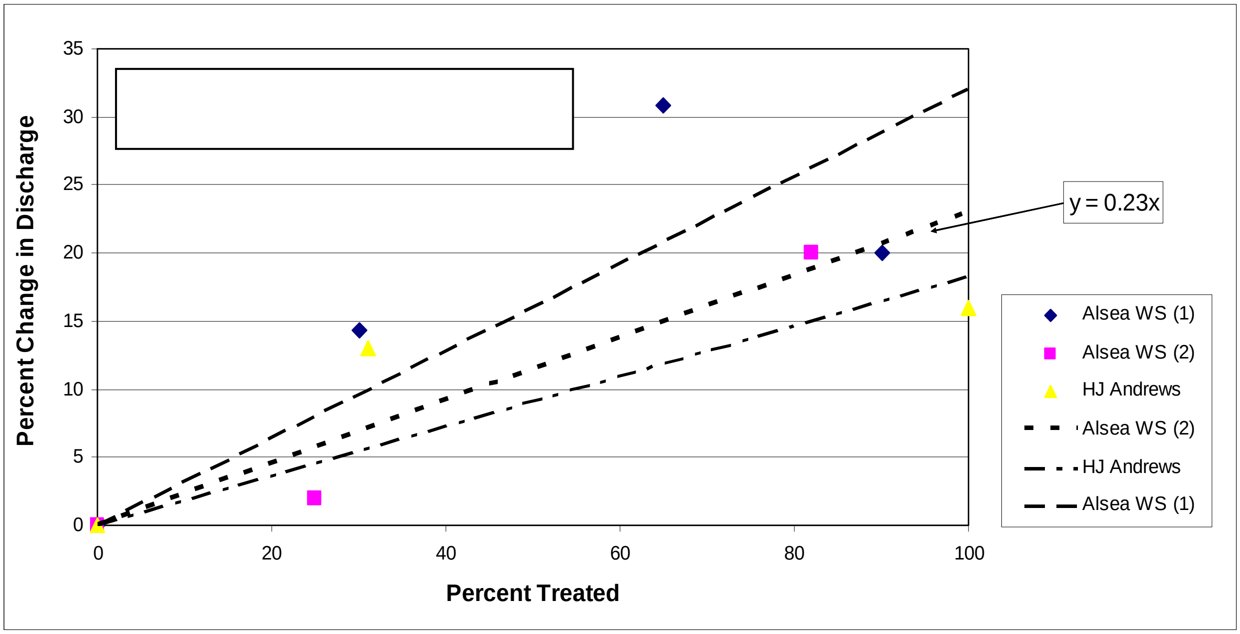


Illustration 2
Changes to 2-Year Peak Flow Discharge Due to Watershed Treatments



The estimated change in stream flow from existing conditions was calculated for each flow (low flow or peak flow) by determining the percentage of the watershed proposed for treatment and inserting the percentage into the appropriate equation. The treated area in each watershed for existing and proposed conditions was determined by calculating the total area of modified herbaceous and developed land cover in each watershed and dividing that value by the area of the watershed to be analyzed. Since there are no continuous stream gauges in the vicinity of the Flow Model Analysis Area, existing stream flow for the low flow and peak flow events was estimated using basin specific regression equations created by the U.S. Geological Survey (Sumioka et al. 1998). The regression equations are designed to provide stream flow estimates for various flow events (e.g., 2-year peak flow, 25-year peak flow, etc.) for ungauged streams by combining flow data from the nearest stream gauge with watershed specific data for the ungauged streams along with regression coefficients for the basin the streams are located in. The stream flow data from the Packwood station was used along with altitude corrected precipitation data from the Packwood weather station and analysis of watershed characteristics within the Flow Model Analysis Area to calculate low flow and 2-year peak flow estimates for the Upper Clear Fork Cowlitz River and the Upper Tieton River, at the downstream extent of the Flow Model Analysis Area. These calculations represent existing stream flow conditions for the Flow Model Analysis Area that are suitable for rough comparisons to the predicted increases in stream flow due to implementation of the Action Alternatives.

Using the stream flow prediction methods described above, in the existing conditions, the 7-day low flow for the Upper Clear Fork Cowlitz River is 3.12 cubic feet per second (cfs) at the mouth of the Flow Model Analysis Area (refer to Table 1). The estimated low flow for the Upper Tieton River is 1.23 cfs, which is less than the Upper Clear Fork Cowlitz due to the smaller watershed area (refer to Table 1). The estimated 2-year peak flows for the Upper Clear Fork Cowlitz and the Upper Tieton rivers are 130.7 cfs and 54.4 cfs respectively. The standard error for the flow calculation is 57 percent (Sumioka et al. 1998).

Table 1:
Estimated Stream Flows for the Two Mainstem Rivers in the Flow Model Analysis Area

Watershed Name	Drainage Area (acres)	7-Day Low Flow (cfs)	2-yr Peak Flow (cfs)
Upper Clear Fork Cowlitz River	1,460	3.12	130.7
Upper Tieton River	535	1.23	54.4

2.0 ENVIRONMENTAL CONSEQUENCES

2.1 ALTERNATIVE 1

Water Use

Under Alternative 1, the proposed White Pass Ski Area Expansion would not be implemented; therefore there would be no new impacts to the current water use at White Pass and conditions would remain as described in Section 3.3.2 of the FEIS.

Flow Regime

Under Alternative 1, the proposed White Pass Ski Area Expansion would not be implemented; therefore no impacts to the flow regimes of the Upper Clear Fork Cowlitz River and Upper Tieton River watersheds would occur as a result of tree removal or water withdrawals. The flow regimes of the streams within the White Pass Study Area would remain as described in Section 3.3.2 of the FEIS.

2.2 ALTERNATIVE 2

Water Use

Under Alternative 2, the source of domestic water for the White Pass Ski Area would continue to be from a surface water diversion on Millridge Creek located in the Upper Clear Fork Cowlitz River watershed. Due to the proposed increase in the CCC of White Pass under Alternative 2, the peak water demand during the ski season would increase from 12,561 gallons/day to 23,001 gallons/day (refer to Table Appendix E – FEIS1).

Table Appendix E-FEIS1:
White Pass Water Demand

	Alt. 1	Alt. 2	Modified Alt 4	Alt. 6	Alt. 9
CCC (skiers)	2,670	4,250	3,800	3,640	3,280
Peak Day (skiers)	2,949[a]	4,675	4,180	4,004	3,608
Gallons per skier[b]	4.92	4.92	4.92	4.92	4.92
Peak Demand (gal)	12,561[a]	23,001	20,566	19,700	17,751
Percent of Capacity[c]	24%	44%	40%	38%	34%

[a] Peak Day CCC and Peak Demand for Alternative 1 are measured values for a record skier visitation day.
[b] The measured peak is described under Existing Conditions in Section 3.3.2.5 – Flow Regime. Under the Action Alternatives, skiers are assumed to use 4.92 gallons per day (based on current peak usage).
[c] Storage capacity is 52,000 gallons.

This conservative estimate is based on assumed full utilization of the ski area capacity and facilities and an average water demand per guest of 4.92 gallons/day. The projected increase in water demand (based on measured peak demand values) would decrease the daily streamflow in Millridge Creek by approximately 0.016 cubic feet per second (cfs) during the ski season. The projected decrease of 0.016 cfs in Millridge Creek under Alternative 2 was not included in the flow model below because this amount would not be measurable with current monitoring technology and the flow model estimates stream flow impacts for the summer low flow period and the 2-year peak flow event when water withdrawals are unlikely by the ski area.

Flow Regime

Under Alternative 2, approximately 19.8 acres of forest clearing and construction of impervious surfaces would occur during the construction of the Hogback Express and Basin Chairlifts and associated trails. The proposed development would result in an estimated 1.4 percent (0.04 cfs) increase in 7-day low flow in the Upper Clear Fork Cowlitz River at the mouth of the Flow Model Analysis Area (refer to Table 2 and Figure 3-12 of the FEIS). Based on the relatively small projected increase in low flow and the typical amount of instrumentation error associated with measuring discharge rates, it is expected that the estimated increase in 2-year peak flow in the Upper Clear Fork Cowlitz River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology (refer to Figure 3-12 of the FEIS).

There would be no forest clearing or new impervious surfaces in the Upper Tieton River watershed under Alternative 2, therefore, there would be no changes to the 7-day low flow discharge of the Upper Tieton River from this project (refer to Table 2).

Table 2:
Changes to Flow in the Upper Clear Fork Cowlitz River and Upper Tieton River Watersheds due to Proposed Development in the Flow Model Analysis Area

Watershed	Alt. 1	Alt. 2		Modified Alt. 4		Alt. 6		Alt. 9	
	Existing Flow (cfs)	Increase in Flow	Increase in Flow (cfs)	Increase in Flow (%)	Increase in Flow (cfs)	Increase in Flow (%)	Increase in Flow (cfs)	Increase in Flow (%)	Increase in Flow (cfs)
7-Day Low Flow									
Upper Clear Fork Cowlitz	3.12	1.4 %	0.04	1.6 %	0.05	0.8 %	0.02	0.7 %	0.02
Upper Tieton	1.23	0.0 %	0.00	2.1 %	0.03	0.7 %	0.01	4.6 %	0.06
2-Year Peak Flow									
Upper Clear Fork Cowlitz	130.7	0.3 %	0.4	0.4 %	0.5	0.2 %	0.2	0.2 %	0.2
Upper Tieton	54.4	0.0 %	0.0	0.5 %	0.3	0.2 %	0.1	1.1 %	0.6
Note – Calculations of the Existing flows have a standard error of 57 percent according to the model. The percent increase in flows has approximately a 49 percent standard of error.									

The flow model results estimate that the 2-year peak flow discharge rate would increase by approximately 0.3 percent (0.4 cfs) over existing conditions in the Upper Clear Fork Cowlitz River as a result of the 19.8 acres of forest clearing and new impervious surfaces proposed in Alternative 2 (refer to Table 2). The relatively small projected increase in 2-year peak flow combined with the typical amount of instrumentation error associated with measuring discharge rates suggests that the estimated increase in 2-year peak flow in the Upper Clear Fork Cowlitz River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology. It is anticipated that measurable changes to bank full discharge would not occur because bankfull flows in mountainous terrain have 11 to 100-year return intervals (Nolan et al. 1987), and regional studies used in this model indicate that the effects of watershed treatments do not significantly affect large peak flows (i.e., recurrence interval of 25 to 100 years) (Beschta et al. 2000; Harr et al. 1975). Since the majority of sediment transport and changes in channel morphology occur during large peak flow events, the relatively small changes in low flow and 2-year peak flow conditions estimated in this model indicate that implementation of Alternative 2 would not measurably affect sediment transport or channel morphology in the Upper Clear Fork Cowlitz River (Dunne and Leopold 1978; Beschta et al. 2000).

There would be no forest clearing or new impervious surfaces in the Upper Tieton River watershed under Alternative 2, therefore, there would be no changes to the 2-year peak flow discharge of the Upper Tieton River from this project (refer to Table 2).

Due to the small size of the Flow Model Analysis Area within each watershed, when compared to the 5th field watershed area (approximately 96 times as large as the respective portions in the model) the overall increase in flows would not be measurable and are therefore not included in the analysis.

Indirect impacts to the flow regimes of the Upper Clear Fork Cowlitz River and Upper Tieton River watersheds could occur from changes in the snow accumulation and the snow melt cycle from timber harvest and snow grooming. Timber harvest associated with construction of the proposed Hogback Express and Basin chairlifts would create new patch cuts within the Flow Model Analysis Area. Research shows that large clear-cuts increase snow accumulation and snow melt rates within the cleared areas and result in increases in flows to adjacent stream systems. However, data regarding patch and strip forest harvesting, which is typically used in ski trail construction, are more variable with mixed effects to stream flow. The variability in the results of these studies is likely due to the unpredictable changes in wind scour patterns between forested areas and patch openings due to changes in the snow accumulation and deposition rates within the opening. Research by Rixen and Stockli (2000) and Rixen et al. (2001) indicates that snow melt is typically delayed by one to two weeks on ski trails as compared to natural, ungroomed snow patches, due to the snow compaction from skiing and grooming operations. Therefore, no foreseeable indirect impacts to flow regimes in Upper Clear Fork Cowlitz River and Upper Tieton River watersheds are expected from timber harvest and ski trail grooming associated with the proposed project.

2.3 MODIFIED ALTERNATIVE 4

Water Use

Under Modified Alternative 4, the source of domestic water for the White Pass Ski Area would continue to be from a surface water diversion on Millridge Creek located in the Upper Clear Fork Cowlitz River watershed.

Due to the proposed increase in the CCC of the White Pass Ski Area under Modified Alternative 4, the peak water demand during the ski season would increase from approximately 12,561 gallons/day to 20,566 gallons/day, including approximately 225 gallons per day conveyed to the mid-mountain lodge through a pipe (refer to Section 3.13 – Utilities and Infrastructure). This conservative estimate is based on assumed full utilization of the ski area capacity and facilities and an average water demand per guest of 4.92 gallons/day. The projected increase in water demand (based on measured peak demand values) would decrease the daily streamflow in Millridge Creek by approximately 0.013 cfs during the ski season. The projected decrease of 0.013 cfs in Millridge Creek under Modified Alternative 4 was not included in the flow model because this amount would not be measurable with current monitoring technology and the flow model estimates stream flow impacts for the summer low flow period and the 2-year peak flow event when water withdrawals by the ski area are unlikely.

Under Modified Alternative 4, if the utility trenching for the waterline to the mid-mountain lodge was determined to be too impactful to streams and wetlands, a shallow groundwater well would be constructed in the vicinity of the proposed mid-mountain lodge to provide domestic water instead. If the well was to be built, the overall projected water demand for Modified Alternative 4 would be the same as under the trenched waterline, but the domestic water demand for the mid-mountain lodge would come from the groundwater well. The groundwater withdrawn would be approximately 225 gallons/day for potable use by the guests of the mid-mountain lodge. The localized soil moisture and flow regime impacts from the proposed groundwater withdrawn are not expected to be measurable due to the low volume of the withdrawn and surface disposal of grey water through a septic drainfield.

Flow Regime

Under Modified Alternative 4, impacts to the flow regime in the Upper Clear Fork Cowlitz River and Upper Tieton River watersheds would be similar to, but more than the impacts described under Alternative 2. Under Modified Alternative 4, additional clearing and grading would be required for construction of Trail 4-16. However, low flow in the Upper Clear Fork Cowlitz River would increase by approximately 1.6 percent over existing conditions, which is slightly more than under Alternative 2 and more than any other Action Alternative. This projected increase in low flow under Modified Alternative 4 would result in an estimated increase in discharge of approximately 0.05 cfs over the calculated existing discharge of 3.12 cfs (refer to Table 2). Similarly, the 2-year peak flow in the Upper Clear Fork Cowlitz would increase by approximately 0.4 percent under Modified Alternative 4, which is also the largest estimated increase as compared to the other Action Alternatives. Relating the estimated increase in 2-year peak flow under Modified Alternative 4 to calculated discharge rates would result in an increase from 130.7 cfs under existing conditions to 131.2 cfs under proposed conditions (refer to Table 2). The relatively small projected increase in low flow and 2-year peak flow combined with the typical amount of instrumentation error associated with measuring discharge rates indicates that the estimated increase in stream flow in the Upper Clear Fork Cowlitz River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology. Similar to Alternative 2, Modified Alternative 4 would not measurably affect sediment transport or channel morphology in the Upper Clear Fork Cowlitz River because large peak flow events would not be affected by the proposal.

Implementation of Modified Alternative 4 would result in an increase in low flow in the Upper Tieton River by approximately 2.1 percent over existing conditions due to proposed forest clearing and construction of new impervious surfaces. This projected increase in low flow would result in an estimated increase of approximately 0.03 cfs during a low flow event. Likewise, the estimated 2-year peak flows in the Upper Tieton River would increase by approximately 0.5 percent over existing conditions under Modified Alternative 4 resulting in an increase of approximately 0.3 cfs in discharge. The relatively small projected increase in low flow and 2-year peak flow combined with the typical amount of instrumentation error associated with measuring discharge rates indicates that the estimated increase in stream flow in the

Upper Tieton River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology. Similar to Alternative 2, Modified Alternative 4 would not measurably affect sediment transport or channel morphology in the Upper Tieton River because large peak flow events would not be affected by the proposal.

2.4 ALTERNATIVE 6

Water Use

Under Alternative 6, the source of domestic water for the White Pass Ski Area would continue to be from a surface water diversion on Millridge Creek located in the Upper Clear Fork Cowlitz River watershed. Due to the proposed increase in the CCC of White Pass under Alternative 6, the peak water demand during the ski season would increase from 12,561 gallons/day to 19,700 gallons/day. This conservative estimate is based on assumed full utilization of the ski area capacity and facilities and an average water demand per guest of 4.92 gallons/day. The projected increase in water demand (based on measured peak demand values) would decrease the daily streamflow in Millridge Creek by approximately 0.011 cfs during the ski season. The projected decrease of 0.011 cfs in Millridge Creek under Alternative 6 was not included in the flow model because this amount would not be measurable with current monitoring technology and the flow model estimates stream flow impacts for the summer low flow period and the 2-year peak flow event when water withdrawals by the ski area are unlikely.

Flow Regime

Impacts to low flow in the Upper Clear Fork Cowlitz River under Alternative 6 would be less than under Alternative 2 and Modified Alternative 4, with an increase of only 0.8 percent due to the elimination of the Hogback Express chair and trails from the proposal. The projected increase in low flow under Alternative 6 would result in an estimated increase in discharge of approximately 0.02 cfs over the calculated existing discharge of 3.12 cfs (refer to Table 2). Similarly, the 2-year peak flow in the Upper Clear Fork Cowlitz would increase by approximately 0.2 percent under Alternative 6, which is lower than Alternative 2 and Modified Alternative 4. The proposed forest clearing and construction of new impervious surfaces would increase peak flow discharge by approximately 0.2 cfs (refer to Table 2). The relatively small projected increase in low flow and 2-year peak flow combined with the typical amount of instrumentation error associated with measuring discharge rates indicates that the estimated increases in stream flow in the Upper Clear Fork Cowlitz River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology. Similar to Alternative 2, Alternative 6 would not measurably affect sediment transport or channel morphology in the Upper Clear Fork Cowlitz River because large peak flow events would not be affected by the proposal.

Implementation of Alternative 6 would result in an increase in low flow in the Upper Tieton River by approximately 0.7 percent over existing conditions due to proposed forest clearing and construction of new impervious surfaces. This projected increase in low flow would result in an estimated increase of approximately 0.01 cfs during a low flow event. Likewise, the estimated 2-year peak flows in the Upper Tieton River would increase by approximately 0.2 percent over existing conditions under Modified Alternative 4 resulting in an increase of approximately 0.1 cfs in discharge. The relatively small projected increase in low flow and 2-year peak flow combined with the typical amount of instrumentation error associated with measuring discharge rates indicates that the estimated increase in stream flow in the Upper Tieton River would not be measurable at the mouth of the Analysis Area with current monitoring technology.

2.5 ALTERNATIVE 9

Water Use

Under Alternative 9, the source of domestic water for the White Pass Ski Area would continue to be from a surface water diversion on Millridge Creek located in the Upper Clear Fork Cowlitz River watershed. Due to the proposed increase in the CCC of the White Pass Ski Area under Alternative 9, the peak water demand during the ski season would increase from 12,561 gallons/day to 17,751 gallons/day. This conservative estimate is based on assumed full utilization of the ski area capacity and facilities and an average water demand per guest of 4.92 gallons/day. The projected increase in water demand (based on measured peak demand values) would decrease the daily streamflow in Millridge Creek by approximately 0.008 cfs during the ski season. The projected decrease of 0.008 cfs in Millridge Creek under Alternative 9 was not included in the flow model because this amount would not be measurable with current monitoring technology and the flow model estimates stream flow impacts for the summer low flow period and the 2-year peak flow event when water withdrawals by the ski area are unlikely.

Flow Regime

Implementation of Alternative 9 would result in projected increases in low flow in the Upper Clear Fork Cowlitz River that would be very similar to those projected under Alternative 6 even though the distribution of the proposed impacts would be very different. According to the results of the model, Alternative 9 would result in an increase in low flow of approximately 0.7 percent (0.02 cfs) over existing conditions in the Upper Clear Fork Cowlitz River, which is less than any other Action Alternative (Refer to Table 2). Similarly, the 2-year peak flow in the Upper Clear Fork Cowlitz would increase by approximately 0.2 percent under Alternative 9, which is less than Alternative 2 and Modified Alternative 4, and equal to Alternative 6. The relatively small projected increase in low flow and 2-year peak flow, combined with the typical amount of instrumentation error associated with measuring discharge rates indicates that the estimated increase in stream flow in the Upper Clear Fork Cowlitz River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology. Similar to Alternative 6, Alternative 9 would not measurably affect sediment transport or channel morphology in the Upper Clear Fork Cowlitz River because large peak flow events would not be affected by the proposal.

The activities under Alternative 9 would result in the largest increases in low flow and peak flow in the Upper Tieton River as compared to the other Action Alternative due to the relatively extensive forest clearing proposed for the Chair 5 chairlift and associated trails. Under Alternative 9, approximately 38.9 acres of forest clearing and construction of new impervious surfaces would occur in the Upper Tieton River watershed, resulting in an approximately 4.6 percent (0.06 cfs) increase in low flow (refer to Table 2). Similarly, 2-year peak flows in the Upper Tieton River would increase by approximately 1.1 percent over existing conditions under Alternative 9 resulting in an increase of approximately 0.6 cfs in discharge (refer to Table 2). Even though these projected stream flow increases are the largest out of all of the Action Alternatives, these estimated discharge values are still within the typical amount of instrumentation error associated with measuring discharge rates, and therefore, these estimated increases in stream flow in the Upper Tieton River would not be measurable at the mouth of the Flow Model Analysis Area with current monitoring technology. Furthermore, the flow effects under Alternative 9 would not measurably affect sediment transport or channel morphology in the Upper Tieton River because large peak flow events would not be affected by the proposal.

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TECHNICAL MEMORANDUM

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TO:	White Pass MDP FEIS Project File
FROM:	Alex White
CC:	SE GROUP Project Files
DATE:	November 11, 2004
RE:	White Pass MDP FEIS Lakes and Ponds

This memorandum addresses the lakes and ponds within the White Pass MDP project area and impacts associated with the implementation of the alternatives evaluated in the White Pass MDP FEIS. These water bodies have not been identified as a significant issue for tracking in the FEIS, nor did they drive the development of any alternative. This analysis was developed to identify the potential to impacts to lakes and ponds with the construction of ski area facilities under the alternatives evaluated in the FEIS.

1.0 AFFECTED ENVIRONMENT

Two relatively large lakes whose water quality has been designated as Class AA by the State of Washington Department of Ecology are located within and adjacent to the White Pass Study Area. These include the shallow (mostly less than ten feet deep) Leech Lake on the north side of US 12 and Knuppenburg Lake. Both lakes are fed from springs and seeps that convey water to the lakes through streams from the White Pass Study Area.

Leech Lake is located immediately off US 12 and has picnic and camping areas on the north and east sides of the lake, as well as an undeveloped boat launch. These areas contain largely defoliated, compacted and eroding banks. In the same complex lie three trailheads (White Pass North, White Pass South, and White Pass Horse Camp) that provide access to the Pacific Crest Trail. At the White Pass South Trailhead, the Leech Lake outlet stream flows through a culvert under the Pacific Crest Trail.

Knuppenburg Lake covers about 4.5 acres and lies west of the White Pass Ski Area and south of US 12. The water quality, although it is not measured, appears exceptional (Class AA) during most periods of the year; however, it is suspected that significant sediment moves into the lake from the direct deposition of road sand and gravel through maintenance during snow melt periods. Observations of Knuppenberg Lake indicated that it is filling in due to the sediment loading from US 12 (Shepard. Pers. Comm.). During the summer months the lake is used for fishing because it is adjacent to US 12.

There are 12 small seasonal and perennial ponds scattered across the upper portion of the existing ski area above the large cliff bank in Landtype A (refer to Section 3.2 of the FEIS). These ponds serve as the headwaters to most of the intermittent streams that are tributaries to the Upper Tieton River within the White Pass Study Area. The distribution of these small ponds is displayed in Figure 3-14 of the FEIS.

2.0 ENVIRONMENTAL CONSEQUENCES

2.1 ALTERNATIVE 1

Under Alternative 1, the proposed expansion of White Pass Ski Area would not occur, and no direct or indirect impacts to lakes and ponds would occur from construction activities. Impacts to lakes and ponds from the ongoing operation and maintenance of White Pass Ski Area would continue to occur under Alternative 1. Therefore, the condition of the lakes and ponds within the White Pass Study Area would remain as described above in the Affected Environment section.

2.2 ALTERNATIVES 2, 6, 9, AND MODIFIED ALTERNATIVE 4

Under all Action Alternatives, there would be slight, but immeasurable impacts to lakes and ponds from construction activities taking place at White Pass Ski Area, therefore it is assumed that lakes and ponds would remain close to their existing conditions described above in the Affected Environment section. Impacts to lakes and ponds from the ongoing and increased operation and maintenance of White Pass Ski Area would continue to occur under all Action Alternatives.