APPENDIX B

WATER YIELD MODELING

KNF Equivalent Clearcut Acres (ECA) Calculator

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ECAC Model Capabilities and Limitations:

The Kootenai National Forest beta version of the Equivalent Clearcut Acres Calculator (ECAC) is a GIS interface with management activity databases (Oracle and TSMRS), that allows watershed specialists to model the current equivalent clearcut acres (ECA) within a watershed of interest. The ECAC model calculates ECA for a specified watershed based on the most recent and most impactive (greatest crown removal) management activities associated with roads, timber harvest, prescribed fire, and wildfire. The ECAC model does not model peak flows or sediment production and transport. Watershed specialists must use additional models, indices, measures, monitoring, site specific data, and experience to model these watershed variables and analyze cumulative watershed effects.

The most current model for reviewing the effects of forest management activities has been the R1-WATSED model (USDA, 1991). Watershed modeling is used to predict and evaluate the cumulative watershed effects of the existing harvest, roading and proposed alternatives within the subject watershed. The Kootenai National Forest uses the R1 - WATSED model which is considered to be "state-of-the-art". The values produced are estimates, and are used to compare effects between the existing conditions and alternatives. The R1 - WATSED model predicts the highest 30-day-average water yield increase and the annual sediment yield increase using naturally caused and human activities in the watershed as input. Water yield and sediment yield recovery is also predicted by the model. The model calculates disturbances based on the "ECA" (Equivalent Clearcut Acre) procedure, for example a 100 acre harvest area with 50 percent canopy removal would equate to a 50 acre clearcut. Information on how the model functions and the data it requires to complete an analysis is located at the end of this discussion. Included in the model discussion are the values the Kootenai National Forest has input into the various data bases required to run the model. The values for these data bases have been adjusted for site specific conditions found on the Kootenai National Forest. The predicted values generated by the model do not reflect rare or episodic weather events (such as the rain-on-snow events that have occurred in this area in the past), or the effects the predicted increases will have on fish or aquatic habitat.

R1 -WATSED also requires the input of local adjustments for variables like delayed recovery for different disturbances, and canopy removal due to natural causes, like fire. The most recent local research and field data were used to generate these adjustments. The following adjustments have been used during the completion of the R1 - WATSED model runs on the forest.

Canopy Removal From Fire:

Fire Intensity	Percent Canopy Removed
High	80
Moderate	55
Low	25

Delayed Recovery (in years) by Habitat and Disturbance Type:

	Disturbance Types			
Habitat Type	Harvest and Site Prep.	Fire (low)	Fire(mod.)	Fire(high)
Fast Growing	5	0	5	8
Moderately Growing	7	0	7	11
Slow Growing	9	9	9	14

The Kootenai National Forest (Libby Ranger District) is currently reviewing and compiling data to begin the validation process for the R1 - WATSED model for the forest. The initial efforts at validation have showed that the water yield portion of the model displays good correlation between collected data and the model predictions (see below). Additional intense sediment data collection is needed to get a better idea on the sediment volume predicting possibilities of the model. One data set has been used thus far for validation of the sediment prediction capabilities of the model. That analysis showed the model under predicted actual measurements by 300%. The values for sediment prediction should only be used for comparison purposes between different alternatives. The volumes predicted for sediment generation reflect only increases of suspended sediment in the stream, at the analysis point. Predicted sediment is delivered to the stream from upslope activities only and does not include any in-channel generated sediment. The sediment values predicted are not exact amounts.

Water and Suspended Sediment Yield Validation Example for R1 WATSED

Assumptions: 95% of suspended sediment occurs in a one month period.
Streamflow is divided equally per day in the high month period.
Routed sediment from R1WATSED is equivalent to suspended sediment.
Sediment (tons/ day) = mg/L TSS x cfs x .0027

Example Calculations: Quartz Creek (34.07 $mi.^{2}$)
R1WATSED - Natural Conditions; Average 30 day Peakflow = 161.7 cfs, Routed Sediment = 8.1 tons/mi^2

8.1 tons/mi^2 x 34.07 mi^2 = 276 tons/year
276 tons/year x .95 (high month) = 262 tons
262 tons / 30 days = 8.74 tons/ day
High 30 day average mg/L TSS = 8.74/ 161.7 x .0027 = 20 mg/L TSS

R1WATSED - 1995 Estimates; Peakflow Increase = 7%, Annual Sediment Increase = 123%

Average 30 day peakflow = 173 cfs, Routed Sediment = 18.06 tons/mi^2

18.06 tons/mi^2 x 34.07 mi^2 = 615 tons/year
615 tons/year x .95 (high month) = 584 tons
584 tons / 30 days = 19.5 tons/ day
High 30 day average mg/L TSS = 19.5/ 173 x .0027 = 42 mg/L TSS

Collected Data -1995; Avg. 30 day peakflow = 212 cfs, 7 day peakflow = 261 cfs, One day peakflow = 292 cfs

1,864 tons TSS in high 30 day period, 1,864 tons/ 30 days = 62.1 tons/day
1,176 tons TSS in high 7 day period, 1176 tons/ 7 days = 168 tons/day
562 tons on high day
High 30 day average mg/L TSS = 62.1/ 212 x .0027 = 108 mg/L TSS
High 7 day average mg/L TSS = 168/ 261 x .0027 = 301 mg/L TSS
High day mg/L TSS = 562/ 210 x .0027 = 991 mg/L TSS

Water Year 95 = 22 inches ppt., 80 year average = 17.6 inches ppt. Water Year 95 is 130% of average
1995 collected high 30-day flow data is 122% above what R1WATSED predicted for the 30 day peakflow.

On Libby Ranger District during the mid-1990s numerous watersheds were run to obtain existing conditions. Because of computer system changes, personnel changes, and problems with interfacing various evolving data bases and the model, a process was completed that allowed an easier path to the data that WATSED provided. This process included separating watersheds by size class and precipitation regime that had already been run through the model and comparing

their results with the above mentioned ECAC process to look at water yield estimates. This procedure has allowed us to use a more simplified analysis path based on ECAs to generate water yield estimates that have been validated by comparison with the WATSED model output. A new version of WATSED is in the process of been completed and beta tested for use. The process on Libby Ranger District uses regression lines created from WATSED outputs to determine the number of ECAs required to generate a 1% increase in peakflows and also the number of ECAs that recover each year in a watershed based on its drainage size and precipitation regime. Copies of the regression graphs are included in the project file.

Because the sediment validation of the model needs extensive data collection and a secure amount of long-term funding, sediment validation of the model has been lagging. Suspended sediment data collection has been ongoing on the District for a few years but the time need to complete the validation process does not allow both project work and validation work to proceed. Validation work is completed on a "free-time" basis and thus far has not been completed. For this reason the effects analysis for sediment concerns is based on actual data such as stage/discharge relationships, suspended sediment sampling (daily and grab), streamcore sediment sampling, and macroinvetebrate sampling.

The values generated from the ECAC process are related to actual project area streamflow monitoring or streamflow monitoring from a representative watershed near the project area with similar attributes (precipitation, geology, development history, etc). The values are compared to the actual data and based on the stream geomorphology and professional judgment is used to determine the potential effects to the watershed resource.

USDA - FS. 1991. R1-WATSED Water Yield and Sediment Yield Model. USDA Forest Service, Northern Region.