APPENDIX F
UPLAND SEDIMENT MODEL SCENARIO DEVELOPMENT

F.1 Introduction

In order to derive sediment loads from upland sources in the Upper Clark Fork TPA, a SWAT model was used to represent the typical land uses and associated conditions affecting sediment production. An initial existing condition scenario was used that incorporated some basic assumptions regarding land use management practices to estimate current existing loads. Changes were then made to parameters in the model to represent potential land use management practice improvements and thereby estimate the sediment loads that could be expected if those practices were adopted.

As mentioned in **Section 5.5.3.2**, only modifications to land uses classified as barnyard, range brush, and range grass, were applied to estimate the sediment reduction potential from upland sources in the Upper Clark Fork. Changes in land management practices on these land use categories were applied to the entire watershed and are not stream or stream segment specific. The various conditions represented in the scenarios are broad estimations of Upper Clark Fork conditions however they are based on known information directly related to the Upper Clark Fork TPA or similar representations of western Montana land use. The assumptions and rationale for the modifications used in the Upper Clark Fork model are presented below.

F.2 Agricultural BMPs

Agricultural best management practices (BMPs) have been discussed by DEQ to reduce agricultural non-point source loads and improve overall stream water quality in the Upper Clark Fork River (UCF) TPA. Agouridis et al. (2005) provides a comprehensive literature review of common agricultural BMP implementation practices in the United States, and reports in general, that at least one aspect of stream water quality (e.g. chemical, physical, or biological) has improved in watersheds that received one of the following measures: livestock exclusion, offstream watering, alternate shade, rotational grazing, supplemental feeding, and buffer strips. As such, DEQ believes that in many cases, one or more practices could cost-effectively be implemented (e.g. through cost-shares with NRCS) to improve water quality in the UCF TPA. Allocations of the TMDLs were formulated using general agricultural BMP scenarios to evaluate load reductions from a range of agricultural BMPs. Specifically measures were targeted to improve: (1) streambank stability, (2) upland rangeland condition, or (3) riparian buffer condition and associated filtering capacity.

Management files in SWAT were developed to reflect activities occurring on the landscape in the UCF TPA. Contacts were made with local NRCS offices, and in general most of the agricultural production in the valley was believed to be either grass or alfalfa hay (personal communication to NRCS). Review of the 2002 census of agriculture (same as the landcover period) suggests similarly, as of the 13,756 acres of harvest cropland, 13,133 were used for forage (e.g. hay, haylage, silage, or greenchop) As such on NLCD land classes considered pasture or cultivated crops the following practices were implemented: (1) fertilization of a 20-50

N:P mix at a rate of 200 lb/acre (XX ton/ha) (personal communication Hogan's Ranchers AG Supply), two cuttings of hay, one in late June and the other in August with 90% removal of biomass, and grazing in late fall from November to December at a stocking rate of 1 AUM per 5 acres.

Additional management included mostly grazing practices. Grazing was also included on rangeland and range-brush and forest. Forest grazing occurred in the model from approximately June to October while grazing on range-grass and brush occurred from April through June.

F.3 Rangeland Management Scenarios

F.3.1 Range Improvement Scenario

It has been well established that grazing decreases ground cover, which by default, influences sedimentation processes. As a result, a ground cover improvement scenario was developed for the UCF watershed. No specific practice was specified for this improvement, as ground cover can potentially be altered through a number of BMPs including alteration of cattle distribution on the landscape (e.g. through water, shade, and perhaps salt), modification of grazing time-frame and duration through different rotatational practices, or reductions in stocking density. To reflect some combination of these changes, modifications were made to the USLE c-factors in SWAT. Adjustment was made based on several studies in southwestern and central Montana which relate rangeland ground cover response to grazing practices. A very good review of most of the statewide studies has been provided by Thrift (2006). She concludes that elk have little effect on surface ground cover, while in her literature review it is apparent that domestic animals (e.g. cattle and sheep) do. According to Evanko and Peterson (1955), bare ground was shown to be 14.9, 18.6, and 6.8 percent higher on the Beaverhead National Forest near Dillon, MT on sites that were heavily, moderately, and lightly grazed than those with no cattle on them. The comparison was made after a 15-18 year exclusion period. Similar results were found in an exclusion study on foothill sheep ranges in Meagher County near White Sulpher Springs, MT. Total cover (e.g. foliage and litter) was 16.7 percent higher between protected and grazed plots in that study after four years of exclusion (Vogel and Van Dyne, 1966). Thus it is apparent that a relationship between ground cover and grazing does exist, and a maximum difference between grazed and ungrazed lands is around 15-20 percent. Thus a conservative estimate of a 20 percent change between grazed and ungrazed lands was used in the modeling.

Because BMPs would only influence a percentage of that 20 percent (e.g. it is not expected that grazing would be entirely removed from the landscape, only that improvements in grazing practices would be employed to reduce the sediment load), a proposed 25% improvement on that 20 percent (e.g. 5 percent improvement in cover over the existing condition) was simulated. This concept is illustrated in **Figure F-1**. A similar procedure was completed for the range-brush (e.g. sagebrush dominant lands) although it was assumed that only 50% of the land had grass forage therefore the percent improvement in cover would only be 2.5%.

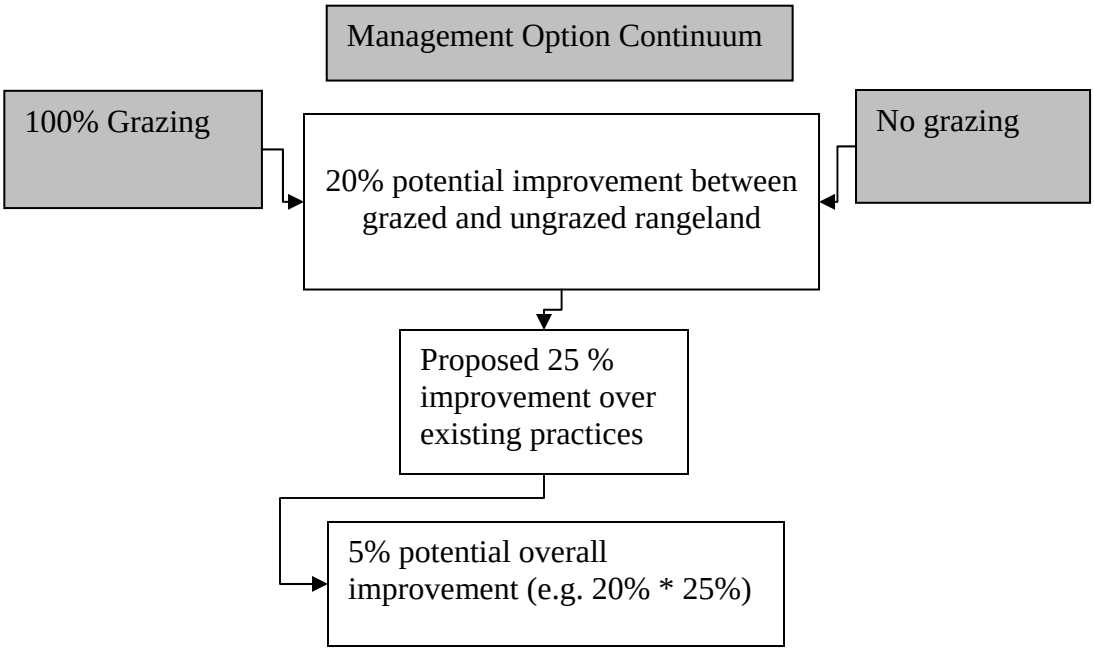

Figure F-1. Rangeland cover improvement scenario management option continuum.

Percent cover data for existing condition rangelands were taken from 12 sites 8 km northwest of Garrison, MT (Lacey et al. 1989), which are believed to be representative of much of the rest of the Upper Clark Fork River Watershed. Reported values were adjusted down approximately 10% as all sites had been rested during the summer and fall to better reflect average conditions from summer grazing. Additionally, sagebrush-rangeland was assumed to have 5% more cover than rangeland. Other assumptions related to the range improvement scenario are shown in **Table F-1** below.

Table F-1. Assumptions used in development of range improvement scenario.

Cover Type	Assumptions	Existing Condition Cover (%)	Annual USLE C-factor	Improved Condition Cover (%)	Annual USLE C-factor
Barnyard	Heavily compacted soil; no cover	0	0.75	20	0.20
Range Grass	Grass cover type; no canopy cover	60	0.042	63	0.038
Range Brush	50% grass cover, 50% brush canopy; 2 m fall height	65	0.032	67	0.029

Results of the rangeland management scenario suggest a possible reduction in sediment load of anywhere from 12-14% from range-brush, and 7-14% from range-grass.

F.3.3 Severe Grazing Scenario

A second range management scenario was also evaluated to assess the affect of severe and unmanaged grazing in the Upper Clark Fork River TPA. This scenario is useful to represent existing conditions in some particularly heavily grazed sub-watersheds, and to illustrate the potential variability between mismanaged heavily grazed lands and those with sound management. Identical existing conditions were used as in the previous scenario; however assumptions were revised to reduce existing ground cover 10 percent of that of the initial condition. Assumptions regarding the severe grazing scenario are shown in **Table F-2**.

Table F-2. Assumptions used in development of severe grazing scenario.

Cover Type	Assumptions	Existing Condition Cover (%)	Annual USLE C-factor	Severe Condition Cover (%)	Annual USLE C-factor
Barnyard	Heavily compacted soil; no cover	0	0.75	0	0.75
Range Grass	Grass cover type; no canopy cover	60	0.042	54	0.059
Range Brush	50% grass cover, 50% brush canopy; 2 m fall height	65	0.032	62	0.035

A comparison between the loads from severe conditions and improved conditions suggest potential sediment reduction of 21-24% for range-brush, and 30-47% for range-grass.