APPENDIX B
REFERENCE CONDITIONS AND TARGET VALUE RATIONALE

B.1 Reference Conditions and Data Sources

DEQ uses the reference condition to determine if narrative water quality standards are being achieved. The term "reference condition" is defined as the condition of a water body capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, reference condition reflects a water body's greatest potential for water quality given historic land use activities.

Two main sources of data served as sources of information for "reference conditions" in the UCF TPA. Target values for the parameters of interest were based on unpublished data from the Beaverhead-Deer Lodge National Forest (BDLNF), and from data collected during the 2007 DEQ Upper Clark Fork sediment/habitat field study.

Beaverhead Deer Lodge National Forest data was reviewed for assistance in developing target values for width to depth ratios, entrenchment ratios, and percent fines less than 6mm. Beaverhead-Deer Lodge National Forest includes data from throughout the BDNF and other National Forest management units, some of which occurs outside the Upper Clark Fork TMDL planning area. BDLNF data was stratified by Rosgen stream type, and by its characterization as "reference" or "non-reference".

2007 DEQ field data was used for the development of all parameter values. Data from the DEQ field effort was collected on listed and non-listed streams throughout the Upper Clark Fork TPA.

2007 DEQ data was categorized by the reach results based on the stream stratification procedure. No true "reference" reaches were identified through the stream stratification procedure; however "least impacted" reaches were classified as those reaches where 25% or less of the adjacent land use affecting bank erosion was attributed to anthropogenic sources. During the sampling analysis design for the 2007 field data study, sites were chosen to represent the variability among reach type categories and stratification parameters. Although few if any of the reaches represent full application of all reasonable land, soil, and water conservation practices, some reaches were sampled that reflected some of the healthiest reaches in the study area where negative impacts from land use activities were most limited.

B.2 Target Value Development

Target values are often presented for a range of values based on stream size, parent geology, or other significant factors that influence stream function and response. For instance, sediment and habitat conditions in a 5th order stream may vary considerably from those in a 2nd order stream and therefore assessing the respective condition of each against the same target values would be inappropriate. In the Upper Clark Fork TPA, given the similar stream sizes for all the streams assessed, similar dominant ecoregion character, and similarity to BDLNF streams used for

reference comparison, a range of target values were not deemed necessary in this case except to differentiate between "transport" and "depositional" reaches.

Targets were developed for two categories for the purposes of this TMDL; those targets that are applicable to high gradient stream segments, also referred to as "transport reaches" (streams with a slope greater than 2%), and targets that are applicable to low gradient stream segments, or depositional reaches (slope less than 2%). Although USFS and DEQ employed two different methodologies for classifying the reaches and grouping the corresponding data, the criteria for the reach classifications are similar and the relationship to slope allow for comparison. Rosgen A and B reaches are classified with slopes >2%, and can thus qualify as high gradient reaches; Rosgen C reaches have slopes <2%, and apply to low gradient reaches.

The use of median and percentiles in statistical analysis is often employed when data, such as water quality data, tend to have a non-normal distribution. Also, limited amounts of data can sometimes result in skewed results if using normal distribution statistics. For these reasons, it is more appropriate to use non-normal or non-parametric statistics for setting reference conditions, and determining target values for most parameters.

If parameters are used where lower numbers represent better water quality conditions, then typically the 75th percentile of the reference data set is often the reference value used as a potential target value, because values greater than the 75th percentile are beyond the range of expected variability. If the opposite were true, then the 25th percentile would apply. Where there is less confidence in the data to represent "reference" conditions, the 50th percentile or median value can be used, such as when a total data set incorporates both reference and non-reference conditions.

When developing target values, generally the 75th percentile of values from DEQ "least impacted" and USFS reference reaches, and the median (50th percentile) of the total population of the DEQ and USFS data sets were reviewed, and a target value was determined based on a comparison between the data sets, and relation to commonly accepted literature values. Twenty four sites were assessed during the 2007 DEQ field study, 11 sites qualified as "Low Gradient" or "depositional" reaches, and 13 sites qualified as "High Gradient" or "transitional" reaches. Only 2 of the 11 depositional reaches were categorized as least impacted, as opposed to 5 of 8 least impacted reaches for High Gradient reaches. Therefore, due to the low number of least impacted reaches investigated for low gradient stream reaches, in this case, it was decided the sample was too small to assess a target based on least impacted reaches for low gradient reaches and those statistics were not reviewed. Least impacted reaches within the High Gradient category were reviewed for this analysis.

The use of a non-parametric statistical distribution for interpreting narrative water quality standards or developing numeric criteria is consistent with EPA guidance for determining 'water quality' criteria (EPA, 2000). Therefore, the selection of the applicable 25th or 75th percentiles from a reference data set is consistent with ongoing DEQ and EPA guidance development for interpreting narrative water quality standards.

Information and rationale used to derive target values follows below. Target parameter description and rationale for inclusion is presented in **Section 5.4**.

B.2.1 Width Depth Ratio

Table B-1. Width Depth Ratio

	High Gradient (>2%)		**Low Gradient (<2%)**
Rosgen Stream Type	A	B	C
BDNF – Median all reaches	7.8	12.2	17.4
DEQ – Median all reaches	13.4		12.4
75th percentile – BDNF (reference)	10.0	15.7	22
75th percentile – DEQ ("least impacted")	15.1		-
Target Value	**<15**		**<22**

Preliminary delineative criteria based on Rosgen stream type classification for width to depth ratios gives guidance of <12 for A stream types, and >12 for B and C stream types (**Table B-1**). Because the high gradient category incorporates both A and B Rosgen stream types, and based on the 75th percentile of reference B streams from the BDNF a target of <15 was conservatively set for High Gradient streams. Similarly, the 75th percentile for BDNF reference streams was the highest value of the statistics reviewed and determined to be an appropriate upper range of the acceptable width to depth conditions for lower gradient streams in the Upper Clark Fork TPA.

B.2.2 Entrenchment

Table B-2. Entrenchment

	High Gradient (>2%)		**Low Gradient (<2%)**
Rosgen Stream Type	A	B	C
BDNF – Median all reaches	1.4	1.6	3.5
DEQ – Median all reaches	1.6		3.0
75th percentile – BDNF (reference)	1.4	1.8	10
75th percentile – DEQ ("least impacted")	2.9		-
Target Value	**<1.8**		**>2.2**

Preliminary delineative criteria based on Rosgen stream type classification for entrenchment (**Table B-2**) gives guidance of <1.4 for A streams, 1.4-2.2 for B streams, and >2.2 for C streams. As such the B stream type reference value from the BDNF was used as the upper range of acceptable entrenchment ratio for High Gradient stream systems. Entrenchment values >2.2 are described by Rosgen as slightly entrenched to non-entrenchment as the values increase. A target value based on Rosgen delineative criteria is used for this parameter.

B.2.3 Pebble Count - <6mm

Table B-3. Pebble Count – Percent Subtrate less than 6mm

Pebble Count – Percent substrate less than 6mm	**High Gradient (>2%)**		**Low Gradient (<2%)**
Rosgen Stream Type	A	B	C
BDNF – Median all reaches	17	18	18.6
DEQ – Median all reaches	17.9		22.9
75th percentile – BDNF (reference)	24	19.5	28.5
75th percentile – DEQ ("least impacted")	24.3		-
Target Value	**18**		**23**

High gradient reaches are also defined within this document as "transport" reaches, or those reaches where slope and velocity are conducive to the movement of sediment through a system, rather than low gradient reaches, which tend to deposit sediment on the stream bottom. As a result, it is expected that transport reaches will have less percent surface fines than low gradient reaches. The BDNF values were not used in this case as they were higher than those values specific to the UCF TPA and not as protective, especially in the case of low gradient reaches (**Table B-3**). According to Weaver and Fraley, an inverse relationship occurs between westslope cutthroat emergent fry survival and % fines less than 6mm. Because of this, the most protective target value as it relates specifically to the UCF is deemed appropriate here.

B.2.4 Pebble Count - <2mm

Table B-4. Pebble Count – Percent Substrate less than 2mm

Rosgen Stream Type	**High Gradient (>2%)**	**Low Gradient (<2%)**
DEQ – Median all reaches	6.7	9.3
75th percentile – DEQ ("least impacted")	5.5	-
Target Value	**6**	**10**

BDNF data was not available for this parameter. Studies have shown that increased substrate fine materials less than 2mm can adversely affect embryo development success (Meehan, 1991). In this case, the most protective value was chosen for the high gradient reaches (**Table B-4**). Only one data set was deemed appropriate for review of low gradient reaches.

B.2.5 Residual Pool Depth

Table B-5. Residual Pool Depth (feet)

Rosgen Stream Type	**High Gradient (>2%)**	**Low Gradient (<2%)**
DEQ – Median all reaches	0.8	1.0
75th percentile – DEQ ("least impacted")	1.2	-
Target Value	**0.8**	**1.0**

It is assumed that high gradient reaches in the Upper Clark Fork TPA are typically characterized by smaller stream systems and generally occur in the upper or headwater reaches of a given stream, which often display more numerous, but more shallow pools as would be found in low gradient portions of a stream. The data set for "least impacted" reaches does show higher overall depths (**Table B-5**), however this may be somewhat skewed by the relatively small data set for this category. The analysis in this case does not truly stratify by size and as such, for the high gradient streams, the median value of all reaches is used here as it is assumed that this is more representative of common, achievable, and protective conditions that also accounts for the variation among the high gradient stream systems.

B.2.6 Pool Frequency (per 1000')

Table B-6. Pool Frequency (per 1000 feet)

Rosgen Stream Type	High Gradient (>2%)	Low Gradient (<2%)
DEQ – Median all reaches	15.0	11.5
75th percentile – DEQ ("least impacted")	20.0	-
Target Value	**>15**	**>12**

It is assumed that high gradient reaches in the Upper Clark Fork TPA are typically characterized by smaller stream systems and generally occur in the upper or headwater reaches of a given stream, which often display more numerous, but more shallow pools as would be found in low gradient portions of a stream. The data set for "least impacted" reaches does show higher pool frequency (**Table B-6**), however this may be somewhat skewed by the relatively small data set for this category. The analysis in this case does not truly stratify by size and as such, for the high gradient streams, the median value of all reaches is used here as it is assumed that this is more representative of common, achievable, and protective conditions that also accounts for the variation among the high gradient stream systems.

B.2.7 Greenline – Percent Shrub

Table B-7. Greenline – Percent Shrub

	"Least Impacted" Reaches	Anthropogenically Influenced Reaches	All Reaches
Minimum	40	0	0
25th percentile	56	16	39
Median	56	56	56
75th percentile	64	73	68
Maximum	88	85	88
Target Value			**70**

Riparian green line (**Table B-7**) is not used as a true "target" for analysis in the Upper Clark Fork, however it is reviewed as supplemental information, because of its relation to potential sediment production and overall gage of stream health. Shrub cover in particular provides stronger, more stable stream side woody vegetation, and it often provides an indicator of

potential bank stability, and temperature variability. As the riparian health is not dependent on the slope of the terrain in this case, data from the 2007 field study was not segregated into high and low gradient reaches.

The statistics for riparian greenline are presented here, simply to demonstrate the range of values that occur in the sites sampled as part of the 2007 field study. The methodology employed for determining the target values of the preceding parameters may draw inappropriate conclusions in this case. For instance, the 75th percentile of least impacted reaches would be expected to be close to a desired achievable percentage of shrub cover, but the 75th percentile of least impacted reaches is actually less than the 75th percentile for anthropogenically influenced reaches, and "all reaches" combined. This discrepancy is likely a factor of the 'least impacted' reaches being affected by some anthropogenic influence and not true reference. However, a comparison of minimums and the 25th percentiles does show that the lower values on the "least impacted" reaches had much better shrub coverage and indicates that "least impacted" reaches were likely correctly identified as such. Based on observations in the field, both reach categories are not achieving their full potential; it is expected that a 'healthy' and robust riparian shrub cover would be expected under most conditions throughout the planning area, and a reasonable and potentially achievable shrub cover should be 70% or greater.

B.2.8 Greenline – Percent Bare Ground

Table B-8. Greenline – Percent Bare Ground

	"Least Impacted" Reaches	**Anthropogenically Influenced Reaches**	**All Reaches**
Minimum	0	0	0
25th percentile	0	1	0
Median	1	6	3
75th percentile	5	17	12
Maximum	7	50	50
Target Value			**5**

Riparian green line is not used as a true "target" for analysis in the Upper Clark Fork, however it is reviewed as supplemental information because of its relation to potential sediment production and overall gage of stream health. Bare ground along the riparian is the most unstable and most indicative display of sediment sources (**Table B-8**). Similar to the percent shrub analysis, the statistics for percent bare ground are only used as a relative gage by which to select an appropriate value to achieve. In this case, lower percentages of percent bare ground are the expected and desired condition. Based on a review of this information, while some bare ground may naturally exist in any system, a value greater than 5 percent bare ground is deemed likely to be associated with impacted reaches where anthropogenic influence is occurring, and riparian improvement potential exists.