Montana Department of
ENVIRONMENTAL QUALITY

Big Creek Sediment TMDL Implementation Evaluation

Bull trout spawning habitat in the upper Big Creek watershed. Photo date: May 4, 2010

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Brian Schweitzer, Governor
Richard Opper, Director DEQ

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Prepared by:
Water Quality Planning Bureau
Watershed Protection Section
Patrick Lizon, Water Quality Specialist

Contributors:
Water Quality Planning Bureau
Watershed Management Section

Flathead National Forest

Montana Department of Environmental Quality
Water Quality Planning Bureau
1520 E. Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901

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ACRONYMS

Acronym	Definition
BAER	Burned Area Emergency Response
BEHI	Bank Erosion Hazard Index
BMP	Best Management Practices
DEQ	Department of Environmental Quality (Montana)
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (US)
FNF	Flathead National Forest
FWP	Fish, Wildlife, and Parks
INFISH	Inland Native Fish Strategy
MCA	Montana Codes Annotated
MT	Montana
TMDL	Total Maximum Daily Load
USFS	United States Forest Service
WRP	Watershed Restoration Plans

EXECUTIVE SUMMARY

This document provides an evaluation of Total Maximum Daily Load (TMDL) implementation for sediment within the Big Creek watershed. Progress towards the attainment of water quality standards has been gauged through an evaluation of: 1) the significance of efforts to reduce anthropogenic sources of pollutants; and 2) whether improvements in water quality have occurred, as measured through TMDL associated monitoring parameters.

Big Creek is a 15.7 mile long tributary to the North Fork of the Flathead River, is in the Hydrologic Unit Code 17010206 and has a waterbody ID MT76Q002_050 (DeHerrera, 1999). The designated waterbody use-class is B-1 (Montana Department of Environmental Quality, 2010). All lands within the Big Creek watershed are under federal ownership and are managed by the United States Forest Service (USFS) as part of the Flathead National Forest (FNF). Big Creek was placed on the 303(d) List of impaired waters during 1996 because it was determined to be partially supporting its aquatic life and coldwater fishery beneficial uses. Sediment was listed as the sole pollutant contributing to the impairment of the beneficial uses of Big Creek (Montana Department of Environmental Quality, 2010). Sources of impairment are listed as forest roads and streambank modification/destabilization (Montana Department of Environmental Quality, 2010).

The *Watershed Restoration Plan for Big Creek, North Fork of the Flathead River* (United States Forest Service, 2003) established a TMDL for sediment through its approval by the United States Environmental Protection Agency (EPA) on May 9, 2003. The sediment TMDL is expressed as a combination of load reductions from a performance-based allocation, meaning that instead of establishing numeric load allocations and reductions, load reductions were described in terms of percent reductions from identified sediment sources, e.g. a 90% reduction in erosion from skid trails rather than a 90 ton/year reduction in sediment from skid trails (United States Forest Service, 2003). The most quantifiable TMDL target is <30% fines less than 6.35mm in channel substrate core samples (United States Forest Service, 2003).

The Big Creek TMDL document (United States Forest Service, 2003) prescribed specific treatments for identified anthropogenic sources. The USFS has implemented restoration activities associated with the Big Creek TMDL as described in a memo from FNF District Ranger Jimmy DeHerrera sent to DEQ in April 2009 (United States Forest Service, 2003). Restoration activities included skid road re-vegetation (20-25 acres), 60+ miles of road decommissioning, large woody debris augmentation, and road network improvement (United States Forest Service, 2003). In 2001 the Moose Fire burned a major portion of the watershed. Since the wildfire, McNeil core values have ranged from 30.1% – 33.9% (Montana Department of Fish, Wildlife and Parks, unpublished).

It is apparent that the *Watershed Restoration Plan for Big Creek, North Fork of the Flathead River* (United States Forest Service, 2003) has provided a successful blueprint for guiding water quality restoration activities to mitigate sediment impacts. Substantial evidence exists to support the conclusion that the current land use paradigm employs land, soil, and water conservation practices that are consistent with attaining the State of Montana's water quality standard for sediment. The available information regarding water quality restoration progress indicates a formal assessment of water quality standards attainment is warranted at this time in order to evaluate if sediment remains a cause of impairment to the fish and aquatic life beneficial uses.

1.0 - BACKGROUND

The following impaired water bodies are included in whole or in part, within the boundaries of the Big Creek TMDL Planning Area:

- Big Creek, waterbody segment ID: MT76Q002_050

Pollutants of concern include the following:

- Sedimentation/Siltation

Within the Big Creek TMDL Planning Area, the main anthropogenic pollutant sources include:

- Forest Roads
- Upland erosion associated with historic logging practices

Historical Background

Extensive road building and logging occurred primarily during the 1950's and 1960's on FNF lands throughout the Big Creek watershed as well as on several sections of private land on the north slope of Big Mountain, where the headwaters of Big Creek are located (United States Forest Service, 2003). The intensity of the logging activities caused excessive increases in water yield and sediment loading to Big Creek and resulted in documented impacts to the habitat of cutthroat and bull trout (United States Forest Service, 2003). The USFS acquired all private lands in the upper watershed during the 1980s and 1990s and subsequently initiated a series of erosion control and road reclamation projects (United States Forest Service, 2003). Big Creek was placed on Montana's 303(d) List of impaired streams in 1996 due to the sediment impacts associated with the historical logging practices. In 2001, the Moose Fire burned through much of the Big Creek watershed, further altering sediment and water dynamics in the watershed. The Big Creek TMDL was approved in 2003. Since the fire occurred during the writing of the Big Creek TMDL, the actual effects that it would have upon water quality were largely unknown. The primary author of the plan was Dean Sirucek, FNF hydrologist (United States Forest Service, 2003). After completion of the Big Creek TMDL, the USFS continued to perform road decommissioning and road best management practices (BMPs) projects (DeHererra, J, personal communication 2009). The Burned Area Emergency Response (BAER) and the Moose Fire Salvage projects provided an avenue for allocating resources towards the proposed watershed restoration activities. In 2009, the USFS informed MT DEQ of their position that all necessary sediment reduction activities for the Big Creek watershed that were prescribed by the Big Creek TMDL have been implemented (DeHererra, J, personal communication 2009). Accordingly, the USFS requested DEQ reassess if sediment continues to be a cause of impairment to the fish and aquatic life beneficial uses. Documenting that progress has been made towards meeting water quality goals (e.g. achieving TMDL targets) provides the basis for performing a subsequent analysis of water quality standards attainment.

2.0 - TMDL-RECOMMENDED ACTIVITIES

The Big Creek TMDL (United States Forest Service, 2003) recommended specific restoration activities for addressing pollutants within the Big Creek TMDL Planning Area. In this performance based TMDL, these activities serve as "load reductions".

2.1 RECOMMENDED ACTIONS

The recommended actions are summarized below:

- Upland sediment source stabilization on 20 to 25 acres
- Decommission 56 miles of road to reduce hydrologic alteration and increased sediment delivery to stream channels.
- Meet Forest Service road BMPs standards on 48 miles of existing roads, upsize approximately 77 culverts, and add approximately 35 cross-drains.
- Stabilize stream banks and associated hillslopes from erosion through vegetation planting on up to 10 acres.
- Stabilize or remove existing logjams and remove stored sediment in ½ mile of stream.
- Increase large woody debris for up to 10 miles of headwater tributaries in order to increase in-stream sediment storage capacity and reduce streambed and bank erosion in high gradient channels.

2.2 TMDL DOCUMENT RECOMMENDATIONS

The TMDL document (United States Forest Service, 2003) recommended the following types of monitoring activities:

- Effectiveness reviews of road BMP and upland erosion control projects to evaluate whether sources of sediment are being reduced.
- Annual McNeil Core sampling to monitor trends in levels of sub-surface fine sediments in the main bull trout spawning reach and evaluate attainment of the TMDL target of <30% sediment <6.35mm.
- Wolman pebble counts for evaluating the amount of fine sediments on the surface of the channel substrate.
- Channel cross-section measurements, Bank Erosion Hazard Index (BEHI) evaluations and bank profile monitoring for filling data gaps on the amount of bank erosion occurring.
- Aquatic macroinvertebrate and periphyton sampling and analysis to assess additional indicators of sediment impacts to aquatic biological communities.

3.0 - INDICATORS OF PROGRESS

Indicators of progress towards achieving water quality goals and objectives identified in the Big Creek TMDL are associated with one of three main categories: 1) Planning; 2) Restoration; and 3) Monitoring.

SECTION 3.1 – PLANNING

- The *Big Mountain Ski and Summer Resort Final Environmental Impact Statement* (USFS, 1995) authorized the initial 35 miles of road decommissioning (DeHererra, J, personal communication 2009).

- The *Moose Fire Salvage EIS* (DeHererra, J, personal communication 2009) allocated resources to the restoration activities that have been implemented in the watershed since TMDL completion (DeHererra, J, personal communication 2009).

SECTION 3.2 – RESTORATION

- The stabilization/re-vegetation of upland sediment sources on 20 to 25 acres by the USFS from 2000 to 2003 (DeHererra, J, personal communication 2009).

- 60.6 miles of road were decommissioned by the USFS from 1995 to 2008; this included the removal of 47 culverts (DeHererra, J, personal communication 2009).

- Between 2002 and 2005, BMP's were implemented on 89 miles of road by the USFS in accordance with both State of Montana and the United States Fish and Wildlife Service's Inland Fish Strategy (INFISH) standards (DeHererra, J, personal communication 2009). Additionally, 16 culverts were enlarged, 3 new arch culverts were installed, and 2 new bridges were built to replace culverts during this period (DeHererra, J, personal communication 2009).

- During the 1990's large wood additions were made to headwater tributaries by MT Dept. of Fish, Wildlife, and Parks (FWP) & USFS (DeHererra, J, personal communication 2009) and during 2005 FWP placed large wood in the lower 3 miles of Hallowatt Creek.

- Vegetation plantings were undertaken in order to stabilize actively eroding stream terraces.

SECTION 3.3 – MONITORING

This section provides a list of the known monitoring efforts for Big Creek

Fisheries Data (Data Location: FWP- Kalispell)

FWP has conducted annual fisheries monitoring within an index reach of Big Creek utilized by migratory bull trout from Flathead Lake since 1981. Funding assistance for this effort is contributed by the USFS. FWP performs bull trout population surveys within the index reach during the late summer and also performs qualitative fish habitat assessments. During the late summer or fall, FWP performs bull trout redd (e.g. nests for spawning) counts within the index reach. During the winter FWP measures the amount of subsurface fine sediment within the spawning substrates of the index reach. The fine sediment monitoring employs "McNeil Core" sampling methodology.

Aquatic macroinvertebrate and diatom community analysis (Data Location: DEQ- Helena)

Montana DEQ collected four aquatic macroinvertebrate samples during 2009 and two diatom samples during 2010 in order to acquire additional biological community data for the assessment of sediment impacts. The biological indices have been completed for the aquatic macroinvertebrates, and DEQ is awaiting the completion of the diatom biological indices.

Channel morphology measurements (Data Location: DEQ- Helena)
During the summer of 2010, Montana DEQ and the USFS collaborated to collect data for sediment related parameters at three sites along Big Creek. Monitoring included riffle pebble counts, grid toss measurements in pool "tail-outs", residual pool depth measurements, pool frequency measurements, and riffle stability index measurements.

Bank erosion (Data Location: Flathead National Forest - Hungry Horse Ranger District)
Monitoring was initiated by the USFS following the completion of the Big Creek TMDL, but was discontinued due to a channel shift that caused abandonment of the section being monitored.

Historical data (Data Location- Flathead National Forest - Hungry Horse Ranger District)
The USFS monitored stream flow, suspended and bedload sediment, and water chemistry near the mouth of Big Creek from 1986 to 1992. Pfankuch stream channel ratings were performed in the late 1970's, in 1992, and in 2001 after the Moose Fire. During 1993, Riffle stability index measurements were performed in the upper watershed. Pebble counts and channel cross-sections were performed in 1997 on two reaches and on eight additional reaches during 2001 after the Moose Fire.

4.0 - RECOMMENDATIONS

The following recommendations are based upon the professional judgment of the TMDL implementation evaluator. It should not be construed that implementation of these recommendations is a prerequisite for water quality standards attainment.

1. The TMDL supplies a target value for particles less than 6.35 mm in McNeil Core samples but does not indicate whether this target relates to an annual value or a value over specific multi-year period. Applying an inter-annual evaluation period better accounts for natural variability. Natural variability associated with floods, drought, fire, breaches of log jams, etc. may cause year to year values to fluctuate slightly above and below the target value. Evaluating a five-year running median for McNeil core values smoothes out slight inter-annual variations, more accurately portray data trends, better aligns with the biological time scale of the most sensitive use (i.e. bull trout mature at 4-7 years and live for 7-12 years on average), and better matches the time scale of watershed management planning efforts.

2. In addition to culvert removal associate with road decommissioning, the Watershed Restoration Plan for Big Creek recommended that 77 road crossings (i.e. culverts) in the watershed have BMP's applied, however, it appears that 68 of the 77 road crossings have been addressed. It is recommended that the USFS address potential impacts associated with the remaining 9 road crossings to ensure that they are not significant sources of sediment loading (either individually or collectively).

3. Large wood in Big Creek downstream of Hallowatt Creek appears to be abundant, but infrequent. This seems to be related to the ability of the stream to transport all but the largest wood inputs, leading to very large, but widely spaced log jams. Prior to riparian logging and fire disturbance the site potential old growth riparian forest was likely a spruce-subalpine fir community (i.e. USFS western MT Old Growth Type Code 4) with a potentially more frequent distribution of in-stream large diameter wood pieces. Although there currently appears to be a high recruitment potential of large wood, it appears as though much of the large wood recruitment from the riparian zone will come from smaller diameter trees that would likely be transported downstream to existing log jams. Augmentation of key pieces of large wood (i.e. "strainer" logs that would capture other large wood) in the Big Creek channel downstream of Hallowatt Creek may lead to a greater frequency of habitat forming log jams. An increase in the frequency of log jams would likely increase the frequency and/or depth of pools, enhance gravel retention, facilitate sorting of sediments in fish spawning areas, increase habitat complexity, and dissipate the energy of flood flows. Key pieces of wood large enough to resist fluvial transport (e.g. ≥ 43cm diameter, i.e. the minimum dbh for old growth trees in Type 4 communities) would likely be more effective at improving aquatic habitat than additions of smaller diameter trees.

4. Research has shown that bull and cutthroat trout fisheries have inherent biological vulnerabilities to conditions such as habitat siltation, scouring of spawning redds by untimely high flows, and increased water temperatures. Therefore, a recommended long-term goal for future watershed management activities in the Big Creek drainage is to produce ongoing reductions in the risk of anthropogenic impacts to fisheries from identified types of biological vulnerabilities. By reinforcing inherent patterns of stability and resiliency of ecosystem processes in the Big Creek watershed, ongoing reductions in the risk of anthropogenic water quality impacts would serve to protect the fishery beneficial uses for current and future generations.

5.0 - CONCLUSIONS

Please also see **Appendix A – Conclusions Spreadsheet** for further detail regarding the assessment of progress for the Big Creek sediment TMDL.

Overall, the evidence indicates that most of the anthropogenic sediment sources in the watershed have been appropriately mitigated. The monitoring data indicates that the effects of excessive erosion upon aquatic habitat have been largely ameliorated, although some evidence suggests that the waterbody has not fully recovered from historic sediment loading. Partial recovery from disturbance does not necessarily preclude the full support of beneficial uses. The Flathead National Forest should continue to address any remaining issues with the road network in the watershed to decrease the risk of additional sediment loading associated with potential culvert failures and road prism erosion.

At this time it does not appear as though implementation of a new or improved phase of voluntary reasonable land soil and water conservation practices is necessary in the Big Creek watershed. Rather, the current land use management paradigm should continue. Revisions to the TMDL are probably not necessary to achieve applicable water quality standards and it seems likely that more time is not needed for compliance with water quality standards.

Although most of the available data indicates that sediment impairment has been mitigated, some data suggests that more time may be needed. The USFS has requested that a reassessment of sediment impairment occur. This TMDL progress evaluation serves as a preliminary analysis for determining if sufficient progress has been made to warrant reassessment. This evaluation indicates that the substantial progress in the implementation of the sediment TMDL for Big Creek warrants a formal evaluation of sediment impacts to the fishery and aquatic life beneficial use support in order to determine whether sediment continues to be a cause of impairment.

6.0 - REFERENCES

Information sources consulted during the preparation of the Big Creek TMDL Implementation Evaluation are listed not listed below was U.S. EPA. 2004. Water Quality Assessment and TMDLs for the Flathead River Headwaters Planning Area, Montana.

Questions regarding the TMDL Implementation Evaluation for Big Creek, North Fork of the Flathead River should be directed to Robert Ray, supervisor of the Montana DEQ Watershed Protection Section by telephone- (406) 444-5319 or email- rray@mt.gov.

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APPENDIX A – CONCLUSIONS SPREADSHEET

Big Creek, Tributary to the North Fork of the Flathead River Watershed Restoration Plan for Big Creek, North Fork of the Flathead River		
Waterbody/ Pollutant	**Conclusion***	**Justification/Recommendations**
Big Creek/ Sedimentation	4	**Load Reductions:** Most of the restoration activities proposed in the Big Creek watershed restoration plan have been implemented. • The load reduction for road BMPs has been met. BMPs have been implemented on 89 miles of road. As per the WRP, this is estimated to have achieved a reduction of greater than 40% in road miles roads not meeting state BMP standards. • The load reduction for upland erosion has been met. 20 to 25 acres of eroding upland sites have been stabilized. As per the WRP, this is estimated to have achieved a reduction of 90% in erosion from the associated skid roads. • The load reduction for road decommissioning has been met. 60.6 miles of road have been decommissioned by the USFS; this has included the removal of 47 culverts. As per the WRP, this action is estimated to have achieved a reduction of greater than 31% in road miles potentially contributing to increased sediment loading. • DEQ considers the load reduction associated with large wood placement in the upper watershed to be met because FWP and USFS have addressed the priority sites in the upper watershed identified as needing large wood augmentation • DEQ agrees with USFS and FWP that the streambank erosion load reduction is no longer applicable because most areas of terrace erosion were determined by USFS to be natural in origin. • An evaluation by USFS & FWP after the 2001 Moose Fire indicated that stabilization or removal of existing logjams and removal stored sediment behind log jams was not appropriate. DEQ agrees that load reduction associated with log jam stabilization/removal and removal of stored sediment is no longer applicable. • The load reduction for road crossings has not been fully met because 9 of the proposed 77 crossings have not been addressed.
Big Creek/ sedimentation	4	**TMDL Targets:** • The TMDL target for the successful re-vegetation and/or protection of >75% of identified upland erosion sources has been met. • McNeil core values collected in the monitored bull trout spawning reach have decreased significantly from historic peak values that exceeded 40%. The values are currently slightly above the TMDL target of 30%, but are currently on a decreasing trend; the current 5 year running median is average is 32.3%, and the most current annual value from 2009 is 31.4%. Subsurface fine particles are below the threshold (35%) at which FWP and the Flathead National Forest consider bull trout spawning substrates to be threatened by fine sediment and are similar to values observed in un-developed watersheds (Flathead Basin Commision, 1991). Current levels of subsurface fine sediment in the bull trout spawning reach may reflect lingering fine sediment storage associated with historic land use practices; however, this level of subsurface fine sediment may meet the definition of "naturally occurring". It is plausible that the fishery beneficial use may be fully supported at the current levels of fine sediment.

Big Creek, Tributary to the North Fork of the Flathead River Watershed Restoration Plan for Big Creek, North Fork of the Flathead River		
Waterbody/ Pollutant	**Conclusion***	**Justification/Recommendations**
		• The TMDL target for bank erosion along Big Creek is no longer applicable because USFS/FWP/DEQ concur that bank erosion is within the range of natural variability.
Big Creek/ Sedimentation	4	**<u>Monitoring Data:</u>** The majority of in-stream parameters measured by DEQ/USFS during the 2009-2010 field visits suggest that the sedimentation impacts have been ameliorated. There was some evidence that residual sediment storage (i.e. both coarse and fine sediment) associated with historic sources may still be impacting aquatic habitat. However, a weight of evidence approach suggests that the fish and aquatic life beneficial uses may no longer be impaired by sediment. Please refer to the Big Creek Sediment TMDL Implementation Progress Evaluation- Assessment Report (Montana Department of Environmental Quality, unpublished) for further information about the monitoring data evaluation. Fish population data was not analyzed as part of this evaluation, but will be part of a future beneficial use support evaluation. • **Riffle Pebble Count** o Criteria for indicating sufficient progress: Percent surface fines < 2mm are below 20%; Percent surface fines <6.35mm are below 20%. o Monitoring Results: Fines < 2mm were less than 10% at 3 of 3 sites in 2010; Fines < 6.35mm were less than 10% at 3 of 3 sites. • **Grid Toss** o Criteria for indicating sufficient progress: Percent surface fines <6.35mm in pool tail-outs are below the 75th percentile of reference values. o Monitoring Results: Median values for fines < 6.35mm were below the 50th percentile of reference values at 2 of 2 sites. • **Residual Pool Depth** o Criteria for indicating sufficient progress: Residual pool depths are above the 25th percentile of reference values. o Monitoring Results: Pool depths at 3 of 3 sites exceed the 75th percentile of the reference data set. • **Macroinvertebrates** o Criteria for indicating sufficient progress: DEQ O/E and Multi Metric Index model scores indicate non-impairment at all sites. o Monitoring Results: Bio-assessment scores at 4 of 4 sites indicated non-impairment. • **Riffle Stability Index** o Criteria for indicating sufficient progress: Riffle Stability Index values are below 85. o Monitoring Results: Riffle Stability Indices at two sites in the upper watershed were estimated to be in the 85 to 90 range, suggesting that riffles are highly loaded with sediment. One site was above the burned area and the other has a partially burned contributing area. Pebble counts suggest that the riffles are loaded with coarse, not fine sediment. Index values were similar to some of the 1993 values reported in the TMDL document suggesting that there may be residual storage of sediments in the upper watershed associated with historic land use practices.

Big Creek, Tributary to the North Fork of the Flathead River Watershed Restoration Plan for Big Creek, North Fork of the Flathead River		
Waterbody/ Pollutant	**Conclusion***	**Justification/Recommendations**
Big Creek/ Sedimentation	4	**Recommendations:** • Research has shown that bull and cutthroat trout fisheries have inherent biological vulnerabilities to conditions such as habitat siltation, scouring of spawning redds by untimely high flows, and increased water temperatures. Therefore, a recommended long-term goal for future watershed management activities in the Big Creek drainage is to produce ongoing reductions in the risk of anthropogenic impacts to fisheries from identified types of biological vulnerabilities. By reinforcing inherent patterns of stability and resiliency of ecosystem processes in the Big Creek watershed, ongoing reductions in the risk of anthropogenic water quality impacts would serve to protect the fishery beneficial uses for current and future generations. • Large wood in Big Creek downstream of Hallowatt Creek appears to be abundant, but infrequent. This seems to be related to the ability of the stream to transport all but the largest wood inputs, leading to very large, but widely spaced log jams. Prior to riparian logging and fire disturbance the site potential old growth riparian forest was likely a spruce-subalpine fir community (i.e. USFS western MT Old Growth Type Code 4) with a more frequent distribution of in-stream large wood. Currently, it appears as though much of the potential recruitment of large wood in the riparian zone is from smaller diameter trees that will likely be transported downstream to existing log jams. Augmentation of key pieces of large wood (i.e. "strainer" logs that would capture other large wood) downstream of Hallowatt Creek would likely increase the frequency and/or depth of pools, enhance gravel retention, facilitate sorting of sediments in fish spawning areas, increase habitat complexity, and dissipate the energy of flood flows. Key pieces of wood large enough to resist fluvial transport (e.g. ≥ 43cm diameter, i.e. the minimum dbh for old growth trees in Type 4 communities) would be likely more effective at improving aquatic habitat than additions of smaller diameter trees. • In addition to culvert removal associated with road decommissioning, the Watershed Restoration Plan for Big Creek recommended that 77 road crossings (i.e. culverts) in the watershed have BMP's applied, however, it appears as though 68 of the 77 road crossings have been addressed. DEQ recommends that the USFS address potential impacts associated with the remaining road crossings to ensure that they are not significant sources of sediment loading (either individually or collectively). • The TMDL supplies a target value for particles less than 6.35 mm in McNeil Core samples but does not indicate whether this target relates to an annual value or a value over specific multi-year period. Applying an inter-annual evaluation period better accounts for natural variability. Natural variability associated with floods, drought, fire, debris jam movement, etc. may cause year to year values to fluctuate slightly above and below the target value. Evaluating a five year running median for McNeil core values smoothes out slight inter-annual variations, more accurately portray data trends, better aligns with the biological time scale of the most sensitive use (i.e. bull trout mature at 4-7 years and live for 7-12 years on average), and better matches the time scale of watershed management planning efforts.

Big Creek, Tributary to the North Fork of the Flathead River Watershed Restoration Plan for Big Creek, North Fork of the Flathead River		
Waterbody/ Pollutant	**Conclusion***	**Justification/Recommendations**
Big Creek/ Sedimentation	4	**Conclusions:** • In general, the available information suggests that most of the anthropogenic sediment sources in the watershed have been appropriately addressed, although some evidence suggests that the waterbody has not fully recovered from historic sediment loading. However, partial recovery from disturbance does not necessarily preclude the full support of beneficial uses. It is recommended that the Flathead National Forest address any remaining issues with the road network in the watershed to decrease the risk of additional sediment loading associated with potential culvert failures and road prism erosion. • Overall, the measured residual pool depths exceeded the expectations established through a reference condition comparison. • Fine sediment on the surface pool tail-out substrates was within the expected range of variability as determined through a reference condition comparison. Fine sediment on the surface of riffle substrates was well below the value considered to be indicative of impairment in the Flathead Headwaters TMDL. • Riffle Stability Indices in the upper watershed during 2010 were higher than would be expected for a stream that has does not have an excessive load of sediment. In combination with the pebble count data, the indices suggest that riffle substrates are highly mobile and a major component of the bedload movement consists of very coarse particles (e.g. stream power is high). Index values were similar to some of the 1993 values reported in the TMDL document suggesting that there may be residual storage of sediments in the upper watershed associated with historic land use practices. • Subsurface fine particles slightly exceed the TMDL target value but are below the threshold at which FWP and the Flathead National Forest consider bull trout spawning substrates to be threatened by fine sediment and are similar to values observed in un-developed watersheds. Current levels of subsurface fine sediment in the bull trout spawning reach may reflect lingering fine sediment storage associated with historic land use practices; however, this level of subsurface fine sediment may meet the definition of “naturally occurring”. • Macroinvertebrate communities are similar to reference conditions and do not indicate impairment. • **This evaluation has determined that substantial progress in the implementation of the sediment TMDL for Big Creek warrants an evaluation of fishery and aquatic life beneficial use support through a formal water quality standards attainment analysis in order to determine whether sediment continues to be a cause of impairment.**

*Conclusions are limited to the four options described below. Conclusions 1, 2 and 3 are the basic, 5-year review conclusions outlined in 75-5-703(9) MCA. “Other” is used as described below.

1 – The implementation of a new or improved phase of voluntary reasonable land, soil, and water conservation practice is necessary.

2 – Water quality is improving but a specified time is needed for compliance with water quality standards.

3 – Revisions to the TMDL are necessary to achieve applicable water quality standards.

4 – Other: In these instances, either the waterbody appears ready for a water quality standards attainment evaluation or there is a lack of sufficient information available to draw conclusions.