Montana DEQ - Water Quality Standards Attainment Record

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

ASSESSMENT UNIT INFORMATION

Reporting Cycle:	2018
Assessment Unit:	MT40C003_010
Waterbody Name:	Musselshell River
Location Description:	MUSSELSHELL RIVER, Flatwillow Creek to Fort Peck Reservoir

Water Type:	Size (Miles/Acres)	Use Class:
RIVER	75.94 MILES	C-3

Hydrologic Unit Code:	10040205
HUC Name:	Lower Musselshell
Watershed:	Musselshell
Basin:	Lower Missouri
TMDL Planning Area:	Lower Musselshell
Ecoregion:	Northwestern Great Plains
County:	Garfield County, Petroleum County
Lat/Long AU Start (U/S):	46.927891 / -107.929732
Lat/Long AU End (D/S):	47.362296 / -107.952305

MONITORING INFORMATION

Date Assessment Started:	12/15/2017
Assessed By:	Makarowski, Kathryn

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CITATIONS

Citation	Location	Biological Data	Habitat Data	Chemistry Data
U.S. Department of Health, Education, and Welfare, Federal Welfare, Federal Water Polution Control Administration (1966), Water Quality Control Study, Lower Musselshell Project, Montana: Study of Potential Needs and Value of Water for the Purpose of Water Quality Control of the Lower Musselshell Project, Montana	DEQ Metcalf Stacks		riparian &/or instream surveys & physical features	benthic sediment data
Bahls, Loren L. (1977), Results of the September 15-16, 1977 Periphyton Survey on the Musselshell River: Memorandum	Assessment Record	algae		
Hills, Gordon C. (1977), Musselshell River Study: Preliminary Report Prepared for Statewide 208 Project	DEQ Metcalf Stacks			common ions, pH, conductivity, miscellaneous; major nutrients
Bahls, Loren L. ; Fillinger, Mike ; Greene, Richard ; Horpestad, Abe A. ; Ingman, Gary L. ; Weber, Erich E. (1981), Biological Water Quality Monitoring Eastern Montana 1979	DEQ Metcalf Stacks	algae; chlorophyll; fish; macroinvertebrates	riparian &/or instream surveys & physical features	common ions, pH, conductivity, miscellaneous; major nutrients; metals; quantitative physical data
Ostrowski, Tom ; Hedges, Robert B. (1982), Perennial-Streamflow Characteristics Related to Channel Geometry and Sediment in Missouri River Basin, Geological Survey Professional Paper 1242	DEQ Metcalf Stacks			quantitative physical data
Knapton, J. Roger ; Brosten, Tordis M. (1987), Supplemental Arsenic Data for Selected Streams in the Missouri River Basin, Montana, 1987, Open-File Report 87-697	DEQ Metcalf Stacks			common ions, pH, conductivity, miscellaneous; metals; quantitative physical data
Montana Department of Fish, Wildlife, and Parks (1991), Dewatered Streams List, 1991	DEQ Metcalf Stacks		riparian &/or instream surveys & physical	common ions, pH, conductivity,

Citation	Location	Biological Data	Habitat Data	Chemistry Data
			features	miscellaneous; quantitative physical data
(1997), Pre 1997 Field Assessments	Assessment Record	algae; chlorophyll; fecal coliforms; fish; macroinvertebrates	Land use; photo points; riparian &/or instream surveys & physical features	Rosgen type; benthic sediment data; bioaccumulation; common ions, pH, conductivity, miscellaneous; major nutrients; metals; quantitative physical data
U.S. Department of the Interior, Bureau of Reclamation ; Montana Department of Natural Resources and Conservation ; Upper Musselshell Water Users Association ; Deadman's Basin Water Users Association (1998), Musselshell River Basin Water Management Study	DEQ Metcalf Stacks		riparian &/or instream surveys & physical features	common ions, pH, conductivity, miscellaneous; metals; quantitative physical data
Montana Department of Fish, Wildlife, and Parks (1999), Montana Rivers Information System (MRIS)	Assessment Record	algae; fish; macroinvertebrates; wildlife	Land use; riparian &/or instream surveys & physical features	common ions, pH, conductivity, miscellaneous; quantitative physical data
(199n), Proper Functioning Condition Inventory	Assessment Record	fish; macroinvertebrates	photo points; riparian &/or instream surveys & physical features	Rosgen type; quantitative physical data
U.S. Geological Survey (199n), USGS Water Data for the Nation - NWIS	Assessment Record	algae; chlorophyll; fecal coliforms; fish; other bacteriological data	Land use; riparian &/or instream surveys & physical features	benthic sediment data; bioaccumulation; common ions, pH, conductivity, miscellaneous; major

Citation	Location	Biological Data	Habitat Data	Chemistry Data
				nutrients; metals; organics; quantitative physical data
Bahls, Loren L. (2000), Support of Aquatic Life Uses in the Musselshell River Based on Periphyton Composition and Community Structure, DEQ Contract No. 200012	DEQ Metcalf Stacks	algae	riparian &/or instream surveys & physical features	
Bollman, Wease (2000), Aquatic Invertebrates of the Lower Musselshell River: An Assessment	DEQ Metcalf Stacks	macroinvertebrates		
Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078	DEQ Metcalf Stacks	algae; other bacteriological data	General; riparian &/or instream surveys & physical features	
Bollman, Wease (2002), Aquatic Invertebrates and Habitat at a Fixed Station on the Musselshell River, Garfield County, Montana: July 10, 2001	DEQ Metcalf Stacks	General	General	
(2002), DEQ Field Assessment Form	Assessment Record	algae; chlorophyll; fish; macroinvertebrates	Land use; photo points; riparian &/or instream surveys & physical features	Rosgen type; benthic sediment data; common ions, pH, conductivity, miscellaneous; major nutrients; metals; quantitative physical data
(2004), Musselshell River Assessment		General; fish	General; riparian &/or instream surveys & physical features	General; General; quantitative physical data
Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (2006), STORET/Storease Data Archive [Electronic Resource]	DEQ Metcalf Multimedia Case	General; algae; chlorophyll; fecal coliforms; fish; macroinvertebrates; other bacteriological data	General; Land use; riparian &/or instream surveys & physical features	General; Rosgen type; benthic sediment data; common ions, pH, conductivity, miscellaneous; imagery data; major nutrients;

Citation	Location	Biological Data	Habitat Data	Chemistry Data
				metals; organics; quantitative physical data
Suplee, Michael W. ; Watson, Vicki ; Varghese, Arun ; Cleland, Joshua (2008), Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers	DEQ Metcalf Stacks	chlorophyll		major nutrients
U.S. Department of Commerce, National Oceanic and Atmospheric Admin. (2008), Screening Quick Reference Tables (SQuiRTs), OR&R Report 08-1	WQPB Ebrary			benthic sediment data; organics
Unknown (200n), Montana Interagency Stream Fishery Data for the Lower Missouri River Basin	DEQ PPA Data Archive	fish	riparian &/or instream surveys & physical features	common ions, pH, conductivity, miscellaneous; quantitative physical data
Drygas, Jonathan (2012), The Montana Department of Environmental Quality Metals Assessment Method-Final, WQPBMASTR-03	WQPB Ebrary			benthic sediment data; metals
Montana Department of Environmental Quality (2012), Montana Numeric Water Quality Standards: Circular DEQ-7, Circular DEQ-7	DEQ Metcalf Stacks			common ions, pH, conductivity, miscellaneous; major nutrients; metals; organics
(2012), Musselshell River Flood Rehabilitation River Assessment Triage Team (RATT) Summary Report			General; Land use; riparian &/or instream surveys & physical features	General; quantitative physical data
(2013), Drought, Flood, Saving, and Sharing: A History of Water Resource Supply, Conservation and Distribution in the Musselshell River Basin of Montana			General	General

Citation	Location	Biological Data	Habitat Data	Chemistry Data
(2013), River Assessment Triage Team (RATT) Development of Post-2011 Best Management Practices (BMPs)			General; Land use; riparian &/or instream surveys & physical features	General; quantitative physical data
Montana Department of Environmental Quality (2014), Department Circular DEQ-12A: Montana Base Numeric Nutrient Standards, Circular DEQ-12A	DEQ Metcalf Stacks			major nutrients
(2015), Musselshell River Watershed Plan Final Report		fish	General; Land use; riparian &/or instream surveys & physical features	General; quantitative physical data
(2016), Assessment Methodology for Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels		General; algae; chlorophyll; macroinvertebrates		General; common ions, pH, conductivity, miscellaneous; major nutrients
Makarowski, Kathryn (2016), Musselshell Sediment and Habitat Sampling - 2016: Sampling and Analysis Plan	WQPB Ebrary		General; Land use; photo points; riparian &/or instream surveys & physical features	General; Rosgen type; quantitative physical data
(nnnn), DEQ Fixed Station Monitoring Project	Assessment Record	chlorophyll		common ions, pH, conductivity, miscellaneous; quantitative physical data
Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS	WEB	General; algae; chlorophyll; e-coli; macroinvertebrates	riparian &/or instream surveys & physical features	General; General; benthic sediment data; common ions, pH, conductivity, miscellaneous; major nutrients; metals;

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Citation	Location	Biological Data	Habitat Data	Chemistry Data
				organics; quantitative physical data

Comments:

DATA MATRIX
Biological Data

Comments: E. COLI: All samples were collected April 1 through October 31, during which the water quality standard for C-3 streams for Escherichia coli bacteria (E-coli) reads, 'the geometric mean number of E-coli may not exceed 126 colony forming units per 100 milliliters and 10% of the total samples may not exceed 252 colony forming units per 100 milliliters during any 30-day period (ARM 17.30.629)." Combined dataset from August 2015: n = 5; geometric mean = 51.11 cfu/100ml; 0 of 5 (0%) samples exceed 252 cfu/100ml. Combined dataset from July 2016: n = 1; insufficient data to evaluate geometric mean; 1 of 1 (100%) samples exceed 252 cfu/100ml. Combined dataset from September 2016: n = 2; insufficient data to evaluate geometric mean; 0 of 2 (0%) samples exceed 252 cfu/100ml.

PERIPHYTON: Periphyton samples were collected following DEQ sampling protocols during the index period when nutrient standards apply for the Northwestern Great Plains level III ecoregion (July 1 - Sept 30). For each sample, diatoms were identified to the lowest taxonomic level possible and nutrient and sediment increaser taxa metrics were calculated. These metrics were developed to indicate the likelihood of nutrient or sediment impairments in a waterbody. A diatom sample is suggesting a nutrient or sediment impairment when the probability of impairment is > 51%. Of all the periphyton samples collected (n = 2), one sample exceeded the probability of impairment threshold for nutrients (29.24 and 66.13%) and zero samples exceeded the probability of impairment threshold for sediment (23.19 and 30.86%).

Entire segment (Flatwillow Creek to Fort Peck Reservoir)

Data Type	Comments	Ref Num	Citation
algae	Low diversity and high number of sediment tolerant taxa. Nevertheless, diversity and equitability were still above levels indicative of pollution stress.	11749	Bahls, Loren L. (1977), Results of the September 15-16, 1977 Periphyton Survey on the Musselshell River: Memorandum
algae	This study was a early attempt at biological monitoring and is difficult to interpret. Diatoms collected at Mosby had >25 diatom species and average diversity >3, at the time of study, these criteria indicates full support. The Musselshell River at Mosby ranked in the lower 1/3 of streams included in the study.	565	Bahls, Loren L. ; Fillinger, Mike ; Greene, Richard ; Horpestad, Abe A. ; Ingman, Gary L. ; Weber, Erich E. (1981), Biological Water Quality Monitoring Eastern Montana 1979
algae	Musselshell River Basin Chlorophyll data from site at Mosby, MT (10/80-9/81): No indication of eutrophication	10472	(1997), Pre 1997 Field Assessments
algae	Green algae and diatoms were present at 6 sites, while benthic algae counts were noted to be low; Pollution and siltation indices for diatoms indicated minor impairment and full support of aquatic life for prairie streams	2443	Bahls, Loren L. (2000), Support of Aquatic Life Uses in the Musselshell River Based on Periphyton Composition and Community Structure, DEQ Contract No. 200012

Data Type	Comments	Ref Num	Citation
algae	Two periphyton samples were collected (2015-2016): probability of impairment from nutrients = 29.24 and 66.13%; probability of impairment from sediment = 23.19 and 30.86%.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
chlorophyll	This study was a early attempt at biological monitoring and is difficult to interpret. The Musselshell River at Mosby ranked in the lower 1/3 of streams included in the study.	565	Bahls, Loren L. ; Fillinger, Mike ; Greene, Richard ; Horpestad, Abe A. ; Ingman, Gary L. ; Weber, Erich E. (1981), Biological Water Quality Monitoring Eastern Montana 1979
chlorophyll	Musselshell River Basin Chlorophyll data from site at Mosby, MT (10/80-9/81): No indication of eutrophication	10472	(1997), Pre 1997 Field Assessments
chlorophyll	Fixed station monitoring, DEQ staff (R. Apfelbeck), 7-21-01: Chl a = 3 mg/m2 Fixed station monitoring, DEQ staff (R. Apfelbeck), 7-7-02: Chl a = 42 mg/m2	10092	(nnnn), DEQ Fixed Station Monitoring Project
e-coli	Five E. coli samples were collected at one site from 8/10/2015 - 8/18/2015. Station M28MUSSR01 (near Mosby): n = 5; 41.4, 75.9, 35.4, 79.8 and 39.3 cfu/100ml; geometric mean = 51.11 cfu/100ml; 0 of 5 (0%) samples exceed 252 cfu/100ml. One sample was collected on 7/27/16. Station M28MUSSR01 (near Mosby): n = 1; 461.1 cfu/100ml; insufficient data to evaluate geometric mean; 1 of 1 (100%) samples exceed 252 cfu/100ml. Two samples were collected from 9/27/16 - 9/29/16. Station M28MUSSR01 (near Mosby): n = 2; 109.5 and 22.1 cfu/100ml; insufficient data to evaluate geometric mean; 0 of 2 (0%) samples exceed 252 cfu/100ml.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
fecal coliforms	Collected for 2 field seasons ('99, '00, 3 visits/year) at several sites (9 stations); Aug '99 had conc of 2730 counts/100-mL (site4), 2450 counts/100-mL (site 7), 1740 counts/100-mL (site 8); presentation of data from '76-94 (source of collecting	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078

Data Type	Comments	Ref Num	Citation
	agency not disclosed, possibly USGS?) indicating several elevated levels (report suggests an upward trend in increasing fecal coliform)		
fish	Rivers Information System: Fish assemblage typical of larger prairie river. Several species are missing, however, this may be related to the ecological barrier for riverine species formed by Ft. Peck reservoir.	11349	Montana Department of Fish, Wildlife, and Parks (1999), Montana Rivers Information System (MRIS)
fish	Storease: Same as Ref# 11348 (fish).	11348	Unknown (200n), Montana Interagency Stream Fishery Data for the Lower Missouri River Basin
fish	Currently there are multiple efforts underway to improve the overall fishery in the Musselshell River through habitat improvements and restorative fish stocking.	15662	(2015), Musselshell River Watershed Plan Final Report
macroinvertebrates	This study was a early attempt at biological monitoring and is difficult to interpret. The Musselshell River at Mosby ranked in the lower 1/3 of streams included in the study.	565	Bahls, Loren L. ; Fillinger, Mike ; Greene, Richard ; Horpestad, Abe A. ; Ingman, Gary L. ; Weber, Erich E. (1981), Biological Water Quality Monitoring Eastern Montana 1979
macroinvertebrates	Conclusions were vague, bioassessment criteria for plains ecoregion is not well known/understood; flow was attributed to be the largest contributor to low bug assemblage/diversity; 2 seasons were sampled ('99 & '00), but data from '99 not valid because DEQ sampling protocols were not followed; Data from 2000 showed high biotic indices (>7) suggesting significant organic enrichment; EPA richness was very low at the upper sites, but improved (although still low) d/s towards mouth; taxa richness was poor at u/s sites (Woodford and Rowton), but improved some (max was 24, which may be good for prairie stream?); upper sites were dominated by "unknown" functional types; clingers were reported at lower 4 stations (absent at upper 2)	10564	Bollman, Wease (2000), Aquatic Invertebrates of the Lower Musselshell River: An Assessment

Data Type	Comments	Ref Num	Citation
macroinvertebrates	Bioassessment score: 87% of max, impairment classification: "non-impaired", use support: "full". 25 taxa were collected, many of which are rheophiles (flowing water lovers); while only 4 mayfly taxa were present, they accounted for 24% of the total sample; Mild nutrient enrichment is indicated by increase biotic index (5.53), and warm water temperatures appear to influence the composition; hemoglobin-bearing midges were abundant, showing that anoxic conditions were present; filamentous algae are also present due to the presents of the caddisfly Hydrophtilasp. Long-lived taxa were present, suggesting dewatering has not occurred; In her conclusions, Bollman states that while the overall bioassessment score is very positive, that the importance for more water in the channel should not be overlooked.	308	Bollman, Wease (2002), Aquatic Invertebrates and Habitat at a Fixed Station on the Musselshell River, Garfield County, Montana: July 10, 2001

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DATA MATRIX

Habitat Data

Comments:

Entire segment (Flatwillow Creek to Fort Peck Reservoir)

Data Type	Comments	Ref Num	Citation
General	In spring of 2011, the Musselshell River experienced unprecedented flooding that resulted in extensive damage to irrigation infrastructure, roads, bridges, residential structures, and productive agricultural fields. The peak had a (estimated) 157-year return interval. The flood persisted for over three weeks. Responses to the 2011 flood include the carving of new channels, excessive bank erosion, damage to siphons, breaching of the railroad berm, damages to diversion structures, extensive sediment deposition on the river floodplain, damages to pump sites, scouring of the floodplain, and lost access to property. The flood caused extensive bank erosion and 59 avulsions, which abandoned almost 37 miles of channel and created just over nine miles of new channel (net loss of 27.9 miles of channel, or 8% of the total channel). The most severe shortening occurred in the lowermost 89 miles of river, below Flatwillow Creek. There were a total of 31 breaches through the railroad grade. In some places, the river migrated several hundreds of feet during the flood, causing massive erosion and sediment delivery downstream. Several diversion structures were flanked or abandoned, dozens of irrigation pumps were abandoned, and floodplain deposition was several feet thick in some agricultural fields. During construction of the railroad (Milwaukee Road) in the early 20th Century, the Musselshell River was dramatically straightened and shortened. Of the 207 total miles of river affected, a total of 35 miles of meander length was isolated behind the abandoned rail berm; this represents 19% or nearly one fifth of the channel length. Between Melstone and	15660	(2012), Musselshell River Flood Rehabilitation River Assessment Triage Team (RATT) Summary Report

Data Type	Comments	Ref Num	Citation
	approximately 25 miles upstream of Harlowton, a total of 82 meanders are isolated. This isolation occurs at a relatively consistent rate of 1000 feet of isolated meander length per mile of existing channel. Bank erosion was severe throughout the entire river during the 2011 flood. The process of high bank erosion, channel widening, and low inset bar/floodplain surface development appears to have been pervasive in channel segments that were entrenched prior to the flood. During the 2011 flood, entrenched channel segments experienced high velocities that caused in-channel erosion, destabilization of extensive swaths of vegetation, and channel widening. The long duration of the flood caused streambanks to become deeply saturated, and as flows dropped, banks rapidly failed as they were unable to support their weight. Gravitational failure and river erosion of high banks resulted in massive sediment loading downstream that caused floodplain aggradation and contributed to avulsions. The perched, sparsely vegetated historic floodplain was inundated for weeks, which resulted in local scour and new channel excavation on the erodible surface.		
General	A history of water resource supply, conservation, and distribution in the Musselshell River Basin was written in 2013. This report describes the history of water rights, and state water projects to store water to allow irrigation, including the creation and management of Bair Reservoir, Martinsdale Reservoir, and Deadman's Basin, as well as the Delphia-Melstone Canal. It also describes the 1995 agreement between two water user association boards to cooperatively manage river diversion rates and timing.	15663	(2013), Drought, Flood, Saving, and Sharing: A History of Water Resource Supply, Conservation and Distribution in the Musselshell River Basin of Montana

Data Type	Comments	Ref Num	Citation
General	In 2014 and 2015, public stakeholder meetings were held throughout the Musselshell to solicit input from local producers, agency representatives, government officials, water user associations, and others regarding water resource management?related project needs and opportunities within the basin. 58 project proposals were then refined and ranked to 27 projects. Another meeting with funding entities was held to develop an implementation strategy. Projects include diversion structure, canal, dam repairs, fish passages, bank stabilization, and others. Additional planning projects and studies include channel migration zone mapping, flood mitigation, native species re-introduction, canal seepage studies, weed and salt cedar management, soil health monitoring, railroad berm remediation, and others. This plan is a living document that will assist the Musselshell Watershed Coalition in its continued development and implementation of stakeholder-driven water management efforts in the basin. The Musselshell River basin drains high elevation areas that provide seasonal snowmelt runoff that is highly relied on for agricultural use. At Martinsdale, where average annual precipitation is 15.5 inches, spring runoff typically peaks in late May at about 300 cfs. In Roundup ,the river tends to peak in early June, typically around 400 cfs. At Mosby, where annual precipitation averages 13.2 inches, the river tends to peak in mid-June with a median spring runoff discharge of about 450 cfs. Lower in the basin, the river has a snowmelt pulse but also has a prairie runoff pattern with an increasingly flashy hydrology created by rain events. The 2011 flood was notable in terms of its very long duration of high flows; a 10-year flood discharge was exceeded for 19 days at Mosby and 22 days at Roundup. In early March of 2014, ice jams caused flooding	15662	(2015), Musselshell River Watershed Plan Final Report

Data Type	Comments	Ref Num	Citation
	around Roundup and this flood peaked at over 10,000cfs.In late August of 2014, Petroleum County experienced record setting rainfall and flooding within the Flatwillow Basin and the receiving lower Musselshell River. Flows increased from 150 cfs to 20,090 cfs over three days. Three major floods since 2011 in a river that has seen little change in the 30 years prior influenced the desire to develop a Watershed Plan. River straightening by the railroad above Melstone drive channel downcutting and detachment of the river from its historic floodplain. Prior to the 2011 flood, the channel above Roundup was entrenched with a floodplain perched 6-10 feet above the water table, and little inset floodplain had developed. Below Roundup, the channel was in early stages of recovery following downcutting.		
Land use	Population of watershed is roughly 660; land ownership is divided into 30,800 hectares (ha) as federal and 43,200 ha as private; landuse is divided among 5 categories: cultivated cropland (460 ha), non-cultivated cropland (1390 ha), forest (6050 ha), pasture (460 ha), & rangeland (127,157 ha).	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
photo points	Lotic survey pages indicate photos taken at each site; 4 specific sites shown in report; all show very limited riparian zones, both in species diversification and width; Large woody species appears to be scarce and lacking age diversification (mature trees only); water looks muddy-murky; photo taken at "Site 4" (near HWY 200 crossing) shows evidence of heavy livestock use	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
riparian &/or instream surveys & physical features	Nonpoint Source Stream Reach Assessment (Levine 1992): This assessment describes significant bank erosion and riparian degradation due to livestock grazing and cultivated fields encroaching on the stream.	10472	(1997), Pre 1997 Field Assessments

Data Type	Comments	Ref Num	Citation
riparian &/or instream surveys & physical features	lotic inventory: 7 polygons have been assessed, all scored as functional at risk or non-functional.	2773	(199n), Proper Functioning Condition Inventory
riparian &/or instream surveys & physical features	Reaches (.5 mi/reach) were evaluated using RWRP Lotic Health Assessment forms; 92% scored "functioning at risk" (healthy but w/ problems) and 8% was "non-functioning"; Specifies problem areas lacking woody cover, presence of invasive plants, lack of native graminoids, & dewatering; Positive areas indicated by surveys include lack of "human-caused" bare ground, few exotic woody species, high shrub and cottonwood regeneration, and high densities of dead/decadent woody species	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
riparian &/or instream surveys & physical features	Habitat was rated as 61% of maximum, or "sub-optimal"; Sediment deposition was low & was the only habitat parameter that was scored better than 80% of max; flow conditions were rated very poor & riffle habitat was basically non-existent; substrate partial size diversify was sub-optimal & embeddedness affected habitat somewhat; channel alteration was observed; streambanks were moderately unstable w/ disrupted vegetation protection	308	Bollman, Wease (2002), Aquatic Invertebrates and Habitat at a Fixed Station on the Musselshell River, Garfield County, Montana: July 10, 2001
riparian &/or instream surveys & physical features	Riparian plant community health varies all along the Musselshell River; some reaches have good species and age diversity that provide excellent wildlife cover and bank stability, others have either been heavily impacted by livestock or have been cleared for field development sometime in the past. Common native woody plant communities range from plains cottonwood and peachleaf willow stands on the lower reaches, to black cottonwood, thinleaf alder, sandbar willow, water birch, and red osier dogwood communities in the upper reaches. Undergrowth is dominated by native forbs, grasses, sedges and rushes. Common chokecherry, silver	15664	(2004), Musselshell River Assessment

Data Type	Comments	Ref Num	Citation
	buffaloberry, various willow species, western snowberry, honeysuckle, boxelder maple, green ash and black hawthorn are native species that vary in density and frequency along the Musselshell. Over 40 years, non-native Russian olive has invaded areas formerly occupied by native willows and cottonwoods and has spread rapidly along. The introduced and highly aggressive salt cedar (Tamarix), a noxious weed, is also expanding. Over 100 years of railroad and highway construction, irrigation development, field clearing, channel straightening, channel downcutting, and heavy grazing pressure has significantly limited the river's ability to sustain native riparian plant communities. In 2004, an extensive functional assessment of the Musselshell River riparian corridor completed by the conservation districts and Musselshell River Watershed Coalition rated the majority of the riparian corridor as being either "Not Sustainable" or "Sustainable-at Risk". According to the NRCS riparian assessment method, a stream reach is considered Sustainable when it has adequate vegetation, landform, or large woody material for dissipating stream energy, filter sediment, capture bedload, aid floodplain development, improve flood-water retention and ground-water recharge. A Non-Sustainable stream reach clearly lacks these elements, thus making it susceptible to further degradation from a high flow event (considered to be a 30 year storm). A reach that is at risk is in between these. This report also contains recommendations for best management practices to improve riparian condition.		
riparian &/or instream surveys & physical features	Whereas the Musselshell River used to commonly go dry in the summer, recent changes in cooperative water management have prevented complete dewatering during the	15660	(2012), Musselshell River Flood Rehabilitation River Assessment Triage Team (RATT) Summary Report

Data Type	Comments	Ref Num	Citation
	late irrigation season. Vast carpets of cottonwood and willow seedlings were established by the 2011 flood. Noxious weed infestations are a major issue along the Musselshell River stream corridor. Upstream from Harlowton, there are extensive infestations of leafy spurge, spotted knapweed, and Canada thistle. Downstream from Harlowton, these weeds are common as well as ever-increasing infestations of Russian olive and salt cedar. Salt cedar (tamarix) is a highly aggressive invasive species that has recently been expanding along the bars and banks of the Musselshell main stem.		
riparian &/or instream surveys & physical features	The River Assessment Triage Team (RATT) revisted a selection of sites along the length of the Musselshell River affected by the 2011 flood. The purpose of the field visits was to interview a selection of landowners who had participated in the 2011 post-flood RATT process. Through discussion and observation it was the goal to determine what restoration practices have been completed; what practices have worked; what lessons have been learned; and how lessons can be shared with current and future river users.	15661	(2013), River Assessment Triage Team (RATT) Development of Post-2011 Best Management Practices (BMPs)
riparian &/or instream surveys & physical features	This document describes the qualitative habitat assessment method that was piloted, in the Musselshell watershed in 2016. Three sites were evaluated using DEQ's pilot qualitative habitat assessment process. A majority of indicators for riparian condition and instream habitat conditions are optimal or sub-optimal; few are marginal, none are poor.	15654	Makarowski, Kathryn (2016), Musselshell Sediment and Habitat Sampling - 2016: Sampling and Analysis Plan
riparian &/or instream surveys & physical features	Site M28MUSSR01 (near Mosby): Sedge, rushes and willows are common. Some banks lack sufficient vegetation with deep, binding root mass. Thistle and knapweed, both noxious weeds, were observed. Cottonwood regeneration is common. Surrounding pasture is limiting riparian buffer width in places. There is naturally eroding banks in areas with steep terrain.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS

Data Type	Comments	Ref Num	Citation
	The river has access to its floodplain. Flows are highly altered (likely the primary influence on habitat quality). Indicators for channel stability, morphology, and channel features are all optimal or sub-optimal. Site M28MUSSR02 (near mouth): Multiple species of sedges are present but make up a small percentage of the riparian area. Cottonwoods are common. Many banks are lacking sufficient vegetation with deep, binding root mass. Soil surface integrity is generally intact, and minor impacts are predominantly from natural sources (wildlife, stream power during high flow events). Persistent drought conditions have also likely limited potential for riparian vegetation vigor. Salt cedar and Russian olive are observed.		

DATA MATRIX

Chemistry Data

Comments:

NUTRIENTS: Nine nutrient samples were collected following DEQ sampling protocols during the index period when numeric nutrient standards apply for the Northwestern Great Plains level III ecoregion (July 1 - Sept 30). Data were evaluated against numeric nutrient standards for TN and TP and to recommended NO2+3 nutrient criteria for the Northwestern Great Plains ecoregion (TN = 1.30 mg/L; TP = 0.15 mg/L; NO2+3 = 0.10 mg/L). Of all the nutrient samples collected (n = 9 for TN, n = 8 for TP, n = 7 for NO2+3), zero samples exceeded the TN standard (range = 0.260 - 0.678 mg/L), one sample exceeded the TP standard (range = 0.013 - 0.156 mg/L) and zero samples exceeded the NO2+3 recommended criteria (range = < 0.01 mg/L). Data were analyzed following the DEQ nutrient assessment method for the plains region of Montana. Four additional nutrient samples were collected outside of the index period in 2015 and 2016: TN range = 0.35 - 0.49 mg/L; TP range = 0.031 - 0.581 mg/L; NO2+3 range = < 0.01 - 0.07 mg/L.

DO DELTA: DO delta values (daily maximum DO minus the daily minimum DO) were measured following DEQ sampling protocols during the index period when nutrient standards apply for the Northwestern Great Plains level III ecoregion (July 1 - Sept 30). Elevated DO delta values indicate high productivity and the potential for DO standards exceedances (per DEQ - 7) that would impact fish and aquatic life. Daily DO delta values were compared to the recommended DO delta threshold (less than or equal to 5.3 mg/L). Of all the DO delta values measured (n = 3), zero measurements exceeded the recommended DO delta threshold (range = 2.02 - 2.32 mg/L).

METALS: All water column metals samples (n = 16 for Al, n = 20 for As, Cd, Cr, Cu, Fe, Pb, Se, and Zn, n = 6 for Ag, and n = 13 for Hg) were collected using DEQ sampling protocols. Total recoverable fractions were analyzed for all metals except aluminum for which the dissolved fraction was analyzed. For each metal except Ag and Hg, five samples were collected during a period of high flow conditions (one for Ag and three for Hg); the remaining samples were collected during baseflow. Water column data for each metal was evaluated against numeric water quality standards (acute, chronic, and human health) according to the DEQ assessment method for metals. Al, As, Cd, Cr, Cu, Pb, Se, Ag, Hg and Zn: zero samples exceed acute or chronic aquatic life or human health standards. Fe: ten samples exceed the chronic aquatic life standard.

SEDIMENT METALS: Seven samples were collected and analyzed for As, Cd, Cr, Cu, Fe, Pb, Hg and Zn. Benthic sediment metals data was considered separately from water column metals data and is not explicitly included in the assessment decision-making process. Data was evaluated using NOAAs Screening Quick Reference Tables for Inorganics in Soil (Probable Effect Level). All concentrations are below the screening criteria used (17 ug/g As, 3.53 ug/g Cd, 90 ug/g Cr, 197 ug/g Cu, 91.3 ug/g Pb, 0.486 ug/g Hg and 315 ug/g Zn).

Entire segment (Flatwillow Creek to Fort Peck Reservoir)

Data Type	Comments	Ref Num	Citation
General	Three DO delta values were calculated: DO delta = 2.02, 2.26 and 2.32 mg/L.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
Rosgen type	Channel morphology and x-sections were performed along 5 reaches of the river; Classified C-4 based on reported values for: entrenchment ratio (>2.2), w/d (>12, moderate), slope (0.001-0.02), sinuosity (>1.2, high), bed composition (gravel and silt)	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
benthic sediment data	This document contains NOAA's Screening Quick Reference Tables for Inorganics in Soil with which benthic sediment metals concentrations were evaluated in the Musselshell River watershed.	14365	U.S. Department of Commerce, National Oceanic and Atmospheric Admin. (2008), Screening Quick Reference Tables (SQuiRTs), OR&R Report 08-1
benthic sediment data	Seven benthic sediment samples were collected and analyzed for As, Cd, Cr, Cu, Fe, Pb, Hg and Zn (2012-2015). All concentrations are below the screening criteria. Sediment metals results are not explicitly included in the metals assessment decision-making process.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
common ions, pH, conductivity, miscellaneous	Nonpoint Source Stream Reach Assessment (Levine 1992): 2360 umhos/cm Water Quality Data for Musselshell River (1993-95): acceptable for a C-3 stream	10472	(1997), Pre 1997 Field Assessments
common ions, pH, conductivity, miscellaneous	Gauging Station Data (Mosby, # 06130500): Water is very hard (<<200 mg/L CaCO3) & is Na-SO4 dominated; SAR values are less than 10, but SC (<3000 uS/cm) & TDS (<1500 mg/L) can be high. SC range from 1190-6940 uS/cm, median	2772	U.S. Geological Survey (199n), USGS Water Data for the Nation - NWIS

Data Type	Comments	Ref Num	Citation
	value = 3045 uS/cm; TDS range from 815-6201 mg/L, median value = 1889 mg/L		
common ions, pH, conductivity, miscellaneous	Samples were collected during field seasons '99, '00 (3 trips/season for each of 9 stations); TDS were analyzed and compared to flow and irrigation return flows, report gives average values ranging from 1000 mg/L in Aug '99 to 4000 mg/L in Aug '00; TSS were compared with flow, report gives values that range around 50-100 mg/L, except 2 times when samples were gathered shortly after rain events; 8-19-99 rainstorm gave elevated levels of 250 mg/L at 130 cfs; the storm shortly before 7-20-00 was reported as the 100-yr event and produced flows that caused "dramatic scouring of tributary coulees and creeks that feed the Lower Musselshell River", average TDS was 3694 mg/L	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
common ions, pH, conductivity, miscellaneous	Field Survey, DEQ in co-op with CDs/NRCS, May 2002: At Mosby (UM site #4), field parameters: flow = 1 cfs, water temp = 11.5°C, pH = 8.00, SC = 3580 uS/cm, DO-na, turbid water; Common ions reported as mg/L: Ca= 171, Mg= 135, Na= 581, SO4= 1930, Cl= 44, SAR=8.06, TDS= 3260; Near mouth (UM Site#9), field parameters: flow = 0 cfs, water temp = 11.6°C, pH = 8.12, SC = 3600 uS/cm, DO = nr; Common ions reported as mg/L: Ca= 209, Mg= 139, Na= 562, SO4= 2040, Cl= 33, SAR=7.39, TDS= 3410	4649	(2002), DEQ Field Assessment Form
common ions, pH, conductivity, miscellaneous	Storease: Specific conductance ranged between 800 and 5200 umhos/cm. No relationship between flow and specific conductance.	10255	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (2006), STORET/Storease Data Archive [Electronic Resource]
common ions, pH, conductivity,	Fixed station monitoring, DEQ staff (R. Apfelbeck), 7-21-01: At Mosby, v. low flow; Meter readings: pH= 8.14, SC = 519	10092	(nnnn), DEQ Fixed Station Monitoring Project

Data Type	Comments	Ref Num	Citation
miscellaneous	uS/cm, water temp = 24.5°C, DO = 11.16 mg/L, slight turbidity Fixed station monitoring, DEQ staff (R. Apfelbeck), 7-7-02: At Mosby: meter readings: pH = 7.9, SC = 368 uS/cm, water temp = 29°C, DO = 7.3 mg/L, water turbidity was moderate		
common ions, pH, conductivity, miscellaneous	Twenty hardness values, range = 501 - 1020 mg/L.Data collected in 2012, 2013, 2015 and 2016: 41 DO measurements, range = 1.67 - 13.50 mg/L. 27 TSS measurements, range = 8.5 - 494 mg/L. 42 SC instantaneous measurements, range = 1,272 - 3,593 uS/cm. 37 flow measurements, range = 1.42 - 950.00 cfs. 41 pH measurements, range = 8.20 - 8.58. The maximum temperature (TMAX) recorded by a continuous data logger was 83.5 degF near Mosby and 83.2 degF upstream of Lodgepole Creek. The highest maximum weekly maximum temperature (MWMT) recorded by a continuous data logger was 82.3 degF near Mosby and 81.1 degF upstream of Lodgepole Creek.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
major nutrients	TP levels are above enrichment levels. I believe that this is due to soil erosion and some natural sediment loading and is not a nutrient enrichment issue.	1915	Hills, Gordon C. (1977), Musselshell River Study: Preliminary Report Prepared for Statewide 208 Project
major nutrients	TP levels are above enrichment levels. I believe that this is due to soil erosion and some natural sediment loading and is not a nutrient enrichment issue. Nitrogen related parameters are acceptable.	565	Bahls, Loren L. ; Fillinger, Mike ; Greene, Richard ; Horpestad, Abe A. ; Ingman, Gary L. ; Weber, Erich E. (1981), Biological Water Quality Monitoring Eastern Montana 1979
major nutrients	Gauging Station Data (Mosby, # 06130500): Pre-1998 data pooled in Storease; 1999-2002, TKN ranged 0.17-2.7 mg/L as N, NO2/3 ranged from less than reporting limit to 0.30 mg/L, Total P ranged from 0.012 - 0.78 mg/L; TSS data correlate well with Total P; using linear regression, Total P vs. TSS has	2772	U.S. Geological Survey (199n), USGS Water Data for the Nation - NWIS

Data Type	Comments	Ref Num	Citation
	a correlation factor of 0.95; TP & TSS relationship may indicate increase nutrients due to erosion. TSS values ranged fro 41-1860 mg/L between 1999-2002. Max reported values for nutrients & TSS occurred in Jun '99 (flow = 180 cfs)		
major nutrients	Nitrate/Nitrite and Total P were analyzed for 5 of 6 water samples collected in field seasons '99 and '00; no sample was noted to exceed EPA/MT DEQ standards or recommended max concentrations	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
major nutrients	Field Survey, DEQ in co-op with CDs/NRCS, May 2002: All Nutrients recorded in mg/L: site #4: NO3 +NO2 as N: 0.02 NH3 as N:ND TKN: 0.6, Total Pas P:0.042, TSS: 23 site #9: NO3 +NO2 as N: ND NH3 as N:ND TKN: 0.7, Total Pas P:0.055, TSS: 20	4649	(2002), DEQ Field Assessment Form
major nutrients	Storease: TP is highly correlated with flow indicating edaphic sources. Other nutrients are typical of prairie streams.	10255	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (2006), STORET/Storease Data Archive [Electronic Resource]
major nutrients	This document contains information supporting the nitrate plus nitrite recommended criteria used to evaluate nitrate plus nitrite data while assessing wadeable streams in the Musselshell River watershed.	11934	Suplee, Michael W. ; Watson, Vicki ; Varghese, Arun ; Cleland, Joshua (2008), Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers
major nutrients	This document contains the numeric total nitrogen (TN) and total phosphorus (TP) standards for wadeable streams in the Northwestern Great Plains level III ecoregion. These standards were used to analyze TN and TP data for beneficial use determination for wadeable streams in the Musselshell River watershed.	15265	Montana Department of Environmental Quality (2014), Department Circular DEQ-12A: Montana Base Numeric Nutrient Standards, Circular DEQ-12A
major nutrients	This document contains the assessment method with which	15655	(2016), Assessment Methodology for

Data Type	Comments	Ref Num	Citation
	nutrient data were analyzed for beneficial use determination.		Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels
major nutrients	Nine water samples were collected (2012-2013, 2015-2016) during the index period and analyzed for TN, TP and NO2+3. When compared to numeric nutrient standards for TN and TP and to recommended NO2+3 nutrient criteria for the Northwestern Great Plains ecoregion: zero TN exceedances, one TP exceedance and zero NO2+3 exceedances. Four water samples were collected outside of the index period and analyzed for TN, TP, NO2+3 and SRP: TN range = 0.35 - 0.49 mg/L; TP range = 0.031 - 0.581 mg/L; NO2+3 range = < 0.01 - 0.07 mg/L; SRP range = < 0.002 - 0.006 mg/L.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
metals	This report includes describes a sampling site on the Musselshell River but reports no results from this station.	2419	Knapton, J. Roger ; Brosten, Tordis M. (1987), Supplemental Arsenic Data for Selected Streams in the Missouri River Basin, Montana, 1987, Open-File Report 87-697
metals	This document contains the assessment method with which metals data was analyzed for beneficial use determination.	14350	Drygas, Jonathan (2012), The Montana Department of Environmental Quality Metals Assessment Method-Final, WQPBMASTR-03
metals	This document contains the numeric water quality standards used to evaluate metals concentrations for beneficial use support in waters in the Musselshell River watershed.	13619	Montana Department of Environmental Quality (2012), Montana Numeric Water Quality Standards: Circular DEQ-7, Circular DEQ-7
metals	Twenty samples were collected (2015-2016) and analyzed for As, Cd, Cr, Cu, Fe, Pb, Se, and Zn, sixteen samples were analyzed for Al, six samples were analyzed for Ag, and thirteen samples were analyzed for mercury. Ten dissolved iron concentrations, range = < 20 ug/L.	15288	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau (nnnn), Montana Water Quality EQuIS
organics	Storease: no exceedences of pesticides/herbicides.	10255	Montana Department of Environmental Quality, Planning, Prevention and Assistance Division,

Data Type	Comments	Ref Num	Citation
			Water Quality Planning Bureau (2006), STORET/Storease Data Archive [Electronic Resource]
quantitative physical data	This was a study of water availability related to potential coal development in the basin. There is discussion of limited water availability for this kind of development.	2392	U.S. Department of Health, Education, and Welfare, Federal Welfare, Federal Water Polution Control Administration (1966), Water Quality Control Study, Lower Musselshell Project, Montana: Study of Potential Needs and Value of Water for the Purpose of Water Quality Control of the Lower Musselshell Project, Montana
quantitative physical data	Flows and temperature varied with season.	565	Bahls, Loren L. ; Fillinger, Mike ; Greene, Richard ; Horpestad, Abe A. ; Ingman, Gary L. ; Weber, Erich E. (1981), Biological Water Quality Monitoring Eastern Montana 1979
quantitative physical data	USGS study regarding discharge, bedload, and bank material along the Musselshell River; reported median substrate grain size was 10 mm (med. Gravel)	10474	Ostrowski, Tom ; Hedges, Robert B. (1982), Perennial-Streamflow Characteristics Related to Channel Geometry and Sediment in Missouri River Basin, Geological Survey Professional Paper 1242
quantitative physical data	Is listed by MFWP as a chronically dewatered stream (i.e. dewatering is a significant problem in nearly all years).	958	Montana Department of Fish, Wildlife, and Parks (1991), Dewatered Streams List, 1991
quantitative physical data	Water Quality Data for Musselshell River (1993-95): These data are pooled in Storease	10472	(1997), Pre 1997 Field Assessments
quantitative physical data	Most years the Musselshell River cannot meet all the demands placed on it (chronically dewatered).	1913	U.S. Department of the Interior, Bureau of Reclamation ; Montana Department of Natural Resources and Conservation ; Upper Musselshell Water Users Association ; Deadman's Basin Water Users Association

Data Type	Comments	Ref Num	Citation
			(1998), Musselshell River Basin Water Management Study
quantitative physical data	Gauging Station Data (Mosby, # 06130500): Flow data from 1929 through present; High flows are related to season, but stream will also flow high in response to summer storm event; The high flow was 15700, and the low is 0; For the past 10 years, highs have reached nearly 10000 cfs, but most flows are between 10-100 cfs, and no flow is not uncommon! Sieve analysis was preformed by the USGS from 1984 through 1999; D50 reveals 8-32 mm (gravel); however, not much relevance should be placed on this data because it represents one solitary place in the substrate (not know to us), not the whole river	2772	U.S. Geological Survey (199n), USGS Water Data for the Nation - NWIS
quantitative physical data	Flow measurements were gathered for 2 seasons ('99, '00, 3 field visits/season) at 9 stations and are used to compare susp sediment and quantify nutrients; "Average" flows were given by report as ranging between 140 cfs (7-20-00) to 0 cfs (8-19-99); high flow in July '00 is attributed to a summer rainstorm event	1681	Hollow, O'Brien ; Chadwick, Amy ; Hansen, Paul L. (2001), Lower Musselshell River Study, DEQ Contract # 290078
quantitative physical data	This study describes 140 meanders as shortened or cut off from the river. Over 100 years of railroad and highway construction, expanded irrigation development, channel straightening, channel downcutting and grazing pressure continued to alter the river?s natural ability to disperse the erosive energy. The Musselshell River is largely represented by Rosgen C and Rosgen F channels.	15664	(2004), Musselshell River Assessment

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

DQA SUMMARY

Aquatic Life & Fishes

Nutrients	FAIL
Metals	PASS
Sediment	NOT ASSESSED
Temperature	NOT ASSESSED
Other	NOT ASSESSED

Drinking Water

Metals	NOT ASSESSED
Other	NOT ASSESSED

Recreation

Nutrients	NOT ASSESSED
E.coli	PASS
Other	NOT ASSESSED

Agriculture

Common	NOT ASSESSED
Other	NOT ASSESSED

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

ASSESSMENT HISTORY

Cycle 2006

This use attainment record has been partially updated. Please refer to the TMDL document (http://www.deq.mt.gov/wqinfo/TMDL/finalReports.asp) for more recent information and status of this waterbody segment.

Cycle 2008

Not assessed this cycle

Cycle 2010

Not assessed this cycle

Cycle 2012

Not assessed this cycle

Cycle 2014

Not assessed this cycle

Cycle 2016

Not assessed this cycle

Cycle 2018

A nutrient assessment was performed following the DEQ nutrient assessment method to update the 2018 303(d) list. According to minimum data requirements, insufficient data exists to assess this segment for total nitrogen, total phosphorus and nitrate plus nitrite.

Assessments for aluminum, arsenic, cadmium, chromium, copper, iron, lead, selenium, silver, mercury and zinc were performed according the DEQ metals assessment method to update the 2018 303(d) list. Metals assessment indicates this segment experiences elevated iron concentrations, and greater than ten percent of samples exceed the chronic aquatic life standard; iron is added as a cause of impairment affecting the Aquatic Life and Fishes beneficial use. Assessment for remaining metals indicates this segment is not impaired by additional metals.

Escherichia coli assessment was performed according to specifications in water quality standards for Escherichia coli for C-3 waters to update the 2018 303(d) list. E. coli is added as a cause of impairment affecting the Primary Contact Recreation beneficial use.

Habitat assessment indicates this segment is considered impaired due to riparian degradation and alteration in stream-side or littoral vegetative covers remains as a cause of impairment affecting the Aquatic Life and Fishes beneficial use. This segment is also considered impaired due to habitat alterations affecting the Aquatic Life and Fishes beneficial use.

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

Overall Condition of Segment

This segment of the mainstem Musselshell River originates below its confluence with Flatwillow Creek and flows 75.94 miles north where it empties into Fork Peck Reservoir. The entire segment is located within the Northwestern Great Plains ecoregion and flows through sedimentary geology and a landscape comprised of grasslands, shrublands, and interspersed agricultural land and evergreen forests. Analysis of aerial imagery, geospatial land cover data and site observations reveals that the primary land use along the river is agricultural, mainly irrigated crop production. Residential development along the river is minimal. Septic density is moderate throughout the entire reach with 35 septics present along the river channel. According to DEQ and MBMG records, there is no mining influence throughout the reach. Multiple municipal wastewater treatment facilities exist in the vicinity of the Musselshell River; the discharge status and water quality composition of effluent was not verified at the time of this assessment.

According to minimum data requirements in DEQ's nutrient assessment method, insufficient data exists to assess this segment for total nitrogen, total phosphorus and nitrate plus nitrite. Overall, there were no exceedances of the total nitrogen numeric water quality standard, one exceedance of the total phosphorus numeric water quality standard and no exceedances of the nitrate plus nitrite recommended criteria identified in the existing dataset. DEQ recommends collecting additional data for total nitrogen, total phosphorus and nitrate plus nitrite.

Assessment using DEQ's metals assessment method demonstrated that this segment is attaining numeric water quality standards for aluminum, arsenic, cadmium, chromium, copper, lead, selenium, silver, zinc and mercury with respect to Aquatic Life and Fishes and Drinking Water beneficial uses. Ten of 20 samples collected on this segment have iron concentrations that exceed the chronic aquatic life standard. Four of these samples were collected during high flow conditions when TSS concentrations are also high; six exceedances were found during low or baseflow conditions. Iron-stained or ferruginous (containing iron oxide or rust) concretions are noted in lithologic layers, and elevated iron concentrations are likely predominantly natural in this segment due to regional geology. There is some indication of major landscape-scale erosion occurring, and abandoned mines are present in the drainage upstream of the sampling location. Because human sources of elevated iron cannot be ruled out and may be contributing to iron above natural concentrations, and because greater than ten percent of the samples exceeded the chronic aquatic life standard, this segment is considered impaired for iron with respect to the Aquatic Life and Fishes beneficial use.

Sampling for Escherichia coli took place at one site, in August 2015, July 2016, and September 2016. Samples were collected such that data could be analyzed according to the water quality standard for E. coli for C-3 use classification waters (ARM 17.30.629). The geometric mean of the combined dataset (n = 5) in August 2015 (51.11 cfu/100ml) does not exceed the standard of 126 cfu/100ml, and greater than 10% of the samples (0%) does not exceed the standard of 252 cfu/100ml. One sample from July 2016 (461.1 cfu/100ml, 1 of 1 = 100%) exceeds the standard of 252 cfu/100ml. Additional samples (n = 2) collected in September 2016 do not exceed 252 cfu/100ml. This segment is impaired by E. coli.

Qualitative habitat information was collected at two sites in 2016. Most indicators for riparian vegetation and instream habitat conditions were rated optimal or sub-optimal, few were marginal and only one vegetation indicator was rated poor. Aerial images indicate the riparian buffer along most of this segment is intact. Some streambanks have insufficient vegetation with deep, binding root mass. Noxious weeds, including salt cedar and Russian olive were observed. Isolated area exist where agricultural fields encroach on the channel and limit riparian buffer width and continuity. Confinement by roads or railroad is not as limiting here as in other segments.

The Musselshell watershed is underlain primarily by Tertiary and Cretaceous sedimentary sandstones, siltstones, and shales; the edges of the river valley in the upper watershed are fairly erosion resistant due to sandstone outcrops, whereas the lower reaches are predominantly Bearpaw shale prone to erosion and mass failure (hillslope sloughing) when saturated (Boyd, 2012). The Musselshell River is largely represented by Rosgen C and Rosgen F channels (Boyd, Thatcher, and Kellogg, 2015). The Musselshell River drains high elevation areas that provide seasonal snowmelt runoff. In upper and middle reaches of the river, average annual precipitation is about 13-15 inches and spring runoff typically peaks in late May or early June at about 300 to 450 cfs. Lower in the basin, the river has a snowmelt pulse but also has a prairie runoff pattern with an increasingly flashy hydrology created by rain events. Whereas the Musselshell River used to commonly go dry in the summer, recent changes in cooperative water management have prevented complete dewatering during the late irrigation season (Boyd, 2012; Beye, 2013).

Over 100 years, the river's ability to disperse erosive energy has been altered by railroad and highway construction, expanded irrigation development, channel straightening, channel downcutting, and grazing pressure (Lower Musselshell Conservation District, 2004). The construction of the Milwaukee Road railroad in the early 20th Century dramatically straightened and shortened the Musselshell River. Of 207 total miles of river affected, 35 miles of meander length (nearly 19% or nearly one fifth of the channel length) was isolated behind the abandoned rail berm; this isolation occurs at a relatively consistent rate of 1000 feet of isolated meander length per mile of existing channel (Boyd, 2012). Isolating meanders also decreases natural floodplain storage potential.

Shortening and straightening has increased channel velocities, driven channel downcutting, and detachment of the river from its historic floodplain. Prior to 2011, the channel above Roundup was entrenched with a floodplain was perched 6-10 feet above the water table. Below Roundup, the channel was in early stages of recovery and an inset floodplain was gradually developing (Boyd, Thatcher, and Kellogg, 2015). In spring of 2011, the Musselshell River experienced unprecedented flooding, with an estimated 157-year return interval (Boyd, 2012) and notably long duration; a 10-year flood discharge was exceeded for 19 days at Mosby and 22 days at Roundup (Boyd, Thatcher, and Kellogg, 2015). Also, in early March of 2014, ice jams caused flooding around Roundup and this flood peaked at over 10,000cfs, and in late August of 2014, Petroleum County experienced record setting rainfall and flooding within the Flatwillow Basin and the receiving lower Musselshell River. Flows increased from 150 cfs to 20,090 cfs over three days (Boyd, Thatcher, and Kellogg, 2015).

Responses to the 2011 flood include the carving of new channels, excessive bank erosion, damage to siphons, breaching of the railroad berm, damages to diversion structures, extensive sediment deposition on the river floodplain, damages to pump sites, scouring of the floodplain, and lost access to property (Boyd, 2012). Entrenched channel segments and saturated banks experienced high velocities that caused severe in-channel erosion, destabilization of extensive swaths of vegetation, and channel widening; massive sediment loading downstream caused floodplain aggradation and contributed to avulsions (Boyd, 2012). The perched, sparsely vegetated historic floodplain was inundated for weeks, which resulted in local scour and new channel excavation on the erodible surface (Boyd, 2012). The flood caused 59 avulsions and a net loss of 27.9 miles of channel, or 8% of the total channel length, particularly in the lower reaches below Flatwillow Creek (Boyd, 2012). 31 breaches through the railroad grade occurred, and the river migrated several hundreds of feet in places. Several diversion structures were flanked or abandoned, dozens of irrigation pumps were abandoned, and floodplain deposition was several feet thick in some agricultural fields (Boyd, 2012).

Over 100 years irrigation development, field clearing, channel straightening and downcutting, and heavy grazing pressure has significantly limited the river's ability to sustain native riparian plant communities (Lower Musselshell Conservation District, 2004). In 2004, an extensive functional assessment of the Musselshell River riparian corridor rated the majority of the riparian corridor as being either "Not Sustainable" or "Sustainable-at Risk;" some riparian areas have good species and age diversity that provide excellent wildlife cover and bank stability, and others have riparian zones that have either been heavily impacted by livestock or have been cleared for field development sometime in the past (Lower Musselshell Conservation District, 2004). Vast carpets of cottonwood and willow seedlings were established by the 2011 flood (Boyd, 2012). Noxious weed infestations are a major issue along the Musselshell River stream corridor, including salt cedar (Tamarix) and leafy spurge, spotted knapweed, and Canada thistle (Lower Musselshell Conservation District, 2004; Boyd, 2012).

In 2015, following a process to engage public stakeholders and funding entities, a Watershed Plan was developed for the Musselshell watershed which assists the Musselshell Watershed Coalition in its continued development and implementation of stakeholder-driven water management efforts in the basin (Boyd, Thatcher, and Kellogg, 2015). Projects include diversion structure, canal, dam repairs, fish passages, and bank stabilization, and additional studies described include channel migration zone mapping, flood mitigation, native species re-introduction and habitat improvements, canal seepage studies, weed and salt cedar management, soil health monitoring, railroad berm remediation, and others (Boyd, Thatcher, and Kellogg, 2015).

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

USE SUPPORT DECISION

Use Class C-3

Trophic Status: **Trophic Trend:**

Uses	DQA	Method, Data, and Information Used	Assessment Type and Confidence	Use Support	Partial Flag	Use Support Certainty	Threatened
Aquatic Life	Fail	130, 222, 250, 340, 375	BIOLOGICAL-FAIR, HABITAT-GOOD, PHYSICAL/CHEMICAL-FAIR	Not Fully Supporting	No	Medium	No
Primary Contact Recreation	Pass	420	PHYSICAL/CHEMICAL-GOOD	Not Fully Supporting	No	High	No

Method Number and Description
130-Land use information and location of sources
222-Non-fixed-station monitoring (conventional during key seasons and flows)
250-Chemical monitoring of sediments
340-Primary producer surveys (phytoplankton/periphyton/macrophyton)
375-Visual observation, may not quantify some parameters; single season; by prof.
420-Water column surveys (e.g. fecal coliform)

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

IMPAIRMENT INFORMATION

Uses	Cause (Confidence): Source(Confirmed)	Observed Effects
Aquatic Life	84 (Medium): 20 (N), 46 (N), 58 (N), 125 (N), 144 (N), 155 (N) 260 (High): 56 (N), 125 (N), 155 (N) 526 (Medium): 58 (N) 527 (Medium): 20 (N), 46 (N), 58 (N), 125 (N), 144 (N), 155 (N)	
Primary Contact Recreation	217 (High): 46 (N), 85 (N), 92 (N)	

Cause Number and Description	Source Number and Description	Observed Effect Number and Description
84-Alteration in stream-side or littoral vegetative covers 217-Escherichia coli (E. Coli) 260-Iron 526-Flow Regime Modification 527-Habitat Alterations	20-Channelization 46-Grazing in Riparian or Shoreline Zones 56-Impacts from Abandoned Mine Lands (Inactive) 58-Impacts from Hydrostructure Flow Regulation/modification 85-Municipal Point Source Discharges 92-On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) 125-Streambank Modifications/destabilization 144-Crop Production (Crop Land or Dry Land) 155-Natural Sources	

DELISTING / STATUS CHANGES

Cause	Reason for Change	Date of Change

Reporting Cycle: 2018 **Assessment Record:** MT40C003_010.pdf **Status:** Completed

CATEGORY INFORMATION

Previous Cycle

Cycle	2016
Category	4C - Identified threats or impairments result from pollution categories such as dewatering or habitat modification and, thus, the calculation of a Total Maximum Daily Load (TMDL) is not required
User Defined Category	N/A

Current Cycle

Cycle	2018
Category	5 - Waters where one or more applicable beneficial uses have been assessed as being impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat.
User Defined Category	N/A