Miller Creek

Watershed Restoration Plan

2018

Acknowledgements

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Introduction

Miller Creek is located in Missoula County, Montana. It flows west for 18 miles from the Sapphire Mountains to its confluence with the Bitterroot River near the city of Missoula (Figure 1). The watershed encompasses 47.9 square miles and supports a variety of land uses, from silviculture and agriculture, to residential subdivisions. The watershed has been undergoing many changes in land use and ownership in recent decades, and this presents challenges and opportunities for management and restoration.

The Missoula Valley Water Quality District (MVWQD) is a local government agency charged with protecting and improving the quality of surface and groundwater within the district boundaries. MVWQD works with interested landowners and partnering agencies and organizations to conduct on-the-ground restoration work as well as educating residents on the importance of watershed health in protecting water quality. The District also collects surface and groundwater data to assess water quality and develops programs to detect and remedy contamination.

The goal of this Watershed Restoration Plan (WRP) is to present a broad framework to guide property owners and restoration organizations in developing and implementing projects that can make meaningful, measurable improvements to the condition of Miller Creek in the coming years.

This WRP was developed using the “Nine Minimum Elements of an Environmental Protection Agency (EPA) Watershed Restoration Plan” and guidance from the Montana Department of Environmental Quality (DEQ) (Figure 2).

The process of engaging local stakeholders took place in several ways. MVWQD conducted one-on-one interviews with major landowners including United States Forest Service (USFS), The Nature Conservancy, Northwestern Energy and three large ranch owners. Additional outreach was conducted using a postage-paid mail-in survey which was mailed out to any entity or individual that owned property adjacent to Miller Creek. Approximately 200 of these surveys were mailed out and 59 were returned (29.5% participation). This survey asked residents what they valued most about the watershed, and what changes they had observed (positive and negative). Residents were also asked about projects (riparian restoration, weed treatment, beaver re-introduction) that they would consider undertaking on their properties. Additionally, stakeholders such as the Montana Department of Natural Resources and Conservation (DNRC) Water Resources Division, Montana Fish Wildlife and Parks (FWP), Missoula Conservation District were contacted via phone and email for comments and thoughts about Miller Creek.

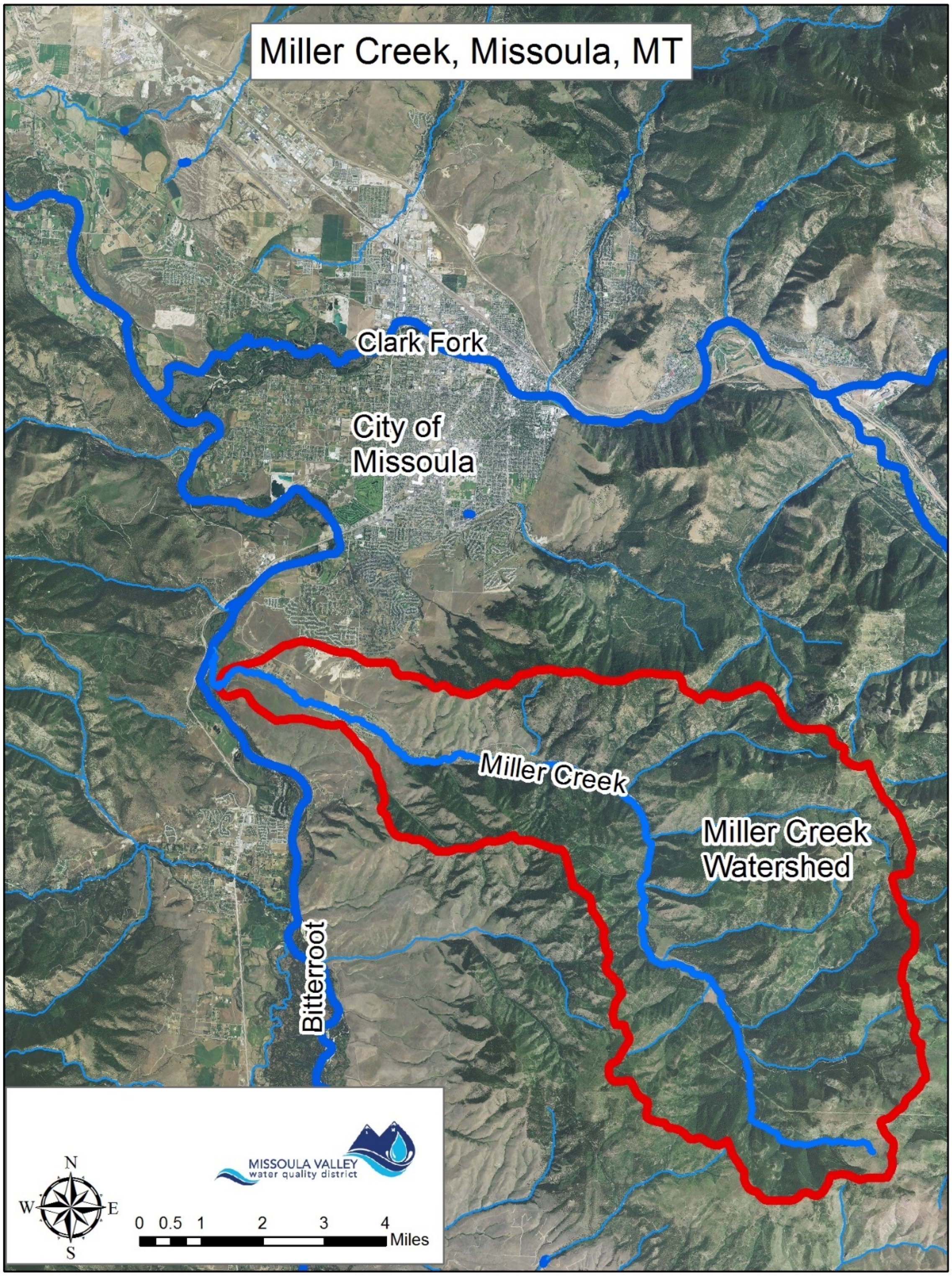


Figure 1: Miller Creek watershed

Environmental Protection Agency Nine Elements of a Watershed Restoration Plan

a. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.

b. An estimate of the load reductions expected from management measures.

c. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.

d. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

e. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

f. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

g. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above.

Figure 2: EPA Nine Minimum Elements

Description of the Watershed

Silviculture is the dominant land use type within the Miller Creek watershed, with growing residential development along its lower reach (Table 1, Figure 3).

Table 1. Dominant Miller Creek Watershed Land Use		
Property Type	**Acres**	**Percent**
Forest/Prairie	27399.87	89.83%
Agricultural (Valley Floor)	1026.50	3.37%
Residential	1988.62	6.52%
Total	30500.36	

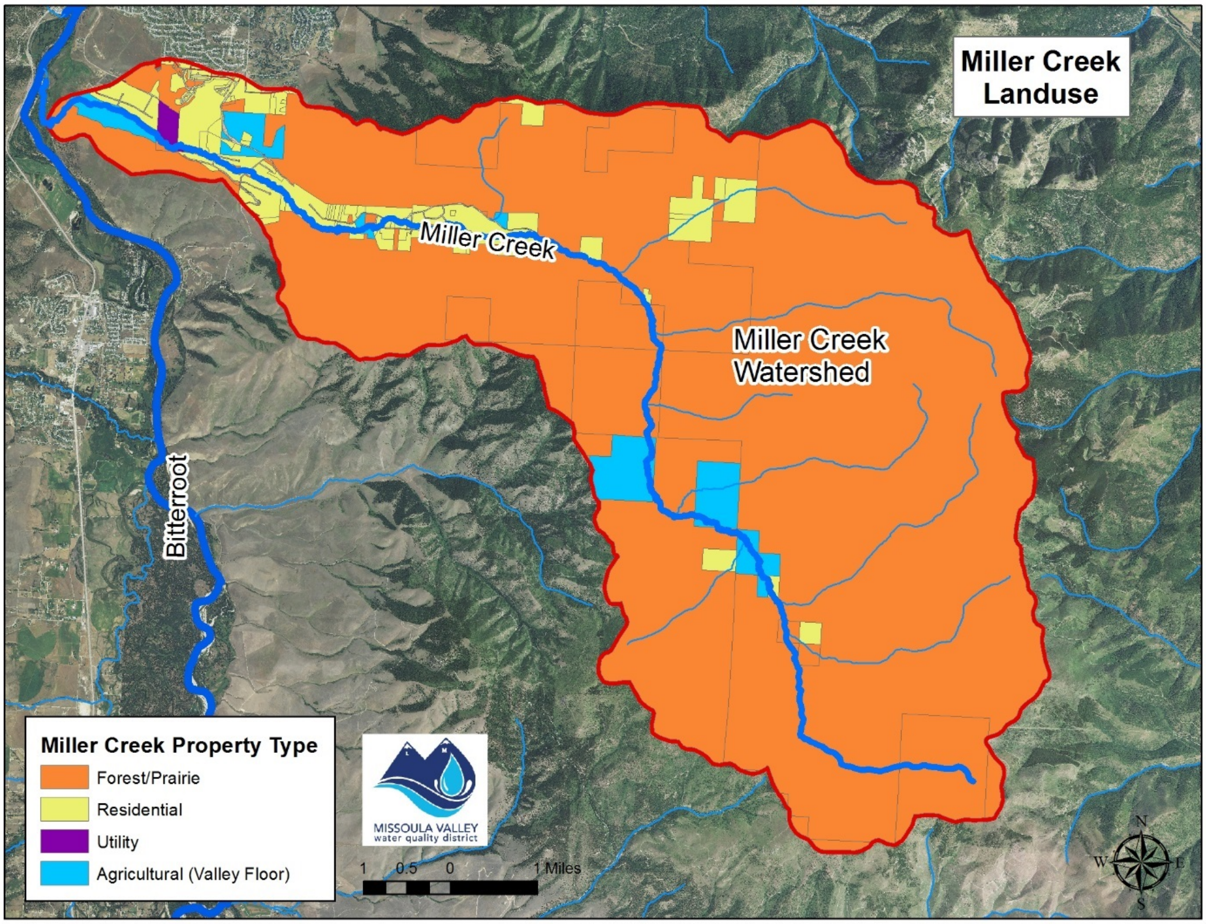


Figure 3: Miller Creek Land Use

With the exception of Weyerhaeuser land in the uppermost 1 mile of the stream which burned in 2003 and is regenerating, the upper 4 miles of the watershed are in excellent condition and exhibit little or no impairment. These areas will need to be protected, to prevent degradation, as the growing population in Miller Creek and beyond increases recreational pressure. Partnering with USFS and private forest owners will be important to ensure that these areas of the watershed are preserved (and improved, where needed), into the future.

As of the 2010 census, approximately 2,695 people live within the Miller Creek Watershed. This number is expected to more than double as two major subdivisions are expected to be completed totaling more than 1500 new homes by 2030 (Linda Vista Estates and Teton Addition Phasing Amendments, 2015)

According to a FWP fisheries biologist, the middle and lower perennial sections are dominated by rainbow trout/westslope cutthroat trout hybrids in addition to brook trout, with some brown trout in lower reaches (Knotek 2016 email). There is seasonal and limited connectivity with the Bitterroot River for migratory fish. In general, as one moves upstream into headwater tributaries, the proportion, density and genetic purity of westslope cutthroat trout (WCT) increases with some tributaries having only genetically pure WCT. According to FWP, road issues are of significant concern to fisheries within this watershed (undersized, malfunctioning culverts and contribution of sediment from roads) (Figure 4). Fish passage obstructions in the watershed need to be assessed and a plan for mitigation developed and implemented (Knotek, 2017).

Figure 4 Miller Creek Headwaters: Though the headwaters are relatively healthy, undersized culverts carry high velocity flows that serve as a barrier to fish migration

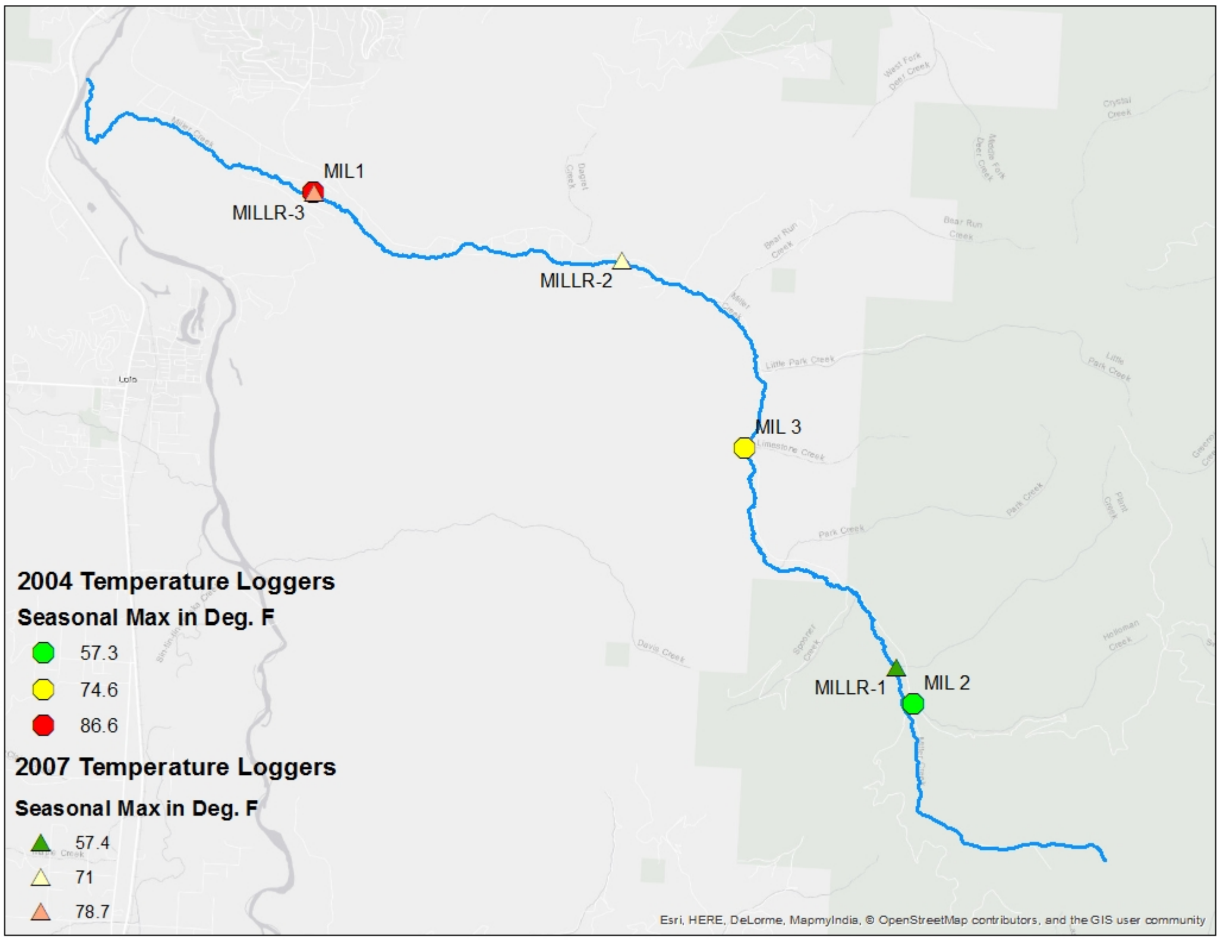
Impairment Causes and Pollutant Sources

(EPA Element a)

Miller Creek is listed for temperature and sediment impairments on the 2016 Clean Water Act section 303(d) list. A water body is determined to be impaired if it does not meet all of its potential beneficial uses, such as recreation, fishery, agriculture, etc. For all impaired water bodies in the state, the DEQ determines total maximum daily loads (TMDLs) of pollutants that need to be met in order for all beneficial uses to be supported. The status of Montana’s waters is updated biennially by the DEQ in the Integrated Report. The Bitterroot TMDL document (DEQ, 2011), which includes Miller Creek, guided the development of this WRP.

Temperature

In 2007 and 2004, the DEQ conducted assessments at three sites on Miller Creek (Figure 5). Each showed measurable increases in stream temperature from up-gradient to down-gradient locations (Table 2). A thermal infrared flight (TIF) in 2004 also documented a rise in stream temperature. Monitoring in the warmest reaches of the stream showed 47 days with temperatures above 70 degrees Fahrenheit. This trend continues until Trails End Road, where most of the remaining warm water is diverted for irrigation. Groundwater and springs enter the stream below Trails End Rd, which sustains the creek until it disappears below the stream bed. The lower three miles of the stream often do not flow year-round.



(MT DEQ, 2011)

Figure 5: Miller Creek Temperature Monitoring Locations; 2004 & 2007

Table 2. Temperature Data Summary								
SiteID	Seasonal Maximum		7-Day Average During Warmest Week of Summer				Days>	Days>
	Date	Value	Date	Daily Max	Daily Min	Delta T	59 °F	70 °F
Mil1	08/17/04	86.6	08/14/04	81.9	54.6	27.3	44	38
Mil2	07/17/04	57.3	08/14/04	55.9	48.4	7.6	0	0
Mil3	07/17/04	74.6	07/26/04	71.6	49.9	21.7	43	24
MILLR-1	07/28/07	57.4	07/28/07	56.7	50.0	6.7	0	0
MILLR-2	07/18/07	71.0	07/17/07	69.5	54.4	15.1	53	3
MILLR-3	07/28/07	78.7	07/28/07	76.5	58.5	18.0	69	47

The QUAL2K model was used to estimate anthropogenic causes of impairment in the Total Maximum Daily Load document (TMDL).The model indicated that the two major factors impacting stream water temperatures are shading from riparian vegetation and instream flow volume.

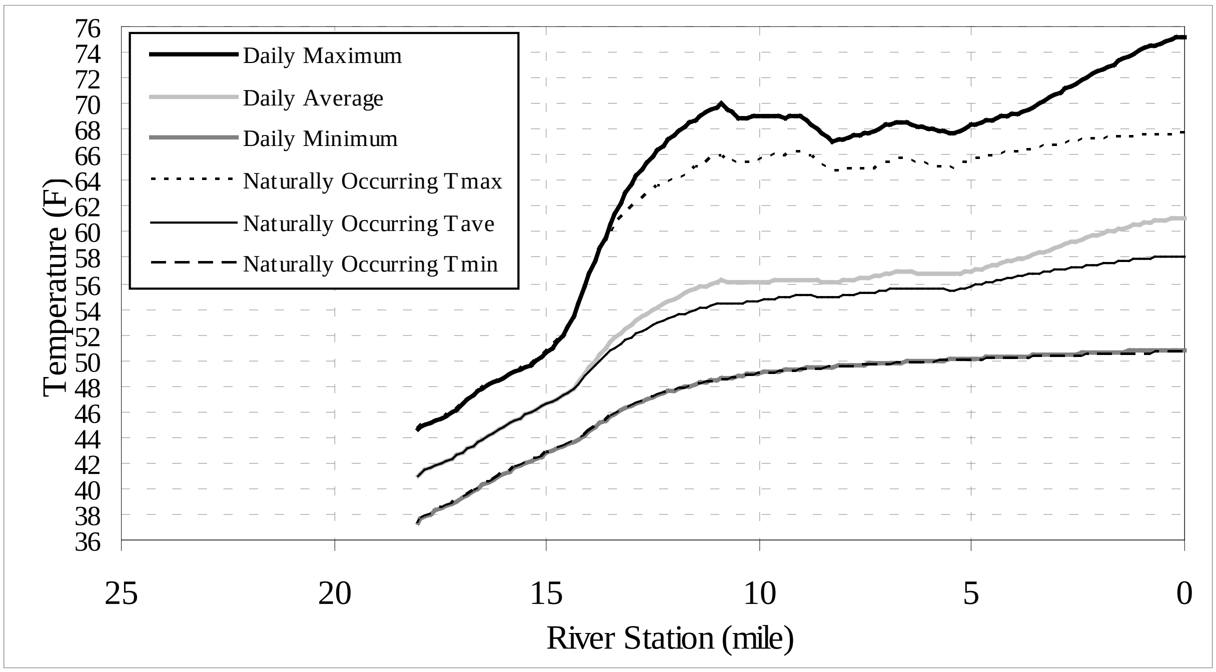


Figure 6: Model scenario results show impacts from irrigation diversions and riparian degradation in lower miles (MT DEQ, 2011)

Riparian and Stream Channel Conditions

In 2007 the DEQ conducted riparian assessments along each 500 meter section of the stream using aerial photography and stereoscope. From this assessment, effective shade percentage was developed along with a target condition (Figure 7).

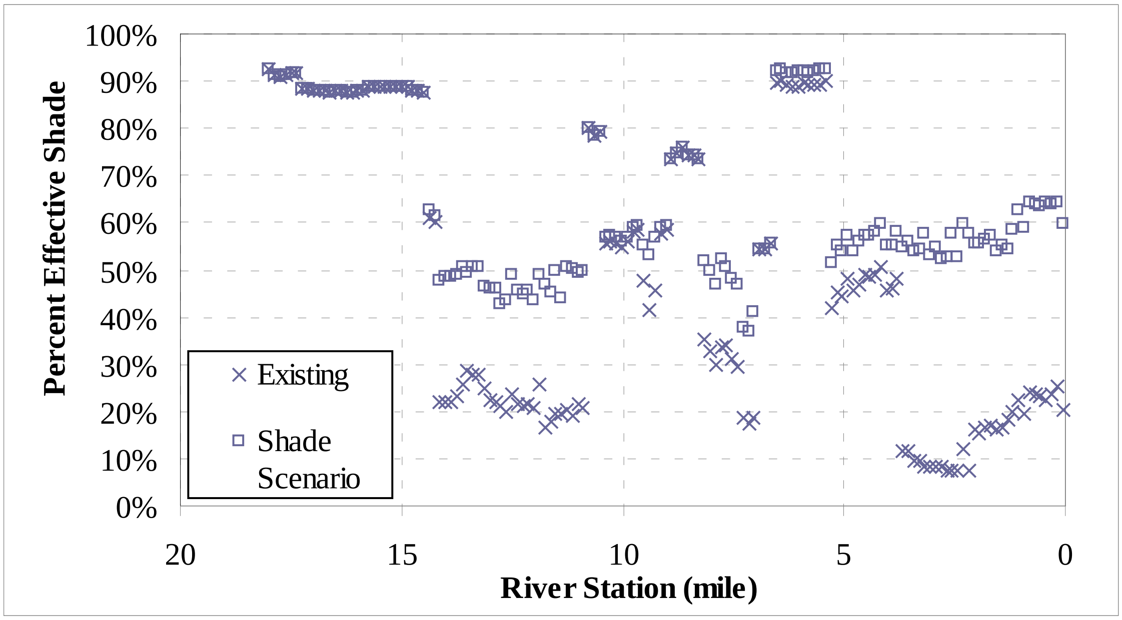


Figure 7: Existing vs potential shade (MT DEQ, 2011)

Daily effective shade ranged from 92% in the headwaters to 7% in the lower reaches. Because the creek is narrow, shading has a large effect on water temperature. Upstream reaches of riparian vegetation consist of douglas fir, ponderosa pine, dogwood, aspen and other native riparian species. Middle and lower reaches are dominated by irrigated fields and lawns. As agricultural practices have shifted from cattle production, some natural recruitment of native species has occurred. This has, however, coincided with invasive weed infestations. Average shade conditions in 2007 were estimated to be 48%. Restoring riparian vegetation to increase shade coverage to 65% would lower stream temperatures by an estimated 7.5^0 F.

The major human impacts reducing shade cover identified in the TMDL (DEQ, 2011) include livestock grazing and hay production in miles 0-4 and 11-15. Grazing and suburban developments are the primary impacts from miles 4-11.

Irrigation Water Use

The TMDL document identifies irrigation as a potential contributing factor to high stream temperatures. According to the model output, from stream mile 4-14, maximum stream temperatures during summer months were found to deviate significantly from naturally occurring maximum temperatures Figure 8.

Irrigation diversions may exacerbate warm temperatures by lowering instream flow. Lower stream flows become more easily warmed as the temperature buffering capacity is inhibited. Also, the water used for irrigation is often warmed when it is applied to the land surface, raising the stream temperature when it re-enters as return flow. Since this temperature assessment and model were completed, surface water withdrawals have changed. Nine of the lower-most surface water irrigation rights were retired in 2014 to mitigate impacts of public drinking water supply development in the lower watershed. 2017 withdraws from this well field total 187 acre feet with an allowed withdrawal up to 623 acre feet per year (Mountain Water Change of Use Application, DNRC page 38). As this area becomes more developed, groundwater withdrawals could increase by 70% from the new public water supply well field consisting of three wells located in the alluvium at the mouth of Miller Creek. Miller Creek is hydraulically disconnected from groundwater over much of its course, and loses water rapidly through a highly permeable bed (Hewitt, 2004); Because of this disconnection, groundwater withdrawal is not projected to affect Miller Creek (Mountain Water Change of Use Application, DNRC page 25). To mitigate effects on the Bitterroot drainage as a whole, nine surface water irrigation rights on Miller Creek were retired, removing 345 irrigated acres from the watershed. These mitigation efforts may improve in-stream flow and thus reduce temperature. These nine retired water rights are the most senior in the drainage with priority dates of June 1, 1877, June 7, 1878 and September 1, 1878.

Developing a drought management plan in this basin may be beneficial in reducing temperature on Miller Creek. Climate change could play a major role in the temperature and flow profile of Miller Creek in the coming decades, making a drought management plan even more important. Also, temperature targets may need to be reevaluated in coming years to account for possible climatic changes.

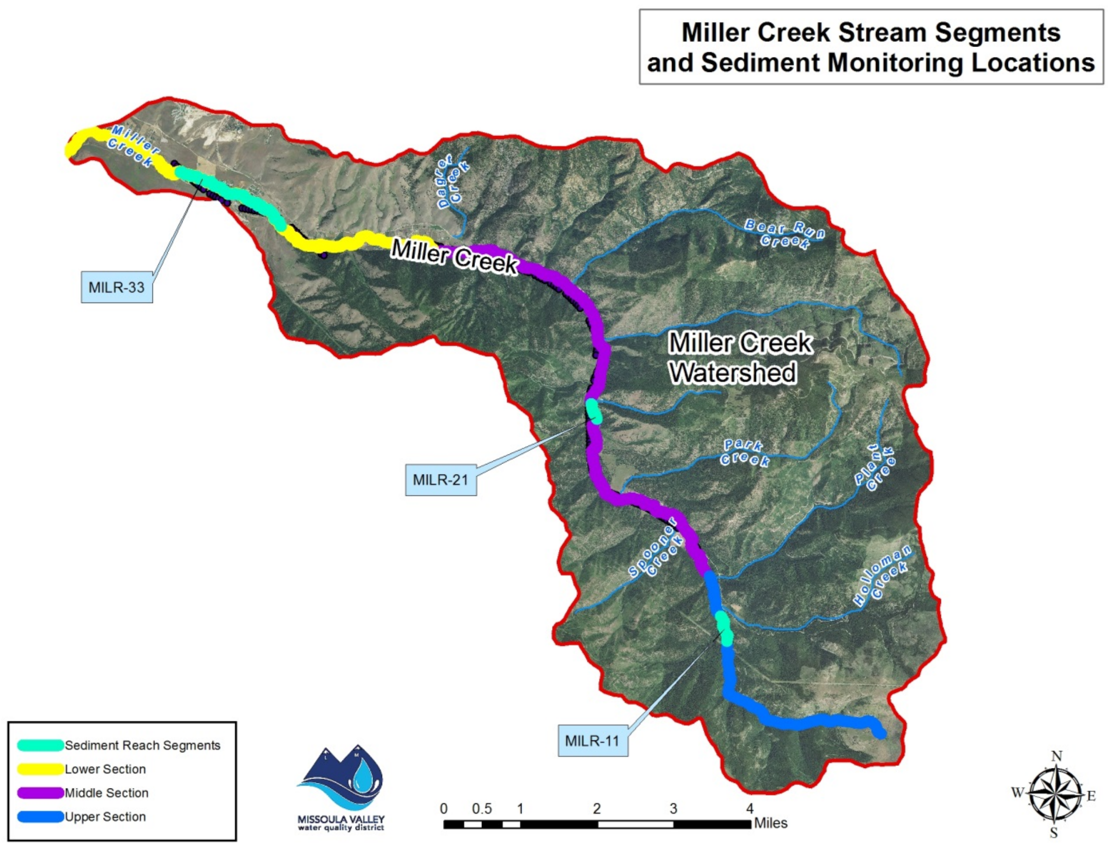


Figure 8: Sediment Monitoring Locations and Identified Stream Segments

Sediment

The Department of Environmental Quality (DEQ) carried out sediment assessments for the TMDL in 2007 at three locations (Figure 8). The upper reach was mainly coniferous forests with dense underbrush, and channel morphology was largely intact with no active erosion identified. Large woody debris provided pools with potential spawning gravels. This segment was classified as a potential Rosgen B4 channel type. The middle reach flows through meadows that showed evidence of recent logging and agricultural use. The channel was over-widened, and significant erosion was identified on the outside of meander bends. There were some pools at meander bends. Mostly grasses and wetland vegetation were found along the banks. This segment was classified as a potential Rosgen C4 channel. DEQ assessors described the lower segment of Miller Creek as "one continuous riffle" with no pools or large woody debris. The stream flowed through open space and suburban neighborhoods, and vegetation was primarily grass and weeds. (DEQ, 2011) (Table 4).

Table 4. Sediment and Habitat Data Compared with Targets
(Bold values indicate targets not met)

Reach	Mean BFW (ft)	Level III Ecoregion	Potential Stream Type	Riffle Pebble Count (Mean)		Grid Toss (Mean)		Channel Form (Median)		Instream Habitat			Riparian	Sediment Source
				% < 6 mm	% < 2 mm	Riffle % < 6mm	Pool % < 6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools/Mile	LWD/Mile	Greenline % Shrub Cover	Riffle Stability Index
Milr-11	8.2	MR	B4	**27**	10	**21**	**11**	9.8	5.0	**0.6**	148	**570**	86	NC
Milr-21	23.5	MR	C4	**32**	**12**	**15**	**20**	**31.3**	3.9	**1.0**	69	**222**	**7**	NC
Milr-33	28.6	MR	C4	**24**	**14**	**24**	NC	**48**	5.1	**0.0**	**0**	**9**	**20**	NC

(MT DEQ, 2011)

Miller Creek has many sections where banks appear to be eroding excessively. This is the major source of sediment to the stream (DEQ, 2011).

An additional source of sediment is roads. Paved roads can contribute sediment when sanded during the winter months. Unpaved roads, such as the upper portion of Miller Creek Road, private drives, and forest management roads can contribute sediment to the creek and its tributaries throughout the year, especially during higher-intensity convective runoff events (Sugden and Woods 2007). In addition, stormwater runoff from road or other construction projects can carry sediment to the creek unless appropriate best management practices (BMPs) are implemented.

Load Reduction Estimates and Non-Point-Source Management Measures

(EPA Elements b and c)

Temperature

"The most influential non-point source restoration strategy for Miller Creek will be restoring shade-producing vegetation along the whole segment."
Miller Creek TMDL (2007)

During the summers of 2004 and 2007, the DEQ monitored instream temperature at three different locations. 2007 data showed the upper sections of the stream to be cool with a gradual warming in the middle section. The lower mile of Miller Creek experiences significant heating. A thermal infrared flight during the 2004 field season showed a similar warming trend from upstream to downstream on Miller Creek (Figure 9). This temperature gradient also corresponded well to riparian vegetation surveys (Figure 10).

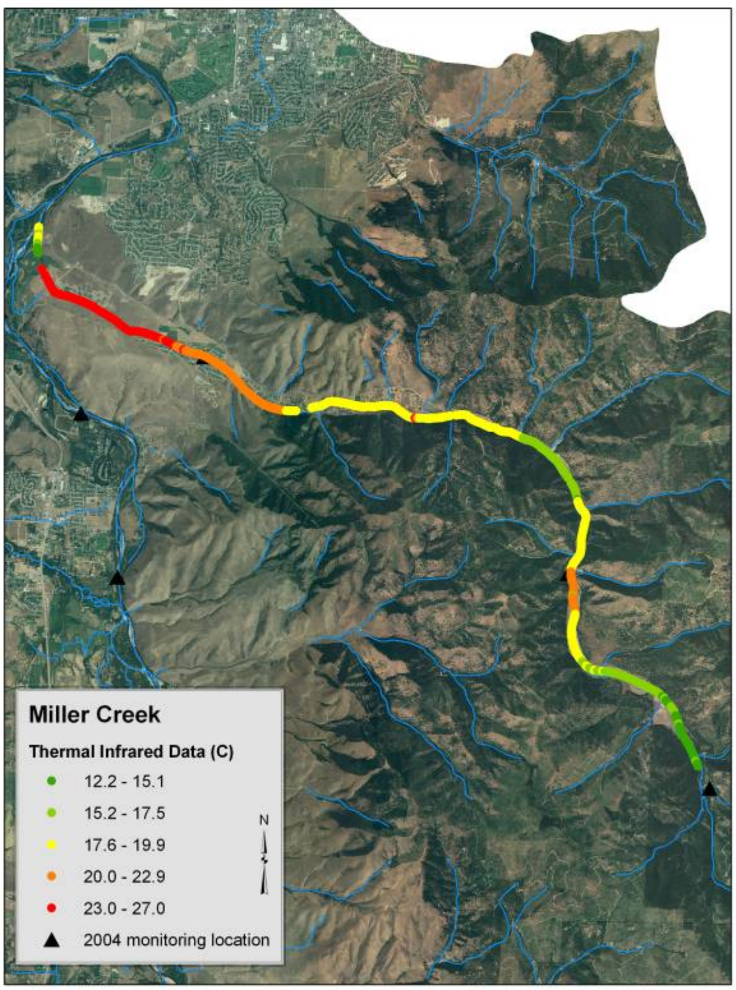


Figure 9: FLIR Stream Temperature Profile 2004 (MT DEQ)

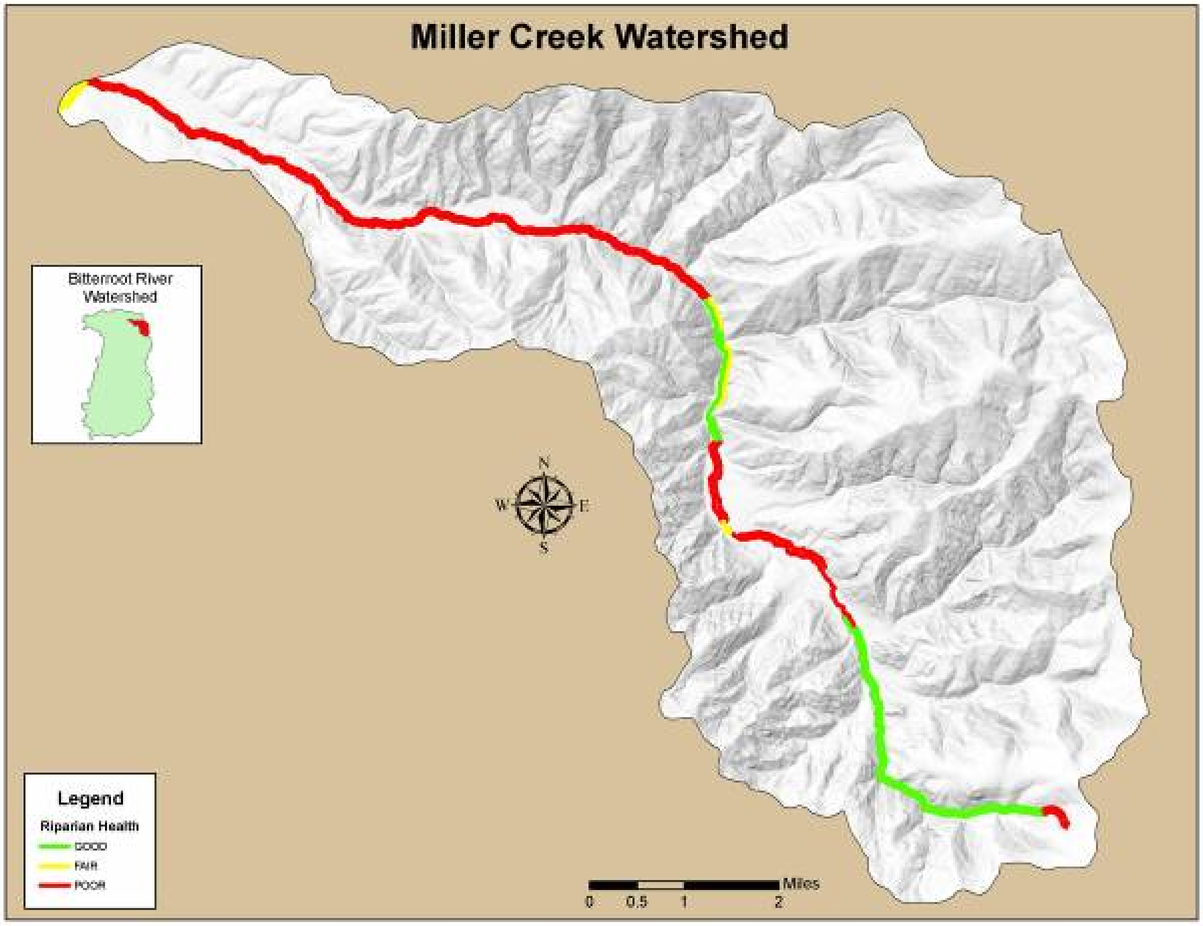


Figure 10: 2007 Riparian Conditions (MT DEQ)

Table 3. Temperature Target and Existing Conditions		
Water Quality Targets	Criteria	Existing Condition
Maximum allowable increase over naturally occurring temperature	B-1 Waters: 1°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F – 66°F; within the naturally occurring range of 66°F – 66.5°F, no discharge is allowed that will cause water temperature to exceed 67°F; where naturally occurring water temperature is >/= 66.5°F, maximum allowable increase is 0.5°F.	QUAL2K modeling indicates Montana's temperature standard is not being met during average summer afternoon conditions. If conditions provided below for sources are met, daily maximum summertime temperatures would likely be reduced by at least 8°F.
OR meet ALL of the temperature influence restoration targets below		
Effective Shade	65% Effective Shade	48% Effective Shade
Channel Width/Depth Ratio	</= 16	9.8 – 48
Irrigation Water Management	15% improvement in irrigation efficiency with water saving applied to in-stream flow mid-June through August.	Irrigation systems need to be assessed on a case-by-case basis.
Irrigation Return Flow	Reduce warm return irrigation water entering stream by 75%.	Unknown

(From Bitterroot TMDL, MT DEQ, 2011)

High temperatures on Miller Creek correspond directly to poor riparian vegetation conditions. A 2005 survey of the banks and adjacent property found that 72% of streambank along Miller Creek had significant anthropogenic effects within 100 feet of the channel. 74% of the banks' riparian areas (27 miles) were rated in fair or poor condition. The focus for watershed restoration on this stream will be improving riparian health. However, other restorative techniques will reduce thermal load to the stream. There are three primary methods for improving temperature conditions on Miller Creek:

- Improve and protect riparian vegetation
- Increase flow
- Improve channel morphology in lower reaches through addition of meanders and woody debris

Increasing stream flow through irrigation efficiency and instream flow leases will put more water in the stream and bring temperatures down. Reducing warm-water irrigation returns may also help mitigate temperature impacts in some locations.

Figure 11: Lower section of Miller Creek was straightened by previous owners and large trees removed.

Physical assessment of the stream shows the lower reach to be partially channelized and separated from its floodplain by low berms in places (Figure 11). The lower reach is starved of large woody debris and is comprised of one continuous riffle. To restore this section of Miller Creek, a combination of fencing, revegetation, addition of large woody debris, passive restoration by elevating the stream bank through use of beaver analogs, and capturing and dispersing sediment will improve both sediment and temperature conditions. Relocation of the stream in order to reconnect it to its floodplains may be necessary in certain reaches. Increasing effective shade to 65% should result in a reduction of stream temperatures by 7.5-8 degrees Fahrenheit, according to the TMDL (DEQ, 2011). Consequently, a major goal of this WRP is to make progress toward achieving 65% effective shade per mile of stream. This will be focused in the lower and middle stream sections, where degradation of riparian vegetation and elevated temperatures are most severe. Physical assessments in the middle section of the stream noted that the stream was overly-wide due to grazing. Some important ways to improve temperature and sediment in these areas are through streamside protection efforts such as providing a buffer between tilled or grazed land and the stream using fences or management practices, and actively replanting some areas where natural regeneration is not likely to be successful in a reasonable timeframe. Some stretches of Miller Creek have conservation easements in place, and finding additional areas for protection could help achieve restoration goals. Planting projects carried out over the larger scale of agricultural lands can be challenging due to the need for watering, weeding and other maintenance for several years. Fencing and other management practice changes that allow natural regeneration may be more feasible and cost effective in many of these areas.

In residential areas, homeowners can be engaged to plant riparian vegetation and/or stop mowing along their stream segment. Providing technical assistance, matching grants and possibly coordinating volunteer labor would facilitate projects on residential lots. Homeowners could then provide for watering and maintenance of the restored vegetation. Technical assistance could help them identify native species that would work well in their landscape. There are three designated common areas that are owned by homeowners associations or the county within the middle reaches that would be ideal targets for restoration efforts (Figure 12).

Figure 12: Common Area of Stillwater Subdivision

Sediment

The major sources of sediment to Miller Creek (Table 5) – eroding banks, roads (including sanding and agricultural access (Figure 13)) and stormwater runoff– can be addressed by a number of restoration measures (Table 6). Many of the measures implemented to address temperature impairment, discussed above, would also be effective in reducing sediment loads to the stream. The primary measures that will be used to address sediment in Miller Creek are:

- Allowing riparian vegetation to regenerate naturally, and/or planting new vegetation where needed
- Modifying channel structure to create more stable banks, and allow access to floodplain (including beaver/beaver mimicry structures and/or woody debris structures)
- Decommissioning unneeded forest roads
- Implementing stormwater BMPs
- Improving agricultural stream crossings
- Upgrading or removing under-sized culverts

Figure 13: Agricultural creek crossing introduces sediment into Miller Creek

Planting and regeneration of riparian vegetation helps to stabilize banks and reduce excessive erosion. Beaver mimicry structures can help slow flow and create areas of aggradation, reducing sediment loading downstream. There are also some locations, including one near the intersection of Horseshoe Lane and Singletree Lane, where it appears the creek has avulsed and lost one or more meanders, due to some combination of flooding and informal flood mitigation (berms and channelization) measures, resulting in instability and excessive erosion. Restoring meanders and woody debris to the system will improve both temperature and sediment regimes.

Decommissioning forest management roads that are no longer needed in the watershed could reduce sediment loading to the creek depending on their condition and proximity to streams. The major forest road landowners and agencies do not have near-term plans for decommissioning, but working with these parties to prioritize and implement decommissioning will be important in the coming years, and at least one landowner has expressed an interest in exploring decommissioning. Water Erosion Prediction Project (WEPP) or USFS Geomorphic Road Analysis and Inventory Package (GRAIP) modeling could be used to help prioritize roads for decommissioning.

Another important periodic source of sediment is stormwater runoff. As the population in Miller Creek is projected to double by 2031 (Linda Vista Estates and Teton Addition Phasing Plans (2015) and adherence to stormwater permit provisions will be important to prevent impacts from construction activities and increase non-point source stormwater runoff as development continues in this fastgrowing area. As this area develops, it will also be important to plan for and mitigate effects of increased impervious area and increased stormwater runoff.

(From Bitterroot TMDL, MT DEQ, 2011)

Table 5. Existing and Allowable Sediment Loads				
Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (% Reduction)
Roads		27	10	63%
Eroding Banks	Anthropogenically Influenced	1415	792	30%
	Natural	659	659	
Upland Erosion	All Land Uses	131	77	41%
Total Sediment Load		2232	1538	31%

Temperature and Sediment Restoration Activity

Temperature and Sediment reductions will be primarily addressed through improvement of channel morphology, addition of woody debris to encourage a more natural sediment regime and restoration of riparian vegetation. Restoration measures are outlined in Table 6.

Table 6. Nonpoint Source Management Measures Needed To Address Temperature and Sediment Impairment	
Stream Reach (Mile)	**Restoration Activities**
0-5	Beaver Analog Riparian Planting Irrigation Efficiency Improve channel structure
5-10	Beaver Analog Riparian Planting Improve channel structure
10-15	Riparian Planting Riparian Fencing Decommissioning forest roads Improve channel structure Removing fish-passage barriers
15-18	Decommissioning forest roads Removing fish-passage barriers

Public Outreach and Education

(EPA Element e)

MVWQD met with landowners and in some cases visited properties to see previous restoration projects and get input on priorities for their land and the watershed as a whole. In addition, all landowners living along Miller Creek were sent a letter and survey to introduce the watershed planning process and to get their input regarding what they most value about Miller Creek, and what they think are the major challenges and priorities for the watershed. They were also asked whether or not they would be interested in participating in restoration activities on their land. This input was used in developing this WRP and will be used to identify restoration opportunities when the plan is implemented. The response rate for this survey was 29.6%. Respondents could select as many values, concerns and restoration interests as desired, so percentages do not add up to 100. The top values that were reported in the survey were scenic (59%) and wildlife (57%). The top issues that respondents felt needed to be addressed were lack of streamside vegetation (45%), low stream flows (38%) and weed management (51%). 83% of survey respondents were willing to participate in restoration activities of some sort on their own property. The projects that garnered the most interest were weed management, stream flow enhancement projects and streamside vegetation restoration. Complete survey results can be found in appendix A.

Future outreach and education activities will be carried out periodically to keep the community informed of the importance of restoration, to encourage participation in restoration activities and to highlight progress toward restoration goals over time. MVWQD has previously carried out education activities in the Miller Creek watershed, and other watersheds, and will continue to provide education and outreach. However, establishment of a citizen-based watershed group for Miller Creek would be a more effective and participatory way to provide ongoing outreach and collective energy for restoration implementation. Alternatively, an existing organization could provide these services. MVWQD will explore interest and capacity for citizen involvement through a new or existing organization as implementation of the restoration plan gets underway.

Education and outreach strategies may include:

- Establishing Miller Creek watershed group or Miller Creek focus within existing group.
- Establishing Facebook page for Miller Creek.
- Presenting to homeowner associations regarding condition issues in the watershed and restoration opportunities for individual properties and common areas.
- Targeted mailing with information on restoration opportunities.
- Restoration project tours to highlight successful efforts in the watershed.
- Engaging students in restoration projects

Table 10. Education and Outreach Activities

Activity	Potential Partners
Miller Cr. Watershed Group	MVWQD, CFC
Miller Creek Facebook Page	MVWQD, new group, CFC
Present to HOAs	MVWQD, CFC, New group
Targeted Mailing	MVWQD
Project Tours	Property owners, MVWQD, CFC, New group
Engage primary/secondary students in restoration	CFC, Watershed Education Network (WEN)

Implementation Schedule

(EPA Element f)

Table 7 shows the proposed schedule for implementation of non-point-source management measures needed over the next five years to progress toward achieving load reductions required by the TMDL. Most of the listed measures will address both sediment and temperature. This schedule is an initial estimate of measures that are achievable in the coming years, and will be modified as restoration progresses. Watershed planning is a dynamic process that evolves as new information becomes available, as opportunities arise and as stakeholder priorities change.

[T (temperature), S (sediment) or H (habitat) indicates impairments/issues that will be addressed]

Table 7. Implementation Schedule									
Restoration Activity	**T**	**S**	**H**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023 -**
Stream assessments	X	X	X	■	■	■			
Riparian planting	X	X	X	■	■	■	■	■	■
Riparian Fencing	X	X	X	■	■	■			
Beaver/Beaver Analog Structures/Woody Debris	X	X	X	■	■	■	■	■	■
Channel Structure Work	X	X	X		■	■	■	■	
Fish Passage Work			X		■	■	■	■	■
Facilitate Watershed Group Formation	X	X	X	■	■				
Presentations to HOAs	X	X	X	■	■				
Student restoration work	X	X	X		■	■	■	■	■
Road Decommissioning		X	X			■	■	■	■

Measurable Milestones

(EPA Element g)

Milestones represent targets for the first five years of implementation of WRP. These targets are based on prioritizing the most impacted reaches of the creek, and also potential opportunities for collaboration with interested partners, such as property owners (PO), homeowner associations (HOA), the Clark Fork Coalition (CFC), Trout Unlimited (TU), the Bitterroot Water Forum (BWF) and the Missoula Conservation District (MCD) (Table 8).

Table 8. Measurable Milestones			
Milestone	**Objective**	**Segment**	**Possible Partners**
Plant 2500 native riparian trees and shrubs	Reduce summer temperature; provide woody debris; reduce bank erosion; improve channel structure/function	Mile 0 – 3 (from mouth)	HOAs, CFC, BWF, POs
Plant 5000 native riparian trees and shrubs	Reduce summer temperature; provide woody debris; reduce bank erosion; improve channel structure/function	Mile 3 – 10	HOAs, CFC, BWF, POs
Install 4000 feet of riparian fencing	Allow regeneration of riparian vegetation	Mile 0 – 10	BWF, MCD
Install 12 beaver analog structures	Storage; reduce summer temperature; improve channel structure/function; reduce sediment load	Mile 0 – 10 (from mouth)	BWF, CFC, TU, POs
Install irrigation efficiency infrastructure at 2 locations	Increase flow; decrease temperature	Mile 0 – 10 (from mouth)	MCD, CFC, BWF
Reconfigure avulsed section of creek	Improve channel structure/function; reduce bank erosion.	Mile 5 – 10	CFC, Missoula County
Present to 2 HOAs regarding restoration opportunities	Provide education regarding restoration objectives and opportunities		BWF, HOAs
Facilitate formation of Miller Cr. watershed group, or inclusion of Miller Cr. focus in existing group	Provide ongoing grassroots organization to prioritize projects and energize local residents to pursue restoration activities		CFC, BWF, HOAs, POs
Engage 2 classes of students in restoration	Provide education on riparian vegetation and stream health.	0 – 10	CFC, WEN

Resources Needed

(EPA Element c)

Restoration costs are variable, depending on several factors. For example, buying, planting and maintaining new riparian vegetation can be expensive, whereas changing management practices so that vegetation can naturally regenerate over time could be much less expensive. Some organizations have significant volunteer pools that can provide free or low-cost technical assistance and labor, and for smaller scale actions in urban areas, homeowners may be able to provide their own labor and maintenance. Restoration strategies and activities will vary, depending on the needs of each restoration project, and the resources available to those carrying out the restoration.

This WRP provides an estimate of resources needed for different methods at the scales needed to achieve the WRP goals. Table 9 shows estimated resource needs for different restoration activities.

Table 9. Resources Needed

Measure	Treatment Cost per Unit	Units Needed for Goal	Total Cost	Potential Funding Sources
Road assessment and decommissioning	$10,000- $14,000/mile	unknown	n/a	USFS Partnership Grant DEQ 319, SWCDM Ranching For Rivers
Stream Assessment and Prioritization	$10,000	1	$10,000	DNRC Watershed Mgmt. Grant, NFWF Five Star, Trout Unlimited (TU), Montana DNRC Renewable Resource Grant and Loan, Private Funders
Beaver analog structures	$0 - $500 each	unknown	n/a	DEQ 319 Natl. Fish & Wildlife Fndn. (NFWF) Five Star Grant, Private Funding
Vegetation planting (incl. weed/browse protection)	$15 - $20/plant	7,500	$112,000 - $150,000	DEQ 319 NFWF Five Star, Missoula Conservation District, MVWQD, SWCDM Ranching for Rivers
Channel morphology work	$50 - $100/foot	Unknown	n/a	DNRC Watershed Mgmt. Grant NFWF Five Star, Trout Unlimited (TU), Montana DNRC Renewable Resource Grant and Loan
Culvert replacement	$27,000	unknown	n/a	FWP Future Fisheries Grant, Trout Unlimited,
Riparian fencing	$2-$7 per foot	2 - 5 miles	$8,000- $80,000	SWCDM Ranching for Rivers Grant, NRCS EQIP, DEQ 319
Irrigation Efficiency	$10-$50K per project	Unknown	n/a	NRCS EQIP, DNRC RRGL

Technical Assistance

Technical Assistance may be provided by the following:

- Fish Wildlife and Parks Biologist – Fisheries improvement and monitoring
- Missoula County Weed District – Weed management
- Missoula Valley Water Quality District – Groundwater/surface water interactions and restoration
- Clark Fork Coalition – Monitoring and Restoration methodologies, Road Decommissioning
- Trout Unlimited – Fisheries
- Bitterroot Water Forum – Restoration Methodologies
- Lolo National Forest – Hydrology
- DEQ Water Quality Specialist – Water Quality Monitoring
- Missoula Conservation District – Irrigation, Fencing, Agricultural practices

Monitoring Plan and Criteria for Measuring Progress

(EPA Elements h and i)

Information about restoration projects implemented will be tracked and compiled for the entire watershed. Monitoring will be conducted prior to and after restoration project implementation to assess the effectiveness of restoration strategies and guide future projects. Monitoring after restoration will take place at an interval appropriate to the practice to identify improvement over time, and will vary depending on the setting and method used.

Achievement of restoration objectives will be measured over time using the criteria outlined below, as well as additional criteria that may emerge, as restoration progresses.

Temperature Monitoring

Temperatures will be monitored periodically at the locations and approximate dates that were monitored for TMDL development, as well as above and below restoration sites, before and after restoration, when the restoration activity is anticipated to mitigate temperatures. Infrared surveys could be conducted as well if funding becomes available.

Sediment Monitoring

The following parameters were selected based on TMDL methodologies, and will be measured and compared to TMDL targets:

- Riffle Pebble Count using Wolman Pebble Count Methodology and/or 49-point grid tosses
- Residual Pool Depth Measurements
- NRCS Proper Functioning Condition (PFC)
- Bank Assessment for Non-point source Consequences of Sediment (BANCS) model/BEHI – Bank Erosion Hazard Index

Table 11. Monitoring			
Parameter	**Methods**	**Responsible Parties**	**Costs**
Temperature	Direct Measurement including synoptic Infrared Surveys	MVWQD CFC	$40 - $60/hour
Sediment	Riffle Pebble Count/49-point Grid Tosses Residual Pool Depth Measurements WEPP Modeling USFS GRAIP Modeling Macroinvertebrate surveys	MVWQD and others, including UM students	$40 - $60/hour or free
Vegetation	Greenline Assessment Photo Points NRCS Riparian Assessment	MVWQD and others, including UM students	$40-&60/hour or free
Fishery	Inventory fish-passage barriers Monitor WCT genetic composition Assess connectivity with Bitterroot River and wild trout fluvial component	FWP & TU	$50 -$ 60/hour
Education and Outreach	Tracking number of people attending events, receiving educational materials or participating in restoration activities.	MVWQD and others.	$40/hour

Additional information will be collected as needed based on future conditions. Some possible parameters include total suspended solids measurements, surveys of eroding bank areas, width-to-depth ratios, macroinvertebrate studies, and fish population surveys. WEPP road modeling will be used, as appropriate, to estimate expected load reductions from road decommissioning.

Table 12. Criteria for Measuring Progress		
Parameter	*Criteria*	*Timeframe*
Temperature	Reduce high temperature by 1 – 2°F	15 years
Sediment	Reduce sediment loading by 15%	15 years
Vegetation	Increase shade percentage by 10 – 15%	15 years
Fishery	Maintain WCT genetic purity in isolates Expand area of perennial flow in main stem reach Enhance connectivity with Bitterroot River Mitigate fish passage obstructions	15 years
Education and Outreach	>200 people reached Two HOAs participating in revegetation efforts Engaging students from one local school in restoration project	2 years

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Appendix A

Miller Creek Survey Results

Q1 - What is most important to you about Miller Creek?

Code	Response Item	Frequency	Percent
1	Scenic	9	16.67%
2	Fish & Wildlife	7	12.96%
3	Irrigation/Agriculture	1	1.85%
4	Other	5	9.26%
5	All of the Above	4	7.41%
6	Scenic, Fish & Wildlife, and Irrigation/Agriculture	3	5.56%
7	Scenic and Fish & Wildlife	13	24.07%
8	Scenic & Irrigation	1	1.85%
9	Scenic & Other	2	3.70%
10	Fish & Wildlife and Irrigation/Agriculture	1	1.85%
11	Fish & Wildlife and Other	3	5.56%
13	Did not Answer	1	1.85%
14	Scenic, Fish & Wildlife, and Other	4	7.41%
	TOTAL	**54**	

Q2 - What issues do you think need to be addressed to maintain and improve the health of the creek and the watershed?

Code	Response Item	Frequency	Percent
1	More streamside vegetation	2	3.77%
2	Opportunities to increase stream flow	7	13.21%
3	Fencing	0	0.00%
4	Culvert replacement	0	0.00%
5	Weed Management	5	9.43%
6	Other	5	9.43%
11	More streamside vegetation and Opportunities to increase stream flow	1	1.89%
14	More streamside vegetation and Weed Management	7	13.21%
15	More streamside vegetation and Other	2	3.77%
19	Opportunities to increase stream flow and Fencing	1	1.89%
21	Opportunities to increase stream flow and Weed Management	2	3.77%

22	Opportunities to increase stream flow and Other	3	5.66%
26	Fencing & Weed Management	1	1.89%
29	Culvert replacement and Weed Management	1	1.89%
31	Weed Management and Other	2	3.77%
32	Not Answered	2	3.77%
35	More steamside vegetation, Fencing, Culvert replacement and Weed management	1	1.89%
37	More streamside vegetation, Weed management and Other	1	1.89%
39	More streamside vegetation, Opportunities to increase stream flow and Weed management	6	11.32%
40	More steamside vegetation, Fencing and Other	2	3.77%
41	More streamside vegetation, Opportunities to increase stream flow, Fencing and Other	1	1.89%
42	More steamside vegetation, Opportunities to increase stream flow, Culvert replacement and Weed management	1	1.89%
	TOTAL	53	

Column1	Response Item	Frequency	Percent
	More streamside vegetation	2	3.57%
	Opportunities to increase stream flow	0	0.00%
	Fencing	1	1.79%
	Culvert replacement	0	0.00%
	Weed Management	8	14.29%
	Other	18	32.14%
	More streamside vegetation and Opportunities to increase stream flow	2	3.57%
	More streamside vegetation and Weed Management	4	7.14%
	More streamside vegetation and Other	2	3.57%
	Opportunities to increase stream flow and Weed Management	2	3.57%
	Fencing & Other	1	1.79%
	Culvert replacement and Weed Management	1	1.79%
	Culvert replacement and Other	1	1.79%
	Weed Management and Other	1	1.79%
	Not Answered	7	12.50%
	More steamside vegetation, Fencing, Culvert replacement and Weed management	1	1.79%
	More streamside vegetation, Weed management and Other	1	1.79%
	More streamside vegetation, Opportunities to increase stream flow and Weed management	3	5.36%

	More steamside vegetation, Opportunities to increase stream flow, Culvert replacement and Weed management	1	1.79%
	TOTAL	**56**	

Top Values	
Scenic	59.26%
Wildlife	57.41%

Top Issues to be Addressed	
Streamside vegetation	45.28%
Increased stream flow	37.74%
Weed management	50.94%

Top Issues to be Addressed on Property	
Streamside Vegetation	28.57%
Increased Streamflow	14.29%
Weed management	37.50%
Total interested in projects on property	83.05%