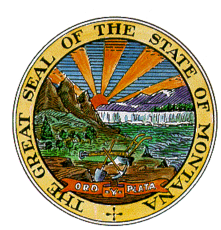
DEQ
Montana Department
of Environmental Quality

Bitterroot River Nutrient Protection Plan

March 2023



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Cover Photo:
Bitterroot River
Montana Department of Environmental Quality

Photo is during high spring flow conditions. Vigorous streamside vegetation is shown stabilizing the streambanks and dissipating flood energy.

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ACRONYMS AND ABBREVIATIONS

Unit of Measure	Definition
14Q5	14-day, 5-year average low flow condition
cfs	cubic feet per second
lbs/day	pounds per day
mg/L	milligram per liter (equivalent to parts per million, or ppm)

Acronym or Abbreviation	Definition
CRA	Community Readiness Assessment
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
EPA	Environmental Protection Agency (United States)
IR	Integrated Report
MGWPCS	Montana Ground Water Pollution Control System
MPDES	Montana Pollutant Discharge Elimination System
NHD	National Hydrography Dataset
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
WRP	Watershed Restoration Plan
WWTF	Wastewater Treatment Facility

DOCUMENT SUMMARY

This document presents a voluntary nutrient protection plan for the mainstem Bitterroot River. It addresses total nitrogen and total phosphorus for all three segments of the Bitterroot River. The Bitterroot River remains unimpaired by nutrients, a condition unique for Montana rivers of similar size and setting. The Bitterroot River Nutrient Protection Plan identifies and helps minimize risks to this high-quality condition. It complements the Bitterroot Watershed Restoration Plan (Bitter Root Water Forum, 2020) by coarsely focusing on the entire watershed, including point and nonpoint sources.

The Protection Plan quantifies current nutrient concentrations in the river and compares the data to suggested target values. It also estimates risks to the high-quality condition from sources including:

- Natural background
- Nutrient impaired tributaries (a nonpoint source)
- Municipal wastewater facilities
- Septic systems (a nonpoint source)
- Other nonpoint sources

Natural background nutrient loading is the largest contributor of nutrients in the watershed. Wastewater treatment facilities and septic systems are another major source of nutrient pollution; nitrogen primarily coming from septic systems and phosphorus primarily coming from wastewater treatment facilities.

Although nutrient impaired tributaries are one of the smaller sources of nutrients to the Bitterroot River, actions to restore these waters should be prioritized. In their impaired state, these tributaries do not fully support aquatic life nor primary contact recreation.

Nonpoint sources of pollution are a large contributor of nutrients to the Bitterroot River, primarily via septic systems and nutrient impaired tributaries. Nitrogen pollution from other nonpoint sources (e.g., run off from crop and lawn fertilizer, animal waste, erosion) is apparent in the lower Bitterroot River segment. Nitrogen and phosphorus pollution from other nonpoint sources likely does reach all three segments of the Bitterroot River, though in smaller amounts than the error generated by other nutrient source estimates. There is a wide range of accuracy in each method used to estimate the five nutrient sources listed above, and the "other nonpoint source" load was assumed to be the difference between the current nutrient load and the sum of natural background, nutrient impaired tributaries, municipal wastewater facilities, and septic systems. Additionally, calculations do not account for biological nutrient recycling within a stream segment. Regardless, it is reasonable to expect that nonpoint sources of pollution are of greater concern for nitrogen because phosphorus is less mobile. Additionally, phosphorus is likely the limiting and more readily biologically utilized nutrient in the Bitterroot River.

This Protection Plan analyzed two population growth scenarios: one where a given increase in population was placed on individual septic systems, and one where the same population increase was connected to municipal wastewater treatment. The results suggest that an increase in septic systems will more rapidly exhaust the river's capacity to take on additional nutrient load and continue supporting beneficial uses. Households should be hooked up to municipal or centralized wastewater treatment facilities wherever possible to protect the nutrient status of the Bitterroot River. Where this is not possible, households should be built with pressure dosing drainfields or Level II treatment or higher septic systems to minimize nutrients reaching the Bitterroot River.

Population growth and increased development is anticipated in the Bitterroot watershed, which will impact all categories of nutrient sources considered in this document. This Protection Plan provides best practices and effectiveness monitoring recommendations for to guide this development in the most sustainable way for maintaining water quality.

Finally, this document contains recommendations only and does not create any legally binding requirements. Any conclusions or recommendations contained herein are not intended to dictate future land use decisions, permit limits, impairment determinations, or Total Maximum Daily Load development.

1.0 INTRODUCTION

This document presents a voluntary protection plan for avoiding and minimizing nutrient pollution in the Bitterroot River. The Protection Plan concerns the entirety of the Bitterroot River watershed (**Fig. 1.1, Table 1.1**).

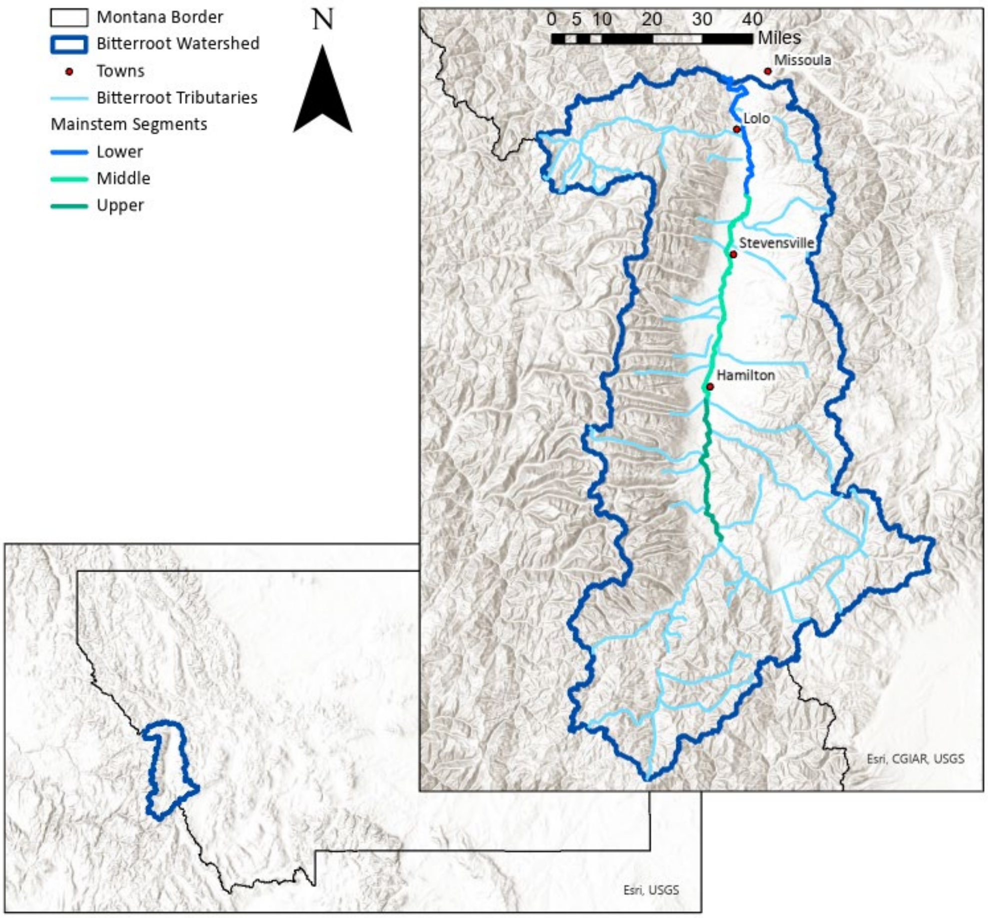

Figure 1.1. Location of the Bitterroot River watershed, including the three mainstem segments: the mouth of the Bitterroot River to Eightmile Creek, Eightmile Creek to Skalkaho Creek near Hamilton, and Skalkaho Creek to the confluence of the East and West Forks Bitterroot River.

Table 1.1. Parameters addressed by this Protection Plan

Waterbody (Assessment Unit)	Waterbody ID (Assessment Unit ID)	Parameter Addressed
Bitterroot River, Eightmile Creek to mouth (Clark Fork River)	MT76H001_030	Total Nitrogen, Total Phosphorus
Bitterroot River, Skalkaho Creek to Eightmile Creek	MT76H001_020	Total Nitrogen, Total Phosphorus
Bitterroot River, East and West forks to Skalkaho Creek	MT76H001_010	Total Nitrogen, Total Phosphorus

1.1 Why We Write Protection Plans

Montana's Constitution is unique in the nation for ordaining a clean and healthy environment as an inalienable right and is one of only three constitutions in the nation that recognizes environmental interests for future generations. It directs that "the state and each person shall *maintain* and improve a clean and healthful environment" (emphasis added), and this need to maintain high quality water is reiterated in the federal Clean Water Act and Montana Water Quality Act.

Montana classifies its waterbodies according to present and future beneficial uses they are expected to support (§ 75-5-301, MCA), including:

- Fish and aquatic life
- Wildlife
- Recreation
- Agriculture
- Industry
- Drinking water

Each waterbody in Montana has a set of designated uses from the list above. Montana has established water quality criteria to protect these uses, and a waterbody that does not meet one or more criteria is called an impaired water. Each state must monitor their waters to track if they are supporting their designated uses, and every two years the Montana Department of Environmental Quality (DEQ) prepares a Water Quality Integrated Report (IR) which lists all impaired waterbodies, identified impairment causes, and findings of non-impairment. Impairment causes fall within two main categories: pollutant (e.g., nutrients) and non-pollutants (e.g., loss of streamside vegetation). The Bitterroot River is designated to protect aquatic life, agricultural, drinking water, and primary contact creation beneficial uses.

Waterbodies that have been monitored by the state are also referred to by their "assessment unit." Assessment units can be the full length of a stream or the full extent of a lake or reservoir, or they may be a portion of a stream (a stream segment) or lake. Streams may be broken into individual segments, determined by a variety of factors such as stream length for very long streams. Due to its length, the Bitterroot River has three assessment units, or three stream segments (**Table 1.1**).

Montana's biennial IR identifies all the state's impaired waterbody segments in the 303(d) list. Total Maximum Daily Loads (TMDLs, or a water quality improvement plan) are required for each pollutant on the list. **Table 1.2** identifies all impairments along the mainstem Bitterroot from Montana's 2020 303(d) List (DEQ, 2020; see **Section 5.3** for a discussion about nutrient impaired tributaries). While the Bitterroot River has impairments, it remains unimpaired by nutrients. As **Section 2.0** describes, this is unique for Montana rivers of similar size and setting, and protection planning helps identify and minimize risks to this high-quality condition.

Table 1.2. Water quality impairment causes for the mainstem Bitterroot River

Waterbody (Assessment Unit)[1]	Waterbody ID (Assessment Unit ID)	Impairment Cause	Impairment Cause Status	Beneficial Use Support Information	
				Not Fully Supporting	Not Assessed
Bitterroot River, Eightmile Creek to mouth (Clark Fork River)	MT76H001_030	Alteration in stream-side vegetation	Non-pollutant, no TMDL required	Aquatic life	
		Lead	TMDL completed (DEQ & EPA, 2014)		
		Temperature	TMDL completed (DEQ, 2011)		
Bitterroot River, Skalkaho Creek to Eightmile Creek	MT76H001_020	Flow regime modification	Non-pollutant, no TMDL required	Aquatic life	Primary Contact Recreation
		Temperature	TMDL completed (DEQ, 2011)		
Bitterroot River, East and West forks to Skalkaho Creek	MT76H001_010	Alteration in stream-side vegetation	Non-pollutant, no TMDL required	Aquatic life	

[1]All assessment units within Montana's Water Quality Integrated Report are indexed to the National Hydrography Dataset (NHD).

This condition makes the Bitterroot River a high-quality water subject to nondegradation requirements for nutrients. New or increased sources of nitrogen and phosphorus in domestic wastewater are required to be reviewed under Montana nondegradation requirements for impacts to high quality state waters (75-5-303, MCA and ARM 17.30.7). The three basic types of wastewater discharges from a regulatory perspective are:

- Groundwater discharges via septic systems reviewed with subdivision applications
- Groundwater discharges via large septic systems (design flow over 5,000 gallons/day) reviewed under the Montana Ground Water Pollution Control System (MGWPCS)
- Direct discharges to surface water reviewed under the Montana Pollution Discharge Elimination System (MPDES)

Septic systems reviewed with subdivision applications are required to meet the nitrate (0.01 mg/L) and phosphorus (0.001 mg/L) trigger values (DEQ, 2019) in receiving surface waters that are within ¼ or ½ mile of the subdivision (measured in the direction of groundwater flow). The ¼ or ½ mile criteria is based on site-specific soil criteria. The phosphorus trigger value does not need to be calculated if there is sufficient soil between each drainfield and the surface water to absorb the phosphorus discharges for at least 50 years. The trigger value calculation is based on dilution with the 14-day 5-year low flow (14Q5) value of the receiving surface water.

Septic system discharges reviewed under the MGWPCS program undergo a reasonable potential analysis to determine if the activity is likely to degrade the nearest downgradient surface water. DEQ uses the nitrogen concentrations in effluent and the nearest surface water, the available groundwater for mixing, and several groundwater mixing zone scenarios to calculate the potential surface water nitrate concentration. DEQ uses these calculations to determine that the resulting change in nitrogen concentration in the downgradient surface water remains below trigger values. For phosphorus, a breakthrough time analysis is conducted based on soil adsorption capacity and whether a breakthrough is estimated to occur within 50 years. If impacts to surface water are likely, then a groundwater discharge permit may not be issued and consultation with the MPDES permit program may need to take place.

Direct discharges to surface water reviewed under the MPDES program are required to undergo a significance determination and either meet effluent limitations based on the nonsignificance criteria of ARM 17.30.715 or apply for and receive an authorization to degrade as described in ARM 17.30.708.

Note that some or all the above procedures may be altered in the future as DEQ continues working on the draft narrative nutrient standards and the draft adaptive management program.

Protection plans are a nonregulatory approach for protecting high quality waters that can be developed by state or local entities. The Bitterroot River Watershed Restoration Plan (WRP; Bitter Root Water Forum, 2020) identifies the Bitterroot River as a priority for water quality protection. The primary difference between the Bitterroot WRP and this Protection Plan is the spatial and community scope. This Protection Plan coarsely focuses on the entire Bitterroot River watershed, whereas the Bitterroot WRP focuses on 13 priority streams. This Protection Plan also incorporates voluntary protection actions that can be taken by point sources and municipalities, whereas the Bitterroot WRP focuses on nonpoint source pollution issues and landowner-scale actions. Both types of plans are highly valuable for their varied stakeholder engagement and ability to inform ongoing and future planning efforts.

The goal of the Bitterroot River Nutrient Protection Plan is to document strategies and activities that avoid water quality degradation from nutrient stressors. The document also includes measures to evaluate success at implementing this plan, with the intent that these measures may be revisited in the future (e.g., every 5 years). This Protection Plan is non-regulatory and entirely voluntary. Engaging in water quality protection will help avoid costs of:

- lost revenue from recreation, property value, and other beneficial uses;
- expanded restoration efforts; and
- increased water treatment.

Many of the same activities recommended to protect the Bitterroot from nutrient pollution can lead to water quality restoration for the existing impairments identified in **Table 1.1**.

1.2 What This Document Contains

This document includes components required for an implementable protection plan, including:

1. A description of physical and social characteristics of the Bitterroot River watershed (**Sections 1.3** and **2.0**)
2. A discussion of suggested water quality targets and the identification of high-quality water (**Section 3.0** and **4.0**)
3. Risks to the high-quality condition (**Section 5.0**)
4. An estimate of a time frame over which a protection target is expected to be maintained (**Sections 6.0 and 8.1**)
5. A summary of ongoing and proposed activities to resist degradation of high-quality water (**Section 7.0**)
6. Measures of success of maintaining high quality water (**Sections 7.0 and 8.0**)
7. Planned responses to observed changes in risks or high-quality condition (**Section 9.0**)

8. A description of stakeholders who were involved in the development of this plan, and the public participation process used to develop the document (**Section 10.0**)

1.3 Nutrient Sources and Pollution Effects in the Bitterroot Watershed

Nitrogen and phosphorus are naturally occurring elements required for healthy functioning of aquatic ecosystems. Healthy streams strike a balance between organic and inorganic nutrients from sources such as natural erosion, groundwater discharge, and instream biological decomposition. This balance relies on autotrophic organisms to consume nutrients (e.g., algae fixes nitrogen and phosphorus), on higher organisms in the food chain to consume those fixed nutrients (e.g. macroinvertebrates and fish), and on nutrient decomposition (e.g., changing organic, fixed nutrients back into inorganic forms; Odum, 1956; Vannote *et al*., 1980). Human influences may alter nutrient cycling by adding excess nutrients or altering the food chain, damaging biological stream function, and degrading water quality (Smith, 2003; **Figure 1.2**).

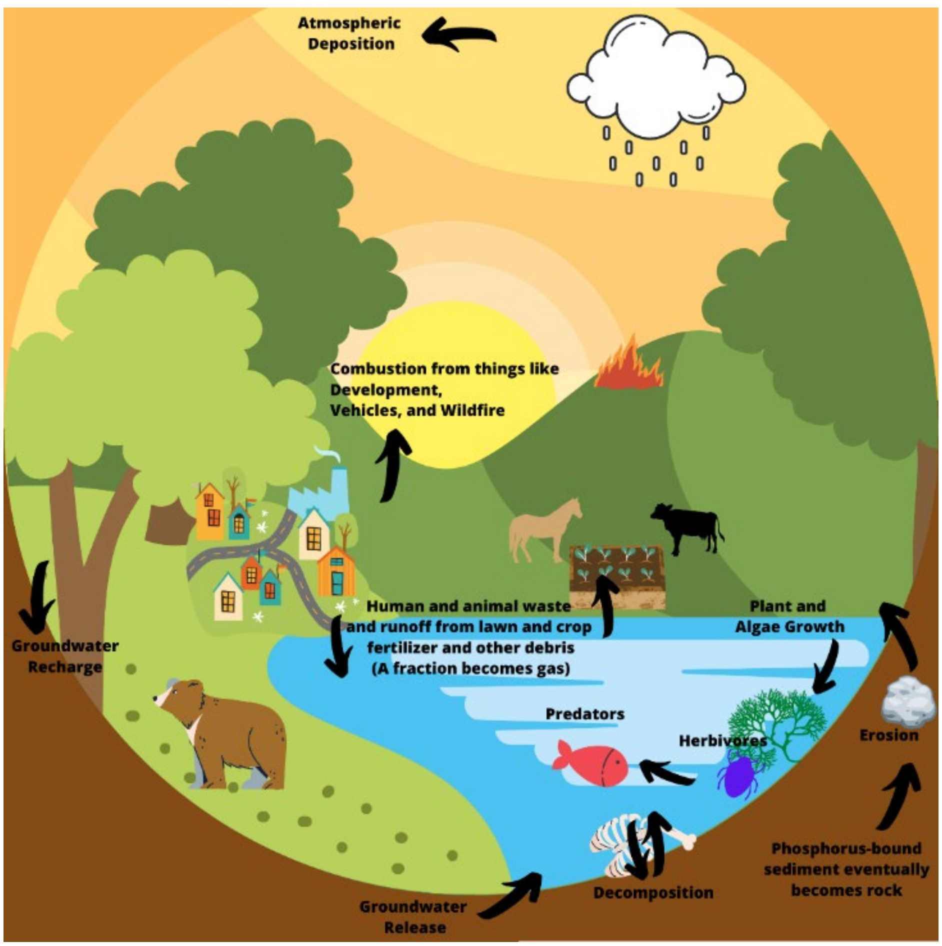

Figure 1.2. Diagram depicting how nutrients (nitrogen and phosphorus) cycle through a landscape. Too much or too little of any pathway, such as too much human or animal waste or too little vegetation, can overwhelm the balance.

Human-caused sources of nutrient pollution in the Bitterroot watershed include forestry and silviculture operations, road and streambank erosion, stormwater, fertilizers (e.g., from croplands, orchards, golf courses, and lawns), human and animal waste, and atmospheric contributions (e.g., wildfire smoke). A common trait magnifying each of these nutrient sources is a loss of native vegetation, which results in soil erosion and less water storage in soil. Streamside vegetation is particularly effective at protecting streams and rivers from nutrients and other causes of pollution. Not only does it physically buffer surface water from pollution run off and secure streambanks against erosion, but the vegetation itself uptakes nitrogen and uses it for growth.

Recreation and agriculture are two major industries in the Bitterroot watershed that would likely be affected by an increase in nutrients. The Bitterroot River is a renowned fishery that routinely ranks among the top 10 in the state for angler days, with nearly 50% of those days driven by out-of-state visitors (e.g., FWP, 2015). Excess nitrogen in the form of dissolved ammonia (which is typically associated with wastewater) can be toxic to fish and other aquatic life. In addition, excess nitrogen and phosphorus can cause an overabundance of algal growth, which depletes the supply of dissolved oxygen and can kill fish and other aquatic life. Nuisance algae can reduce water clarity and shift the structure of macroinvertebrate communities, which may also negatively affect the fish that feed on macroinvertebrates. A reduction in angler days due to a weakened fishery would negatively affect related tourist businesses like restaurants, hotels, and guide services. Certain types of algal blooms, known as cyanobacteria blooms, can produce cyanotoxins that can sicken humans and even kill wildlife, livestock, and humans. Furthermore, algal growth in irrigation canals can severely limit carrying capacity to deliver water to water users. Changes in water clarity and aesthetics can harm property values and recreational uses, such as swimming, and boating (**Figure 1.3**; Wolf and Klaiber, 2017; Suplee et al. 2009).

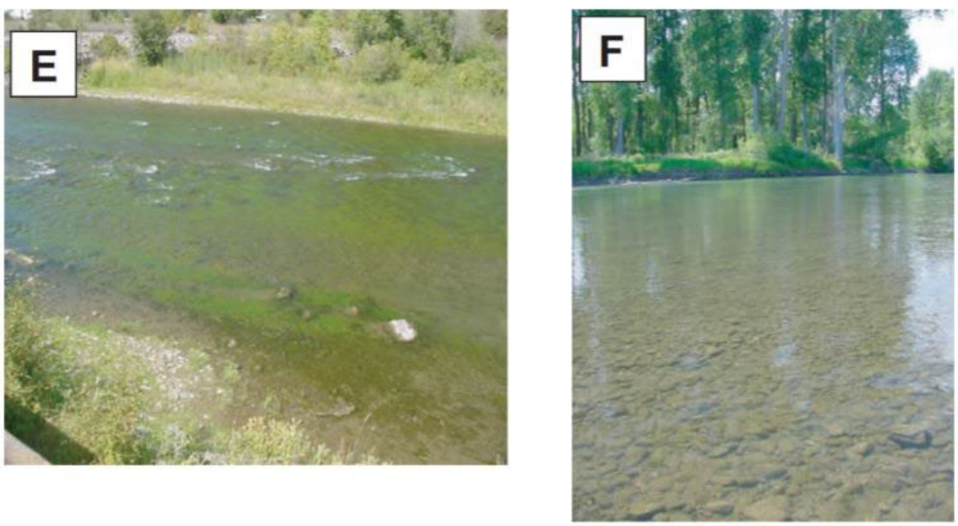

Figure 1.3. Image E represents the point at which a majority of survey respondents found conditions "undesirable" for recreation. Image F represents the highest concentration of chlorophyll-a that survey respondents found "desirable" for recreation. Images from Suplee et al. 2009.

Besides recreation and agricultural industries, nutrient pollution can have broad implications for general community welfare. Excess nitrogen in the form of nitrate in drinking water can inhibit normal hemoglobin function in infants, a scenario especially of concern for people with individual drinking water wells. Nuisance algae can also increase the cost of treating drinking water, and cyanotoxins pose health risks if ingested in drinking water (World Health Organization, 2003).

2.0 Bitterroot River Watershed Description

Section 2.0 of the Bitterroot Watershed TMDL and Water Quality Improvement Plan (DEQ & EPA, 2014) provides a thorough description of physical, ecological, and cultural characteristics in the Bitterroot Watershed (HUC 17010205).

The mainstem Bitterroot River is unique amongst Montana rivers of similar size and setting. The watershed has one of the fastest growing populations in the state (DOC & REMI, 2020; **Figure 2.1**), several of its tributaries are impaired by nutrients, and yet the river mainstem is not (**Figure 2.2**). An increase in population brings changes in land use. For example, 87% of homes built in Ravalli County between 1990 and 2018 are situated outside of incorporated city boundaries (Hernandez, 2018). Rather than development linked into a municipal wastewater treatment system, these new residences use individual septic systems to treat human waste. Individual septic systems are excluded from state groundwater permitting requirements, county septic regulations vary across the state, and often there is no mechanism for ensuring aged systems are properly maintained or sited. Septic systems can affect the quality of nearby surface water or drinking water wells if not properly placed, functioning, or maintained. New development also co-occurs with an increase in impervious surfaces. During storm events, impervious surfaces can concentrate stormwater, thereby increasing erosion and delivery of pollutants to surface waters. Additionally, impervious surfaces prevent water from percolating below ground and recharging groundwater.

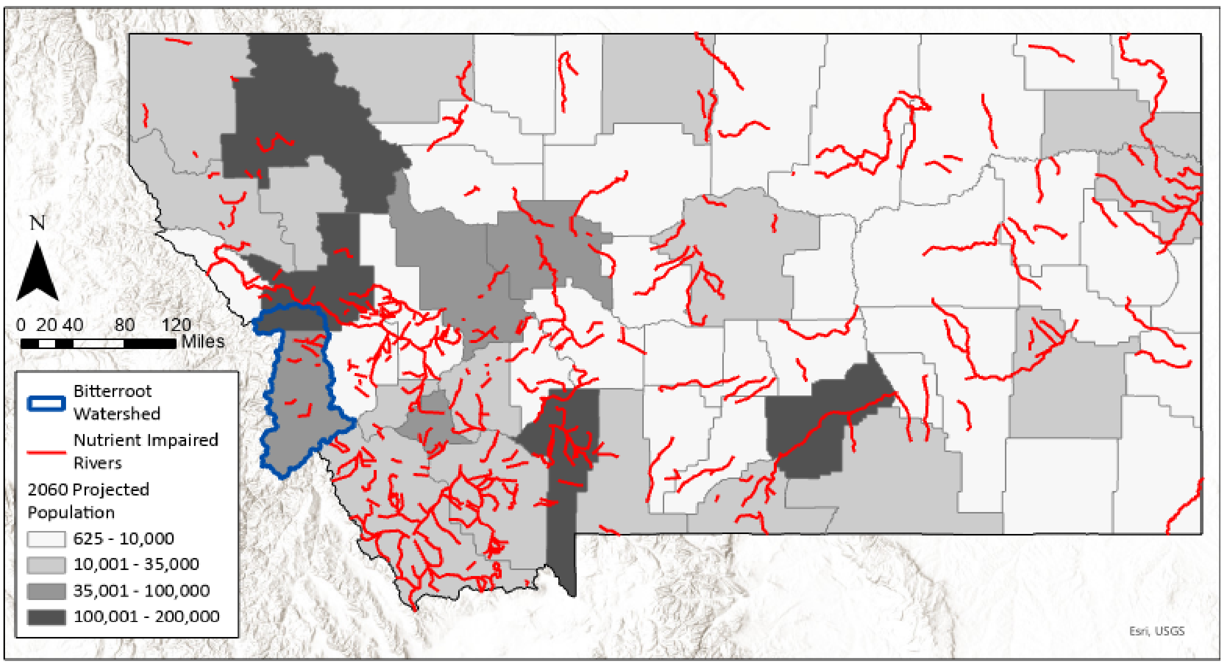

Figure 2.1. Projected population for 2060 by county (DOC & REMI, 2020), overlaid by rivers and lakes with nutrient or chlorophyll-*a* impairment. The Bitterroot River watershed, which is encompassed by Ravalli County and a small portion of southern Missoula County, is within some of the fastest growing counties in the state. It is rare for rivers of similar size and setting to not have a nutrient impairment.

Population growth and the accompanying land use changes are an inevitability for the Bitterroot River watershed. This Protection Plan is intended to provide proactive tools and information to ensure this development occurs in a way protective of the Bitterroot River. By maintaining the high-quality condition of the Bitterroot River, municipalities can avoid high costs of increased drinking water and wastewater treatment. Individual landowners may have less concern about their groundwater or irrigated water supply. Downstream communities, such as those along the nutrient impaired Clark Fork River, may enjoy the nutrient diluting benefits of the Bitterroot River.

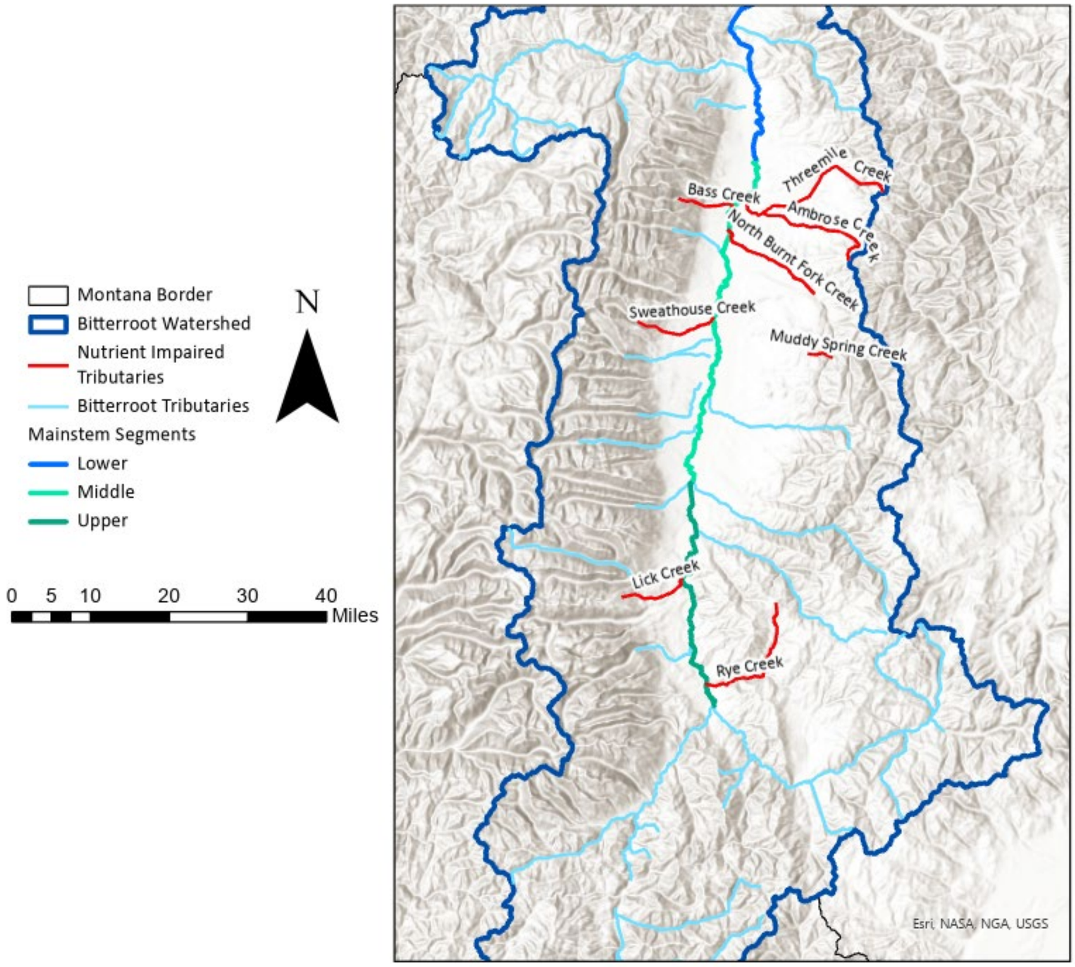

Figure 2.2. Bitterroot River watershed map showing tributaries that are currently impaired by nutrients.

3.0 Instream Nutrient Conditions of the Bitterroot River

Suggested ecoregional nutrient targets to ensure that beneficial uses are protected for Northern Rockies Ecoregion streams are 0.3 mg/L total nitrogen and 0.03 mg/L total phosphorus (Suplee & Watson, 2013). Data from each of the three Bitterroot River segments (**Figure 3.1**) show nutrient concentrations consistently below suggested nitrogen and phosphorus concentration targets (**Table 3.1; Figure 3.2; Appendix A**). This was true during the TMDL development period (2002-2012), and for a period that includes more recent data (2013-2021). This demonstrates nutrient conditions in the Bitterroot River are high-quality and protective against algal growth that would compromise beneficial uses of the resource.

Between the two time periods evaluated, there was no apparent or statistically significant ($p > 0.05$) change in the 75th percentile nitrogen concentration for the three segments of the Bitterroot River. The 75th percentile phosphorus concentration has decreased for the three segments of the Bitterroot, although the decrease was only statistically significant (Tukey's adjusted $p = 0.00017$) for the middle segment. The 75th percentile nutrient concentration is emphasized because it presents a worst-case scenario compared to an average.

Table 3.1. The number of samples from which nutrient data was evaluated for Figure 3.2

Assessment Unit (AU)		Number of Total Nitrogen Samples		Number of Total Phosphorus Samples	
		(2002-2012)	(2013-2021)	(2002-2012)	(2013-2021)
Lower	MT76H001_030, Eightmile Creek to mouth (Clark Fork River)	22	27	60	27
Middle	MT76H001_020, Skalkaho Creek to Eightmile Creek	41	93	122	93
Upper	MT76H001_010, East and West forks to Skalkaho Creek	14	25	33	25

Between 2002 and 2021, algae samples were only collected in 2012, 2019, 2020, and 2021, and data is more sparse than nutrient chemistry data. The 75th percentile values for each segment are well below the algae biomass target (≤ 125 mg/m^2; **Table 3.2**). The relative concentration of nitrogen and phosphorus within algal cells can be used to estimate which nutrient might be limiting algal growth. A nitrogen to phosphorus (N:P) ratio in algal cells of <6 suggests nitrogen is limiting algal growth, whereas >10 suggests phosphorus is limiting algal growth (Hillebrand and Sommer, 1999). Algal nitrogen and phosphorus data is not available, but the concept may be roughly applied to water chemistry (Suplee and Watson, 2013). **Table 3.2** also shows average N:P ratios for nutrient concentration water column data collected during the assessment (2002-2012) and planning (2013-2021) time periods. The data suggest that phosphorus is the limiting nutrient.

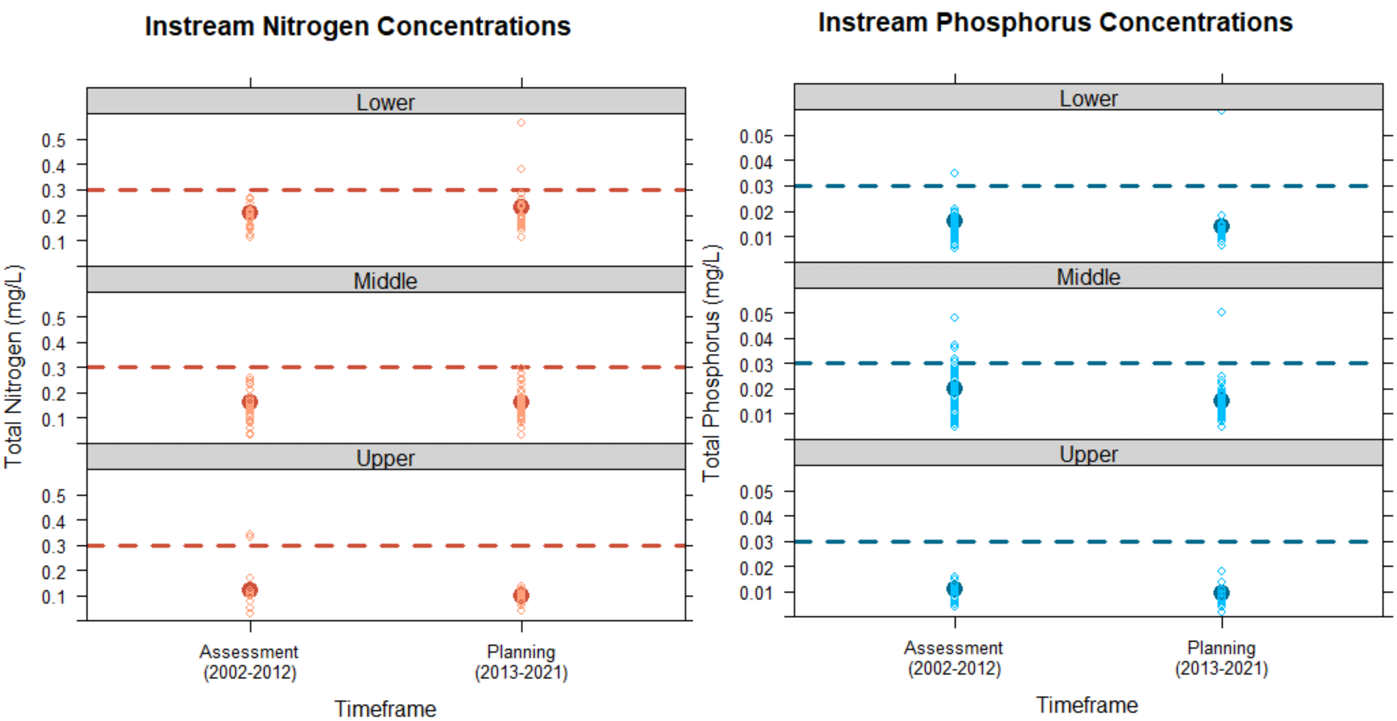

Figure 3.2. Nitrogen (red) and phosphorus (blue) concentrations in the Upper, Middle, and Lower Bitterroot River segments. Hollow points represent samples taken within each segment, and solid data points show the 75th percentile concentration. Data was compared across two time periods, 2002-2012 during water quality assessment for TMDL development, and 2013-2021 to include more recent data. Dashed lines represent suggested nitrogen and phosphorus concentration targets.

Table 3.2. 75th percentile algae biomass on each segment of the Bitterroot River, and average nitrogen to phosphorus ratios (N:P) of water column samples.

Assessment Unit (AU)		2012 75th Percentile Algae Biomass (mg/ m²) [sample size]	2013-2021 75th Percentile Algae Biomass (mg/ m²) [sample size]	Average Water Column N:P Ratio	
				2002-2012	2013-2021
Lower	MT76H001_030, Eightmile Creek to mouth (Clark Fork River)	28 [4]	39 [5]	16	17
Middle	MT76H001_020, Skalkaho Creek to Eightmile Creek	14 [4]	50 [20]	10	11
Upper	MT76H001_010, East and West forks to Skalkaho Creek	22 [3]	62 [5]	20	13

4.0 MAXIMUM SUSTAINABLE NUTRIENT LOAD VS. CURRENT CONDITIONS

A maximum sustainable nutrient load is the amount of pollution, expressed in units of mass per time, that may be delivered to a river or lake and still support beneficial uses (**Equation 4.1**). The maximum sustainable nutrient load is an entirely non-regulatory concept that is simply used to compare with current conditions to demonstrate the high-quality condition of the Bitterroot River and help prioritize voluntary protection actions.

Equation 4.1: Maximum Sustainable Load = (X) (Y) (5.4)

Maximum Sustainable Load = Maximum pollutant load in a stream that still meets beneficial uses, in units of lbs/day

X = suggested water quality target in mg/L (0.3 mg/L Total Nitrogen or 0.03 mg/L Total Phosphorus; Suplee & Watson, 2013)

Y = example streamflow in cubic feet per second (cfs)

5.4 = conversion factor

For this Protection Plan, DEQ selected an example flow value at the downstream end of each Bitterroot River segment using USGS StreamStats software July to October 14Q5 flow values (McCarthy et al., 2016; **Table 4.1**). The "14Q5" component of this StreamStats measure refers to a 14-day, 5-year average low flow condition. StreamStats considers a longer summer season (the "July to October" component) than the suggested nutrient targets (July 1st through September 30th). This is reasonable because stream flows are often lower in October than during summer, meaning the maximum sustainable load estimated using StreamStats' July to October 14Q5 flow values will represent a worst-case scenario, such as drought conditions. As flow decreases, so will the maximum sustainable load.

Table 4.1. Example flow values used for calculating maximum sustainable, current, and natural background nutrient loads

Bitterroot Segment (Assessment Unit ID)	Example flow used throughout this document
Lower (MT76H001_030)	561 cfs
Middle (MT76H001_020)	487 cfs
Upper (MT76H001_010)	336 cfs

The maximum sustainable nitrogen and phosphorus loads calculated using **Equation 4.1** and example flows in **Table 4.1** are shown in **Figure 4.1**.

Water quality monitoring data from 2013-2021 were used to compare the current 75th percentile nutrient load with the maximum sustainable load in **Figure 4.1**. This is a similar dataset used to construct the "planning" timeframe shown **Figure 3.2**, although only data collected from locations near the downstream end of each segment was used to calculate the current load where possible (**Table 4.2; Appendix A**). This is due to load calculations hinging on the example flow values established at the downstream end of each segment. For the lower Bitterroot, this only includes data collected from the Highway 93 bridge (also known as "Buckhouse Bridge") in Missoula. For the middle Bitterroot, this only includes data collected at Florence Bridge. For the upper Bitterroot, the only data available is from the Hannon Fishing Access Site bridge in the middle of the reach.

Table 4.2. The sample data from which the 75th percentile current nutrient load was estimated in Figure 4.1

Assessment Unit (AU)	Site Location	Number of Total Nitrogen and Phosphorus Samples (2013-2021)
Lower; MT76H001_030, Eightmile Creek to mouth (Clark Fork River)	HWY 93 Bridge (46.83195, -114.05306)	27
Middle; MT76H001_020, Skalkaho Creek to Eightmile Creek	Florence Bridge (46.633056, -114.049167)	24
Upper; MT76H001_010, East and West forks to Skalkaho Creek	Hannon Fishing Access Bridge (45.9735, -114.14096)	25

Assimilative capacity is the amount of pollutant loading that a waterbody can take on while continuing to meet suggested water quality targets. While **Figure 4.1** shows that each segment of the Bitterroot River has assimilative capacity to take on more nutrients, **Section 5.0** demonstrates how population growth may increase any or all nutrient loading sources. Local planners, landowners, and regulators should carefully consider the balance of managing population growth while still maintaining the high-quality condition of the Bitterroot River.

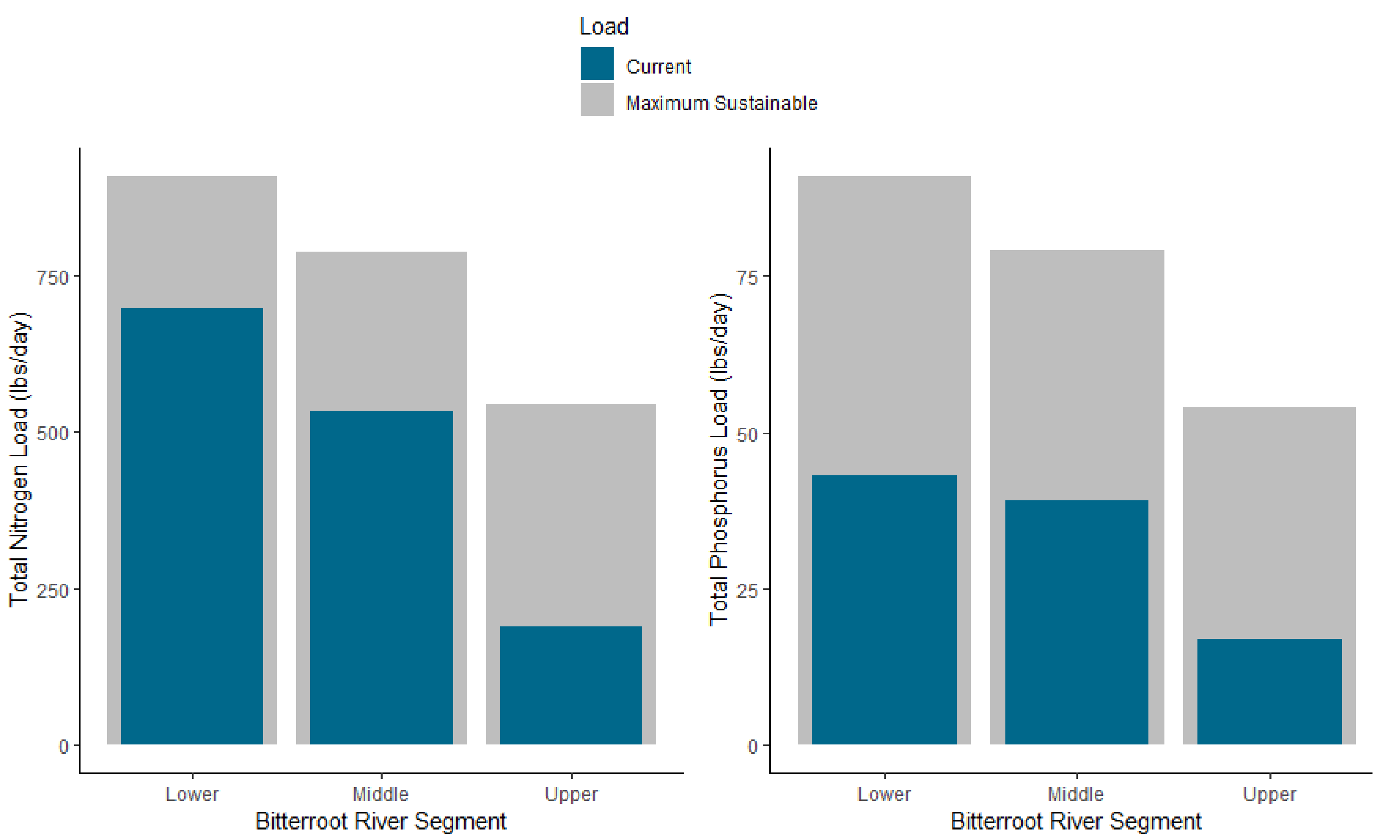

Figure 4.1. Maximum sustainable nutrient load compared to current nutrient load for each segment of the Bitterroot River.

5.0 NUTRIENT SOURCES AND ESTIMATION METHODS

This section evaluates significant sources of nutrient pollution loading to the mainstem Bitterroot River, including natural background loading. Some sources are easily quantifiable. For example, municipal wastewater treatment facilities are required to monitor effluent nutrients as part of their Montana Pollutant Discharge Elimination System (MPDES) permit. Surface water data from tributaries was acquired from the EPA's Water Quality Portal and includes samples collected by DEQ, the former Tristate Water Quality Council, Clark Fork Coalition, and the Bitterroot River Protection Association. Volunteer monitoring data must meet QA/QC requirements prior to its inclusion in the Water Quality Portal. Other sources, such as nutrient loading from septic sources and other nonpoint sources are more difficult to estimate because of their ubiquitous spatial distribution and cumulative effect. Each subsection will discuss data sources and any modeling and assumptions for nutrient sources.

Due to the range of approaches and accuracy in estimated nutrient sources, the sources are presented relative to each other, rather than as a fixed value. By presenting these semi-quantified risks to the high-quality condition of the Bitterroot River, the goal is to show that addressing any or all of the nutrient source categories can go a long way to protecting the river. Similarly, any nutrient source category has the potential to tip the nutrient condition into an impairment status.

5.1. METHOD FOR ESTIMATING NATURAL BACKGROUND NUTRIENTS

Natural background nutrient loading includes all non-human caused sources. The load from natural background sources of nutrients is based on 75th percentile concentration values from reference sites in the Middle Rockies, Northern Rockies, and Idaho Batholith Level III Ecoregions (**Table 5.1, Fig. 5.1**). Natural background nutrient concentrations for each ecoregion are applicable during the July 1 to September 30 growing season (Suplee and Watson, 2013). 75th percentile values are used here, as with throughout the document, because they depict more of a worst-case loading scenario than using a median or average value. Reference sites were chosen to represent stream conditions where human activities may be present but do not negatively harm stream uses. The effects of natural events such as flooding, fire, and beetle kill may be captured at these sites.

Table 5.1. Natural background nutrient concentrations for each Level III Ecoregion in the Bitterroot Watershed.

Ecoregion	75th Percentile TN (mg/L)	75th Percentile TP (mg/L)
Idaho Batholith	0.095	0.008
Middle Rockies	0.141	0.020
Northern Rockies	0.094	0.009

Natural background loads are calculated by multiplying an ecoregion area-based weighted average natural background concentration by the example streamflow (**Table 4.1**), as in **Equation 5.1**.

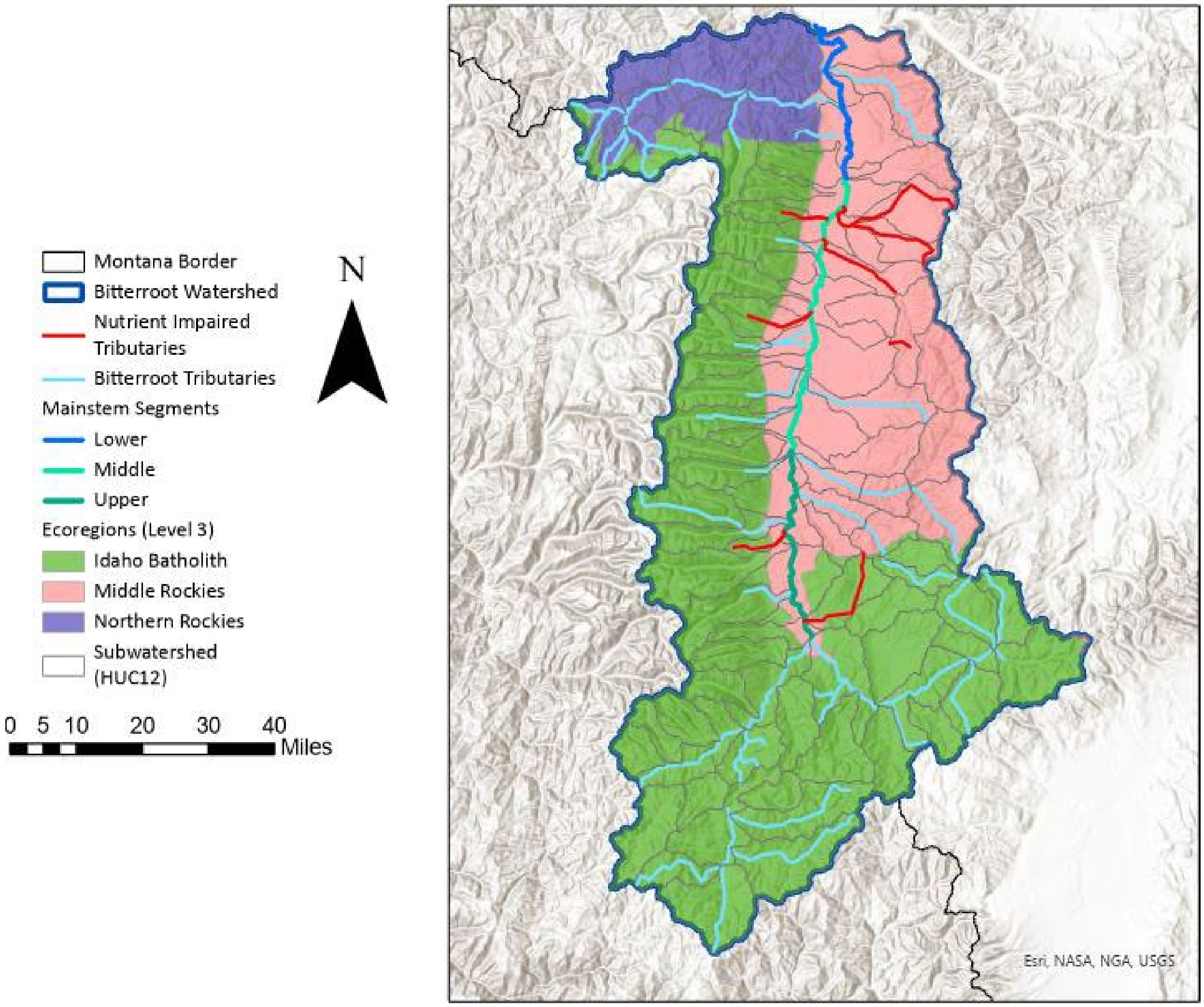

Figure 5.1. Map showing mainstem Bitterroot segments, nutrient impaired tributaries, level 3 ecoregions, and subwatersheds.

Equation 5.1: Natural Background Load = (X) (Y) (5.4)

Natural Background Load = Nutrient load from sources regardless of human influence, in units of lbs/day

X = (proportion of drainage area in Idaho Batholith from ***Fig. 5.1*** *× 75th percentile nutrient concentration from* ***Table 5.1****) + (proportion of drainage area in Middle Rockies × 75th percentile nutrient concentration) + (proportion of drainage area in Northern Rockies × 75th percentile nutrient concentration).*

*Y = example streamflow in cubic feet per second (cfs) (****Table 4.1****)*

5.4 = conversion factor

5.2. Method for Estimating Nutrients from Impaired Tributaries

As shown in **Figure 2.2**, there are six nutrient impaired tributaries that confluence with the Bitterroot River. Bass, Sweathouse, North Burnt Fork, and Threemile Creeks confluence with the middle section of the Bitterroot River (MT76H001_020), and Rye and Lick Creeks confluence with the upper segment

(MT76001_010). None of these tributaries receive water from a point source, indicating that nutrient impairment is due to nonpoint sources of pollution.

To estimate the nutrient load, DEQ selected an example flow value at the mouth of each tributary using USGS StreamStats software's July to October 14Q5 flow values (**Table 5.2**; McCarthy et al. 2016). As described in **Section 4.0**, this example flow value provides a worst-case scenario. The 75th percentile nutrient concentration from data collected near the mouth of each tributary, between July 1 – September 30 of 2005 – 2021, was established as representative of current tributary conditions (**Figure 5.2; Appendix A**). This data was acquired from the EPA's Water Quality Portal and includes samples collected by DEQ, the former Tristate Water Quality Council, and the Bitterroot River Protection Association. Volunteer monitoring data must meet QA/QC requirements prior to its inclusion in the Water Quality Portal. The 75th percentile nutrient concentration is used because it supports a worst-case scenario compared to an average. To avoid double counting natural background nutrient loading, the watershed area-based weighted average natural background ecoregional nutrient concentration was subtracted from the 75th percentile nutrient concentrations measured in the field. The example flow value and 75th percentile nutrient concentrations were used in **Equation 5.2** to calculate the nutrient load attributed to tributaries impaired by nutrients.

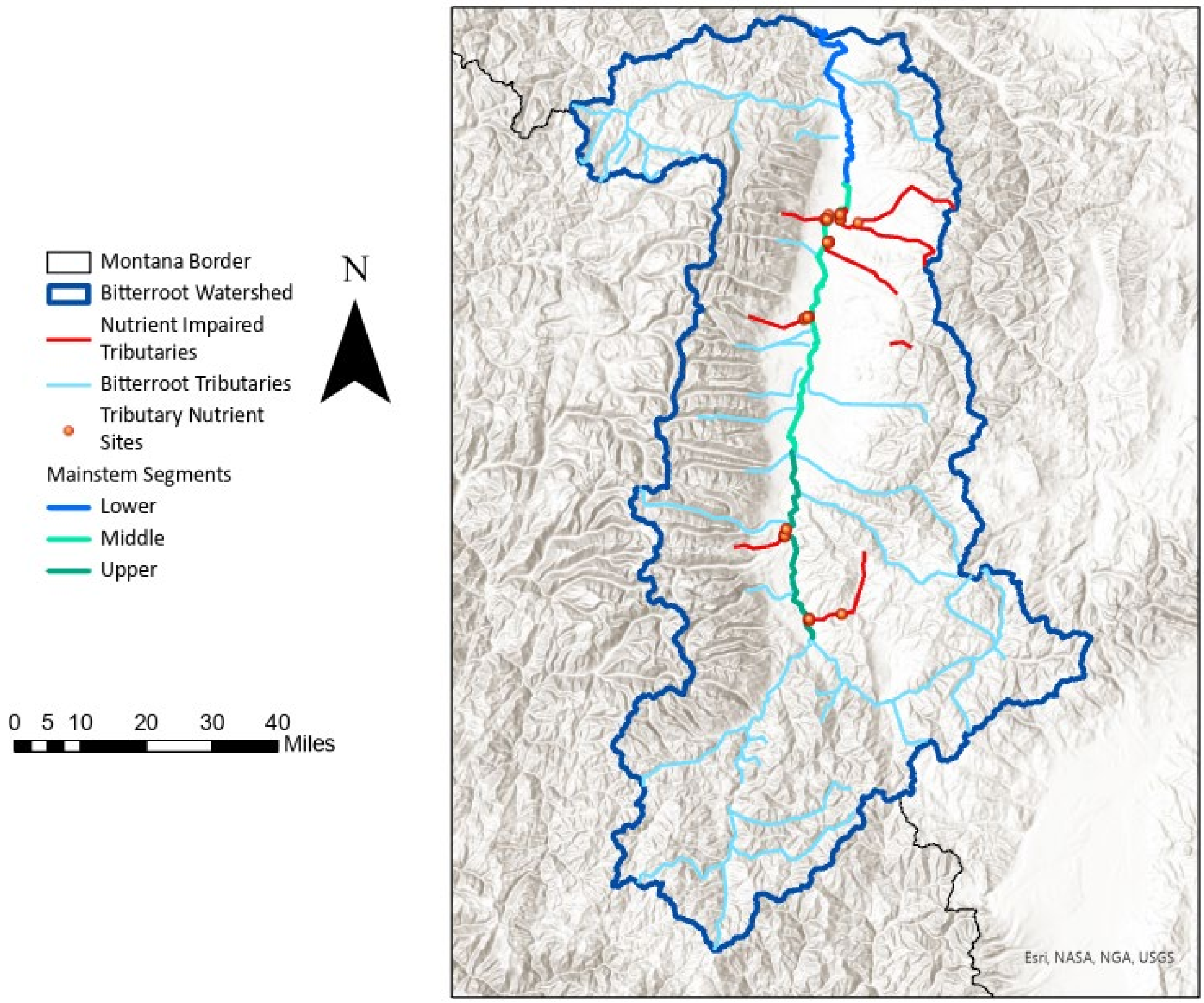

Figure 5.2. Map showing nutrient impaired tributary nutrient data sample locations relative to the Bitterroot River segments

Table 5.2. Example flow values and current and natural background nutrient concentrations used for calculating current nutrient loading from nutrient impaired tributaries. "—" indicates this tributary is not impaired by nitrogen and therefore not considered a nitrogen source to the Bitterroot River beyond its natural background loading (Section 5.1).

Tributary (Assessment Unit ID)	Confluencing Bitterroot Segment	Example flow used throughout this document	75th percentile concentration (mg/L) from monitoring locations near mouth		Area-weighted natural background concentration (mg/L)	
			TN	TP	TN	TP
Rye Creek (MT76H004_190)	Upper	9.75 cfs	0.21	0.027	0.098	0.0089
Lick Creek (MT76H004_170)	Upper	0.61 cfs	—	0.038	0.11	0.011
Threemile Creek (MT76H004_140)	Middle	11.3 cfs	0.41	0.076	0.141	0.020
North Burnt Fork Creek (MT76H004_200)	Middle	19.8 cfs	0.27	0.054	0.141	0.020
Bass Creek (MT76H004_010)	Middle	8.60 cfs	0.53	0.074	0.097	0.0086
Sweathouse Creek (MT76H004_210)	Middle	8.09 cfs	—	0.056	0.11	0.013

Equation 5.2: Nutrient Impaired Tributary Load = (X - NB) (Y) (5.4)

Nutrient Impaired Tributary Load = Human-caused nutrient load, in units of lbs/day, in the mainstem Bitterroot that is attributable to tributaries impaired by nutrients

X = 75th percentile nutrient concentration, in units of mg/L, measured near tributary confluence

*NB = (proportion of drainage area in Idaho Batholith from **Fig. 5.1** × 75th percentile nutrient concentration from **Table 5.1**) + (proportion of drainage area in Middle Rockies × 75th percentile nutrient concentration) + (proportion of drainage area in Northern Rockies × 75th percentile nutrient concentration)*

Y = example streamflow in cubic feet per second (cfs)

5.4 = conversion factor

5.3. Method for Estimating Nutrients from Wastewater Treatment Facilities and Other Permitted Sources

There are 26 active point sources permitted under the Montana Pollutant Discharge Elimination System (MPDES) that discharge to the Bitterroot Watershed, according to EPA's Integrated Compliance Information System database as of June 2022. It is assumed that nutrient discharge to tributaries or groundwater are account for via other methods (i.e., **Section 5.2, 5.4, and 5.5**) or are taken up by biota.

5.3.1. Wastewater Treatment Facilities

Four municipal wastewater treatment facilities (WWTFs) serving Lolo (MT0020168), Stevensville (MT0022713), Hamilton (MT0020028), and Darby (MTG580011) are permitted to discharge to the Bitterroot River. Lolo discharges to the lower segment, Hamilton and Stevensville to the middle segment, and Darby to the upper segment. These permittees submit effluent discharge monitoring reports monthly, including average monthly nutrient loading during the summer growing season, and therefore data is readily available for analysis.

The potential for continued population growth in the Bitterroot watershed makes WWTF contributions an important source to monitor. **Figure 5.3** shows monthly average effluent nutrient concentrations for the four facilities during the summer growing season (July – September). Particularly for phosphorus, nutrient concentrations have generally been decreasing.

Some of this improvement is likely due to facility optimization, a process of operator training, technical support, and modifying the use of existing treatment equipment to improve wastewater treatment. This process began in 2014 for Lolo WWTF, and 2015 for Hamilton WWTF. For $4.5 million, the Stevensville WWTF upgraded from a UV light disinfection system to a biological nutrient removal system in 2016. DEQ began working with Stevensville on optimizations in 2018. Darby's WWTF is a facultative lagoon whose permit does not allow discharge during the growing season. The Town of Darby was awarded Treasure State Endowment Program and American Rescue Plan Act funds in 2021 that will address repairs and install new equipment.

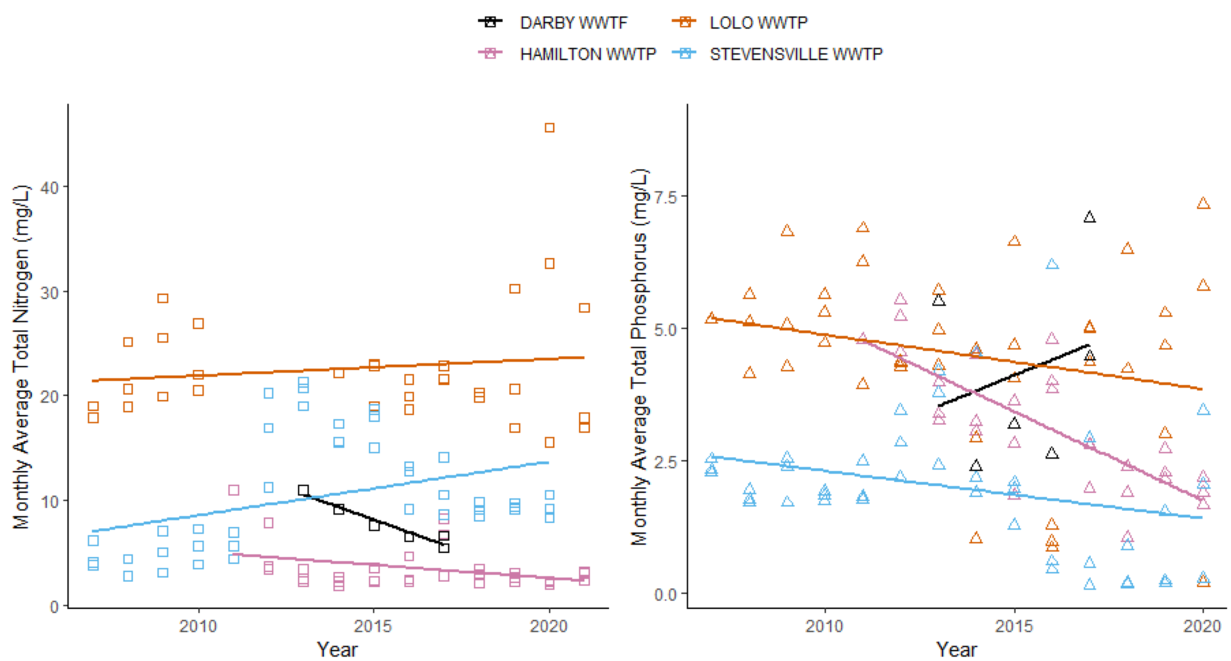

Figure 5.3. Nutrient concentrations in Bitterroot wastewater treatment facility effluent. Data shown are summer growing season (July – September) monthly averages from each facility's discharge monitoring reports.

Improvements in nutrient treatment are even more apparent when considering loads. **Figure 5.4** shows monthly average effluent nutrient loading for the four facilities during the summer growing season (July – September). The 75th percentile of the five most recent years of data shown in **Figure 5.4** was assumed to represent the current nutrient loading to the Bitterroot River (**Table 6.1).** The maximum sustainable load ranges from 908 to 544 lbs/day total nitrogen and 91 to 54 lbs/day total phosphorus, the range depending on the segment of the Bitterroot River (**Figure 4.1**). This evaluation indicates that municipal wastewater treatment is a considerable, though not the largest, source of nutrients in the Bitterroot watershed.

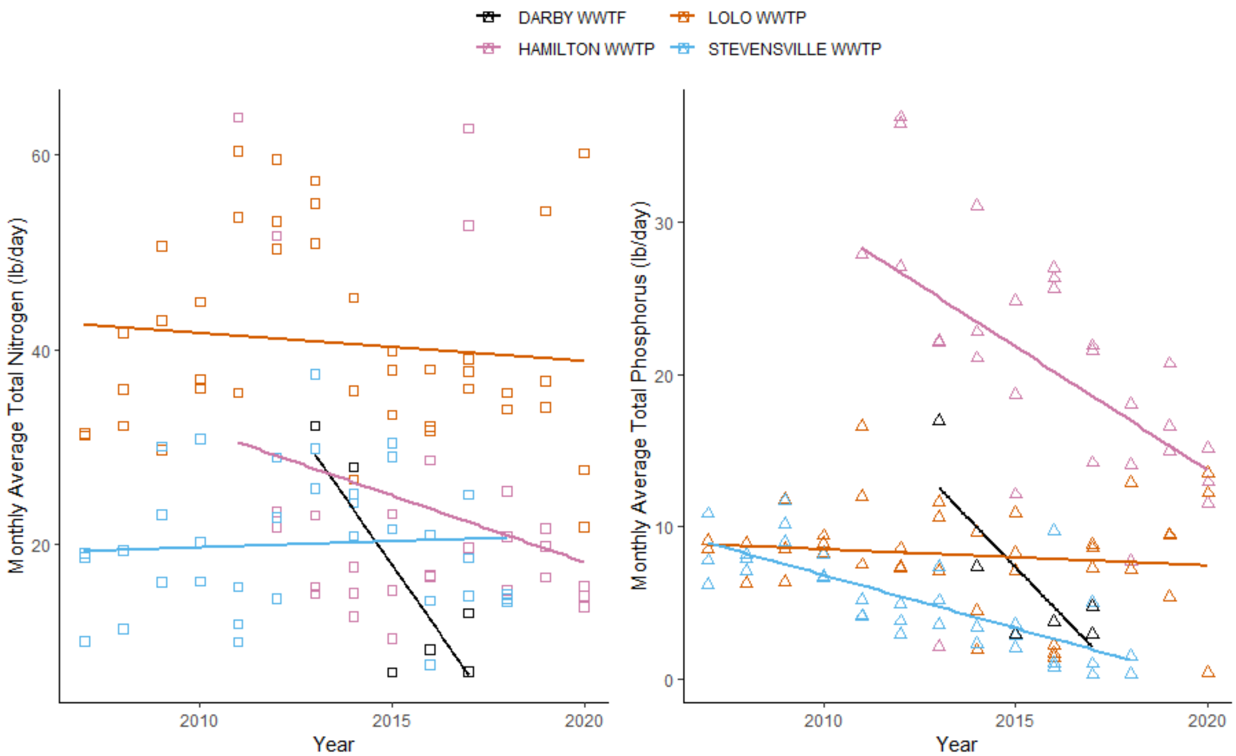

Figure 5.4. Nutrient loads in Bitterroot wastewater treatment facility effluent. Data shown are summer growing season (July – September) monthly averages from each facility's discharge monitoring reports.

5.3.2. Other Permitted Sources

In addition to the four wastewater treatment facilities, there are 20 general permits for stormwater discharges associated with construction and industrial activities and one general permit for construction dewatering. These sources are generally intermittent and considered to have a negligible nutrient contribution. There are no concentrated animal feeding operations (CAFOs) in the Bitterroot watershed.

The City of Missoula is permitted under a municipal separate storm sewer system (MS4) permit to discharge to the Bitterroot and Clark Fork Rivers. The City of Missoula periodically monitors a storm sewer outfall to the lower Bitterroot River on Pattee Creek during dry weather conditions (City of Missoula, 2018 & 2019). The average nutrient load of three separate sampling events (September 2017, October 2018, and August 2019) was extremely low (0.38 lbs/day total nitrogen and 0.033 lbs/day total phosphorus) compared to the lower Bitterroot River's maximum sustainable load of 908 lbs/day total nitrogen and 91 lbs/day total phosphorus (**Figure 4.1**).

There is also permit coverage available for stormwater discharge associated with construction activity. Due to the short-term impact and transient nature of these construction stormwater permits, nutrient pollution from these sources is considered negligible. Stormwater management should still be a consideration when planning for projects and development. The primary method to control stormwater pollution is the use of best practices. Additional information can be found in Montana's Nonpoint Source Management Plan (Watershed Protection Section, 2017).

The permits discussed in this section (**5.3.2**) are considered negligible and are not directly incorporated into nutrient loading estimates.

5.4 Method for Estimating Nutrients from Septic Systems

Septic systems are typically considered a nonpoint source of pollution and can be a primary source of nutrient loading in Montana. Municipal wastewater systems only serve about 30% of Bitterroot residents. Septic systems, even when operating as designed, can contribute nutrients to surface water through subsurface pathways. A simple model, the Method for Estimating Attenuation of Nutrients from Septic Systems (MEANSS), was used to provide coarse estimates of nutrient loads to the Bitterroot River (DEQ, 2014).

Key assumptions for this method are as follows:

- All septic systems are working properly (because a complete system failure is typically addressed very quickly).
- All septic systems are conventional systems consisting of a septic tank and drainfield that service an individual household.
- All septic systems release nutrients at the same rate (30.5 lbs/yr nitrogen and 6.44 lbs/yr phosphorus; DEQ, 2009).
- A portion of the nutrients released by septic systems is attenuated into soils and never reaches surface water. This portion varies based on soil characteristics and distance from surface water.

The location of each septic system in the Bitterroot watershed was estimated from the Montana Structures Framework (https://ftpgeoinfo.msl.mt.gov/Data/Spatial/MSDI/AddressStructures/). Structures that fell within Darby, Hamilton, Stevensville, Lolo, and Missoula city limits were removed because it is assumed these structures are serviced by municipal wastewater treatment. Next, structures classified as dwelling, mobile home, or farm/ranch were retained, while structures listed as commercial establishments, government buildings, hospitals, schools, etc. were removed. The nutrient load from the population that visits these latter structures is likely already accounted for by the former.

The remaining structures that are linearly closest to a Bitterroot River tributary were removed, and structures linearly closest to the Bitterroot River were retained. Nutrients from structures linearly closest to perennial tributaries are assumed to be accounted for by tributaries impaired by nutrients (**Section 5.2**) or nonpoint sources (**Section 5.5**).

The reduction in nutrient loading from each individual septic system by the time nutrients reach the Bitterroot River is estimated based on distance, soil type at the drainfield, and soil type at the Bitterroot River (**Table 5.3, Figure 5.5**). The approach is similar for phosphorus but includes a reduction factor for calcium carbonate percent in the soil beneath the drainfield (**Table 5.4**). Calcareous soils, defined as containing more than 15% calcium carbonate, typically maintain neutral pH levels that do not readily precipitate phosphorus. Non-calcareous soils, defined as containing less than 1% calcium carbonate, slow the movement of phosphorus more than calcareous soils (Lombardo, 2006). These factors were attributed for each septic system using a GIS analysis of the Natural Resources and Conservation Service Soil Survey Geographic Database's (SSURGO) hydrologic soil group (HSG) and $CaCO_3$ classification system, and the National Hydrography Dataset (NHD).

The estimate for current nutrient loading from septic systems to the Bitterroot River is based off the 25th percentile nutrient reduction due to soil and distance to River parameters. Rather than consider the average or median nutrient reduction from soil and distance parameters, the 25th percentile provides more of a worst-case scenario estimate (i.e., the 75th percentile would provide a best-case scenario estimate that would be inconsistent with other source estimates in this document).

Table 5.3. MEANSS Septic System Nitrogen Loading Matrix

Percent Nitrogen Load Reduction[1]	Soil Type @ Drainfield[2]	Soil Type within 100' of surface water[2]	Distance to surface water (ft)
0	A	A	≤ 100
10	B		> 100 - 500
20	C	B	> 500 - 5000
30	D	C	> 5000 - 20,000
50		D	> 20,000

[1] The total nitrogen reduction is the sum of the individual reductions for each column of the table. For example, the nitrogen load reduction associated with a drainfield in a type C soil that drains to a surface water with type B soil, and is 200 feet from the nearest surface water would be 50 percent (e.g., 20% + 20% + 10% = 50%, or 30.5 lbs/year * 0.5 = 15.25 lbs/year removed prior to discharge to surface water).

[2] Soil drainage class:

A = excessively drained or somewhat excessively drained
B = well drained or moderately well drained
C = somewhat poorly drained
D = poorly drained or very poorly drained

Table 5.4. MEANSS Septic System Phosphorus Loading Matrix

Percent Phosphorus Load Reduction[1]	Soil Type @ Drainfield[2] ($CaCO_3$ ≤ 1%)	Soil Type @ Drainfield[2] ($CaCO_3$ > 1% and < 15%)	Soil Type @ Drainfield[2] ($CaCO_3$ ≥ 15%)	Distance to surface water (ft)
10	A	A	A	≤ 100
20			B	
40		B	C	
50				> 100 - 500
60	B	C	D	
80	C	D		> 500 - 5,000
100	D			> 5,000

[1] The total phosphorus reduction is the sum of the two reductions for soil type/$CaCO_3$ and distance. For example, the phosphorus load reduction associated with a drainfield that is in a type C soil with greater than 15 percent $CaCO_3$ (40 percent) and is 300 feet from the surface water (50 percent) would be 90 percent (40% + 50% = 90%, or 6.44 lbs/year * 0.9 = 5.8 lbs/year removed prior to discharge to surface water).

[2] Soil drainage class:

A = excessively drained or somewhat excessively drained
B = well drained or moderately well drained
C = somewhat poorly drained
D = poorly drained or very poorly drained

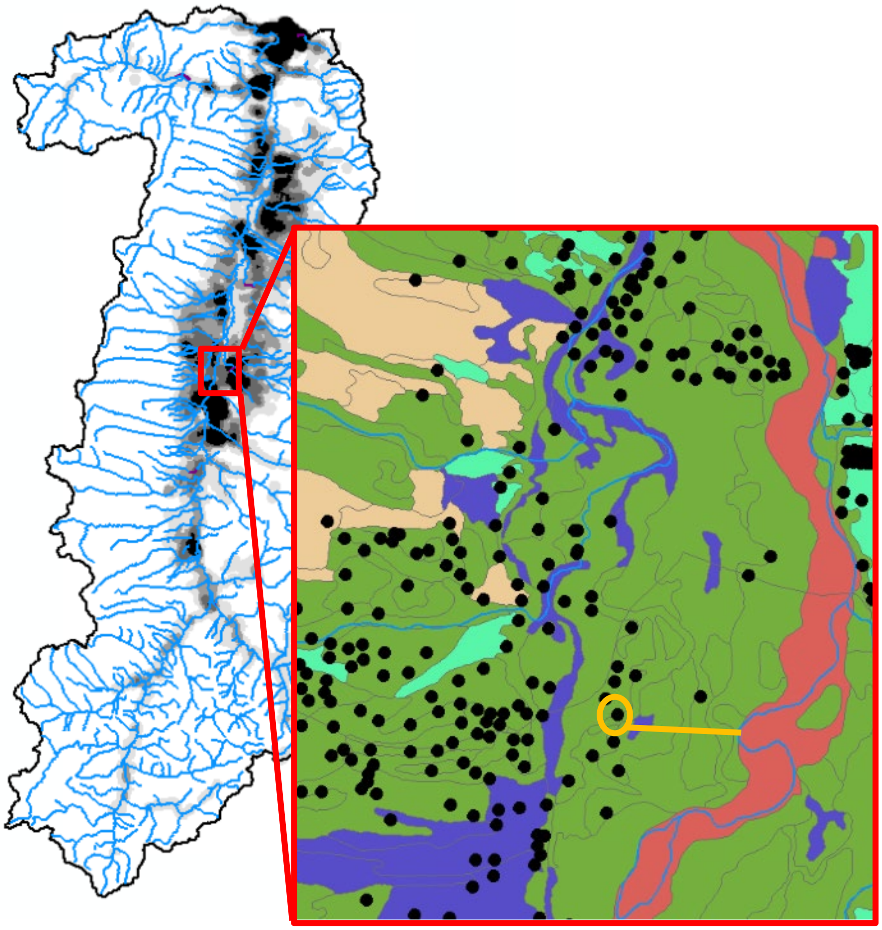

Figure 5.5. A representation of how septic systems contributing nutrients to the Bitterroot River were estimated. The background map shows a density diagram of structures. The inset image shows individual structures overlaying different soil types; the yellow line depicts one structure's distance from the mainstem Bitterroot. In the final analysis, only structures linearly closest to the Bitterroot River were retained.

The MEANSS model incorporates many assumptions and as a result there is wide uncertainty in watershed-scale loading estimates. To protect the Bitterroot River, more refined models or site-specific water quality studies could be used to reduce uncertainty in estimates of nutrient loading from septic systems.

5.5 Method for Estimating Nutrients from Other Nonpoint Sources

Nonpoint source pollution is the largest contributor of water quality problems in Montana. Nonpoint sources include contributions from stormwater runoff, fertilizers for lawns and crops, erosion from roads and streambanks, fire retardants, atmospheric contributions, and livestock and animal waste (human waste is covered in **Sections 5.3 and 5.4**). Nonpoint sources of nutrient pollution are a difficult category to quantify, due to their numerous and dispersed nature. **Equation 5.3** was used to estimate nutrient loading from nonpoint sources of pollutants.

If the sum of estimated natural background, wastewater treatment facility, nutrient impaired tributary, and septic systems nutrient loads were larger than the estimated current nutrient load, the resulting negative value was assigned as potential error rather than nonpoint source nutrient pollution. Nonpoint source pollution inherently cannot be a negative value. Sources of error include variability in mainstem, tributary, and wastewater treatment facility nutrient monitoring data, ranges in accuracy of natural background and septic system nutrient loading estimates, and the nutrient uptake throughout the watershed (**Section 5.7**).

Equation 5.3: NPS Load or Error = Current – NB – WWTF – Tributaries – Septic Systems

NPS Load = Nutrient load, in units of lbs/day, in the mainstem Bitterroot that is attributable to nonpoint sources of nutrients other than septic systems

Error = Nonpoint source pollution cannot be a negative value; these scenarios represent accumulated error of nutrient source estimates

*Current = Current nutrient load (**Section 4.0**)*

*NB = Natural background nutrient load (**Section 5.1**)*

*WWTF = Wastewater treatment facility load (**Section 5.3**)*

*Tributaries = Human-caused nitrogen- and/or phosphorus-impaired tributary load (**Section 5.2**)*

*Septic Systems = Septic system load (**Section 5.4**)*

5.6. Nutrient Sources Summary

Figure 5.6 shows the relative nitrogen and phosphorus loads estimated from natural background, nutrient impaired tributaries, wastewater treatment facilities, septic systems, and other nonpoint sources (**Sections 5.1—5.5**). Nutrient loads in the upstream to downstream direction are not additive. The figure is intended to show loading contributions from sources relative to each other, not as absolute values, because loads were calculated using various methods and differing levels of uncertainty.

The largest source of nutrients overall comes from natural background sources of nutrients. Wastewater treatment facilities and septic systems are another major source of nutrient pollution; nitrogen primarily coming from septic systems and phosphorus primarily coming from wastewater treatment facilities. This is to be expected considering how the different waste treatment systems operate. Because phosphorus binds easily to soils, effluent phosphorus is treated quite well as it migrates away from the septic system, whereas nitrates are more mobile in groundwater. At WWTFs, denitrifying bacteria ultimately convert most nitrates into unreactive nitrogen gas that is released to the atmosphere. Septic systems, closed systems, are not designed to release gas.

Nonpoint sources of pollution, which include septic systems and nutrient impaired tributaries, are a large contributor of nutrients to the Bitterroot River. Nonpoint source pollution, other than septic systems or nutrient impaired tributaries, is only apparent for nitrogen in the lower Bitterroot River segment. However, it is likely that some nitrogen and phosphorus nonpoint source pollution reaches all three segments of the river, just in smaller amounts than the error generated by nutrient source estimates (**Section 5.7**). It is reasonable to expect that nonpoint sources of pollution are of greater concern for nitrogen because phosphorus is less mobile. Additionally, phosphorus is likely the limiting and more readily utilized nutrient in the Bitterroot River (**Table 3.2**).

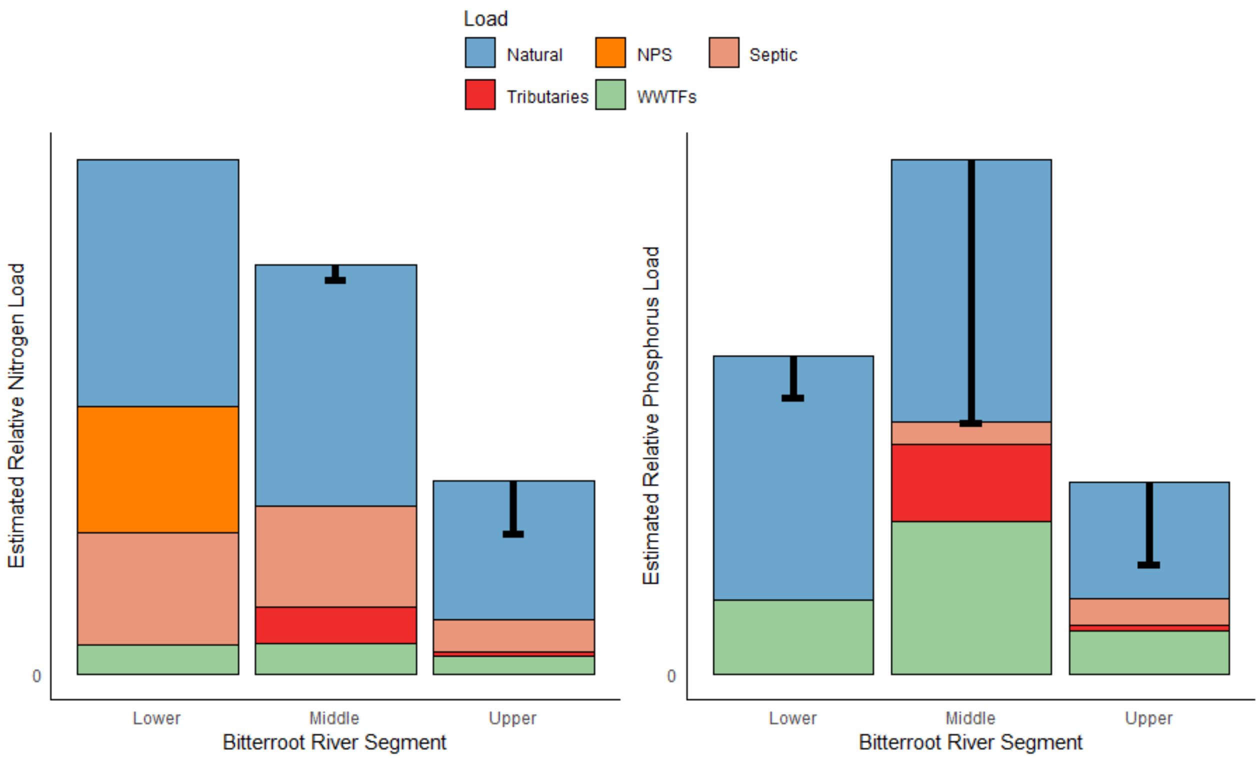

Figure 5.6. This figure shows the relative estimated nitrogen and phosphorus loads from natural background, wastewater treatment facilities (WWTFs), septic systems (a nonpoint source), tributaries impaired by nutrients (a nonpoint source), and other nonpoint sources (NPS). Error bars represent scenarios where the sum of loads from natural background, septic systems, tributaries, and WWTFs was larger than the current estimated nutrient load. Sources of error are discussed in Section 5.7.

Although nutrient impaired tributaries are one of the smaller sources of nutrients to the Bitterroot River, actions to restore these waters should be prioritized. In their impaired state, they do not fully support aquatic life nor primary contact recreation.

Results confirm that protecting the Bitterroot River from nutrient impairment will require widespread adoption of voluntary best practices that reduce nutrient loading (see **Section 7.0** for recommendations). This approach would also reduce nutrient loading to nutrient impaired tributaries. Continued population growth will likely increase nutrient loading associated with septic systems (**Section 6.0**) and other nonpoint sources if not managed in a way to reduce nutrient loading, restore degraded wetlands and riparian areas, and protect existing high-quality resources.

5.7. Uncertainty and Seasonality

This Plan implicitly contains uncertainty about pollutant loads and the quality of the receiving water. This uncertainty errs on the side of protecting beneficial uses and is accounted in a variety of ways:

- Nutrient load estimates from sources covered in this Protection Plan were derived by using a variety of methods, each which their own assumptions, ranges of accuracy, and potential for error.

- This Protection Plan does not account for biological nutrient recycling within a stream segment; it does assume that nutrient inputs to one segment do not reach the next segment downstream.
- Before a river is identified as impaired, data must surpass an exceedance rate of target values. Allowable exceedances of ecoregional nutrient target values (0.30 mg/L for TN and 0.030 mg/L for) nutrient targets were not incorporated into the calculation of the maximum sustainable load.
- Continued monitoring and adaptive management (**Section 7.0 and 8.0**) is recommended to evaluate nutrient source loading assumptions and restoration strategies and will further reduce uncertainties over time.
- Water quality targets are applicable for the summer growing season (July 1 to September 30), to coincide with seasonal algal growth targets. Additionally, only data from this yearly timeframe was used to estimate nutrient loading.

6.0 POTENTIAL SCENARIOS

Wastewater treatment facilities are designed to treat a maximum capacity or serve a certain population of citizens. Typically, the average effluent volume processed by a facility is below the design capacity, meaning that facilities are designed in anticipation of accommodating population growth. The Lolo, Stevensville, and Hamilton WWTF MPDES permits provide information about the current population served and the population the facility is design for. DEQ extrapolated from each facility's current nutrient effluent load (**Section 5.3**) what the expected nutrient load could be if each facility reached their maximum design population (**Table 6.1**). Note that because the Town of Darby's facility is a lagoon system that rarely, if ever, discharges during the growing season, it is not accurate to assume that an increase in nutrient load corresponds to an increase in population. Therefore, that facility, and the Upper Bitterroot River segment it is permitted to discharge to, was excluded from the analysis.

Table 6.1. Data used for the nutrient loading scenario where a population increase is connected to municipal WWTFs

Bitterroot Segment of Outfall Location	Facility	Current TN Load (lbs/day)[a]	Current TP Load (lbs/day)[a]	Current Population Served	Design Population	Design Population TN Load (lbs/day)	Design Population TP load (lbs/day)
Lower	Lolo[b]	38	6.3	2,248	2,500	42.3	10.2
Middle	Stevensville[c]	24.7	3.5	1,900	2,800	36.4	5.2
Middle	Hamilton[d]	24.3	23.4	4,400	5,200	28.7	27.7

[a]These values are the 75th percentile of summertime (July-September) monthly averages reported in discharge monitoring reports. This data is displayed in **Figure 5.3**. For Lolo and Hamilton, 2015-2019 is considered for current conditions. For Stevensville, 2014-2018.
[b]Current and design population acquired from 2014-2019 MPDES permit factsheet.
[c]Current and design population acquired from 2012-2017 MPDES permit factsheet.
[d]Current and design population acquired from 2011-2016 MPDES permit factsheet.

Next, DEQ calculated the expected nutrient load that could result if households associated with the same population increase were served by new individual septic systems instead of the WWTFs. The current number of septic systems and associated nutrient load from those systems was estimated in **Section 5.4**; the new individual septic systems described for this scenario follow the same assumptions.

Table 6.2. Data used for the nutrient loading scenario where a population increase is placed on new individual septic systems

Bitterroot Segment	Current Septic Systems	Current Population on Septic Systems[a,c]	Example Future Population on Septic Systems[b]	Example Future Septic Systems[c]	Current TN Load (lbs/day)[a]	Current TP Load (lbs/day)[a]	Example Future Population TN Load (lbs/day)	Example Future Population TP Load (lbs/day)
Lower	2,289	5,494	5,746	2,394	153	0	160	0
Middle	2,029	4,870	6,570	2,737	136	3.6	183	4.9

[a] See **Section 5.4** for a discussion of how the current number of septic systems and current nutrient loads were calculated. Example future septic systems are assumed to reduce nutrient loading by the same amount that MEANSS calculates.
[b]The population increase is equivalent to the difference between the WWTF's design population and current population served.
[c]It is assumed that an average of 2.4 people reside in each household (U.S. Census Bureau, 2019).

Figure 6.1 shows the increase in nutrient loads under these two scenarios: a population increase served by municipal WWTFs or served by new individual septic systems.

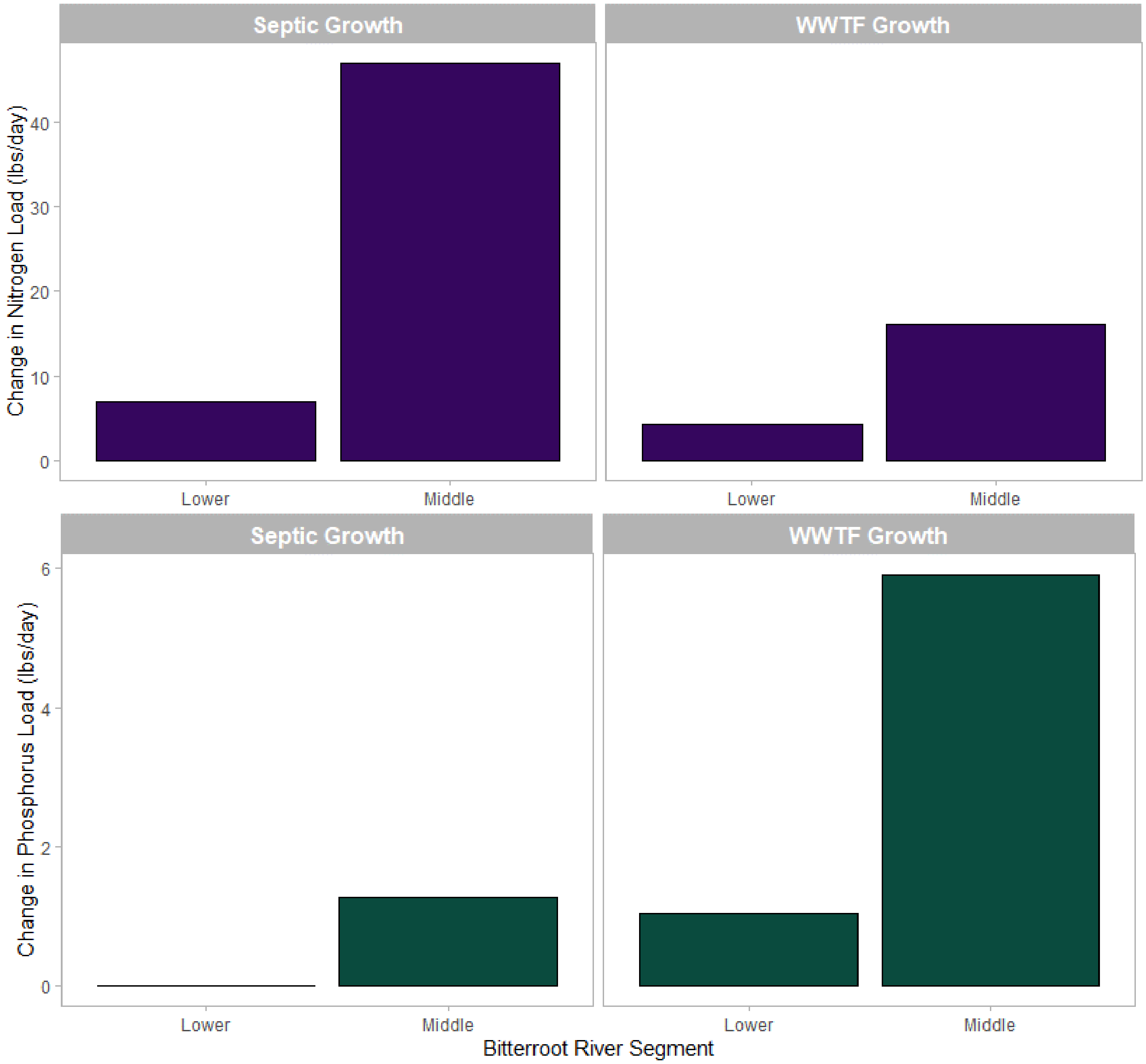

Figure 6.1. This figure shows the change in nutrient load from current conditions under two population growth scenarios. On the right, the expected increase in nitrogen (top) and phosphorus (bottom) load was estimated for the scenario where the population served increased to the facility design capacity. On the left, the expected increase in nutrient loading was estimated for the scenario where the same population increase is placed on new individual septic systems.

This exercise shows differing results for nitrogen and phosphorus loading to the Bitterroot River associated with two scenarios for wastewater treatment. For example, a population growth of 252 people served by new septic systems along the lower Bitterroot River results in a twofold increase in nitrogen loading compared to the same population served instead by the Lolo WWTF (i.e., from 38 to 42 versus 153 to 160 lbs/day). For the middle Bitterroot segment, a population increase of 1,700 people served by new septic systems would result in more than a threefold increase in nitrogen loading, compared to the same population served instead by the Stevensville and Hamilton WWTFs (i.e., from 49 to 65 versus 136 to 183 lbs/day). The exercise also shows that the same population growth treated by new septic systems would result in less phosphorus loading to the Bitterroot River, compared to the same population served by municipal WWTFs.

If WWTFs continue implementing technology improvements and process optimizations, WWTF nutrient loads can reasonably be expected to continue decreasing, and the estimate of increased loading from WWTFs in **Figure 6.1** may be an overestimate. The estimated load from septic systems assumes a conventional tank and drainfield system (**Section 5.4**), however if septic systems with higher levels of nitrogen treatment are installed, then the nitrogen increases estimated in **Figure 6.1** are likely an overestimate. Improved phosphorus treatment in septic systems is not anticipated to occur, so the phosphorus increases estimated in **Figure 6.1** are likely more accurate than for nitrogen.

It is also important to consider the mechanisms of how nitrogen and phosphorus are removed from wastewater. At WWTFs, denitrifying bacteria ultimately convert most nitrates into unreactive nitrogen gas that is released to the atmosphere. Septic systems, closed systems, are not designed to release gas. The MEANSS model accounts for naturally occurring denitrification that occurs after the wastewater migrates away from the drainfield (**Section 5.4**), but it is typically not as effective a process as in a WWTF, particularly in coarse-grained soils that are common along the Bitterroot River. Phosphorus is not as mobile or volatile as nitrogen. At WWTFs, phosphorus molecules are bound to microorganisms or chemicals, settled out of the water column, and the resulting sludge is removed. However, not all phosphorus can be removed with this approach, and the excess is discharged in effluent. Septic systems themselves do not treat phosphorus; they rely on naturally occurring adsorption to soil particles. Therefore, most phosphorus associated with septic systems ends up bound in the soils, and for this reason, they result in less phosphorus loading to surface water.

Lastly, there is less of a difference between the maximum sustainable and current nitrogen load in the Bitterroot River than there is for phosphorus (**Figure 4.1**), indicating an increase in phosphorus loading may be more sustainable than an increase in nitrogen loading. For example, the increase in phosphorus loading to the middle Bitterroot River associated with the WWTF scenario is 6 lbs/day, approximately 23% of the remaining phosphorus load that segment could receive while still supporting beneficial uses. Conversely, the increase in nitrogen loading to the middle Bitterroot River associated with the septic scenario is 47 lbs/day, approximately 37% of the remaining nitrogen load that segment could receive while still supporting beneficial uses.

This exercise demonstrates the importance of hooking up new households to municipal or centralized WWTFs wherever possible to protect the nutrient status of the Bitterroot River. Where this is not possible, new households should be built with pressure dosing drainfields or Level II treatment or higher septic systems to minimize nutrients reaching the Bitterroot River.

7.0 Water Quality Improvement Activities & Measures of Success

This section describes an overall strategy and specific on-the-ground measures designed to protect beneficial uses and maintain suggested water quality targets in the Bitterroot River. The strategy includes general measures for reducing loading from each identified significant pollutant source. Recommendations in this Protection Plan are not required by the Clean Water Act or Montana statute and are primarily implemented through voluntary actions.

DEQ does not implement these actions and activities itself. Instead, successful implementation of this Protection Plan requires collaboration among land use planners, private landowners, land management agencies, and other stakeholders. DEQ and other entities provide technical and financial assistance to local organizations interested in protecting and improving their water quality. Please find a compilation of potential funding sources on the DEQ website (http://deq.mt.gov).

7.1 Continue Implementing the Bitterroot Watershed Restoration Plan and Recommendations from the TMDLs

The Bitter Root Water Forum has maintained an up-to-date Watershed Restoration Plan for the Bitterroot Watershed (Bitter Root Water Forum, 2020). It prioritizes restoration action in 13 subwatersheds throughout the Bitterroot valley. It specifically addresses the mainstem Bitterroot and all nutrient impaired tributaries covered in this document, except Lick, Bass, and Sweathouse Creek. The WRP recommends management measures that restore shade and instream flow on tributaries and within the Bitterroot River corridor itself, including:

- targeted riparian plantings with or without livestock exclusion fencing
- off stream water systems for livestock
- irrigation efficiency projects
- instream flow transactions
- upgrading or relocating septic systems currently near streams
- establishing conservation easements or riparian management zones on farms and ranchlands
- restoration activities that promote channel complexity, such as large woody debris or beavery mimicry, especially in channelized areas

Section 9.0 of the Bitterroot Watershed TMDLs (DEQ & EPA, 2014) provides recommendations specific to nutrient impaired tributaries that address grazing, irrigation, cropland, timber harvest, urban development, roads, mining, riparian, floodplain, and wetland solutions. Many of these recommended actions can be taken along the Bitterroot mainstem to ensure it maintains its high-quality nutrient status. Particularly important for protecting water quality in the mainstem is restoring riparian areas, floodplains, and wetlands, and protecting those that already exist. Initiatives to protect riparian areas and floodplains will help protect property, increase channel stability, and buffer waters from pollutants.

MEASURES OF SUCCESS
• Number of projects or best practices implemented • Acres of new conservation easements along streams and wetlands • Miles of riparian fencing installed • Number of septic systems upgraded or hooked into centralized wastewater treatment systems • Miles of streambank with riparian vegetation restored

7.2 Prioritize Riparian and Wetland Projects by Existing Condition

DEQ has categorized wetlands and riparian areas in the Bitterroot watershed according to their condition (**Figures 7.1 and 7.2**). This resource (**Appendix B**) can be used to prioritize outreach and identify the most effective locations for best practice implementation.

Wetlands, like riparian areas, can be extremely effective climate resiliency tools. They provide water storage for drought and flood mitigation, refugia for wildlife, and buffering streams, rivers, and lakes from nonpoint sources of pollutants. Beginning with tracking, then increasing, the acres of wetlands restored or protected is a measure of success for protecting the mainstem Bitterroot from nutrient impairment.

The Montana Wetland Program and Montana Natural Heritage Program developed a GIS model to help prioritize wetland restoration or protection activities. Individual wetlands were indexed based on their ecological importance and vulnerability to threat using a statewide geographic data model. The following factors were used to assign each wetland a value for ecological importance:

- Rarity
- Hydrologic complexity
- Patchiness of wetlands
- Patchiness of surrounding landscape
- Headwaters location
- Habitat significance for species of conservation concern

The following factors were used to assign each wetland a value for vulnerability to threat:

- Potential for the wetland's conversion to exurban development, human land use, or oil and gas development
- Risk based on Montana Natural Heritage Program's Human Disturbance Index
- Potential change in the wetland's water balance from climate change
- Potential for surrounding native land covers being converted to cropland

Based on the resulting ecological importance and vulnerability to threat, each wetland was categorized into priority action quadrants that identify approaches to protect and restore wetlands in the Bitterroot Watershed (e.g., high ecological priority and high vulnerability wetlands are a top priority to target for restoration and protection. Results for the Bitterroot watershed are shown in **Figure 7.1** (see **Appendix B** for a web map application).

MEASURES OF SUCCESS
• Number of projects implemented where riparian vegetation or wetlands are poor or under threat

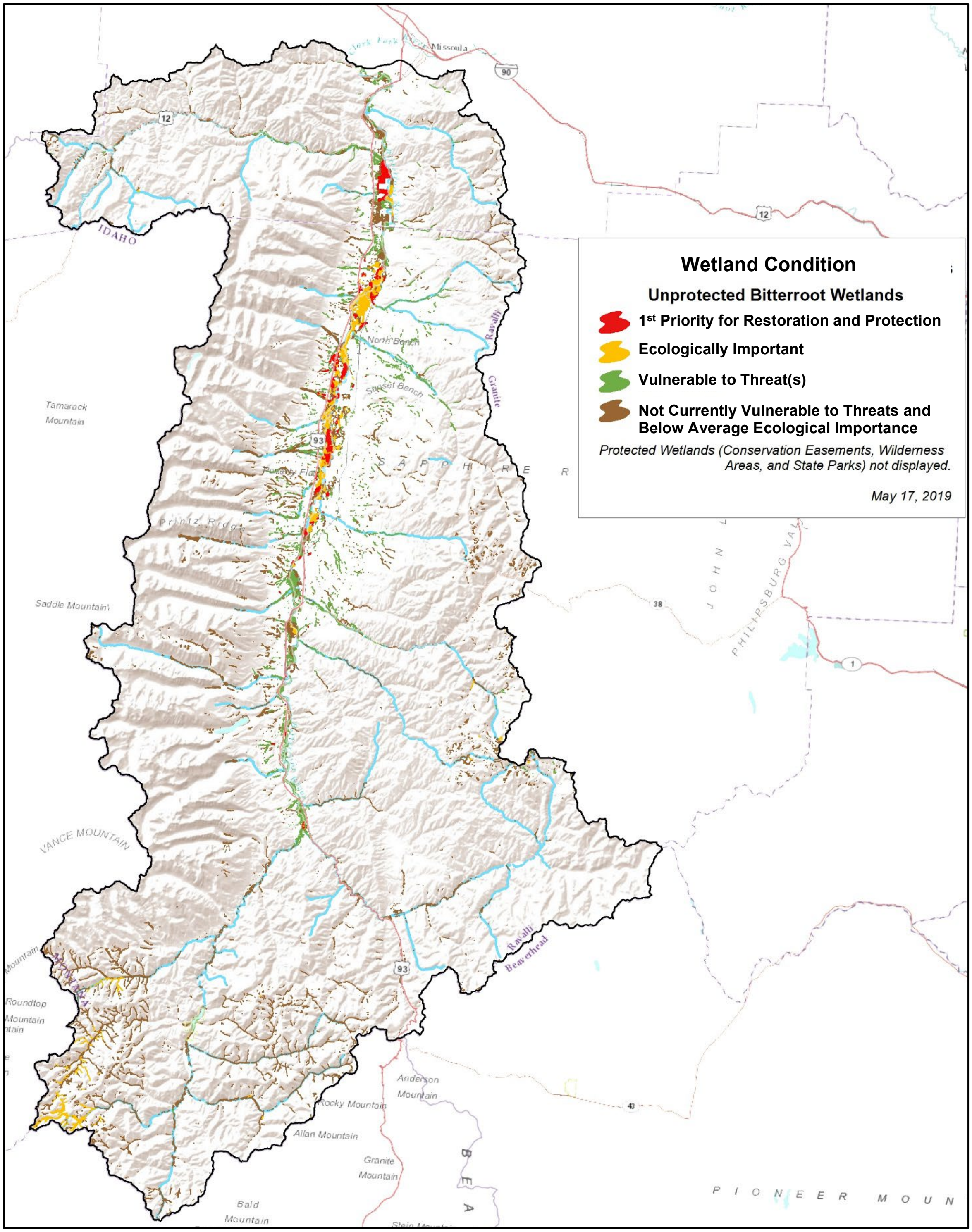

Figure 7.1. A map of wetland condition. Red corresponds to ecologically important wetlands that are vulnerable to threats and should be a priority for protection and restoration. Yellow corresponds to ecologically important wetlands that are not currently vulnerable to threats. Green corresponds to wetlands with below average ecological importance but are vulnerable to threats. Brown corresponds to wetlands that are not currently vulnerable to threats and have below average ecological importance.

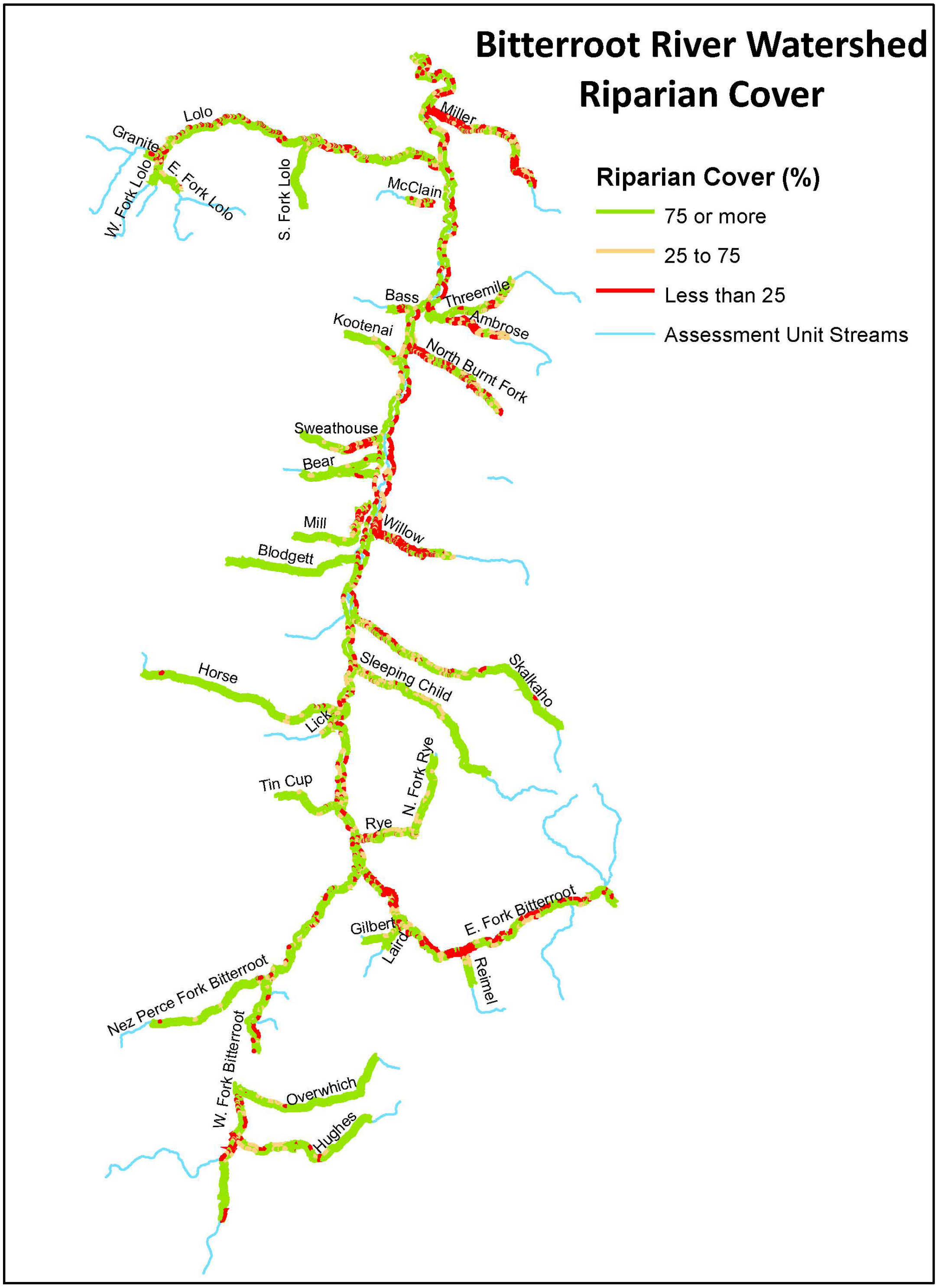

Figure 7.2. A map of riparian vegetation cover condition along impaired streams in the Bitterroot watershed.

7.3 Locally Implemented Regulation and Education to Promote Water Quality-Friendly Development

New local zoning or regulations can protect the functions of floodplains and wetland areas where future development may occur. Implementing requirements for protecting native vegetation buffers within a minimum of 50 feet of streams, or maintaining septic systems, can be effective mechanisms for maintaining or improving stream health. As large acreages are subdivided into smaller lots, the number of septic systems and impervious surfaces in the watershed increases. Plans for development of lands within the Bitterroot watershed should consider the effects of additional septic systems (**Section 6.0**) and consider ways of minimizing septic impacts to water quality such as:

- Installing pressure dosed drainfields to improve system treatment and longevity
- Installing Level II treatment systems to decrease nitrogen loading
- Installing systems further away from streams to allow for more nutrients attenuation
- Connecting new residences to an existing wastewater treatment facility (WWTF) or a community facility.

New local ordinances can require periodic reporting of septic system status or extra requirements for septic systems. For example, Missoula County already uses special management areas where extra regulations or requirements, often related to septic systems, are enacted. In 2011, Lewis and Clark County implemented the Septic System Maintenance Program, which requires pumping and inspection of all septic treatment systems and reporting on their status every 3-5 years (Lewis and Clark County, 2020). Regular maintenance ensures that human health is protected from diseases found in wastewater and transported through groundwater and helps avoid more costly repairs. For systems with the potential to influence surface waters, regular maintenance can help reduce nutrient pollution, particularly if an inspection finds the system has failed or is at risk of failing.

Simply raising awareness about local threats to human health and water resources due to septic systems can result in water quality improvement actions. For example, the Flathead Basin Commission published a study that maps the effectiveness of a septic system's performance due to geophysical factors in Lake and Flathead Counties, similar to the MEANSS model (**Section 5.4**, River Design Group, 2022). Additionally, Flathead County began a septic system permit in 1978, and has since compiled a database of septic system locations and ages throughout the county. This aged-weighted density data was combined with the geophysical risk model to create a county-wide map of areas where existing septic systems pose significant risk to adjacent water resources and public health. This tool is a valuable resource for homeowners, planners, and regulators to make science-based decisions with local saliency. Alongside this effort, the Flathead Basin Septic Maintenance Reimbursement Program began in 2020, funded in part with a §319 grant. Eligible septic system owners are eligible for a 50% cost reimbursement to have their septic system pumped. Water quality improvement is one goal of this program, although program partners recognize that remedying poorly sited, aged or failing, and undersized systems is where most water quality benefits are to be found. Nonetheless, the program provides important outreach opportunities to inform landowners about their septic systems and actions needed to maintain them.

Outreach campaigns could provide information about appropriate fertilizer application rates for lawns and gardens, preserving existing riparian vegetation, native vegetation for landscaping, maintaining a buffer to protect riparian and wetland areas, and practices to reduce the amount of stormwater originating from developed property. Collectively, these education campaigns and locally-driven ordinances help prevent cumulative impacts on water quality from existing and new development.

MEASURES OF SUCCESS
• Number of distinct outreach campaigns. "Distinct" may be defined by a specific audience (e.g. new homeowners in Ravalli County), reached with a specific strategy (e.g. informational brochure) and calls to action (e.g. maintain septic system) • Number of County, City, or Homeowner Association level ordinances for water quality-friendly development

7.4 Avoid Installing Rip Rap

The use of riprap or other "hard" approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although it is necessary in some instances, it generally redirects channel energy, exacerbates erosion for downstream landowners, disconnects floodplains and reduces native vegetation. Bank armoring should be limited to areas with a demonstrated threat to infrastructure. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the bank, reduce stream scouring energy, and provide shading and habitat. Limit threats to infrastructure by reducing floodplain development through local land use planning initiatives.

MEASURES OF SUCCESS
• Number of 310 inquiries for rip rap where a softer approach was used instead

7.5 Continue Developing Strategies to Address Water Shortages

Water rights in the Bitterroot watershed, like many watersheds in Montana, are over-allocated. This results in many streams becoming dewatered during virtually all years, and especially during drought years. Most of the middle segment of the Bitterroot River is considered chronically dewatered, along with a few tributaries impaired by nutrients (FWP, 2015; **Figure 7.3**). Increasing year-round instream flows may help dilute nutrient pollution, meet temperature targets, and improve habitat quality and connectivity for aquatic organisms.

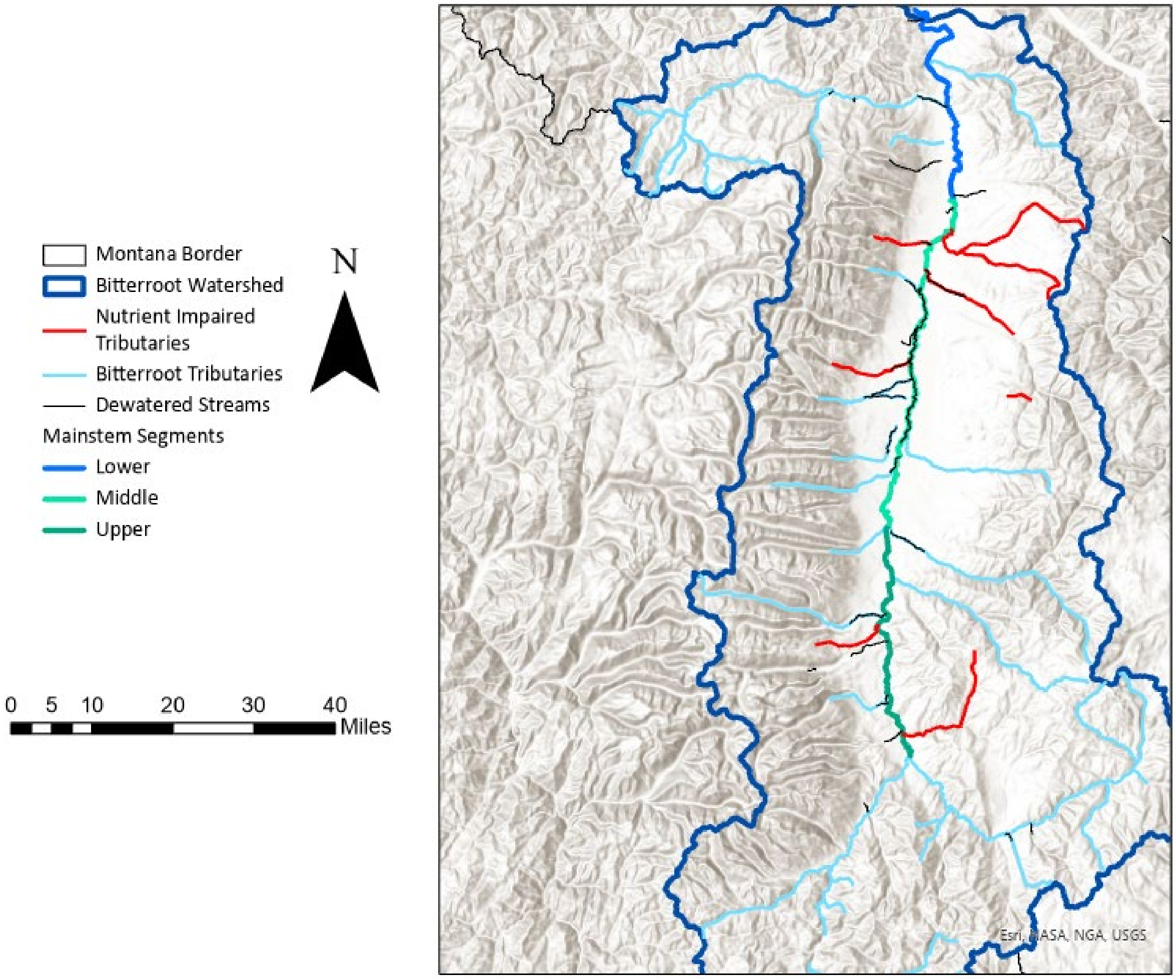

Figure 7.3. Chronically dewaters streams overlaying nutrient impaired tributaries and the three mainstem segments.

Multiple local organizations, such as the Bitter Root Water Forum, Bitterroot Conservation District, Clark Fork Coalition, and Trout Unlimited, work to implement strategies that address water shortages. Some potential projects include increasing reservoir storage, securing instream flow leases, and addressing ditch seepage and flood irrigation in a way that does not negatively impact groundwater recharge. Other strategies include implementing voluntary drought management plans where consumptive water users voluntarily reduce water use when instream flows reach pre-established thresholds (e.g., Big Hole Watershed Committee, 2016). This strategy helps distribute the impacts of drought years to junior and senior water rights holders and ensures instream flows are maintained.

MEASURES OF SUCCESS
• Number of instream flow leases secured • Number of irrigation improvement projects • Number of stakeholder meetings to address voluntary drought management • Reduction in the number of days hoot owl restrictions (i.e., temporary fishing closures due to high water temperatures) are placed on the Bitterroot River

7.6 Continue Optimizing or Upgrading Treatment of Municipal Wastewater and Stormwater

Municipal wastewater treatment facilities in the Bitterroot watershed can continue the iterative process of facility optimization. Optimization uses existing facility infrastructure to improve nutrient treatment at a fraction of the cost of a traditional upgrade. DEQ encourages facility operators to continue attending DEQ's optimization trainings and hosting one-on-one site visits to gain insights specific to their facility.

Most municipalities in the Bitterroot watershed, excluding much of Missoula, are not regulated under a municipal stormwater permit. Where stormwater is not regulated, it is considered a nonpoint source of pollution, and voluntary actions may be implemented to reduce pollution loading. DEQ recommends municipalities monitor their stormwater infrastructure, especially outfalls that reach surface water, to determine where improvements may be made. Because stormwater in municipalities like Stevensville, Hamilton, and Darby are considered nonpoint sources, best practices to improve stormwater treatment are eligible for nonpoint source §319 grant funding.

MEASURES OF SUCCESS
• Declining trend of effluent nutrient concentrations or loads from wastewater treatment facilities • Number of stormwater projects implemented within towns and cities

7.7 Leverage Diverse Funding Sources

Protecting and restoring water quality can help mitigate impacts from future natural disasters, like drought and flooding. By protecting and restoring riparian areas and wetlands, these zones can provide space for flood water energy to dissipate, and for groundwater to be recharged, both of which can mitigate late season drought.

As Counties work to update Hazard Mitigation Plans that are necessary to receive emergency resources, incorporating floodplain and riparian restoration and protection can increase the pools of funding available to local communities.

MEASURES OF SUCCESS
• Riparian and wetland restoration and protection incorporated into hazard mitigation planning • Number of water quality projects funded with FEMA grants

8.0 Water Quality Monitoring Activities & Measures of Success

This section describes an overall strategy for monitoring and evaluation to ensure that water quality is maintained in the Bitterroot River. Recommendations in this Protection Plan are not required by the Clean Water Act or Montana statute and are primarily implemented through voluntary actions.

DEQ does not implement these actions and activities itself. Instead, successful implementation of this Protection Plan requires collaboration among land use planners, land management agencies, and other stakeholders. DEQ and other entities provide technical and financial assistance to local organizations interested in monitoring their water quality. Please find more information at https://deq.mt.gov/water/Programs/sw#accordion3-collapse1.

8.1 Maintain or Decrease Current Bitterroot River Nutrient Concentrations

A key concept required of Protection Plans is a timeframe over which a protection target is expected to be attained and maintained. DEQ's previous 5-year trend analysis projects have generated robust datasets with sufficient power to detect changes in water quality (HydroSolutions, 2019). Beginning in 2019, DEQ and the Clark Fork Coalition initiated long-term nutrient monitoring on the mainstem Bitterroot River. Continued summer monitoring, annual status reports, and trend analyses every 5-years will provide an ideal measure of success for protecting the Bitterroot River. These reports and trend analyses may be found on the Clark Fork Coalition's webpage, clarkfork.org.

MEASURES OF SUCCESS
• Each year of mainstem nutrient monitoring results, or each 5-year trend analysis, show nutrient concentrations are maintaining current conditions • Nutrient concentrations remain below the suggested nutrient targets (**Section 3.0**)

8.2 Decrease Nutrient Concentrations in Tributaries Impaired by Nutrients

Decreasing nutrient concentrations in tributaries impaired by nutrients will benefit local and downstream conditions. Locally, streams will be better able to support aquatic life and other beneficial uses. Downstream, reduced nutrients will help protect the Bitterroot River from nutrient impairment.

Nutrient concentrations may be measured and tracked by collecting water column samples for laboratory analysis. DEQ provides volunteer monitoring technical and financial support for local organizations interested in this activity. In the Bitterroot watershed, the Bitterroot River Protection Association conducts volunteer monitoring on a number of tributaries. It is important that this data is collected and submitted to DEQ according to QA/QC protocols (https://deq.mt.gov/water/Programs/sw#accordion3-collapse2) for its inclusion in any future impairment assessments.

Monitoring nutrient concentrations with water quality sampling in tributaries may not be the most effective use of resources until significantly more best practices have been implemented. For example, the Bitterroot tributaries nutrient TMDLs state that agriculture is the primary land use and the most likely significant nutrient source to North Burnt Fork Creek (DEQ, 2014). To meet total nitrogen targets, human-caused sources of nutrients, primarily from agriculture, must be reduced by approximately 20%. Periodically, DEQ's Nonpoint Source Program will publish TMDL Implementation Evaluations (TIEs), which compile the monitoring, restoration, and planning work that has been implemented since TMDLs were published. If sufficient TMDL implementation has occurred, TIEs may include a recommendation for the waterbody to be reassessed. Therefore, an increase in the number of conservation practices implemented are a great measure of success towards improving nutrient condition in Bitterroot tributaries. For a compilation of known conservation practices implemented, see the Bitterroot Watershed Restoration Plan (Bitter Root Water Forum, 2020), or DEQ's §319 projects map (**Appendix B**). Nutrient load reductions reported with §319 projects are another great indicator of decreasing nutrient concentrations.

MEASURES OF SUCCESS
• Decreasing nutrient concentrations in tributaries impaired by nutrients • Monitoring data collected by local organizations submitted to DEQ • Number of TMDL Implementation Evaluations published by DEQ • Nutrient load reductions associated with §319 projects

8.3 Increase Riparian Vegetation Along the Mainstem and its Tributaries

Streamside vegetation, or "riparian" vegetation, can be extremely effective at buffering streams, rivers, and lakes from nonpoint sources of pollutants. It is possible to use publicly available imagery to account for varying riparian vegetation cover as a proxy for water quality conditions. This method is limited by the fact that some sources of nonpoint source pollution can be below ground or difficult to observe from aerial imagery. DEQ evaluated riparian vegetation cover along impaired streams within the Bitterroot Watershed, primarily using 2017 aerial imagery (**Appendix B**). This information can help prioritize restoration efforts and track changes of riparian vegetation in the future.

DEQ intends to re-run this analysis in approximately 2027 using up-to-date aerial imagery, and an increase in riparian cover would be a great indicator of success. **Figure 8.1** shows the results of the initial 2017 analysis. Of Bitterroot tributaries that are impaired by nutrients, Ambrose (a tributary to Threemile), North Burnt Fork, and Lick Creeks have remarkably low amounts of riparian cover and would greatly benefit from passive or active riparian restoration activities. The Bitterroot River itself has over 60% "high" riparian cover, relatively high compared to other streams evaluated. However, there are portions along the Bitterroot River with much lower quality riparian cover, such as between Willow and North Burnt Fork Creeks (**Figure 7.2**).

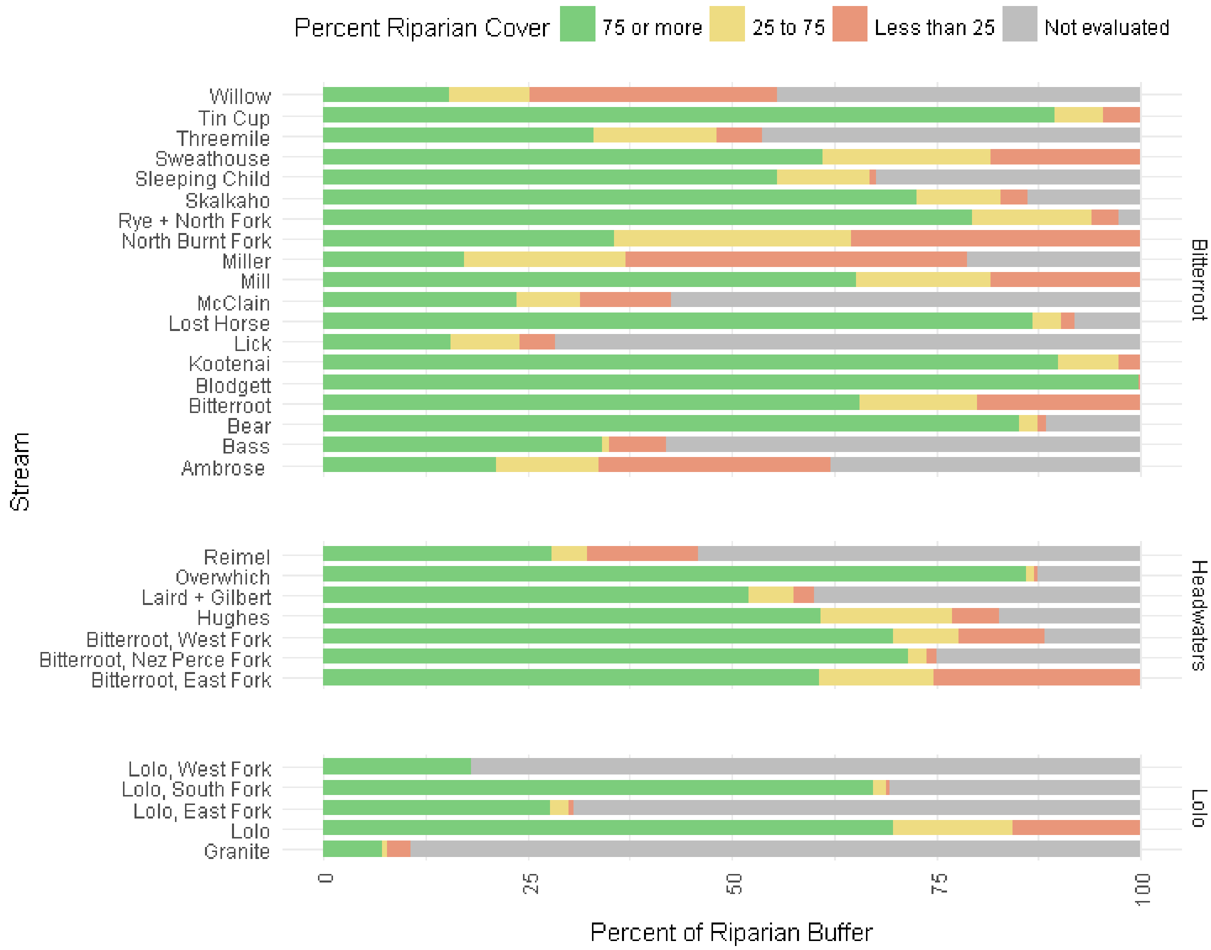

Figure 8.1. This graphic shows the proportion of stream evaluated by aerial imagery that was found to have high (>75%), moderate (25-75%) or low (<25%) vegetation coverage in the riparian buffer. Most unevaluated reaches are in heavily forested USFS property, where fine scale source assessment work is routinely conducted.

Note that the Bitterroot temperature TMDL recommends an effective increase in shade over the river of at least 0.5% (DEQ, 2011). This aerial evaluation does not directly measure shade over the stream, although it may be a good indicator of progress towards achieving temperature targets.

MEASURES OF SUCCESS
• Increase in riparian vegetation cover since the 2017 riparian evaluation completed by DEQ, especially if that increase occurs along nutrient impaired tributaries or the mainstem Bitterroot

8.4 Social Indicators

Reducing nonpoint sources of pollution in a way that results in measurable water quality improvement requires widespread understanding of the issue and action taken by individuals and communities to address the issue. Even after widespread adoption of nonpoint source pollution reduction activities, it will take time for these improvements to manifest in a water chemistry signature. For example, it takes time for a newly installed riparian vegetation buffer to establish and effectively buffer streams from pollution. Detectable water quality improvement will always be preceded by a change in community awareness and willingness to act on nonpoint source pollution issues.

Community Readiness Assessments (CRA) can help guide outreach strategies and measure social change (Oetting et al., 2001). CRAs can gauge how ready a community is to address a particular issue and provides recommendations for outreach specific to that stage. After implementing the recommended activities, the CRA may be rerun to detect change in readiness. In 2020, DEQ and the Bitter Root Water Forum completed a CRA focused on the issue of "the loss of riparian vegetation" within the Bitterroot rancher community. Results show that community is in a "Preplanning" phase, the 4th of nine phases. DEQ seeks to use this CRA as a measure of success by rerunning interviews with key community informants again in approximately 2023.

MEASURES OF SUCCESS

- Raise awareness
    - An increase in the number of press releases, media articles, videos or social media content, and TV or radio public service announcements developed about nonpoint source pollution
    - An increase in participation at public forums or volunteer events
    - An increase in nonpoint source pollution related webpage views
- Increase actions taken
    - An increase in inquiries to local organizations seeking guidance for managing nonpoint source pollution on their property
    - An increase in legislative priorities or local ordinances aimed at reducing nonpoint sources of pollution
- Increase community readiness levels

9.0 Planned Responses to Changes in Condition

Tracking measures of success (**Sections 7.0-8.0**) will guide the effectiveness of Bitterroot River protection activities. An understanding of the ramifications of Bitterroot River nutrient impairment will be a useful framework for outreach to protect the Bitterroot River's high-quality status. For example, it may be easier to build buy-in to implement voluntary best practices if local jurisdictions can communicate the risk of utility rate increases due to increased water treatment required to maintain human health. Additionally, hoot owl fishing closures (i.e., temporary fishing closures due to high water temperatures) can impact local economies that rely on the business of recreators on the Bitterroot River. Local experts and guides can communicate with the public that these hoot owl restrictions originate at the watershed scale. Protecting and restoring riparian vegetation throughout the watershed can lower temperatures and help prevent future restrictions on the mainstem Bitterroot River. Similarly, when water shortages limit access to surface water rights, local experts can use this opportunity to promote restoration activities that increase stream channel complexity, store water on the landscape longer, and help reduce nutrient pollution. Ultimately, the management practices that protect water quality have short- and long-term economic benefits and can also improve the quality of living in the Bitterroot valley.

For DEQ's part in implementing this Protection Plan, the agency will continue support for the Bitterroot Mainstem long-term nutrient monitoring and ensure that results are reported to the public. If nutrient conditions begin to worsen, DEQ will issue a press release, reinvigorate outreach with stakeholders, and if possible, target outreach to stakeholders most likely to influence nutrient pollution. More specific studies may be necessary to determine the highest risk of nutrient pollution and future nutrient reassessment may be warranted as population and pollution sources increase. If reassessment indicates that one or more segments of the Bitterroot River have become impaired by nutrients, a TMDL will be required and may lead to changes in permit requirements and limits. Additionally, voluntary water quality improvement projects may rise in priority for available funding. However, the costs to restore water quality are notoriously larger than costs to protect water quality (Postel and Thompson, 2005). Similarly, implementing certain projects may become more expensive the longer they are delayed. For example, the opportunity to implement an easement may become prohibitively expensive as land value increases.

This Protection Plan was written to emphasize the unique, high-quality condition of the Bitterroot River. Implementing the recommendations in this Protection Plan will maintain and protect water quality, while also building resiliency for Bitterroot communities as climate, population, and water quality conditions fluctuate.

10.0 PUBLIC PARTICIPATION AND PUBLIC COMMENTS

The document contains input from local stakeholders throughout. The concept of a protection plan was presented at a Bitterroot stakeholders' meeting in the summer of 2020. The public comment document was presented at a Bitterroot stakeholders' meeting in the winter of 2022, concurrent with the 4-week public comment period. DEQ reached out to the following stakeholder groups for Bitterroot stakeholders' meetings:

- Bitter Root Water Forum
- Bitterroot Conservation District
- Bitterroot National Forest
- Bitterroot River Protection Association
- Cities of Stevensville, Hamilton, and Darby
- Clark Fork Coalition
- Environmental Protection Agency
- Lee Metcalf National Wildlife Refuge
- Lolo National Forest
- Lolo Watershed Group
- Missoula Conservation District
- Missoula County & Water Quality District
- Ravalli County Environmental Health
- Trout Unlimited
- University of Montana

Upon completing the draft Protection Plan, DEQ issued a press release on February 25th that announced the public comment period and a Bitterroot stakeholders' meeting that included a presentation on the draft Protection Plan. The press release was published on DEQ's website and distributed to multiple media outlets based in Missoula and Ravalli Counties. The public comment period for this document began February 25, 2022, and closed March 28, 2022. No public comment was received. At the stakeholders' meeting, DEQ provided an overview of the Protection Plan document, answered questions, and solicited input and comment on the document. The Protection Plan was one of many topics on the stakeholders' meeting agenda.

Additionally, the Water Pollution Control Advisory Council and the Statewide TMDL Advisory Group were notified of the public comment period. Stakeholder and public involvement are not required by state law for publishing protection plans.

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APPENDIX A – NUTRIENT MONITORING DATA

This appendix contains two tables of the data used by the Montana Department of Environmental Quality (DEQ) to determine water column nutrient concentrations and loads on the mainstem Bitterroot (**Tables A.1** and **A.2**). The tables are included to aid readers in finding data more easily. All data contained in the tables are available in the National Water Quality Portal at https://www.waterqualitydata.us/. Note that.

Table Symbols and notations:

- "<" symbol: Indicates non-detectable samples where the detection limit is populated as the value
- Blank cell: Where no value is given, no data was collected

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Montana DEQ	Bitterroot R near Missoula abv bridge on N Ave-akaC04BITTR01	C05BITTR01	8/24/2012	Lower	46.853333	-114.098889	0.22	0.007
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/2/2009	Lower	46.83194	-114.05306	0.142	0.0136
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/6/2009	Lower	46.83194	-114.05306	0.208	0.0175
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/3/2009	Lower	46.83194	-114.05306	0.212	0.012
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/8/2010	Lower	46.83194	-114.05306	0.154	0.0132
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/12/2010	Lower	46.83194	-114.05306	0.264	0.0193
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/16/2010	Lower	46.83194	-114.05306	0.189	0.013
Montana DEQ	Bitterroot River at Buckhouse Bridge	MDEQ_WQ_WQX-C05BITRR02	8/24/2012	Lower	46.83012	-114.05406	0.16	0.008
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	10/1/2013	Lower	46.83194	-114.05306	0.5639	0.05959
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/12/2017	Lower	46.83194	-114.05306	0.189	0.0126
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/27/2017	Lower	46.83194	-114.05306	0.381	0.0145
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/9/2017	Lower	46.83194	-114.05306	0.286	0.0151

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/23/2017	Lower	46.83194	-114.05306	0.233	0.0107
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/6/2017	Lower	46.83194	-114.05306	0.239	0.0118
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/20/2017	Lower	46.83194	-114.05306	0.23	0.0114
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/7/2019	Lower	46.83194	-114.05306	0.2	0.015
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/16/2019	Lower	46.83194	-114.05306	0.18	0.012
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/30/2019	Lower	46.83194	-114.05306	0.23	0.014
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/20/2019	Lower	46.83194	-114.05306	0.19	0.01
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/5/2019	Lower	46.83194	-114.05306	0.17	0.011
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/19/2019	Lower	46.83194	-114.05306	0.16	0.013
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	10/3/2019	Lower	46.83194	-114.05306	0.14	0.01
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/9/2020	Lower	46.83194	-114.05306	0.11	0.009
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/31/2020	Lower	46.83194	-114.05306	0.26	0.008
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/13/2020	Lower	46.83194	-114.05306	0.18	0.012
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/27/2020	Lower	46.83194	-114.05306	0.17	0.012
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/10/2020	Lower	46.83194	-114.05306	0.18	0.006
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	10/1/2020	Lower	46.83194	-114.05306	0.18	0.01
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/14/2021	Lower	46.83194	-114.05306	0.15	0.015
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	7/14/2021	Lower	46.83194	-114.05306	0.16	0.015

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/4/2021	Lower	46.83194	-114.05306	0.17	0.011
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/16/2021	Lower	46.83194	-114.05306	0.19	0.018
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	8/31/2021	Lower	46.83194	-114.05306	0.16	0.012
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/10/2021	Lower	46.83194	-114.05306	0.16	0.012
Local Organization	Bitterroot River at Buckhouse Bridge	MTWTRSHD_WQX-COMBITR02	9/28/2021	Lower	46.83194	-114.05306	0.15	0.01
Montana DEQ	Bitterroot River at Chief Looking Glass	MDEQ_WQ_WQX-C05BITRR27	8/20/2012	Lower	46.66113	-114.05181	0.16	0.01
Montana DEQ	Bitterroot River at Chief Looking Glass	MDEQ_WQ_WQX-C05BITRR27	9/19/2012	Lower	46.66113	-114.05181	0.11	0.006
Montana DEQ	Bitterroot River at Lolo Park	MDEQ_WQ_WQX-C05BITRR26	9/19/2012	Lower	46.77441	-114.06442	0.11	0.006
Local Organization	Bitterroot River at McClay's Bridge	COMBITR01	7/2/2009	Lower	46.85389	-114.09889	0.143	0.015
Local Organization	Bitterroot River at McClay's Bridge	COMBITR01	8/6/2009	Lower	46.85389	-114.09889	0.246	0.017
Local Organization	Bitterroot River at McClay's Bridge	COMBITR01	9/3/2009	Lower	46.85389	-114.09889	0.216	0.0119
Local Organization	Bitterroot River at McClay's Bridge	COMBITR01	7/8/2010	Lower	46.85389	-114.09889	0.155	0.013
Local Organization	Bitterroot River at McClay's Bridge	COMBITR01	8/12/2010	Lower	46.85389	-114.09889	0.267	0.0177
Local Organization	Bitterroot River at McClay's Bridge	COMBITR01	9/16/2010	Lower	46.85389	-114.09889	0.204	0.0115
Tristate Water Quality Council	Bitterroot River mainstem at Buckhouse Bridge	TSWQC_WQX-BWMBUKHSBR	7/27/2008	Lower	46.831667	-114.053611	0.15	0.014
Tristate Water Quality Council	Bitterroot River mainstem at Buckhouse Bridge	TSWQC_WQX-BWMBUKHSBR	8/31/2008	Lower	46.831667	-114.053611	0.18	0.02
Tristate Water Quality Council	Bitterroot River mainstem at Buckhouse Bridge	TSWQC_WQX-BWMBUKHSBR	9/28/2008	Lower	46.831667	-114.053611	0.12	0.01
Montana DEQ	Bitterroot River upstream Miller Creek	MDEQ_WQ_WQX-C05BITRR32	9/19/2012	Lower	46.80373	-114.09509	0.12	0.006

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Montana DEQ	Bitterroot River upstream of Maclay Bridge	MDEQ_WQ_WQX-C05BITRR25	9/21/2012	Lower	46.8375	-114.10389	0.19	0.005
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/11/2017	Middle	46.24693	-114.176	0.099	0.0109
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/25/2017	Middle	46.24693	-114.176	0.142	0.0097
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/8/2017	Middle	46.24693	-114.176	0.143	0.0112
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/22/2017	Middle	46.24693	-114.176	0.143	0.01
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/5/2017	Middle	46.24693	-114.176	0.2	0.0095
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/19/2017	Middle	46.24693	-114.176	0.162	0.0088
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/6/2019	Middle	46.24693	-114.176	0.1	0.008
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/17/2019	Middle	46.24693	-114.176	0.08	0.007
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/31/2019	Middle	46.24693	-114.176	0.12	0.012
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/21/2019	Middle	46.24693	-114.176	0.13	0.007
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/4/2019	Middle	46.24693	-114.176	0.13	0.01
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/18/2019	Middle	46.24693	-114.176	0.1	0.015
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	10/2/2019	Middle	46.24693	-114.176	0.08	0.008
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/8/2020	Middle	46.24693	-114.176	0.03	0.009
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/29/2020	Middle	46.24693	-114.176	0.08	0.008
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/12/2020	Middle	46.24693	-114.176	0.12	0.008
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/26/2020	Middle	46.24693	-114.176	0.11	0.009

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/9/2020	Middle	46.24693	-114.176	0.09	0.005
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/30/2020	Middle	46.24693	-114.176	0.09	0.008
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	7/13/2021	Middle	46.24693	-114.176	0.12	0.022
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/4/2021	Middle	46.24693	-114.176	0.12	0.011
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/16/2021	Middle	46.24693	-114.176	0.12	0.012
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	8/31/2021	Middle	46.24693	-114.176	0.1	0.01
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/13/2021	Middle	46.24693	-114.176	0.1	0.008
Local Organization	Bitteroot River at Hamilton Bridge	MTWTRSHD_WQX-BITR-C05BITTR03	9/28/2021	Middle	46.24693	-114.176	0.11	0.007
Montana DEQ	Bitterroot River at Bell Crossing	MDEQ_WQ_WQX-C05BITRR24	8/13/2012	Middle	46.4436	-114.1263	0.12	0.009
Montana DEQ	Bitterroot River at Bell Crossing	MDEQ_WQ_WQX-C05BITRR24	9/14/2012	Middle	46.4436	-114.1263	0.1	0.006
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	7/7/2019	Middle	46.4436	-114.1263	0.11	0.012
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	7/16/2019	Middle	46.4436	-114.1263	0.1	0.009
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	7/30/2019	Middle	46.4436	-114.1263	0.12	0.012
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	8/20/2019	Middle	46.4436	-114.1263	0.12	0.008
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	9/5/2019	Middle	46.4436	-114.1263	0.12	0.011
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	9/18/2019	Middle	46.4436	-114.1263	0.1	0.013
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	10/2/2019	Middle	46.4436	-114.1263	0.08	0.011
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	7/9/2020	Middle	46.4436	-114.1263	0.09	0.009

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	7/31/2020	Middle	46.4436	-114.1263	0.09	0.008
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	8/13/2020	Middle	46.4436	-114.1263	0.11	0.012
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	8/27/2020	Middle	46.4436	-114.1263	0.11	0.015
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	9/10/2020	Middle	46.4436	-114.1263	0.11	0.008
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	10/1/2020	Middle	46.4436	-114.1263	0.1	0.01
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	7/13/2021	Middle	46.4436	-114.1263	0.12	0.016
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	8/4/2021	Middle	46.4436	-114.1263	0.11	0.012
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	8/17/2021	Middle	46.4436	-114.1263	0.12	0.013
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	8/27/2021	Middle	46.4436	-114.1263	0.13	0.011
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	9/14/2021	Middle	46.4436	-114.1263	0.12	0.01
Local Organization	Bitterroot River at Bell Crossing	MTWTRSHD_WQX-BITR-C05BITRR24	9/28/2021	Middle	46.4436	-114.1263	0.1	0.008
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/11/2017	Middle	46.633056	-114.049167	0.199	0.0158
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/25/2017	Middle	46.633056	-114.049167	0.297	0.0171
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/8/2017	Middle	46.633056	-114.049167	0.255	0.0185
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/22/2017	Middle	46.633056	-114.049167	0.273	0.0124
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/5/2017	Middle	46.633056	-114.049167	0.232	0.0133
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/19/2017	Middle	46.633056	-114.049167	0.251	0.0124
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/7/2019	Middle	46.633056	-114.049167	0.17	0.015

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/16/2019	Middle	46.633056	-114.049167	0.17	0.014
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/30/2019	Middle	46.633056	-114.049167	0.21	0.015
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/20/2019	Middle	46.633056	-114.049167	0.18	0.014
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/5/2019	Middle	46.633056	-114.049167	0.2	0.011
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/19/2019	Middle	46.633056	-114.049167	0.17	0.012
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	10/3/2019	Middle	46.633056	-114.049167	0.13	0.011
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/9/2020	Middle	46.633056	-114.049167	0.1	0.012
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	7/31/2020	Middle	46.633056	-114.049167	0.14	0.019
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/13/2020	Middle	46.633056	-114.049167	0.17	0.012
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/27/2020	Middle	46.633056	-114.049167	0.16	0.014
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/10/2020	Middle	46.633056	-114.049167	0.15	0.012
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	10/1/2020	Middle	46.633056	-114.049167	0.17	0.011
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/4/2021	Middle	46.633056	-114.049167	0.15	0.014
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/17/2021	Middle	46.633056	-114.049167	0.17	0.018
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	8/27/2021	Middle	46.633056	-114.049167	0.13	0.011
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/14/2021	Middle	46.633056	-114.049167	0.13	0.012
Local Organization	Bitterroot River at Florence bridge	MTWTRSHD_WQX-COMBITR03	9/27/2021	Middle	46.633056	-114.049167	0.14	0.01
Montana DEQ	Bitterroot River at Poker Joe Fishing Access	MDEQ_WQ_WQX-C05BITRR31	8/8/2012	Middle	46.58027	-114.0775	0.16	0.009

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Montana DEQ	Bitterroot River at Poker Joe Fishing Access	MDEQ_WQ_WQX-C05BITRR31	9/14/2012	Middle	46.58027	-114.0775	0.12	0.005
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/11/2017	Middle	46.2792	-114.1606	0.129	0.0181
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/25/2017	Middle	46.2792	-114.1606	0.155	0.0231
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/8/2017	Middle	46.2792	-114.1606	0.176	0.0172
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/22/2017	Middle	46.2792	-114.1606	0.174	0.0157
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/5/2017	Middle	46.2792	-114.1606	0.181	0.0132
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/19/2017	Middle	46.2792	-114.1606	0.158	0.0153
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/6/2019	Middle	46.2792	-114.1606	0.11	0.01
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/17/2019	Middle	46.2792	-114.1606	0.09	0.01
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/31/2019	Middle	46.2792	-114.1606	0.12	0.025
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/21/2019	Middle	46.2792	-114.1606	0.14	0.018
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/4/2019	Middle	46.2792	-114.1606	0.15	0.016
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/18/2019	Middle	46.2792	-114.1606	0.11	0.015
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	10/2/2019	Middle	46.2792	-114.1606	0.09	0.01
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/8/2020	Middle	46.2792	-114.1606	0.06	0.008
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/29/2020	Middle	46.2792	-114.1606	0.09	0.011
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/12/2020	Middle	46.2792	-114.1606	0.12	0.01
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/26/2020	Middle	46.2792	-114.1606	0.11	0.011

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/9/2020	Middle	46.2792	-114.1606	0.11	0.007
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/30/2020	Middle	46.2792	-114.1606	0.11	0.018
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	7/16/2021	Middle	46.2792	-114.1606	0.11	0.014
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/4/2021	Middle	46.2792	-114.1606	0.16	0.023
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/17/2021	Middle	46.2792	-114.1606	0.14	0.02
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	8/31/2021	Middle	46.2792	-114.1606	0.12	0.015
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/14/2021	Middle	46.2792	-114.1606	0.12	0.022
Local Organization	Bitterroot River at Veterans Bridge in Hamilton	MTWTRSHD_WQX-COMBITR04	9/27/2021	Middle	46.2792	-114.1606	0.15	0.05
Tristate Water Quality Council	Bitterroot River at Veteran's Bridge in Hamilton	TSWQC_WQX-BWMVTRNSBR	7/27/2008	Middle	46.2792	-114.1606	0.1	0.015
Tristate Water Quality Council	Bitterroot River at Veteran's Bridge in Hamilton	TSWQC_WQX-BWMVTRNSBR	8/31/2008	Middle	46.2792	-114.1606	0.17	0.028
Tristate Water Quality Council	Bitterroot River at Veteran's Bridge in Hamilton	TSWQC_WQX-BWMVTRNSBR	9/28/2008	Middle	46.2792	-114.1606	0.1	0.011
Montana DEQ	Bitterroot River at Veteran's Bridge in Hamilton	MDEQ_WQ_WQX-C05BITRR33	9/14/2012	Middle	46.27833	-114.16135	0.14	0.027
Montana DEQ	Bitterroot River at Woodside Bridge crossing just east of Corvalis	MDEQ_WQ_WQX-C05BITRR23	8/13/2012	Middle	46.3128	-114.1444	0.13	0.014
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	6/30/2007	Middle	46.443611	-114.123333	0.04	0.012
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	7/28/2007	Middle	46.443611	-114.123333	0.18	0.01
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	8/25/2007	Middle	46.443611	-114.123333	0.08	0.01
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	9/30/2007	Middle	46.443611	-114.123333	0.12	0.011
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	7/27/2008	Middle	46.443611	-114.123333	0.1	0.013

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	8/31/2008	Middle	46.443611	-114.123333	0.16	0.021
Tristate Water Quality Council	Bitterroot River mainstem at Bell Crossing	TSWQC_WQX-BWMBELCROS	9/28/2008	Middle	46.443611	-114.123333	0.1	0.01
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	6/30/2007	Middle	46.633056	-114.049167	0.06	0.015
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	7/28/2007	Middle	46.633056	-114.049167	0.24	0.016
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	8/25/2007	Middle	46.633056	-114.049167	0.14	0.013
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	9/30/2007	Middle	46.633056	-114.049167	0.15	0.014
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	7/27/2008	Middle	46.633056	-114.049167	0.13	0.016
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	8/31/2008	Middle	46.633056	-114.049167	0.24	0.028
Tristate Water Quality Council	Bitterroot River mainstem at Florence Bridge	TSWQC_WQX-BWMFLRNCBR	9/28/2008	Middle	46.633056	-114.049167	0.15	0.012
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	6/30/2007	Middle	46.2475	-114.177222	0.04	0.01
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	7/28/2007	Middle	46.2475	-114.177222	0.21	0.009
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	8/25/2007	Middle	46.2475	-114.177222	0.087	0.008
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	9/30/2007	Middle	46.2475	-114.177222	0.094	0.006
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	7/27/2008	Middle	46.2475	-114.177222	0.09	0.009
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	8/31/2008	Middle	46.2475	-114.177222	0.13	0.016
Tristate Water Quality Council	Bitterroot River mainstem at Main Street Hamilton	TSWQC_WQX-BWMMAINSTBR	9/28/2008	Middle	46.2475	-114.177222	0.1	0.005
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	6/30/2007	Middle	46.580278	-114.0775	0.03	0.013
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	7/28/2007	Middle	46.580278	-114.0775	0.26	0.016

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	8/25/2007	Middle	46.580278	-114.0775	0.14	0.01
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	9/30/2007	Middle	46.580278	-114.0775	0.14	0.012
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	7/27/2008	Middle	46.580278	-114.0775	0.16	0.016
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	8/31/2008	Middle	46.580278	-114.0775	0.25	0.029
Tristate Water Quality Council	Bitterroot River mainstem at Poker Joe RR Bridge	TSWQC_WQX-BWMPKRJORR	9/28/2008	Middle	46.580278	-114.0775	0.12	0.012
Tristate Water Quality Council	Bitterroot River mainstem at Silver Bridge in Hamilton	TSWQC_WQX-BWMSILVRBR	6/30/2007	Middle	46.278333	-114.161111	0.04	0.023
Tristate Water Quality Council	Bitterroot River mainstem at Silver Bridge in Hamilton	TSWQC_WQX-BWMSILVRBR	7/28/2007	Middle	46.278333	-114.161111	0.23	0.048
Tristate Water Quality Council	Bitterroot River mainstem at Silver Bridge in Hamilton	TSWQC_WQX-BWMSILVRBR	8/25/2007	Middle	46.278333	-114.161111	0.13	0.037
Tristate Water Quality Council	Bitterroot River mainstem at Silver Bridge in Hamilton	TSWQC_WQX-BWMSILVRBR	9/30/2007	Middle	46.278333	-114.161111	0.11	0.02
Montana DEQ	Bitterroot River at Anglers Rest above Hamilton and at Hwy 93 crossing	MDEQ_WQ_WQX-C05BITRR22	8/7/2012	Upper	46.1984	-114.169	0.11	0.005
Montana DEQ	Bitterroot River at Anglers Rest above Hamilton and at Hwy 93 crossing	MDEQ_WQ_WQX-C05BITRR22	9/13/2012	Upper	46.1984	-114.169	0.1	0.006
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/11/2017	Upper	45.9735	-114.14096	0.108	0.0135
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/25/2017	Upper	45.9735	-114.14096	0.126	0.007
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/8/2017	Upper	45.9735	-114.14096	0.104	0.0108
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/22/2017	Upper	45.9735	-114.14096	0.119	0.0105
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/5/2017	Upper	45.9735	-114.14096	0.136	0.0073
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/19/2017	Upper	45.9735	-114.14096	0.127	0.0092

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/6/2019	Upper	45.9735	-114.14096	0.07	0.006
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/17/2019	Upper	45.9735	-114.14096	0.06	0.018
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/31/2019	Upper	45.9735	-114.14096	0.11	0.008
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/21/2019	Upper	45.9735	-114.14096	0.09	0.005
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/4/2019	Upper	45.9735	-114.14096	0.1	0.009
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/18/2019	Upper	45.9735	-114.14096	0.06	0.014
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	10/2/2019	Upper	45.9735	-114.14096	0.06	0.008
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/8/2020	Upper	45.9735	-114.14096	0.04	0.008
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/29/2020	Upper	45.9735	-114.14096	0.08	0.002
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/12/2020	Upper	45.9735	-114.14096	0.1	0.007
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/26/2020	Upper	45.9735	-114.14096	0.09	0.014
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/9/2020	Upper	45.9735	-114.14096	0.08	0.005
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/30/2020	Upper	45.9735	-114.14096	0.1	0.007
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	7/13/2021	Upper	45.9735	-114.14096	0.1	0.009
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/4/2021	Upper	45.9735	-114.14096	0.08	0.008
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/16/2021	Upper	45.9735	-114.14096	0.1	0.004
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	8/31/2021	Upper	45.9735	-114.14096	0.09	0.007
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/13/2021	Upper	45.9735	-114.14096	0.1	0.008

Table A.1. Mainstem Bitterroot River nutrient data

Data Collection Entity	Site Name	Site ID	Activity Date	Bitterroot River Segment	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Local Organization	Bitterroot River at Hannon Fishing Access	MTWTRSHD_WQX-BITR-C05BITTR06	9/28/2021	Upper	45.9735	-114.14096	0.1	0.006
Montana DEQ	Bitterroot River below Rye Creek at USGS gaging station	MDEQ_WQ_WQX-C05BITRR21	8/7/2012	Upper	45.9725	-114.141111	0.33	0.004
Montana DEQ	Bitterroot River below Rye Creek at USGS gaging station	MDEQ_WQ_WQX-C05BITRR21	9/13/2012	Upper	45.9725	-114.141111	0.11	0.007
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	6/30/2007	Upper	45.973333	-114.140833	0.03	0.009
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	6/30/2007	Upper	45.973333	-114.140833	0.03	0.009
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	7/28/2007	Upper	45.973333	-114.140833	0.17	0.007
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	8/25/2007	Upper	45.973333	-114.140833	0.1	0.01
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	9/30/2007	Upper	45.973333	-114.140833	0.12	0.008
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	7/27/2008	Upper	45.973333	-114.140833	0.05	0.009
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	8/31/2008	Upper	45.973333	-114.140833	0.079	0.011
Tristate Water Quality Council	Bitterroot River mainstem at Darby Bridge	TSWQC_WQX-BWMDARBYBR	9/28/2008	Upper	45.973333	-114.140833	0.08	0.007
Montana DEQ	Bitterroot River near Darby	MDEQ_WQ_WQX-C05BITRR01	8/7/2012	Upper	46.092222	-114.174167	0.34	0.007
Montana DEQ	Bitterroot River near Darby	MDEQ_WQ_WQX-C05BITRR01	9/13/2012	Upper	46.092222	-114.174167	0.1	0.005

Table A.2. Nutrient-impaired Bitterroot River tributary data

Tributary	Data Collection Entity	Site Name	Site ID	Activity Date	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
North Burnt Fork	Montana DEQ	Burnt Fork Creek North at Metcalf Wild Refuge	C05BRFNC01	8/16/2005	46.54057	-114.09318		0.056
North Burnt Fork	Tristate Water Quality Council	North Burnt Fork Creek at confluence with Bitterroot River	BURNTRIVER	7/25/2006	46.5413	-114.099		0.065
North Burnt Fork	Tristate Water Quality Council	North Burnt Fork Creek at confluence with Bitterroot River	BURNTRIVER	8/2/2007	46.5413	-114.099	0.3	0.047
North Burnt Fork	Tristate Water Quality Council	North Burnt Fork Creek at confluence with Bitterroot River	BURNTRIVER	8/24/2007	46.5413	-114.099	0.19	0.037
North Burnt Fork	Montana DEQ	Burnt Fork Creek North at Metcalf Wild Refuge	C05BRFNC01	8/29/2012	46.54057	-114.09318	0.19	0.032
North Burnt Fork	Montana DEQ	Burnt Fork Creek North at Metcalf Wild Refuge	C05BRFNC01	9/28/2012	46.54057	-114.09318	0.13	0.023
North Burnt Fork	Local Organization	North Burnt Fork Creek upstream of irrigation supply ditch on private property	MTVOLWQM_WQX-EL-EAST	8/23/2019	46.520945	-114.07306	0.16	0.06
North Burnt Fork	Local Organization	North Burnt Fork Creek upstream of irrigation supply ditch on private property	MTVOLWQM_WQX-EL-EAST	9/10/2019	46.520945	-114.07306	0.24	0.058
North Burnt Fork	Local Organization	North Burnt Fork Creek downstream of irrigation supply ditch on private property	MTVOLWQM_WQX-EL-WEST	8/23/2019	46.521873	-114.07349	0.28	0.058
North Burnt Fork	Local Organization	North Burnt Fork Creek downstream of irrigation supply ditch on private property	MTVOLWQM_WQX-EL-WEST	9/10/2019	46.521873	-114.07349	0.27	0.049
North Burnt Fork	Local Organization	North Burnt Fork Creek above walking path in Lee Metcalf Wildlife Refuge	MTVOLWQM_WQX-LM1	8/23/2019	46.539182	-114.09457	0.21	0.053
North Burnt Fork	Local Organization	North Burnt Fork Creek above walking path in Lee Metcalf Wildlife Refuge	MTVOLWQM_WQX-LM1	9/10/2019	46.539182	-114.09457	0.25	0.046
North Burnt Fork	Local Organization	N. Burnt Fork Creek AA	MTVOLWQM_WQX-SF-NBURNTFK-AA	7/20/2021	46.533834	-114.09773	0.28	0.066
North Burnt Fork	Local Organization	N. Burnt Fork Creek AA	MTVOLWQM_WQX-SF-NBURNTFK-AA	8/17/2021	46.533834	-114.09773	0.2	0.069
North Burnt Fork	Local Organization	N. Burnt Fork Creek AA	MTVOLWQM_WQX-SF-NBURNTFK-AA	9/15/2021	46.533834	-114.09773	0.16	0.034
Threemile	Local Organization	Threemile Creek on Lee Metcalf NWR near mouth	BTR-THREEMILE1	8/6/2010	46.58056	-114.06772	0.41	0.07
Threemile	Tristate Water Quality Council	Threemile Creek-Mouth	THMRIVER	7/24/2006	46.58128	-114.06798		0.076

Table A.2. Nutrient-impaired Bitterroot River tributary data

Tributary	Data Collection Entity	Site Name	Site ID	Activity Date	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Threemile	Tristate Water Quality Council	Threemile Creek-Mouth	THMRIVER	8/1/2007	46.58128	-114.06798	0.43	0.043
Threemile	Tristate Water Quality Council	Threemile Creek-Mouth	THMRIVER	8/27/2007	46.58128	-114.06798	0.3	0.035
Threemile	Tristate Water Quality Council	Threemile Creek-Refuge #1	THMREFU-1	7/24/2006	46.57422	-114.06713		0.099
Threemile	Tristate Water Quality Council	Threemile Creek-Refuge #1	THMREFU-1	8/1/2007	46.57422	-114.06713	0.31	0.075
Threemile	Tristate Water Quality Council	Threemile Creek-Refuge #1	THMREFU-1	8/27/2007	46.57422	-114.06713	0.28	0.073
Sweathouse	Tristate Water Quality Council	Sweathouse Creek at mouth near Eldredge residence	SWEATMOU	7/24/2006	46.42572	-114.13744		0.057
Sweathouse	Tristate Water Quality Council	Sweathouse Creek at mouth near Eldredge residence	SWEATMOU	7/25/2007	46.42572	-114.13744	0.5	0.058
Sweathouse	Tristate Water Quality Council	Sweathouse Creek at mouth near Eldredge residence	SWEATMOU	8/24/2007	46.42572	-114.13744	0.25	0.053
Sweathouse	Local Organization	Sweathouse Creek near mouth	BTR-SWEAT1	8/5/2010	46.42569	-114.13607	0.31	0.049
Sweathouse	Montana DEQ	Sweathouse Creek at Hwy 93 just north of Victor	MDEQ_WQ_WQX-C05SWTHC03	8/14/2012	46.4238	-114.1462	0.23	0.042
Sweathouse	Montana DEQ	Sweathouse Creek at Hwy 93 just north of Victor	MDEQ_WQ_WQX-C05SWTHC03	9/19/2012	46.4238	-114.1462	0.12	0.034
Lick	Montana DEQ	Lick Creek about 1/2 mile upstream from mouth	C05LICKC20	7/14/2004	46.09195	-114.19201		0.038
Lick	Tristate Water Quality Council	Lick Creek lower site upstream of Hwy 93 crossing	LICK93	6/26/2007	46.105	-114.18538	0.06	0.039
Lick	Tristate Water Quality Council	Lick Creek lower site upstream of Hwy 93 crossing	LICK93	7/26/2007	46.105	-114.18538	0.23	0.043
Lick	Tristate Water Quality Council	Lick Creek lower site upstream of Hwy 93 crossing	LICK93	8/24/2007	46.105	-114.18538	0.17	0.036
Lick	Local Organization	Lick Creek near mouth	BTR-LICK1	8/5/2010	46.09308	-114.19086	0.11	0.03
Lick	Montana DEQ	Lick Creek at Lick Creek Road crossing near mouth	C05LICKC01	8/8/2012	46.09424	-114.18955	0.13	0.033
Lick	Montana DEQ	Lick Creek off Hwy 93	C05LICKC02	8/28/2012	46.10497	-114.18537	0.09	0.029

Table A.2. Nutrient-impaired Bitterroot River tributary data

Tributary	Data Collection Entity	Site Name	Site ID	Activity Date	Latitude	Longitude	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Lick	Montana DEQ	Lick Creek at Lick Creek Road crossing near mouth	C05LICKC01	9/20/2012	46.09424	-114.18955	< 0.05	0.022
Lick	Montana DEQ	Lick Creek off Hwy 93	C05LICKC02	9/28/2012	46.10497	-114.18537	0.11	0.023
Bass	Montana DEQ	Bass Creek about 150 yards upstream from Hoblitt Lane	C05BASSC20	7/9/2004	46.57577	-114.09946		0.037
Bass	Montana DEQ	Bass Creek about 150 yards upstream from Hoblitt Lane	C05BASSC20	8/14/2012	46.57577	-114.09946	0.24	0.022
Bass	Montana DEQ	Bass Creek about 150 yards upstream from Hoblitt Lane	C05BASSC20	9/14/2012	46.57577	-114.09946	0.17	0.015
Bass	Montana DEQ	Bass Creek South Fork at Hwy 93 crossing	C05BASSC02	8/14/2012	46.5741	-114.0945	0.81	0.152
Bass	Montana DEQ	Bass Creek South Fork at Hwy 93 crossing	C05BASSC02	9/14/2012	46.5741	-114.0945	0.26	0.031
Bass	Tristate Water Quality Council	South Bass Creek below Hwy 93 bridge	BASS93S	8/1/2007	46.5739	-114.09414	0.6	0.089
Bass	Tristate Water Quality Council	South Bass Creek below Hwy 93 bridge	BASS93S	8/28/2007	46.5739	-114.09414	0.33	0.058
Rye	Tristate Water Quality Council	Rye Creek below Hwy 93 bridge	RYEBEL93	7/25/2006	45.96689	-114.13551		0.019
Rye	Tristate Water Quality Council	Rye Creek below Hwy 93 bridge	RYEBEL93	7/24/2007	45.96689	-114.13551	0.28	0.043
Rye	Tristate Water Quality Council	Rye Creek below Hwy 93 bridge	RYEBEL93	8/25/2007	45.96689	-114.13551	0.37	0.051
Rye	Local Organization	Rye Creek near mouth	BITR-C05RYEC02	8/2/2010	45.96634	-114.135	0.19	0.023
Rye	Montana DEQ	Rye Creek at Hwy 93 crossing	C05RYEC01	8/7/2012	45.96634	-114.1355	0.17	0.01
Rye	Montana DEQ	Rye Creek	C05RYEC02	8/9/2012	45.96634	-114.06193	0.15	0.027
Rye	Montana DEQ	Rye Creek at Hwy 93 crossing	C05RYEC01	9/13/2012	45.96634	-114.1355	0.1	0.006
Rye	Montana DEQ	Rye Creek	C05RYEC02	9/13/2012	45.96634	-114.06193	0.13	0.022
Rye	Local Organization	Rye Creek AA	MTVOLWQM_WQX-SF-RYECR-AA	7/17/2021	45.9672	-114.11701	0.15	0.019

APPENDIX B – PROJECT PRIORITIZATION MAP TOOL

View an interactive map of completed and ongoing §319-funded water quality improvement projects in the Bitterroot River watershed, and 2019 riparian vegetation cover and wetland status data to help prioritize future projects:

https://mtdeq.maps.arcgis.com/apps/webappviewer/index.html?id=f6bbccd420e64c33b4e938be3771a488