UPPER GALLATIN RIVER
WATERSHED RESTORATION PLAN

PREPARED BY:
THE BLUE WATER TASK FORCE, INC.
MAY 2012

The Blue Water Task Force is a nonprofit organization with a mission to promote public stewardship of aquatic resources in the Gallatin River Watershed through community education, citizen involvement in water quality monitoring, and scientific data collection. For more information, please visit www.bluewatertaskforce.org.

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The Upper Gallatin Watershed Restoration Plan is a blueprint to improve water quality and habitat conditions of the Upper Gallatin River. The Upper Gallatin River extends from the confluence with Spanish Creek to the headwaters at Gallatin Lake in Yellowstone National Park. This watershed restoration plan was built from data collected as part of the Montana Department of Environmental Quality's (MTDEQ) Total Maximum Daily Load (TMDL) Program mandated by the Clean Water Act. The local organization that coordinated the Upper Gallatin TMDL was the Blue Water Task Force (BWTF), a nonprofit 501(c)(3) organization headquartered in Big Sky, with a mission to promote the aquatic stewardship of the Gallatin River through community education, citizen involvement in water quality monitoring, and scientific data collection.

After the Upper Gallatin TMDL was accepted by the Environmental Protection Agency in the fall of 2010, the BWTF took the lead on developing the Upper Gallatin Watershed Restoration Plan. This plan has a scope of three to five years, in which time; BWTF chose to focus restoration efforts on the West Fork of the Gallatin ("West Fork") Watershed because of its failure to meet water quality standards set by the MTDEQ for nitrogen, E. coli, and sediment. Specific restoration strategies within this plan include: 1) developing and implementing a plan to reduce sources of nitrogen in the West Fork Watershed, 2) working with the Montana Department of Transportation to reduce the impacts of winter maintenance activities on rivers and streams, and 3) assessing and prioritizing culvert replacement projects to reduce sediment loading and improve fish passage. BWTF and interested watershed stakeholders will review and update this plan within the next three to five years.

This Upper Gallatin Watershed Restoration Plan has been reviewed and accepted by the Montana Department of Environmental Quality. Opportunity for comment was provided to watershed stakeholders and to the public at the BWTF Annual Meeting on April 12, 2012.

1.0 Introduction

The Upper Gallatin Watershed Restoration Plan ("UGWRP") seeks to improve water quality in the Upper Gallatin Watershed (Figure 1), with a focus on the West Fork of the Gallatin Watershed ("West Fork") (Figure 2) over the next **three to five years**. After three to five years, the BWTF and interested watershed stakeholders will review and revise the UGWRP. The UGWRP provides initial structure for interested groups and government agencies to implement a watershed restoration and enhancement effort. The intent is to engage a range of watershed stakeholders in seeking scientifically based voluntary solutions to improve water quality, and instream and riparian habitat.

The UGWRP contains the essential requirements of the United States Environmental Protection Agency (USEPA) to achieve improvements in water quality. Specifically, the USEPA requires that watershed plans funded by Clean Water Act Section 319 funds contain a minimum of nine critical elements [USEPA, 2008]. These minimum requirements are summarized in the box below.

Nine Minimum Elements of an EPA Watershed Restoration Plan

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.
2. An estimate of the load reductions expected from management measures.
3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in # 2, and a description of the critical areas in which those measures will be needed to implement this plan.
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.
5. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above.

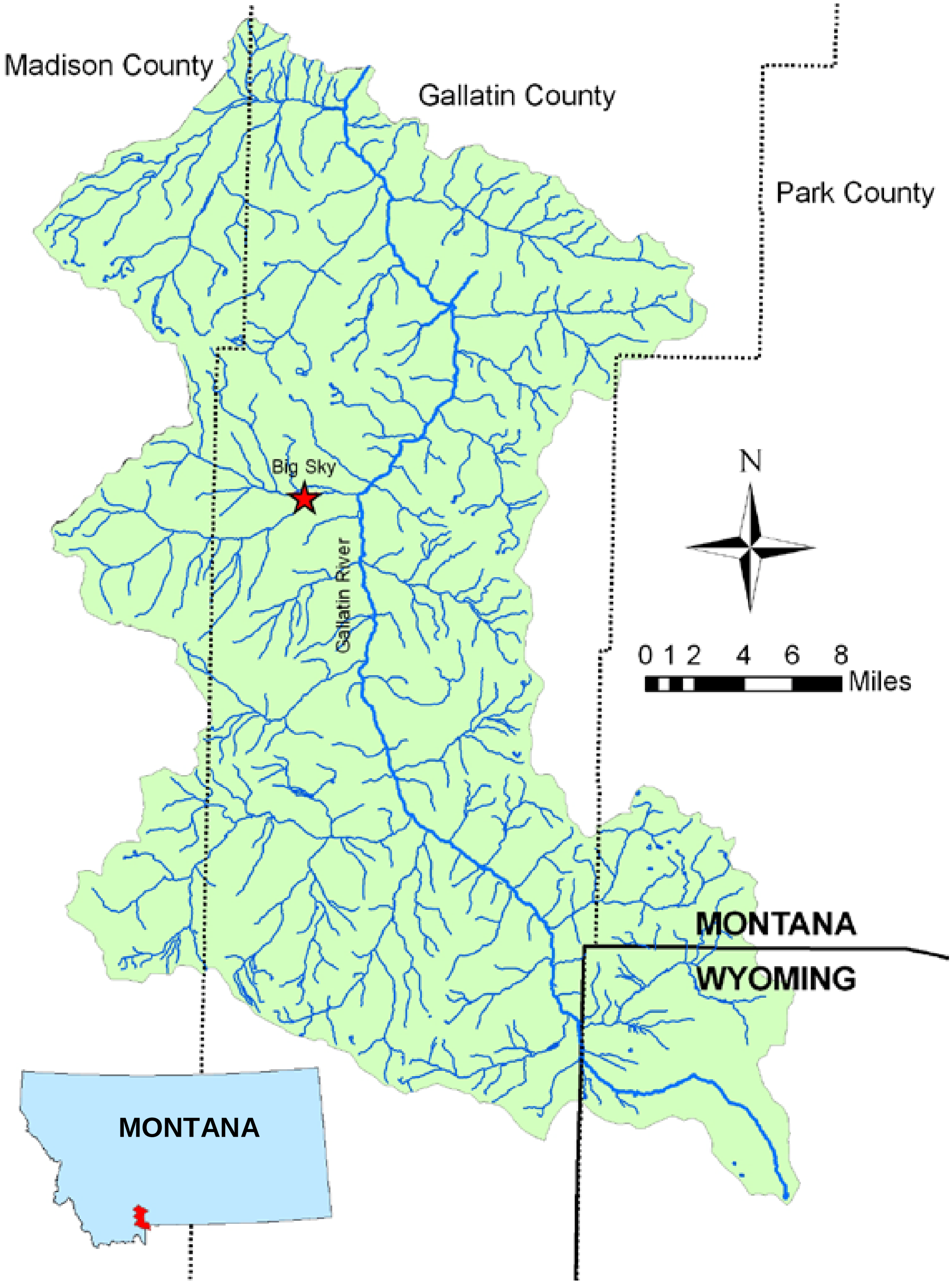

Figure 1: Location of the Upper Gallatin Watershed

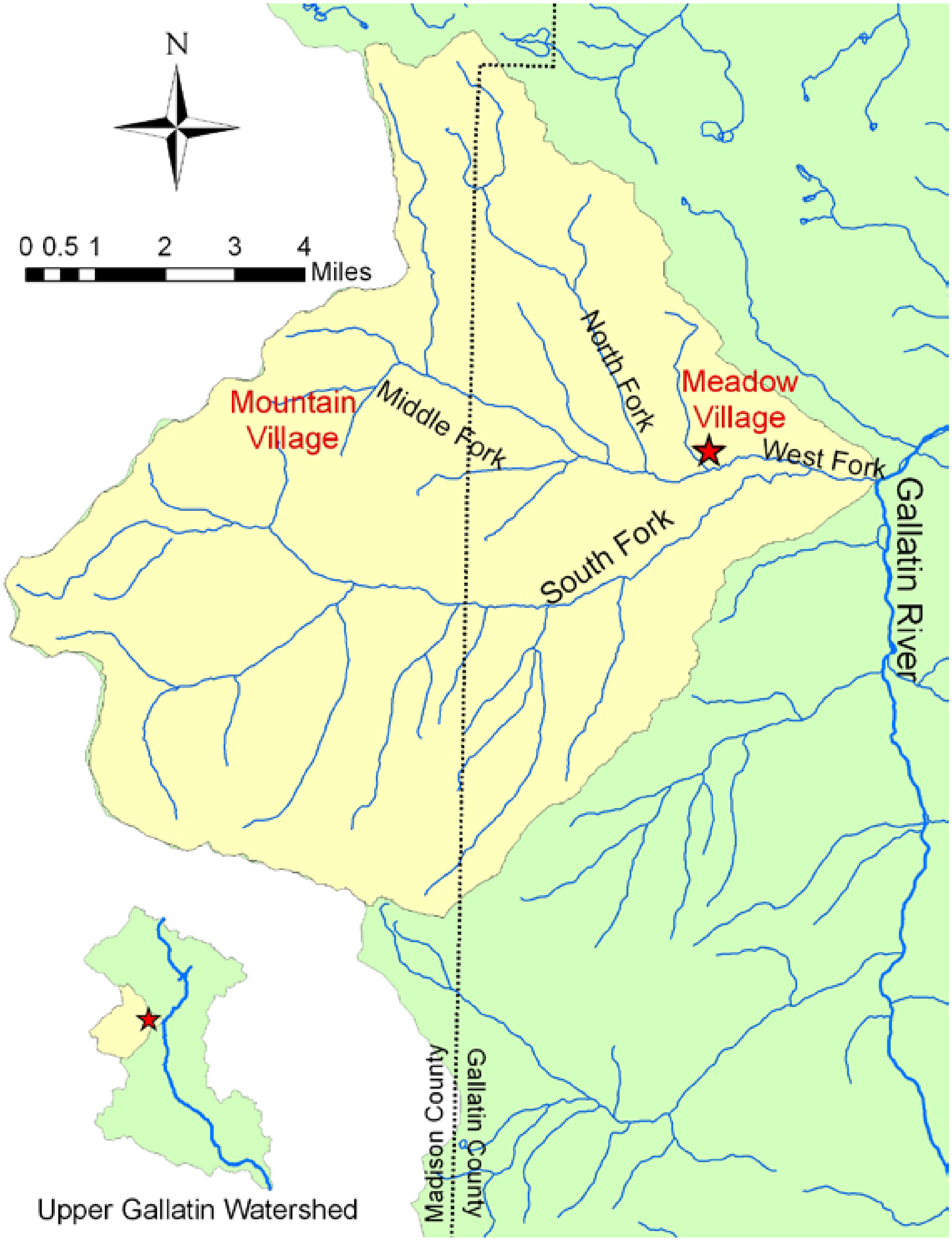

Figure 2: Location of the West Fork Watershed

2.0 Description of the Upper Gallatin River Watershed

This section describes the physical, ecological, and cultural characteristics of the Upper Gallatin River Watershed, which extends in the south from the Spanish Peaks to its headwaters at Gallatin Lake in Yellowstone National Park and is bordered by the Gallatin Mountain range to the east and the Madison Mountain Range to the west (Figure 1).

2.1 Physical Characteristics

2.1.1 Topography

Elevations in the Upper Gallatin Watershed range from approximately 1,582 to 3,403 meters above mean sea level. The geography is characterized by alpine valleys draining into the Gallatin River canyon.

2.1.2 Climate

Climate in the Upper Gallatin Watershed is typical of high-elevation mountain valleys in southern Montana. Precipitation is most abundant in May and June. Annual average precipitation ranges from 19 inches in the lower elevations to 61 inches in the upper elevations.

2.1.3 Soils

The US Geological Survey (USGS) Water Resources Division (Schwartz and Alexander, 1995) created a dataset of hydrology-relevant soil attributes, based on the US Department of Agriculture Natural Resources Conservation Service (NRCS) STATSGO soil database. The STATSGO data is intended for small-scale (watershed or larger) mapping, and is too general to be used at scales larger than 1:250,000. It is important to realize, therefore, that each soil unit in the STATSGO data may include up to 21 soil components. Soil analysis at a larger scale should use NRCS SSURGO data. The soil attributes considered in this characterization are erodibility and slope.

The soil permeability of the majority of the Upper Gallatin Watershed (78%) is less than 2 inches per hour. Thirteen percent of the Upper Gallatin Watershed is mapped with infiltration rates of 6.53 inches per hour. These higher- permeability areas are associated with the highest elevations and probably correspond to exposed fractured bedrock or areas with very thin soil cover.

Soil erodibility is based on the Universal Soil Loss Equation (USLE) K-factor (Wischmeier & Smith 1978). K-factor values range from zero to one, with a greater value corresponding to greater potential for erosion.

The majority of the Upper Gallatin Watershed (78%) is covered with moderate-low susceptibility soils. A small percentage (15%) is covered with low susceptibility, and only 7% is mapped with moderate-high susceptibility soils.

2.1.4 Geology

The bedrock within the Upper Gallatin Watershed includes Precambrian metamorphic and metasedimentary rocks, aleozoic and Mesozoic sedimentary rocks, Cretaceous igneous intrusions, and Tertiary volcanic rocks (Ross et al., 1955). Lone Mountain is an igneous intrusion of dacite porphyry, and this erosion-resistant rock is responsible for the high topography. North of the Spanish Peaks Fault, Precambrian metamorphic rocks dominate the Madison Range; south of the fault the bedrock is mostly Mesozoic sedimentary rocks, with the underlying Paleozoic sedimentary rocks exposed in the southern and lower elevation portions of the watershed. The Gallatin Range is dominated by volcanic rocks.

The Mesozoic sedimentary rocks, particularly those of Cretaceous age, are more susceptible to erosion as they are not as indurated as the other units. The Cretaceous units include terrestrial, nearshore and offshore facies, and commonly feature weakly lithified fine-grained sediments. In contrast, the older sedimentary rocks, by virtue of their greater age, have been subject to further consolidation and lithification. The watersheds of the West Fork Gallatin River, Taylor Fork and Cache Creek are underlain predominantly by Mesozoic sedimentary rocks.

Sediments in the valleys are primarily alluvial and glacial deposits. Due to the narrow width of these high-elevation valleys, the alluvial deposits are limited in extent. Glacial deposits are more widespread.

Landslide deposits are widespread in the West Fork Gallatin (Vuke, 2009). These deposits consist largely of reworked glacial sediments and eroded sedimentary rock. By their nature, landslide deposits are likely to be more susceptible to erosion than alluvium or glacial deposits.

2.1.5 Surface Water

The United States Geological Survey (USGS) maintains one gaging station within the Upper Gallatin TMDL Planning Area. This station is at the mouth of Gallatin canyon (http://waterdata.usgs.gov/mt/nwis/inventory?search_site_no=06043500). The following statistics are based on data available online. Streamflow varies considerably over a calendar year. Historical peak annual discharges in the Gallatin River vary over nearly an order of magnitude. Statistically, flow peaks in July (2,920 cfs) and is lowest in February (300 cubic feet per second (cfs)). During the period of record annual peaks have ranged from 9,160 (cfs) (June 2, 1997) to 1,740 cfs (May 8, 1934). The mean peak annual discharge during the period of record is 5,234 cfs. Of the annual peak discharges, 20 occurred in May, one occurred in July, and the rest in June. Annual peaks have occurred as early as May 8 and late as July 4.

The Blue Water Task Force maintains four real-time streamflow stations in the West Fork Watershed (http://www.bluewatertaskforce.org/test-sites.php).

2.1.6 Ground Water

Ground water occurs in both shallow alluvial and bedrock aquifers. Porosity in bedrock aquifers is of two types: primary (interstitial spaces between sediment grains) and secondary (void space created by dissolution or structural deformation). Natural recharge occurs from infiltration of precipitation, stream loss, and flow out of the adjacent bedrock aquifers.

The average ground water flow velocity in the bedrock is probably several orders of magnitude lower than in the valley fill sediments. Bedrock ground water flow is complicated by variability in lithology and geologic structures. However, carbonate and siliciclastic sedimentary rocks in the mountains may have zones of significant permeability. The hydrologic role of the structural geology (faults and folds) is uncertain. Faults may act as flow conduits or flow barriers. No studies of the Gallatin Canyon hydrogeology were identified.

Due to the commercial development in and around Big Sky, the West Fork of the Gallatin watershed is better studied. In general, ground water flows from the margins of the West

Fork valley towards the center, where flow is along the axis of the valley. The Middle Fork of the Gallatin River is a gaining stream to its confluence with the North Fork West Fork of the Gallatin where it forms the West Fork of the Gallatin and infiltration into the alluvial aquifer beneath the Meadow Village area results in a losing reach of the West Fork (Baldwin, 1996) for approximately three-quarters of a mile and then the West Fork is strongly connected again until its confluence with the Gallatin mainstem.

2.1.7 Vegetation

Vegetation below tree line consists of coniferous forest (lodgepole pine, Sub-alpine fir, Engelmann spruce, and Douglas-fir), grasslands, shrublands, and willow and aspen groves in the riparian areas. The watershed has a brief growing season from mid-June through mid-September (75 – 90 frost free days), decreasing with elevation [USDA FS, 1994].

2.1.8 Aquatic Life

Native fish species present in the Upper Gallatin Watershed include westslope cutthroat trout, mountain whitefish, longnose dace, longnose sucker, mountain sucker, white sucker, and mottled scuplin. Westslope cutthroat trout are designated "Species of Concern" by Montana Department of Fish, Wildlife and Parks (FWP). Introduced species are also present in streams, including brook, brown, golden and rainbow trout. Hybrids (rainbow-cutthroat) are reported in streams. Data on fish species distribution are collected, maintained and provided by Montana Fish Wildlife & Parks.

2.1.9 Population

An estimated 2,200 persons lived within the Upper Gallatin Watershed in 2010. Population estimates are derived from census data (US Census Bureau, 2010), based upon the populations reported from census blocks within and intersecting the watershed boundary. The majority of the population is located within the West Fork Watershed. The remainder of the population is sparsely distributed and much of the watershed is unpopulated.

2.1.10 Land Use / Land Cover

Land cover within both the Upper Gallatin Watershed is dominated by evergreen forest. Information on land use is based on the USGS National Land Cover Dataset. As the restoration strategies for the next three to five years focus primarily on the West Fork (see section 3.0), Table 2 and Figure 3 show land use/ land cover within the West Fork Watershed. Figure 4 illustrates land ownership within the West Fork watershed.

Table 1: Land Use and Land Cover in the Upper Gallatin Watershed.

Land Use	Acres	% of Total
Evergreen Forest	319,314	66.03%
Shrub/Scrub	118,674	24.54%
Herbaceous	32,549	6.73%
Barren Land	3,305	0.68%
Emergent Herbaceous Wetlands	3,171	0.66%
Developed Open Space	1,999	0.41%
Woody Wetlands	1,673	0.35%
Deciduous Forest	1,641	0.34%
Developed Low Intensity	263	0.05%
Hay Pasture	251	0.05%
Mixed Forest	224	0.05%
Open Water	452	0.09
Cultivated Crops	46	0.01%
Developed Moderate Intensity	9	0.00%

Table 2: Land Use and Land Cover in the West Fork Watershed.

Land Use	Acres	% Of Total
Evergreen Forest	26,232	51.08%
Shrub/Scrub	16,473	32.08%
Grassland/Herbaceous	6,602	12.86%
Developed, Open Space	1,159	2.26%
Barren Land	212	0.41%
Emergent Herbaceous Wetlands	188	0.37%
Deciduous Forest	171	0.33%
Developed, Low Intensity	132	0.26%
Woody Wetlands	117	0.23%
Mixed Forest	40	0.08%
Open Water	11	0.02%
Developed, Medium Intensity	8	0.02%
Pasture/Hay	6	0.01%
Cultivated Crops	4	0.01%

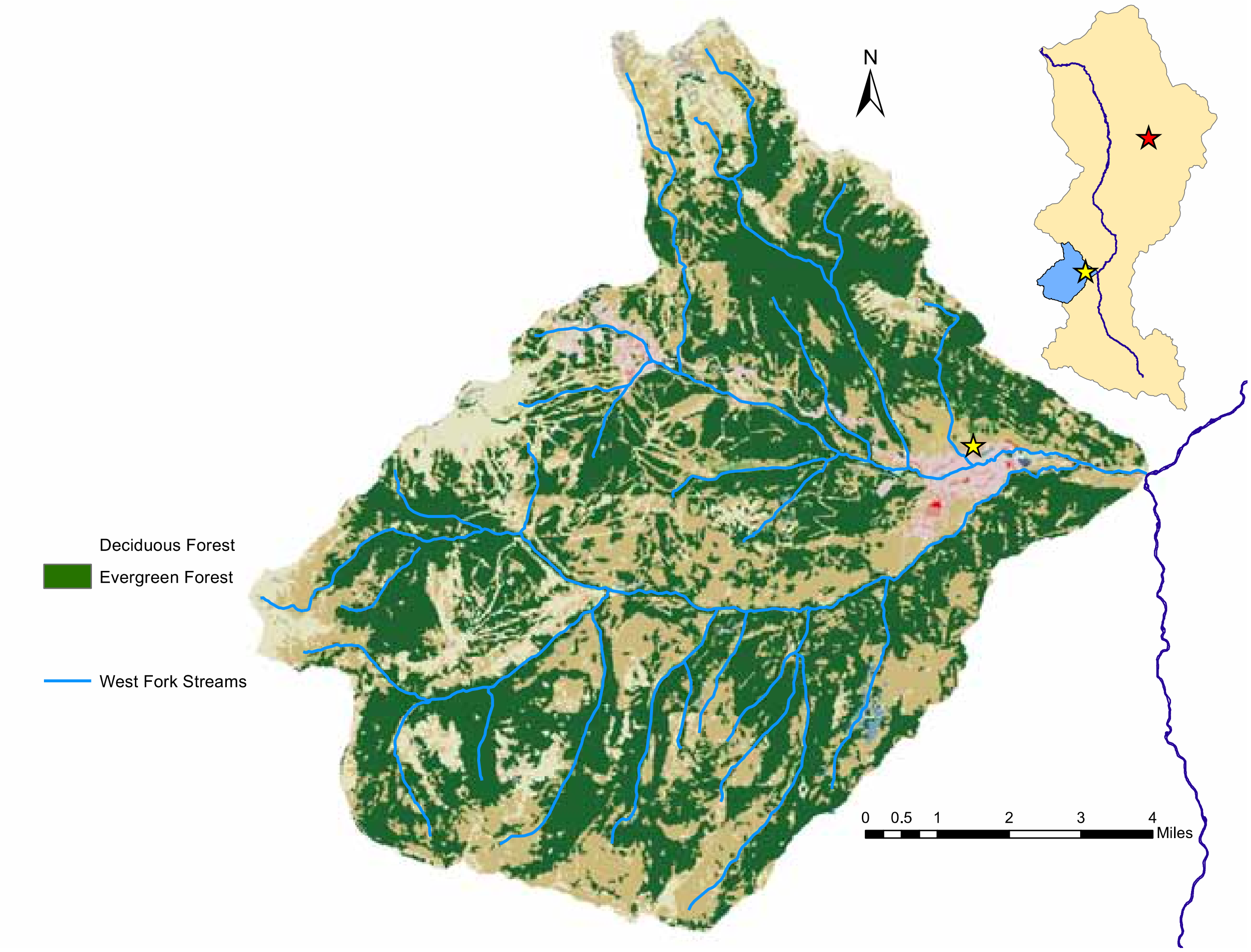

Figure 3: Land Use/ Land Cover within the West Fork Watershed.

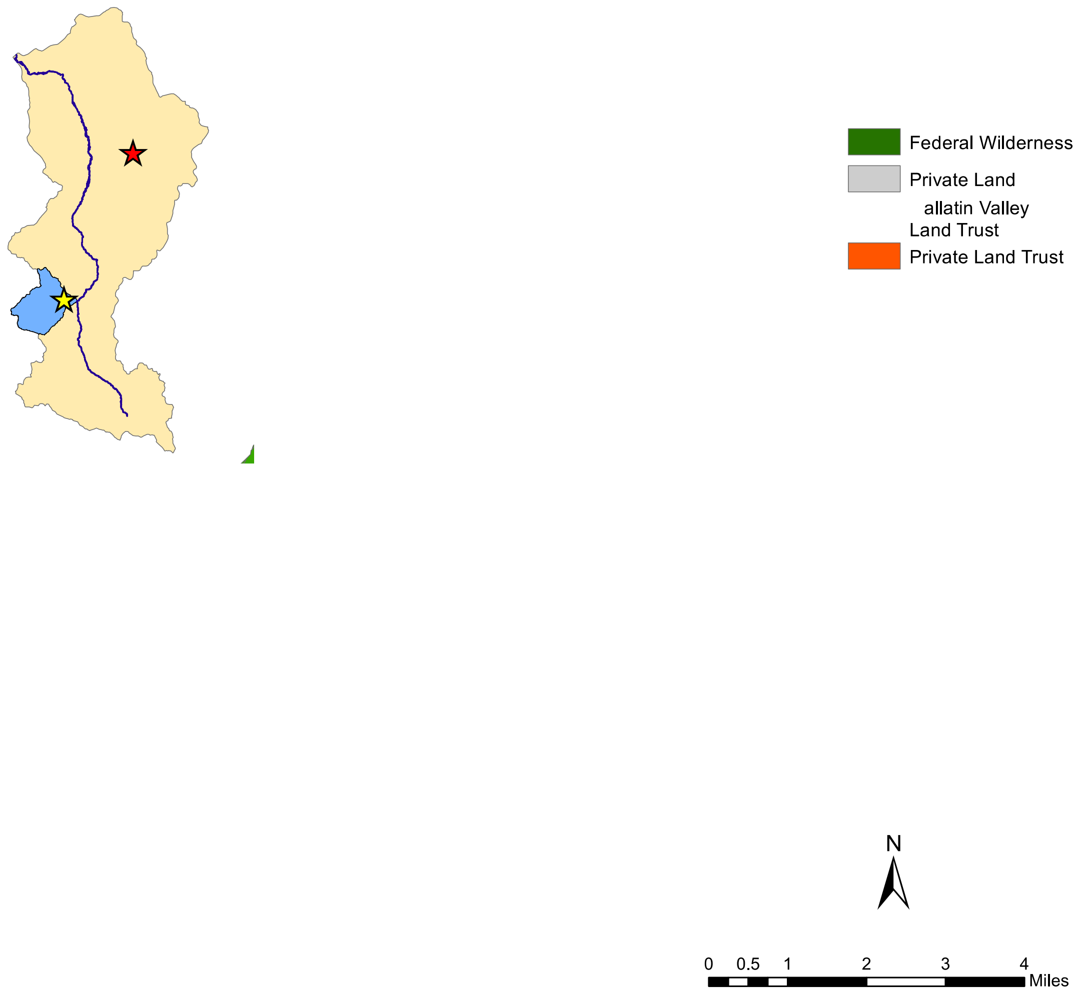

Figure 4: Land Ownership within the West Fork Watershed.

2.2 Water Resource Conditions

This section focuses on the conditions of the West Fork Watershed because it was the primary focus of the Upper Gallatin TMDL [MTDEQ, 2010] and because it shows the most anthropogenic impacts on water quality. To date, the water quality data collected by BWTF indicates the mainstem Gallatin generally has good water quality between the Yellowstone Park boundary and the confluence of the West Fork. Although, the focus of the UGWRP is the West Fork Watershed, future restoration planning may expand the scope of the area to the entire Upper Gallatin Watershed.

2.2.1 Nutrients

Extensive nutrient data (nitrogen and phosphorous) were collected in the West Fork Watershed between 2005 and 2008 as part of the Upper Gallatin TMDL assessments and Montana State University research. In addition to water chemistry, the Upper Gallatin

TMDL assessments collected algal samples in 2005 and in 2008 that were analyzed for chlorophyll-a density.

Total nitrogen and nitrate-nitrogen exceeded MTDEQ target levels (0.25 and 0.1 mg/L-N, respectively) [MTDEQ, 2011] in the Upper Middle Fork and the West Fork [Gardner and McGlynn, 2009; MTDEQ, 2010]. Water quality data collected as part of the Blue Water Task Force volunteer water quality program confirmed the elevated levels of nitrate (www.bluewatertaskforce.org). In addition, Chlorophyll-*a* levels were above state recommended concentrations (120 mg/m^3) in the South Fork and the West Fork.

2.2.2 E. coli Data

E. coli concentrations measured as part of the Upper Gallatin TMDL were above Montana state standards at some sites in the Middle Fork and West Fork; however, since the high levels of E. coli were sporadic in space and time it is difficult to determine any spatial or temporal trends.

2.2.3 Sediment

Through the Upper Gallatin TMDL assessments, significant anthropogenic sources of excess sediment in the West Fork, Middle Fork, and South Fork were identified. Major sources include roads and residential development, undersized or improperly installed culverts, and road traction sand [MTDEQ, 2010].

2.2.4 Instream Habitat

PBS&J conducted a habitat assessment in the West Fork Watershed as part of the TMDL assessments [PBS&J, 2009]. Overall channel morphology was within the expected range. In the Middle Fork, upstream of Lake Levinsky, excess fine sediment in riffles and pool tails was found with probable effects to aquatic life. In the West Fork, excess fine sediment was found near the Big Sky Golf Course and near the confluence with the Gallatin River with probable impacts on aquatic life. Low pool and large woody debris frequencies were documented in Middle Fork, South Fork, and West Fork and are likely impacting aquatic life. Target pool and woody debris frequencies are listed in Table 3.

2.2.5 Riparian Health

Riparian health was assessed through aerial photography as part of the Upper Gallatin TMDL assessments [MTDEQ, 2010]. Sections of the Lower West Fork, Upper Middle Fork and Upper South Fork were estimated to have poor riparian buffering capacity for sediment.

2.2.6 Macroinvertebrates

Macroinvertebrate data collected by BWTF from the West Fork of the Gallatin River has shown impacts from excess nutrients (http://www.bluewatertaskforce.org/docs.php). Macroinvertebrate indices determined through the Upper Gallatin TMDL assessments indicate sediment impacts on macroinvertebrates in the Lower South Fork, Upper and Lower West Fork and one upstream site on the Upper Middle Fork [MTDEQ, 2010].

Table 3: Sediment Targets for the West Fork Watershed

Sediment Target	Criterion
Fine sediment < 2mm based on the reach average of riffle pebble counts	Comparable with reference values for the appropriate Rosgen stream type based on the BDNF channel morphology dataset (Table 4)
Fine sediment <6mm in riffles based on reach average of riffle pebble counts	≤ 7% for B3 stream types ≤ 8% for all other stream types
Fine sediment <6mm based on the reach average of grid tosses in riffles and pool tails	≤ 5% for riffles and ≤ 7% for pools
Pool frequency	≥39 pools/mile for reaches <4% gradient ≥ 72 pools/mile for reaches >4% gradient
Large woody debris (LWD) frequency	≥188 LWD/mile for reaches <2% gradient ≥222 LWD/mile for reaches 2-4% gradient ≥330 LWD/mile for reaches >4% gradient

Table 4: Beaver Deerlodge National Forest Reference Dataset Median Percent Fine Sediment <6mm

Parameter	B3	B4	B	C3	C4	C	E3	E4	Ea	E
Sample Size (n)	26	14	40	11	19	30	12	64	23	115
% Surface Fines <6 mm	7	18	9	8	22	17	17	30	28	30

2.3 Pollution Sources

2.3.1 Nonpoint Sources

Nitrogen

The primary sources of nitrogen to the Upper Gallatin Watershed are associated with resort and residential development, with wastewater, from both septic systems and public disposal of wastewater effluent on the Big Sky Golf Course, being the largest source. The Big Sky Water and Sewer District provides central sewer to both Big Sky Mountain Village and Big Sky Meadow Village. Wastewater treatment is provided via a tertiary type treatment plant. Wastewater effluent is transported to a lagoon system located near Big Sky Meadow Village and is land-applied during the summer months to the Big Sky Golf Course at Meadow Village.

Outside of Big Sky Mountain and Meadow Villages, wastewater treatment systems are largely limited to individual residences with a few community systems. Wastewater treatment and disposal is via on-site septic system drain fields. Gallatin County septic system records show 864 septic systems installed within the Upper Gallatin Watershed. Of these, 34 are commercial systems. 226 septic systems (8 commercial) are recorded in the West Fork Gallatin River watershed. Aside from wastewater, other sources of nitrogen associated with resort and residential development include fertilizer, horse manure, pet waste and stormwater runoff.

E. coli

Potential sources of E. coli to streams in the West Fork watershed include anthropogenic sources (wastewater from septic systems, horse corrals, pet waste, and sewer/storage pond leaks) and natural sources (wildlife excrement).

Sediment

The primary sources of sediment to the West Fork watershed are upland and bank erosion associated with resort and residential development, ski areas, logging, historic riparian vegetation removal, stormwater from construction sites, unpaved roads, culvert failure, and road traction sand.

2.3.2 Point Sources

There are no point sources of pollution in the Upper Gallatin Watershed.

2.4 Pollution Reduction Goals

Pollution reductions goals were largely taken from the Upper Gallatin TMDL [MTDEQ, 2010]. The exceptions are noted. Loading estimates can be found in Appendix A.

2.4.1 Nitrogen

Anthropogenic sources of nitrogen accounted for in the TMDL assessments were residential and resort sources, septic system effluent, and wastewater irrigation. Residential and resort nitrogen sources were defined "as a variety of variable and diffuse nitrogen sources associated with widespread land clearing and development that may include nitrogen derived from: 1) vegetative decay of detritus derived from land clearing or land maintenance activities, 2) residential landscape and/or golf course fertilizer application, and 3) general refuse inherent in residential development (animal waste, garbage etc.)". The Upper Gallatin TMDL combined the residential and resort and septic sources to determine the percent reduction goals and therefore, these two sources were combined for the UGWRP (Table 5).

Table 5: Nitrogen Reduction Goals for the West Fork Watershed [MTDEQ, 2010].

Stream Segment	Source	Percent Reduction	Restoration Strategies
Upper Middle Fork	Residential/Resort Septic	44%	Development and Implementation of West Fork Nitrogen Reduction Plan and associated BMP's Education/ Outreach Further Assessment
South Fork	Residential/Resort and Septic	44%[1]	
	Wastewater	100%	
West Fork	Residential/Resort Septic	44%[2]	
	Wastewater	100%	

[1] Although total nitrogen and NO_3^-+NO_2^- concentrations did not exceed state water quality targets in the South Fork, high algal densities were observed in 2005 [PBS&J, 2005] verifying impairment [MTDEQ, 2010]. To lessen nuisance algal growth, we propose to reduce the nitrogen load to the South Fork. We suggest a loading reduction from the Residential/Resort source equivalent to that of the West Fork (44%).

[2] The Upper Gallatin TMDL did not recommended reduction in the residential/resort and septic source from the West Fork; however, recognizing that the TMDL's are rough estimates, 44% reduction goal in the Residential/Resort/Septic source was set to be consistent with the Upper Middle Fork and the South Fork.

2.4.2 E. coli

E. coli reductions goals are stated in Table 6. Since the E. coli concentrations were quite variable in space and time and the sources not well defined by the TMDL, the BWTF has chosen not to focus on reducing E. coli loads over the timeline of this WRP; however, we do expect some reductions in E. coli load from nitrogen reduction strategies described in Section 3.0. BWTF does recognize that other measures will most likely be needed to reach a pollution reduction goal of 66% and will address this in the next version of the UGWRP.

Table 6: E. coli reduction goals for the West Fork Watershed [MTDEQ, 2010].

Stream Segment	Source	Percent Reduction	Restoration Strategy
Middle Fork	Residential/Resort	66%	Education/Outreach

2.4.3 Sediment

Sediment reduction goals are stated in Table 7.

Table 7: Sediment Reduction Goals for the West Fork Watershed [MTDEQ, 2010].

Stream Segment	Source	Percent Reduction	Restoration Strategies
Middle Fork	Culverts[3]	Not quantified	Assess and prioritize culverts Work with winter maintenance crews to reduce road traction sand Assess and prioritize riparian areas Education & Outreach
	Road crossings	65%	
	Traction sand	75%	
	Streambank erosion (human)	41%	
	Upland erosion (resi/ski area)	37%	
	Construction storm water permits[4]	36%	
South Fork	Culverts[3]	Not quantified	
	Road crossings	67%	
	Traction sand	72%	
	Streambank erosion (human)	21%	
	Upland erosion (residential and ski area)	33%	
	Construction storm water permits[4]	35%	
West Fork[5]	Culverts[3]	Not quantified	
	Road Crossings	64%	
	Traction Sand	73%	
	Streambank erosion (human caused)	31%	
	Upland erosion (residential and ski area)	37%	
	Construction storm water permits[4]	36%	

[3] For culverts, passing the 25-year event is the minimum requirement but passing the 100-year event is recommended for fish-bearing streams or those with a high level of existing or anticipated development upstream.

[4] The loads for construction storm water permits are a portion of the human loads from the upland erosion source assessment.

[5] West Fork incorporates sources from the entire watershed including the Middle Fork and the South Fork.

3.0 Restoration Strategies (3-5 year outlook)

The BWTF has produced the following list of watershed restoration strategies to improve water quality in the Upper Gallatin Watershed, with the focus on the West Fork Watershed. The BWTF has chosen to primarily focus on the West Fork Watershed because recent water quality assessments have shown several streams in the West Fork Watershed to have elevated levels of nitrogen, E. coli, and sediment [MTDEQ, 2012]. For the implementation schedule of these restoration strategies, see Appendix B.

3.1 West Fork Nitrogen Reduction Plan/Implementation – High Priority

The West Fork Nitrogen Reduction Plan will produce a detailed nitrogen budget for the West Fork Watershed using the Upper Gallatin TMDL as a guide. Nitrogen sources in the West Fork watershed include: natural sources, horse corrals, residential and golf course fertilizer, wastewater irrigation, septic system effluent, and sewer leaks. The detailed nitrogen budget developed in this plan will be used to prioritize the order in which nitrogen sources are addressed. The BWTF will work individually with watershed stakeholders to develop and implement strategies to reduce nitrogen loading. Additional implementation activities will include analyzing video of the Meadow Village sewer system and mapping and prioritizing riparian areas for restoration based on existing condition and potential for water quality improvement.

Potential BMP's: plant native vegetation, test soils for nutrients and use this information to apply fertilizer, maintain riparian buffer with appropriate vegetation, control stormwater runoff, inspect septic system every three years, pick up pet waste, move horse corrals away from the stream**.**

Estimate of Reduction: With the execution of the West Fork Nitrogen Reduction Plan and Implementation project, we expect the South Fork, Middle Fork, and West Fork to meet the nitrogen reduction goals recommended by the Upper Gallatin TMDL and listed in Table 5. In addition, E. coli loads may be reduced; however, quantification of a reduction estimate is difficult.

3.2 Develop and Implement a Plan to Reduce Traction Sand/Salt Loading – High Priority

BWTF will work with Montana Department of Transportation and other private snow plowers to develop and implement a plan to reduce transport of road traction sand to rivers and streams.

Potential BMP's: sediment catch basins, road signage to indicate river sensitive areas, traction sand pick-up.

Estimate of Reduction: We expect to meet the Upper Gallatin TMDL recommendations for reduction for road traction sand listed in Table 7.

3.3 Map Culverts and Prioritize for Replacement – Medium Priority

BWTF will map culvert conditions and prioritize for repair and/or replacement based on adequate size, ability for fish passage, and the potential for sediment reduction. Emphasis will be placed on some combination of the potential for sediment reduction and ability for fish passage. This combination will be decided by discussions with the BWTF technical advisors group.

Potential BMP's: NA

Estimate of Reduction: We do not expect to meet any sediment reduction goals with the prioritized list of culvert repair/replacement; however, this list will be the first step to implement future projects to reduce sediment from inadequately sized culverts.

4.0 Water Quality and Water Quantity Monitoring

4.1 Water Quality

To the extent possible, BWTF will restructure its current volunteer water quality monitoring program to assess the success and/or failures of restoration projects. Currently, BWTF collects the following water quality parameters: nitrate, temperature, E. coli, conductivity, turbidity, and dissolved oxygen. By the end of 2012, BWTF will add monitoring for chloride and sediment distribution to its volunteer water quality monitoring program to assess for wastewater contamination and excess sediment. Prior to the launch of the revised BWTF volunteer monitoring program, BWTF will work with the MTDEQ to develop a MTDEQ accepted Sampling Analysis Plan (SAP) for the volunteer water quality monitoring program. If additional sites should be monitored to assess the success failures of restoration projects then funding will be sought to cover monitoring those sites.

In addition to monitoring to evaluate the success/failure of restoration projects, BWTF will monitor sites along the South Fork and the Upper Middle Fork to better define sources of nitrate as recommended in the Upper Gallatin TMDL [MTDEQ, 2010].

4.2 Water Quantity

Surface water and ground water quantity will be monitored to assess for trends and surface water flows will be used for pollutant load calculations. Surface water is currently being monitored at the mouth of the South Fork, North Fork, Middle Fork, and West Fork (http://www.bluewatertaskforce.org/test-sites.php). Ground water will be monitored as part of Montana Bureau of Mines and Geology's long-term monitoring network. BWTF will routinely analyze the MBMG data for trends.

5.0 Criteria to Determine Achievement of Load Reductions

Water quality monitoring targets set by the MTDEQ determine whether water bodies are achieving pollutant load reduction goals; however, we do not expect water bodies to meet water quality criteria/standards immediately. Instead, we anticipate a lag time in creating instream conditions that will meet water quality monitoring targets/standards due to historical N loading and travel times from N source areas to stream.

6.0 Implementation Schedule and Measurable Milestones

The intent is for the UGWRP to be fully implemented by 2017. At that time, BWTF will review the UGWRP and revise/make additions as necessary. For a detailed implementation schedule, see Appendix B, Table B-1. The interim measureable milestones are described in Appendix B, Table B-2.

7.0 Public Information and Educational Component

Stakeholder involvement and Input will be a key component to restoration planning and implementation. Stakeholders will be informed of all restoration planning and implementation activities through email, newsletters, website, press releases, and public events.

In addition to the routine updates to stakeholders regarding restoration activities, BWTF will be implementing the following education and outreach activities as part of the UGWRP:

1. *Septic system maintenance outreach* – work with Ophir middle school students on septic maintenance outreach project. Ideas include making a video for BWTF website and working with septic system company to develop incentives for homeowners to inspect/maintain septic system. **High Priority**
2. *Demonstration rain garden at Ophir School* to capture stormwater runoff, promote water infiltration to groundwater, and focus on the use of native plants, which will survive in existing rainfall patterns. The rain garden will serve as an educational tool for Ophir students and as a model for the broader Big Sky Community. **High Priority**
3. *Education & Outreach to winter maintenance crews* regarding river sensitive areas on the Upper Gallatin and potential impacts of winter maintenance activities on water quality and aquatic organisms. **High Priority**
4. *Education & Outreach on Nitrogen Reduction Strategies* for local watershed stakeholders (e.g. ski resorts and their associated golf courses, local businesses, homeowners associations, residents). **High Priority**
5. *Interpretive signage on water resource topics relevant to the Big Sky area* along the Big Sky Community Park Trail, which meanders along the Upper West Fork**.** **Medium Priority**

8.0 Technical and Financial Assistance

8.1 Technical Assistance

Technical assistance will be requested routinely from the appropriate state agencies and regional scientists (Montana Fish, Wildlife and Parks, US Forest Service, Natural Resources Conservation Service, Montana DEQ, Gallatin Local Water Quality District, Gallatin Conservation District, Montana State University). These folks are part of the Technical Advisory Committee organized during the Upper Gallatin TMDL assessments.

8.2 Financial Assistance

We expect that a wide range of funding sources will be used to implement the UGWRP. Each management measure or restoration project will generally call for a different funding approach. A partial list of potential funding sources includes:

1. 319 Grant funding from MTDEQ
2. Big Sky Resort Tax District

3. Montana Fish Wildlife and Parks - Future Fisheries Improvement Program
4. Various types of funding from the USFS including: RAC (Secure Rural Schools and Community Self-Determination Act of 2000) and USFS Partnership Grant
5. National Fish and Wildlife Foundation
6. Department of Natural Resources and Conservation Grants (Watershed Planning Assistance Grant Program, Renewable Resource Grant and Loan Program, Reclamation and Development Grant Program)
10. Individual and business donations

Cost estimates for the restoration strategies defined in Section 3 are listed in Table 8. It is difficult to provide an estimate for the total costs associated with implementation of the West Fork Nitrogen Reduction Plan (WFNRP) and the Traction Sand/Salt Reduction Plan (TSSRP). This is because the implementation costs will depend on the elements listed in the associated plan, which are unknown at this time. Cost estimates will be updated once the WFNRP and TSSRP plans have been developed.

Table 8: Cost Estimates for Restoration Strategies Described in Section 3.0.

Restoration Strategy	**Expected Cost**
3.1 West Fork Nitrogen Reduction Plan	$25,000
3.1 West Fork Nitrogen Reduction Plan Implementation	Costs will depend on projects defined in the plan.
3.2 Traction Sand/Salt Reduction Plan	$10,000
3.2 Traction Sand/Salt Reduction Plan Implementation	Costs will depend on projects defined in the plan.
3.3 Culvert Mapping and Prioritization	$30,000

9.0 References

Montana Department of Environmental Quality (MTDEQ) [2011]. Department Circular DEQ-12, Parts A and B: Montana Base Numeric Nutrient Standards and Nutrient Standards Variances.

MTDEQ (2010). The West Fork Gallatin River Watershed Total Maximum Daily Loads (TMDLs) and Framework Watershed Water Quality Improvement Plan. Final Report. (http://www.bluewatertaskforce.org/documents/WFGRFinalMaster_211.pdf)

PBS&J (2010). Base Parameter Assessment Upper Gallatin TMDL Planning Area. Final Report submitted to the Blue Water Task Force and MTDEQ.

Ross, C. P., Andres, D. A., and Witkind, I. J. (1955). Geologic map of Montana: U.S. Geological Survey, plate 2, Scale 1:500,000.

U.S. Census Bureau (2010): http://2010.census.gov/2010census/.

U.S. Department of Agriculture (USDA) Forest Service (FS) (1994). Ecoregions of the United States: http://www.fs.fed.us/land/pubs/ecoregions.

United States Environmental Protection Agency (2008). Handbook for Developing Watershed Plans to Restore and Protect Our Waters. http://water.epa.gov/polwaste/nps/handbook_index.cfm

Vuke, S.M. (2009). Geologic map of landslide and other Cenozoic deposits, Big Sky-Moonlight Basin-Lost Lake area, Madison Range, Montana, Montana Bureau of Mines and Geology: Open-File Report 581, 11 p., 1 sheet(s), 1:24,000.

Wischmeier, W.H. and D.D. Smith (1978). "Predicting Rainfall Erosion Losses: A Guide to Conservation Planning." Agriculture Handbook No. 537. USDA/Science and Education Administration, US. Govt. Printing Office, Washington, DC.

APPENDIX A
Existing Pollutant Load Estimates

Table A-1: Existing Nitrogen Load Estimates for the West Fork Watershed.

Stream Segment	Source	Existing Load
Upper Middle Fork	Residential/Resort	0.589 lbs/day
	Septic	0.015 lbs/day
South Fork	Residential/Resort and Septic	6.8 lbs/day
	Wastewater	0.2 lbs/day
West Fork	Residential/Resort	11.2 lb/day
	Septic	negligible
	Wastewater	9.0 lb/day

Table A-2: Existing E. coli Load Estimates for the West Fork Watershed.

Stream Segment	Source	Existing Load	Percent Reduction
Middle Fork	Residential/Resort	9,543 Mcfu/day	66%

Table A-3: Existing Sediment Load Estimates for the West Fork Watershed.

Stream Segment	Source	Existing Load	Percent Reduction
Middle Fork	Culverts[3]	Not quantified	Not quantified
	Road crossings	4.8 tons/year	65%
	Traction sand	8.4 tons/year	75%
	Streambank erosion (human)	145 tons/year	41%
	Upland erosion (resi/ski area)	6,007 lb/day	37%
	Construction storm water permits[4]		36%
South Fork	Culverts[3]	Not quantified	Not quantified
	Road crossings	2.1 tons/year	67%
	Traction sand	6.5 tons/year	72%
	Streambank erosion (human)	338 tons/year	21%
	Upland erosion (residential and ski area)	3,491 lb/day	33%
	Construction storm water permits[4]	202	35%
West Fork[5]	Culverts[3]	Not quantified	Not quantified
	Road Crossings	8.1 tons/year	64%
	Traction Sand	155 tons/year	73%
	Streambank erosion (human caused)	604 tons/year	31%
	Upland erosion (residential and ski area)	11,495 lbs/day	37%
	Construction storm water permits[4]	568	36%

[3] For culverts, passing the 25-year event is a minimum but passing the 100-year event is recommended for fish-bearing streams or those with a high level of existing or anticipated development upstream.

[4] The loads for construction storm water permits are a portion of the human loads from the upland erosion source assessment.

[5] West Fork incorporates sources from the entire watershed including the Middle Fork and the South Fork.

APPENDIX B
Implementation Schedule and Measureable Milestones

Table B-1: Upper Gallatin Watershed Restoration Plan Implementation Schedule

Restoration Strategy	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
West Fork Nitrogen Reduction Plan	■	■				
West Fork Nitrogen Reduction Plan Implementation	■	■	■	■	■	■
Traction Sand Reduction Plan	■	■	■			
Map Culverts and Prioritize for Replacement					■	■
Water Quality Monitoring	■	■	■	■	■	■
Education and Outreach	■	■	■	■	■	■

Table B-2: Upper Gallatin Watershed Restoration Plan Measureable Milestones

Measureable Milestones	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
West Fork Nitrogen Reduction Plan (WFNRP)						
- DEQ Approved Plan		■				
WFNRP Implementation						
- Implementation of 2 WFNRP projects each year	■	■	■	■	■	■
- Riparian mapping and prioritization		■				
- Meet nitrogen loading reduction goals (Section 2)						■
Traction Sand Reduction Plan/Implementation						
- Traction Sand Reduction Plan approved by						
MDOT and local snow plowers				■		
- Plan implementation	■	■	■	■	■	■
Water Quality Monitoring						
- 50 data points collected each year	■	■	■	■	■	■
Education and outreach						
- Annual meeting presentation	■	■	■	■	■	■
- Email, newsletters, website, Facebook	■	■	■	■	■	■
- Annual press release in local newspaper	■	■	■	■	■	■
- Winter Maintenance E&O	■	■				
- Nitrogen Reduction E&O	■	■	■	■	■	■
- Septic System E&O	■	■				
- Demonstration Rain Garden	■	■	■	■	■	■
- Water quality interpretive signage		■	■			

APPENDIX C
Glossary of Terms and Abbreviations

Algae: referring to aquatic plants (algae).

Alluvial: relating to, composed of or found in alluvium.

Alluvium: clay, silt, sand, or gravel deposited by running water

Anthropogenic: caused or produced by humans

BDNF: "Beaver Deerlodge National Forest" is the largest of the national forests in Montana covers 3.35 million acres, and lies in eight Southwest Montana counties (Granite, Powell, Jefferson, Deer Lodge, Silver Bow, Madison, Gallatin and Beaverhead).

BMP: "Best Management Practices" are measures taken to reduce water pollution. For example, installing a silt fence during construction is a BMP to reduce sediment transported to a water body (river, lake, stream, ocean).

BWTF: The Blue Water Task Force (www.bluewatertaskforce.org) is a nonprofit watershed group in Big Sky, Montana whose mission is to promote public stewardship of aquatic resources in the Gallatin River Watershed through community education, citizen involvement in water quality monitoring, and scientific data collection

Chlorophyll *a*: a green pigment found in plants and algae necessary to conduct photosynthesis. Monitoring chlorophyll levels is a direct way of tracking algal growth.

Conductivity: is a measurement of the ability of water to pass an electric current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. In addition, discharges to streams can change the conductivity depending on their make-up. For example, a failing septic system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; while, an oil spill would lower the conductivity. Conductivity is measured in microsiemens per centimeter (µmhos/cm). Distilled water has a conductivity in the range of 0.5 to 3 µmhos/cm. The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates.

Confluence: The meeting of two or more bodies of water.

Cretaceous: A geologic period within the Mesozoic era between approximately 145 and 65 million years ago.

Emergent: as in "emergent herbaceous wetland" (Table 1) means above water.

Fine sediment: is sediment less than 6.35 mm in diameter which can be harmful to the health of aquatic ecosystems. Excess fine sediment can destroy habitat for fish spawning and aquatic insects.

FWP: Montana "Fish, Wildlife & Parks" (http://fwp.mt.gov/) is a government agency in the executive branch state of Montana with responsibility for protecting sustainable fish, wildlife, and state-owned park resources in Montana for the purpose of providing recreational activities.

Herbaceous: referring to a type of plant that has leaves and stems that die down at the end of the growing season to the soil level. Herbaceous plants have no persistent woody stem above ground.

Hydrologic: referring to the scientific study of water.

Interstitial: referring to the empty space between particles.

K-factor: is a relative number describing the potential for soils to erode due to rainfall or runoff. Easily erodible soils have a K-factor close to zero (0.05-0.15) while less erodible soils have a K-factor greater than 0.4.

Lithology: A description of the physical characteristics of rocks.

Load reductions: A decrease in the amount of pollution released.

Mcfu/day: "Mega coliform units per day" is the measuring unit E. Coli in.

Macroinvertebrates: aquatic insects (e.g. mayfly, stonefly, caddisfly)

Mesozoic: Geologic era from approximately 250 to 65.5 million years ago. Dinosaurs lived during the Mesozoic era.

Metamorphic: rocks formed by heat and pressure causing physical or chemical change.

Morphology: a branch of biology dealing with structure and form of organisms. This includes aspects of the outward appearance (shape, structure, color, pattern) as well as the form and structure of the internal parts like bones and organs.

MTDEQ: the "Montana Department of Environmental Quality" (www.deq.mt.gov) is a government agency in the executive branch state of Montana with a mission to protect, sustain, and improve a clean and healthful environment to benefit present and future generations.

Nitrogen: is a common chemical element required by living organisms. Too much nitrogen in streams can cause excessive algal growth.

Nutrient: A nutrient is a substance that an organism needs to live and grow. Common nutrients considered in stream ecosystems include nitrogen, phosphorous, and carbon.

NRCS: the "Natural Resource Conservation Service" (www.nrcs.usda.gov) formerly known as the Soil Conservation Service (SCS), is an agency of the United States Department of Agriculture (USDA) that provides technical assistance to farmers and other private landowners and managers.

Order of magnitude: is an estimate of size expressed as a power of ten.

PBS&J: is an environmental consulting firm acquired by Atkins in 2010.

Paleozoic: Geologic era 542 to 251 million years ago.

Phosphorous: is a common chemical element required by living organisms. Too much phosphorous in streams can cause excessive algal growth.

Porosity: The ratio of empty space to total volume – commonly used in soils. Water flows quickly through soil with high porosity.

Precambrian: The Precambrian (Pre-Cambrian) is the name which describes the large span of time in Earth's history before the current Phanerozoic Eon,- approximately between 4600 million years ago to 542 million years ago.

RAC: a "Resource Advisory Committee" is a committee developed as part of the Secure Rural Schools Act, which decides on local community collaboration with federal land managers in recommending Title II projects on federal lands or that will benefit resources on federal lands.

Reach: a stream reach is the length of the stream selected for a project, (e.g. monitoring)

Restoration: the return of a landscape, ecosystem, or other ecological entity to a predefined historical state.

Riparian: is the interface between land and a river or stream.

Riparian buffering capacity: is the ability of riparian zone to capture or transform pollution.

SAP: a "Sampling Analysis Plan" is often required for water quality sampling programs funded by government agencies.

SSURGO: The "Soil Survey Geographic" database is one of two of the most commonly used soil databases (SSURGO and STATSGO) used for planning, management, and monitoring. SSURGO data are much more detailed than STATSGO.

STATSGO: The "State Soil Geographic" database is one of two of the most commonly used soil databases (SSURGO and STATSGO) used for planning, management, and monitoring. SSURGO data are much more detailed than STATSGO.

Sediment loading: sediment transported to a water body.

Siliciclastic: Siliciclastic sedimentary rocks are clastic (consisting of rock fragments) rocks rich in silica (e.g. quartz, feldspar, biotite).

Tertiary treatment: Tertiary treatment is the wastewater treatment process succeeding secondary treatment. Tertiary treatment removes stubborn contaminants that secondary treatment is not able to clean up. Tertiary processes include filtration, lagooning, nutrient removal, and disinfection.

Turbidity: Turbidity is a measure of water clarity and is measured by the waters ability to allow the passage of light.

TMDL: A "Total Maximum Daily Load" is a regulatory term in the U.S. Clean Water Act, describing the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

UGWRP: Upper Gallatin Watershed Restoration Plan (this document)

USEPA: The "United States Environmental Protection Agency" (www.epa.gov) is an agency of the U.S. government created for the purpose of protecting human health and the environment

USLE: The "Universal Soil Loss Equation" predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, crop system and management practices.

USGS: The "United States Geological Survey" (www.usgs.gov) is a scientific agency of the United States government. The scientists of the USGS study the landscape of the United States, its natural resources, and the natural hazards that threaten it.

Upper Gallatin watershed: The southern section of the Gallatin Watershed south of Spanish Creek (see Figure 1).

WFNRD: The "West Fork Nitrogen Reduction Plan" is a plan to be developed by the Blue Water Task Force in collaboration with watershed stakeholders to reduce excess nitrogen in the West Fork of the Gallatin River.

Wastewater effluent: is the discharge of wastewater after treatment from a wastewater treatment plant or a septic system.

Watershed: All of the land which drains precipitation in the form of rain or snow to a specific point.

Wetlands: A wetland is an area of the landscape that is inundated or saturated by surface or groundwater and supports vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.