Lolo Creek
Watershed Restoration Plan
2013

Early autumn 2010 photograph of Lower Lolo Creek. Photo credit: Matt Navarre

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Foreword

The Montana Department of Environmental Quality (DEQ) awarded the Lolo Watershed Group (LWG) a $10,000 grant in 2009 to develop a draft watershed restoration plan and facilitate the involvement of stakeholders in the process of determining priorities and securing funding for restoration projects.

The Lolo Watershed Group's mission is to understand and conserve the unique characteristics of the Lolo Creek watershed, including its wildlife and fisheries, scenic and rural character, local agriculture, and recreational opportunities while supporting private property and water rights.

With support from the Montana Department of Natural Resources and Conservation (DNRC) and the Montana Department of Environmental Quality from 2003 to 2009, the LWG conducted several assessments and compiled the results, maintained a Board of Directors, established a membership base, and stepped up its education and outreach efforts by hosting events, public meetings and various landowner tours to educate citizens about water, weeds, fire and wildlife issues in the watershed. The LWG also produced two maps of the watershed (a general map with key geographic features and a map depicting water rights) and developed a website (www.lolowatershed.org)

Since its inception, the LWG has worked to support stabilization projects in lower Lolo Creek, partnered with the Clark Fork Coalition (CFC) (formerly the Montana Water Trust) to bring the LWG Board of Directors into the field to collect flow data from three sites on lower Lolo Creek,

and presented the results of four years of field studies. These studies have yielded useful data, established a baseline for future studies, strengthened relationships with landowners, and laid a foundation of support for future restoration activities. A goal of the flow studies and cooperative work with the CFC is to increase the quantity of water in Lolo Creek during low flow periods. This is being accomplished through the flow assessment studies to understand seasonal flows in Lolo Creek and work to encourage water rights owners to use more efficient irrigation techniques and leave more water in the creek through CFC water rights lease agreements, eventually developing a drought management plan.

Purpose and Goals of the LWG's Watershed Restoration Plan

The purpose of the LWG's Watershed Restoration Plan (WRP) is to outline a strategy to answer the following questions and to kick-off a locally-driven collaborative effort that results in a 5-10 year restoration plan to achieve conservation and restoration goals in the Lolo Creek watershed. This WRP is the result of LWG's first efforts to compile available information and data and provide detailed information about proposed restoration goals. The WRP is an essential tool for facilitating dialog with key stakeholders and partners who will be involved in developing the specific projects, costs and timelines.

1. What are the existing conditions?
2. What are the causal factors influencing the current conditions and what is the degree and potential of effect in the future?
3. What do we want our watershed to look like? What needs to be protected? What needs to be restored?
4. Who are the stakeholders that have a vested interest in the watershed?
5. What are goals and what are the short- and long-term objectives will be used to attain those goals?
6. What are the priorities?
7. How can we leverage resources to accomplish our goals?
8. What short- and long-term performance measures or outcomes do we use to determine when we've met our goals?

Lolo Creek and many of its tributaries are listed as impaired water bodies by DEQ. Landowners and visitors in the watershed are concerned about a variety of issues stemming from past and present land uses. The goal of the Watershed Restoration Plan is to outline an approach to restore and conserve the Lolo Creek watershed by improving water quality, terrestrial and aquatic habitat, and maintaining adequate stream flows through a results-driven collaborative effort.

Vision Statement

As stakeholders of Lolo Creek, we endeavor to sustain a community-based membership organization that works to rehabilitate and maintain a more resilient, naturally functioning stream corridor and watershed. We envision the Watershed Restoration Plan as a guide to create and maintain a watershed where:

- Sediment entering the creek is kept within DEQ’s TMDL guidelines through the use of Best Management Practices (BMPs) in forests, land management practices, and on roads and highways.
- Riparian vegetation along streambanks and adjacent floodplain areas are managed for native species and assemblages to promote strong, healthy streambanks and adequate streamside buffers.

- Native fish and other aquatic organisms travel and reproduce within their historical range.
- Natural stream functions are allowed and maintained to the extent feasible to provide complex aquatic habitat, recruitable wood to the channel for energy dissipation, floodplain water storage and habitat, and to reduce stream energies by promoting meandering and bends in the channel network.
- The presence of beaver is allowed and facilitated to exploit the multiple benefits that beavers achieve (i.e. complex habitat, reductions in stream energies, floodplain water storage, elevated base flow conditions), while reducing maintenance issues through appropriate management.
- Land management methods provide weed-free forage for agriculture and wildlife and an acceptable plan for treatment and control of noxious weeds is employed.
- Land management methods appreciate soil conservation and employ methods to promote soil conditions that are productive, allow appropriate infiltration, and retard compaction and erosion.
- Excessive nutrients such as nitrogen, phosphorus, or other substances are not contributing to undesirable runoff concentrations and water quality conditions.
- Water rights users conserve water through efficient irrigation methods and return unused water to the creek.
- Potential aquatic invasive species are identified with appropriate management awareness and methods based on the level of risk.
- Residents and visitors understand, respect and protect the beauty and health of the watershed.

Background on Federal and State Efforts

In 1972, Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act. The goal of this act is to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” The Clean Water Act requires each state to set water quality standards to protect designated beneficial water uses and to monitor the attainment of those uses. Fish and aquatic life, wildlife, recreation, agriculture, industrial, and drinking water are all types of beneficial uses designated in Montana. Streams and lakes (which are referred to as water bodies) that do not meet established standards are called *impaired waters*, and those not expected to meet the standards are called *threatened waters*.

Both Montana state law (Section 75-5-701 of the Montana Water Quality Act) and section 303(d) of the federal Clean Water Act require the development of total maximum daily loads (TMDLs) for impaired and threatened waters where a measurable pollutant (for example, sediment, nutrients, metals or temperature) is the cause of the impairment. A TMDL is the maximum amount of a pollutant a water body can receive and still meet water quality standards. The goals of TMDLs are to eventually attain and maintain water quality standards in all of Montana's streams and lakes, and to improve water quality to levels that support all state-designated beneficial water uses.

The water body segments with pollutant impairment causes in need of TMDL development are contained within the 303(d) list portion of the State’s Integrated Water Quality Report. Lolo Creek and several of its tributaries are on the 303(d) list with sediment as the source of impairment.

Montana DEQ's Nonpoint Source (NPS) program relies on a combination of voluntary and regulatory elements applied at both the statewide and watershed levels. It has a long-standing policy to promote a voluntary program of reasonable land, soil and water conservation practices to achieve compliance with water quality standards for NPS-producing activities. DEQ encourages and supports the efforts of local watershed groups to develop Watershed Restoration Plans (WRPs) that will achieve these objectives. DEQ supports TMDL implementation by prioritizing and providing staff support and funding to local watershed efforts that pursue NPS controls through development of a WRP and use of adaptive management. These plans must be integrated with DEQ's TMDL pollution reductions and targets wherever possible.

WRPs are viewed as locally developed "road maps", complete with specific activities, identified funding sources and timelines for meeting state water quality standards and Nonpoint Source Management Plan goals. Once approved by DEQ, a locally-developed WRP can be the catalyst for heightened involvement from key stakeholders, increase the potential for collaboration with partners, lay the groundwork for more strategic project planning, increase the capacity of the organization, and improve the chances for successful fundraising efforts.

Executive Summary

This watershed restoration plan includes background information about the Lolo Creek watershed and outlines plans for implementing water quality improvement for Lolo Creek and its tributaries. TMDLs have been developed for stream segments that do not meet, or are not expected to meet, Montana water quality standards with the goal to eventually attain and maintain those water quality standards and to improve water quality to levels that support all designated beneficial water uses. TMDLs have been developed for four segments of Lolo Creek including some of its tributaries: Upper Lolo Creek (from the headwaters to Sheldon Creek), Middle Lolo Creek (from Sheldon Creek to Mormon Creek), and Lower Lolo Creek (from Mormon Creek to the mouth at the Bitterroot River). The South Fork of Lolo Creek was assessed separately. The Department of Environmental Quality's Water Quality Restoration Plan and Total Maximum Daily Loads for the Upper Lolo Creek TMDL Planning Area (Mathieus 2003) listed the following tributaries in the Upper Lolo Creek TMDL planning area (TPA) as impaired. Each has an individual TMDL.

- East Fork Lolo Creek
- Granite Creek
- Lee Creek
- Lost Park Creek
- West Fork Lolo Creek

TMDLs for the other subunits of the Lolo Creek Watershed were developed and published in the Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan (Montana DEQ 2011). This plan suggests a watershed restoration plan should include the following points.

- Implement best management practices (BMPs) to protect water conditions so that all streams in the watershed maintain good quality, with an emphasis on waters with completed TMDLs.
- Develop more detailed cost-benefit and spatial considerations for water quality improvement projects.

- Develop an approach for future BMP installments and efficiency results tracking.
- Provide information and education to reach out to stakeholders about approaches to restoration, its benefits, and funding assistance.

The Environmental Protection Agency (EPA) researched watershed restoration plans and plan application. EPA has identified nine key elements that have been addressed by successful watershed restoration plans. Those elements are included in this plan and will meet the needs outlined by the Bitterroot Plan.

- Identification of pollutant causes and sources (Chapters 2 & 3)
- Load reduction estimates (Chapter 3)
- Identification of nonpoint source (NPS) management measures (Chapter 4)
- Technical and financial assistance needed (Chapter 5)
- Education and outreach (Chapter 6)
- Implementation Schedule (Chapter 7)
- Measurable milestones (Chapter 8)
- Short term criteria (Chapter 9)
- Monitoring (Chapter 10)

These key elements present the restoration opportunities for the Lolo Creek Watershed.

The Lolo Creek Watershed Restoration Plan presents an overview of the watershed including a brief history and information about some of the documents and plans that relate to the watershed. It offers an inventory of information about the watershed, including TMDLs, then reviews Lolo Creek and its tributaries by subunit including factors that limit water quality, quantity, and/or aquatic habitat within subunits, and restoration opportunities. Measurable interim milestones are described, criteria to show water quality/quantity goals are being met are listed, the technical monitoring and analysis plan is described, and a reassessment/adaptive management plan is developed.

The primary focus in Upper Lolo Creek will be to address the TMDL requirements relative to sediment reduction strategies, but planning will also address other watershed condition issues such as fish passage barriers, roadside weeds, and suitable aquatic and terrestrial habitats for key indicator species. Concurrently, the focus in the lower creek and its tributaries will include expanded efforts to reach the diverse ownership and other stakeholders through education, outreach, and stewardship activities. Stakeholder participation will help realize the Lolo Watershed Group's vision statement with planning that includes drought management, surface and ground water quantity improvement, weed reduction, healthy and well-established streamside vegetation, proper stream structure and function, reduction of fish entrainment in irrigation ditches. Proper planning for future residential, commercial, and recreational development will be critical to maintain watershed health in the lower reaches of Lolo Creek.

Chapter 1. Watershed Overview

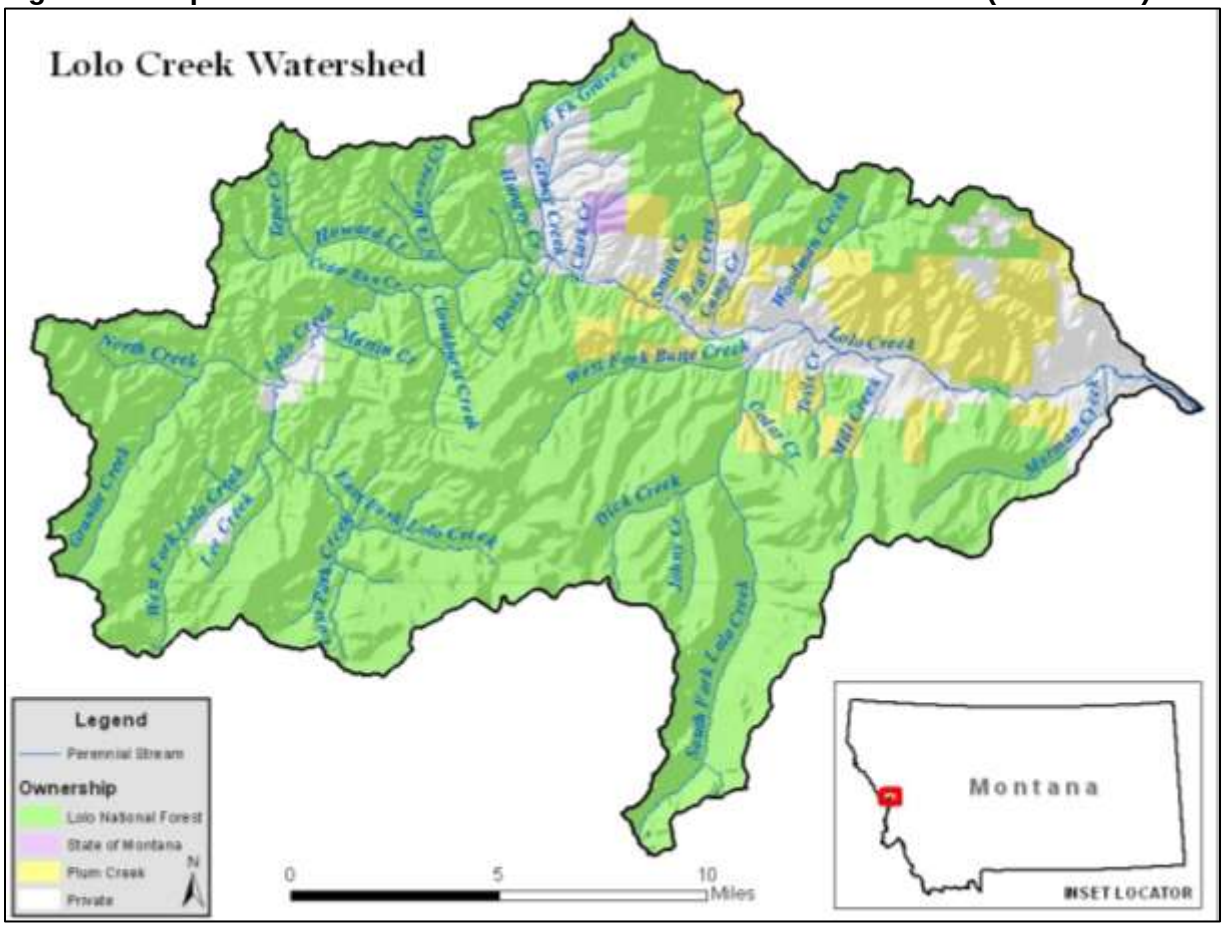
Physical and Biological Characteristics

Lolo Creek is the northern-most major tributary of the Bitterroot watershed, which drains into the Clark Fork River, which in turn drains into the Columbia River and ultimately flows into the Pacific Ocean.

The Lolo Creek watershed covers about 175,484 acres or about 274 square miles, sitting in the middle portion of the Bitterroot Mountains, southwest of Missoula, Montana. Lolo Creek originates at the crest of the Bitterroot Range near the Idaho/Montana border, not far from Lolo Pass, at 5235 feet above sea level. Lolo Creek flows eastward about 37 miles to its confluence with the Bitterroot River at about 3150 feet elevation. The highest point in the drainage is Lolo Peak (9075 feet) on the southern edge of the watershed.

The upper and middle portions of Lolo Creek sit in a narrow, V-shaped valley. The lower portion of the Lolo Creek drainage broadens, although the adjacent hillsides are steep throughout. The soils are easily erodible. They are formed from predominantly sedimentary formations on the north and granitic intrusions to the south and in the upper reaches to the west.

Figure 1.1 Map of the Lolo Creek Watershed from Lolo National Forest (Nock 2012)



Natural forest vegetation in the watershed includes ponderosa pine, Douglas-fir, western larch, and lodgepole pine on north aspects with subalpine fir and Engelmann spruce in wet drainages and upper elevations. Some pockets of grand fir and western red cedar can be found but are not predominant. South aspects are occupied by Douglas-fir and ponderosa pine, along with native bunchgrasses on lower exposures and lodgepole pine at the higher elevations. Willow, red osier dogwood, and cottonwood are the predominant species along the stream corridor.

This area is home to a variety of wildlife including elk, deer, moose, pileated woodpecker, goshawk, golden eagle, pine marten, mountain goat, hoary marmot, and wolf. Lolo Creek was designated a bull trout Priority Watershed, and the East and West Forks provide high quality habitat that supports these populations. In the West Fork Lolo Creek, there is a unique, isolated Westslope cutthroat trout population above Snowshoe Falls that may serve as natural genetic reserve. Spawning habitat exists for both species in the watershed. There are diverse populations of macroinvertebrates throughout the watershed.

Human History and Use of the Watershed

The watershed was used as an east-west passageway for the area's earliest inhabitants. The route, now called the Lolo Trail, provided access to fishing (to the west), hunting (including bison further east), gathering, and trade for Salish and Nez Perce peoples. The Lewis and Clark expedition followed this route both on the westward journey to the Pacific in September 1805 and on the return trip in June 1806. The trail followed the valley bottom for about 7 miles before ascending to the ridge tops approximately bounding the northern rim of the watershed. Lewis and Clark totally avoided the flat Lolo Creek valley bottom during their travel to the Pacific Ocean. Instead, they chose the adjacent steep mountains because the bottomland was so "choked with beaver and deadfall". Fur traders and explorers referred to the area as Lou Lou Creek. Theories explaining the name include the Native American shortened pronunciation of Lawrence, a French-Canadian fur trapper killed by a grizzly bear and buried near Grave Creek or a rendition of Le Louis, a name given by early French trappers in honor of Meriwether Lewis (Lewis and Clark Fort Mandan Foundation 2011). The name was shortened to Lolo when the first post office was established in the area.

Today, much of Lolo Creek has been developed. In the lower and middle watershed, residences, roads, and pastures parcel the landscape and significant portions of the valley floor and streamside vegetation have been cleared. Beaver presence is very minimal, as is the presence and complexity of valley bottom and streamside shrubs and trees. Ditches and diversions are prevalent, transferring water to domestic and agricultural purposes. State Highway 12 bifurcates the valley, truncating many meander bends and straightening long stream segments. In the upper watershed and tributaries, extensive timber harvest and road construction have occurred. Noxious weeds exploit the drier and more disturbed landscape and road systems throughout the watershed.

Land Use and Ownership

Agriculture

The Homestead Act of 1862 allowed legal claim to land ownership and by the mid-1860's livestock ranching, including extensive upland grazing by sheep, and mining activities were established in the watershed. Large ranches developed in the 1880's with the arrival of the Woodman, McClain and Maclay families bringing agricultural development and diversion of Lolo

Creek's water for irrigation. The six-mile-long Lolo-Maclay ditch, built by hand over a twenty-year period, remains a substantial present-day delivery system for water from Lolo Creek to holdings south of Lolo. Agriculture continues in the watershed along with the use of water rights from Lolo Creek and its tributaries. While entities like the Clark Fork Coalition work with water rights holders to become more efficient in the use of water and to encourage others to leave unneeded water in the creek, dewatering is still an issue in the lower reaches of Lolo Creek and its tributaries. Removal of streamside vegetation to create pasture land, coupled with historic over-grazing on some parcels, has substantively reduced streamside shrub and tree species necessary for deep roots and strong streambanks to resist normal erosive forces and form deep pool habitats. Consequently, bank erosion is significant in lower reaches, producing large quantities of sediment and leaving portions of the channel over-widened, shallow, and unable to transport sediment efficiently.

Timber Industry

The timber industry history in the watershed is complex. In the 1860's, the U.S. Congress provided land grants to the Northern Pacific Railway as an incentive to build the trans-continental railroad, and as a source of raw material (railroad ties, bridge timbers, etc.). Railroad companies could select odd numbered sections within the 80 to 100 mile swath including rail segments. In Lolo Creek, the railroad grants encompassed about 30% of the land in the watershed, with much of this land concentrated in the headwaters in a checkerboard pattern of square-mile parcels. An additional 68% of the land in the watershed was set aside as a national forest reserve in the late 1800's, and ultimately became the Lolo National Forest. This resulted in a checkerboard pattern of federal, state, and private ownership. Northern Pacific became Burlington Northern whose timber programs were held by Plum Creek. The Anaconda Mining Company and Champion International also held property in the watershed and purchased additional private properties as well.

Over the past 100 years, the private and public lands have had ongoing timber management, and a road network was constructed to facilitate timber removal. After heavy cutting by Champion in the 1980's, Plum Creek assumed ownership of the Champion International Timberlands in the watershed and continued logging. Plum Creek's holdings amounted to almost 30% of the watershed in 2003. In 1989, the U.S. Forest Service felt that the watershed had been over-harvested, principally due to impacts on wildlife habitat, but also due to watershed conditions. At that time, they placed a 10-year moratorium on timber removal on the national forest land.

In the 25-years since the moratorium was enacted, the U.S. Forest Service and private forest landowners have made many improvements to the road network to reduce erosion and sediment delivery to streams. This included gravel surfacing of many primary access roads (e.g., East Fork Lolo Creek), and construction of gravel "berms" along the shoulder of many road segments as a sediment filter. Over the past decade, Plum Creek and the U.S. Forest Service have had renewed efforts to decommission roads not needed for forestry, upgrade other roads to modern Best Management Practice (BMP) standards, and remove culverts that are barriers to fish movement. The Native Fish Habitat Conservation Plan (NFHCP) that was approved by the U.S. Fish and Wildlife Service in 2000 was used to upgrade the programs on Plum Creek lands.

The Nature Conservancy negotiated the purchase of over 40 square miles of "checkerboard" Plum Creek lands, 28,500 acres, in the upper Lolo Creek watershed, almost all of which was

conveyed to the U.S. Forest Service. These were Plum Creek's most ecologically and biologically important lands in the watershed. Plum Creek currently owns 17,900 acres in the lower watershed, and remains the largest private landowner.

The legacy of dense road networks for accessing timber contributes to the high sediment loads Lolo Creek now carries. Decades of logging before the development of modern Best Management Practices have left riparian areas and forests open to excessive sediment movement. Insufficient or damaged culverts prevent the travel of native trout species to spawning areas. Increased access to forest lands has added to the invasive weed problem in some of the watershed.

Figure 1.2. East Fork of Lolo Creek at the Confluence with the West Fork. (04/12/2011.Roberta Bartlette)

Note the cutting units in the background.

Transportation

The road that leads west from Lolo began as a six-mile-long wagon road along the valley bottom in the late 1860's. By the early 1880's the road was extended to the Woodman homestead about 11 miles west of Lolo, and reached Lolo Hot Springs by 1888. In 1909-1910, an uncompleted project to build a railway over Lolo Pass left a roadbed in place that later became Highway 12. See Appendix A for the 1912 USGS map of the Missoula Quadrangle containing the Lolo Creek Watershed from the mouth at the Bitterroot River to approximately 2 miles west of the Howard Creek confluence with Lolo Creek. The map was engraved from 1907-1909 survey data. The road up the Lolo Creek drainage is shown on the map. It appears to

cross Lolo Creek a number of times west or upstream of Bear Creek's confluence with Lolo Creek. Travel to from Missoula to Lolo Hot Springs by stagecoach was a two-day trip (Burk et al 2002).

In 1912 the road was improved from Lolo to Lolo Hot Springs. In the 1920's the first automobiles reached Lolo Hot Springs, fording Lolo Creek 16 times between Lolo and the Hot Springs (Burk et al 2002). The road was completed over Lolo Pass in 1928. The gravel road can be see to cross through creeks in 1937 air photos, but slowly gained bridges or confined the creek by rip rap in channels along the road as can be seen in 1958 air photos. The Lewis and Clark Highway, a federally funded project completed in 1962, created a paved road over Lolo Pass to connect Western Montana towns with those of Central Idaho. With that construction, many natural meanders in Lolo Creek were removed. The creek was confined within riprap-bounded straight channels that increased its velocity. Highway maintenance, especially sand and gravel application for winter driving safety, have substantially increased the sediment load (Mathieus 2003)

Geographical, Cultural, and Social Aspects of Lolo Creek

The community of Lolo has a bit of an identity crisis. Lolo is 8 miles south of the city of Missoula, near the south edge of Missoula County, and many residents commute the short distance for jobs and services. It is a bedroom-community where houses are affordable, young families are invested in the K-8 independent school, and older residents enjoy the scenic and rural setting.

Lolo is composed of three main neighborhoods: "The Lake" neighborhood (along the Bitterroot River), "The Hill", and along Lolo Creek (Highway 12). The town is divided by four-lane Highway 93 and has no "downtown" to speak of only an assortment of grocery stores, gas stations, banks, churches, automotive services, restaurants, bars, and secondhand stores.

Lolo is also known as "the Gateway to the Bitterroot Mountains". Geographically it is the northern-most town of the Bitterroot Valley watershed, and Lolo Creek is the last major creek that empties into the Bitterroot River before its confluence with the Clark Fork River in Missoula. Locals who want to distinguish themselves from Missoula call themselves "north Bitterrooters". But the Bitterroot Valley is primarily in Ravalli County, which starts at the county line in Florence, a small town 10 miles south of Lolo. One could say that Lolo is "owned by both and claimed by neither" county. Political boundaries do not necessarily match watershed boundaries. This presents a challenge in that the Lolo community needs to work with organizations and agencies in both counties to accomplish its goals.

Fortunately, Lolo has some distinguishing geographic and cultural features that provide residents with a sense of community and a sense of place. These include:

Lolo Peak:

Visible from Missoula, this impressive peak stands at the northern boundary of the Selway-Bitterroot Wilderness straddling the Lolo and Bitterroot National Forests. The area is almost entirely managed for semi-primitive and non-motorized recreation use and is extremely popular for traditional recreational activities such as hiking, camping, horseback riding, backcountry skiing, winter mountaineering, big-game hunting, and fishing.

Carlton Ridge Natural Research Area:

For decades, the 920-acre Carlton Ridge Natural Research Area (RNA) has served as an excellent resource for scientific research and environmental education. This U.S. Forest Service site harbors a scientifically significant alpine and western larch forest. The natural hybrids from these two trees are found nowhere else in the United States, making the RNA permanently off-limits to development.

Travelers' Rest State Park:

Opened in 2002, this unique site is managed by Montana Fish, Wildlife & Parks and has been designated as a National Historic Landmark. It is the only scientifically and archeologically documented site of a Lewis and Clark campground, and was used twice by the Lewis and Clark Expedition. It has year-round facilities and programs with a 10,000 square-foot museum containing collections that were donated by a long-time local landowner.

Lolo Trail National Historic Landmark:

An ancient travel route across the Bitterroot Mountains, the Lolo Trail (also known as the Nez Perce Trail) was used by Native Americans to access buffalo and salmon, by Lewis and Clark's Corps of Discovery, and by the Nez Perce in their attempt to flee to Canada in the 1877 Nez Perce War. From Grave Creek east to Travelers' Rest, the trail is in danger of being obliterated by private subdivisions. In 2009, the Lolo Trail was listed as one of the top five most endangered historic sites in the county by Preserve Historic Missoula. This preservation organization encourages easements on or outright sale of segments of the trail to the U.S. Forest Service for administration as an historic resource.

Lolo National Forest Recreational Sites:

Recreational sites managed by the U.S. Forest Service include the day use site at Fort Fizzle and overnight campgrounds along Lolo Creek: the Lolo Creek, Earl Tennant, and Lee Creek sites. Hiking trails include the historical Lolo Trail accessed from Howard Creek, Lee Creek, Lolo Peak, and West Fork Butte Lookout. Interpretive information is available at these sites.

Lolo Pass Visitor Center:

Operated by the Clearwater National Forest, this site offers information about the Lolo Creek and Lolo Pass area including interpretive displays on the explorers' passage through the mountains, the Nez Perce War of 1877, and geologic formations in the area. Hiking and interpretive trails are available in summer and cross-country skiing and snowmobiling trails are popular in the winter.

Commercial Recreation sites:

Commercial recreation sites along Lolo Creek include the Holt Ranch Museum, the Square Dance Center and Campground, and Lolo Hot Springs.

Challenges, Threats, and Opportunities

The community of Lolo has recently faced a myriad of proposed projects that could potentially have a negative impact on the watershed. A lack of zoning, various proposed developments, and recent changes in land management leave the watershed vulnerable to additional impacts.

Residential Development

As people find Montana an alluring place in which to settle or summer, the communities of Missoula and Lolo will most likely continue to grow. The transition from undeveloped creekside properties to subdivisions will increase impacts on vegetation, wildlife, and the aquatic environment.

The Bitterroot Resort, a proposed 4-season destination ski resort at the Maclay Ranch south of Lolo, prompted residents from Lolo, Missoula -- and beyond -- to express concerns about both water quality and water quantity issues: changes in water use and water rights, clearcutting for ski-runs, chemical impacts of snow-making, fertilizer on golf courses, septic and sewer issues, and increased run-off from impervious road surfaces. The proposal includes encroachment on current public land with likely impacts to the adjacent wilderness area and the Carlton Ridge Research Natural Area.

Natural Resource Development within Residential/Agricultural Areas

A proposed gravel mining pit and asphalt plant (including a wash plant, pug mill, concrete plant, crusher and screening facilities) was proposed in 2007 for a 36-acre irrigated pasture on Highway 93 just north of Lolo. After 18 years of operation and reclamation, the site would be converted to a subdivision with a pond. Concerns raised by local residents included contamination of private wells and the aquifer, cement dust and air quality, chemical and fuel spills, traffic safety, impacts to wildlife, diminished property values, and the negative impacts of toxic odors, noise and light pollution to human health. Emergency interim zoning was ultimately adopted by Missoula County in 2008 to protect the public health in light of legal issues regarding DEQ's permitting process as well as traffic safety issues. Similar proposals will continue to be a threat until the community is proactive about planning, zoning, and determines what resources need to be protected.

Wastewater Treatment

Upgrades have been proposed to the Lolo Wastewater Treatment Facility RSID 901**.** Current economic conditions have slowed development in Lolo temporarily. The Voluntary Nutrient Reduction Program, a project of the Tri-State Implementation Council, included nutrient reduction as one important concern. In the past, Montana DEQ requirements for subdivision lot size outside the area served by municipal wastewater treatment plants were specified in Circular DEQ-4 as follows: the minimum lot size must be one acre for each living unit and one acre for up to 700 gallons per day of design wastewater flow for commercial and other non-residential uses. Montana Code Annotated 2011 specifies the mixing zone for a proposed drainfield must be located wholly within the boundaries of a proposed subdivision for new developments, with a few provisional exceptions**.** Further study is needed as future development may impact ground water nutrient loads.

Changes in Land Management

Through a partnership known as The Montana Legacy Project, The Nature Conservancy, and the Trust for Public Land in 2008 purchased large tracts of Plum Creek land in western Montana, including thousands of acres and creek frontage in upper Lolo Creek’s watershed. These lands have been placed into public ownership through purchase transfers to the U.S. Forest Service and Montana state land management agencies. This transfer eliminates the checkerboard grid in upper Lolo Creek, and will greatly simplify land management and facilitate the improvement of water quality. Plum Creek currently is the largest private property holder in

lower Lolo Creek. The potential of subdivision on private ranch and forest lands in lower Lolo Creek creates additional incentive to work with landowners to protect the creek's riparian vegetation, wildlife, and water quality. Wise use of irrigation water, continuing the development of agricultural grazing practices that protect from streambank erosion, correcting fish passage barriers from irrigation diversions and inadequate culverts, and continued mitigation of sediment delivery by logging roads will be priorities in the Lolo Creek Restoration Plan in the lower part of the watershed.

Transportation

A recent development with a potential to impact Lolo Creek is the plan to use Highway 12 as part of an industrial corridor for transporting equipment that are too tall to travel on the Interstate Highway System and as wide or wider than a two lane highway. They have been called megaloads by some to distinguish them from the common term "big rig" used to denote commercial loads commonly pulled by semi-tractor. The term overlegal has also been used to denote these loads that exceed size and weight limits set by a number of western states (WASHTO 1995). There is a potential for hundreds of these loads over a period of decades to move through the watershed on Highway 12. Most, but not all, of the loads carry equipment destined to oil sand development in Canada. The transportation plans may include building additional turnouts along the highway, some in areas near wetlands or within the designated floodplain (Tetra Tech 2010). While this effort has been slowed, in part by judicial ruling that ordered the Montana Department of Transportation to do a more extensive environmental review of the Kearl Module Transportation Project, the Highway 12 route continues to be listed as a "preferred" route by companies wishing to move loads that exceed Interstate Highway System height limits. Additional megaloads have traveled the route as single loads or in pairs, thus avoiding the environmental review required of a multiple load project.

A bill has been introduced in the Montana 2013 legislative session to exempt permitting oversize loads from an environmental review requirement (Montana Legislature, 2013). House Bill 513 is titled "An Act Exempting Permits For Oversize Vehicles From Environmental Review; And Amending Section 61-10-121, MCA." This bill has passed through the House Transportation Committee with a vote of 8 to 3, through its 3rd reading in the House with a vote of 71 to 27 and has been transmitted to the Senate. Whether or not this bill becomes law, this legislative action indicates a continued push to bring oversized loads over Montana's highways, such as Hwy 12 along Lolo Creek.

Utility lines have been buried along the road edge where possible, which ultimately has a positive impact on Lolo Creek since the riparian and hillside vegetation that was under the overhead lines will no longer have to be periodically cut down. Other segments of the lines have been raised, involving equipment crossing Lolo Creek and trenching along the road edge. Best Management Practices for individual pole relocation do not seem to have been followed in all cases resulting in damage to wetlands within the Lolo Creek Watershed (Nielsen 2012). Line burial within the Lolo National Forest has not yet received approval.

Two ConocoPhillips oversized loads were transported through the watershed during the winter of 2010-2011. Heavy use of deicing chemicals was apparent in preparation for moving the loads as they required snow-free road surfaces. Additionally, due to the size of the equipment and transporters, snow berm removal was required to accommodate the extra width (sometimes extending beyond the guardrails). Snow blowers removed the snow berm to the top level of the guardrails on the road and beyond, depositing the snow/sand/chemical mix over embankments

and often into the creek, along the creek bank, and onto wetlands adjacent to the creek. Additional companies have since transported oversized loads along this route with many others expressing interest in the route. This prompts a need and creates an opportunity to work more closely with the Montana Department of Transportation to assure traction sand and deicing chemicals do not enter the wetlands and waterway.

Planning and Zoning

These controversial projects have prompted Rural Initiatives, the county planning arm of the Missoula County Office of Planning and Grants, to step up its efforts to review local planning documents and work with the community of Lolo to determine if, how, when and where development that could potentially impact water, air or human health may occur. The current document that guides development in Lolo is the Lolo Regional Plan (2002). It is not a regulatory document, but rather a set of guidelines that leaves citizens unclear on what development is appropriate or might be allowed. Consequently, subdivision regulations are the primary land-use planning tool in place for this area, and they are only utilized when a subdivision application is submitted to the County. Rural Initiatives has recently facilitated meetings with local citizens and businesses to update the Lolo Regional Plan and determine if it should be developed into a zoning document that would amend the Missoula County Growth Policy. The Lolo community has a small window of opportunity to work with key stakeholders and shape the documents that guide development and minimize impacts to watershed resources.

Missoula County's Rural Initiatives, now called Missoula County Community and Planning Services (CAPS), has worked with residents of Lolo, at their request, to update or revise the 2002 plan to direct growth to appropriate areas yet protect valuable conservation resources. The North Lolo Growth Policy Amendment (2011) was adopted by the Board of County Commissioners in spring of 2011. This area is outside of the Lolo Watershed, but continued work with CAPS is needed to add protection for guided growth to the watershed.

They also partnered with the Montana Natural Heritage Project and is currently completing a detailed riparian mapping project of the county, including Lolo Creek, which will provide aerial photographs, GIS data depicting riparian vegetation, maps and outreach materials that will help the Lolo Watershed Group determine what riparian resources are in need of protection. The threat of development provides an opportunity for outreach and education on streamside stewardship and available options for protection of riparian areas.

Establishing stream-side buffers (or "setbacks") may also be a very reasonable approach to allowing growth and development, but facilitating smart growth through protecting stream and riparian vegetation, while substantively reducing future risks of land loss, structure damage, and associated maintenance and insurance fees. Educating current landowners and potential developers to best management practices for streamside properties may be sufficient to encourage protection without regulation.

Climate Change

A two-day workshop on climate change was held in 2011 for Missoula County residents to identify 1) qualities about the environment they feel are important, 2) risks climate change presents to those qualities, and 3) strategies and actions they can take to prepare for change in those qualities. They stated:

> …Missoula County is experiencing some unsettling symptoms. Average annual temperatures are rising. Our snowpack is declining, and our mountains store less water. The spring thaw comes earlier and so does peak runoff. Our late summer flows are lower, and the water is warmer. Scientists anticipate that these trends will intensify. We can expect to see larger wildfires, more insect infestations, greater stress on our native fish and wildlife, and outbreaks of invasive species and disease. Scenarios also include higher chances of severe weather, including a potential for increased flooding. " from Missoula County Climate Change Primer. Strategies to Care For Our Community, Land & Water. Highlights from a Climatewise Community Workshop in Missoula: A countywide and citizen-driven project convened by the Clark Fork Coalition in partnership with the Geos Institute and Headwaters Economics (Missoula County 2011).

Impacts of climate change to our local area are well expressed in the statement above. Some impacts that involve the Lolo watershed directly as we experience greater extremes in weather include large wildfires, low snowpack or timing of snowmelt that result in insufficient water for all current uses, and flooding. Climate change may bring increasing stress on our watershed from increased development, increased needs for food production, increased need for domestic water supply, and increased pressure for recreation uses.

Three key actions were identified.

1. Water conservation coupled with watershed restoration will preserve and increase water holding capacity in riparian areas to moderate both low flow and high flow periods, maintain instream flows and water quality to preserve wildlife and fisheries.
2. Education can help our public and the watershed's landowners to take actions to protect the riparian corridor through their property or they playground.
3. Energy conservation can reduce the need for increased land devoted to energy production, will protect natural resources, and save money.

Existing Partnerships

To build support for restoration planning, the LWG has focused on building partnerships with other stakeholders. Montana Fish Wildlife & Parks, Lolo National Forest, Missoula Conservation District, Missoula County Rural Initiatives, Missoula Water Quality District, Clark Fork Coalition, Nature Conservancy, Missoula Weed District, Friends of Lolo Peak and others have participated as co-sponsors or presenters at meetings to inform citizens about watershed topics such as riparian protections, land management, land use planning, preservation of Lolo Peak, and the transfer of Plum Creek land to the Lolo National Forest.

Table 1.1. Partners of the Lolo Watershed Group and Key Agencies & Organizations to Involve in Development of the Lolo Creek Watershed Restoration Plan.

Agency / Organization	Individual contact (* LWG Advisory Board member)	Details on Partnership
Bitterroot Water Forum (BWF)	Heather Mullee, Coordinator & Board of Directors	Share information & resources; attend each others' meetings when possible; currently discussing ideas for collaborative training for board of directors and possible joint education/outreach projects
Clark Fork Coalition (CFC) (includes former Montana Water Trust)	Jed Whiteley * Will McDowell	Provides information, resources & technical support; collaborate to publicize & co-host joint public meetings; ideas for education/outreach (especially on water monitoring, water rights, riparian protections and stream restoration); established formal partnership in 2008 to monitor flow of Lolo Creek and train board & volunteers about water monitoring
Friends of Lolo Peak	Daphne Herling Steve Seninger	Provides information about conservation and protection of Lolo Peak and Carlton Ridge; shares information on potential threats to resources (i.e. high-impact developments such as proposed ski area); collaborate to publicize meetings related to protection of local natural resources and wilderness
Lolo Community Council (LCC)	Sue Hadnot, Chair	Collaborate to publicize meetings and issues of concern to Lolo citizens; attend each other's meetings to learn about or educate about issues of concern
Missoula Conservation District	Tara Comfort Lori Zeiser Tim Hall, Chair	Administers 310 permits; provides information, resources & technical support; provides landowner education & cost-share funding for landowner projects; collaborate on education & outreach; collaboration in progress with NRCS re: improving fish passage & fish screens for Lolo Creek
Missoula County Community Planning Services, Office of Planning and Grants	Kali Becher Karen Hughes	Provides information, resources & technical support; collaborate on landowner education & outreach projects (especially riparian protections, planning & zoning); currently collaborating on DEQ mini-grant project for summer/fall 2011 (stream walks & education/outreach for Lolo Creek);
Missoula Water Quality District, Environmental Health Division of Missoula City-County Health Department	Travis Ross * Michelle Hutchins	Provides information, resources & technical support; landowner education (especially on riparian protections); arranges for printing of maps & other resources as needed; provides LWG with use of photocopy machine for educational materials & info for Board of Directors

Agency / Organization	Individual contact (* LWG Advisory Board member)	Details on Partnership
Montana Department of Environmental Quality (DEQ)	Laura Andersen Robert Ray Darin Kron Christina Staten	Administers 319 funding; provides technical support & guidance for watershed groups; provides TMDL data, monitoring & assessments; assures restoration plans meet EPA guidelines; provides funding through mini-grant program
Montana Fish, Wildlife & Parks (FWP)	Ladd Knotek *	Provides information & resources on fish and aquatic resource management; technical support; landowner education; permitting oversight; explore project ideas for aquatic habitat, fish passage & screens;
Natural Resources & Conservation Service (NRCS)	Mark Novak	Provides technical support; collaboration in progress with Missoula Conservation District re: fish screens to improve fish passage on Lolo Creek
The Nature Conservancy (TNC)	Chris Bryant	Collaborate to publicize & co-host meetings; provide updates to citizens regarding the Montana Legacy Project (purchase and transfer of Plum Creek lands to Lolo NF in upper Lolo Creek)
Trout Conservancy (formerly Montana Trout)	John Zelazny *	Share information & resources; provides input on ideas for projects & funding; network & provide outreach/education to landowners; MT Trout was the organization that founded the Lolo Watershed Group
USFS - Lolo National Forest (LNF)	Traci Sylte * Shane Hendrickson * Taylor Greenup	Provides information & resources; technical support; landowner education; explore project ideas; currently developing a formal partnership agreement; past assistance with fundraising; past collaboration on “4-Party Lolo Creek Landowner Assessment Tour” in fall of 2006 with LWG & Geum Consulting
Five Valleys Land Trust	Grant Kier	Provides information on conservation strategies; collaborate to identify key Lolo Creek landowners and prioritize conservation properties
Missoula County Floodplain Administrator	Todd Klietz	Provides information regarding floodplain regulations. Assists with providing data on stabilization projects and contacts for flow measurements.
Missoula County Weed District	Jed Little, Jerry Marks	Provides information & resources for weed management; education and funding for landowner weed projects; past support for educational tours & speakers at meetings

Agency / Organization	Individual contact (* LWG Advisory Board member)	Details on Partnership
Montana Dept of Transportation (MDT)	Dwane Kailey	Provided information on highway maintenance (sand & gravel application and recovery rates); past collaboration on minimizing animal/vehicle collisions and establishing moose-crossing areas (erecting and maintaining signage)
Montana Forest Restoration Committee - Lolo	Beverly Dupree	A volunteer, consensus-based collaborative group that was set up in 2007 to guide restoration on National Forest lands; committees exist for the Lolo, Bitterroot and Helena National Forests
PBS&J	John DeArment	Provides input on technical documents
Plum Creek	Brian Sugden *	Provides input on technical documents
Rhithron Associates	Sean Sullivan	Provides input on technical documents
Trout Unlimited (TU)	Bruce Farling	Provides input on technical documents
Watershed Consulting	Pedro Marques Amy Chadwick Mark Vander Meer	Provides input on technical documents
Watershed Education Network (WEN)	Deb Fassnacht	Provides resources & technical support for water monitoring data collection; has school monitoring data for Lolo Creek from Woodman & Lolo Schools; past collaborations included project planning & fundraising; potential collaborator for training of volunteers for water monitoring
Watershed Health Clinic, Environmental Studies Program, University of Montana	Vicki Watson	Provides input on technical documents. Partners on educational projects.
Montana Dept of Natural Resources & Conservation (DNRC)	Dave Martin	Provides information, resources & technical support, landowner education; past funder of LWG through Watershed Planning & Assistance grants (2003-07) and a mini-grant for Landowner Awareness Tour (2009) to educate about weeds/fire/wildlife
Geum Consulting	Amy Sacry Tom Parker	Past collaboration on LWG's “4-Party Lolo Creek Landowner Assessment Tour”, a field assessment conducted in late fall 2006 in conjunction with LWG & Lolo National Forest
StreamBasics	Mike VanderVelden	Provides input on technical documents

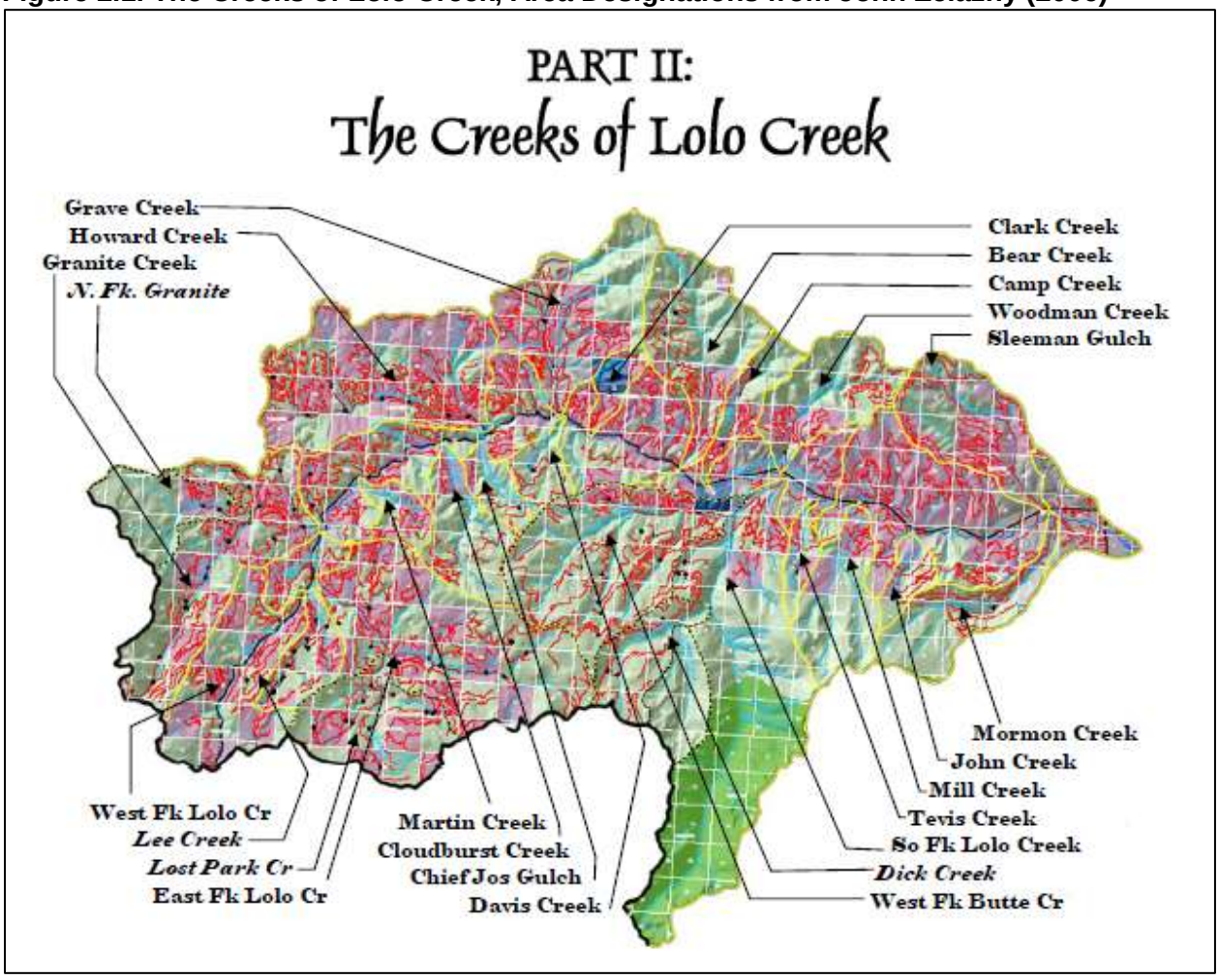
Agency / Organization	Individual contact (* LWG Advisory Board member)	Details on Partnership
Confluence Consulting	Mike Sanctuary	Conducted assessments on Lolo Creek prior to 2007 (aerial assessment, reach sampling, Sample Analysis Plan)
National Wildlife Federation	Sterling Miller	Collaborated on landowner awareness tour 2009; provides information and resources on wildlife.
Missoula Rural Fire District		Collaborated on landowner awareness tour 2009; provides information on fire mitigation and cost-share funding
Waste Water Treatment Facility, Lolo RSID 901	Jasen Neese	
Sierra Club	Bob Clark	Provides information and resources on conservation of Lolo Peak and Carlton Ridge Research Natural Area
Missoula County Commissioners	Michele Landquist	Provides information on Missoula County issues related to Lolo community and watershed residents
Bitterroot Conservation Partnership	Heather Mullee, Heather Whiteley	Provides input on technical documents
Montana Conservation Corps		Provided assistance with riparian planting

Chapter 2. Inventory of Available Information

Tributaries within the Lolo Creek Watershed

Studies of the Lolo Creek Watershed have examined the area by a variety of area specifications. Some studies have considered the main stem in two parts: upper (above Lolo Hot Springs), and lower. Others have looked at Lolo Creek by segments of the main stem and by individual tributaries. The Bitterroot River Subbasin report uses another designation that often combines some of the tributaries to logical units. Where possible the Watershed Restoration Plan will group tributaries to logical units based on work that has been, or needs to be done within units. The following map details tributaries of Lolo Creek and can serve as a reference to locations of study data. One tributary, Sheldon Creek, is used as an area division designation. Sheldon Creek enters Lolo Creek from the north between Grave and Bear Creek.

Figure 2.1. The Creeks of Lolo Creek, Area Designations from John Zelazny (2006)



Physical information such as drainage length and area and elevation range as well as by subsection and/or tributary is summarized in Appendix B.

Climate

Lolo Hot Springs (elevation 4160 ft) and Lolo Pass (5240 ft) can be used as references for climate in the Upper Lolo Creek subbasins.

The weather station at Lolo Pass has been reporting since 10-01-1982. The average annual precipitation total at that station is about 50 inches. A weather station situated at Lolo Hot Springs operating from 1959 to 1984 recorded average annual snowfall of 103.2 inches and average total precipitation of 24.22 inches (roughly half the annual precipitation at Lolo Pass). Precipitation amounts for the lowest reaches of Lolo Creek could be represented by weather from the Missoula, Montana valley weather station. The average annual precipitation for the Missoula Valley is 13.65 inches.

Data for these stations can be accessed at the following web sites:
Lolo Pass http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=588&state=id

Lolo Hot Springs (1959-1984) http://weather-warehouse.com/WeatherHistory/PastWeatherData_LoloHotSprings2Ne_Lolo_MT_August.html

Missoula, MT http://weather-warehouse.com/WeatherHistory/PastWeatherData_Missoula2Ne_Missoula_MT_March.html

See Appendix C for monthly climate summary information.

The agricultural growing season for the area typically runs from May to September, depending on the timing of spring and autumn frost. The warmest months of July, August, and September are also the driest months, and the months with the significant demands on Lolo Creek for irrigation water. Relatively warm, dry weather can extend into October. Snowpack that provides water for the Lolo Creek watershed builds mostly between late October and May with occasional additions in June.

Stream Flow

The USGS maintained a gauging station from 1951-1960 situated on Lolo Creek between Sleeman Creek and the Maclay Diversion ditch (Station 12352000). This station measured a drainage area of 250 square miles. A few additional measurements are available for this location and another upstream. See Appendix D for a description of those locations and stream data. The data are available online from the USGS National Water Information System: Web Interface http://nwis.waterdata.usgs.gov/nwis/

For the period of record at these stations on Lolo Creek, the mean annual flow was 226 cubic feet per second (cfs), the mean annual water yield was about 0.9 cfs/square mile, the maximum recorded flow was 2660 cfs, and the minimum recorded flow was 8.8 cfs. This historical record indicated very low flows of 10 cfs or less occurred 3 out of the 10 years of continual record and high flows approaching or exceeding 2000 cfs occurred twice. Both the very low flows and the very high flows are of concern in the Lolo Creek watershed for maintaining a healthy fishery and for streambank erosion respectively.

No other stream gage has been placed on Lolo Creek. Placing a gage near the location of the historical gage would provide useful information for monitoring streamflow in the watershed.

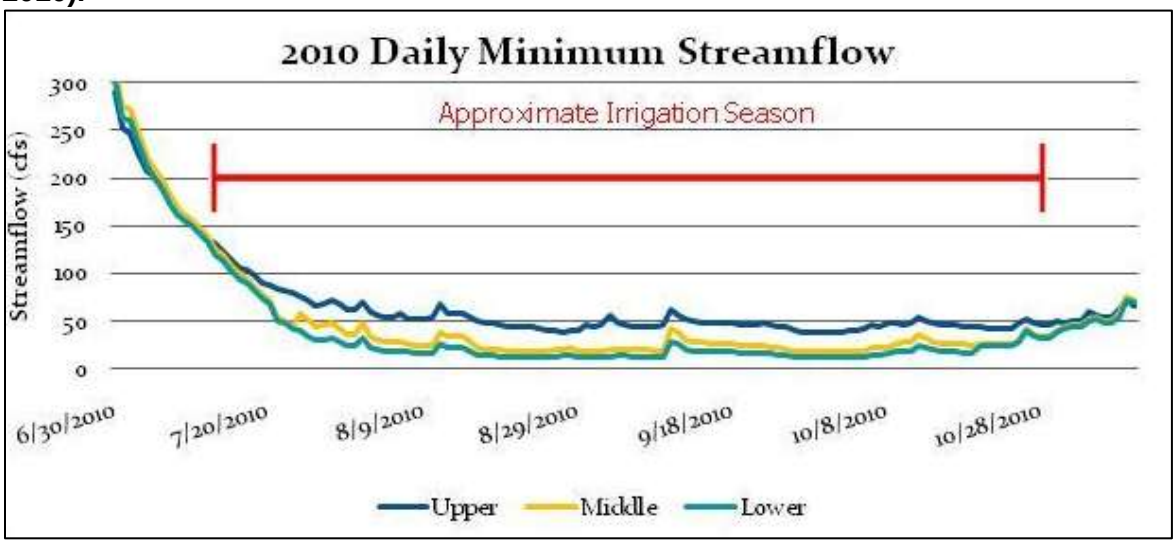
Lower Lolo Creek is recognized by the MT Department of Fish, Wildlife, and Parks as dewatered as a consequence of water diversions and many years of drought. Lower Lolo Creek has gone completely dry multiple times in recent history. In recent decades, agricultural land has been converted to residential subdivision, in part because of its proximity to Missoula. With that development, new impacts associated with groundwater withdrawal and septic drain fields are becoming an additional stress on Lolo Creek. The Clark Fork Coalition (CFC) has collaborated with the Lolo Watershed Group to establish a streamflow monitoring network on Lolo Creek (see map). In 2008, three automated monitoring instruments were installed that record water height and temperature every ½ hour. These data are being used to monitor streamflow on Lolo Creek and guide future water use and drought management practices. The sampling sites are listed below.

1. **1 - Fort Fizzle:** This site is under US Forest Service ownership. It is 6 miles from the confluence of Lolo Creek with the Bitterroot River. Through the work of the CFC, 2.37 cfs of instream flow is dedicated to Lolo Creek. This site is located above most of the large, lower valley diversions and represents how much water is entering the lower Lolo Creek system. The site is above the location of the historical USGS gauging station 1235200.
2. **2 - Middle Lolo Creek Monitoring Site:** Located 2.5 miles from the creek's confluence with the Bitterroot River at the Landquist property and is positioned above the most severely dewatered stream reach. This site is below the Maclay Diversion ditch and downstream of the historical USGS gauging station 1235200 but would provide the best site for comparison to the historical USGS station.
3. **3 - Lower Lolo Creek Monitoring Site:** 1.3 miles from the mouth of the creek, this is the lowest station in the flow monitoring network and it falls within the stretch that is most affected by dewatering. This station provides valuable information on the temperature and volume of water that reaches the Bitterroot River via Lolo Creek.

Figure 2.2. Mapped locations of sample sites: Fort Fizzle or Upper site, Landquist property or Middle site, and Larson property or Lower site. Red line identifies Lolo Creek watershed boundary.

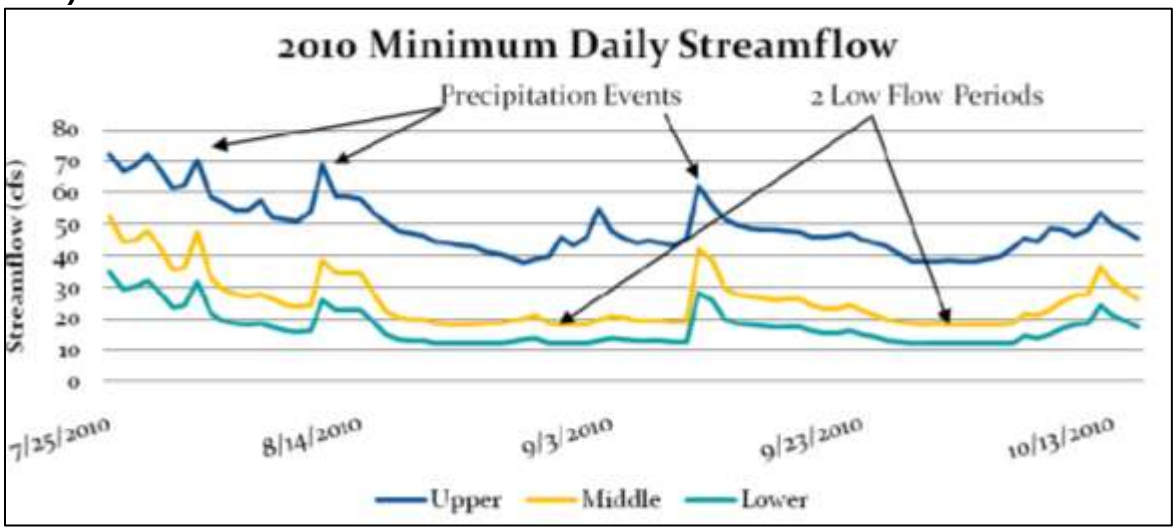
The effects of the diversion ditches are evident when one looks at stream flows from spring through fall. (Gaut 2010). The following graph illustrates little difference in streamflow, measured in cubic feet per second (cfs), in the spring and fall outside of irrigation season. The flow decreases at each measured point downstream of Fort Fizzle during irrigation season showing the effects of water drawn out of the stream channel.

Figure 2.3. 2010 daily maximum streamflow from June 30 through October 31. (Gaut 2010).



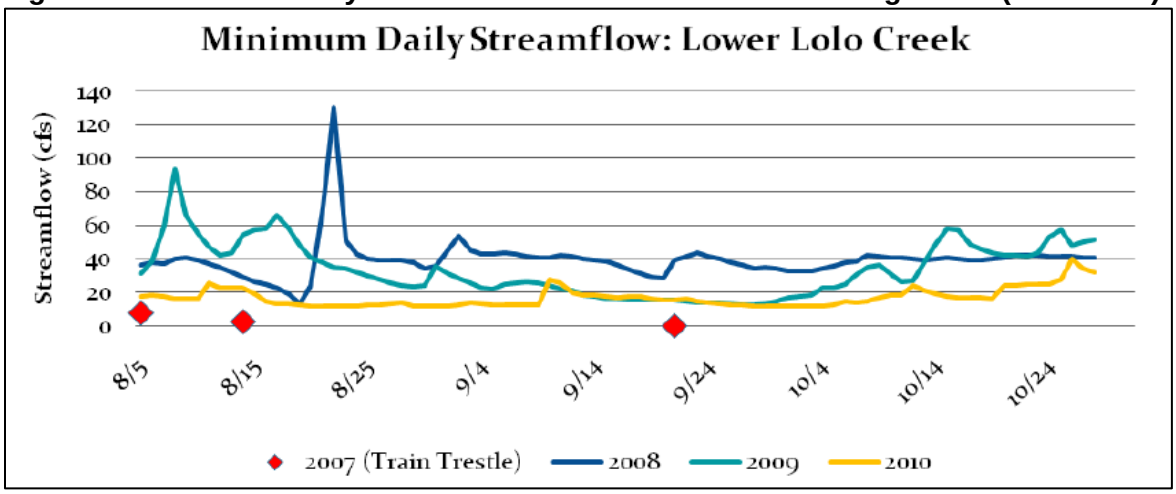
Streamflow at all three sites is very similar in spring, before irrigation season, and in late autumn. The loss between the upper and middle sites averaged about 20 cfs through the irrigation season. The loss between the middle and lower site averaged 10 cfs.

Figure 2.4. 2010 late summer and fall streamflow data at the three monitoring sites. (Gaut 2010)



The lowest flow periods occurred in late August - early September, and again in late September - early October, measuring 12 cfs at the lower site. The streamflow data also show rapid response to rainfall events in the nearly vertical rising peak in flow following rain.

Figure 2.5. Minimum daily streamflow on Lolo Creek 2007 through 2010 (Gaut 2010).



This comparison of stream flow at the Fort Fizzle site is for the years 2008-2010. The red dots show the flow in 2007 at the train trestle below Highway 93 on the severely dewatered lower creek that became totally dewatered at this site.

Figure 2.6. Dewatered Lolo Creek ¼ mile downstream of Highway 93 bridge. (08/16/2010 Katie Gaut)

Lolo Creek became dewatered again in September 2012 about ½ mile downstream of the Larson sampling site during extended warm, dry summer. The effects of groundwater use and

Bitterroot River level need to be studied to determine whether conservation measures in water use in the lower Lolo Creek watershed would help maintain connectivity to the Bitterroot River.

Figure 2.7. Dewatered Lolo Creek ¼ mile downstream of railroad bridge east of Hwy 93 bridge. (September 19, 2012 Roberta Bartlette)

Additional Hydrographs from 2007 through 2012 can be seen in Appendix E.

Ice jams also affect stream flow. While ice is a natural phenomenon in stream systems, it is especially prevalent where there is lack of vegetation. Especially on smaller streams such as Lolo Creek, healthy dense vegetation often retards substantive ice formation as temperatures remain higher under vegetation from radiant energy transfers. However, because long stream segments lack adequate vegetation, ice formation is substantive on Lolo Creek. Since settlement of the valley and encroachment on the floodplain has occurred, ice jams have historically caused damaging surface flows in some residential areas along lower Lolo Creek during a few high spring runoff events. In addition, just as stream bends dissipate energy in stream currents, the same is true for ice. Ice damage and the frequency and magnitude of debris jams increases as streams become straighter. Consequently, the reductions in stream bends are also likely exacerbating ice conditions.

Groundwater

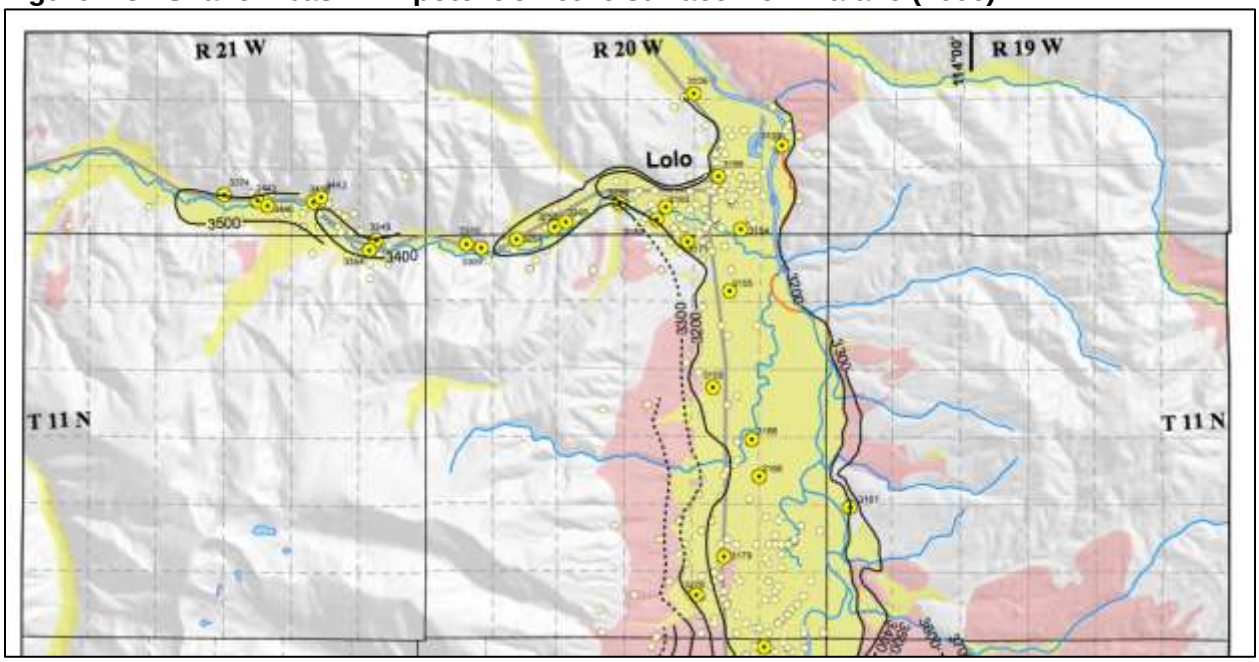
The valley bottom of Lolo Creek varies between a narrow steep canyon and broader floodplains. The floodplains are subject to high groundwater, especially during spring runoff. High groundwater is a positive effect for healthy riparian vegetation, hay crops, and pastures. Historically groundwater levels were higher as abundant beaver provided checks to stream flows causing vast storage of water, as floodplains essentially act as “sponges”. Higher groundwater levels also help to increase summer base flow conditions as groundwater absorbed by the adjacent floodplain is released during drier months. Lacking historical beaver activity and wood in the stream system, in addition to overall water withdrawals and drought

conditions have all contributed to much lower groundwater and thus baseflow conditions than historical averages. Typically high groundwater is experienced in the valley only during flooding conditions and most pasturelands are very dry by July and August.

High groundwater during flooding has resulted in damage to building foundations and basements and contamination from septic systems, especially where these infrastructures are near the stream or in the valley bottom segments with naturally high groundwater levels. Consequently, in effort to reduce future damage and protect properties, the Missoula City-County Health Department requires that an applicant demonstrate that groundwater is more than six feet below ground surface before permitting septic system construction.

The following map segment illustrates the basin-fill aquifer in the area of Lolo Creek showing the direction of ground water flow. Water moves from higher to lower altitudes within the aquifer. The aquifer from the mouth of Sleeman Gulch to the Bitterroot River in the area of the town of Lolo falls within the 3200-foot contour.

Figure 2.8. Shallow basin-fill potentiometric surface from Lafave (2006)



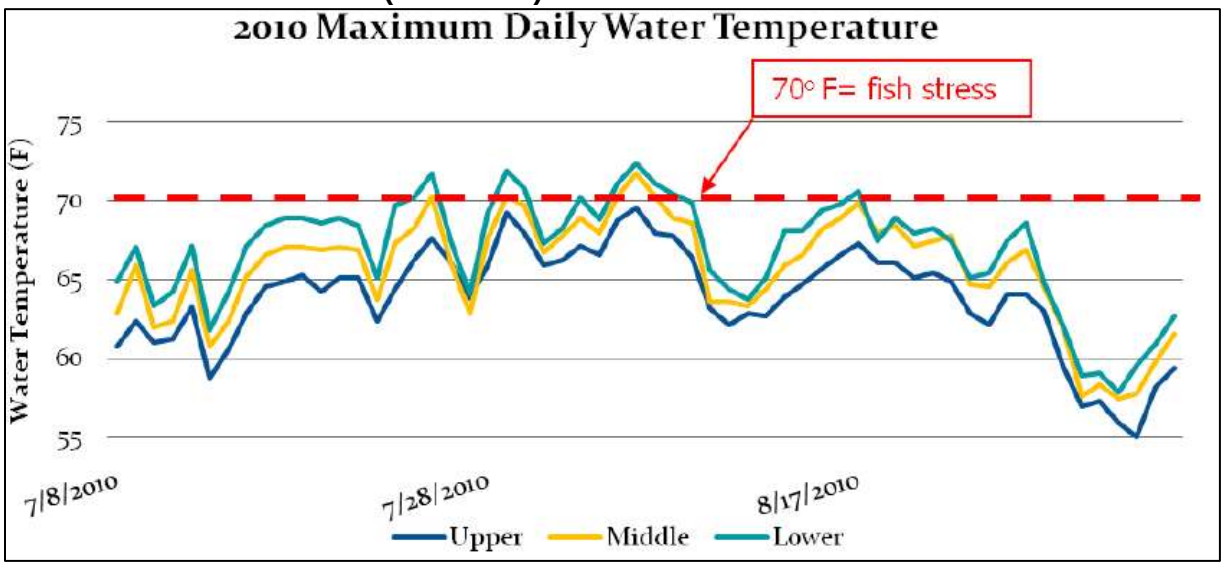
Yellow areas indicate Quaternary sediments of alluvium, outwash and alluvial fill. Red shading indicates Tertiary sediments of alluvium and alluvial fill. Contours were drawn between measured water level altitudes (shown as yellow dots). The map can be used to estimate the general direction of water flow.

Lafave (2006) found irrigation water was an important recharge source to the shallow aquifer within the Bitterroot Valley. However, we do not know if the residential and agricultural use of groundwater in the lowest reaches of Lolo Creek affects the flow of the creek or if it is most influenced by the level of the Bitterroot River. Understanding the dynamics of the aquifer, the use effects of groundwater use, and the influence of late season Bitterroot River flows would help in developing a plan to limit or eliminate the amount of time Lolo Creek is disconnected from the Bitterroot River.

Water Temperature

The effects of dewatering also can be observed in the water temperature as compared between three monitoring sites on Lower Lolo Creek between Fort Fizzle (the upper site), Landquist site (middle) and Larson site just east of the Highway 93 bridge crossing). Both the middle and the lower sites reach or exceed the 70 degree F marker for fish stress. The figure below gives an example of temperatures at the sample sites. Additional temperature data is shown in Appendix E.

Figure 2.9. The maximum daily water temperature recorded in 2010 at three monitoring sites on Lower Lolo Creek. (Gaut 2010).



An educational partnership has existed for years between the Woodman and Lolo elementary schools and the Watershed Education Network which has brought students to the waters of Lolo Creek at the OZ Ranch, Fort Fizzle and the Landquist property to study physical characteristics such as velocity, temperature, and dissolved oxygen as well as biological characteristics such as macroinvertebrates. Most of the data collected in this program resides with teachers at the Woodman School. Students have made presentations to the Lolo Watershed Group and provide general interest information but sets of yearly records have not been obtained. However, a data request has been made to this group.

Floodplain

On April 6, 2009, FEMA issued the City of Missoula and Missoula County Revised Preliminary Digital Flood Insurance Rate Maps (DFIRM). This was the first major update to these maps in over twenty years.

On December 20, 2010 FEMA issued the third official draft of the City of Missoula and Missoula County Revised Preliminary Digital Flood Insurance Rate Maps (DFIRM). Included in this update is the removal of levee-like structures such as Hwy 12, Hwy 93, Mullan Road and Interstate 90 from providing flood protection. This means that properties that have previously been shown as being out of the floodplain due to the presence of these non-levee embankments, are now shown as being within the regulatory floodplain.

The vertical datum and flood elevations are shifted from NGVD29 to NAVD88. Although this results in higher flood elevations, the actual flood depth remains the same. Several more miles of Lolo Creek (upstream to Graves Creek) have been added as a zone-A floodplain (as indicated by the blue hatched area in the maps below). Much of the area within the zone-A designation in the lower reaches of Lolo Creek contains residential structures. Appendix F contains maps segments following Lolo Creek from the upper reaches of the DFIRM mapped area to the confluence of Lolo Creek with the Bitterroot River. Points of interest to the watershed restoration plan include residential development within Lolo Creek's 100 year floodplain and Highway 12 immediately adjacent to the floodplain in some areas.

Streambank Erosion/Stabilization

Stream bank erosion is greatly accelerated along many sections of Lolo Creek. Meandering streams are very dependent on two primary factors for stability: 1) healthy, dense and deep rooted streamside shrubs and trees, and 2) the ability to meander, where typically bends dissipate up to 90% of stream energies through induced turbulence. Large wood jams and beavers also provide necessary energy dissipation mechanisms. Where any of these features has been removed or compromised, land loss, sediment delivery, and loss of channel capacity (as the channels become wider and more shallow) can be expected.

Often stream stabilization projects are performed to mitigate "symptoms" of the problem, instead of addressing the cause of instability. Activities, such as armoring streambanks with stone, often reduces other necessary channel functions and ultimately contributes to a downward trend in stream functions and habitat conditions for both local and sometimes adjacent landowners. In addition, stream stabilization often leads to additional stabilization efforts either through maintenance or to upstream and downstream segments as the root cause (often lack of healthy vegetation because of agricultural clearing or infrastructure encroachment), is not addressed and armoring exacerbates the conditions. Stream projects that work towards remedying the fundamental issues of providing healthy channel migration zones (providing a buffer of healthy vegetation and allowing the stream to bend) would work more favorably for both long-term stream, fisheries, and land-owner protections.

The Missoula Conservation District has administered the 310 permit program for Missoula County, which addresses stream projects affecting the bed and banks of streams. The Conservation District has indicated that the number of 310 permits issued for Lolo Creek has exceeded the numbers issued for other similar streams in the area.

On Lolo Creek, Brandt and Ringelberg (Watershed Education Network 1999) observed consecutive outside meander armoring, channel straightening by Highway 12, and levees in the reach between Highway 93 and the confluence with the Bitterroot River. Much of Lolo Creek, from the Elk Meadow Road to the Bitterroot River, was stabilized. Individual land owners in this reach have subsequently been issued 310 permits for stabilization projects.

A 2003 streamwalk of almost 27 miles of the main stem of Lolo Creek upstream from the Highway 93 bridge found 23.7% of the bank armored with rip rap (Zelazny 2004).

A 2006 LWG tour assessed erosion and stabilization efforts at 4 sites (Landquist 2007) The four properties assessed were in relatively close proximity to each other within a mile downstream of

Fort Fizzle and each has infrastructure such as water systems and homes that have been in place for decades and would not be cost effective to move putting additional constraints on potential channel migration. This study concluded it will be important to look at the lower Lolo Creek from, a geomorphic stability perspective as stabilization or restoration plans were made. Designing and implementing stabilization projects will be a challenge given numerous adjacent private and public ownerships, FEMA floodplain designations, and regulation by numerous agencies from county through federal. Ultimately, a blend of approaches that provide as much buffer to the riparian vegetation and stream meandering, together with techniques that facilitate rather than retard stream function and riparian vegetation, will be most successful.

A 2011 streamwalk below Fort Fizzle (data on file with LWG) found many changes in the stream channel due to sustained high water during the spring 2011 runoff period. Flooding conditions and changes to stream meander patterns are a normal channel function. Interestingly, former engineered stabilization projects (rip rapped banks) that generally prevented erosion, were either abandoned as the stream seeks to regain lost meanders or have maintenance issues as they continue to erode (such as the rip rap upstream of the Mormon Peak Bridge). History is proving that normal stream functions will prevail and even well armored projects will either be abaondoned or require maintenance. Erosion is continuing on several previously recognized sites and they became further eroded in 2011.

Figure 2.10. Lolo Creek channelized and armored. Native vegetation on the south bank provides some shading. The north bank is impacted by highway maintenance materials. (04/12/2011, Roberta Bartlette)

Significant bank erosion was observed on 3.2% of the stream length. The Lolo Watershed Group conducted a stream walk in late summer of 2011, in part, to document stabilization projects and their effectiveness. This project will update the 1999 and 2003 surveys.

Figure 2.11. Riparian vegetation was stripped by the spring flows of Lolo Creek leaving the bank vulnerable to undercutting and erosion. 2.5 miles west of Lolo. (06/04/2008, Roberta Bartlette)

The take home message is to foster natural stream meandering and riparian vegetation to the extent possible. Streams will continue to meander as time passes, and humans have the option to be in continual battle and expense with the stream, or we can provide as much buffer to our encroachment activities as possible. We can attempt to regain necessary shrubs and trees within the channel migration zones. Where encroachment is an issue that cannot be resolved, we can devise stabilization projects that include desired vegetation and facilitate natural functions. In areas where wood debris jams and beaver can be allowed, great strides in energy dissipation, increased base flows, and habitat conditions could be realized

Road Densities

Data for road densities and roadless areas distributed through some of the major tributary areas of the Bitterroot subbasin were collected for the Interior Columbia Basin Ecosystem Management Project (Northwest Power and Conservation Council 2009). The Lolo Creek tributary to the Bitterroot River was described to have a total watershed area of 273.2 square miles with 1153.0 miles of roads yielding a road density of 4.2 miles/square mile. Over the entire Columbia River basin, road densities between 1.7 and two miles per square mile of watershed appeared to be a threshold above which watershed and fisheries condition could be negatively impacted (USFS 1996). The Lolo National Forest found that the percentage of surface fines increased with watershed road density, which supported the Interior Columbia River Basin Ecosystem findings (Riggers et al. 1998). Lolo Creek is one of the tributary watersheds where agencies recognize some of the most severe sediment or siltation problems in the Bitterroot Subbasin having road densities among the highest of any tributaries in the subbasin. Appendix B lists an estimate of road densities by tributary. Lolo Creek, including the South Fork of Lolo Creek, receives about.85 tons of sediment per square mile of road, or 171.7 tons of sediment from unpaved road crossings (90.4 tons/year) and unpaved road segments along waterways (81.4 tons/year) for a total of 171.7 tons of sediment per year (DEQ 2011).

Effects of Highway 12 Maintenance

US Highway 12 runs adjacent to the West Fork Lolo Creek and Lolo Creek for much of its length. Traction sand and deicing chloride salts are used to improve winter driving safety on Montana highways, including US Highway 12. Plowing, snowblowing, and runoff deposit sand and chemicals on the embankment and into the West Fork Lolo Creek and Lolo Creek's mainstem. The Montana Department of Transportation MDT) is able to recover a portion of the traction sand applied. The Montana Department of Environmental Quality (DEQ) has listed recommendations for reducing the amount of sediment that reaches Lolo Creek. MDT reports summaries of tractions sand use and recovery to DEQ.

Table 2.1 Traction sand summary for US Highway 12, West Fork Lolo Creek. (DEQ-PPA-WQPB-WPS 2010)

Year	Applied (Tons.Year)	Recovered (Tons/Year)	Net loss (Tons/Year)
2003	1,238	765	473
2004	930	649	281
2005	700	327	373
2006	863	358	505
2007	628	15	613
2008	778	480	298

Lowell Chandler, a student in the Environmental Studies program at the University of Montana wrote a paper on winter maintenance on Highway 12 and its potential effects on Lolo Creek (Chandler 2011). He interviewed Montana Department of Transportation's Winter Maintenance Specialist, Justin Juelfs and obtained information about recent years' winter maintenance. The Upper Lolo TMDL is 81.25% of the Highway 12 maintenance area (MDT 2008). The total sand and chemical used is multiplied by 81.25% to obtain values for the Upper Lolo TMDL. In the table below, the sand amounts listed for the Upper Lolo TPA portion of Highway 12 can be compared to the amounts listed in the table above for the years 2003-2008.

Table 2.2 Traction sand and deicing chemical use for winter maintenance on US Highway 12. (Chandler 2011)

Year (Winter)	Highway 12 from Lolo Pass to Lolo		Upper Lolo TPA portion of Highway 12	
	Traction Sand (Tons)	Deicing Chemicals (Gallons)	Traction Sand (Tons)	Deicing Chemicals (Gallons)
2008-2009	1,005	4,300	816.6	3494
2009-2010	698	5,200	567	4,225
2010-2011*	1,233	3,800	1002	3,088

**The information for 2010-2011 was obtained in late April, before winter maintenance ended for 2011.*

The Kearl Module Transportation Plan (Tetra Tech 2010) illustrates changes that have been suggested for transporting oversized loads on Highway 12 including construction of new turnouts and "improvement" of existing turnouts along with the requirement for maintaining snow-free road surfaces. Although the loads for which this plan was created have been cut down in size to travel on the Interstate Highway System, many other companies have

expressed interest in this route. These activities could increase sediment production as well as impact wetlands adjacent to Lolo Creek.

Figure 2.12. Photo of Highway 12 traction sand distributed down the embankment to the West Fork Lolo Creek. (04/12/2011 Roberta Bartlette)

Sewage Contamination

Boer (2002) studied septic-derived nutrient loading to ground and surface water In Lolo, He found detectible plumes from septic systems, particularly in the lowest reaches of Lolo Creek in the lower Mormon Creek area and in shallow portions of aquifers. The current state limitation of one septic system per acre seems to be adequate at present in soils in the Lolo Creek watershed to keep nutrients from septic systems at acceptable levels. However, there were accumulations below unsewered subdivisions, mobile home parks, and commercial areas causing nitrate-N contaminated groundwater to be discharging to the Bitterroot River and possibly into lower Lolo Creek.

The following table from the Tri-State Water Quality Council, (2005) illustrates the difference between nutrient discharge from different treatment systems. Although wastewater treatment in Lolo produces lower total nitrogen discharge, it does not necessarily reduce phosphorus discharge over drain field systems.

Table 2.3 Comparison of nutrient concentrations discharged from various types of wastewater treatment.

Wastewater Treatment Technology (examples)	Total Nitrogen	Total Phosphorus
1. Lolo Conventional Secondary Wastewater Treatment	22.0 mg/l	3.8 mg/l
2. Missoula WWTP in 1992 Secondary Treatment	21.9 mg/l	3.5 mg/l
3. Kalispell Biological Nutrient Removal WWTP-2001	9.4 mg/l	0.11 mg/l
4. Missoula Biological Nutrient Removal (Design Goals)	10.0 mg/l	1.0 mg/l
5. Conventional on-site septic tank (EPA 2002).	40-100 mg/l	5-15 mg/l -
6. Estimated Removal by Drainfield Soil Treatment (conventional septic system): (EPA, 2002, Table 3.17)	10-40%	85-95%
7. Estimated Remaining Nutrients Discharged to Ground Water (based on #6 above)	30-45 mg/l	0.5-1.6 mg/l
8. Montana Level 2 Nitrogen Removal Systems	24 mg/l	10.6 mg/l (0.5-1.6 mg/l after soil treatment

New developments should be analyzed to determine whether individual septic systems or using the wastewater treatment plant best protects ground water.

The Lolo area has been experiencing sustained population growth and subdivision due, in part, to is proximity to Missoula. Changes in land management and ownership, the movement of a major landowner, Plum Creek, to real estate sales, plans for ski area development and recent expansion of area using the Lolo Sewer System have lead to increased concern about inadequate planning tools. The 2002 Lolo Regional Plan detailed preferred minimum building site size within the watershed with increasing density in the near vicinity of Lolo. However, without zoning in place, subdivisions have been created at higher densities than outlined in the plan. With these increased densities there is a need for continued monitoring of ground water and a need for guiding development to meet the lowered densities preferred in the Lolo plan.

Fish and Wildlife Concerns in Lolo Creek Watershed

The Lolo Creek Watershed is rich in plant and animal species. Species of concern in the area that includes the Lolo Creek Watershed (USDI 2013) include Canada lynx (*Lynx Canadensis*) and Bull Trout (*Salvelinus confuentus*), both listed as threatened by the U.S. Fish and Wildlife Service. While grizzly bear (*Ursus arctos horribilis*) is listed as a threatened species on the Lolo National Forest, its presence in the Lolo Creek watershed in uncertain. The Yellow-billed Cuckoo (*Coccyzus americanus*) is a candidate species and wolverine (*Gulo gulo luscus*) is a proposed species. Moose (*Alces americanus)*, elk (*Cervus Canadensis)*, white-tailed deer (*Odocoileus virginianus)*, and mule deer (*Odocoileus hemionus)* are the ungulates residing within the watershed. Other larger animals include black bear (*Ursus americanus*), gray wolf

(*Canis lupus*), mountain lion (*Puma concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), beaver (*Castor canadensis*), raccoon (*Procyon lotor*) and river otter *Lontra canadensis*). Numerous smaller mammals, birds, aquatic vertebrates and invertebrates and a vast number of native plants reside in the watershed. Healthy riparian, forest and aquatic habitat is critical to maintaining the species diversity that currently exists.

Lolo Creek, the South Fork of Lolo Creek and Mormon Creek were designated critical habitat for bull trout by the U.S. Fish and Wildlife Service in 2010 (Federal Register 2010) and retains that designation in 2012 with the exception of segments covered by the Plum Creek Native Fish Habitat Conservation Plan (HCP). Briefly, the primary constituent elements of critical habitat include:

- Springs, seeps, groundwater sources and subsurface water connectivity
- Migration habitats with minimal impediments
- An abundant food base
- Complexity in gradient, depth, velocity and structure
- Cool water temperatures ranging from 2 to 15^{o}C (36-59^{o}F)
- Spawning and rearing areas
- Natural range of flows including peak, high, low and base within historical and seasonal ranges
- Water quality and quantity adequate through all life stages
- Low levels of nonnative predators, interbreeding or competitive species.

As has been shown in this chapter, Lolo Creek can lose its connectivity with the Bitterroot River and reaches summer temperatures outside of the preferred range for Bull trout. However, the upper portion of the drainage holds promise of adequate habitat with reduced sedimentation and removal of fish passage/migration barriers and inadequate culverts. Continued work within the lower watershed can improve these habitat elements.

Westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) is considered a *Species of Concern* by the State of Montana, and a *Sensitive Species* by the U.S. Forest Service (USFS) (Montana Fish Wildlife and Parks 2007). Active restoration projects are occurring within the watershed, including the removal of human-made barriers to migration and study to determine species response to barrier removal. (Neville and Peterson 2010). Habitat degradation and competition with nonnative trout are among causes leading to the decline in this species. Maintaining and enhancing cutthroat trout populations in Montana, especially genetically pure components and seeking collaborative opportunities to restore and/or expand each cutthroat trout subspecies into selected suitable habitats within their respective historical ranges are among the objectives of a multi organization memorandum of understanding and cutthroat trout conservation agreement (Montana Fish Wildlife and Parks 2007). Surveying genetics and distribution, monitoring and educational outreach are additional objectives.

Westslope cutthroat trout appeared in electrofishing samples of most of the tributaries of Lolo Creek. Non-native Brook trout (*Salvelinus fontinalis)* followed by Brown trout (*Salmo trutta)* were the next most common. Mountain whitefish (*Prosopium williamsoni*) were found in the main stem of Lolo Creek and rainbow trout (*Oncorhynchus mykiss*) were found in a few of the tributaries. Granite Creek, Mormon Creek and the South Fork of Lolo Creek were the only places Bull trout were found in this sample set. See Appendix G for recent information from fish sampling within the watershed.

The objectives outlined within the WRP will help maintain and enhance habitat for these and other native species within the Lolo Creek Watershed.

Chapter 3. Impairment Causes and Sources

EPA Element 1. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.

EPA Element 2. An estimate of the load reductions expected for the management measures listed.

A number of studies, assessments, and planning documents have been produced in the past several years that will provide the technical data, resource needs, and proposed plan information that makes up the backbone of the Lolo Creek Watershed Restoration Plan. This chapter reviews a portion of this work, particularly related to identifying sources of water quality impairment, extent of impairment, and load reductions expected if TMDL values are achieved. Some other factors of concern in the watershed are also listed.

Key Findings

A variety of studies from many land and aquatic management agencies repeatedly point to the problems summarized below.

Sediment-caused impairment in the Lolo Creek Watershed is related to:

- High density of logging roads in the watershed
- Traction sand used for winter highway maintenance
- Lack of BMP use in past road building and silvicultural activities
- Surface water quality monitoring to quantify change has been lacking

Fisheries, wildlife, and water quality issues in the Lolo Creek Watershed relate to:

- Loss of creek meanders due to channelization and
- Hard surface bank stabilization projects – riparian encroachment/disturbance
- Lack of woody debris in the creek
- Beaver activity at much lower than historical levels
- Barriers to fish passage
- Dewatering
- Elevated sedimentation

Additional concerns related to human activities include:

- Groundwater quality changes with increasing development
- Loss of surface flow from groundwater/surface water use in drought
- Streambank erosion on private property
- Armoring in response to channel migration
- Winter highway maintenance application of deicer chemicals reaching the creek
- Loss of water from ditches that are leaking
- Loss of fish from entrainment to ditches

Sedimentation

The Montana Department of Environmental Quality has completed the TMDL for the Bitterroot drainage (Montana DEQ 2011). This document has identified sediment-related effects as a cause of impairment on Lolo Creek. Sedimentation (a TMDL pollutant) and siltation cause impairment of Lolo Creek's aquatic life and coldwater fishery.

The anthropogenic sources of sediment for the Bitterroot TMDL area (including Lolo Creek) include:

- Upland and bank erosion associated with removal or riparian vegetation
- Unpaved roads
- Culvert failure
- Logging
- Disturbed ground on small and large acreage ranches
- Agriculture
- Stormwater runoff from construction sites

The physical substrate habitat alterations are considered a source of impairment, but are not considered a pollutant.

The following table summarizes the causes and sources of impairment on four segments of Lolo Creek. Sheldon Creek is a minor tributary on the north side of Lolo Creek, downstream of Grave Creek. Impaired stream segments in the middle and lower Bitterroot Subbasin are based on the Montana Department of Environmental Quality 2006 (303d) list of impaired water bodies.

Table 3.1 Causes of impairment and probable sources by segments of Lolo Creek are given in the Bitterroot River Subbasin Plan (Northwest Power and Conservation Council 2009).

Water Body	Miles Affected	Causes of Impairment	Probable Sources of Impairment
West Fork Lolo Creek	6.8	Alteration in stream-side or littoral vegetation cover, Sedimentation/siltation	Forest roads, Streambank modifications/ destabilization, Highway & bridge runoff
Lolo Creek (Headwaters to Sheldon Creek)	13.0	Physical substrate habitat alterations, Sedimentation/siltation	Hydromodification, Highways, roads, bridges, Silviculture
Lolo Creek (Sheldon Creek to Mormon Creek)	14.3	Physical substrate habitat alterations, Sedimentation/siltation	Habitat modification - other than, Hydromodification, Highways, roads, bridges infrastructure (new construction), Silviculture activities

Water Body	Miles Affected	Causes of Impairment	Probable Sources of Impairment
Lolo Creek (Mormon Creek to the mouth)	2.8	Low flow alterations, Physical substrate habitat alterations, Sedimentation/siltation	Agriculture, Silviculture activities, Streambank modifications/ destabilization
Lolo Creek, South Fork	6.2	Low flow alterations, Physical substrate habitat alterations	Impacts from hydrostructure flow, regulation/modification, Forest roads, Silviculture

Figure 3.1. Deicing salts and traction sand/gravel have direct pathways to Lolo Creek at bridge crossings. Photo 04/12/2011 Roberta Bartlette.

Upper Lolo Creek causes of impairment were listed in Water quality restoration plan and total maximum daily loads for the Upper Lolo Creek TMDL planning area (Mathieus 2003).

Delineations for Upper Lolo Creek in this study give additional definition by stream segment and tributary.

Table 3.2. Current sediment loads and causes of impairment in Upper Lolo Creek (Mathieus, 2003).

Bitterroot Subbasin	Creeks of Lolo Creek	Current Sediment Loads tons/year	Source of Impairment
West Fork of Lolo Creek 1401	West Fork of Lolo Creek	19 t/yr from forest roads, 425-518 t/yr from highway, 246 t/yr natural erosion	Silviculture, Habitat modification[1], Bank destabilization[2], Highways[3], Logging roads
	Lee Creek Separate in TMDL document only	9 t/yr from roads, 95 t/yr natural erosion	Silviculture, Habitat modification[1], Bank destabilization[2], Logging roads[4]
East Fork of Lolo Creek 1402	East Fork of Lolo Creek	53 t/yr from roads, 596 t/yr natural erosion	Silviculture, Logging roads[4]
	Lost Park Creek	21 t/yr from roads, 192 t/yr natural erosion	Silviculture, Logging roads[4]
Granite Creek 1403	Granite Creek	96 t/yr from roads, 449 t/yr natural erosion	Silviculture, Logging roads[4]

1. Habitat modification other than hydromodification
2. Bank or shoreline modification / destabilization
3. Highway maintenance and runoff
4. Logging road construction and maintenance

Sediment Sources and Loads for Lolo Creek (including S. Fork Lolo Creek)

Data for the following tables are summarized from the Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan (Montana DEQ 2011) in tons/year.

Table 3.3a. Sediment load from streambank erosion in tons/year (from Table 5-50)

Source	Transportation	Riparian Grazing	Cropland	Mining	Silviculture	Irrigation shifts in stream energy	Natural sources	Other
Load	1145.7	613.2	188.8	0	113.4	127.4	2761.8	477.1
	Total load (tons/year) = 5427.5				Normalized (tons/year/mile = 22.1			

Table 3.3b. Sediment load from upland sources as modeled using the Soil Water Assessment Tool (from Table 5-51)

Source	Agriculture	Small rural acreage livestock	Forest	Rangeland (brush)	Rangeland (grass)	Medium to low density Urban
Load	184.0	41.8	1744.5	1914.6	1044.5	15.5
	Total Load (tons/acre) = 4944.9			Normalized (tons/acre/sq mi = 24.4		

Values reported are for the Lolo Creek Watershed including the South Fork of Lolo Creek, below the Upper Lolo Creek TMDL Planning Area. Tons/year.

Note the Upper Lolo TMDL determined negligible input from upland sources given the limited agricultural and residential development in that area (Mathieus 2003).

Table 3.3c. Sediment load from unpaved roads (Table 5-52)

Source	Unpaved road crossings	Unpaved parallel road segments
Load	90.4	81.4
	Total Load (tons/acre) = 171.7	Normalized load (t/yr/sq mi) = 0.85

Aquatic Habitat Health as Related to Sediment

The watershed in its current condition fully supports agriculture and industry, but impairment results in only partial support for aquatic life and cold-water fisheries. Drinking water quality was not assessed due to a lack of sufficient credible data. Primary contact recreation is partially supported in the lowest unit and fully supported in the upper two.

Macroinvertebrate counts in September 2005 were within the target range indicating full support of aquatic life, however sediment and habitat parameters fell outside of targets leaving this this classification as questionable (personal communication, Ladd Knotek). Anthropogenic effects within 100 feet of the channel affect 69% of the stream bank along the length of Lolo Creek. The following table summarizes these counts. MMI is Mult-Metric Index (an index that combines indicators, or metrics, into a single index value) and O/I is Observed/Expected. These are model assessment tools used to evaluate macroinvertebrate numbers.

Table 3.4. Macroinvertebrate metrics for Lolo Creek (Montana DEQ 2011)

Station ID	Collection Date	Mountain MMI	Valley MMI	O/E
Upper Lolo	9/11/2005	77	Not applicable	1.19
Middle Lolo	9/10/2005	Not applicable	57	1.23
Lower Lolo	9/8/2005	Not applicable	63	1.23

The following table displays sediment and habitat data compared with targets from a 2007 survey by Montana DEQ. The percent fines exceeded targets in several, but not all, categories.

Pool frequency and amount of large woody debris fell below targets at the three reaches sampled.

Table 3.5. Lolo Creek data compared with targets (Montana DEQ 2011)

Reach ID	Mean BFW (ft)	Level III Ecoregion	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat			Riparian	Sediment Source
				%<6mm	%<2mm	Riffle %<6mm	Pool %<6mm	W/D Ratio	Entrenchment	Residual Pool	Pools/Mile	LWD/Mile	Greenline % Shrub Cover	Riffle Stability Index
LOLO-26	48.1	NR	C4	20	5	6	35	28.5	1.6	1.2	13	45	65	81
LOLO-34	51.4	NR	C4	13	2	7	31	31.1	4.5	1.6	11	161	82	61
LOLO-56	82.5	NR	C4	16	8	6	17	39.4	3.7	1.4	16	92	86	80

Shaded cells indicate target value was not met.

TMDL for Lolo Creek Segments including percent reduction if TMDL values are achieved.

Total Maximum Daily Load, or TMDL, refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards. The Montana Department of Environmental Quality has completed the TMDL for the Bitterroot drainage (Montana DEQ 2011). Bank erosion and unpaved road source assessments for Lolo Creek were originally estimated for the entire Lolo watershed (DEQ 2011). Those assessments included the Upper Lolo TPA. Loads and reductions specific to the subwatersheds for each listed segment were calculated using the percent of the area in the subwatershed compared to the total Lolo Creek watershed area. That ratio was used to recalculate totals for each subwatershed. These allocations are shown in the tables below. The tables also list the percent reduction in sediment expected when TMDL values are reached.

Table 3.6. Upper Lolo Creek Sediment TMDL (headwaters to Sheldon Creek). (Montana DEQ 2011)

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (Percent Reduction)
Roads		41	15	63%
Eroding Banks	**Anthropogenically Influenced**	863	362	28%
	Natural	897	897	
Upland Erosing	**All Land Uses**	1125	820	27%
Point Source	**Stormwater Construction**	0	7*	0%
Total Sediment Load		2926	2094	28%

**This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than this amount.*

Table 3.7. Middle Lolo Creek Sediment TMDL (Sheldon Creek to Mormon Creek). (Montana DEQ 2011)

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (Percent Reduction)
Roads		84	31	63%
Eroding Banks	**Anthropogenically Influenced**	1762	740	28%
	Natural	1833	1833	
Upland Erosing	**All Land Uses**	2690	2086	22%
Point Source	**Stormwater Construction**	0	7*	0%
	Billingsley Placer Mine	0	0.4	0%
Total Sediment Load		6369	4690.4	26%

**This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than this amount.*

Table 3.8. Lower Lolo Creek Sediment TMDL (Mormon Creek to the mouth at the Bitterroot River) (Montana DEQ 2011).

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (Percent Reduction)
Roads		1.72	0.64	63%
Eroding Banks	**Anthropogenically Influenced**	37	16	28%
	Natural	37	37	
Upland Erosing	**All Land Uses**	199	122	39%
Point Source	**Stormwater Construction**	0	7*	0%
Total Sediment Load		275	176	36%

**This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than this amount.*

South Fork of Lolo Creek

The South Fork of Lolo Creek (from its headwaters in the Bitterroot Selway Wilderness to its confluence with Lolo Creek, (Unit MT76H005_020) is somewhat unique. Although listed with impaired units with low flow alterations and physical substrate habitat alterations, it is not presently included with those units polluted by sediment. The beneficial use status for the South Fork of Lolo Creek is as follows:

- Agriculture, industry, and drinking water (full support)
- Aquatic life, coldwater fishery and primary contact recreation (partial support)

Fisheries, wildlife, and water quality/quantity issues in the Lolo Creek Watershed

Loss of Creek Meanders Due to Channelization and Confinement by Armoring

Lolo Creek has been straightened throughout its length to accommodate U.S. Highway 12. The highway is located along much of the north side of the creek. Armoring, mostly along the north

banks has left inhospitable environment for vegetation with large rock, southern exposure, and steep incline. The loss of meanders and the loss of shade from vegetation diminishes habitat. Armoring also limits the addition of woody debris along this bank but increased flows do undercut trees on the opposite bank and downstream.

Ice jams formed by periods of very cold winter weather, then released during periods of rapid warming or Chinook weather create changes to the streambank and channel which has become a problem due to human encroachment. Ice jam buildup has also been the cause flooding during the winter. Anecdotal comments indicate this process has become more common following straightening by Highway 12 construction.

Figure 3.2 Ice jam on Lolo Creek at the Earl Tennant recreation site.
Ice and water are elevated to near the height of the highway and the bridge crossing the creek at the photo point. Photo 2/27/2011. Roberta Bartlette.

Riparian vegetation is lacking on the north bank of the creek where it has been replaced with riprap as it parallels Highway 12. Vegetation along stream banks not only provides summer shading and cooling for aquatic life, but also helps limit cooling by long-wave radiation from the creek and the bank during winter months. Duncan (2002) provides a good explanation of the energy balance affecting stream temperature.

Also, during spring runoff streambank erosion becomes a serious problem for many private landowners along lower Lolo Creek due to channelization and sedimentation problems from the upper reaches.

An inventory and assessment of bank stabilization projects in Missoula County (Brandt and Ringelberg 1999) examined Lolo Creek from the Elk Meadows Road Bridge to the mouth of Lolo Creek. They found that bank stabilization and channel relocation have altered Lolo Creek.

Private ownership dominates the valley bottom where consecutive outside meanders have been armored. Channel straightening and channel meander armoring have led to channel incision

where the creek parallels the road and along armored private properties. Future meandering will be limited by these structures, although some armored areas are aging and may need replacing. Forty-one projects were surveyed with an average project length of 308 feet. Of the 13.6 miles surveyed, both sides of the 6.8 miles of stream length, 2.4 were covered by stabilization projects, or 18%.

Zelazny (2004) reported 23.7% of the total stream of 26.86 miles of the main stem of Lolo Creek had riprap banks. 3.2% of the banks sustained significant erosion and 2.5 % of the banks were adequately stable to have undercut banks with vegetative overhangs. His study area included both the Lower Lolo Creek subbasin and the mainstem upstream to Lee Creek's confluence with the West Fork of Lolo Creek. A 2011 streamwalk by the Lolo Watershed Group from Fort Fizzle to the railroad trestle downstream of Hwy 93 found additional stabilization projects totally about 400 feet plus additional large angular rock that had been placed at the water's edge is a few locations.

Lack of Woody Debris and Diminished Wetlands

Beaver, once abundant along Lolo Creek, create pools and wetlands by damming or slowing the water flow as they create structures. These wetlands absorb and hold water to be released slowly to the creek, allow suspended sediment to settle and encourage riparian vegetation providing a diverse habitat favorable to terrestrial and aquatic life. Although there are pockets of beaver living along lower Lolo Creek the incised channel with little braiding and frequent armored banks do not provide the best environment for beaver dams do to high flow velocities during parts of the year. Lack of habitat and management to remove beaver either because they have been considered troublesome or for the value of their fur has diminished population along the main stem and tributaries of Lolo Creek.

Logging near waterways in the upper reaches of Lolo Creek and its tributaries along with decades of livestock pasturing along the main stem and valley bottoms of tributaries has removed protective riparian shrubs and trees that can provide shade and structural diversity within the creek when they fall into the waterway. Wetland vegetation has been removed through grazing and streambanks have been compacted or eroded through overuse. Some of the large ranches along Lolo Creek have been improving pasturing practices to encourage riparian vegetation response. Deer, elk, bear, and moose can be commonly seen in these fields in the early morning and late evening.

Logging, channelizing, and reduced beaver populations have diminished the source for woody debris within Lolo Creek and its tributaries. Erosion in the lower reaches adds trees to the creek with each spring's high water. However, too often private property owners feel the need to remove the wood or cut it into smaller pieces that float on down the channel. Wood in the creek can add sinuosity that is a challenge to property owners, especially those who have built close to the creek. However, wood in the creek helps slow water flows overall, helps stabilize gravel bars and adds habitat diversity.

Dewatering and Fish Passage Barriers

Lower Lolo Creek, within the main stem of Lolo Creek through Bitterroot Subbasin 1409, was categorized as chronically dewatered from summer irrigation in the Bitterroot River Subbasin Assessment (Northwest Power and Conservation Council 2009).

Major irrigation diversions are located along this segment of Lolo Creek. In addition to contributing to dewatering on the main stem, the ditches are responsible for loss of trout and other aquatic species as shown in studies of two of the major diversions on tributaries of the Bitterroot River for Montana Fish Wildlife and Parks (Bahn and Zale 2007). Often water is diverted to a ditch by a dam across the creek used to elevate the water level to that of the opening of the ditch. During periods of low water, these diversion dams can prevent or limit fish passage to upstream areas. Dams also serve to entrain upstream fish into the irrigation ditches, many of which do not have fish screens. Use of fish screens on ditches has been shown to reduce loss of fish to the ditches (Gale and Zale 2005).

Figure 3.3 Diversion dam on Lolo Creek in autumn effectively blocks fish passage. Photo 09/20/2011. Roberta Bartlette.

A fish ladder and pools to encourage passage was recently installed on this diversion dam although the ditch itself remains without a fish screen to prevent entrainment into the ditch.

Figure 3.4 Fish ladder and pools installed to replace the diversion dam's fish barrier. Photo 11/11/2012. Gayland Enockson.

Zelazny (2004) classified the habitat of the Main Stem of Lolo Creek as either “Non Functional” or “Functional at Risk” for the entire segment within the Lower Lolo Creek subbasin with the exception of the reach through the U.S. Forest Service-owned Fort Fizzle area. Causes of impairment include habitat modification/alteration and sedimentation/siltation as well as dewatering, fish entrainment to ditches and fish passage barriers. Other sources of impairment include silviculture and roads.

Culverts lacking capacity to maintain flows suitable for fish passage remain in the upper reaches of Lolo Creek and its tributaries with a history of logging. Some culverts remain perched without flow a some points during the year and others cannot handle high flows in a way that maintain velocities slow enough to allow fish passage.

Tributaries in Lower Lolo Creek have many of the same problems as are seen in the upper Lolo Creek watershed with a history of road construction, logging, agriculture and residential development.

Table 3.9. Summary of Lower Lolo Creek Tributaries (Zelazny 2004)

Tributary	Length /area	Road density	Upper Reaches	Lower reaches
Sleeman Gulch	6 mi/9.6 sq mi	6.8 miles/sq mi	Intermittent except lower 1/2 mi	residential
Tevis Creek	1.8 sq mi	2.7 miles/sq mi	Upper USFS, mid Plum Creek	OZ Ranch
Mill Creek	7.5 sq mi	1.2 miles/sq mi	Upper USFS roadless, mid Plum Creek	residential
John Creek	2 mi/2.1 sq mi	1 mi/sq mi	Diverted to irrigation, Plum Creek logging	Interrupted springs, flow rare to Lolo Creek
Mormon Creek	7 mi/7.3 sq mi	4.5 miles/sq mi	Logging impacts	Dewatered by irrigation, degraded by heavy livestock use, residential

Additional Concerns Related to Human Activities

Increasing residential development and desire for recreational access adds concerns for the health of the Lolo Creek Watershed and challenges for planning to accommodate change.

Groundwater Quality Changes

A nitrogen plume, related to residential development, has been detected, although not at hazardous levels. Development is increasing in the Lolo Creek watershed outside of the area serviced by the community’s sewer system. The slowed economy has only temporarily slowed building. Additional land currently held in ranches and by Plum Creek Timberlands hold potential for development.

Dewatering

The factors responsible for loss of continuous flow in Lolo Creek need to be studied. Lower Lolo Creek, at and downstream of the Highway 93 bridge, has become completely dewatered, generally in late August and September during extended warm, dry periods. While irrigation use of Lolo Creek is part of the problem, as the population increases in the lower part of the watershed, additional pressure is put on the system by heavy use of groundwater to water pastures, lawns and gardens. Understanding the effects of groundwater use on the level of Lolo Creek would help to develop criteria for asking for public conservation of water during low flow periods. Also, the relationship of water level in lower Lolo Creek and the water level in the Bitterroot River is not completely understood.

Understanding Channel Migration

The lateral migration of Lolo Creek has not been mapped, but has been captured in air photos dating back to 1937 and in satellite images of the past two decades. Mapping the zone of historical and potential future migration would be useful tool in educating landowners who may build or who have built within or near the migration zone, preventing future conflicts. It would be helpful in designing appropriate stabilization projects to protect structures and infrastructure that is currently at risk due to lateral movement of the creek.

Streambank Erosion

Streambank erosion will continue and may increase as climate change brings increased variability in weather. Zoned or educated future development is needed to prevent further channelizing or creek bank armoring.

Armoring In Response to Channel Migration

Structures that are currently present will need protecting in ways that will not pass the energy problem down to the next property but will enhance habitat.

Winter Highway Maintenance Application of Deicer Chemicals Reaching the Creek

Heavy winter commercial and recreational use of U.S. Highway 12 challenges the Montana Department of Transportation to maintain highway safety while limiting sedimentation to the creek from traction sand use. Increasingly, deicer chemicals have been used for winter highway maintenance. However, the salts used damage streamside vegetation and may impair aquatic life forms. Some studies indicate dilution prevents stream damage, but others indicate levels of salts in the water can cause harm.

Loss of Water from Ditches that are Leaking

In 2011 a stream walk survey was conducted of Lolo Creek from Fort Fizzle to below the railroad bridge downstream of Highway 93 (Lolo Watershed Group, 2011), funded by a SWCDMI Section 319 Mini-Grant Program. The purpose of the stream walk was to review areas of streambank erosion and stabilization as a follow up on similar studies done in previous years. The Maclay Ditch was in operation at the time of the stream walk (September and early October). Water seeping and or running out of the ditch and flowing down the hillside was observed along that portion of the ditch that runs immediately uphill of Lolo Creek. Clearly, not all water removed from the creek reaches its endpoint for use. However, not all leaked water returns to Lolo Creek.

Loss of Fish from Entrainment to Ditches

Some of the ditches collecting surface water from Lolo Creek are without fish screens. Fish screens help to prevent fish from entering (and becoming trapped) in the ditches, are not expensive to install, but require time to maintain. One of the larger ditches without a screen is the Maclay Ditch. Fish recovery from the Maclay Ditch is carried out immediately after the ditch is closed for the year lead by Fish Wildlife and Parks fisheries personnel and assisted by volunteers.

Creating a plan to manage current problems while getting out ahead of future challenges will be the subject of the following chapters.

Chapter 4. Needs in Lolo Creek

EPA Element 3. A description of nonpoint source management measures that will need to be implemented to achieve sediment load reductions.

Much work has been completed to date to improve water quality in Lolo Creek. With the acquisition of Legacy Lands and resulting management by the Forest Service and Montana Department of Natural Resources and Conservation, there will be water quality improvement with continued use of Best Management Practices on forest roads, upgrading of culverts, and decommissioning of forest roads. The Montana Department of Transportation has indicated it will reduce use of traction materials on Highway 12 and increase recovery efforts. Nonprofit groups such as the Lolo Watershed Group, the Clark Fork Coalition, the Watershed Education Network and others continue to monitor and measure various parameters of Lolo Creek and work toward public awareness and education about watershed needs.

The following table will be used throughout the document to capture specific concerns requiring management to implement sediment reduction, to improve habitat for fish and wildlife, and to educate and mitigate other human caused concerns.

Table 4.1 Lolo Creek Watershed Restoration Plan: watershed problems and management measures summary.

Problems/Concerns	Measures needed to mediate problem
Sediment-caused impairment in the Lolo Creek Watershed	
High Density of forest roads	Decommission unused
Lack of BMP use in past	Update to current BMP standards
Traction sand use on Hwy 12	Monitor sand use, trap & recover excess
Monitor surface water quality	Develop monitor team (coordinate with LNF)
Fisheries, wildlife, and water quality issues in the Lolo Creek Watershed	
Fish passage barriers	Replace limiting culverts
Fish entrainment in ditches	Increase fish screen use, fish salvage
Dewatering	Continue to monitor flows, obtain water rights for creek, improve irrigation efficiency
Lack of woody debris	Allow recruitment
Low beaver activity	Reintroduce beaver or enhance habitat
Loss of meanders	Allow meanders to develop, replace lost meanders
Armoring for highway protection	Soften with plantings
Elevated sedimentation	See sediment-caused impairment
Additional concerns related to human activities	
Ground water quality	Monitor
Drought management	Study effect of well use on creek flow, educate
Streambank erosion on private property	Work with landowners, educate
Armoring to prevent channel migration, private	Soften with plantings, encourage alternatives
Deicing chemical use	Work to MDT to monitor use

Problems/Concerns	Measures needed to mediate problem
Future Plans	
Increase flow/temperature database	Add more automated flow/ temp monitor sites
Gaging station to capture maximum flows	Return USGS gaging station near historical location
Improve understanding of channel migration	Obtain Channel Migration Zone data
Build Lolo Watershed Group capacity	Coordination with other groups, membership, Hire a half time coordinator/grant writer.

The balance of this chapter details work that has been done in the Lolo Creek Watershed to identify problems and suggested strategies to improve watershed conditions.

There is still concern about the effects of potentially adding turnout construction, excavation for power line burial, and snow berm removal for the use of megaload transport on Highway 12. The Environmental Assessment (Tetra Tech, 2010) indicated Best Management Practices would be used but did not specify what those would be. Also some turnouts marked for construction or modification, are near or within wetlands or the floodplain. Finally, no mention is made of mitigation for the additional winter maintenance required to keep road and shoulders free of snow. While the Imperial Oil/Exxon Mobile project addressed by Tetra Tech may no longer be an issue, the company continues to state the HWY 12 route remains the preferred route for transporting equipment too tall for the Interstate Highway System. Other companies also continue to express interest in this transport route.

The Bitterroot River Subbasin Plan for fish and wildlife conservation (Northwest Power and Conservation Council 2009) assigned the Active Restoration category for the East Fork Lolo Creek, West Fork Lolo Creek, and Granite Creek They suggested these watersheds are a high priority for aquatic restoration during the next 10-15 years. While these watersheds generally do not meet desired conditions, they have a high potential to move toward desired conditions with appropriate restoration measures. The management approach indicated for the U.S. Forest Service is to protect and maintain quality aquatic habitat and strong native fish populations through forest plan direction and applicable policy and guidance. While the Bitterroot River Subbasin Plan may not represent Montana's Fish Wildlife and Parks priorities, nor those of some of the nonprofit organizations working in the watershed, their rationale for active restoration follows.

- The Lolo Creek TMDL plan is being implemented to improve water quality.
- NEPA is complete for a variety of restoration projects.
- Some partnerships are already in place.
- There is an abundance of low gradient spawning habitat for fluvial cutthroat and bull trout.
- Opportunities exist to expand and secure Westslope cutthroat trout and bull trout habitat throughout the entire Lolo Creek drainage.
- Lolo Creek, the South Fork of Lolo Creek and Mormon Creek were designated critical habitat for bull trout by the U.S. Fish and Wildlife Service in 2010 and retains that designation in 2012.
- In the West Fork Lolo Creek, there is an, isolated Westslope cutthroat trout population above Snowshoe Falls.
- Adds to restoration of the Lolo Creek ecosystem.
- Headwaters contain high-quality habitats within un-roaded lands.

Restoration opportunities for the Lolo Creek watershed include:

- Restore water to the drainages by ensuring only valid water rights users are diverting water
- Place fish screens on ditches
- Remove fish passage barriers such as irrigation dams and inadequate culverts to help restore fish movement through the drainages
- Reclaim excess logging roads
- Maintain needed roads using BMPs to reduce sedimentation.
- Ameliorate damage from the history of intensive timber management by
    - Limiting logging in heavily logged areas
    - Restricting logging in riparian zones
    - Recruiting large woody debris to increase habitat complexity in streams
- Educate landowners and developers on the risks of building too near waterways
- Encourage restoration native riparian vegetation along streambanks
- Help landowners facing streambank erosion to develop stabilization plans that do not transfer the stream's energy downstream (such as using soft stabilization techniques rather than riprap)
- Manage irrigation water more efficiently
- Encourage water rights holders who are not using the water to return water rights to instream flow through cooperation with the Clark Fork Coalition
- Restore meanders to Lolo Creek to decrease the effects of channelization on downstream property owners. (This would involve creating bridges or culverts on Highway 12,)

Restoration opportunities and recommendations

Table 4.2. Restoration opportunities (Zelazny, 2004, 2006) by subbasin/tributary/mainstem section.

Bitterroot Subbasin	***Creeks of Lolo Creek***	***Restoration Opportunities***
West Fork of Lolo Creek 1401	West Fork of Lolo Creek	1, 5, 6
	Lee Creek Separate in TMDL document only	5, 2
East Fork of Lolo Creek 1402	East Fork of Lolo Creek	2, 5, 6, 11
	Lost Park Creek	1, 2, 5, 6, 11
Granite Creek 1403	Granite Creek	1, 2, 5, 6, 11
Howard Creek 1404	Howard Creek	1, 2, 5, 6, 11
Upper Lolo Creek 1405	Davis Creek	1, 2, 5, 6, 11
	Chief Joseph Gulch	1, 5, 6, 11

Bitterroot Subbasin	***Creeks of Lolo Creek***	***Restoration Opportunities***
	Cloudburst Creek	1, 5, 6, 11
	Martin Creek	
West Fork Butte Creek 1406	West Fork Butte Creek (within South Fork of Lolo Creek)	1, 2, 5, 6
South Fork of Lolo Creek 1407	South Fork of Lolo Creek (less West Fork Butte Cr.)	3, 5, 6, 10
Lolo Creek - Grave Creek 1408	Grave Creek and East Fork of Grave Creek	1, 5, 6, 11
	Clark Creek	1, 5, 6, 11
	Bear Creek	1, 2, 5
	Camp Creek	1, 3, 4-6, 11
	Woodman Creek	1-6, 11
Lower Lolo Creek 1409	Sleeman Gulch	little influence on watershed health
	Tevis Creek	1, 2, 3, 10
	Mill Creek	1,3, 4, 9
	John Creek	3, 7, 8
	Mormon Creek	1-6

Key to codes in table:

Restoration opportunities as noted in Zelazny (2004, 2006)

1. Recruit large woody debris
2. Remove inadequate/damaged culverts
3. Maintain instream flows
4. Screen irrigation diversions
5. Reduce sedimentation through BMPs
6. Remove unneeded roads
7. Reconnect to Lolo Creek main stem
8. Repair damage to springs
9. Remove illegal diversions
10. Manage livestock grazing
11. Restrict silviculture to areas away from creek (Forest BMPs)

Upper Lolo Creek TMDL Area: Study recommendations

The 2003 Upper Lolo Creek area completed by Montana DEQ outlines steps that can be taken to improve water quality in three subbasins and the two tributaries make up the TMDL planning area called Upper Lolo Creek.

- Upgrade forest roads to meet BMPs.
- Reclaim forest roads that are no longer needed for forest management.
- Replace undersized culverts to better accommodate large floods.
- Reduce sediment delivery from Highway 12 through improved sediment traps, plowing techniques, and guardrail cleaning.
- Remove fish passage barriers that significantly affect the connectivity of native fish habitats.

The U.S. Forest Service 2005 Upper Lolo Creek Watershed Restoration Environmental Assessment proposed to improve water quality and fish habitat while maintaining recreational and administrative access:

- Remove or replace 21 culverts that hinder fish passage or are undersized (not capable of handling a 100 year flood event).
- Permanently close and reclaim about 39 miles of overgrown historic roads and almost 234 miles of un-drivable jammer roads.
- Decommission just over 17 miles of USFS roads that are no longer used. Most of these roads are currently closed to the public except for snowmobile use.
- Reclaim about two miles of open, drivable USFS roads.
- Improve about 35 miles of major roads by applying BMP (Best Management Practices).
- Replace a culvert and improve drainage on Trail # 300.

Recommendation from the Upper Lolo Sediment TMDL Implementation Evaluation (DEQ-PPA-WQPB-WPS 2010) *reflects the 2003 findings while recognizing work completed thus far:*

- Upgrade remaining forest roads to meet Montana Forestry BMPs.
- Reclaim forest roads that are surplus to the needs of forest land managers.
- Improve inspection and maintenance of existing culverts.
- Implement Montana's Forestry BMPs on all harvest operations.
- Upgrade undersized culverts over time to better accommodate large floods.
- Further reduce sediment delivery from U.S. Highway 12 through improved use and maintenance of sediment traps, plowing techniques, and guardrail cleaning,
- Correct priority fish passage barriers that are significantly affecting the connectivity of native fish habitats.

Lower Lolo Creek: Recommendations

The upper Lolo Creek recommendations apply to Lower Lolo Creek due to use of upper elevations forests for resource extraction and the proximity of Highway 12 to Lolo Creek. In addition, subdivision of private timber and ranch land for residential development brings with it potential for additional sedimentation, and water quality and water quantity issues.

Recommendations from the Clark Fork Coalition

- Conduct research with the Lolo Watershed Group to further quantify water withdrawals between monitoring sites.
- Continue automated flow and temperature monitoring to discern statistically significant flow and temperature variations.
- Pursue additional opportunities to improve instream flow in the Lolo Creek watershed.

Recommendations from the Lolo Watershed Group – in addition to Clark Fork Coalition points

- Continue periodic stream walks to identify areas in need of stabilization to reduce sedimentation and/or protect private property
- Study the connection between loss of surface flow due to groundwater and surface water use and level of the Bitterroot River near the mouth of Lolo Creek.
- Monitor public well database for change in groundwater quality
- Educate landowners on normal channel migration, stream health, dewatering issues.
- Work with the Watershed Education Network, Clark Fork Coalition and others to develop and implement monitoring and education programs that involve Lolo Watershed residents.
- Encourage collaboration with agencies such as the Missoula Conservation District and the Missoula Valley Water Quality District.
- Build membership and volunteer teams
- Obtain funding to hire a half time coordinator/grant writer.

Throughout the watershed

Beaver as a potential management tool throughout the watershed

Beaver populations are believed to be only about 10% of pre-European levels, mostly because of habitat loss and trapping (Parker et. al. 1985). In the face of climate change and corresponding drought, reintroducing and managing beaver may an asset to watershed restoration, as beavers are great water engineers, managers, and conservators (Bird et al, 2011).

Beavers are considered a keystone species with far reaching benefits beyond their immediate requirements for food and space. Beaver management practices preserve existing land uses while maintaining benefits such as enhanced water quality, wildlife habitat, livestock grazing, recreation, and aesthetic values (Olsen and Hubert, 1994). The following attributes are cost-effective examples of the important role that beavers currently play, or could be managed to provide, during climate change. Beaver activity enhances riparian habitat by:

- Impounding water and raising water tables, which facilitates more favorable and longer growing conditions for riparian vegetation and hayfields. Higher water tables can also result in less weeds and greater forage production and shelter for domestic livestock. Greater water availability also helps protect riparian vegetation from aggressive grazing because plants are healthier and more resilient.
- Increasing water storage and late summer stream flows. Impounding water forces more water into floodplains that in turn acts as a “sponge”. Beavers can make intermittent streams flow all year or for greater time frames, as floodplains slowly release water during drier months.
- Reducing stream velocity and collecting sediment, which reduces bank and channel erosion and improves water quality by trapping nutrients and chemicals, respectively.
- Improving stream temperature conditions – Deep ponds buffer air temperatures, as deeper water doesn’t heat up as much in the summer and is less prone to freezing in the winter.

- Improving habitat and water availability for big game, waterfowl, game and non-game birds, and other small mammals.

Figure 4.1. Beaver reintroduction efforts on the Custer National Forest are turning intermittent streams perennial and facilitating greater water for cattle.

Beavers can be problematic if not managed appropriately. However, beaver population numbers can be controlled. It may be valuable to assess the costs of wisely addressing any nuisances or apparent problems versus the loss of benefits to the system if they are not present. For example, while in some situations available agricultural land may decrease (as beavers impound more water and riparian areas expand), crop yields and available forage commonly increase. Many impacts can be avoided or controlled by intelligent management techniques, coupled with education and outreach about their benefits.

As higher temperatures and drought are likely in the future, higher water temperatures, lower stream flows, water scarcity and parched croplands are also likely common scenarios. Both economic and human value costs are likely more expensive, as agricultural production, recreational experiences, fish and wildlife species, and other factors are influenced. Viewing all benefits and costs utilizing beavers in many situations may provide a viable option to move beyond the tipping point of drought-stress to a flourishing landscape.

Additional oversight

The Missoula Valley Water Quality District was created in 1993 to allow the local government to assume more direct control for the protection of drinking water and streams. The district geographical area includes the city of Missoula, but does not extend to the Missoula County boundaries although some watersheds, like Lolo Creek, lie entirely within the county and drain into the surface waters within the district's jurisdiction. One of the goals of the district is the enforcement of state water quality laws and local ordinances. It may be useful to the watershed to be included within the Missoula Valley Water Quality District for additional oversight and for the research, monitoring and education resources the district could offer.

Future Projects

Add an additional flow and temperature monitoring site. One site possible is above the Fort Fizzle site A property owner upstream of the OZ Ranch irrigation diversion offered to allow access to Lolo Creek to add an additional monitoring streamflow station. Or add a site below the

lowest downstream site C, at an access point off of Lewis and Clark Drive. The Lolo Watershed Group will coordinate with the Clark Fork Coalition to consider adding a site beginning with the 2013 monitoring season. The LWG has one additional Trutrack device available to be deployed on Lolo Creek if the CFC has staffing to cover the additional site.

Return a USGS gauging station to a position near the historical position above the confluence of Sleeman Creek with Lolo Creek and below the Maclay Diversion. Lolo Creek is a major tributary to the Bitterroot River. Monitoring flows of Lolo Creek would offer important information for downstream planning as well as monitoring and developing a database of both high and low water events.

Acquire Channel Migration Zone data for Lolo Creek and historical photography showing the previous position of the creek for use in mapping potential movement within the watershed.

Summary of Suggested Management Measures

- Continue the ongoing efforts to decommission logging roads that are no longer needed.
- Use BMPs to reduce sediment loss from remaining forest roads.
- Reduce the use of traction sand and deicing chemicals on Highway 12.
- Continue work on forest roads to remove or repair areas that have become barriers to fish passage.
- Increase use of fish screens on ditches and develop a volunteer team to maintain them.
- Improve irrigation system efficiency and return unused water rights to the creek.
- Work with landowners to use stabilization techniques that do not transfer energy downstream to the next landowners.
- Map Lolo Creek's Channel Migration Zone to provide information needed to understand what areas are at risk of becoming part of Lolo Creek's channel.
- Develop outreach programs to educate landowners and developers about the importance and workability of BMPs.
- Promote the use of adequate setbacks when developing structures, yards and agricultural practices along creeks and riparian areas.
- Reintroduce beaver as a riparian management tool.
- Add vegetation to armored highway/stream interfaces to capture some of the traction sand and lessen its impact on the sediment load and aquatic life.
- Develop collaborative projects with nonprofit groups and local agencies to monitor stream flow, temperature, water quality, and public education.
- Grow and develop additional capacity for the Lolo Watershed Group.
- Finally and idealistically, return Lolo Creek to some of its historical meanders.

Chapter 5. Technical and Financial Assistance Needs

EPA Element 4. An estimate of the amounts of technical and financial assistance needed to implement the plan.

Given the lists of recommendations and restoration opportunities, we recognize there are limitations in data, personnel, and funding to adequately address potential projects. Fish, Wildlife, and Parks, and the Lolo National Forest have accomplished projects to make improvements in sediment delivery to Lolo Creek and to fish barriers. However, while some information may be available, two challenges have precluded gathering information, 1) large funding reductions in recent years have precluded adequate staffing for monitoring and documentation efforts, and 2) stream and biological processes often take very long-time frames to show effect.

1. Technical information gaps: Information regarding the effects of the work accomplished so far to improve water quality is lacking. A basic understanding of historical and post-highway construction channel migration is needed to help educate landowners on private development plans and/or stabilization needs.
    a. Monitor water quality plan. The TMDL's monitoring plan includes the following objectives.
        i. Document water quality trends associated with proposed implementation efforts.
        ii. Establish additional permanent monitoring sites and collect additional data within the TPA to help better define water quality targets.
        iii. Monitor progress towards meeting water quality targets.
        iv. Conduct an adaptive management strategy to fulfill requirements of the TMDL.
    b. Measure results of removing fish passage barriers.
    c. Determine the effects of stabilization projects on downstream properties.
    d. Develop Channel Migration Zone mapping.
1. Organizational gaps.
    a. The Lolo Watershed Group is one of the volunteer groups that could offer assistance in developing and monitoring projects aimed either toward directly improving water quality and educating the public on the importance of water quality and quantity to the health of the watershed. The group is currently very small so encouraging membership growth and participation is one of the current organizational gaps that needs to be addressed.
    b. Coordination between the Lolo Watershed Group and other watershed related groups is needed
    c. Education and outreach coordination is needed.
1. Human resource gaps
    a. Currently there is a very great need for monitoring to measure the changes in water quality brought about by work completed, and to get a baseline for comparison to planned efforts in the future. Due to budget shortfalls, volunteers may best fill this monitoring need. Locating reliable volunteers and trainers for this group is one of the human resource needs for the immediate future.
    b. Stabilization/revegetation projects could be accomplished by volunteers and accompany adult and student education and outreach. Leaders for these projects are needed.

c. Grant availability and writing. Grant money is available to help with watershed restoration projects. However, there is a need for persons who are familiar with available grant programs and who have experience in writing proposals.

1. Technical resource expertise needs may be available for work on State and Federally owned properties, but is especially needed to guide work on private properties.
    a. Engineers
    b. Biologists
    c. Foresters with silviculture experience
    d. Geomorphologists
    e. Legal advisors
    f. Community planners
    g. Facilitators
    h. Educators
1. Financial resource needs
    a. Expected project costs. These are very rough estimates.
        i. Decommissioning and relocation of roads: $1500 to $4000 per mile depending on level of decommissioning.
        ii. Reconstructing and performing maintenance of primary roads: Cost varies greatly depending on road type & infrastructure needs. Generally very expensive.
        iii. Replacing or removing culverts:
            a) Replacing Culverts: $3,500 - $150,000 depending on structure size & type
            b) Removing Culverts and reconstructing channel through site: $1,000-$5,000 per site
        iv. Fish passage projects: Varies by complexity. An example project - fish passage at Lolo-Maclay diversion cost about $10,000.
        v. Fish screens: both installation and maintenance costs:
            a) Fish screens cost about $4,000-$5,000 per cfs diverted
            b) Maintenance costs have never been calculated because they are usually part of ditch operation
        vi. Wildlife-friendly riparian fencing
        vii. Beaver reintroduction – May not be practical without changes in trapping regulations. If trapping were reduced, beavers might be able to re-colonize on their own in some locations.
        viii. Vegetation planting (vegetation cost estimates based on Missoula Conservation District allowable cost list)
            a) Containerized, bare-root stock - $5.00/plant
            b) Willow or cottonwood cuttings - $1.00/cutting (labor only)
            c) Deer protectors - $1.00/plant
            d) Weed mats - $1.00/mat
            e) Grass seed - $5.00/lb.
            f) Grass/sedge plugs - $1.00/plug
            g) Erosion control fabric - $5.00/sq.yd.
            h) Labor - $10.00/hour
            i) Coir fiber log - $10 to $15 per foot
            j) Labor using stinger planter with operator - $5K/day
        ix. Water diversion flow monitoring - Electronic flow meter: $3,000-$5,000, plus the cost of labor
        x. Water right purchases or leases – information was not available

xi. Education of landowners on Instream Flow Leasing opportunities – could be accomplished through volunteer organizations with grant assistance.
xii. Stream rehabilitation and meander creations – highly expensive
xiii. Educational pamphlets and programs – mini grant funding
xiv. Volunteer stipends or supplemental funding support – grants needed
xv. Monitoring for various existing and remedied impacts – could be accomplished by trained volunteers.

b. Grants need to be tapped for nonprofit groups to aid in restoration work. Some of the available grants are listed below.
   i. 319 Mini-grants of up to $2000
   ii. Grants from the Missoula Conservation District
      a) Up to $5000 cost-share program for natural resource improvement within Missoula County http://missoulacd.org/cost-share-grants/costshareprogram
      b) $500 Riparian planting mini-grant http://missoulacd.org/cost-share-grants/riparian-planting-mini-grants
   iii. The Missoula County Park Board provides planning assistance and some funding in partnership with local groups who match those funds and agree to continually maintain the park. http://www.co.missoula.mt.us/rural/Parks/MatchingGrants.htm
   iv. MT Future Fisheries Improvement Program http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/factsheet.html
   v. Montana Watershed Planning Assistance Grants
      a) Up to $10,000 for watershed planning
      b) Must be applied for by Conservation District
   vi. The Soil & Water Conservation Districts of Montana
      a) Mini grants up to $2000 for local education and outreach efforts that address nonpoint source pollution and water quality issues.

c. Coordination with other larger groups or with state or federal land management agencies will be necessary to reach funding levels needed to accomplish many of the tasks outlined in this watershed restoration plan.

The following table extends the information from Chapter 4 to include technical and financial needs. This table format will be used as additional EPA elements are addressed. Tables summarizing all EPA elements are shown in Appendix H along with priority assignments.

Table 5.1 Lolo Creek Watershed Restoration Plan: problems and assistance needs.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs
Sediment-caused impairment in the Lolo Creek Watershed		
High Density of forest roads	Decommission unused	Agency or technical contractors $1500-$4K per mile
Lack of BMP use in past	Update to current BMP standards	Agency and Technical contractors Highly variable (high) costs
Traction sand use on Hwy 12	Monitor sand use, trap & recover excess	MDT cooperation for reporting Part of MDT maintenance costs
Monitor surface water quality	Develop monitor team	Volunteer team or U of M student, research grant or volunteer and

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs
		minigrant for equipment, mileage
Fisheries, wildlife, and water quality issues (other than sediment) in the Lolo Creek Watershed		
Fish passage barriers	Replace/remove limiting culverts	Technical agency expertise, $1-3,5K remove, up to $150K replace
Fish entrainment in ditches	Increase fish screen use, fish salvage	Volunteer team with technical lead, Screen costs $4-5K per cfs
Dewatering	Continue to monitor flows, obtain water rights for creek, improve irrigation efficiency	Continue to support Clark Fork Coalition monitoring, and water right lease program. Obtain grant to assist or coordinate.
Lack of woody debris	Allow recruitment	Volunteer lead public education on private land, $1-2K minigrant, BMP on public land
Low beaver activity	Reintroduce beaver or enhance habitat	FWP change in trapping rule for Lolo, unknown costs. Habitat suitability survey, $5K.
Loss of meanders	Allow meanders to develop, replace lost meanders	Volunteer led public education on private land, $1-2K minigrant, Replacing would take exceptional highway funding
Armoring for highway protection	Soften with plantings. May also serve to aid in trapping traction sand.	Contracted stinger operator and volunteer planters, $5K MDT support
Additional concerns related to human activities		
Ground water quality	Monitor	May be in Water Quality District capabilities.
Drought management	Study effect of well use and Bitterroot River level on creek flow, educate	U of M student research project. Educate ($1-2K minigrant)
Streambank erosion on private property	Work with landowners, educate	Educate ($1-2K minigrant), stabilize by plantings coir logs Volunteer team within range of Conservation District riparian grant
Armoring to prevent channel migration on private property	Soften with plantings, encourage alternatives	Contracted stinger operator and volunteer planters, $5K per day, Conservation District riparian grant
Deicing chemical use	Work with MDT to monitor use	Within MDT scope of work
Future Plans		
Increase flow/temperature database	Add more automated flow/ temp monitor sites	Develop volunteer team or coordinate with Clark Fork Coalition, $3-5K device costs per site
Gaging station to capture maximum flows	Return USGS gaging station near historical location	Technical setup and maintenance, $2K for instrument, $16K/year maintenance

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs
Improve understanding of channel migration	Obtain Channel Migration Zone (CMZ) data	Technical expertise, digitizing and flight time requires large scale funding and coordination through another agency
Build Lolo Watershed Group Capacity	Coordination with other groups, membership, Hire a half time executive director/grant writer.	Coordination with volunteer time, no cost. Half time director/grant writer $20K

Chapter 6. Outreach and Education

EPA Element 5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing and implementing the NPS management measures.

Lolo Creek Watershed Restoration Plan: Education, Outreach & Fundraising Plan

The goals of educational and outreach activities will support the overall mission of the Lolo Watershed Group and help realize the vision of the Watershed Restoration Plan. The specifics of the educational activities (audiences, message content, delivery methods and sites for field-based activities) will be developed once goals are agreed upon by partners and restoration priorities are determined.

The fundraising plan will identify likely sources of funding and establish a timeline to track application and reporting deadlines. To ensure stable funding, the Lolo Watershed Group and partners will aim to establish a base from diverse sources that could include state, federal and county agency grants, private donors, community foundations, and formal partnership agreements. In addition to grants and direct donations, the LWG will host events, conduct membership campaigns and use tools such as raffles as integral parts of the fundraising strategy. In-kind donations and collaborations with partners will also be key components in order to maximize resources.

The goals of the funding plan are to:

- Ensure adequate staffing to support overall goals and objectives of the restoration plan
- Implement programs
- Build the capacity and increase the sustainability of the organization
- Further the restoration goals of partners and key stakeholders by leveraging funding for high-priority on-the-ground projects

The educational and outreach goals, objectives and proposed tasks are shown in the following table:

Table 6.1 The educational and outreach goals, objectives and proposed tasks.

GOAL:	OBJECTIVE:	TASKS / ACTIVITIES:	PROPOSED PARTNERS	POSSIBLE FUNDING SOURCES
1. Increase public awareness & knowledge of impacts of human activities on the watershed	**a.** Develop community and school-based **educational programs, events and materials** that focus on non-point source pollution, BMPs, human impacts on water quality, water quantity, stream health, weeds and wildlife	Determine priorities; define audiences; develop content & messages; decide delivery mechanisms/methods; develop evaluation & assessment plan; collaborate with partners to obtain funding & maximize resources. Examples: field trips, landowner tours, booths at local fairs, publications, newsletters, presentations at public meetings, monitoring programs.	LWG, DEQ, LNF, MslaCD, FWP, RI, CFC, WQD, WEN, BWF, Weed District	DEQ, DNRC, Msla CD WQD Private foundations
	b. Provide guidance, references, resources and technical assistance to landowners, educators, partners & local organizations to facilitate use of BMPs	Promote & publicize stakeholder agencies/partners and their available resources (permitting, funding and technical expertise) at local meetings, venues & events; provide information on permitting processes; continue to assist landowners with 310 permits, cost-share grant proposals, weed district grants, etc	LWG, DEQ, LNF, MslaCD, FWP, WQD, CFC, DNRC, Weed District	
2. Increase public participation in citizen-based stewardship and conservation activities	**a.** Develop community and school-based **stewardship programs** based on high-priority restoration projects that advance overall watershed goals	Develop volunteer recruitment, training, recognition & retention plan; utilize research & activities that foster stewardship; set targets & timeline for volunteer rates; collaborate with partners to publicize & promote activities. Examples: same as above	LWG, DEQ, LNF, FWP, RI, CFC, , Msla CD, WEN, Trout Conservancy, BWF, TU, UM Watershed Health Clinic,	DEQ, DNRC, Msla CD WQD Private foundations

GOAL:	OBJECTIVE:	TASKS / ACTIVITIES:	PROPOSED PARTNERS	POSSIBLE FUNDING SOURCES
3. Expand organizational capacity of LWG	**a.** Increase visibility of the Lolo Watershed Group	Develop outreach and publicity plan that would: - Increase effectiveness of website - Update & improve content of website - Increase effectiveness of annual report - Schedule production & distribution of newsletter - Expand & maintain membership database - Consider use of a list-serve - Improve & maintain email list & format - Develop a media list: submit letters to the editor; non-profit round-up, business "getting ahead" blurbs, community calendars; record radio PSAs - Improve publicity efforts for meetings and events - Collaborate with partners on outreach, publicity, mailings, website links & articles, calendars etc.	LWG, CFC, RI, WQD, BWF, FVLT, Lolo Community Council, Friends of Lolo Peak, UM Watershed Health Clinic, Trout Unlimited, MT Forest Restoration Committee	DEQ, DNRC, Msla CD WQD Private foundations
	b. Increase effectiveness of Board of Directors	Develop board recruitment, training, recognition & retention plan; network with partners to improve training & increase participation & understanding of board duties & roles; maintain active board; host quarterly or bi-monthly meetings; establish committees to assure oversight & secure resources for the organization & projects; continue to host annual meeting with elections (as per bylaws)	LWG, BWF, MWCC, MT Non-profit Assn	DEQ, DNRC, Msla CD WQD Private foundations

GOAL:	OBJECTIVE:	TASKS / ACTIVITIES:	PROPOSED PARTNERS	POSSIBLE FUNDING SOURCES
	c. Increase effectiveness of Advisory Board	Develop communication plan to improve consistency & effectiveness of interactions with Advisory Board; solicit input & feedback on technical issues & documents; delineate roles & responsibilities; determine common goals; develop formal partnership agreements; collaborate to obtain funding, share resources, plan & publicize events, and distribute publications & information	LWG & Adv Bd members	
	d. Increase communication & collaboration with other partners and stakeholders	Develop communication plan to expand on relationships with partners & stakeholders; determine common goals; collaborate to obtain funding, share resources, plan & publicize events, and distribute publications & information	LWG & partners	
	e. Increase LWG membership base	Develop a membership recruitment & retention plan; continue to maintain database; conduct a membership drive; send annual renewal notices & follow-up; set targets & timeline for membership growth	LWG and partners	
	f. Increase attendance/participation at meetings and events	Establish regular meeting dates; track attendance; conduct evaluations and collect feedback at meetings & events; consider reminder emails and/or phone calls to increase attendance; set targets and timelines for meeting attendance rates	LWG and partners	

Chapter 7. Implementation Schedule

EPA Element 6. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

Timeline and Implementation Schedule for Watershed Restoration Plan's Items Coordinated by State and Federal Agencies

1. Rate of bringing forest road and/or stream crossings to meet Montana Forestry BMPs.
2. Work with Lolo National Forest (LNF) to encourage update of restoration and rehabilitation efforts that have occurred and are planned to fulfill TMDL requirements (Currently the LNF has been challenged by funding reductions and work capacity issues that have taken efforts to other priorities).
3. Rate of decommissioning surplus forest roads.
4. Work with LNF to obtain values for roads that have been decommissioned and encourage a transportation assessment and plan for the former Plum Creek roads (Currently the LNF recognizes the need for such an assessment, but current staffing is not sufficient to perform all necessary assessments).
5. Rate to apply BMPs in timber harvest areas. (Current and past)
6. Work with LNF to obtain values for roads and timber harvest areas to which updated BMPs have been applied.
7. Traction sand and deicer chemical use on Highway 12.
8. Immediately collect past data and request annual updates on traction sand and salt application rates and percent of mitigation measures along Highway 12 that are being met. Annual reports are also needed on weather summaries as application rates will be tied to timing and amount of snowfall.
9. Plan timeline for assessment, development and implementation of geomorphic indicators of proper pattern, profile, and dimension improvements. This can be incorporated with the channel migration zone study.
10. Sampling plan timeline for age classes of native salmonids that exist in the Upper Lolo TPA.
11. Sampling plan timeline for development and implementation to monitor macroinvertebrate indicators associated with sediment and full support based on standard DEQ protocols.
12. Rate of engineering and replacing human-caused fish passage barriers.
13. (This information is available for LNF land, except for the recently acquired Plum Creek lands, where inventory is necessary, but precluded by insufficient staffing and funding).
14. Timeline to develop a routine monitoring program to perform sediment modeling and ground-truthing efforts to determine sediment load reductions.
15. The LNF is planning on conducting this work in the near future to address TMDL completion efforts, but is subject to staffing limitations and related timelines.

Additional items

1. Channel Migration Zone study
2. Adding vegetation to highway/stream interface at armored sections of the highway to help capture sediment from highway maintenance activities
3. Map historical meanders removed by highway construction and categorize for possible return to the creek.

4. Assess the feasibility of beaver reintroduction and potentially map areas where beavers can be reintroduced and managed to improve water resource conditions (work with FWP to manage numbers appropriately).

Timeline and implementation schedule for the Lolo Watershed Group

1. Year 1
    a. Consolidate information
    b. Analyze available data
        i. Stream walk and aerial photo assessment to identify
        ii. Stream segments that lack desired riparian vegetation communities and adequate buffer zones
        iii. Stream bank erosion areas
        iv. Streambank restoration projects,
        v. Potential and feasible meander reconnection locations (private and public lands)
        vi. Irrigation diversion points,
        vii. Restoration needs,
        viii. Riparian fencing opportunities,
        ix. “Beaver friendly” locations (major stream segments where beaver should be managed for increased numbers and support for water resource improvements),
    c. Develop partnership with Montana Department of Transportation, others
    d. Maintain and strengthen partnership with USFS, Plum Creek, Missoula County agencies
    e. Continue cooperative flow measurement project with Clark Fork Coalition
    f. Build on monitoring program by partnering with Watershed Education Network
    g. Enhance membership
    h. Develop volunteer corps for monitoring, and doing projects
    i. Increase meeting participation
    j. Maintain website
    k. Review priorities
    l. Election, recruitment to board, training
    m. Drought/flood management public education and resource study
    n. Weeds education and management projects
    o. Develop consistent funding and budget
    p. Fund raising plan, specific guideline
2. Year 2 all of the above plus
    a. Build map data library
    b. Site assessment
    c. Restoration projects
3. Year 3 - 5 all of the above plus
    a. Monitoring
    b. LWG Program assessment

Table 7.1 Lolo Creek Watershed Restoration Plan: problems, assistance needs, implementation schedule

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule
Sediment-caused impairment in the Lolo Creek Watershed			
High Density of forest roads	Decommission unused	Agency or technical contractors $1500-$4K per mile	Rate of decommissioning is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates
Lack of BMP use in past	Update to current BMP standards	Agency and Technical contractors Highly variable (high) costs	Rate of bringing roads and logged areas to current standard is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates
Traction sand use on Hwy 12	Monitor sand use, trap & recover excess	MDT cooperation for reporting Part of MDT maintenance costs	MT DEQ receives yearly reports on sand and salt use. LWG volunteers can visually monitor traction sand applied to creek or streambank beginning year 1.
Monitor surface water quality	Develop monitor team (coordinate with LNF)	Volunteer team or U of M student, research grant or volunteer and minigrant for equipment, mileage	Some monitoring will be conducted by LNF, rate of completion of monitoring projects depends on budget. LWG Year 1. Identify monitoring activities, write grant request for grad student coordinating with LNF. LWG Year 2-3. Fund graduate student work. Assist LNF with volunteer team.
Fisheries, wildlife, and water quality issues (other than sediment) in the Lolo Creek Watershed			
Fish passage barriers	Replace/remove limiting culverts	Technical agency expertise, $1-3,5K remove, up to $150K replace	Rate of barrier mitigation is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates. LWG year 1 identify fish barrier within financial reach of grant obtained in partnership with LNF. LWG year 2 apply for grant, identify next possible barrier for mitigation. LWG year 3-5 continue as above, identify and apply for grants.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule
Fish entrainment in ditches	Increase fish screen use, fish salvage	Volunteer team with technical lead, Screen costs $4-5K per cfs	LWG Year 1. Identify ditch and owner interested in fish screen. Develop a volunteer team willing to do maintenance. Work with FWP to obtain grant and install fish screen LWG Subsequent years. Identify additional sites for screens, continue to train and build maintenance volunteer team.
Dewatering	Continue to monitor flows, obtain water rights for creek, improve irrigation efficiency	Continue to support Clark Fork Coalition monitoring, and water right lease program. Obtain grant to assist or coordinate.	Clark Fork Coalition is monitoring 3 sites on Lolo Creek. LWG – years 1-5 support CFC mission and encourage addition of more monitoring sites. Develop team to assist in data collection. Work with Watershed Education Network Stream team.
Lack of woody debris	Allow recruitment	Volunteer led public education on private land, $1-2K minigrant, BMP on public land	LNF will allow woody debris recruitment as part of BMPs. LWG – Year 1. Coordinate with education agencies and groups to obtain training materials on importance of woody debris. LWG – Year 2-5. Include in public education package about healthy streams. Encourage landowners to leave wood in stream.
Low beaver activity	Reintroduce beaver or enhance habitat	FWP change in trapping rule for Lolo, unknown costs. Habitat suitability survey, $5K.	LWG Year 1. Coordinate with LNF and FWP to decrease trapping pressure on beaver in Lolo Creek, Year 2 - monitor beaver population response to reduced trapping, prepare educational materials for public and identify areas for potential reintroduction. Year 3 – Continue monitoring population, consider reintroduction.
Loss of meanders	Allow meanders to develop, replace lost meanders	Volunteer led public education on private land, $1-2K minigrant, Replacing would take exceptional highway funding	Year 1 Identify disconnected meanders. Year 3 Identify landowners interested in having meanders reconnected. Watch for opportunities for bridging creek.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule
Armoring for highway protection	Soften with plantings, May also serve to aid in trapping traction sand.	Contracted stinger operator and volunteer planters, $5K MDT support	LWG – Year 1 identify potential planning sites and coordinate with MDT for potential funding to plant water loving shrubs along some armorer, channeled, segments where highway is close to stream.
Additional concerns related to human activities			
Ground water quality	Monitor	May be in Water Quality District capabilities.	LWG – request annual report of water quality data from wells in the watershed from Missoula County. Watch for grants dealing with ground water quality to use to initiate a study on pollution plume in lower Lolo
Drought management	Study effect of well use and Bitterroot River level on creek flow, educate	U of M student research project. Educate ($1-2K minigrant)	LWG Year 1 – Work with Watershed Education Network to develop or implement watershed model training materials for use in public meetings, and in elementary, and secondary schools. Look for data on ground water/surface water connection. LWG - Year 2 – apply for grant to fund student researcher. LWG – Years 3-5 develop a drought management plan to determine minimum flow needed to allow Lolo Creek to flow to its mouth and ground water use limitations needed in sustained drought.
Streambank erosion on private property	Work with landowners, educate	Educate ($1-2K minigrant), stabilize by plantings coir logs Volunteer team within range of Conservation District riparian grant	LWG – Year 1. Identify streambank segments that would benefit from plantings for stabilization. LWG – Year 2. Apply for riparian planting grants or minigrants. Develop volunteer team to help with planting. LWG – Year 3-5. Continue stabilization at other sites.
Armoring to prevent channel migration on private property	Soften with plantings, encourage alternatives	Contracted stinger operator and volunteer planters, $5K per day, Conservation District riparian grant	LWG Year 1. Identify site for planting, apply for CD riparian grant LWG Year 2. Plant site, identify next site for planting LWG year 3. Assess success, if adequate, apply for additional grants

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule
Deicing chemical use	Work with MDT to monitor use	Within MDT scope of work	Obtain reports on deicer use yearly from MDT. LWG Year 1. Obtain weather data for past 5 years on Lolo Pass to compare to deicer use. LWG. Subsequent years. Continue data comparison of weather to deicer use.
Future Plans			
Increase flow/temperature database	Add more automated flow/ temp monitor sites	Develop volunteer team or coordinate with Clark Fork Coalition, $3-5K device costs per site	LWG – ongoing - continue to coordinate with Clark Fork Coalition. Assist to find resources to fund expenses for person to monitor additional sites. Equipment is available to add one site.
Gaging station to capture maximum flows	Return USGS gaging station near historical location	Technical setup and maintenance, $2K for instrument, $16K/year maintenance	LWG will work with Missoula County Floodplain to look for opportunities to collaborate on obtaining a sustainable source of funding for a USGS gage.
Improve understanding of channel migration	Obtain Channel Migration Zone (CMZ) data	Technical expertise and flight time requires large scale funding unless coordinated through another agency	LWG - Year 1. Identify agencies/contractors who could fund, obtain and analyze CMZ data. Locate maps, photos and satellite images for Lolo Creek to use in public education. LWG – Year 2. Encourage data collection
Build Lolo Watershed Group Capacity	Coordination with other groups, membership, Hire a half time executive director/grant writer.	Coordination with volunteer time, no cost. Half time director/grant writer $20K	See outline timeline in this chapter for specific implementation goals for LWG.

Chapter 8. Description of Measurable Interim Milestones

EPA Element 7. A description of interim, measureable milestones for determining whether NPS management measures or other control actions are being implemented.

Examples of completed work upon which to build

Indicators of progress toward reaching TMDL milestones include restoration, monitoring, and planning are shown in Upper Lolo Sediment TMDL Implementation Evaluation (DEQ_PPA_WQPB_WPS 2010). Restoration includes decommissioning unnecessary roads, upgrading roads to meet Montana's BMP standards, or moving roads away from tributary bottoms. Restoration work also includes projects designed to enhance fisheries such as improving fish passage or allowing woody debris to accumulate which provides enhanced habitat. Stabilization of eroding stream banks, fencing to protect and encourage riparian vegetation, and riparian planting projects also fall within the restoration category. Monitoring includes technical measurement of fine sediments to determine if TMDL goals are being reached, or if improvement is being made. Monitoring can also include less technical means such as observing macroinvertebrate populations, either as studied by university students or budding scientists in elementary school. Monitoring can include observations of riparian growth in stabilized areas, or might be tallied in decreasing numbers of 310 permits requested along lower Lolo Creek. In fact, monitoring of completed volunteer restoration projects will offer opportunity for continual education. Planning includes documents such as this watershed restoration plan and planning for small individual projects throughout the watershed.

Restoration examples:

1. At the time of the 2009 sale of Plum Creek to Nature Conservancy, Plum Creek had upgraded 95% of the roads in the Granite, East Fork and West Fork drainages to meet state BMP standards, 0.4 miles of roads were decommissioned, and four fish passage barriers were corrected in partnership with the Forest Service.
2. The Lolo National Forest removed 37 culverts, replaced 18 culverts to stream simulation standards, actively decommissioned approximately 65 miles of roads, and discontinued over 30 more miles of non-impactive Forest roads within the TMDL planning area.
3. The Montana Department of Transportation has taken some steps to reduce the amount of traction sand used in winter highway maintenance on Highway 12 that reaches the West Fork of Lolo Creek.

Monitoring examples:

1. Plum Creek completed some monitoring on the East Fork of Lolo Creek for several years in the span of 2000 through 2010 indicating improvement in water quality as compared to the North Fork of Granite Creek.

Planning examples:

1. This Watershed Restoration Plan is one example of continued planning for restoration on Lolo Creek.

2. The Lolo National Forest has evaluated a restoration plan for Upper Lolo Creek in an Environmental Assessment (USDA-USFS, 2005) and issued a Decision Notice (Pittman, 2005) specifying their commitment to continued restoration activities.
3. The Bitterroot TMDLs (Montana DEQ 2011) have been completed including the lower reaches of Lolo Creek giving the benchmark for planning in the lower reaches as well as updating needs for the upper Lolo Creek TMDL.
4. The Upper Lolo Creek TMDL Implementation Evaluation (DEQ-PPA-WQPB-WPS, 2010) details completed work and outlines efforts necessary to continue progress toward reaching the TMDLs.

Framework for future work in Upper Lolo Creek

The Bitterroot Subbasin Plan for Fish and Wildlife Conservation (Northwest Power and Conservation Council 2009) lists water quality goals and targets, including specific information for the upper Lolo Creek TMDL Planning Area. The following list of measurable milestones includes indicators of restoration success. This list is adapted from the Bitterroot Subbasin Plan.

1. Percent of forest road length and/or stream crossings meeting Montana Forestry BMPs.
2. Length of surplus forest road decommissioned.
3. BMP application rates in timber harvest areas.
4. Traction sand and salt application rates on U.S. Highway 12 as shown in annual reports from MDT. Weather summaries considered along wit application rates as use of traction sand and deicing chemicals is tied to timing and amount of snowfall/freezing weather. Also, reports mitigation measures to trap and remove sediment.
5. Geomorphic indicators of proper pattern, profile and dimension.
6. Number of age classes of native salmonid existing in the Upper Lolo TPA.
7. Macroinvertebrate indicators show full support based on standard DEQ protocols.
8. Number of human-caused fish passage barriers corrected.
9. Routine monitoring program is established to determine amount sediment reduction

The Lolo National Forest values these indicators to monitor implementation success. Marked efforts have been made towards restoration goals in recent years and as addressed in the Upper Lolo Creek Environmental Assessment. In the next two years, efforts to track success will be conducted. However, previous Forest work and assessments did not include cost-share roads and other roads on the Plum Creek lands. Consequently, there are many challenges to meet goals in a consistent manner across the watershed.

An additional environmental and transportation assessment needs to be conducted that includes the entire watershed. The Lolo National Forest is aware of this need, but with limited funding and staffing in engineering and water resources, has not been able to prioritize this necessary work. A reasonable time frame may be ten years without sufficient funding for staff support.

Framework for future work in Lower Lolo Creek

Lower Lolo Creek is a combination of ownerships including the Lolo National Forest and Plum Creek in the upper reaches of tributaries and private holdings along the valley bottom and foothills. As such, the items listed previously also apply for Lower Lolo Creek as well as additional goals for streamside owners. In addition, other measures for stream encroachment, riparian vegetation, and bank erosion are added.

Public Lands

1. Percent of forest road length and/or stream crossings meeting Montana Forestry BMPs.
2. Length of surplus forest road decommissioned.
3. BMP application rates in timber harvest areas.
4. Traction sand and salt application rates and percent of mitigation measures along U.S. Highway 12 being met. Annual reports on these values and measures are needed along with weather summaries as application rates will be tied to timing and amount of snowfall.
5. Geomorphic indicators of proper pattern, profile and dimension improving.
6. Number of age classes of native salmonids.
7. Macroinvertebrate indicators associated with sediment and full support based on standard DEQ protocols.
8. Number of human-caused fish passage barriers corrected.
9. Beaver reintroduction feasibility has been assessed and if deemed feasible at least one-reintroduction has been made within 5 years and State management supports desired beaver populations.

Private Ownerships

Goals for private ownerships include cooperative work between the Lolo Watershed Group and its partners, both governmental and nonprofit.

1. Grants to fund work needed in the lower reaches of Lolo Creek
    a. Apply immediately for grants available in short time frames for small projects to gain awareness of the LWG while providing streambank stabilization and riparian planting in eroding areas on lower Lolo Creek.
    b. At 3 years develop a steady supply of grant funding to address a continuous project list that provide education examples, restoration, and monitoring.
    c. At 5 years have an adequate source of funding to be able to have coordinator and grant writers on staff of Lolo Watershed Group as well as fund projects
2. Coordination with agency and nonprofit partners.
    a. Develop projects in partnership
3. Public Outreach and education goals
    a. Present public education events/meetings quarterly
    b. Increase active membership
    c. Develop a volunteer corps to help with education, fish, stabilization, etc. projects
    d. Increase board membership
4. Bank erosion and areas with compromised riparian vegetation are identified and assisted to revegetate with desired species through either direct planting and replacement of pasture grass species or through buffering techniques such as wildlife-friendly fencing projects, or a combination thereof.
    a. By 3 years have funded and accomplished 1 project per year
    b. By 5 years have funding and personnel to accomplish 2-3 projects per year
5. Beaver reintroduction feasibility has been assessed and if deemed feasiable at least one-reintroduction has been made within 5 years and State management supports desired beaver populations.
6. Fisheries and aquatics
    a. By 3 years move from fish salvage to fish screen maintenance with personnel and funding to acquire and maintain fish screens
    b. Develop monitoring system to assess success in reducing streambank erosion
7. Flow and temperature

   a. By 3 years have USGS stream gauge in place to continue record of old gauge called Sleeman Creek along with stream of funding necessary for maintaining gauge.
   b. Continue partnership with Clark Fork Coalition for monitoring stream flow and temperature. By 3 years, add one additional site above Fort Fizzle, below confluence with South Fork and an additional site above OZ Ranch water right if staffing and funding are available.
   c. By 3 years establish flow and temperature triggers that are acceptable levels for various stream reaches based on cross section and discharge data.
   d. By 3 years explore additional possibilities to purchase or lease water rights to assist instream flows.
   e. By 3 years explore possibilities to fund changes in irrigation methods to conserve water.
   f. Within 3 years, assist beaver feasibility efforts to improve base flow conditions by determining those land ownerships and infrastructures where beaver presence can be allowed to check stream flows for additional floodplain water storage and improved late season releases.
8. Water quality
   a. By 3 years develop partnership to obtain data from public ground water wells to monitor water quality.
   b. Participate in land use planning to assure adequate septic/sewering standards are met as land is subdivided.
   c. Within 3 years determine those sites where additional stream buffers or management changes could improve water quality conditions.
9. Channel Migration
   a. By 3 years obtain adequate historical data to describe Historical Migration Zones.
   b. By 5 years obtain funding and data to complete Channel Migration Zone mapping including likelihood of migration outside of floodplain.
10. Develop outreach programs about benefits of setbacks, streamside vegetation, watershed-friendly agricultural practices for hobby farms and agricultural holdings.

Table 8.1 Lolo Creek Watershed Restoration Plan: problems, assistance needs, implementation schedule, measurable milestones.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones
Sediment-caused impairment in the Lolo Creek Watershed				
High Density of forest roads	Decommission unused	Agency or technical contractors $1500-$4K per mile	Rate of decommissioning is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates	Miles of roads decommissioned
Lack of BMP use in past	Update to current BMP standards	Agency and Technical contractors Highly variable (high) costs	Rate of bringing roads and logged areas to current standard is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates	Area of disturbed land brought to BMP standards
Traction sand use on Hwy 12	Monitor sand use, trap & recover excess	MDT cooperation for reporting. Part of MDT maintenance costs.	MT DEQ receives yearly reports on sand and salt use. LWG volunteers can visually monitor traction sand applied to creek or streambank beginning year 1.	Reduced sand and salt use as shown in annual MDT reports.
Monitor surface water quality	Develop monitor team (coordinate with LNF)	Volunteer team or U of M student, research grant or volunteer and minigrant for equipment, mileage	Some monitoring will be conducted by LNF, rate of completion of monitoring projects depends on budget. LWG Year 1. Identify monitoring activities, write grant request for grad student coordinating with LNF. LWG Year 2-3. Fund graduate student work. Assist LNF with volunteer team.	Number of volunteer days spent monitoring.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones
Fisheries, wildlife, and water quality issues (other than sediment) in the Lolo Creek Watershed				
Fish passage barriers	Replace/remove limiting culverts	Technical agency expertise, $1-3,5K remove, up to $150K replace	Rate of barrier mitigation is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates. LWG year 1 identify fish barrier within financial reach of grant obtained in partnership with LNF. LWG year 2 apply for grant, identify next possible barrier for mitigation. LWG year 3-5 continue as above, identify and apply for grants.	Grant funding obtained for fish passage barrier mitigation. Fish passage barrier location identified. Fish passage barriers removed.
Fish entrainment in ditches	Increase fish screen use, fish salvage	Volunteer team with technical lead, Screen costs $4-5K per cfs	LWG Year 1. Identify ditch and owner interested in fish screen. Develop a volunteer team willing to do maintenance. Work with FWP to obtain grant and install fish screen LWG Subsequent years. Identify additional sites for screens, continue to train and build maintenance volunteer team.	Ditches for which fish screening is appropriate are identified. Fish screens installed. Maintenance teams developed for each fish screen location.
Dewatering	Continue to monitor flows, obtain water rights for creek, improve irrigation efficiency	Continue to support Clark Fork Coalition monitoring, and water right lease program. Obtain grant to assist or coordinate.	Clark Fork Coalition is monitoring 3 sites on Lolo Creek. LWG – years 1-5 support CFC mission and encourage addition of more monitoring sites. Develop team to assist in data collection. Work with Watershed Education Network stream team.	Monitoring continued at current sites. Additional sites identified and funded. Stream teams work with CFC to monitor sites. Additional water rights obtained to maintain instream flow.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones
Lack of woody debris	Allow recruitment	Volunteer led public education on private land, $1-2K minigrant, BMP on public land	LNF will allow woody debris recruitment as part of BMPs. LWG – Year 1. Coordinate with education agencies and groups to obtain training materials on importance of woody debris. LWG – Year 2-5. Include in public education package about healthy streams. Encourage landowners to leave wood in stream.	Education package developed. Present package to landowners along Lolo Creek and its tributaries. Public lands reports indicate increased wood accumulation in streams.
Low beaver activity	Reintroduce beaver or enhance habitat	FWP change in trapping rule for Lolo, unknown costs. Habitat suitability study, $5K.	LWG Year 1. Coordinate with LNF and FWP to decrease trapping pressure on beaver in Lolo Creek, Year 2 - Monitor beaver population response to reduced trapping, prepare educational materials for public and identify areas for potential reintroduction. Year 3 – Continue monitoring population, consider reintroduction.	Beaver trapping quotas reduced. Beaver population monitoring in place. Public education package created and distributed. Suitable habitat locations identified. Population increase identified or reintroduction program in place
Loss of meanders	Allow meanders to develop, replace lost meanders	Volunteer led public education on private land, $1-2K minigrant, Replacing would take exceptional highway funding	Year 1 Identify disconnected meanders. Year 3 Identify landowners interested in having meanders reconnected. Watch for opportunities for bridging creek.	Meanders that could be reconnected are identified. Landowners willing to allow reconnection listed. Idealistically, bridge pairs in place over meanders.
Armoring for highway protection	Soften with plantings, May also serve to aid in trapping traction sand.	Contracted stinger operator and volunteer planters, $5K MDT support	LWG – Year 1 identify potential planning sites and coordinate with MDT for potential funding to plant water loving shrubs along some armorer, channeled, segments where highway is close to stream.	Planting sites identified. Funding obtained for planting. Volunteer planting teams available. Miles of riprap planted.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones
Additional concerns related to human activities				
Ground water quality	Monitor	May be in Water Quality District capabilities.	LWG – request annual report of water quality data from wells in the watershed from Missoula County. Watch for grants dealing with ground water quality to use to initiate a study on pollution plume in lower Lolo	Water quality database in place. Reports indicate no decline in ground water quality.
Drought management	Study effect of well use and Bitterroot River level on creek flow, educate	U of M student research project. Educate ($1-2K minigrant)	LWG Year 1 – Work with Watershed Education Network to develop or implement watershed model training materials for use in public meetings, and in elementary, and secondary schools. Look for data on ground water/surface water connection. LWG - Year 2 – apply for grant to fund student researcher. LWG – Years 3-5 develop a drought management plan to determine minimum flow needed to allow Lolo Creek to flow to its mouth and ground water use limitations needed in sustained drought.	Training package developed. Research student funded. Minimum flow requirements determined. Drought management plan developed and in place.
Streambank erosion on private property	Work with landowners, educate	Educate ($1-2K minigrant), stabilize by plantings coir logs Volunteer team within range of Conservation District riparian grant	LWG – Year 1. Identify streambank segments that would benefit from plantings for stabilization. LWG – Year 2. Apply for riparian planting grants or minigrants. Develop volunteer team to help with planting. LWG – Year 3-5. Continue stabilization at other sites.	Stabilization needs (locations) identified. Teams and funding in place tor plantings. Stabilization plantings conducted as needs funding become available.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones
Armoring to prevent channel migration on private property	Soften with plantings, encourage alternatives	Contracted stinger operator and volunteer planters, $5K per day, Conservation District riparian grant	LWG Year 1. Identify site for planting, apply for CD riparian grant LWG Year 2. Plant site, identify next site for planting LWG year 3. Assess success, if adequate, apply for additional grants	Armored sites on private lands identified. Planting in place as owners request. New stabilization projects include vegetation to reduce armoring effects.
Deicing chemical use	Work to MDT to monitor use	Within MDT scope of work	Obtain reports on deicer use yearly from MDT. LWG Year 1. Obtain weather data for past 5 years on Lolo Pass to compare to deicer use. LWG. Subsequent years. Continue data comparison of weather to deicer use.	Annual deicer use reports available. Historical weather database constructed. Weather to deicer and gravel use relationship determined.
Future Plans				
Increase flow/temperature database	Add more automated flow/ temp monitor sites	Develop volunteer team or coordinate with Clark Fork Coalition, $3-5K device costs per site	LWG – ongoing - continue to coordinate with Clark Fork Coalition. Assist to find resources to fund expenses for person to monitor additional sites. Equipment is available to add one site.	Stream teams trained and in place. Additional sites in routine monitoring for flow rate and temperature.
Gaging station to capture maximum flows	Return USGS gaging station near historical location	Technical setup and maintenance, $2K for instrument, $16K/year maintenance	LWG will work with Missoula County Floodplain to look for opportunities to collaborate on obtaining a sustainable source of funding for a USGS gage.	Funding obtained. USGS gage installed. Maintenance funding obtained.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones
Improve understanding of channel migration	Obtain Channel Migration Zone (CMZ) data	Technical expertise and flight time requires large scale funding unless coordinated through another agency	LWG - Year 1. Identify agencies/contractors who could fund, obtain and analyze CMZ data. Locate maps, photos and satellite images for Lolo Creek to use in public education. LWG – Year 2. Encourage data collection	Public education package prepared. Historical information/ database developed. Funding for CMZ analysis procured. CMZ analysis completed.

Chapter 9. Criteria to Show Water Quality/Quantity Goals are Being Met

EPA Element 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 towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

Load reduction criteria for Upper Lolo Creek.

Load reduction criteria can be developed from the Final Upper Lolo TMDL document (Mathieus, G. 2003) and from the Draft Bitterroot Temperature and Tributary Sediment TMDL document (Montana DEQ 2011). Reduction goals, listed in the following tables, provide the currently available criteria to determine whether water quality standards are being reached.

Table 9.1 Existing sediment loads and load reductions needed to reach TMDL allocations from Table 15, page 42 of the final Upper Lolo TMDL (Mathieus, G. 2003).

Creek	Natural Load	Existing Load Forest Road	Existing Load Hwy 12	Total Load	TMDL	Reduction from Forest Roads	Reduction from HWY 12
Granite Creek	449	95		545	495	50	
Lee Creek	95	9		104	99	5	
Lost Park Creek	192	21		213	204	9	
East Fork Lolo Creek	596	53		649	630	19	
West Fork Lolo Creek	246	19	425-518	690-783	543-605	6	140-171

Table 9.2 Sediment load reduction by segment from Tables 5.57-59 (Montana DEQ 2011). Loads are shown in tons/year listing current value and (allowable value).

Stream segment	Road sediment	Bank erosion (human)	Bank erosion (natural)	Upland erosion	Point source *	Total	Reduction to reach TMDL
Headwaters to Sheldon Creek	41 (15)	863 (362)	897 (897)	1125 (820)	0 (7)	2926 (2094)	832
Sheldon Creek to Mormon Creek	84 (31)	1762 (740)	1833 (1833)	2690 (2086)	0 (7.4)	6369 (4690)	1678.6
Mormon Creek to mouth	1.72 (0.64)	37 (16)	37 (37)	199 (122)	0 (7)	199 (176)	23

** 7 tons/year allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than this amount so is not added to the total allowable load.*

Validating TMDL values and tracking progress

Values for road sediment and bank erosion in the table above were estimated for the entire Lolo watershed, including the Upper Lolo TPA, then allocated to stream segments based on the ratio of the area of the segment/the total watershed area. Values in the Upper Lolo Table are based on modeled estimates using the best available modeling techniques and estimates. A priority should be placed on monitoring sediment values for the watershed to evaluate the modeled and estimated values. Obtaining baseline data will allow validation of the estimated loads and reductions or provide the data needed to revise the load values.

Baseline data, obtained as soon as possible, will also allow tracking of improvements in water quality as work is completed in the watershed.

Table 9.1 Lolo Creek Watershed Restoration Plan: problems, implementation schedule, measurable milestones, criteria to show goals are being met.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Sediment-caused impairment in the Lolo Creek Watershed					
High Density of forest roads	Decommission unused	Agency or technical contractors $1500-$4K per mile	Rate of decommissioning is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates	Miles of roads decommissioned	Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.
Lack of BMP use in past	Update to current BMP standards	Agency and Technical contractors Highly variable (high) costs	Rate of bringing roads and logged areas to current standard is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates	Area of disturbed land brought to BMP standards	Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.
Traction sand use on Hwy 12	Monitor sand use, trap & recover excess	MDT cooperation for reporting. Part of MDT maintenance costs.	MT DEQ receives yearly reports on sand and salt use. LWG volunteers can visually monitor traction sand applied to creek or streambank beginning year 1.	Reduced sand and salt use as shown in annual MDT reports.	Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Monitor surface water quality	Develop monitor team (coordinate with LNF)	Volunteer team or U of M student, research grant or volunteer and minigrant for equipment, mileage	Some monitoring will be conducted by LNF, rate of completion of monitoring projects depends on budget. LWG Year 1. Identify monitoring activities, write grant request for grad student coordinating with LNF. LWG Year 2-3. Fund graduate student work. Assist LNF with volunteer team.	Number of volunteer days spent monitoring.	Baseline values have been developed and teams determine geomorphic indicators of proper pattern, profile and dimension. Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Fisheries, wildlife, and water quality issues (other than sediment) in the Lolo Creek Watershed					
Fish passage barriers	Replace/remove limiting culverts	Technical agency expertise, $1-3,5K remove, up to $150K replace	Rate of barrier mitigation is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates. LWG year 1 identify fish barrier within financial reach of grant obtained in partnership with LNF. LWG year 2 apply for grant, identify next possible barrier for mitigation. LWG year 3-5 continue as above, identify and apply for grants.	Grant funding obtained for fish passage barrier mitigation. Fish passage barrier location identified. Fish passage barriers removed.	Barrier numbers reduced and full range of age classes of native salmonids found

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Fish entrainment in ditches	Increase fish screen use, fish salvage	Volunteer team with technical lead, Screen costs $4-5K per cfs	LWG Year 1. Identify ditch and owner interested in fish screen. Develop a volunteer team willing to do maintenance. Work with FWP to obtain grant and install fish screen LWG Subsequent years. Identify additional sites for screens, continue to train and build maintenance volunteer team.	Ditches for which fish screening is appropriate are identified. Fish screens installed. Maintenance teams developed for each fish screen location.	Number of unscreened ditches is reduced and the full range of age classes of native salmonids found within Lolo Creek
Dewatering	Continue to monitor flows, obtain water rights for creek, improve irrigation efficiency	Continue to support Clark Fork Coalition monitoring, and water right lease program. Obtain grant to assist or coordinate.	Clark Fork Coalition is monitoring 3 sites on Lolo Creek. LWG – years 1-5 support CFC mission and encourage addition of more monitoring sites. Develop team to assist in data collection. Work with Watershed Education Network stream team.	Monitoring continued at current sites. Additional sites identified and funded. Stream teams work with CFC to monitor sites. Additional water rights obtained to maintain instream flow.	Lolo Creek remains connected to the Bitterroot River at all times.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Lack of woody debris	Allow recruitment	Volunteer led public education on private land, $1-2K minigrant, BMP on public land	LNF will allow woody debris recruitment as part of BMPs. LWG – Year 1. Coordinate with education agencies and groups to obtain training materials on importance of woody debris. LWG – Year 2-5. Include in public education package about healthy streams. Encourage landowners to leave wood in stream.	Education package developed. Present package to landowners along Lolo Creek and its tributaries. Public lands reports indicate increased wood accumulation in streams.	Macroinvertebrate indicators show full support based on standard DEQ protocols and native salmonids through all age classes noted in surveys.
Low beaver activity	Reintroduce beaver or enhance habitat	FWP change in trapping rule for Lolo, unknown costs. Habitat suitability study, $5K.	LWG Year 1. Coordinate with LNF and FWP to decrease trapping pressure on beaver in Lolo Creek, Year 2 - Monitor beaver population response to reduced trapping, prepare educational materials for public and identify areas for potential reintroduction. Year 3 – Continue monitoring population, consider reintroduction.	Beaver trapping quotas reduced. Beaver population monitoring in place. Public education package created and distributed. Suitable habitat locations identified. Population increase identified or reintroduction program in place	Beaver population has increased. Nuisance beaver activity is mitigated as needed.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Loss of meanders	Allow meanders to develop, replace lost meanders	Volunteer led public education on private land, $1-2K minigrant, Replacing would take exceptional highway funding	Year 1 Identify disconnected meanders. Year 3 Identify landowners interested in having meanders reconnected. Watch for opportunities for bridging creek.	Meanders that could be reconnected are identified. Landowners willing to allow reconnection listed. Idealistically, bridge pairs in place over meanders.	Study to identify meanders that could be reestablished is complete and potential meander connections are prioritized should opportunity to reconnect present itself
Armoring for highway protection	Soften with plantings, May also serve to aid in trapping traction sand.	Contracted stinger operator and volunteer planters, $5K MDT support	LWG – Year 1 identify potential planning sites and coordinate with MDT for potential funding to plant water loving shrubs along some armorer, channeled, segments where highway is close to stream.	Planting sites identified. Funding obtained for planting. Volunteer planting teams available. Miles of riprap planted.	Streamside plantings are complete with adequate survival to help catch sediment from traction sand use.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Additional concerns related to human activities					
Ground water quality	Monitor	May be in Water Quality District capabilities.	LWG – request annual report of water quality data from wells in the watershed from Missoula County. Watch for grants dealing with ground water quality to use to initiate a study on pollution plume in lower Lolo	Water quality database in place. Reports indicate no decline in ground water quality.	No decline in water quality noted in ground wells throughout watershed.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Drought management	Study effect of well use and Bitterroot River level on creek flow, educate	U of M student research project. Educate ($1-2K minigrant)	LWG Year 1 – Work with Watershed Education Network to develop or implement watershed model training materials for use in public meetings, and in elementary, and secondary schools. Look for data on ground water/surface water connection. LWG - Year 2 – apply for grant to fund student researcher. LWG – Years 3-5 develop a drought management plan to determine minimum flow needed to allow Lolo Creek to flow to its mouth and ground water use limitations needed in sustained drought.	Training package developed. Research student funded. Minimum flow requirements determined. Drought management plan developed and in place.	Lolo Creek remains connected to the Bitterroot River through drought periods.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Streambank erosion on private property	Work with landowners, educate	Educate ($1-2K minigrant), stabilize by plantings coir logs Volunteer team within range of Conservation District riparian grant	LWG – Year 1. Identify streambank segments that would benefit from plantings for stabilization. LWG – Year 2. Apply for riparian planting grants or minigrants. Develop volunteer team to help with planting. LWG – Year 3-5. Continue stabilization at other sites.	Stabilization needs (locations) identified. Teams and funding in place tor plantings. Stabilization plantings conducted as needs funding become available.	Reduction in 310 permits issued for Lolo Creek.
Armoring to prevent channel migration on private property	Soften with plantings, encourage alternatives	Contracted stinger operator and volunteer planters, $5K per day, Conservation District riparian grant	LWG Year 1. Identify site for planting, apply for CD riparian grant LWG Year 2. Plant site, identify next site for planting LWG year 3. Assess success, if adequate, apply for additional grants	Armored sites on private lands identified. Planting in place as owners request. New stabilization projects include vegetation to reduce armoring effects.	Reduction in armoring without plantings noted in stream walks.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Deicing chemical use	Work to MDT to monitor use	Within MDT scope of work	Obtain reports on deicer use yearly from MDT. LWG Year 1. Obtain weather data for past 5 years on Lolo Pass to compare to deicer use. LWG. Subsequent years. Continue data comparison of weather to deicer use.	Annual deicer use reports available. Historical weather database constructed. Weather to deicer and gravel use relationship determined.	Water quality testing shows no hazardous levels of deicer salts.
Future Plans					
Increase flow/temperature database	Add more automated flow/ temp monitor sites	Develop volunteer team or coordinate with Clark Fork Coalition, $3-5K device costs per site	LWG – ongoing - continue to coordinate with Clark Fork Coalition. Assist to find resources to fund expenses for person to monitor additional sites. Equipment is available to add one site.	Stream teams trained and in place. Additional sites in routine monitoring for flow rate and temperature.	5 or more sites are being regularly monitored for flow rates and temperature.
Gaging station to capture maximum flows	Return USGS gaging station near historical location	Technical setup and maintenance, $2K for instrument, $16K/year maintenance	LWG will work with Missoula County Floodplain to look for opportunities to collaborate on obtaining a sustainable source of funding for a USGS gage.	Funding obtained. USGS gage installed. Maintenance funding obtained.	Gaging station in place with steady funding source for maintenance obtained.

Problems/Concerns	Measures needed to mediate problem	Technical and Financial needs	Timeline or Implementation Schedule	Measurable Milestones	Criteria to show goals are being met
Improve understanding of channel migration	Obtain Channel Migration Zone (CMZ) data	Technical expertise and flight time requires large scale funding unless coordinated through another agency	LWG - Year 1. Identify agencies/contractors who could fund, obtain and analyze CMZ data. Locate maps, photos and satellite images for Lolo Creek to use in public education. LWG – Year 2. Encourage data collection	Public education package prepared. Historical information/ database developed. Funding for CMZ analysis procured. CMZ analysis completed.	Historical Migration Zone mapping complete, CMZ data obtained to allow final CMZ mapping.
Build Lolo Watershed Group Capacity	Coordination with other groups, membership, Hire a half time executive director/grant writer.	Coordination with volunteer time, no cost. Half time director/grant writer $20K	See outline timeline in Chapter 7 for specific implementation goals for LWG.	Increase in public and agency participation in LWG meetings. Increase in membership donations. Funding adequate to hire executive director/grant writer.	LWG meetings well attended. LWG board membership is increased. Landowners, land management agencies and organizations work together to enhance watershed health.

Chapter 10. Technical Monitoring and Analysis Plan

EPA Element 9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established in the chapter above.

Upper and Lower Lolo Creek TMDL Planning Areas

To help achieve the TMDL objectives, DEQ_PPA_WQPB_WPS 2010 recommends the following types of monitoring activities:

1. Establish permanent bench-marked cross-sections where channel pattern, dimension and profile can be tracked through time using Rosgen Level II parameters (width/depth ratios, entrenchment ratios and sinuosity) and techniques,
2. Collect additional parameters (pool frequency, pool residual depth),
3. Collect particle size distribution data using Wolman pebble count procedures through riffles at the established cross-sections,
4. Conduct a road sediment assessment using the Forest Road Survey (FRS) for select watersheds in which recent forest management activities have taken place,
5. Monitor for fish redds and fine sediment, and associated documentation of the results, on a yearly basis,
6. Monitor population status of native salmonid species and report findings to DEQ,
7. Update an assessment of channel conditions and other geomorphic indicators for the whole length of the Lolo Creek Watershed to help determine existing conditions and help track potential future impacts to this important waterbody and to tie in with future downstream TMDL development,
8. Track the effectiveness of BMPs on forest roads and US Highways 12 and other mitigation measures at meeting targets. This could be done by comparing existing instream data to data following upgraded practices and mitigation measures,
9. Develop a database using the Forest Service's significant amount of stream data on potential reference reaches with the TPA to help guide future target setting and evaluation for waterbodies in Lolo Creek and elsewhere in the Bitterroot Basin, and,
10. Use data and information to assist the current Clark Fork/Bitterroot model efforts that are being developed.

Additional Monitoring for Lower Lolo Creek public and private ownerships

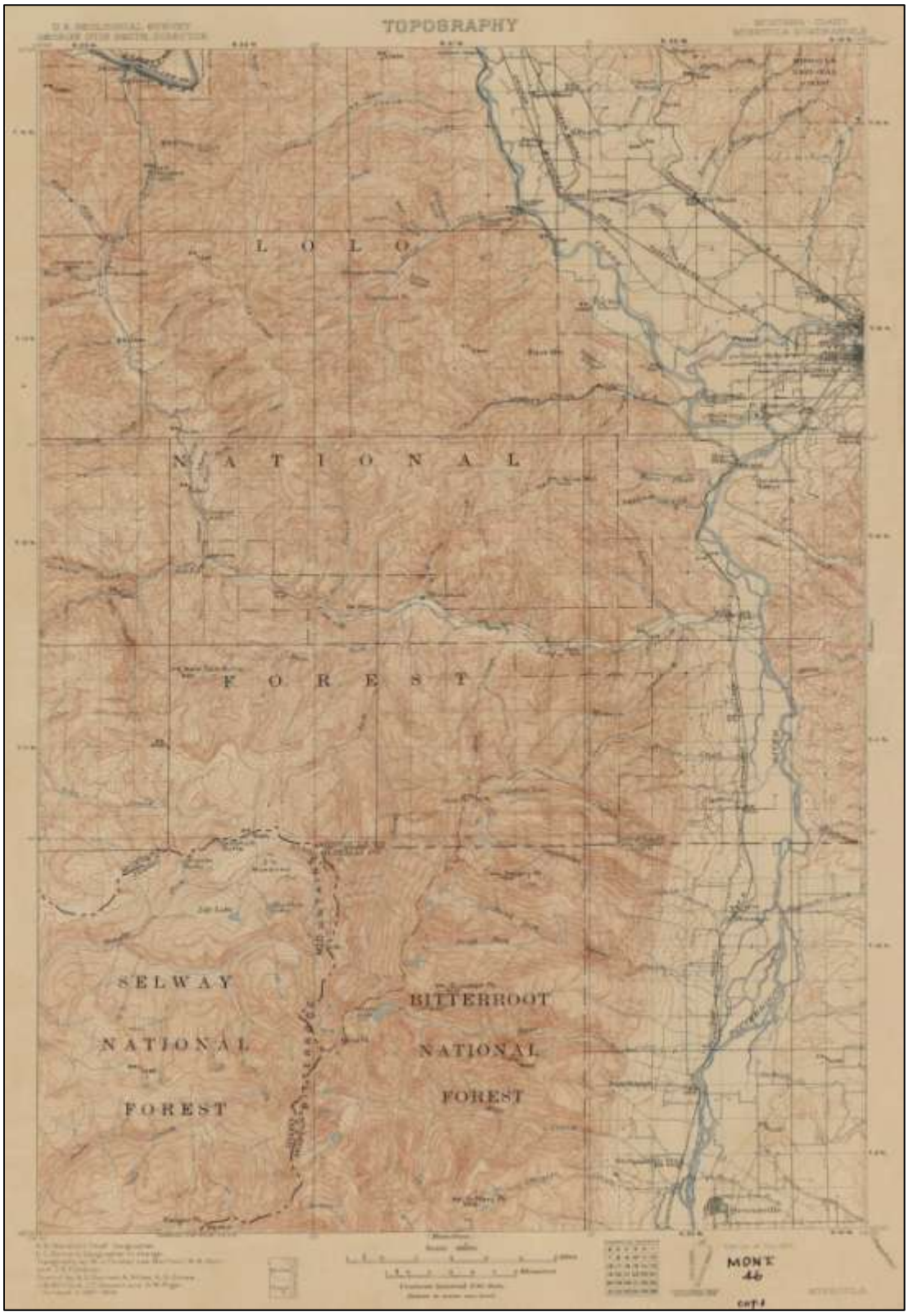
1. Continue stream flow and temperature monitoring partnership with the Clark Fork Coalition, adding one or two additional sites to collect data below the confluence with the South Fork of Lolo Creek and above the OZ Ranch water right. Monitor for flow and temperature changes as streamside vegetation and stabilization projects are completed.
2. Establish a USGS gauging station near the historical site of the Sleeman Creek station to continue the record of output flow from Lolo Creek. Observe flow rate changes through years to observe the effects of timberland revegetation, excess road removal, stabilization and revegetation projects.
3. Develop a database of ground water quality values from public ground water wells in the Lolo Creek watershed, both historical and ongoing to monitor changes in ground water quality.

4. Monitor surface water quality for sediment, road maintenance chemicals, agricultural waste such as manure, fertilizer and pesticides, and septic system discharge.
5. Track macroinvertebrate populations to determine effects of restoration and stabilization work, increase in woody debris and beaver activity.
6. Track fish populations to determine effects of stabilization and restoration work, decrease in fish passage barriers, improved pool and shade cover with beaver activity, woody debris and planted riprap banks, and increased use of fish screens on irrigation ditches.
7. Maintain website illustrating projects underway, projects completed, include links to educational sites and track “hits”.

See Appendix H for the table representation of the EPA elements of the Lolo Creek Watershed Restoration Plan.

Midnight on Lolo Creek. Photo credit Matt Navarre, 2010.

Appendix A. Historic Area Map



Appendix B. Lolo Creek Physical Information Summary by Tributary

The following data were obtained from, Zelazny (2006), the Bitterroot River Subbasin Plan (Northwest Power and Conservation Council. 2009), and Water Quality Restoration Plan and Total Maximum Daily Loads for the Upper Lolo Creek TMDL Planning Area, Montana Department of Environmental Quality. 2003.

Table B.1 Lolo Creek watershed summary of information by tributaries and sections of the main stem. The length and road density differ slightly between the Zelazny and DEQ reports reflecting different measurement techniques and/or differences in delineation of subwatersheds.

Bitterroot Subbasin	Creeks of Lolo Creek	Length in miles (Zelazny)	Length in miles (DEQ)	Elevation Range	Area in acres	Area in Square Miles	Road Density Estimate mi/sq mi 2003	Physical Notes
West Fork of Lolo Creek 1401	West Fork of Lolo Creek	6	6.8		7,698.7	12	5.8	
	Lee Creek Separate in TMDL document only	3.5	3.8		2,511.7	3.9	6.8 to 7.4	
East Fork of Lolo Creek 1402	East Fork of Lolo Creek	10	7.4		20,255.2	31.6	4.3 to 4.6	
	Lost Park Creek		5				4.3	

Bitterroot Subbasin	Creeks of Lolo Creek	Length in miles (Zelazny)	Length in miles (DEQ)	Elevation Range	Area in acres	Area in Square Miles	Road Density Estimate mi/sq mi 2003	Physical Notes
Granite Creek 1403	Granite Creek	9.5	8.5		13,515.6	21.1	4.1 to 4.5	
Howard Creek 1404	Howard Creek	8			12,493.5	19.5	4.5	
Upper Lolo Creek 1405	Davis Creek	3						
	Chief Joseph Gulch	2			1,540.1	2.4	2.8	
	Cloudburst Creek	na			4,146.9	6.5		
	Martin Creek	2.5			1,524, 2	2.4	4.7	
West Fork Butte Creek 1406	West Fork Butte Creek (within South Fork of Lolo Creek)	8.5		6,241 to 3,674	na,	17.32	4.31	perennial

Bitterroot Subbasin	Creeks of Lolo Creek	Length in miles (Zelazny)	Length in miles (DEQ)	Elevation Range	Area in acres	Area in Square Miles	Road Density Estimate mi/sq mi 2003	Physical Notes
South Fork of Lolo Creek 1407	South Fork of Lolo Creek (less West Fork Butte Cr.)	14.5		9,118 to 3,523				perennial
Lolo Creek - Grave Creek 1408	Grave Creek and East Fork of Grave Creek	8+5			8,520.5	13.3	5.5	perennial
	Clark Creek	2			1,238	1.9	11.6	
	Bear Creek	7.5						
	Camp Creek	na					6.7	lower reach not perennial
	Woodman Creek	4.5			8.1		5.3	perennial, diverted to irrigation

Bitterroot Subbasin	Creeks of Lolo Creek	Length in miles (Zelazny)	Length in miles (DEQ)	Elevation Range	Area in acres	Area in Square Miles	Road Density Estimate mi/sq mi 2003	Physical Notes
Lower Lolo Creek 1409	Sleeman Gulch	6		6,458 to 3,241	6,131.5	9.6	6.8	Intermit-tent
	Tevis Creek	na		7,223 to 3,490	1,137.8	1.8	2.7	perennial
	Mill Creek	na		9,030 to 3,447	4,791	7.5	1.2	perennial
	John Creek	2		7,098 to 3,385	1,367	2.1	1	not con-nected
	Mormon Creek	7		8,328 to 3,241	4,963	7.3	4.5	perennial1.1 sinuosity

** na = not available from this source*
Road Density in miles of road per square mile of area

Appendix C. Monthly climate summary data for the upper Lolo Creek Watershed

Combined data from a former weather station at Lolo Hot Springs and a newer station were used to develop a full record through July of 2010 shown in Table 2.1 below. This record can be used to examine the temperature and precipitation patterns that are critical to the flow of Lolo Creek.

Table C.1. Monthly Climate Summary: Lolo Hot Springs 2 NE station MT 245146 Period of Record: 1/01/1959 to 7/31/2010.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max. Temperature (F)	32.2	38.8	43.5	53.3	64.6	72.7	83.1	81.6	70.8	55.8	40.7	32.3	55.8
Avg. Min Temperature (F)	13.5	17.1	19.3	25.7	31.6	38.4	40.5	39.7	32.9	27.2	22.0	14.9	26.9
Avg. Total Precipitation (in.)	3.43	1.99	2.07	1.64	1.92	2.27	1.14	1.38	1.44	1.78	2.42	2.74	24.22
Avg. Total Snowfall (in.)	32.0	17.4	13.0	6.3	0.3	0.0	0.0	0.0	0.2	1.5	10.5	21.9	103.2
Avg. Snow Depth (in.)	14	13	10	1	0	0	0	0	0	0	1	6	4

Data for these stations can be accessed at the following web sites:
Lolo Pass *http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=588&state=id*

Lolo Hot Springs (1959-1984) *http://weather-warehouse.com/WeatherHistory/PastWeatherData_LoloHotSprings2Ne_Lolo_MT_August.html*

Appendix D. USGS Gauging Station 12352000

The USGS gauging station 12352000 operated from 1951-1960 situated on Lolo Creek between Sleeman Creek and the Maclay Diversion ditch.

These data are available online from the USGS National Water Information System: Web Interface
http://nwis.waterdata.usgs.gov/nwis/

Table D.1. USGS Gauging Station Information for Lolo Creek

USGS Station number 12351500 Latitude 46°45'14.94", Longitude 114°13'12.20" NAD83 Missoula County, Montana, Hydrologic Unit 17010205 Drainage area: 231 square miles Datum of gage: 3.430 feet above NGVD29 Period of record from 04/25/1911 to 03/31/1915	USGS Station number 12352000 Latitude 46°44'38.81", Longitude 114°08'36.33" NAD83 Missoula County, Montana, Hydrologic Unit 17010205 Drainage area: 250 square miles Datum of gage: 3,290 feet above NGVD29 Period of record from 11/01/1950 to 09/30/1960 Additional peak streamflow and field records between 1910 and 1974

The following figure illustrates the changes in streamflow through the 10-year period.

Figure D.1. Streamflow recorded for Lolo Creek from 1950 through 1960 at USGS Station 1235200 above Sleeman Creek, Near Lolo, MT.

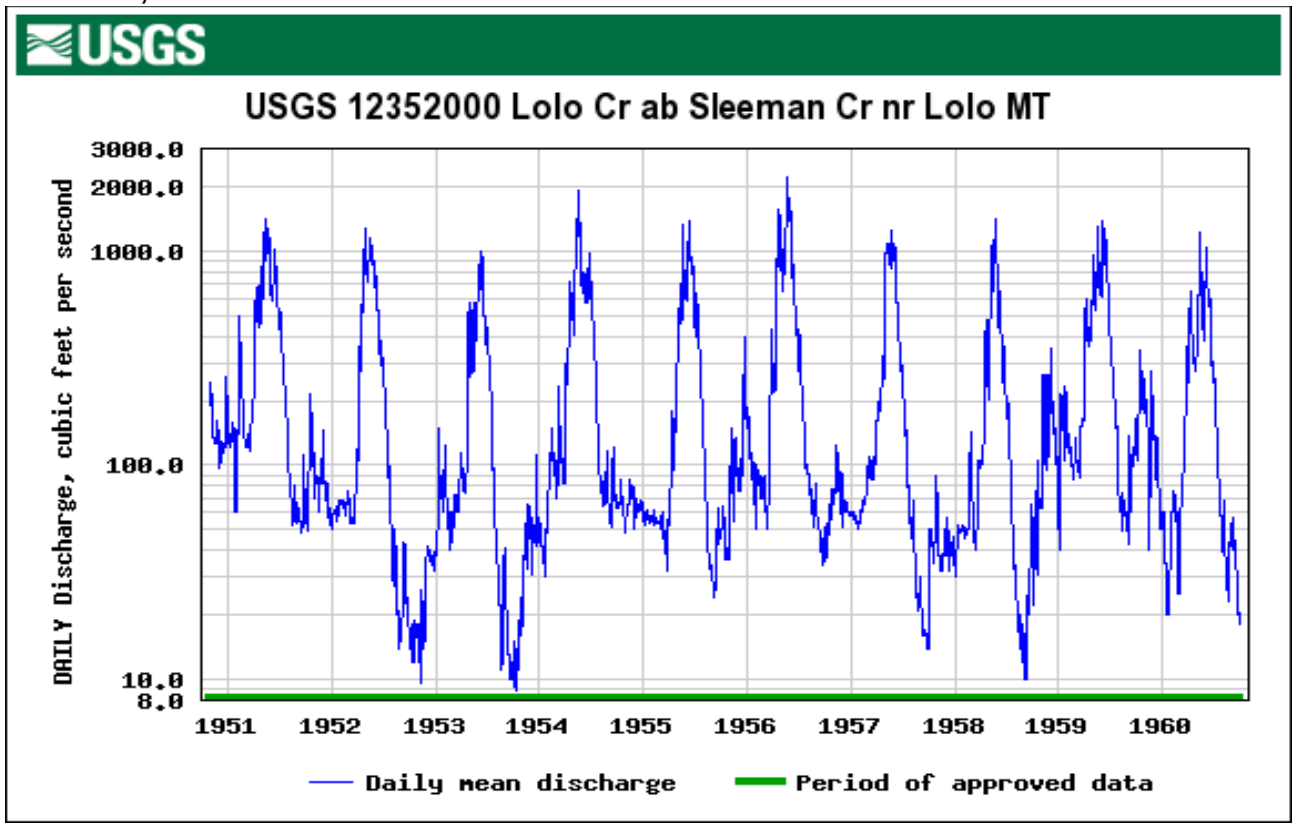


Table D.2. Peak Streamflow for Lolo Creek at USGS Station 1235200.

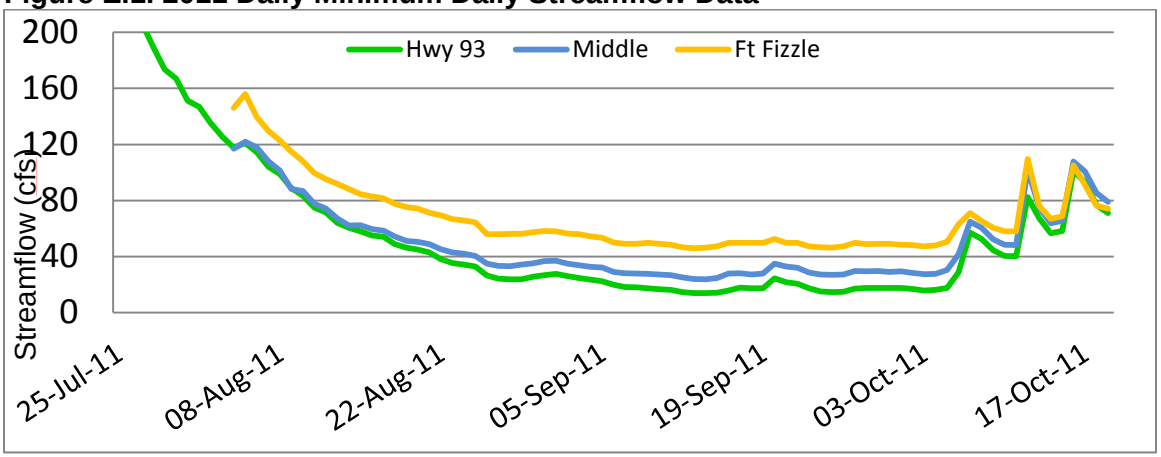
Water Year	Date	Gage Height (feet)	Streamflow (cfs)
1951	05/12/1951	4.98	1,500
1952	04/28/1952	4.72	1,320
1953	06/13/1953	4.30	1,060
1954	05/20/1954	5.72	1,980
1955	06/13/1955	4.98	1,480
1956	05/24/1956	6.24	2,430
1957	05/20/1957	4.76	1,330
1958	05/24/1958	5.04	1,620
1959	06/06/1959	4.75	1,430
1960	05/13/1960	4.65	1,340
1972	June 1972	6.54	2,660
1974	June 1974	6.16	2,410

Appendix E. Stream Flow and Temperature Data at Three Sites on Lolo Creek

Data collected by Clark Fork Coalition.

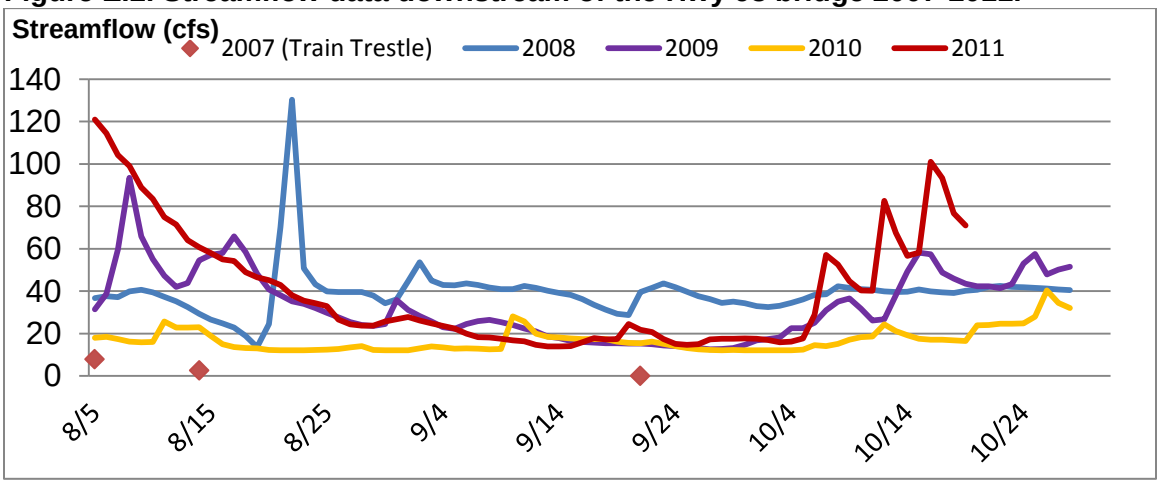
The following graphs illustrate measured flow and temperature for the sampling periods from 2007 through 2012 at Fort Fizzle, Landquist residence (Middle) and Larson residence (Hwy 93).

Figure E.1. 2011 Daily Minimum Daily Streamflow Data



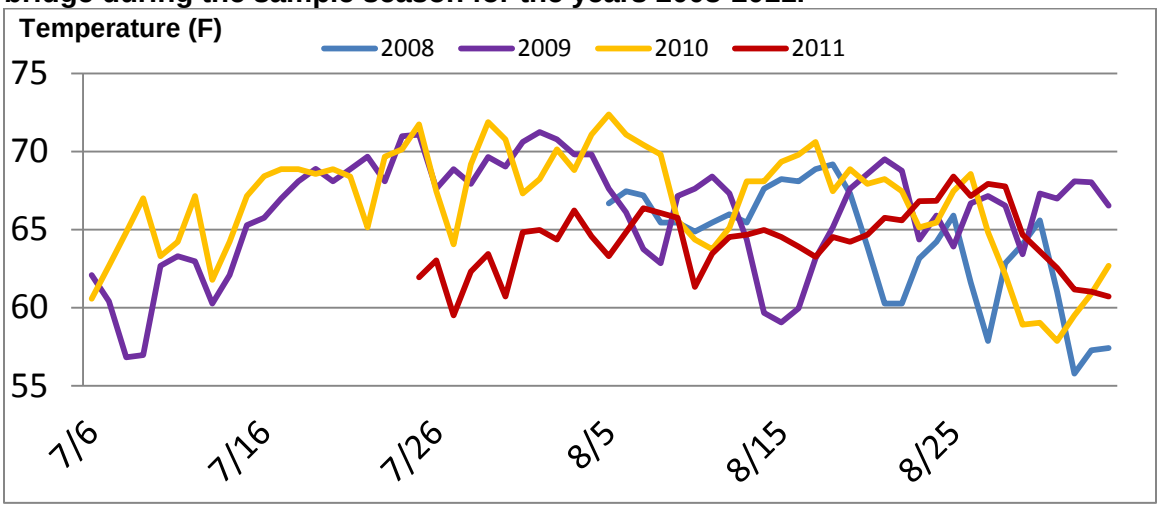
This graph illustrates dual seasonal minimums in the third week of September and the first week of October and precipitation events (peaks) in October. By mid October effects of irrigation use on streamflow have diminished as headgates are closed for the season.

Figure E.2. Streamflow data downstream of the Hwy 93 bridge 2007-2011.



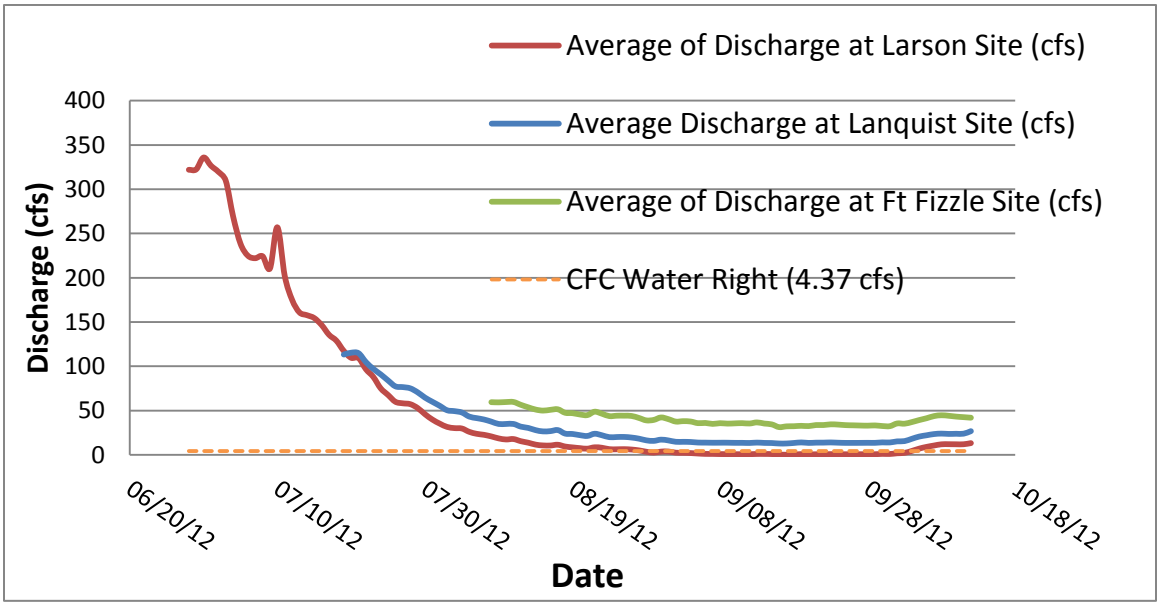
In 2007 point measurements were taken downstream of the railroad trestle (about ½ mile downstream of the HWY 93 bridge). Summer season flow minimums were no flow in 2007,13.6 cfs in 2008, 12.7 cfs in 2009, 12.2 cfs in 2010, 13.9 cfs. In 2011.

Figure E.3. Maximum water temperature at the Larson site downstream of Hwy 93 bridge during the sample season for the years 2008-2011.



The higher water flows during summer of 2011 resulted in cooler daily maximum temperatures than had been measured during periods without rain in other years. The seasonal maximums were as follows 69°F in 2008 (with limited data), 71°F in 2009, 72°F in 2010, 68°F in 2011.

Figure E.4. Streamflow (discharge rate) at three sample sites and Clark Fork Coalition leased base flow in 2012.



The Clark Fork Coalition water right of 4.37 cfs as measured at the Larson site below the Hwy 93 bridge is not adequate to assure Lolo Creek will remain connected to the Bitterroot River as shown in September 2012 when the creek became totally dewatered below the railroad trestle.

Figure E.5. Streamflow (Discharge rate in cfs) at three sample sites and Clark Fork Coalition leased base flow in late summer 2012.

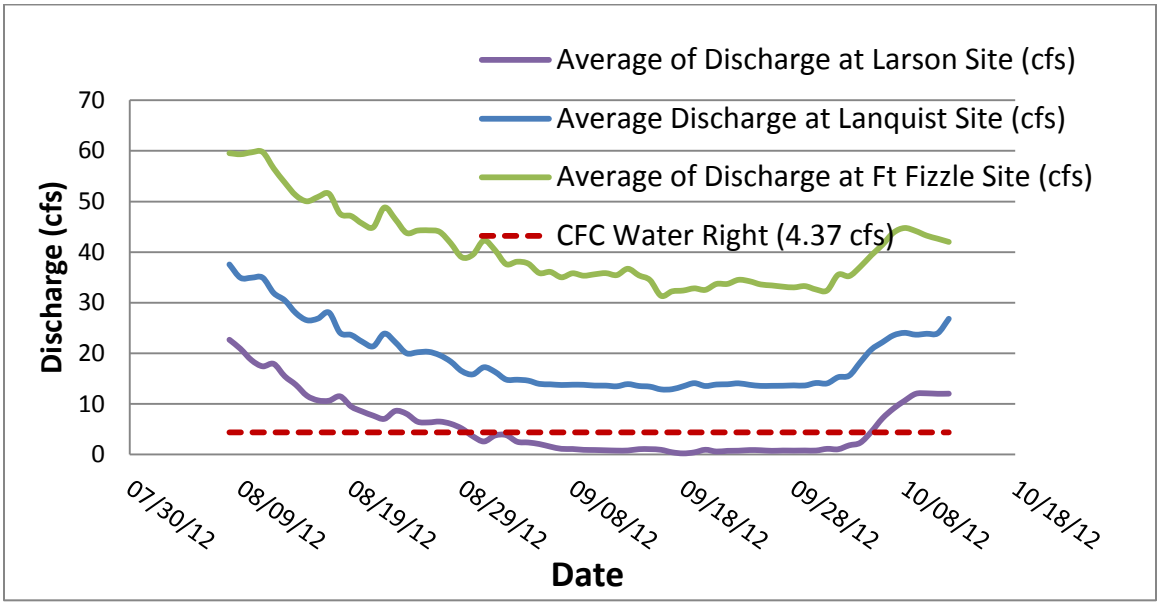
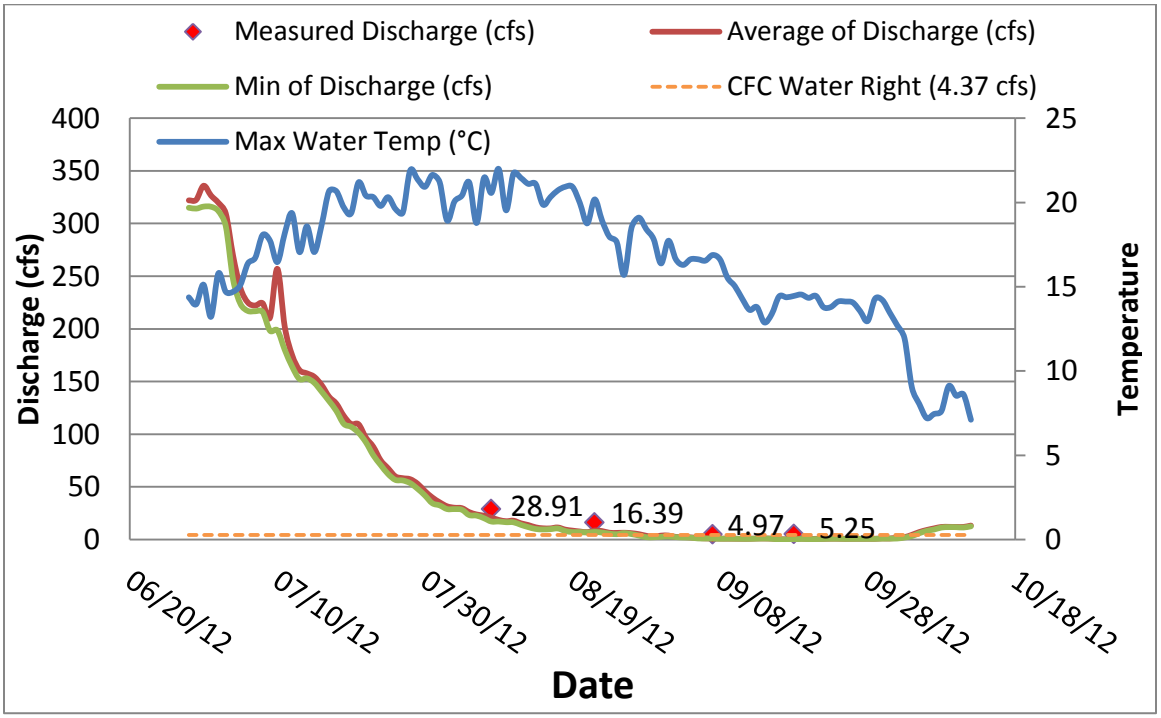


Figure E.6.Streamflow (Discharge rate in cfs) and maximum temperature at Larson site in 2012.



The maximum temperature reached at the Larson sample site downstream of the Hwy 93 bridge in 2012 was 71.6°F. The minimum discharge was .15 cfs on 9/16 and 9/17.

Appendix F. Lolo Creek Floodplain Mapping

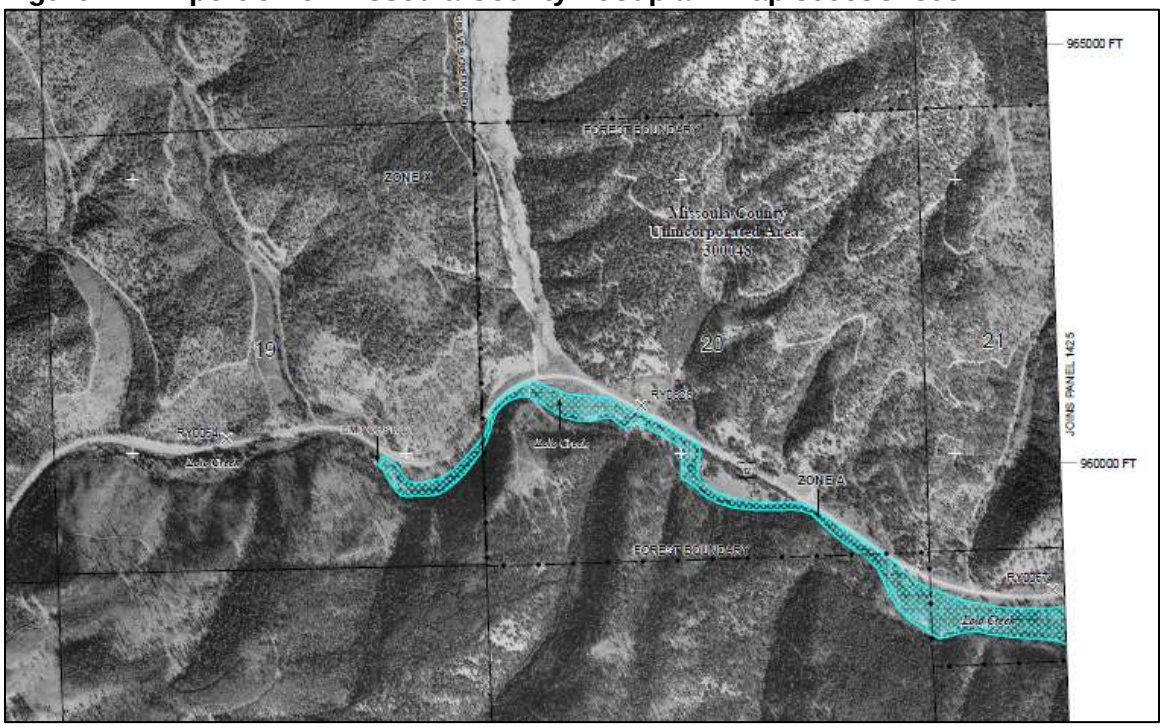
Floodplain maps can be obtained from the Missoula County Office of Planning and Grants Missoula, Floodplain Administration http://www.co.missoula.mt.us/opgweb/Floodplain/Floodplain.htm.

There is an index to the maps that make up the Missoula County area. The maps identifiers for sections including Lolo Creek are 30063C1395E, 1425E, 1450E, 1465C, 1730C, 1735C, and 1755C. These are large PDF files. This appendix includes screen capture close-ups of parts of the files for illustration. The image captures are oriented with north to the top of the image. Section lines can be seen on the images and used for reference to scale although the scale for each is different in as images were adjusted in scale to fit this document and allow best viewing of the Lolo Creek portion of the map.

The following information is taken from the legend included in the floodplain maps. (Federal Emergency Management Agency 2012) Areas outlined with blue lines and covered with blue dots. These are special flood hazard areas subject to inundation by the 1% annual chance flood. The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood. Areas with both blue dots and light cross hatch lines are Floodway areas in Zone AE. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

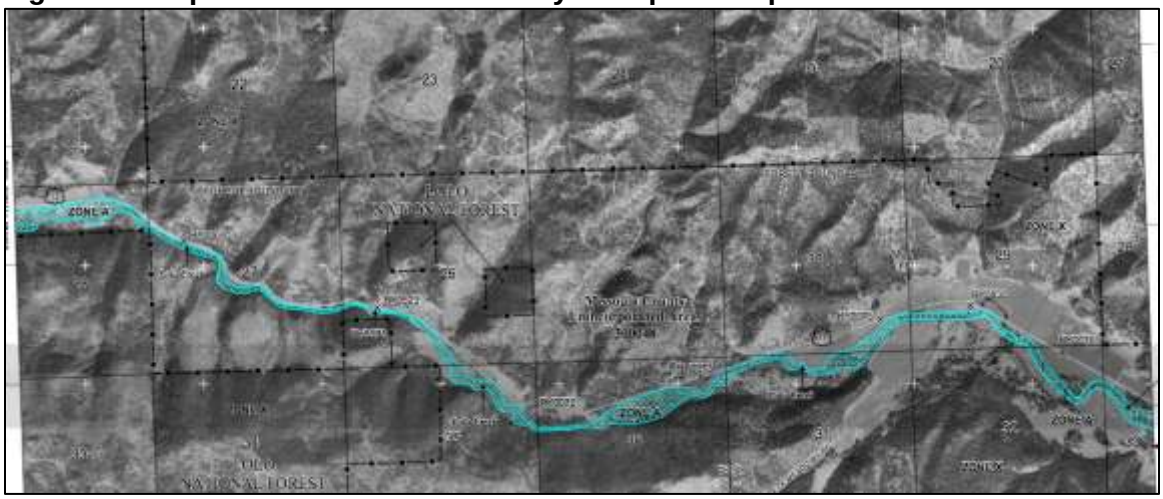
Of interest to the watershed restoration plan include residential development within Lolo Creek's floodplain and Highway 12 immediately adjacent to the floodplain in some areas.

Figure E.1. A portion of Missoula County floodplain map 30063C1395E.



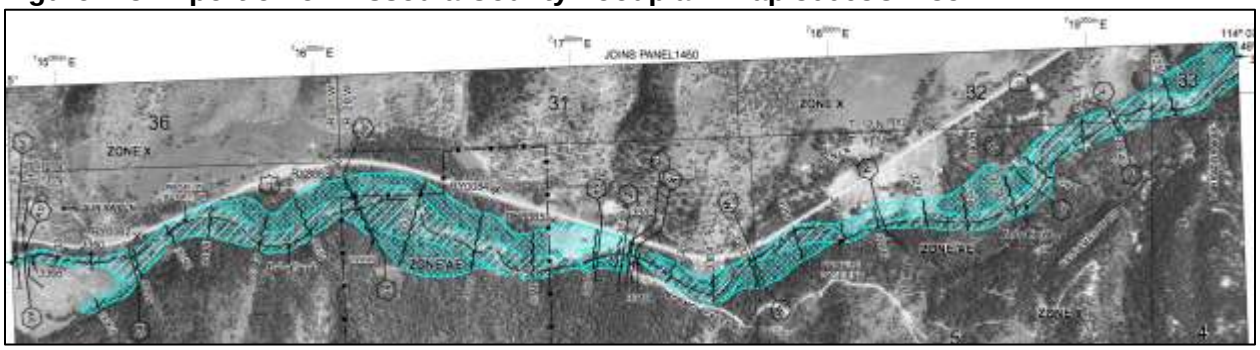
For reference, Grave Creek is the tributary running roughly north/south on the western edge of section 20 in the image above. Sections 19 and 20 are the only sections captured in this image. Highway 12 runs in an east to west direction across the image. Note the floodplain designation adjacent to the highway in some locations.

Figure E.2. A portion of Missoula County floodplain map 30063C1425E.



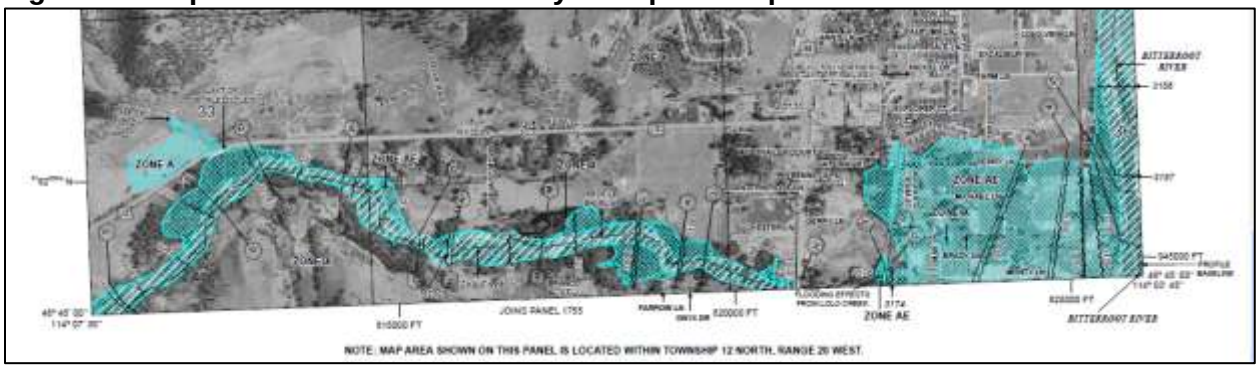
The Elk Meadow Road enters from the southwest through section 31 in the lower right quadrant of the image above.

Figure E.3. A portion of Missoula County floodplain map 30063C1735E.



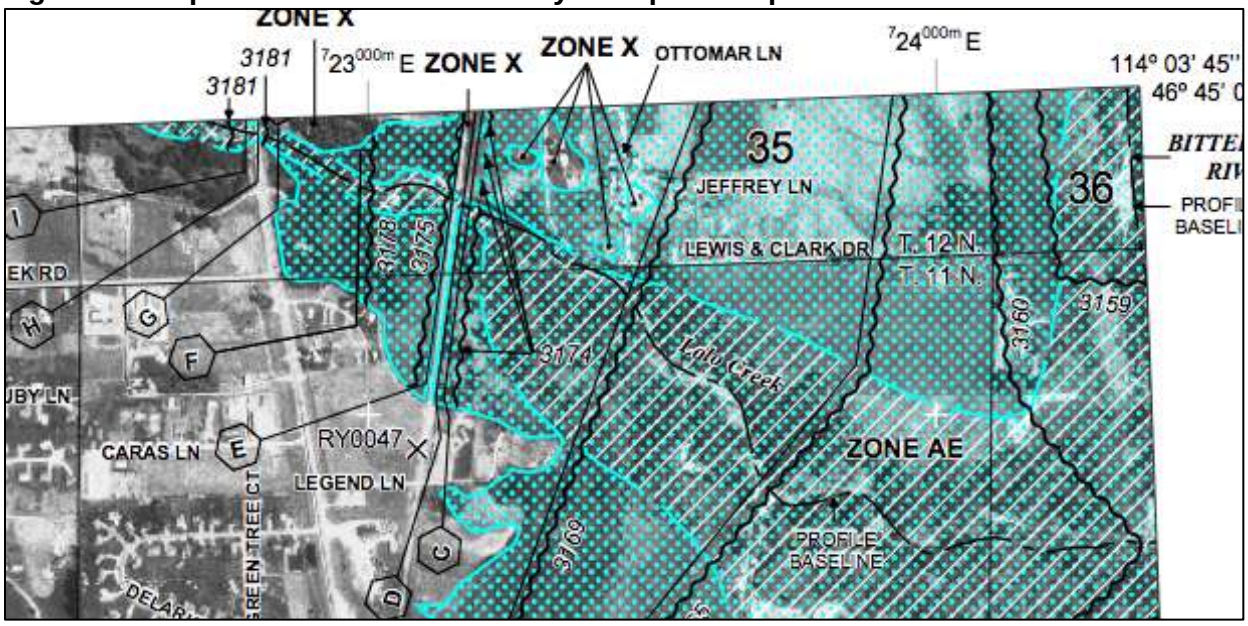
For reference, the bridge across Lolo Creek for the Mormon Ridge Rd is roughly in the center of this image.

Figure E.4. A portion of Missoula County floodplain map 30063C1465E.



This map illustrates lower Lolo Creek from Sleeman Creek's confluence to the point Lolo Creek passes under Highway 93. This segment of Lolo Creek passes through residential properties including properties that have taken bank stabilization actions.

Figure E.5. A portion of Missoula County floodplain map 30063C1755E.



For reference, Hwy 93 runs north/south in the western third of this image. There is a broad area of floodplain from Lolo Creek and the Bitterroot River on the east side of Hwy 93.

Appendix G. Lolo Creek Tributary Electrofishing Database 1996-2010

The following information is taken from Montana Fish Wildlife and Parks unpublished data collected from 2003-2011.

Table G.1. Lolo Creek tributary electrofishing database 2003-2011.

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
Bear Cr	1	7/7/2003	~200	3	10	10	5											
	2	7/7/2003	~200	17	4	26	4											
	3	7/7/2003	~150	17		6	1										X	
Camp Cr	1	7/8/2003	~150	25														
	2	7/8/2003	~100	15														
Cedar Cr	1	7/1/2009	~150	NO	FISH													
	2	7/1/2009	~250	NO	FISH													
Chief Joseph Gu	1	9/17/2003	200	4					5 fry									
Cloudburst Creek	1	9/24/2009	<100	7	42												X	
	2	9/12/3003	~300	8		22	2											
	3	9/16/2009	<100	6		91											X	
	4	9/12/2003	~200	4		24									DV 1		X	
	5	9/12/2003	~200	15		20	6		6				1					
	5-A	9/16/2009	<100	30		27	4										X	
Cooper Cr	1	7/23/20033	~150	16													X	X
	2	7/23/2003	~150	20														
Davis Cr	1	8/29/2003	~150	3					4									

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
East Fork Lolo Creek	1	9/3/2008	<100	22		15	7				2						X	
	2	8/20/2008	78	43		32	4			4				3				
	2-A	8/25/2010	93	28		19				3				5			X	X
	3	9/3/2008	<100	10		1	2										X	
East Fork Lolo Creek	4	9/3/2008	<100	10		3	2										X	
	5	8/7/2003	~150	11		3	2											
	6	9/29/10	100	35		20	8										X	
	7	9/3/2008	<100	11		2	1										X	
	8	8/25/2009	100	8		6											?	?
	9	8/24/2010	110	41		46											X	
	10	8/19/2008	157	32		27												
	10-A	9/3/2008	<100	2		5	1										X	
	10-B	8/7/2003	~175	22		23												
	11	9/3/2008	<100	6		11											X	
	12	9/29/2010	100	36		72											X	
	13	8/7/2003	~200	29		12											X	
	14	9/3/2008	<100	7		9											X	
	15	8/4/209	<100	2		99											X	
Un-named trib 1 East Fork Lolo Cr	1	8/16/2010	~700	29		59											X	
	2	7/14/2008	100	8		3											X	
	3	7/15/2008	94	13		8											X	

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
	4	7/15/2008	92	12		10											X	
	5	7/21/2008	100	2		22											X	
	6	7/22/2008	100	6		21											X	
	7	7/22/2008	100	1		34											X	
	8	7/23/2008	100	1		15											X	
Un-named trib 2 East Fork Lolo Cr	1	7/9/2008	100	14		20											X	
	2	8/4/2010	~600	86		73											X	
	3	7/10/2008	100	16		5											X	
	4	7/11/2008	100	4		5											X	
	5	8/5/2008	100	4		25											X	
	6	8/6/2008	100	3		23											X	
	7	8/7/2008	100	1		14											X	
Sally Basin Creek	1	8/12/2008	100	14		3											X	
	2	8/9/2010	600	10		12												
	3	8/11/2008	100	3		4											X	
	4	8/11/2008	100	10													X	
	5	8/12/2008	100	23		2											X	
	6	8/12/2008	100	14													X	
	7	8/13/2008	100	12													X	
Granite Cr	1	8/26/2003	150	24		36												
	1-A	9/10/2008	132	32		27	1										X	
	2	8/12/2009	100	18													?	?
	3	7/28/2010	~500	25		23											X	

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
	4	8/26/2003	~175	13		28		4					1					
	5	8/20/2009	80	4		3											?	?
	6	8/11/2009	100	2		4											?	?
	7	7/17/2008	100			3							4					
	8	8/26/2003	~200	9		2		5									X	
	9	8/11/2009	100	2													?	?
	10	8/10/2009	100	NO	FISH												?	?
Grave Cr	1	9/4/2001	~100		7	4	4									X		
	2	8/11/2003	~200	14		8											X	X
	3	8/11/2003	~50	8		7											X	
Howard Cr	1	8/4/2003	~175	21	1	8	2										X	
	2	8/4/2003	`125	13		5												
	3	9/17/2009	75	8		18											X	
	4	8/4/2003	~200	13		18	11										?	
	5	9/17/2009	100	7		34	1										X	
	6	8/4/2003	~175	33		46											?	
	7	9/16/2009	100	20		33												
	8	9/17/2009	100	19		22												
	9	8/24/2009	100	9		9											?	?
	10	8/25/2009	100	1		15											?	?
John Creek	1	8/29/2003	~150	NO	FISH												X	X
	2	8/29/2003	~100	NO	FISH												X	X
Johnny Creek	1	7/7/2009	>150	>30														
	2	8/17/2009	>100	17														
	3	8/17/2009	>100	18														

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
	4	7/7/2009	>150	NO	FISH													
Lee Creek	1	8/5/2003	~350	15		28	1											
	2	8/5/2003	~200	10		7												
	3	8/5/2003	~150			20												X
Lolo Creek Main Stem	1	8/27/2002	~100	2			14				1	9		34				X
	2	8/27/2002	~100				12			1	2	4		14				X
	3	8/8/2005	294			1	>94			>10	>50	>30		>171			X	
	4	8/12/2005	288			13	>90			>50	>70	>55		>150			X	
	5	8/15/2005	273			9	>105			16	145	3		>167			X	X
Lost Park Creek	1	8/18/2008	~100	18		3											X	
	2	8/19/2008	~100	15		9											X	
	3	8/5/2003	~200	23		16	2											
	4	7/8/2010	~300	12		14											X	
	5	8/25/2009	100	20													?	?
	6	8/7/2003	~200	15		5												
Marshall Cr	1	7/232003	100			15												
	2	7/23/2003	150			25												
	3	7/23/2003	100			20												
Martin Cr	1	9/17/2003	~200	1		5												
	2	9/17/2003	~200	3														
Mill Cr	1	8/14/2003	~150	39		14											X	
	2	8/14/2003	~150	41														
	3	8/14/2003	~100	23														X
Mormon Cr	1	7/11/2003	~200	7													X	
	2	7/23/2001	~150	9														

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
	3	7/23/2001	~150	8		7		4										
	3-A	7/11/2003	~200	17		11		4										
	4	7/11/2003	~200	9		28												X
Small Cr	1	7/1/2009	~100	NO	FISH													
Small Cr	2	7/1/2009	~100	NO	FISH													
S Fk Lolo Cr	1	7/22/2003	200	7		12	7						1					
	2	7/22/2003	150	11			3											
	3	8/20/2003	150	29				3										
	4	8/20/2003	150	43				3										X
	5	8/18/2009	100	35				10									X	
	6	8/18/2009	100	26				13									X	
Spring Gu	1	8/10/2009	100	17													?	?
Tevis Cr	1	7/22/2003	~200	22													X	
	2	7/22/2003	~200	10													X	
West Fk Buute Cr	1	7/23/2003	~150	15		8	2										X	
	2	7/29/2003	~175	15		16											X	
	3	7/29/2003	~200	9		59											X	
West Fk Lolo Cr	1	8/27/2008	100	25													X	
	2	7/8/2009	~125	14													X	
	3	9/4/2001	~100	7														
	4	7/8/2009	~175	14													X	
	5	9/16/2009	~100	22		14											X	
	6	9/4/2001	~100	19		10										X?		
	7	7/21/2010	~350			28												

Stream Name	Sec	Date	Sec Lgth m	WCT	RBT	EBT	LL	BULL	ONC	LNS	LND	MWF	BULLxEBT	WCTxRBT	other	SC	TF	SF
	8	9/4/2001	~100	14		5	2									X?		
Woodman Cr	1	7/11/2003	~175	13	3	2												
	2	7/11/2003	~150	11														

WCT = Westslope Cutthroat, RBT = Rainbow Trout, EBT = Brook Trout, LL = Brown Trout, Bull = Bull Trout,

ONC = Rainbow & Cutthroat (unidentified), LNS = long nose sucker, MWF = Mountain Whitefish, SC = Sculpin TF = Tailed Frog SF = Spotted Frog X indicates presence at a site. Not to be used for fish density estimate, but for species composition, abundance.

Appendix H. EPA Elements of the Lolo Watershed Restoration Plan.

All of the Problems/Concerns listed in the table below need immediate and continued attention. Land management agencies owning portions of the watershed will address many as funding is available. Items followed by two asterisks ** have been identified as high priority projects for the Lolo Watershed Group to address as funding is procured. Items marked with a single asterisk * indicate projects the watershed group considers priority but will be a secondary cooperator in initiating the project. Unmarked items indicate the Lolo Watershed Group may be a minor contributor without larger scale funding. These items are likely high priority for land management agencies, but current funding and staffing limit activity in the area. Maintaining flexibility in setting priorities is important as unknown opportunities may develop.

Table H.1 EPA Elements 1,3,4,6,7,and 8. of the Lolo Creek Watershed Restoration Plan

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Sediment-caused impairment in the Lolo Creek Watershed					
High Density of forest roads	Decommission unused	Agency or technical contractors $1500-$4K per mile	Rate of decommissioning is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates	Miles of roads decommissioned	Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.
Lack of BMP use in past	Update to current BMP standards	Agency and Technical contractors Highly variable (high) costs	Rate of bringing roads and logged areas to current standard is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates	Area of disturbed land brought to BMP standards	Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Traction sand use on Hwy 12 *	Monitor sand use, trap & recover excess	MDT cooperation for reporting. Part of MDT maintenance costs.	MT DEQ receives yearly reports on sand and salt use. LWG volunteers can visually monitor traction sand applied to creek or streambank beginning year 1.	Reduced sand and salt use as shown in annual MDT reports.	Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.
Monitor surface water quality **	Develop monitor team (coordinate with LNF)	Volunteer team or U of M student, research grant or volunteer and minigrant for equipment, mileage	Some monitoring will be conducted by LNF, rate of completion of monitoring projects depends on budget. LWG Year 1. Identify monitoring activities, write grant request for grad student coordinating with LNF. LWG Year 2-3. Fund graduate student work. Assist LNF with volunteer team.	Number of volunteer days spent monitoring.	Baseline values have been developed and teams determine geomorphic indicators of proper pattern, profile and dimension. Decrease in sediment noted in monitoring. Approaching TMDL values by stream segment.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Fisheries, wildlife, and water quality issues (other than sediment) in the Lolo Creek Watershed					
Fish passage barriers	Replace/remove limiting culverts	Technical agency expertise, $1-3,5K remove, up to $150K replace	Rate of barrier mitigation is determined by LNF budget and personnel availability. LWG will coordinate yearly for progress updates. LWG year 1 identify fish barrier within financial reach of grant obtained in partnership with LNF. LWG year 2 apply for grant, identify next possible barrier for mitigation. LWG year 3-5 continue as above, identify and apply for grants.	Grant funding obtained for fish passage barrier mitigation. Fish passage barrier location identified. Fish passage barriers removed.	Barrier numbers reduced and full range of age classes of native salmonids found
Fish entrainment in ditches *	Increase fish screen use, fish salvage	Volunteer team with technical lead, Screen costs $4-5K per cfs	LWG Year 1. Identify ditch and owner interested in fish screen. Develop a volunteer team willing to do maintenance. Work with FWP to obtain grant and install fish screen LWG Subsequent years. Identify additional sites for screens, continue to train and build maintenance volunteer team.	Ditches for which fish screening is appropriate are identified. Fish screens installed. Maintenance teams developed for each fish screen location.	Number of unscreened ditches is reduced and the full range of age classes of native salmonids found within Lolo Creek

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Dewatering **	Continue to monitor flows, obtain water rights for creek, improve irrigation efficiency	Continue to support Clark Fork Coalition monitoring, and water right lease program. Obtain grant to assist or coordinate.	Clark Fork Coalition is monitoring 3 sites on Lolo Creek. LWG – years 1-5 support CFC mission and encourage addition of more monitoring sites. Develop team to assist in data collection. Work with Watershed Education Network stream team.	Monitoring continued at current sites. Additional sites identified and funded. Stream teams work with CFC to monitor sites. Additional water rights obtained to maintain instream flow.	Lolo Creek remains connected to the Bitterroot River at all times.
Lack of woody debris *	Allow recruitment	Volunteer led public education on private land, $1-2K minigrant, BMP on public land	LNF will allow woody debris recruitment as part of BMPs. LWG – Year 1. Coordinate with education agencies and groups to obtain training materials on importance of woody debris. LWG – Year 2-5. Include in public education package about healthy streams. Encourage landowners to leave wood in stream.	Education package developed. Present package to landowners along Lolo Creek and its tributaries. Public lands reports indicate increased wood accumulation in streams.	Macroinvertebrate indicators show full support based on standard DEQ protocols and native salmonids through all age classes noted in surveys.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Low beaver activity *	Reintroduce beaver or enhance habitat	FWP change in trapping rule for Lolo, unknown costs. Habitat suitability study, $5K.	LWG Year 1. Coordinate with LNF and FWP to decrease trapping pressure on beaver in Lolo Creek, Year 2 - Monitor beaver population response to reduced trapping, prepare educational materials for public and identify areas for potential reintroduction. Year 3 – Continue monitoring population, consider reintroduction.	Beaver trapping quotas reduced. Beaver population monitoring in place. Public education package created and distributed. Suitable habitat locations identified. Population increase identified or reintroduction program in place	Beaver population has increased. Nuisance beaver activity is mitigated as needed.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Loss of meanders *	Allow meanders to develop, replace lost meanders	Volunteer led public education on private land, $1-2K minigrant, Replacing would take exceptional highway funding	Year 1 Identify disconnected meanders. Year 3 Identify landowners interested in having meanders reconnected. Watch for opportunities for bridging creek.	Meanders that could be reconnected are identified. Landowners willing to allow reconnection listed. Idealistically, bridge pairs in place over meanders.	Study to identify meanders that could be reestablished is complete and potential meander connections are prioritized should opportunity to reconnect present itself
Armoring for highway protection **	Soften with plantings, May also serve to aid in trapping traction sand.	Contracted stinger operator and volunteer planters, $5K MDT support	LWG – Year 1 identify potential planning sites and coordinate with MDT for potential funding to plant water loving shrubs along some armorer, channeled, segments where highway is close to stream.	Planting sites identified. Funding obtained for planting. Volunteer planting teams available. Miles of riprap planted.	Streamside plantings are complete with adequate survival to help catch sediment from traction sand use.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Additional concerns related to human activities					
Ground water quality *	Monitor	May be in Water Quality District capabilities.	LWG – request annual report of water quality data from wells in the watershed from Missoula County. Watch for grants dealing with ground water quality to use to initiate a study on pollution plume in lower Lolo	Water quality database in place. Reports indicate no decline in ground water quality.	No decline in water quality noted in ground wells throughout watershed.
Drought management **	Study effect of well use and Bitterroot River level on creek flow, educate	U of M student research project. Educate ($1-2K minigrant)	LWG Year 1 – Work with Watershed Education Network to develop or implement watershed model training materials for use in public meetings, and in elementary, and secondary schools. Look for data on ground water/surface water connection. LWG - Year 2 – apply for grant to fund student researcher. LWG – Years 3-5 develop a drought management plan to determine minimum flow needed to allow Lolo Creek to flow to its mouth and ground water use limitations needed in sustained drought.	Training package developed. Research student funded. Minimum flow requirements determined. Drought management plan developed and in place.	Lolo Creek remains connected to the Bitterroot River through drought periods.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Streambank erosion on private property **	Work with landowners, educate	Educate ($1-2K minigrant), stabilize by plantings coir logs Volunteer team within range of Conservation District riparian grant	LWG – Year 1. Identify streambank segments that would benefit from plantings for stabilization. LWG – Year 2. Apply for riparian planting grants or minigrants. Develop volunteer team to help with planting. LWG – Year 3-5. Continue stabilization at other sites.	Stabilization needs (locations) identified. Teams and funding in place tor plantings. Stabilization plantings conducted as needs funding become available.	Reduction in 310 permits issued for Lolo Creek.
Armoring to prevent channel migration on private property **	Soften with plantings, encourage alternatives	Contracted stinger operator and volunteer planters, $5K per day, Conservation District riparian grant	LWG Year 1. Identify site for planting, apply for CD riparian grant LWG Year 2. Plant site, identify next site for planting LWG year 3. Assess success, if adequate, apply for additional grants	Armored sites on private lands identified. Planting in place as owners request. New stabilization projects include vegetation to reduce armoring effects.	Reduction in armoring without plantings noted in stream walks.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Deicing chemical use	Work to MDT to monitor use	Within MDT scope of work	Obtain reports on deicer use yearly from MDT. LWG Year 1. Obtain weather data for past 5 years on Lolo Pass to compare to deicer use. LWG. Subsequent years. Continue data comparison of weather to deicer use.	Annual deicer use reports available. Historical weather database constructed. Weather to deicer and gravel use relationship determined.	Water quality testing shows no hazardous levels of deicer salts.
Future Plans					
Increase flow/temperature database **	Add more automated flow/ temp monitor sites	Develop volunteer team or coordinate with Clark Fork Coalition, $3-5K device costs per site	LWG – ongoing - continue to coordinate with Clark Fork Coalition. Assist to find resources to fund expenses for person to monitor additional sites. Equipment is available to add one site.	Stream teams trained and in place. Additional sites in routine monitoring for flow rate and temperature.	5 or more sites are being regularly monitored for flow rates and temperature.
Gaging station to capture maximum flows	Return USGS gaging station near historical location	Technical setup and maintenance, $2K for instrument, $16K/year maintenance	LWG will work with Missoula County Floodplain to look for opportunities to collaborate on obtaining a sustainable source of funding for a USGS gage.	Funding obtained. USGS gage installed. Maintenance funding obtained.	Gaging station in place with steady funding source for maintenance obtained.

EPA 1. Problems/Concerns	EPA 3. Measures needed to mediate problem	EPA 4. Technical and Financial needs	EPA 6. Timeline or Implementation Schedule	EPA 7. Measurable Milestones	EPA 8. Criteria to show goals are being met
Improve understanding of channel migration **	Obtain Channel Migration Zone (CMZ) data	Technical expertise and flight time requires large scale funding unless coordinated through another agency	LWG - Year 1. Identify agencies/contractors who could fund, obtain and analyze CMZ data. Locate maps, photos and satellite images for Lolo Creek to use in public education. LWG – Year 2. Encourage data collection	Public education package prepared. Historical information/ database developed. Funding for CMZ analysis procured. CMZ analysis completed.	Historical Migration Zone mapping complete, CMZ data obtained to allow final CMZ mapping.
Build Lolo Watershed Group Capacity **	Coordination with other groups, membership, Hire a half time executive director/grant writer.	Coordination with volunteer time, no cost. Half time director/grant writer $20K	See outline timeline in Chapter 7 for specific implementation goals for LWG.	Increase in public and agency participation in LWG meetings. Increase in membership donations. Funding adequate to hire executive director/grant writer.	LWG meetings well attended. LWG board membership is increased. Landowners, land management agencies and organizations work together to enhance watershed health.

EPA 2. Estimate of expected load reductions.

Table H.2. Estimate of expected load reductions (described in Montana DEQ 2011).

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (Percent Reduction)
Upper Lolo Creek Sediment TMDL (headwaters to Sheldon Creek)				
Roads		41	15	63%
Eroding Banks	**Anthropogenically Influenced**	863	362	28%
	Natural	897	897	
Upland Erosing	**All Land Uses**	1125	820	27%
Point Source	**Stormwater Construction**	0	7*	0%
Total Sediment Load		2926	2094	28%
Middle Lolo Creek Sediment TMDL (Sheldon Creek to Mormon Creek)				
Roads		84	31	63%
Eroding Banks	**Anthropogenically Influenced**	1762	740	28%
	Natural	1833	1833	
Upland Erosing	**All Land Uses**	2690	2086	22%
Point Source	**Stormwater Construction**	0	7*	0%
	Billingsley Placer Mine	0	0.4	0%
Total Sediment Load		6369	4690.4	26%
Lower Lolo Creek Sediment TMDL (Mormon Creek to the mouth of Lolo Creek)				
Roads		1.72	0.64	63%
Eroding Banks	**Anthropogenically Influenced**	37	16	28%
	Natural	37	37	
Upland Erosing	**All Land Uses**	199	122	39%
Point Source	**Stormwater Construction**	0	7*	0%
Total Sediment Load		275	176	36%

**The maximum allowable load under the constraints of the current Stormwater Construction permit.*

Table H.3. EPA 5. The educational and outreach goals, objectives and proposed tasks.

GOAL:	OBJECTIVE:	TASKS / ACTIVITIES:	PROPOSED PARTNERS	POSSIBLE FUNDING SOURCES
1. Increase public awareness & knowledge of impacts of human activities on the watershed	**a.** Develop community and school-based **educational programs, events and materials** that focus on non-point source pollution, BMPs, human impacts on water quality, water quantity, stream health, weeds and wildlife	Determine priorities; define audiences; develop content & messages; decide delivery mechanisms/methods; develop evaluation & assessment plan; collaborate with partners to obtain funding & maximize resources. Examples: field trips, landowner tours, booths at local fairs, publications, newsletters, presentations at public meetings, monitoring programs.	LWG, DEQ, LNF, MslaCD, FWP, RI, CFC, WQD, WEN, BWF, Weed District	DEQ, DNRC, Msla CD WQD Private foundations
	b. Provide guidance, references, resources and technical assistance to landowners, educators, partners & local organizations to facilitate use of BMPs	Promote & publicize stakeholder agencies/partners and their available resources (permitting, funding and technical expertise) at local meetings, venues & events; provide information on permitting processes; continue to assist landowners with 310 permits, cost-share grant proposals, weed district grants, etc	LWG, DEQ, LNF, MslaCD, FWP, WQD, CFC, DNRC, Weed District	

GOAL:	OBJECTIVE:	TASKS / ACTIVITIES:	PROPOSED PARTNERS	POSSIBLE FUNDING SOURCES
2. Increase public participation in citizen-based stewardship and conservation activities	**a.** Develop community and school-based **stewardship programs** based on high-priority restoration projects that advance overall watershed goals	Develop volunteer recruitment, training, recognition & retention plan; utilize research & activities that foster stewardship; set targets & timeline for volunteer rates; collaborate with partners to publicize & promote activities. Examples: same as above	LWG, DEQ, LNF, FWP, RI, CFC, , Msla CD, WEN, Trout Conservancy, BWF, TU, UM Watershed Health Clinic,	DEQ, DNRC, Msla CD WQD Private foundations
3. Expand organizational capacity of LWG	**a.** Increase visibility of the Lolo Watershed Group	Develop outreach and publicity plan that would: - Increase effectiveness of website - Update & improve content of website - Increase effectiveness of annual report - Schedule production & distribution of newsletter - Expand & maintain membership database - Consider use of a list-serve - Improve & maintain email list & format - Develop a media list: submit letters to the editor; non-profit round-up, business “getting ahead” blurbs, community calendars; record radio PSAs - Improve publicity efforts for meetings and events - Collaborate with partners on outreach, publicity, mailings, website links & articles, calendars etc.	LWG, CFC, RI, WQD, BWF, FVLT, Lolo Community Council, Friends of Lolo Peak, UM Watershed Health Clinic, Trout Unlimited, MT Forest Restoration Committee	DEQ, DNRC, Msla CD WQD Private foundations

GOAL:	OBJECTIVE:	TASKS / ACTIVITIES:	PROPOSED PARTNERS	POSSIBLE FUNDING SOURCES
	b. Increase effectiveness of Board of Directors	Develop board recruitment, training, recognition & retention plan; network with partners to improve training & increase participation & understanding of board duties & roles; maintain active board; host quarterly or bi-monthly meetings; establish committees to assure oversight & secure resources for the organization & projects; continue to host annual meeting with elections (as per bylaws)	LWG, BWF, MWCC, MT Non-profit Assn	DEQ, DNRC, Msla CD WQD Private foundations
	c. Increase effectiveness of Advisory Board	Develop communication plan to improve consistency & effectiveness of interactions with Advisory Board; solicit input & feedback on technical issues & documents; delineate roles & responsibilities; determine common goals; develop formal partnership agreements; collaborate to obtain funding, share resources, plan & publicize events, and distribute publications & information	LWG & Adv Bd members	
	d. Increase communication & collaboration with other partners and stakeholders	Develop communication plan to expand on relationships with partners & stakeholders; determine common goals; collaborate to obtain funding, share resources, plan & publicize events, and distribute publications & information	LWG & partners	
	e. Increase LWG membership base	Develop a membership recruitment & retention plan; continue to maintain database; conduct a membership drive; send annual renewal notices & follow-up; set targets & timeline for membership growth	LWG and partners	
	f. Increase attendance/participation at meetings and events	Establish regular meeting dates; track attendance; conduct evaluations and collect feedback at meetings & events; consider reminder emails and/or phone calls to increase attendance; set targets and timelines for meeting attendance rates	LWG and partners	

EPA 9. The Monitoring Component.

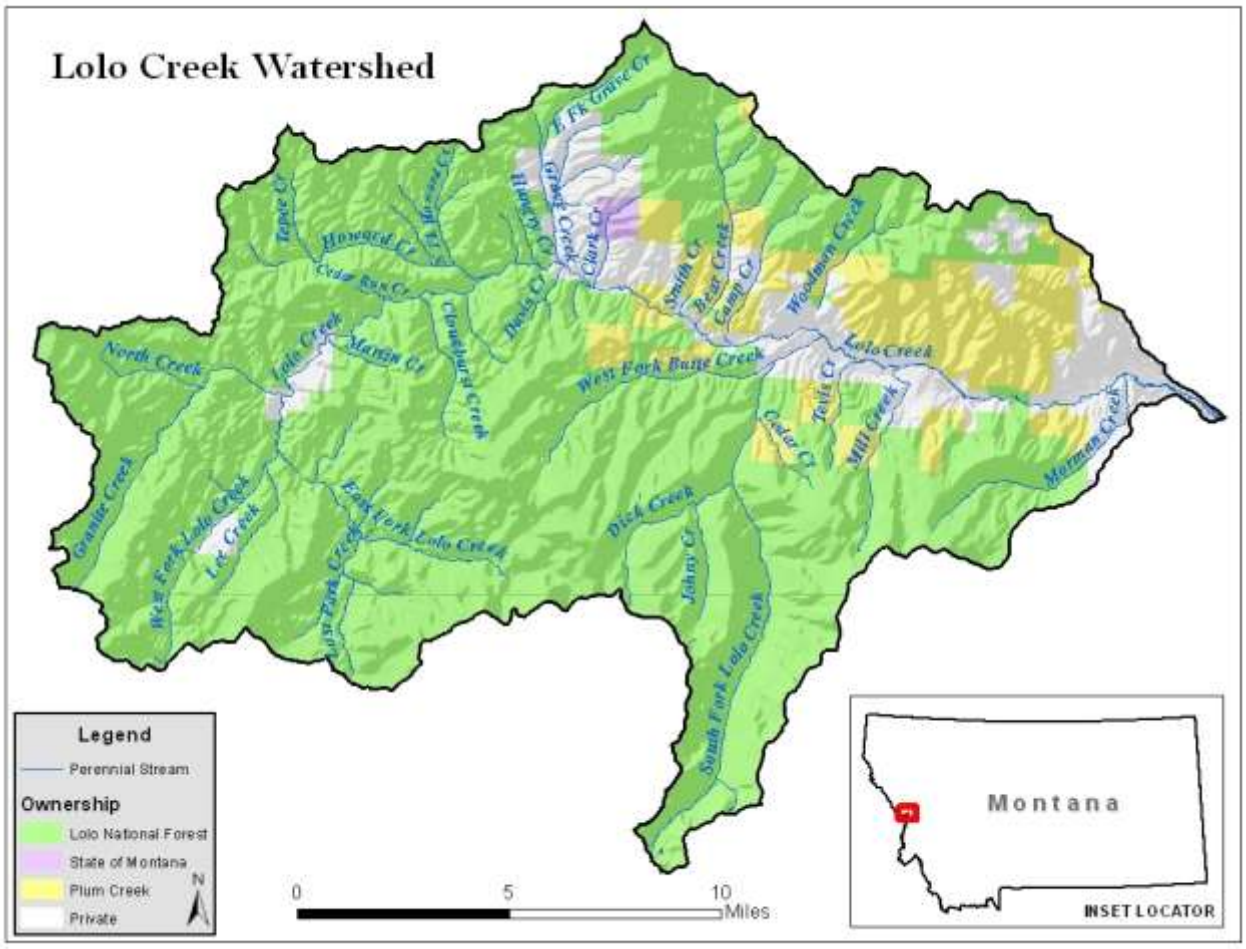
Upper and Lower Lolo Creek TMDL Planning Areas

1. Establish permanent bench-marked cross-sections
2. Collect particle size distribution data using Wolman pebble count procedures
3. Conduct a road sediment assessment using the Forest Road Survey (FRS)
4. Monitor for fish redds and fine sediment yearly
5. Monitor population status of native salmonid species
6. Update an assessment of channel conditions and other geomorphic indicators
7. Determine existing conditions and help track potential future impacts to tie in with future downstream TMDL development,
8. Track the effectiveness of BMPs on forest roads and US Highways
9. Develop a database on potential reference reaches with the TPA to help guide future target setting and evaluation
10. Use data and information to assist the current Clark Fork/Bitterroot modeling

Additional Monitoring for Lower Lolo Creek public and private ownerships

11. Continue stream flow and temperature monitoring
12. Establish a USGS gauging.
13. Track ground water quality values from public ground water wells
14. Monitor surface water quality
15. Track macroinvertebrate populations
16. Track fish populations
17. Maintain website

Appendix I. Lolo Creek Watershed Ownership Map



Appendix J. EPA's Nine Elements of a Watershed-based Restoration Plan (WRP)

The Environmental Protection Agency (EPA) fully intends that the watershed planning process should be implemented in a dynamic and iterative manner to assure that projects whose plans address each of the nine elements below may proceed even though some of the information in the watershed plan is imperfect and may need to be modified over time as information improves.

1. An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (2) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded stream bank needing remediation).
2. An **estimate of the load reductions expected for the management measures** described under paragraph (3) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (1) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded stream banks).
3. A **description of the NPS management measures that will need to be implemented** to achieve the load reductions estimated under paragraph (2) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
4. An **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. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant federal, state, local and private funds that may be available to assist in implementing this plan.
5. **An information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.
6. **A schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious.
7. **A description of interim, measurable milestones** for determining whether NPS 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 towards

attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (8) immediately above.

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