Lame Deer Creek Watershed Nine Element Plan

Northern Cheyenne Tribe
Rosebud County, Montana

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January 2024
Project 350.00804.000

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BIA	Bureau of Indian Affairs
CWA	Clean Water Act
EPA	Environmental Protection Program
EPD	Environmental Protection Department
FMP	Forest Management Plan
GPM	Gallons Per Minute
MDOT	Montana Department of Transportation
MFWP	Montana Fish Wildlife and Parks
MTNHP	Montana Natural Heritage Program
NCDEPNR	Northern Cheyenne Department of Environmental Protection and Natural Resources
NCUC	Northern Cheyenne Tribe Utilities Commission
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NWP	Nation Wide Permit
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USGS	United States Geographic Survey
WPP	Wetland Protection Plan
WQP	Water Quality Plan
WQS	Water Quality Standards

1.0 INTRODUCTION

1.1 PURPOSE AND BACKGROUND

NewFields Companies LLC (NewFields) has prepared this Lame Deer Creek Watershed Nine Element Plan (Plan) for the Northern Cheyenne Tribe (Tribe) to address the Environmental Protection Agency's (EPA) key elements critical for achieving improvements in water quality. The EPA's nine key elements are:

- Element 1: Identification of causes and sources of impairments
- Element 2: Estimate pollutant loading into the watershed and the expected load reductions
- Element 3: Describe management measures that will achieve load reductions and targeted critical areas
- Element 4: Estimate the amounts of technical and financial assistance and the relevant authorities needed to implement the plan
- Element 5: Develop an information/education component
- Element 6: Develop a project schedule
- Element 7: Develop interim, measurable milestones
- Element 8: Identify indicators to measure progress and make adjustments
- Element 9: Develop a monitoring component

This Plan will provide a framework for managing efforts to both restore water quality in degraded areas and protect overall watershed health. The Tribe recognizes that the quality and health of Lame Deer Creek directly affects the quality and health of the community, therefore, ***the overall goal for this WRP is to restore Lame Deer Creek to function as a Class 1 Cold Water Fishery.***

The goals and objectives for this Plan are derived from the EPA approved Northern Cheyenne Reservation water quality standards (2023) and the Northern Cheyenne Reservation Nonpoint Source Assessment (2021). The Assessment states that, "*Lame Deer Creek cannot attain or maintain Northern Cheyenne Tribal Water Quality standards, particularly those pertaining to beneficial and designated uses of the drainage as a cold-water fishery, without the control of nonpoint sources of pollutants into the drainage and improvements in instream flows*."

Lame Deer Creek is located in the southern portion of Rosebud County on Northern Cheyenne Reservation land between the Tongue River to the south and the Rosebud River to the north as shown on **Figure 1**. The Plan will describe the larger Lame Deer Creek Watershed before narrowing the focus to the Lame Deer Creek Subwatershed level.

In 2008, the Tribe developed a Water Quality Program under Section 106 of the Clean Water Act (CWA) and a Nonpoint Source Program operating under Section 319 of the CWA to address the cause and source of water quality impairments. Under these programs, physical, chemical, and biological data have been collected at eight designated monitoring sites throughout the Lame Deer Creek Watershed for over a decade (**Map of Monitoring Points, Appendix B**). The creek is not included on the Montana Department of Environmental Quality (MTDEQ) list of impaired waterbodies (MTDEQ, 2016). However, the Tribe adopted surface WQS for the Northern Cheyenne Reservation (Reservation) that were approved by EPA in 2013. Under the Reservation WQS, the mainstem of Lame Deer Creek is classified as a Class 1 Cold Water Fishery and based on these standards, Lame Deer Creek cannot meet the beneficial and designated uses which are to , “provide for protection, propagation and growth of Salmonid fishes, as well as protection, growth and propagation of associated aquatic life normally found where summer water temperatures do not often exceed 20 degrees Celsius (C).” (WQS, 2023).

The Tribe Environmental Protection Department (EPD) prepared a 2021 Nonpoint Source Assessment (Assessment) (NPS Assessment, 2021) for Lame Deer Creek summarizing the decade's worth of water quality data. The goal of the Assessment was to describe impairments to the Lame Deer Creek caused by nonpoint source pollution and recommend solutions for improving water quality. The results of the Assessment and other supporting documents referenced here, have laid the foundation for the Plan priorities, goals, and objectives.

1.2 Plan Outline

This Plan describes the EPA’s nine key elements critical for achieving improvements in water quality and are found under the following sections:

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- **Section 3.0** identifies four priority reaches, classified by the limiting factors contributing to poor water quality. Each priority reach identifies the pollutant cause, the impairment, and the source (Element 1) followed by the associated water quality goals and objectives (Element 2). Lastly, the section identifies the Nonpoint Source (NPS) management measures effective at meeting water quality goals and objectives (Element 3).
- **Section 4.0** delves into the logistics of implementation by laying the grounds for a technical approach and providing a guide to the financial resources required to meet implementation needs.
- **Section 5.0** describes an education and outreach strategy, recognizing direct ways the community can improve watershed health.
- **Section 6.0** provides a general implementation schedule of specific tasks that will accomplish management measures within the targeted year of completion.
- **Section 7.0** will describe the milestones developed under this WRP that will track progress toward meeting water quality goals and objectives (Element 7), followed by the evaluation criteria that will determine if the implementation is a success or requires modifications (Element 8).
- **Section 8.0** provides a framework for continued water quality monitoring that measures the limiting factors contributing to poor water quality.

2.0 DESCRIPTIONS OF THE WATERSHED

Lame Deer Creek Watershed is located in the southern portion of Rosebud County, Montana on the Northern Cheyenne Tribe Reservation (**Figure 1** and **Figure 2**). The watershed and area of study (Study Area) lies between the Tongue River to the east and south and Rosebud Creek to the west and north. The Tongue River Watershed and its tributaries drain approximately forty percent of the eastern Reservation, while Rosebud Creek Watershed drains sixty percent of the western Reservation land area.

The Lame Deer Creek Watershed contains four major drainages, the South Fork Lame Deer Creek (10 stream miles), East Fork Lame Deer Creek (5 stream miles), Alderson Creek (7 stream miles), and Lame Deer Creek (16 stream miles) (**Figure 3**). Altogether, the Lame Deer Creek Watershed covers approximately 82 square miles and drains into Rosebud Creek. From the confluence of Lame Deer Creek, Rosebud Creek meanders northeast for 111 miles to the confluence of the Yellowstone River (**Figure 3**).

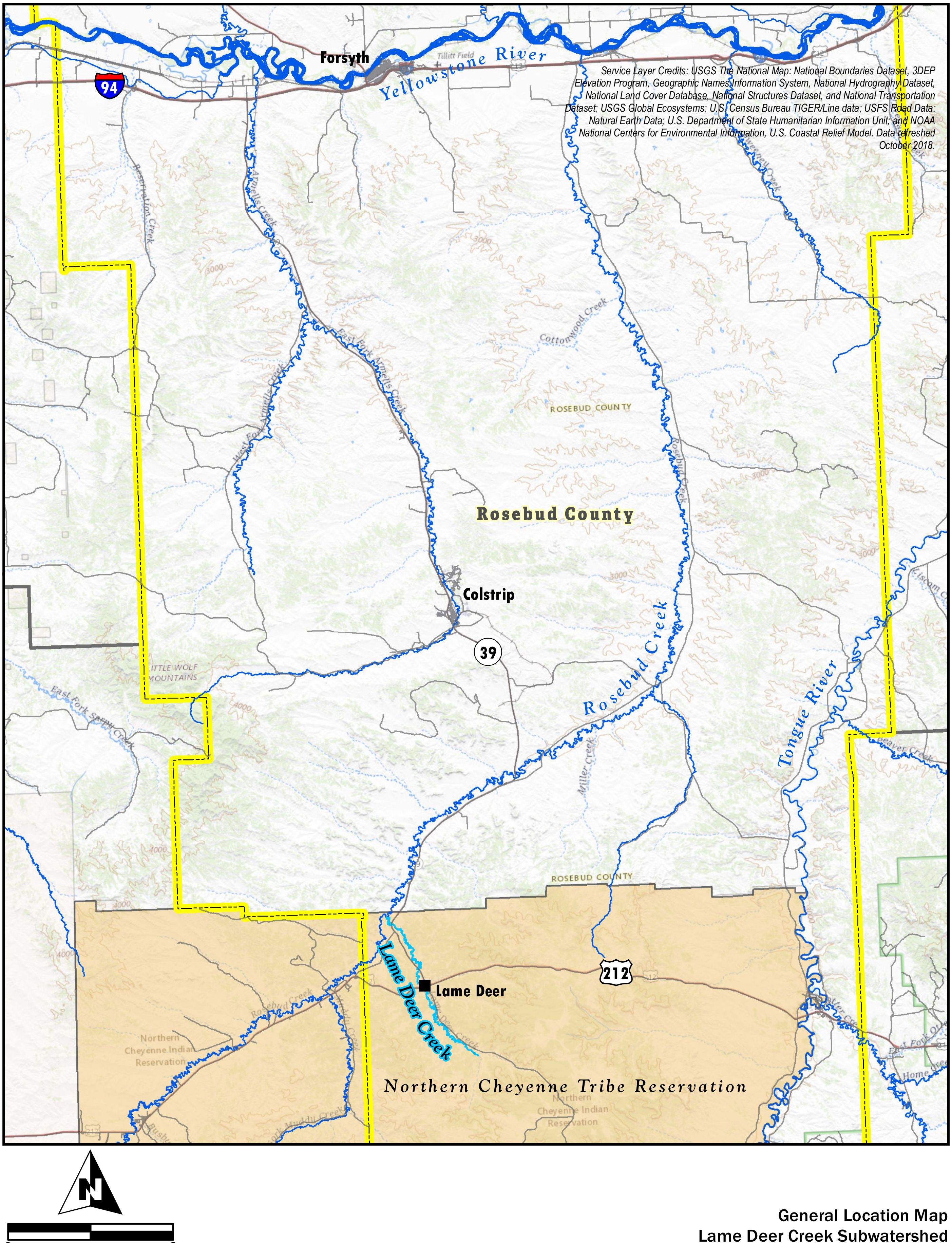
Other than the permitted point source pollution at the Lame Deer Lagoon within the townsite of Lame Deer, most of the water pollution on the Reservation is nonpoint source in origin (NPS, 2023). Agriculture (livestock grazing and crop production) and some hydrologic modifications (beaver dams, and irrigation ditches) are the major contributors to nonpoint sources of pollutants that impair Lame Deer Creek.

2.1.1 Climate

Lame Deer Creek Watershed is within the Sedimentary Plains East Montana Rangeland Resource Unit number 58AE and Northern Rolling High Plains major land resource area (MLRA) number 58A. Climate within the Study Area characterized by cold and dry winters, hot summers, low humidity, light rainfall, and ample sunshine (USDA, 2003). Seasonal precipitation is typically a limiting factor for plant growth. Evaporation or evapotranspiration typically exceeds precipitation, a condition typical of semiarid areas.

The passage of mid-latitude storm systems is characteristic of the climate in this area; day to day weather changes can be quite extreme because of the migrating systems (NRCS, 2022). Winter cold spells are often interrupted by periods of warmer weather. Most of the rainfall occurs during frontal storms early in the growing season, in May and June (NRCS, 2022). Some high-intensity, convective thunderstorms occur in July and August, and some rain occurs in autumn. Precipitation in the winter occurs as snow. The freeze-free period averages 155 days and ranges from 105 to 165 days, decreasing in length with elevation (NRCS, 2022).

The nearest weather station with available data to Lame Deer Creek Watershed is in Colstrip, approximately 20 miles north of Lame Deer (NOAA, 2023) at an elevation of 3,218 feet above mean sea level (amsl). The elevation of Lame Deer is 3340 feet amsl. Climate data for the area (Colstrip weather station) are summarized in **Table 1**.



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General Location Map
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 1

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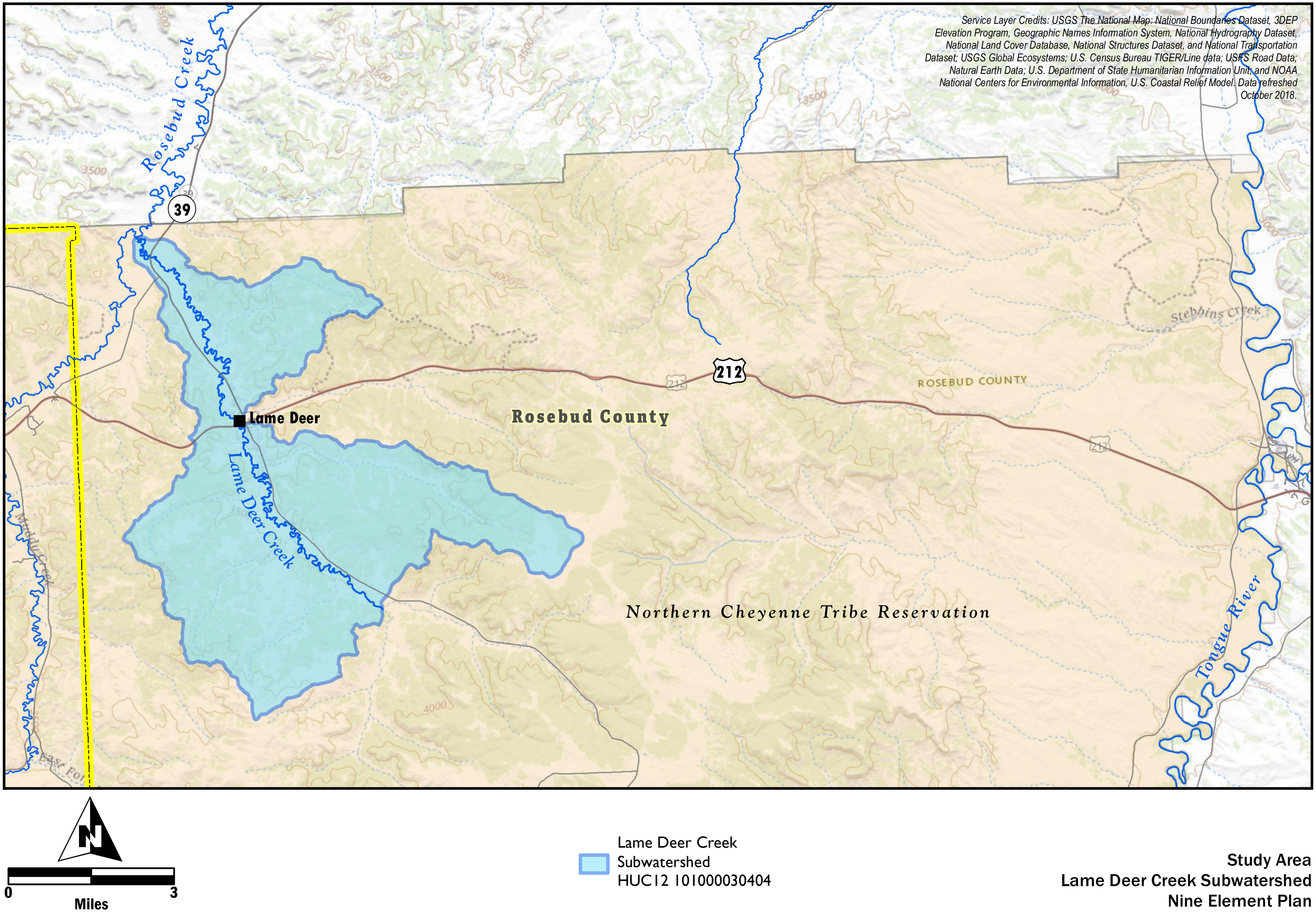

Lame Deer Creek Subwatershed HUC12 101000030404

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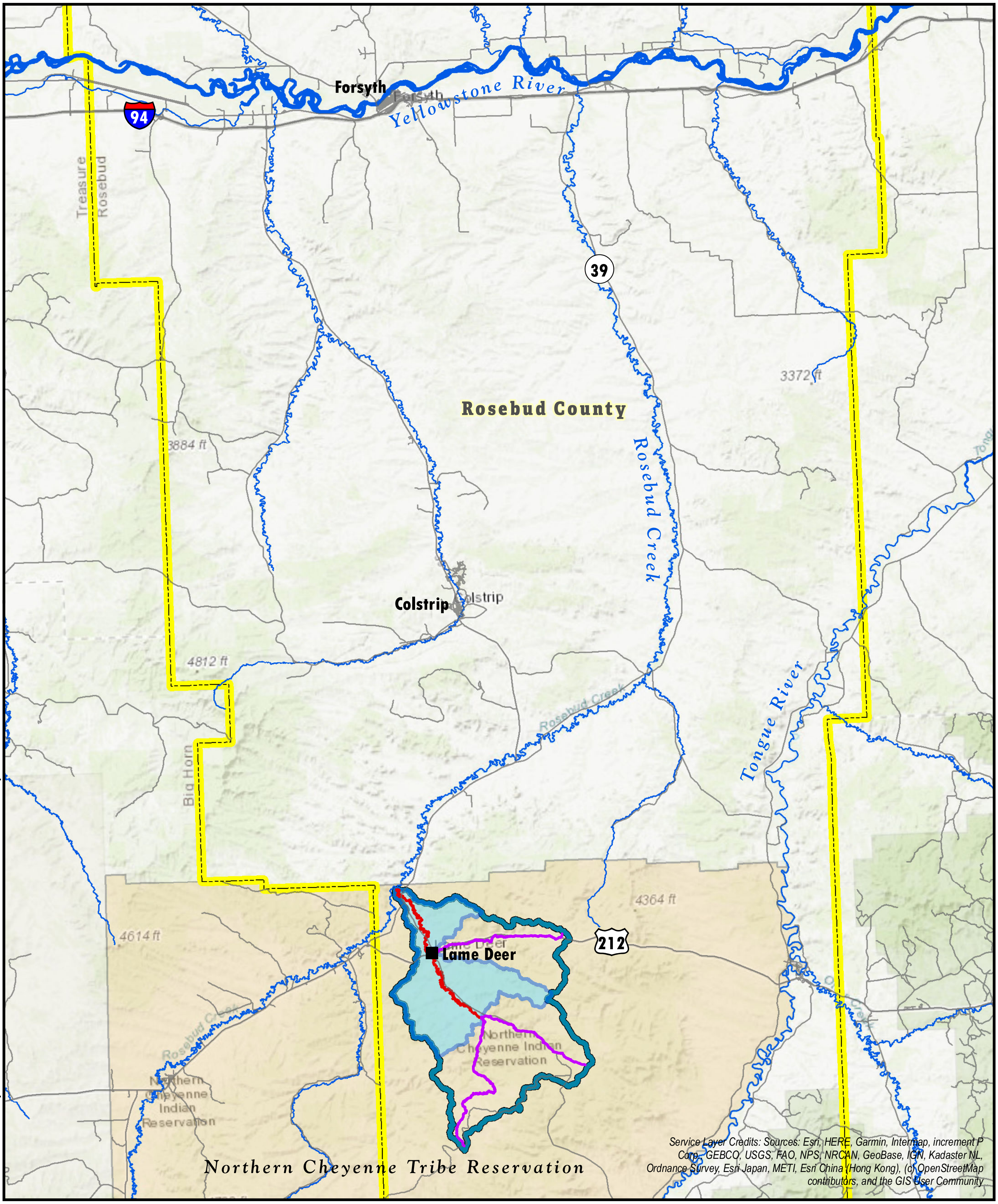
Study Area
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 2



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Lame Deer Creek Watershed HUC10 1010000304

Lame Deer Creek Subwatershed HUC12 101000030404

Lame Deer Creek

Lame Deer Creek Tributaries (East Fork Lame Deer Creek, South Fork Lame Deer Creek, Alderson Creek)

Lame Deer Creek Watershed
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 3

Table 1. Climate Data Summary

Average Total Annual Precipitation (inches)	Average Total Annual Snowfall (inches)	Annual Average High Temperature (degrees Fahrenheit)	Average Annual Low Temperature (degrees Fahrenheit)	Maximum Temperature Recorded in August, 1961 (degrees Fahrenheit)	Minimum Temperature Recorded in February 1936 (degrees Fahrenheit)
19.4	45.7	86	12	111	-50

Source: National Oceanic and Atmospheric Administration (2023).

2.1.2 Culture

The Tsis tsis' tas people of the Northern Cheyenne Reservation have been stewards of the land for thousands of years. They have worked hard to balance ecosystem health, management, and Tribal needs.

The Northern Cheyenne people have a spiritual connection to the natural world and a strong desire to preserve, protect, and restore the sacred land for future generations. An example of this is the traditional ways they have managed and preserved wetland areas out of respect for their botanical and water resources. During an interview conducted for the 2021 Lame Deer Creek NonPoint Source Assessment (NPS Assessment, 2021), Tribal elder Jules Spang Sr. commented that their people historically used burning to manage riparian areas. The Northern Cheyenne people recognize several hundred species of plants used for food, medicine, and religious purposes. The Tribe's Culturally Significant Plant list contains 72 plant species with Wetland Indicator Status (NCT WQP, 2021).

2.1.3 Fishery

In 2021 Tribal elder, Jules Spang, Sr. (80 years old at the time of interview) described Lame Deer Creek Watershed as a stream system that supported a functional fishery when he was a child. Prior to 1940, natural springs fed Lame Deer Creek at a rate sufficient to support a cold-water fishery from the headwaters to the confluence with Rosebud Creek. Tribal elders recall an intact riparian area without stream bank erosion (NCT, 2022b). However, in the late 1940's the Bureau of Indian Affairs (BIA) used explosives to increase flow in Lame Deer Creek. This permanently altered the hydrology of the system resulting in unintended decreases in stream flow (NCT, 2022b).

According to the Northern Cheyenne Tribe WQS, Lame Deer Creek is a Class I Cold Water Fishery with salmonoid propagation and growth listed as a designated use (NCT, 2022a). While conducting the Assessment in 2021, macroinvertebrate biodiversity was evaluated at nine sites within a 14.2-mile stream reach. At the time of the Assessment, fish were absent at all nine sites evaluated within the watershed (NCT, 2022b). According to a *Water Quality Assessment Report* (2020) prepared by EPD, water temperatures in Lame Deer Creek within the sampling period ranged from 50 degrees Fahrenheit (˚F) in late September to 82˚F) in late July. The optimal temperature for trout species in Montana is approximately 55 to 65 ˚F (MT Trout Unlimited, 2021). If temperatures remain above 68 degrees (˚F) for an extended period, trout may die.

Lame Deer Creek and associated tributaries within the watershed are within the Great Plains Intermittent Stream Ecosystem characterized by small, intermittent to perennial prairie streams that originate in the sedimentary high Northwestern Great Plains and foothills (Stagliano, 2005). This community is widely distributed throughout coulees, small first to third order streams, and headwaters of small or medium prairie streams. Streams of this ecosystem are typically small, warm-water intermittent streams that contain interrupted pools or fishless isolated pools due to climatic factors or land use change (Stagliano, 2005). Throughout the range, streams are characterized by short to long (2 to 25 meters long) pools that may be vegetated with silted gravel to cobble substrates (Stagliano, 2005).

Fishless pools provide important amphibian breeding and rearing habitat in otherwise dry, upland conditions. These pools are important for Montana Species of Concern[1] that could inhabit the area, such as the Great Plains Toad (*Anaxyrus cognatus*) and northern leopard frog (*Rana pipiens*) (Stagliano, 2005). In perennial streams, fish communities within the Rosebud and Lame Deer Creek watersheds are generally dominated by the Core Prairie Stream Assemblage, which include medium to large warmwater river fish and medium warmwater river fish to large stream fish assemblages such as shorthead redhorse (*Moxostoma macrolepidotum*), common carp (*Cyprinus carpio*), stonecat (*Noturus flavus*), fathead chub (*Platygobio gracilis*), white sucker (*Catostomus commersonii*), fathead minnow (*Pimephales promelas*), and longnose dace (*Rhinichthys cataractae*). Fathead minnows are typically the dominant species, with the occasional pioneering white sucker present in large pools. In vegetated ponds, brook stickleback (*Culaea inconstans*) may also be present (Stagliano, 2005). Small stock ponds, dams, and cattle intrusions have had the most significant negative impact on this aquatic community (Stagliano, 2005).

According to Montana Natural Heritage Program (MTNHP) data (2023), generalized observations within Lame Deer Creek watershed include lake chub (*Couesius plumbeus*), stonecat, white sucker, brassy minnow (*Hybognathus hankinsoni*), brook stickleback, common carp, and fathead minnow. MFISH is a database and interactive map created by Montana Fish, Wildlife, and Parks (MFWP) to display hydrologic and fisheries information across Montana. Available data is limited within the Lame Deer Creek watershed. An electroshock fish survey conducted by MFWP on Lame Deer Creek (stream mile 6.5; north of Lame Deer townsite) in 2007 found fathead minnow (MFWP, 2023a). Similarly, a survey on Alderson Creek (stream mile 5.2 from confluence of Lame Deer Creek) in 2007 found numerous fathead minnow and at least 18 observations of brook stickleback (MFWP, 2023a).

The most common species of fish identified in Rosebud Creek include channel catfish (*Ictalurus punctatus*), common carp, flathead chub, longnose dace, northern pike (*Esox Lucius*), sauger (*Sander canadensis*), shorthead redhorse, and white sucker (MFWP, 2023a). According to a fish survey conducted by MFWP in 2000 at the confluence of Mud Draw on Rosebud Creek (stream mile 100 from the Yellowstone River confluence; approximately 12 stream miles downstream of the confluence of Lame Deer Creek at river mile 111), the following fish species and counts were recorded: common carp (1), northern pike (5), shorthead redhorse (32), stonecat (8), and white sucker (2).

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[1] Species of Concern are native taxa that are at-risk due to declining population trends, threats to their habitats, restricted distribution, and/or other factors. Designation as a Montana Species of Concern or Potential Species of Concern is based on the Montana Status Rank and is not a statutory or regulatory classification. Rather, these designations provide information that helps resource managers make proactive decisions regarding species conservation and data collection priorities.

According to a National Pollutant Discharge Elimination System (NPDES) Renewal Permit issued by EPA in 2018 for the Lame Deer Lagoon facility, early life stages of salmonid and non-salmonid fish species are assumed to be present in Lame Deer Creek year-round based on dissolved oxygen concentrations at the site. Early life stages include all embryonic and larval stages and all juvenile forms of fish to 30-days following hatching (EPA, 2018).

2.1.4 Geology

Lame Deer Creek Watershed is in the Missouri Plateau and Northwestern Great Plains, Pine Scoria Hills ecoregion, which is characterized by wooded, rugged, broken land with stony hills and plateaued ridges and summits (EPA, 2023). The surrounding landscape is heavily dissected and contains very pronounced features of relief that are expressive of the differences in type of rock structure and resistance to erosion (USGS, 1929). Topographic relief within the watershed is approximately 1,115 feet with an elevational range of 3,150 feet amsl at Rosebud Creek to 4,265 feet amsl along the plateaued ridges.

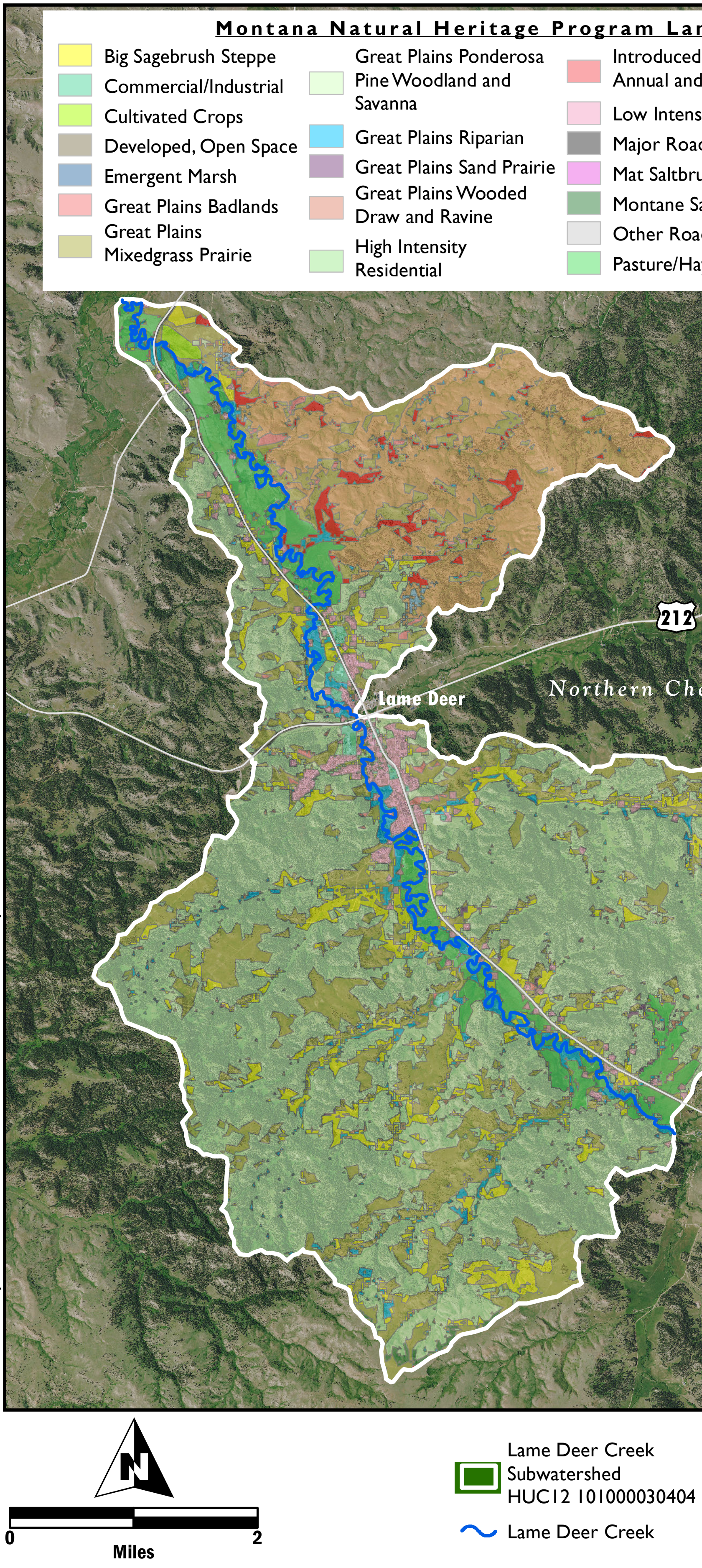
Terrace gravel of the Tertiary and Pleistocene age is present on many of the higher hills (USGS, 1929). Alluvium and rocky, gravelly colluvium are common. The Pine Scoria Hills ecoregion is encompassed by the Central Grasslands ecoregion, which is an unglaciated plain that is dissected by numerous small, ephemeral or intermittent streams that are underlain by noncarbonate, fine-grained sedimentary rock of the Tertiary Fort Union Formation (EPA, 2023). Underlying this area are Paleogene and Neogene continental shales, siltstones, and sandstones (NRCS, 2022).

Numerous coal seams are present beneath the soil, often breaking through the soil surface as seen along Highway 212 between Lame Deer and Ashland. It is estimated that the Reservation sits at 23 billion tons of coal, which formed around 60 million years ago when the land began to rise from a shallow sea (Larson, 2022).

2.1.5 Land Cover

The Lame Deer Creek subwatershed encompasses approximately 18,744 acres, of that, the Great Plains Ponderosa Pine Woodland and Savanna Forest and Woodland system dominates 53 percent (approximately 10,001 acres) (see **Figure 4**). Common understory associates include Rocky Mountain juniper (*Juniperus scopulorum*), western snowberry (*Symphoricarpos occidentalis*), skunkbush sumac (*Rhus trilobata*), and native grassland species. Frequent low-intensity surface fires are common within this system due to generally sparse understories and the accumulation of litter at the base of mature trees (MNHP, 2023). Much of the forested areas within the Lame Deer Creek Watershed have been commercially harvested or burned. Approximately 12 percent (2,221 acres) of land cover is recently burned forest and shrubland or post-fire recovery areas (MTNHP, 2023).

Sagebrush Steppe systems comprise 8 percent (approximately 1,516 acres) of the subwatershed (see **Figure 4**). The shrub components of this system are generally dominated by mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*). Other co-dominant shrubs include silver sagebrush (*Artemisia cana*), three tip sagebrush (*Artemisia tripartite*), antelope bitterbrush (*Purshia tridentata*), and associated graminoid species such as Idaho fescue (*Festuca idahoensis),* spike fescue *(Leucopoa kingii*), and poverty oatgrass (*Danthonia intermedia*).



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Land Cover
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 4

Great Plains Mixed grass Prairie comprises 15 percent (approximately 2,814 acres) of the subwatershed, including components of Great Plains Sand Prairie and Rocky Mountain Lower Montana Grasslands. Grasses typically comprise the greatest canopy cover, and western wheatgrass (*Pascopyrum smithiii*) is usually dominant. Common plant associations include big sagebrush-western wheatgrass. Human land use comprises approximately 8 percent (1,447 acres) of the watershed which includes agriculture and development (MTNHP, 2023). Less than 1 percent of the subwatershed is comprised of sparsely vegetated, barren areas and badland features.

Approximately 4 percent (670 acres) of the land cover is wetland and riparian systems. This includes Great Plains Riparian, Great Plains Wooded Draw and Ravine, and a small component of Emergent Marsh. Great Plains Riparian systems are associated with perennial to intermittent or ephemeral streams and tributaries of the Yellowstone and Missouri River floodplain. The primary inputs of water to these systems include groundwater discharge, overland flow, and subsurface interflow from the adjacent upland (MTNHP, 2023). Flooding is the key ecosystem process, creating suitable sites for seed dispersal and seedling establishment. Black cottonwood (*Populus balsamifera ssp. trichocarpa*), narrowleaf cottonwood (*Populus angustifolia*), and Plains cottonwood *(Populus deltoides*) occur as codominants. Willow (*Salix spp.)*, redosier dogwood (*Cornus stolonifera*), and a diverse herbaceous and shrub community comprise the understory. See **Figure 1a** in **Appendix A** for representative photos of Lame Deer Creek Watershed wetland and riparian vegetation.

2.1.6 Land Use

Forestry

As mentioned, half of the lands within Lame Deer Creek Watershed are forested (see **Figure 5**). Forests and rangelands are managed by the Northern Cheyenne Agency BIA Branch of Forestry, and Northern Cheyenne Fire and Aviation in accordance with a forest management plan (FMP). An FMP is defined as "*…a principal document, approved by the Secretary, reflecting and consistent with an integrated resource management plan, which provides for the regulation of the detailed, multiple-use operation of Indian forest land by methods ensuring that such lands remain in a continuously productive state while meeting the objectives of the tribe…"* (BIA, 2023). FMPs must be approved by the BIA Regional Director and are periodically reviewed and revised to address changes in Tribal goals and objectives, policy, or a change in the state or condition of forest/timber resources. The BIA, Northern Cheyenne Agency, and the Tribe proposed to update and revise the 2009 FMP due to the "catastrophic large wildfires that have substantially changed the Reservation forest landscape" (BIA NOI, 2019). According to an interview on October 26 with Tribal Forest Manager, Terry Spang, the revised FMP was completed in early October 2023.

According to BIA Notice of Intent (NOI) records, thinning and prescribed burning is often used throughout the Reservation and within Lame Deer Creek Watershed to increase the growth and vigor of the native plant communities, enhance the grazing and foraging capacities for livestock and wild game, and to manage grasslands by returning fire to the landscape. Thinning and burning are also intended to safeguard property by creating a fuel break, reduce ladder fuels in the understory, and increase survivability of mature trees to wildfires by reducing fuel loading in overstocked stands. There is a pre-commercial thinning project in operation approximately 5 miles south of Lame Deer. As stated in the FMP, there are regulations and restrictions for forest management activities to reduce the potential effect on forest pathogens. For example, thinning and hand piling within the Reservation is to correspond with the engraver beetle (*Ips* spp.) life cycle and timing of adult emergence to mitigate further infestation. The Tribe has an aquatic lands protection ordinance that calls for a 50-foot exclusion zone around all riparian areas. In contrast to state Best Management Practices (BMPs) and streamside management laws that allow a degree of timber harvest in these zones, the Tribes stay entirely out of these areas (Spang, A., 2023). Prohibiting activities such as timber harvest, burning, off-road travel, or weed control within 50-feet of a riparian area protects water resources, soil, and wetland vegetation.

As previously stated, the land cover types within the watershed are highly susceptible to wildfires. Further, the ignition of exposed or buried coal seams throughout the area has been identified as a cause of recent wildfires. The Richard Spring Fire (2021) burned the northern portion of the watershed along Highway 212 near Lame Deer (**Figure 2a, Fire Perimeter Map** in **Appendix A).** Over 170,000 acres were burned including commercial-grade ponderosa pine. Based on fire perimeter maps and aerial imagery from August 2021, the fire burned approximately 6 stream miles of the Alderson Creek drainage and nearly 3 stream miles of Coal Creek before stopping at Lame Deer Creek.

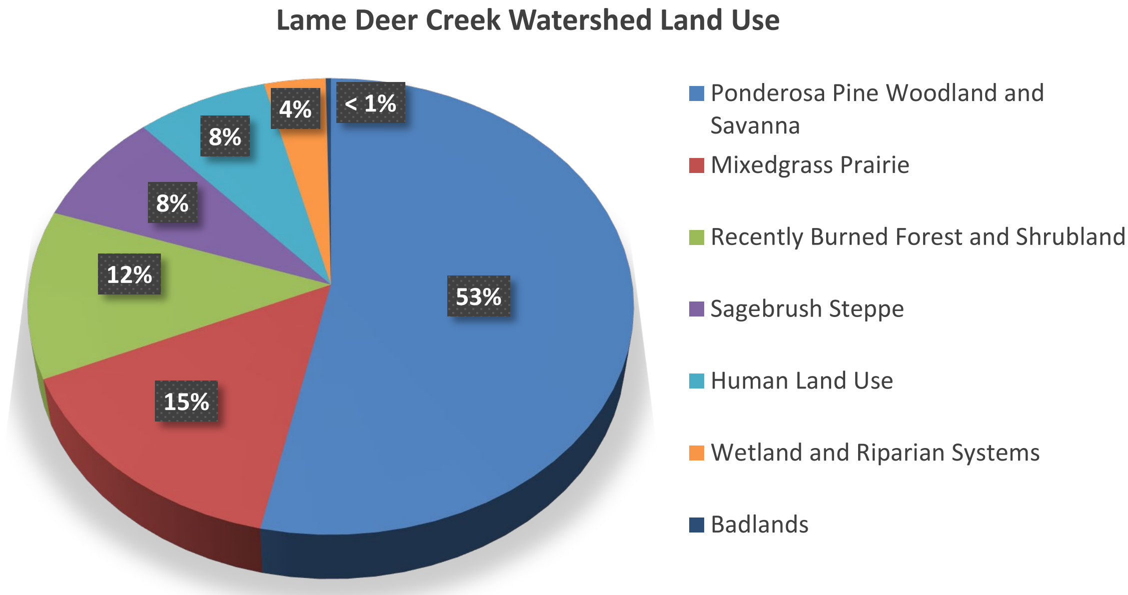
Fire affects the physical, chemical, and biological properties of soils. Combustion of litter and soil organic matter affects cation exchange capacity, aggregate stability, macro pore space, infiltration, and soil microorganisms (Debano, 1991). Volatized organic matter moves downward along steep gradients in the upper layer of the soil and condenses to form a water-repellent layer that impedes infiltration (Debano, 1991). The formation of a hydrophobic layer combined with the loss of protective plant cover increases surface runoff and erosion during rain events following an intense burn. The altered soil physical properties from fire may have deleterious effects on water quality. Revegetating a burned site can be an effective strategy to restore organic litter in soil. According to Terry Spang (Tribal Forest Manager), a timber salvage sale is awaiting approval and purchase. Burns within the area have been historically planted with ponderosa pine to restore the landscape.

Agriculture

Agriculture is the second predominant land use (see **Figure 5**) where crop production and livestock grazing are concentrated in the valleys - often overlapping with riparian and wetland areas. These activities have caused considerable impacts to the riparian areas and water quality of Lame Deer Creek. According to the Northern Cheyenne Competitive 319 Application (2022), agricultural impacts including cattle grazing and nutrient loading in the riparian areas are responsible for over 80 percent of observed water quality impacts in Lame Deer Creek Watershed. Stream banks were visibly and significantly eroded along approximately 6.3 stream miles of Lame Deer Creek in 2021 during the Tribe's Assessment.

Livestock grazing in riparian areas can reduce riparian vegetation cover from browsing and trampling. Overgrazing in riparian areas is well documented for the impacts on soil compaction, vegetation, stream bank stability, water quality, and habitat. Cattle can down-cut stream banks by shearing bank material resulting in setback banks (Oestreich, 2006). Feces and urine deposited in or near streams can cause elevated concentrations of nitrogen and phosphorous as well as increased prevalence of fecal coliforms and fecal *streptococci* (Oestreich, 2006).

Figure 5. Land Use in the Lame Deer Creek Subwatershed



Cultivation within the watershed is highly concentrated along Lame Deer Creek, South Fork of Lame Deer Creek, and the South Fork of Alderson Creek (**Figure 4**). Beef cattle production is the largest sector of animal agriculture in Rosebud County, and crop production on irrigated cropland is dominated by the forage needs of cattle producers (NRCS, 2023). Winter wheat, barley, and alfalfa are commonly grown within Rosebud County. According to Montana Cadastral (2023), alfalfa is the most common agricultural commodity within Lame Deer Creek Watershed. Livestock grazing and crop production requires irrigation, water impoundments, and groundwater wells to meet water requirements. In a semi-arid environment such as Lame Deer Creek Watershed, water redistribution and overuse can have cascading effects on the water table and overall stream and wetland health and function.

Wetlands and Riparian

As discussed in **Section 1.2.5** above (Land Cover), Lame Deer Creek Watershed contains ecologically significant wetlands and riparian systems. Wetlands are highly productive ecosystems that play an integral role in the ecology and health of a watershed (EPA, 2023). Wetlands provide key ecosystem services such as natural water quality improvement, flood protection, and erosion control.

The Tribe has been developing a wetlands program for over 20 years with the overall goal to quantify, assess, protect, and conserve wetlands on the Reservation and to assign appropriate management practices to achieve a “no net-loss” of wetlands (NCT WPP, 2014). Significant work and planning by the Tribe have led to the establishment of a culturally sensitive wetland assessment method with a focus on documenting the presence or absence of culturally significant plants. The Tribe use data from the Montana Natural Heritage Program (MNHP) and US Fish and Wildlife Service (USFWS) to quantify the type and extent of wetlands and riparian areas on the Reservation and to conduct field verification and wetland assessments (NCT WPP, 2014). **Table 2** shows the type and amount of wetland in acres within the Lame Deer Creek watershed. This data was derived from a report generated by MNHC (2023).

Table 2. Lame Deer Creek Watershed Wetland Classification

Wetland Classification	Area (Acres)
Palustrine Emergent Wetlands – areas containing erect, rooted herbaceous vegetation during most of the growing season. These areas are temporarily, seasonally, or semi permanently flooded areas that were artificially or naturally formed.	337
Palustrine Scrub-Shrub Wetlands – areas dominated by woody vegetation less than 6 meters (20 feet) tall. Within the watershed, most of these sites are naturally created wetlands.	131
Palustrine Aquatic Beds – areas that are naturally or artificially impounded wetlands with vegetation growing on or below the water surface for most of the growing season. A fraction of land contains palustrine unconsolidated shore and scrub-shrub wetlands.	25
Forested, Lotic Riparian - forested, lotic riparian areas with woody vegetation that is greater than 6 meters (20 feet) tall.	543
Lotic, Scrub Shrub Riparian - areas dominated by woody vegetation less than 6 meters (20 feet) tall.	391

The MTNHP wetland and riparian mapping is completed through photointerpretation of 1-meter resolution color infrared aerial imagery acquired from 2005 or later. Ancillary data layers such as topographic maps, digital elevation models, soils data, and other aerial imagery sources are also used to improve mapping accuracy. Wetland mapping follows the federal Wetland Mapping Standard and classifies wetlands according to the Cowardin classification system of the National Wetlands Inventory (NWI). Mapped wetland and riparian areas do not represent precise acreage or boundaries and digital wetland data cannot substitute for an on-site determination of jurisdictional wetlands.

Municipal

Municipal impacts within Lame Deer Creek Watershed account for approximately 10 percent of watershed impacts which include point source discharges from the Lame Deer Sewage Lagoons operated by the Northern Cheyenne Utility Commission, municipal runoff from roads, and waste disposal along stream banks in the town of Lame Deer (NCT Competitive 319 Permit, 2022). Other municipal land uses within the watershed include residences, businesses, a post office, churches, government buildings, public schools, automotive shops, health services and a casino, bank, library, college, aviation center, gas station, and a solid waste station.

2.1.7 Land Ownership

More than 97 percent of all land within the Reservation remains with the Tribe and in trust with the federal government. Some land used for grazing and agriculture is leased under the BIA Tribal Lands Leasing Act whereby the lessee has a written contract with the Tribe granting the right to possess or make use of Tribal land for a specified purpose or duration (BIA, 2022).

Less than 1 acre of the land within the watershed is owned by Montana Department of Transportation (MDT) and includes a small parcel adjacent to Montana Highway 212 (MT Hwy 212).

2.1.8 Recreation

According to Terry Spang (Tribal Forest Manager), there are at least two popular recreation areas near or within the boundaries of Lame Deer Creek Watershed. The Greenleaf ponds along Greenleaf and Ash creeks are located at the northeastern portion of the watershed boundary approximately 1 mile north of MT Hwy 212. Similarly, Crazy Head Spring and ponds on the Crazy Head Fork are located at the northeastern portion of the watershed boundary approximately 1 mile south of MT Hwy 212. These sites are popular camping, fishing, and day-use areas for Tribal members (**Figure 6**).

Near the townsite of Lame Deer, People's Park located along Lame Deer Creek and Hwy 4 is a developed day-use area for sports and recreation. The Kenneth Beartusk Memorial Pow Wow grounds are located along the South Fork of Lame Deer Creek and approximately 3 miles south of Lame Deer, where the largest pow-wow on the Reservation is held. There are campsites available to support the premier event that is held over the Fourth of July.

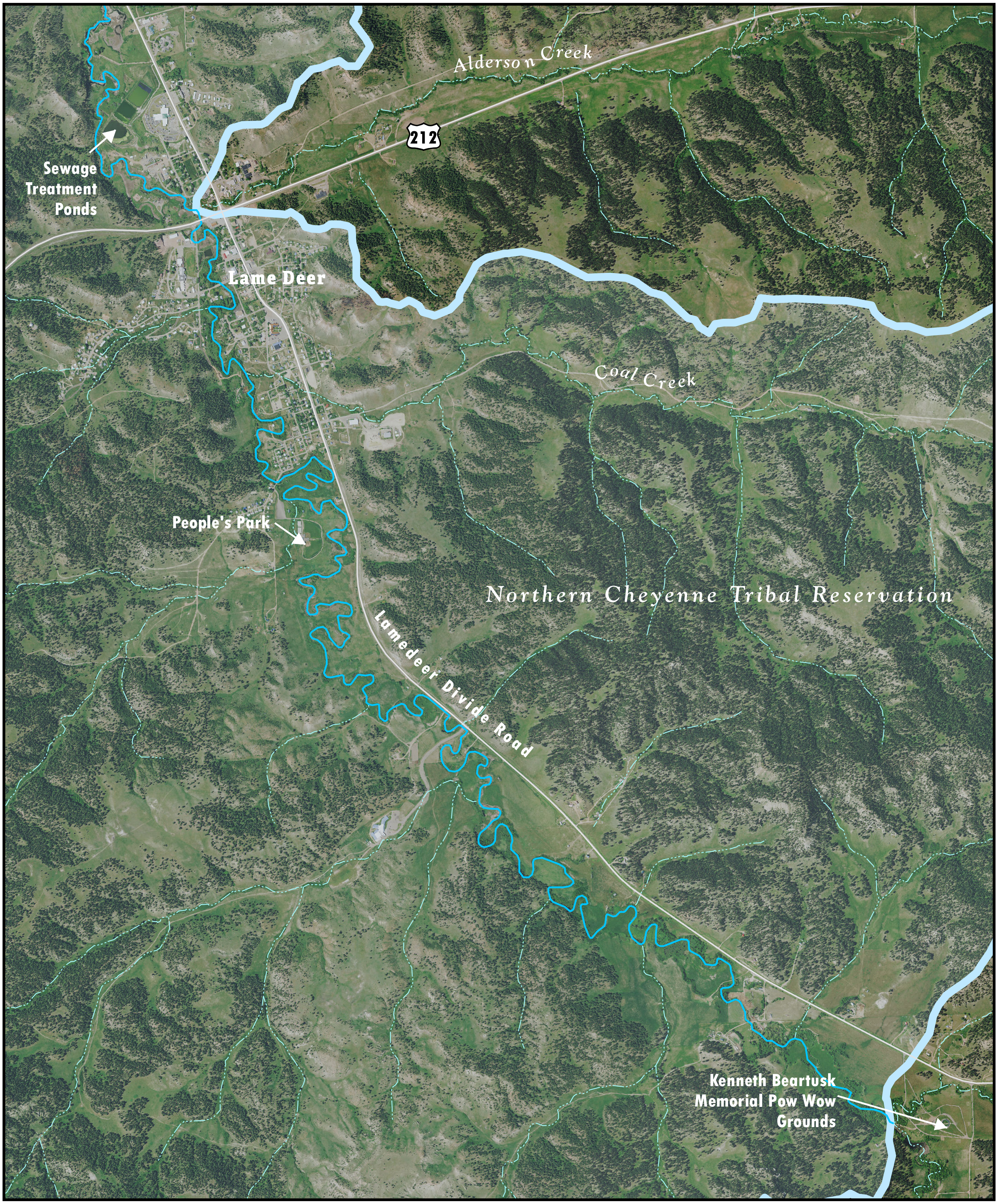
According to Terry Spang, there are no designated or maintained trail systems or campgrounds within the watershed. Hunting, fishing, and offroad motorized vehicle use are likely common within the area. When fire danger is high, offroad travel and campfire restrictions apply.

2.1.9 Soils

The dominant soil orders within the watershed are Entisols and Inceptisols. Based on Natural Resources Conservation Service (NRCS) Web Soil Survey (2023), the most prevalent soil type (14 percent) within the Lame Deer Creek Watershed is 'Bitton, moist-Lamedeer, dry-Ringling, dry, channery loams' found on 25 to 70 percent slopes. The Lame Deer Creek Watershed soil classification percentages are displayed in **Table 3.**

Table 3. Lame Deer Creek Watershed Soil Classification

Soil Classification	Area (Percent of the Watershed area)
Bitton Soil Series - found on hills, side slopes, and base slopes with open ponderosa pine and woodland species. A typical profile consists of channery loam to very gravelly loam soils with a parent material of colluvium derived from porcellanite.	31
Lamedeer Soil Series - found on densely forested hills, backslopes, and foot slopes within the watershed. A typical profile resembles channery loam to very channery sandy loam.	23
Shambo Soil Series - found on gently sloped (< 15 percent) alluvial flats along streams, open meadows, and roadsides within the watershed. A typical soil profile consists of loam to gravelly sandy loam derived from alluvium.	12
Barvon Soil Series - found on densely forested, moderate to steep (15 to 70 percent) hills, shoulders, and backslopes within the watershed. A typical soil profile consists of loam to bedrock with parent material of residuum weathered from sandstone and siltstone. Numerous other soil components are present within the Lame Deer watershed.	12



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N

0 Feet 3,000

NewFields

Lame Deer Creek Subwatershed HUC12 101000030404

Lame Deer Creek

Note: Greenleaf Pond and Crazy Head Spring/Pond are located approximately 8 miles east of Lame Deer.

Points of Interest
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 6

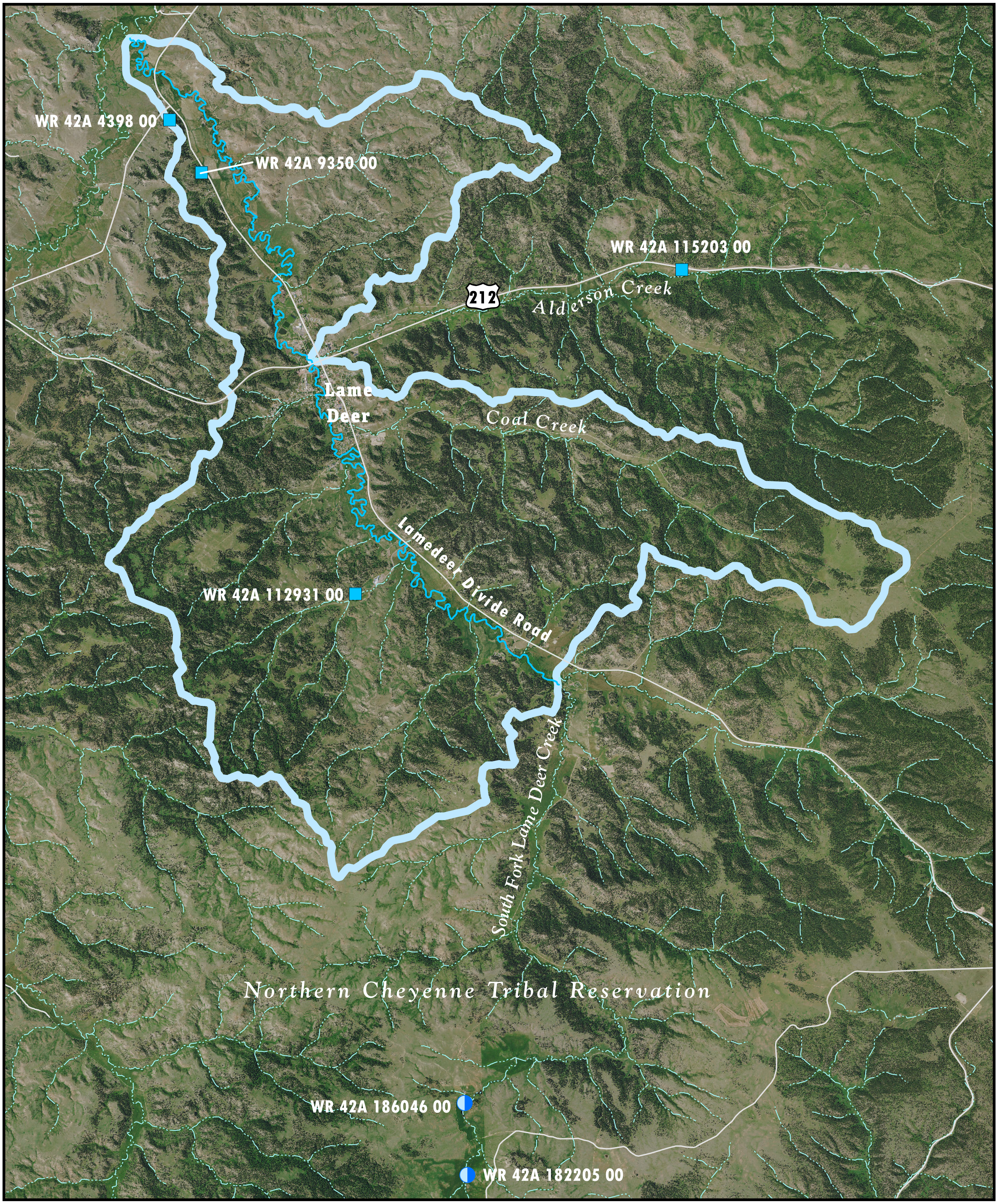
Most soil types (approximately 85 percent) within the watershed have a moderate infiltration rate and primarily consist of moderately deep to deep, well drained soils with a moderately fine to moderately coarse texture. The pH within the watershed ranges from neutral (6.8) to moderately alkaline (8.1) (NRCS, 2023).

Based on NRCS Web Soil Survey (2023), approximately 13 percent (6,367 acres) of soils within the Lame Deer Creek Watershed are classified as *farmland of statewide importance* and approximately 2 percent (1,010 acres) are classified as *prime farmland*. As defined by the U.S. Department of Agriculture (USDA) in the National Soil Survey Handbook (2017), *prime farmland* is available land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. Soils that nearly meet the criteria for *prime farmland* and economically produce high yields of crops when managed according to acceptable farming methods are considered *farmland of statewide importance*. *Prime and unique farmland* soils are of major importance and are becoming increasingly lost to industrial and urban land. NRCS is concerned about any action that tends to impair the productive capacity of American agriculture; policy and procedures are discussed in detail in 7 CFR Part 657 (1978).

The major soil resource concerns within the land resource area include wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soil, management of soil moisture, and the control of saline seeps.

2.1.10 Water Use

The primary use of water in the Lame Deer Creek Watershed is for agriculture. Local water resources include the perennial Lame Deer Creek and groundwater within unconsolidated sediments and bedrock aquifers. The groundwater produced from wells and springs provides an important source of domestic, municipal, and livestock water on the Reservation (Caldwell, 2020). Most water is obtained by digging shallow wells in the alluvial material, in which the water table is typically encountered within 20 to 30 feet of the surface (USGS, 1929). Although the sources of ground springs were not identified during an August 2023 site visit, it is speculated that sections of the South Fork of Lame Deer Creek are spring-fed (Walksalong, 2023). According to data generated from the DNRCS Water Rights Query System (2023), there are four groundwater rights and two surface water rights (**Figure 7**) within the Lame Deer Creek Watershed. Given this source of information is Montana State data, there may be many more water rights in the area under Tribal jurisdiction.



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Lame Deer Creek Subwatershed HUC12 101000030404

Lame Deer Creek

Groundwater Right

Surface Water Right

Note: Water rights data from Montana DNRC

0 Miles 2

NewFields

Water Rights
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 7

3.0 IMPAIRMENT REACHES, SOURCE, GOALS AND OBJECTIVES

This section will cover element 1, (identification of causes and sources of impairments*),* by describing four priority reaches, classified by the limiting factors contributing to poor water quality. Each priority reach identifies the pollutant cause, the impairment, and the source. Element 2, (estimate pollutant loading into the watershed and the expected load reductions) will be covered in the reach narratives and by the associated water quality goals and objectives. Lastly, element 3, (describe management measures that will achieve load reductions and targeted critical areas), are described in the Nonpoint Source (NPS) Best Management Practices (BMPs) for each reach with target values summarized in **Table 5.**

The classification of Reservation waters in the WQS considers the use and value of the waters for public water supplies, protection and propagation of fish, shellfish and wildlife, recreation in and on the waters, agriculture, industry, and other purposes. (NCT WQP, 2021).

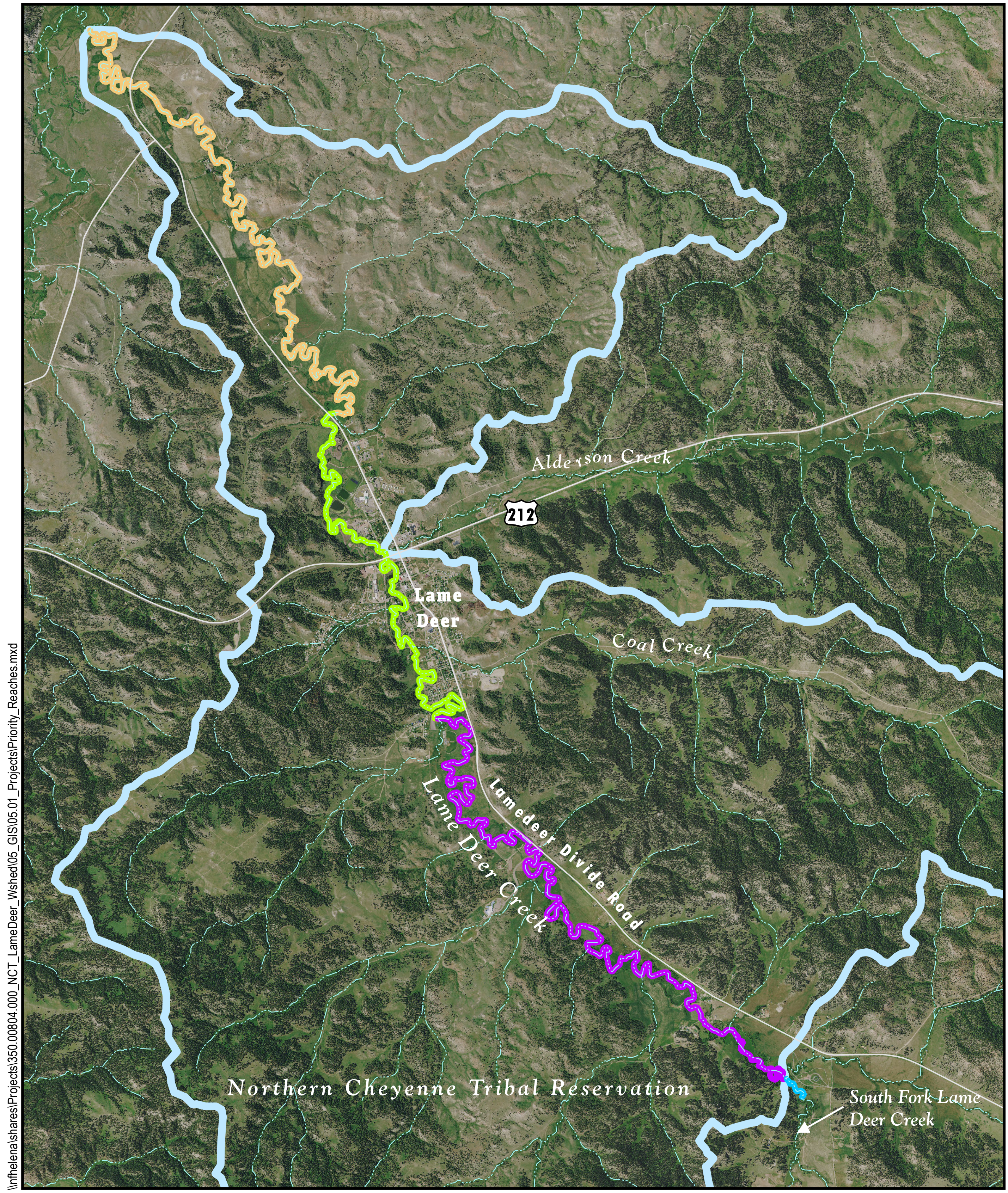
Currently, Lame Deer Creek is classified as a Class 1 Cold Water Fishery:

> " *Class 1 Cold Water Fishery – Provides for protection, propagation, and growth of Salmonid fishes, as well as protection, growth and propagation of associated aquatic life normally found where summer water temperatures do not often exceed 20 degrees C*." (NCT WQP, 2021).

To reach this classification standard, waters need to support, on a year-round basis, wild and stocked trout or other salmonid fishes requiring similar conditions.

The summary of water quality data collected over the past decade indicate that conditions in Lame Deer Creek are not currently capable of sustaining growth of salmonid fishes or a wide variety of invertebrate aquatic biota including sensitive species due to unsuitable physical habitat, restricted water flow, stream temperatures and sediment (NCT WQP, 2021). As reported in **Section 1.2** under fisheries, fish communities within the Rosebud and Lame Deer Creek watersheds are generally dominated by the Core Prairie Stream Assemblage, which include medium to large warmwater river fish and medium warmwater river fish to large stream fish assemblages. Streams of this ecosystem are typically small, warm-water intermittent streams that contain interrupted pools or fishless isolated pools due to climatic factors or land use change (Stagliano, 2005).

To best describe the impairments responsible for the poor conditions, Lame Deer Creek has been divided into four priority reaches. Priority reaches have been identified as critical target areas for mitigation and restoration and are classified by the limiting factors contributing to degraded water quality (see **Figure 8** and **Table 4**).



0 Miles 1

NewFields

Lame Deer Creek Subwatershed HUC12 101000030404

Reach 1: Headwaters South Fork Lame Deer Creek

Reach 2: Upper Lame Deer Creek

Reach 3: MIddle Lame Deer Creek

Reach 4: Lower Lame Deer Creek

Priority Stream Reaches
Lame Deer Creek Subwatershed
Nine Element Plan
Rosebud County, Montana
FIGURE 8

Table 4. Priority Reach Causes and Sources of Impairment

Priority Reach	Causes of Impairment	Probable Sources of Impairment
Reach 1 - Headwaters of Lame Deer Creek	High water temperatures, low flow, low dissolved oxygen, stream channel substrate alterations, stream-side vegetative cover and habitat alterations, and sedimentation/siltation.	Embankment structures, crushed culvert, road, and habitat modifications.
Reach 2 - Upper Lame Deer Creek	High water temperatures, low flow, alteration in stream-side vegetative cover, and habitat and sedimentation/siltation.	Grazing in riparian or shoreline zones, crops grown right up to streambanks, and beaver hydromodifications.
Reach 3 - Middle Lame Deer Creek	High water temperatures, low dissolved oxygen, stream-side vegetative cover and habitat, low biodiversity and sedimentation/siltation.	Anthropogenic causes such as garbage dumping and non-designated stream crossings. Elevated nutrients from the Lame Deer Lagoon.
Reach 4 - Lower Lame Deer Creek	High water temperatures, low flow, high total dissolved solids, alteration in stream-side vegetative cover and habitat, and low dissolved oxygen.	Grazing in riparian or shoreline zones and crops grown right up to streambanks.

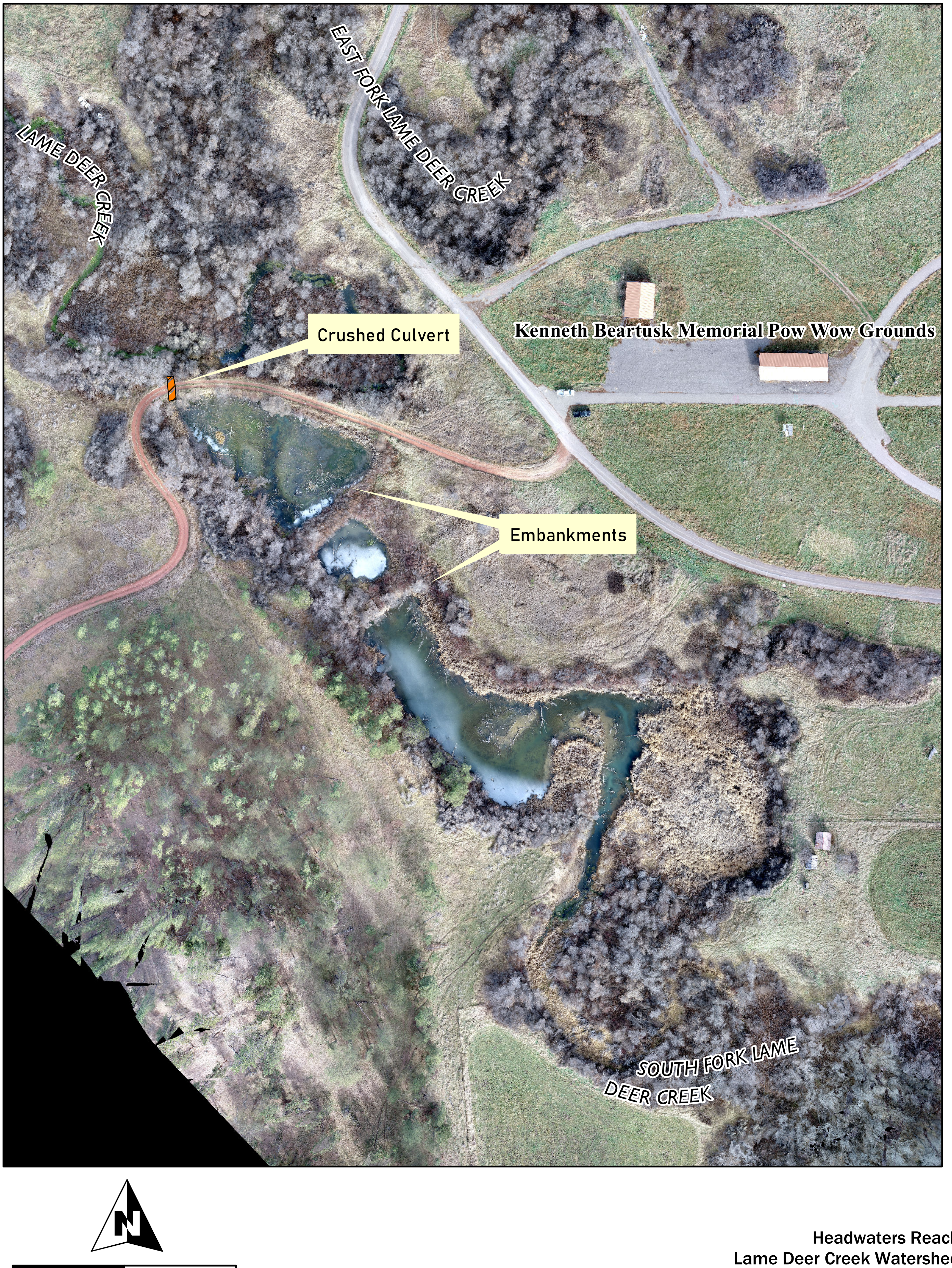
The following section outlines water quality goals and objectives required to meet Class 1 Cold Water Fishery standards for each of the four reaches followed by a description of the NPS BMPs needed to achieve those identified goals.

3.1 Reach 1: Headwaters of Lame Deer Creek

Reach 1 – The headwaters of Lame Deer Creek begin on the perennial South Fork of Lame Deer Creek 1,640 feet upstream of a crushed culvert. Before entering the mainstem of Lame Deer Creek, the South Fork flows through a series of ponds that were maintained by two embankments (see **Figure 9**). These embankments were built in the 1970's to create recreational swimming ponds by backing up the South Fork of Lame Deer Creek. The pond levels were managed by a headgate at the most downstream embankment which is now fully opened allowing the South Fork to freely flow (Walksalong, 2023). Currently, the South Fork of Lame Deer Creek flows are impeded by four crushed culverts that historically conveyed water under a residential road into the mainstem of Lame Deer Creek. During a site visit in early August of 2023, NewFields estimated that 5 gallons per minute (gpm) were discharged from the outfall while most of the South Fork of Lame Deer Creek was backed up into ponds. It was also observed that stream channel substrate consisted of sharp angular rock that had slumped into the stream channel from the roadbed. Also noted was a white, algal film covering the substrate - an indication of warm water temperatures rather than a cold-water stream. **Photo 1** is an aerial view of the impounded sections of the South Fork of Lame Deer Creek. This photo was taken facing north down valley on November 11th, 2023.

Photograph 1. Reach 1 – Headwaters of Lame Deer Creek

The ponded waters of the South Fork of Lame Deer Creek have disrupted an ecological process that historically supported populations of cold-water trout. In 2021, tribal elder, Jules Spang, Sr. described the Lame Deer Creek watershed as a stream system that supported a functional fishery when he was a child (NCT, 2022b). Prior to 1940, natural springs fed Lame Deer Creek at a rate sufficient to support a cold-water fishery from the headwaters to the confluence with Rosebud Creek. Tribal elders recall an intact riparian area without stream bank erosion (NCT, 2022b).



NewFields

Headwaters Reach
Lame Deer Creek Watershed
Restoration Plan Lame Deer, MT

FIGURE 9

EPD staff shared that historically, the headwaters of Lame Deer Creek were fed by natural springs with flows of 65-70 gpm. However, in the late 1940's the BIA used explosives to increase flow in the creek. This permanently altered the hydrology of the system resulting in the unintended decrease of stream flow (NCT, 2022b).

The crushed culverts and embankments have altered the functionality of the water system by slowing water flow, trapping sediments, increasing temperatures, and promoting the presence of non-native and invasive species. It is anticipated that the upstream ponds have accumulated sediment over time which has artificially raised the streambed elevations.

The conditions at the headwaters reach do not meet the basic requirements to support a Class 1 Cold Water Fishery as they once did. Headwater wetlands provide critical functions for the maintenance of aquatic systems, including water storage/groundwater connections support for the hydrodynamic balance and habitat for a diverse assemblage of native species. The crushed culverts currently act as a barrier for fish passage negating the possibility of fish to migrate up and downstream.

Water Quality Based Goals for Reach 1 – Headwaters Lame Deer Creek

1. Reestablish connectivity with the mainstem of Lame Deer Creek to the South Fork of Lame Deer Creek.
2. Reduce stream temperatures to not often exceed 68^0 F to support cold-water salmonid species and associated aquatic life.
3. Improve flows to increase water depths and lengthen the duration of inundation to support populations of cold-water salmonid species and associated aquatic life.
4. Improve habitat to support populations of cold-water salmonid species and associated aquatic life.

NPS BMPs for Reach 1 – Headwaters Lame Deer Creek

1. Restore 600 linear feet of the South Fork of Lame Deer Creek.
2. Remove/ breach two embankments.
3. Replace four crushed culverts between the South Fork of Lame Deer Creek and the mainstem of Lame Deer Creek with a culvert suitable for fish passage and the estimated high flows.
4. Revegetate one acre of riparian vegetation with a variety of native trees and shrubs using both nursery grown stock and local sources such as willow transplants/stakes and wetland (sedge/rush) sod mats.

3.2 Reach 2: Upper Lame Deer Creek

Reach 2 – Upper Lame Deer Creek begins near the headwaters and extends north, 6 river miles downstream towards the town of Lame Deer (**Figure 8**). The stream reach is somewhat low gradient (0-8 percent slopes), maintains adequate sinuosity, and is not channelized.

Reach 2 is impacted by agricultural activities, including crop production and cattle grazing. Crops consisting of grasses and alfalfa grown for cattle feed limit the species biodiversity necessary to provide a range of rooting depths to stabilize streambanks. Further, these monoculture crops attract invasive weed infestations and do not provide the range of riparian tree and shrub canopy to adequately shade and lower stream temperatures.

Based on observations from NewFields' August 2023 site visit, it appears that riparian areas, particularly in tributary drainages, have been subjected to season-long grazing. A lack of grazing management or pasture rotation has resulted in degraded riparian habitat and loss of habitat biodiversity. Riparian habitat represents only a small portion of the landscape but provides seasonal requirements for much of the wildlife species present on the Reservation. Additionally, cattle have trampled stream banks and over-widened the stream channel where they cross and access water. These activities have increased turbidity, nutrient loads, and contributed to sediment supply from streambank erosion. Data summarized for this area stated that "*Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) measurements are very elevated in some years as would be expected with these types of agricultural impacts*" (NPS Assessment, 2021). Salmonid species such as cold-water trout are extremely sensitive to fine sediment generally defined as 6.3 millimeters or less.

Beavers have been known to inhabit this reach of Lame Deer Creek causing conflict with land managers due to flow alterations because of hydromodification. A thorough investigation of these impacts was conducted by NewFields LLC in the summer of 2023 with analysis and management strategies summarized in a Beaver Management Plan for the Lame Deer Creek subwatershed which is included in **Appendix C**. The Beaver Management Plan identifies several beaver management strategies ranging from beaver activities as a watershed restoration tool to installation of beaver deterrents to trapping and relocation depending on land management goals and the extent of beaver-related damage (see **Beaver Management Plan, Appendix C**).

Water Quality Based Goals for Reach 2 – Upper Lame Deer Creek

1. Reduce sediment loads to natural occurring background levels that populations of cold-water salmonid species and associated aquatic life can tolerate.
2. Reduce stream temperatures to not often exceed 68^0 F to support cold-water salmonid species and associated aquatic life.
3. Improve flows to increase water depths and lengthen the duration of inundation to support populations of cold-water salmonid species and associated aquatic life.
4. Improve habitat to support populations of cold-water salmonid species and associated aquatic life.

NPS BMPs for Reach 2 – Upper Lame Deer Creek:

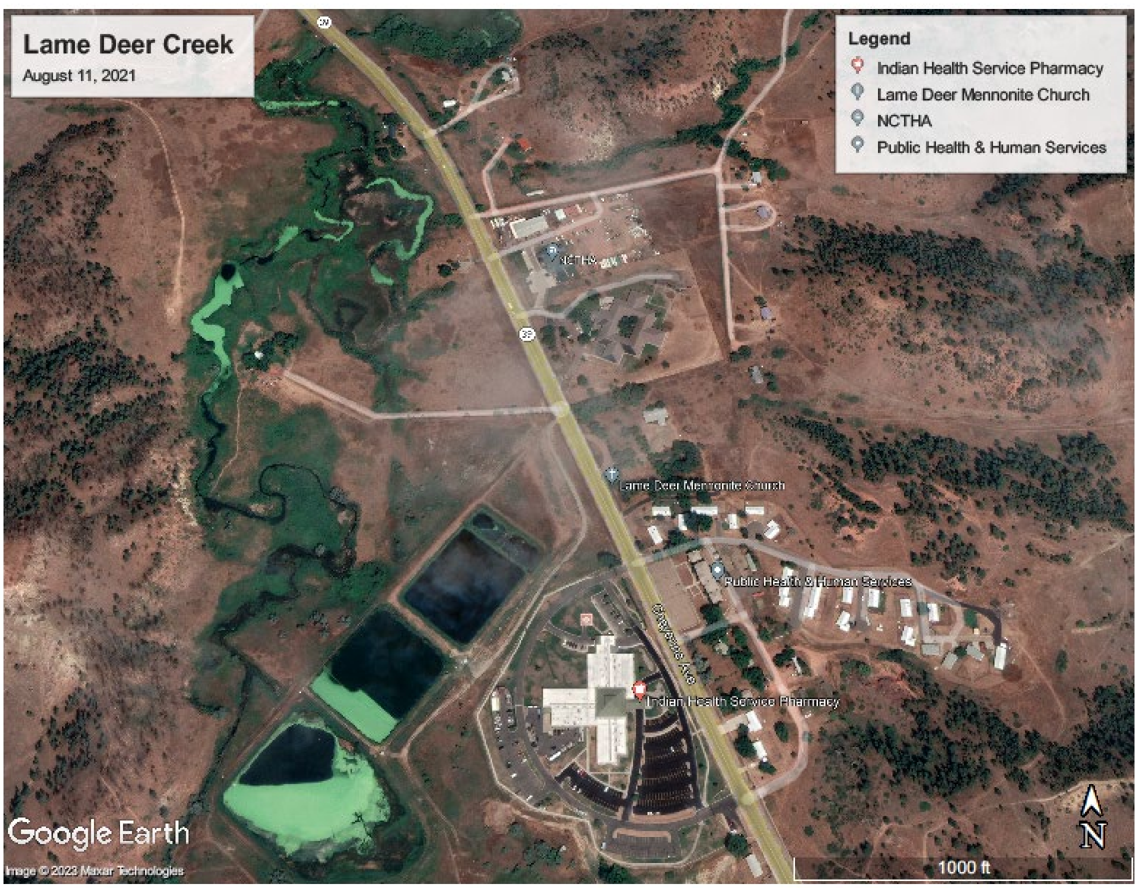
1. On grazing leased land overlapping the riparian corridor, fence up to five miles of riparian corridor from cattle along this reach of Lame Deer Creek.
2. On grazing leased land overlapping the riparian corridor, provide up to two cattle off-site stock watering sites and shaded areas or strategically placed watering gaps to concentrate and mitigate impacts to one area.

3. Revegetate critically damaged streambanks that will be fenced on 2 acres or more of riparian corridor with a variety of native trees and shrubs using both nursery grown stock and local sources such as willow transplants/stakes and wetland (sedge/rush) sod mats.
4. Control noxious weeds before and after planting on revegetated riparian corridor.
5. Educate and incentivize crop producers to incorporate riparian setbacks for watershed health.

3.3 Reach 3: Middle Lame Deer Creek

Reach 3 – Middle Lame Deer Creek flows 5 river miles north through a predominantly urban area skirting the town of Lame Deer to the east. Reach 3 begins where Lame Deer Creek flows through an eco-arch culvert under Sweet Medicine Road south of the town of Lame Deer and ends where Lame Deer Creek bisects Highway 4. Reach 3 is somewhat low gradient (0-4 percent slopes), maintains adequate sinuosity, and is not channelized. Reach 3 is characterized by low flow and water quality influenced by effluent from the Lame Deer Lagoon. Observations recorded during a site visit conducted by a consulting firm in 2021, included a heavy algal bloom overlaying thick sediments (NPS Assessment, 2021) (**Photograph 2**). No aquatic insects (other than Hemipterans) were observed at the site. It was determined that heavy sedimentation, low dissolved oxygen, and warm water temperatures precluded any aquatic insect colonization (NPS Assessment, 2021).

Photograph 2. Reach 3- Middle Lame Deer Creek, Lame Deer Lagoon



Reach 3 has a recreation parking site at the south end where garbage dumping occurs, including appliances and other household waste. **Photo 3** is an aerial view of a crossing and dumping site within Reach 3 taken November 11th, 2023. Water quality data summarized from a monitoring site near the center of the town of Lame Deer indicates stream temperatures are often high (above 68^0 (F)) and dissolved oxygen levels were low. Specific conductance values often exceed the EPA chronic aquatic life criteria of 1,000 micromhos per centimeter (umhos/cm) (NPS Assessment, 2021). There have also been reports of fill dirt deposited in the stream channel at various locations to facilitate creek crossing.

Photograph 3. Reach 3 – Middle Lame Deer Creek Dump Site and Crossing

As previously mentioned, Reach 3 contains a direct pollution point source from the Lame Deer Lagoon. The lagoon operates under the Northern Cheyenne Tribe Utilities Commission (NCUC). The Tribe EPD assumes CWA Section 401 Certification and Section 303 Water Quality Standards Program responsibilities to provide certification to EPA on behalf of the Tribe. In August of 2021, the NCUC reached a joint settlement with EPA and the Justice Department to address sanitary sewer overflows of untreated wastewater that flowed into Lame Deer Creek from 2013 through 2016 and then from 2017-2018 without an NPDES permit authorization (Settlement, 2021). Since 2017, a technical workgroup comprising of Federal, State, and Tribe representatives has assisted NCUC in completing major wastewater infrastructure improvements to the facility's lagoon and collection system. In 2020, the Tribe requested a water quality certification under 401 of the CWA for proposed Nationwide Permits (NWPs) for discharge into waters of the United States.

Limited available information exists regarding local groundwater resources, surface-water dynamics, groundwater-surface water interaction, and water quality within the Lame Deer Creek area. The unknown influence of the Lame Deer Lagoon and private wastewater systems (e.g., septic systems) on the area's water resources is of particular interest for the U.S. Geological Survey (USGS) (Caldwell, 2023).

In 2016, the USGS, under a Northern Cheyenne Cooperative Effort, began a hydrologic assessment with an emphasis on water quality investigation of 30 wells and 7 Lame Deer Creek sites. The study area included the Lame Deer Creek Watershed, but the primary area of focus was within the community of Lame Deer. In June of 2018, 7 Lame Deer Creek sites were sampled by Northern Cheyenne Department of Environmental Protection and Natural Resources (NCDEPNR) and local students. The collected data showed that human-sourced contaminants including pharmaceuticals, hormones, and antibiotics were present in Lame Deer Creek (USGS, NWIS,2018).

Water Quality Based Goals for Reach 3 – Middle Lame Deer Creek

1. Reduce stream temperatures so as not to often exceed 68^0 F and fall within an average temperature range suitable to support cold-water salmonid species and associated aquatic life.
2. Improve habitat to support populations of cold-water salmonid species and associated aquatic life.
3. Reduce sediment loads to natural occurring background levels that still support populations of cold-water salmonid species and associated aquatic life.
4. Reduce water quality constituents of concern to meet NCT WQS standards for the designated beneficial use.

NPS BMPs for Reach 3 – Middle Lame Deer Creek:

1. Revegetate up to 1 acre of riparian corridor with a variety of native trees and shrubs using both nursery-grown stock and local sources such as willow transplants/stakes and wetland (sedge/rush) sod mats.
2. Remove dumped waste and trash from 1 mile of stream channel and riparian corridor to improve habitat.
3. Fence and erect signage along 1 mile of riparian corridor to prevent garbage dumping.
4. Conduct routine monitoring of discharge, water quality parameters, and nutrients above and below Lame Deer Lagoon to track data trends.
5. Engage in public education to inform community about site improvements and the role of BMPs in improving water quality.

3.4 Reach 4: Lower Lame Deer Creek

Reach 4 - Lower Lame Deer Creek begins on the outskirts of the town of Lame Deer and extends approximately 6 river miles north towards the confluence of Rosebud Creek (**Figure 8**). Reach 4 flows through production crop cattle grazed land resulting in low vegetative cover along streambanks easily identifiable in aerial photos (**Photograph 4**). Reach 4 is characterized by low discharge resulting in heavy sedimentation on the bottom of the stream channel. Data collected in 2021, indicated dissolved oxygen concentrations were relatively low and water temperatures sometimes exceeded water quality standards established for this stream reach; aquatic insects were present but had very little species diversity (NPS Assessment, 2021).

Photograph 4. Reach 4- Lower Lame Deer Creek

Cattle along Reach 4 graze year-round and are not fenced out of Lower Lame Deer Creek. These activities have increased turbidity, nutrient loads, and contributed to sediment supply from streambank erosion. Data summarized for Reach 4 stated that" *TSS and TDS measurements are very elevated in some years as would be expected with these types of agricultural impacts*" (NPS Assessment, 2021). Additionally, crop land is grown right up to the edge of the streambank as evident in **Photograph 4.**

Water Quality Based Goals for Reach 4 – Lower Lame Deer Creek

1. Reduce stream temperature so as not to exceed 68^0 F and fall within an average temperature range suitable to support cold-water salmonid species and associated aquatic life.
2. Improve habitat to support populations of cold-water salmonid species and associated aquatic life.
3. Reduce sediment loads to natural occurring background levels that maintain populations of cold-water salmonid species and associated aquatic life.

NPS BMPs for Reach 4 – Lower Lame Deer Creek:

1. On grazing leased land overlapping the riparian corridor, fence up to 2 miles of riparian corridor from cattle along this reach of Lame Deer Creek.
2. On grazing leased land overlapping the riparian corridor, provide up to two cattle off-site stock watering sites and shaded areas or strategically placed watering gaps to concentrate and mitigate impacts to one area.
3. Revegetate critically damaged streambanks that will be fenced on 2 acres or more of riparian corridor with a variety of native trees and shrubs using both nursery grown stock and local sources such as willow transplants/stakes and wetland (sedge/rush) sod mats.
4. Control noxious weeds before and after planting on revegetated riparian corridor.
5. Educate and incentivize crop producers to incorporate riparian setbacks for watershed health.

3.5 Management objectives and Target values for all priority reaches

Table 5 summarizes the management objectives required to meet priority reach water quality goals and the target values that bring Lame Deer Creek into compliance with the water quality standards set for the beneficial use of Lame Deer Creek.

Table 5. Management Objectives with Water Quality Target Values

Management Objective	Target Value
Reduce warm water temperatures	▪ Stream temperatures do not often exceed 68^0 (F).
Improve habitat for fish and aquatic species	▪ Rapid bioassessment analysis captures greater Ephemeroptera, Plecoptera and Tricoptera ratios.
Reduce sediment loads	▪ Reduced conductance levels below 1.5 decisiemens per meter (dS/m). ▪ A year-round maximum TDS total to not exceed 900 milligrams per liter.
Decrease nutrient loading	▪ Nitrogen and phosphorus levels meet tribal surface water quality standards. ▪ Fecal coliform not to exceed 200 per 100 milliliters. ▪ Fewer nuisance algae blooms.

4.0 TECHNICAL AND FINANCIAL ASSISTANCE

This section will cover element 4, (estimate the amount of technical and financial assistance and the relevant authorities needed to implement the plan), by first describing the technical resources needed to plan and prepare for mitigation and restoration actions. **Table 6** combines the actions with an estimated cost which will adjust as technical assistance needs and project scope become more refined. Section 4.2 will further describe the financial assistance available through federal and tribal grants and cooperative programs.

4.1 Technical Assistance

Technical assistance for much of the agricultural related actions will be found through the BIA Natural Resources Department, the Rosebud Conservation District, and the Montana State University (MSU) extension office out of Bozeman Montana. An engineering consulting firm will be required to design and provide oversite of the stream channel restoration and culvert replacement activities while agencies such as USGS and BIA Natural Resources Department can assist with continued water quality monitoring within the community of Lame Deer. **Table 6** organizes the actions with the estimated cost, technical assistance, and source of funding.

Table 6. Technical and Financial Assistance for Lame Deer Creek Watershed Plan Actions

Area of Focus	Actions	Estimated Cost	Technical Assistance Scope of Work	Sources of Funding
Reach 1: Headwaters	▪ Restore historic channel and streambanks through ponds and embankments ▪ Replace culvert ▪ Revegetate new streambanks	Up to $500,000	Engineering/Hydrology consulting and permitting.	EPA, National Fish and Wildlife Foundation (NFWF), United States Department of the Interior, USGS
Reach 2: Upper Lame Deer Creek	▪ Inventory eroding banks ▪ Implement revegetation treatments ▪ Perform weed control techniques ▪ Construct riparian fencing	Less than $300,000	Engineering/Hydrology consulting, partnership with Rosebud County Conservation District, Montana State Extension Office, BIA Natural Resource Department and BIA land lessees.	EPA,USDI
Reach 3: Middle Lame Deer Creek	▪ Inventory eroding banks ▪ Implement revegetation treatments ▪ Perform weed control techniques	Less than $300,000	Engineering/Hydrology consulting, partnership with Rosebud County Conservation District, USGS and the	BLM, Montana Department of Transportation (MDOT), EPA, NFWF, USGS, BIA

Area of Focus	Actions	Estimated Cost	Technical Assistance Scope of Work	Sources of Funding
	▪ Construct riparian fencing ▪ Stream channel trash cleanup ▪ Nutrient load monitoring ▪ Assess need and conditions of culverts		community of Lame Deer.	
Reach 4: Lower Lame Deer Creek	▪ Inventory eroding banks ▪ Implement revegetation treatments ▪ Perform weed control techniques ▪ Construct riparian fencing	Less than $300,000	Engineering/Hydrology consulting, partnership with Rosebud County Conservation District and Montana State Extension Office, BIA Natural Resource Department and BIA land lessees.	EPA, USDI
Monitoring	▪ Install flow and stream temperature gauge ▪ Resume USGS hydrologic assessment and water quality monitoring ▪ Continue water quality monitoring of 6 designated sites throughout Lame Deer Creek.	Less than $200,000	Partnership with USGS, BIA Natural Resource Department, Engineering/Hydrology consulting.	BIA, USGS, EPA,
Education Outreach	▪ Facilitate watershed health community awareness survey ▪ Volunteer planting and stream cleanup ▪ Develop watershed health related brochures, surveys and informational posters ▪ Educate tribal land lessees of riparian protection and setbacks for watershed health.	Less than $100,000	Partnership with Chief Dull Knife College, Bureau of Indian Education, Boys and Girls Club, NCT Environmental Protection Program.	EPA, DNRC, BIA

4.2 Financial Assistance

There are many grant opportunities specific to Tribes thanks in part to the 2023 Bipartisan Infrastructure Law and the Inflation Reduction Act. Grants are available for a range of activities including planning, implementation, and habitat restoration in an effort to help Tribal communities plan for the most severe climate-related environmental threats (USDI, 2023). **Table 7** describes potential funding sources that could be applied to implement mitigation actions described in this Plan.

Table 7. Lame Deer Creek Watershed Nine Element Plan Funding Sources

Funding Source	Description
Bureau of Land Management (BLM)	▪ BLM - Reserved Treaty Rights Lands (RTRL) and Good Neighbor Authority Fund
Department of Transportation (DOT)	▪ Grants for culvert repairs or improvements.
Environmental Protection Agency (EPA)	▪ Five Star and Urban Waters Restoration Grant Program initiated by National Fish and Wildlife Foundation (NFWF). ▪ EPA 319 Tribal Competitive Grant for project design and implementation.
Indian Health Service, Division of Sanitation Facilities Construction	▪ Funding for environmental conditions effected by sanitation services.
United States Department of the Interior (USDI)	▪ BIA Branch of Tribal Climate Resilience has available funding for planning, implementation, and habitat restoration.
United States Fish and Wildlife Service (USFWS)	▪ Provides grants under the National Fish Passage Program.
United States Geological Survey (USGS)	▪ Cooperative agreement with BIA to implement ground water monitoring activities.

5.0 EDUCATION AND OUTREACH

This chapter will cover element 5, (develop an information and education component) by describing an education and outreach strategy that begins with an investigation of community knowledge to best approach the plan for communication style and type of watershed health related topics.

As mentioned in **Section 1.0**, small stock ponds, dams, and cattle intrusions have had the most significant negative impact on the aquatic community of Lame Deer Creek subwatershed (Stagliano, 2005). The Lame Deer community will be involved in Plan mitigation by participating in an “awareness survey” relevant to the history and health of Lame Deer Creek collaborating with local schools and the Boys and Girls Club on the Reservation. The survey will gauge the community level of understanding towards polluted land on the Reservation and measure the value they place on watershed health. Data gathered from this survey will inform the public education direction and provide context for outreach materials. This survey will also provide a baseline understanding from which to measure as an indicator of education success. Furthermore, additional community involvement would include the following:

- Public Meetings – The Lame Deer community will be regularly informed of ongoing mitigation and restoration activities and will be encouraged to volunteer during riparian planting, trash cleanup, and weed monitoring events.
- Tribal Land Leasing - Grazing permits covering tribal lands are issued by the Tribal Council with the approval of the Secretary of the Interior for set time periods. Use this opportunity to contact the permittee or mail educational resources regarding weed management, streambank protection, and grazing practices as permits are being issued.
- Volunteer Events – Riparian planting and stream cleanup volunteer events are not only ways to inform the community of watershed health concepts but also provide a hands-on experience that directly impacts the watershed they live in.

6.0 IMPLEMENTATION SCHEDULE

This chapter covers element 6, (develop a project schedule) for implementing the nonpoint source management measures identified in section 3.0. **Table 8** outlines a project schedule that is reasonable to fulfill if funding goals are met however, it is recognized that a flexible adaptive approach to implementation activities may become necessary as more knowledge is gained through continued monitoring, assessment, and restoration implementation.

Before much of the implementation can occur, an Environmental Assessment (EA) may be required by the Federal or Tribal authorities for any activity affecting or potentially affecting Reservation waters. Development of a Programmatic EA that covers a broader body of work with a greater geographic range would be an ideal approach rather than having to conduct a feasibility study for every individual project.

All activities which require a federal license or permit on the Reservation are subject to certification by the Tribe consistent with Section 401 of the CWA. The CWA also allows Tribes and States to assume administration of the CWA Section 404 dredge and fill permitting program (NCT WQS,2023).

It should also be recognized that any entity who proposes a project that may affect an artificial wetland shall notify the EPD at least 15 working days prior to initiating the project (NCT WQO, 2021).

Table 8 outlines the implementation timeline for the Lame Deer Creek Watershed Plan.

Table 8. Project Timeline

Projected Goal Year	Project Type	Watershed Improvement Category	Project Description
2024	Revegetation	Sediment, temperature, habitat	Implement streambank riparian planting throughout critical priority areas.
2024	Fencing	Sediment, habitat, temperature	Riparian corridor fencing along critical priority areas to keep cattle out.
2024	Culvert Replacement	Fisheries, habitat, temperature	Replace four crushed culverts with eco-arch
2024	Channel Cleanup	Water quality, habitat	Middle Lame Deer priority reach garbage pick up
2024	Flow Gauge Installation	Water quantity	Install stream flow gauge to monitor flows from spring runnoff to the lowest water level months.
2024	Stream Temperature Gauge Installation	Stream temperature	Install stream temperature gauge to monitor temperatures over the long-term (5 years or more).
2024	Community Awareness Survey	Water quality	Issue watershed health awareness survey to gauge community level of understanding.
2024	Volunteer Activities	Water quality	Coordinate planting and clean-up days throughout mainstem Lame Deer Creek.
2025	Stream Channel Restoration	Fisheries, habitat, temperature	Pursue South Fork channel realignment through design, planning, and implementation phases.

7.0 MILESTONES AND CRITERIA FOR DETERMINING SUCCESS

This chapter will cover element 7, (develop interim, measurable milestones) to determine whether nonpoint source management measures or other control actions are being implemented. **Table 9** organizes the nonpoint source management task with the year in which it will be fulfilled as the measurable milestone. This chapter will also cover element 8, (identify indicators to measure progress and make adjustments), to determine whether loading reductions are being achieved over time and if progress is being made toward attaining water quality standards. **Table 10** pairs the water quality issue with the criteria for which to measure its success.

Prior to the start of a project, baseline data will be referenced in each priority reach for physical, chemical, and biologic parameters. Photo points will be established to compare pre- and post-project conditions.

It is important to note that this Plan constitutes a framework, and priorities for the Lame Deer Creek Watershed along with milestones and criteria for determining success may shift once projects are implemented and additional information is acquired. **Table 9** outlines the milestones to be used to measure progress toward meeting water quality goals.

Table 9. Milestones for Measuring Success

Task	Measurable Milestones		
	2024 – Year 1	2025 – Year 2	2026 – Year 3
Regulatory Compliance	▪ Approved programmatic EA	▪ All permits filed and approved for stream channel restoration	
Revegetation	▪ Map and list of priority riparian restoration areas	▪ Plant 3000 linear feet of streambank vegetation	▪ Plant 3000 linear feet of streambank vegetation
Fencing	▪ Map and list of priority riparian fencing zones	▪ 1 mile of riparian fencing installed	▪ 2 miles of riparian fencing installed
Beaver Mitigation	▪ Develop flyers/handouts for land managers along Lame Deer Creek.	▪ Employ beaver mitigation strategies as problems arise	▪ Refine beaver mitigation strategy plan
Culvert Replacement	▪ Approved final design ▪ Hire contractor ▪ Remove culvert	▪ Volunteer planting day on the newly graded Lame Deer Creek streambanks.	
Stream Channel Restoration	▪ Conduct required surveys	▪ Contractor procured	▪ Volunteer planting day on the South Fork Lame Deer

Task	Measurable Milestones		
	2024 – Year 1	2025 – Year 2	2026 – Year 3
	▪ Approved final design	▪ Implement Reach 1 Headwaters Lame Deer Creek (South Fork) stream channel restoration.	Creek restoration project.
Monitoring Physical, Chemical, and Biologic Habitat Characteristics	▪ Install data logger for flow and stream temperatures ▪ Establish photo points for pre restoration or mitigation activity work.	▪ Resume USGS hydrologic study on Lame Deer Creek and water quality monitoring in the town of Lame Deer.	▪ Engage local students in USGS water quality monitoring
Education Outreach	▪ Distribute and analyze awareness survey ▪ Reach 3 - Middle Lame Deer Creek garbage clean-up volunteer day	▪ Volunteer planting day on Reach 3 - Middle Lame Deer Creek priority reach. ▪ Volunteer planting day on the newly graded Lame Deer Creek streambanks.	▪ Volunteer planting day on the South Fork Lame Deer Creek restoration project.
Financial Assistance	▪ Apply for USFWS Fish Passage Grant ▪ Apply for 319 CWA Competitive Grant		

Short-term criteria for evaluating effectiveness of milestones are quantifiable based on water quality thresholds described in the Tribe WQP (WQS,2023). **Table 10** Shows the criteria that were selected to address the limiting factors contributing to poor water quality.

Table 10. Water Quality Issues and Criteria Indicators

Water Quality Issue	Criteria
Warm water temperatures	▪ Greater percent vegetative canopy cover in critical priority area reaches
Direct sediment delivery to streams	▪ Number of off stream water or water gap structures installed Miles of riparian fencing installed Greater percent of revegetated and stable streambanks along priority area reaches
Fish passage barriers	▪ 10 miles of reconnected perennial stream
Loss of riparian vegetation/ riparian condition degraded	▪ Greater percent of woody riparian vegetation along priority reach of streambank ▪ Miles of riparian fencing installed
Nutrient loading	▪ Reduced number of downstream lagoon algal blooms ▪ Fecal coliform testing results do not exceed 200 per 100 milliliters

8.0 MONITORING AND EVALUATION

Chapter 8 covers element 9, (develop a monitoring component), to evaluate the effectiveness of the implementation efforts over time measuring against the criteria that was displayed in **Table 10**. The chapter will describe the past and ongoing monitoring efforts undertaken by the Water Quality Program before recommending an integration of additional monitoring components to measure trends over time.

There is a long history of monitoring activities within the Lame Deer Creek Watershed through the Water Quality Program under Section 106 of the CWA and a Nonpoint Source Program operating under Section 319 of the CWA. Under these programs the Tribe continues to collect water quality data at eight identified sites monthly from April through October (see **Map of Monitoring Sites** and **Table 1b** in **Appendix B)**. **Table 1b** identifies past and ongoing monitoring activities within the watershed. Additionally, outside consulting groups have analyzed, assessed, and summarized long-term water quality data resulting in the 2020 and 2021 NonPoint Source Assessment documents (NPS Assessment, 2021). These documents have largely driven goals and objectives for this Plan as they address water quality impairments in the context of historic, spiritual, cultural, and physical uses of the watershed.

In addition to these monitoring efforts, the USGS initiated a hydrologic assessment of the Lame Deer Creek Watershed, in October of 2016 under a Northern Cheyenne Cooperative Agreement. As discussed in **Section 3.3,** this hydrologic assessment includes the establishment of 30 wells and 7 inventory sites to evaluate flow and water quality conditions with emphasis on the community in the town of Lame Deer (Summary, 2023).

Monitoring and Data Gaps

Additional data collection will be needed to further assess any trends in chemical, physical, and biologic stream characteristics.

The 2021 NonPoint Source Assessment recommends that the following parameters be routinely monitored:

- Chemical parameters: TSS/TDS, total coliforms, ammonia and total nitrogen and phosphorus.
- Physical parameters: temperature, dissolved oxygen, pH, specific conductance, turbidity, and discharge.
- Biodiversity parameters: macroinvertebrate and aquatic species populations.

To capture long-term data trends related to stream temperature and flow improvement actions, data loggers should be installed at select locations following USGS recommendations.

In August of 2023, an outside consulting firm assessed Reach 1 - Headwaters of Lame Deer Creek and provided a technical memorandum with recommendations for the replacement of the crushed culvert (**Conceptual Plan and Recommendations for Culvert Replacement**, **Appendix C**). Recommended next steps include additional survey and investigations to fill specific data gaps including:

- Topographic and bathymetric survey of the area surrounding the altered portions of the South Fork of Lame Deer Creek extending upstream and downstream of the reach into un-affected portions.

- A hydrologic study calibrated and/or confirmed by field observations for development of accurate peak flow estimates and culvert sizing.
- A soil classification of the existing streambed for culvert substrate design.

Additional funding will be required to incorporate the monitoring and evaluation activities outlined in this Plan and purchase monitoring equipment. Coordination among water resource agencies will be key to monitoring the overall watershed restoration efforts, filling data gaps, tracking long-term trends, and finding cost share opportunities. Given these considerations, the establishment of a multi-agency collaborative team such as a technical advisory group including representatives from state, federal and tribal agencies could provide a level of continuity and consistency in water related analysis and monitoring activities.

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Appendix A

	**Photo 1** *Photo taken 8/8/23* **Location:** Facing north; East Fork Lame Deer Creek downstream of culvert. **Description:** Dense riparian and wetland vegetation at pond
	**Photo 2** *Photo taken 8/8/23* **Location:** Facing southwest. South Fork of Lame Deer Creek upstream of culvert **Description:** Pond upstream of crushed culvert with wetland and riparian vegetation

Photo 3
Photo taken 8/8/23

Location:
Facing southwest. South Fork of Lame Deer Creek upstream of crushed culvert on roadway

Description:
Pond Behind crushed culvert with obligate wetland vegetation

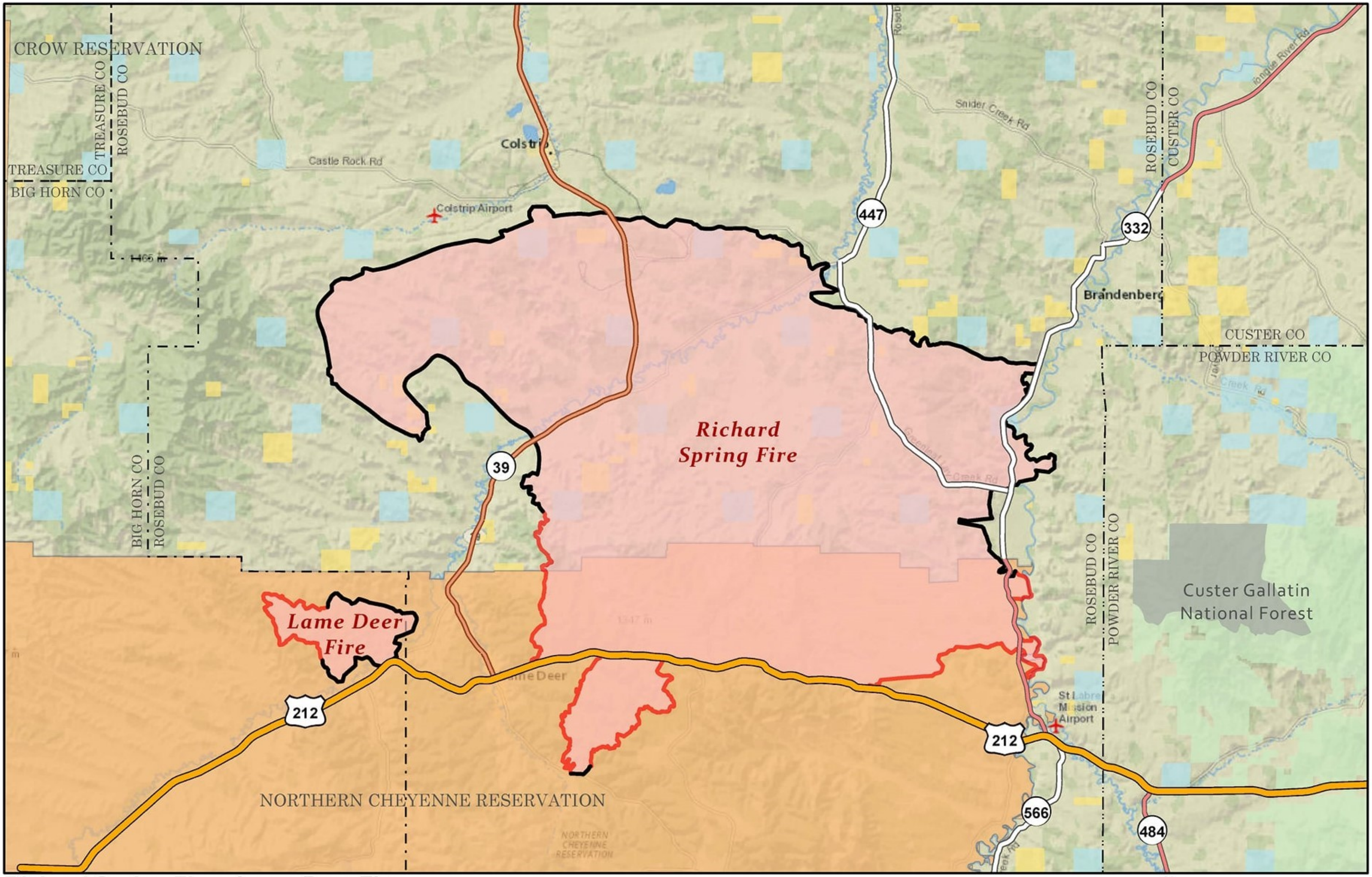
Photo 4
Photo taken 8/8/23

Location:
Facing southwest. Ponded South Fork of Lame Deer Creek upstream of levee

Description:
Pond behind crushed culvert with habitat change in background

Richard Spring Fire

8/19/2021



Richard Spring Fire
MT-LG29-000428
Fire Perimeter as of 08/18/2021 2047 hrs
171,130 Acres

Lame Deer Fire
MT-NCA-000449
Fire Perimeter as of 08/15/2021 2021 hrs
5,427 Acres

- Wildfire Daily Fire Perimeter
- Tribal Lands
- State Lands
- Bureau of Land Management Lands
- National Forest System Lands
- USFS Roadless Areas

NORTHERN ROCKIES INCIDENT MANAGEMENT TEAM · DUTY · RESPECT · INTEGRITY · NORTH IDAHO ZONE

Appendix B

Lame Deer Creek Watershed Water Quality Monitoring Sites

*From the Northern Cheyenne Competitive 319 Grant Application

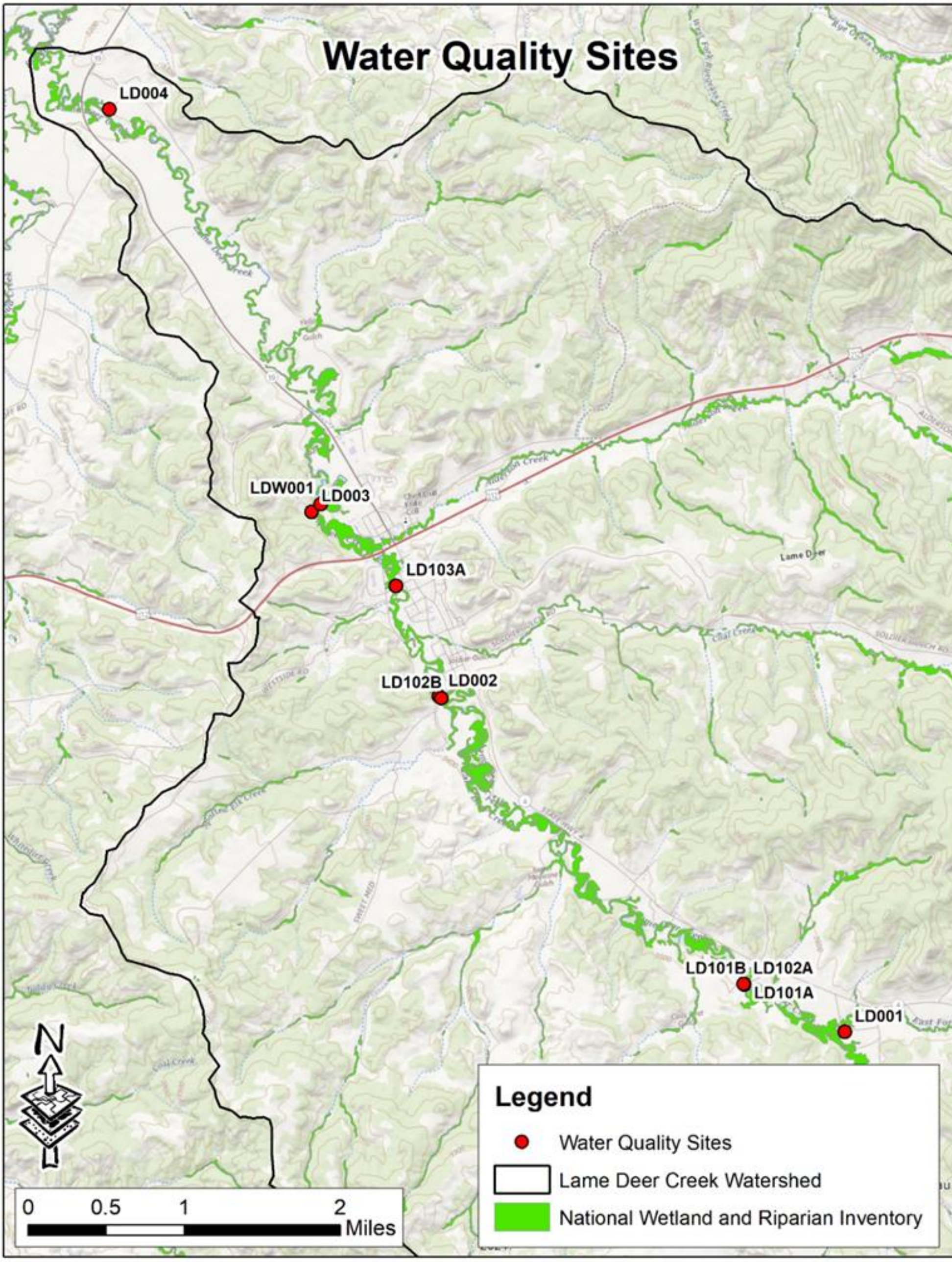


Table 1b. Lame Deer Creek Past and Ongoing Monitoring Sites

* Data extracted from 2021 Non-Point Source Assessment (2021,NPS)

Site Name	Monitored	Distance From Headwater	Impairment	Known Pollutants	Degree of Impact
LD001	2015-16 and once in 2021	0.2	Extremely low flow due to beaver dam and crushed culvert No fish Few aquatic insects	Hydromodification	severe
LD101A	2008, 2015-2016 2021	0.7	Low flow Loss of riparian vegetation Sedimentation No fish Few aquatic insects	Natural and agricultural runoff	moderate
LD002	2007, 2011 2016, 2019, 2021	2.7	Low flow Sedimentation Garbage in stream Loss of riparian vegetation No fish	Natural and agricultural runoff	moderate
LD103A	Once in 2021	3.2	Low flow Sedimentation No fish Few aquatic insects	Natural and agricultural runoff	moderate
LD003	2005-2008 2011 2015-2016 2018-2021	4.2	Low flow Sedimentation Loss of riparian vegetation No fish	Natural and municipal runoff	moderate
LDW001	2014-2016	4.3	Low flow Sedimentation Loss of Riparian vegetation on one bank No fish	Natural and point source input from sewage lagoon	moderate
LD004	2005-2008 2011 2015-2020 2021	10 miles	Low flow Sedimentation No fish	Natural and agricultural runoff	moderate

Appendix C

Beaver Management Plan
Lame Deer Creek Watershed

Northern Cheyenne Tribe Nonpoint Source Program
Rosebud County, Montana

Prepared for:
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December 2023
Project 350.00804.000

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BMP	Best Management Practices
BRAT	Beaver Restoration Assessment Tools
CWA	Clean Water Act
EPD	Environmental Protection Department
ESA	Endangered Species Act
IPaC	Information for Planning and Consultation
IUCN	International Union for Conservation of Nature
MCA	Montana Code Annotated
MFWP	Montana Fish Wildlife and Parks
MTNHP	Montana Natural Heritage Program
NCT	Northern Cheyenne Tribe
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WQS	Water Quality Standards

1.0 INTRODUCTION AND PURPOSE

This Beaver Management Plan (Plan) describes Best Management Practices (BMPs) that have been developed in coordination with the Northern Cheyenne Tribe (NCT) Environmental Protection Department (EPD) to assist with beaver management within the Lame Deer Creek Watershed (**Figure 1**). These BMPs have been prepared in consideration of local stakeholders and regulators within and adjacent to the Lame Deer Creek Watershed.

While the North American beaver (*Castor canadensis*) provides important watershed health and ecological benefits, beaver can be a concern within an agricultural setting because of the damage their activity can cause on property and infrastructure.

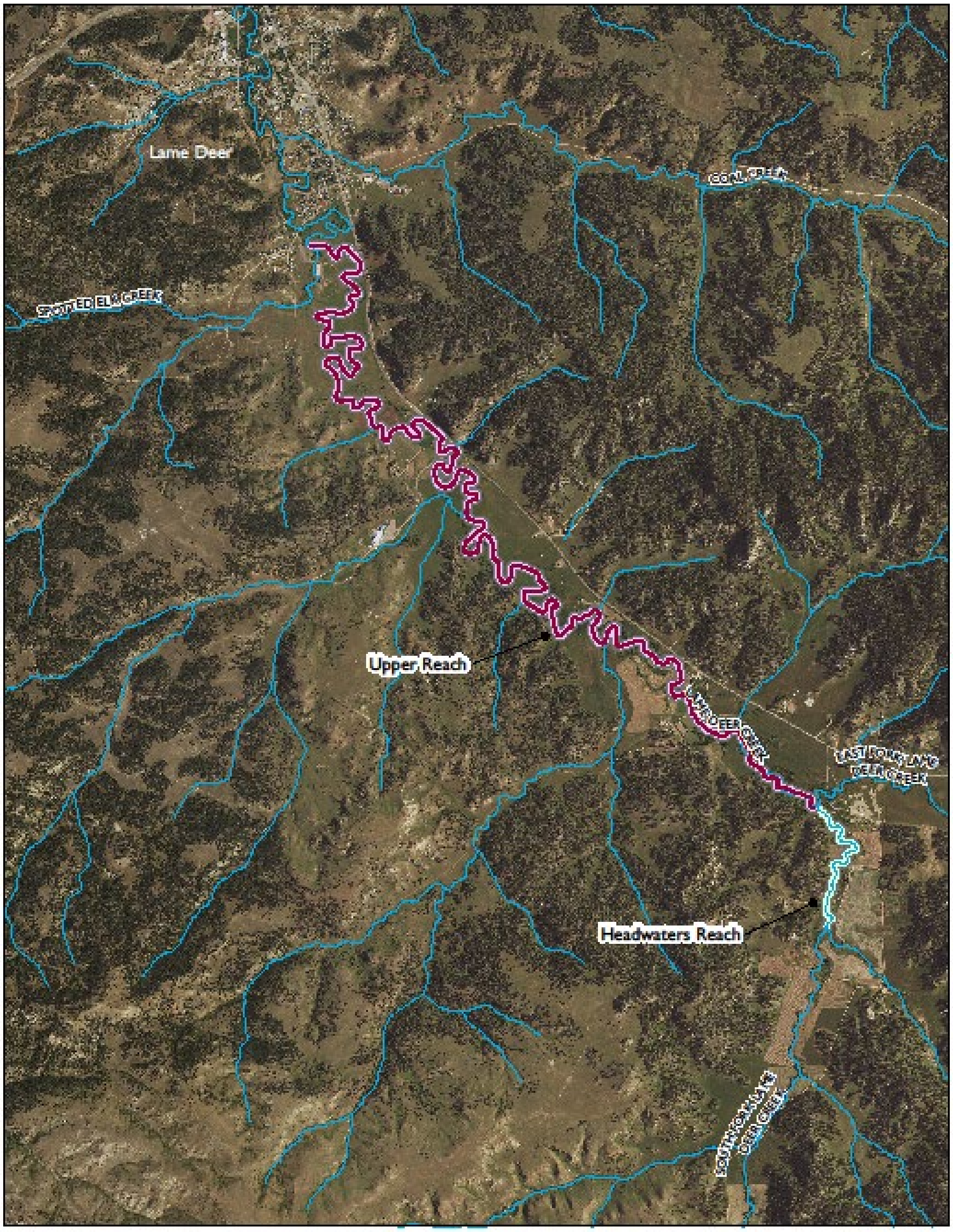
The purpose of developing these BMPs is to: 1) describe watershed health benefits provided by beaver; 2) unify and clarify EPD decision making; 3) document applicable regulatory requirements and consultations for various management actions; and 4) establish standards for when, where, and what methods of beaver deterrence should be used by EPD.

The guiding principle for this effort is the NCT's *Surface Water Quality Standards* (WQS) (NCT, 2022). Under the WQS, the mainstem of Lame Deer Creek is classified as a Class 1 Cold Water Fishery; however, Lame Deer Creek does not currently meet the beneficial and designated uses. The BMPs were also developed to address EPD's three watershed health goals: restore riparian habitat, facilitate stream flows, and cool stream temperatures (NCT, 2023). These guiding principles are intended to comply with U.S. Fish and Wildlife Service (USFWS) regulations and relocation guidelines (Pollock et al., 2023).

While the BMPs covered in this Plan are expected to be effective at most problem sites, all have limitations, and sometimes unsuspected indirect effects or unacceptable costs. The BMPs are intended to provide the information necessary to determine which technique, if any, is the best option for any situation.

This Plan will be reviewed, evaluated, and updated by EPD as needed.

Figure 1. Headwater and Upper Lame Deer Creek Reaches



Headwater and Upper Lame Deer Creek Reaches
Northern Cheyenne
Watershed Restoration Plan
Lame Deer, MT

2.0 NATURAL HISTORY OF THE BEAVER

Beaver are North America's largest rodent and perhaps are second only to humans in their ability to alter the environment. They are considered keystone species and ecosystem engineers for their extensive influence on habitat, water quality, stream morphology, and riparian and aquatic communities (Grudzinski et al., 2022).

The first fur trading post in Montana was established in 1807, following the Lewis and Clark expedition. By the time the fur trade was well established, Native American tribes had been involved for over a century. To satisfy European and eastern American demand for beaver hats and coats, fur trappers virtually eliminated beavers from many landscapes through unregulated trapping. With proper management and wetland protection, beaver have become re-established in much of their former range and are considered common, widespread, and abundant across most of their historic range in Montana. Fur trapping is now more regulated, biologically sustainable, and an important aspect of Montana's cultural history and outdoor lifestyle (MFWP, 2023).

2.1 Beaver Ecology

The North American beaver is a semi-aquatic mammal that inhabit rivers, streams, lakes, reservoirs, and wetlands across North America and have been observed in nearly every county in Montana. The ability of beavers to construct dams to impound water is a unique behavior that profoundly influences their habitat and community ecology. Due to range expansion, beavers are transforming the structure and function of riparian and lotic environments in unoccupied or historically occupied sites (Boyle & Owens, 2007). Physical alterations to the landscape include herbivory, cutting and transporting of dam material, constructing of dens and dams, excavating canals and burrows through stream banks, and creating ponds. Average territory size ranges from 0.4 hectares (approximately 1 acre) to 3.2 hectares (approximately 8 acres), depending on habitat factors including valley width, stream gradient, size of colony, and food and water availability (Castro et al., 2023).

Beaver habitat requirements include year-round surface water, accessible food and construction material, available lodge or denning sites, and suitable dam sites. As stream gradient decreases, beaver occupancy is suggested to increase (Ritter, 2018) as beavers prefer low-gradient (less than 6 percent slope), low-energy streams of 1 to 2 percent slope. Beavers exhibit preferential herbivory that often varies seasonally. Preferred species along Lame Deer Creek include quaking aspen (*Populus tremuloides*), black cottonwood (*Populus balsamifera*), eastern cottonwood (*Populus deltoides*), Bebb's willow (*Salix bebbiana*), narrowleaf cottonwood (*Populus angustifolia*), peach-leaf willow (*Salix amygdaloides)*, sandbar willow (*Salix exigua*), chokecherry (*Prunus virginiana*), and green ash (*Fraxinus pennsylvanica*). See **Appendix A** for site photos. Conifer species in the area, such as ponderosa pine (*Pinus ponderosa*), have a lower nutritional value compared to deciduous species, but are occasionally consumed (Wohl et al., 2019). Leaves, buds, twigs, and inner bark are consumed, and most trees are cut within 100 meters (328 feet) of the water's edge (Boyle & Owens, 2007). Herbaceous and aquatic vegetation, including grasses, sedges (*Carex* spp.), and cattail (*Thypha* spp.) provide an important supplement to winter food caches.

Beavers will occupy aquatic habitats in a wide variety of ecosystems by modifying their habitat to meet their needs via the construction of dens, dams, and ponds. Ponds create deep water for protection from predators, access to food supply, and thermoregulation. In Montana and other cold climate regions, dam construction and maintenance are critical to ensure that the water depth is sufficient to prevent freezing and allow for overwintering and access to food caches (Boyle & Owens, 2007). Beavers typically build more than one dam to maintain a sufficient water supply. As the water level recedes in the summer, beaver activity shifts towards building and maintaining channels that lead to nearby ponds and food sources (COP, 2020).

Stream bank stability is an important factor for construction of dens. The types of dens (i.e., lodges) beavers construct include bank burrows, bank lodges, and water lodges. Numerous temporary dens are often occupied by a colony. Monogamous adult pairs will breed in dens and underwater ponds from January to February. In April to June, an average of three to four kits are born in the main lodge (Boyle & Owens, 2007). Yearlings abandon their dwellings and disperse from their natal colony to expand their range. By fall, the colony returns to the main lodge where huddling behavior helps conserve body heat (Boyle & Owens, 2007). According to a 1990 study, the average colony size in Montana is approximately four individuals (Pollock et al., 2023).

In Montana, beavers live an average of 5 to 10 years in the wild (MFWP, 2023). Humans remain the greatest predatory threat to beavers. When foraging on shore or migrating overland, beavers are also killed by bears, wolves, coyotes, bobcats, cougars, or domestic dogs (MFWP, 2023). Other sources of mortality include severe winter weather, winter starvation, disease, water fluctuations, floods, and falling trees.

2.2 Benefits of Beaver Activity

Beavers provide key ecosystem services by creating or expanding wetlands that provide numerous benefits to a variety of wildlife and aquatic species. Habitat modification activities of beavers have been recognized in scientific literature as instrumental in the creation, expansion, and maintenance of productive riverine systems and associated wetland and riparian habitats (Ritter, 2018; Castro et al., 2023; Boyle & Owens, 2007; Wohl et al., 2019). The benefits are recognized by land and wildlife managers and beaver restoration projects are increasingly being used as a technique to restore degraded streams.

Beaver activity reduces stream channel incision, stream bank erosion, and loss of floodplain habitat by decreasing peak flows, increasing water retention, reducing stream velocity, and increasing lateral spreading and soil saturation (Pollock et al., 2023; Boyle & Owens, 2007; COP, 2020; Ritter, 2018). The increased surface area attributable to lateral expansion of streams contributes to surface and subsurface water present in a watershed. This retention of water within a watershed is expected to be an effective tool to mitigate drought amidst global change (Pollock et al., 2023). Expanding habitats to include fast- and slow-moving water increases habitat heterogeneity (i.e., complexity) and biodiversity of flora and fauna. The increased surface area and water depth in pools provides important habitat and resources for both terrestrial and aquatic biota (Pollock et al., 2023). Ponds greater than six feet deep typically stratify and provide deeper, cooler water refugia for fish species during warmer summer temperatures (Ritter, 2018).

Beaver activity influences wetland plant communities because increased overland flow and wetland expansion drives ecological succession. Herbivory on willow species results in a mutualistic interaction in which beaver cutting stimulates willow growth patterns beneficial to beavers and other wildlife species (Boyle & Owens, 2007). These relationships create habitat complexity and a mosaic landscape with a broad range of age and successional stages of vegetation. Newly created ponds remove upland species (such as ponderosa pine), incapable of tolerating wetland conditions. When upland species are removed by beaver herbivory or saturated conditions, the canopy opens, and sunlight facilitates the growth of emergent hydrophytic vegetation (**Photo 1, 2, 3; Appendix A**). NCT members have recognized many of these wetland and riparian plant species as having significant cultural value that have historically provided medicinal or food value to the NCT (NCT, 2016).

Beaver ponds reduce suspended sediments in the water column, improve nutrient cycling, store and remove freshwater contaminants, and improve water quality (Castro et al., 2023; Ritter, 2018; Pollock et al., 2023). Ponds function as long-term sinks where contaminants, such as excess nutrients (nitrogen and phosphorous), are retained in the system long enough to be removed via deposition, microbial decomposition, plant uptake, or chemical transformation (Pollock et al., 2023). Ponding and lateral flow from beaver activity expands the area of anaerobic soil conditions for microorganisms to thrive. During dry periods, aerobic conditions in the soil facilitate nutrient cycling and nutrients become bioavailable to plants.

3.0 BEAVER LEGAL STATUS

Federal, tribal, and state governments all have a certain amount of jurisdictional authority over the management of beaver. Typically, state legislatures and state Fish and Game Departments set the rules for beaver management across a state, but Indian nations and federal agencies within a particular state's boundaries sometimes develop their own beaver management guidelines.

As previously mentioned, the status of the North American beaver is listed as 'G5' and 'S5' for the global and state ranking, respectively (MT.Gov, 2023). This status indicates that the beaver is common, widespread, abundant, and is not vulnerable to extinction or extirpation in most of its range. The North American beaver is listed as a species of 'least concern' with a stable population, according to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (2016).

In Montana, beavers are classified as furbearers and are regulated by MFWP on non-tribal land. A license or damage permit is required to trap legally within the specified open season. A special license is required to trap furbearers, sell furs, or for landowners to trap problematic beavers on privately-owned land for damage control. Further, a trapper education course is mandatory under Montana Code Annotated (MCA) 87-2-127. Landowners of property being damaged by beaver as described in MCA 87-6-602(2) may request a damage control permit to remove beaver by trapping or shooting and may remove beaver outside the open trapping season.

The Fish and Wildlife Commission has, by rule, closed all State of Montana Trust lands to the hunting and trapping of all furbearers with the use of a state license (MCA 87-6-602 CR). A state-issued license is not valid on Indian Reservations. With some exceptions, there is no Congressional authority to regulate hunting, fishing, trapping, and gathering on Indian reservations. Tribes retain jurisdiction over beaver management on their respective reservations.

3.1 Lethal Trapping on Indian Trust Lands

Tribal members have exclusive rights to hunt, fish, trap, and gather on Indian Trust and restricted lands within the exterior boundaries of their reservations. Tribes also retain jurisdiction over these activities on their respective reservations except for allotted parcels of land within the boundaries of their reservations. Allottees of these parcels of land (individual members of a Tribe) retain the exclusive right to hunt, fish, trap, and gather on their allotments but must comply with Tribal rules, regulations, and ordinances (BIA, 2022).

The extent of authority, jurisdiction, and responsibility varies according to "reservation" and "non-reservation" areas and is dependent upon land status and specific language contained in individual treaties, Executive Orders, court decisions, resource-specific statutes, and other legal instruments. Tribes determine the scope of fish and wildlife program activities for their respective reservations (BIA, 2022).

3.2 Lethal Trapping on Fee Lands

According to Charlene Alden, Tribal Environmental Protection Director (2022), The Tsis tsis' tas people of the Northern Cheyenne Reservation have been stewards of the land for thousands of years. They have worked hard to balance ecosystem health with the needs of subsistence hunting and management. Tribal members have a spiritual connection to the natural world and desire to preserve, protect, and restore land for future generations.

The Northern Cheyenne EPD and Natural Resources issue permits to tribal members to lawfully trap beaver within the open season dates. Further, it is illegal to engage in beaver trapping outside season dates or without the appropriate permit within all lands of the Northern Cheyenne Reservation.

3.3 Relocation

In 1996, the NCT sponsored the Tongue River Watershed Conservation Plan (NCT,1996) with the assistance of the United States Department of Agriculture (USDA). The plan covered a section on Beaver Habitat Enhancement and Reintroduction with the long-term goal of improving water quality and fish and wildlife habitat. The basis for beaver habitat enhancement and reintroduction was to slow water flows thereby reducing sediment scour, improve fish habitat through the addition of open water, and benefit wildlife species through the expansion of the riparian zone (NCT, 1996)

Several criteria were recommended for beaver reintroductions including appropriate tree and shrub availability, the best timing for beaver release and to contact the MFWP to obtain beavers for transplanting to suitable sites.

Each state has specific guidelines, rules, and regulations for managing, capturing, handling, and relocating beavers. On non-tribal land in Montana, relocation of beaver requires cooperation with MFWP, completion of an Environmental Assessment, and approval by the Fish and Wildlife Commission. Wild furbearers captured alive must be killed or released. It is unlawful for a person to possess or transport furbearers alive (MFWP, 2022) without a permit or expertise.

Section 5.0 – Beaver Restoration Assessment Tools of this Plan describes the Beaver Restoration Assessment Tool (BRAT) that can provide an overview of the spatial distribution and abundance of potentially suitable beaver habitat in a stream network. Although this model can inform decisions on areas for relocation, they may also need to be verified with an MFWP wildlife biologist.

4.0 DISTRIBUTION AND ABUNDANCE WITHIN THE WATERSHED

In 2021 tribal elder, Jules Spang, Sr (80 years old at the time of interview) described the Lame Deer Creek Watershed as a stream system that supported a functional fishery when he was a child. He also remembered that large species such as beaver, coyote, and bear were prevalent in his youth.

Prior to 1940, natural springs fed Lame Deer Creek at a rate sufficient to support a cold-water fishery from the headwaters to the confluence with Rosebud Creek. Tribal elders recall an intact riparian area without stream bank erosion (NCT, 2022b). However, in the late 1940's the Bureau of Indian Affairs (BIA) used explosives to increase flow. This permanently altered the hydrology of the system resulting in unintended decreases in stream flow (NCT, 2022b).

In 2021 there was evidence of beaver activity at the headwaters of Lame Deer Creek. Beaver had impounded water at the stream source and had significantly reduced flow into the watershed. During a site visit in 2023, NewFields visited the location of the impoundment but the beaver dam was not located (see **Appendix A** for site photos). According to interviews with tribal members, the dam has been removed by ranchers in the area to provide better drinking water access for cattle.

Beaver populations are limited by habitat availability as discussed above. Typically, the density will not exceed one colony per ½-mile under the best conditions (MFWP, 2023). Beaver observations and dam building capacity within the watersheds of the Northern Cheyenne Reservation are discussed below in **Section 5.0 – Beaver Restoration Assessment Tools.**

4.1 Discussion of Beaver Dam Impacts

4.1.1 Positive

While Lame Deer Creek cannot attain or maintain NCT's WQSs due to both natural and human-made blockages of the creek, beaver impoundments likely provide some benefits to the watershed. Beaver dams slow stream velocity, decrease erosion, promote infiltration, raise the local water table, increase dry-season streamflow, and create ecosystem complexity (Castro, 2015; Puttock et al., 2017).

Beaver impoundments can lead to new channelization parallel to the primary stream channel as overflowing stream discharge begins to migrate around structures. After a time, increased habitat heterogeneity and raised water tables can lead to diverse and complex stream and riparian ecosystems, and the development of low energy wetlands. Natural systems like this consist of features like oxbow lakes, point bars, cut banks, floodplains, and braided channels (Castro, 2015). Each of these features create critical differentiation in both flow velocity and depth (Howard & Larson, 1985) leading to dense vegetation and nutrient cycling. As such, continued development of the restored wetland may result in increased biodiversity and ecosystem resilience (Bouwes et al., 2016; Castro, 2015; Mitchell & Niering, 1993). For example, both diversity and abundance of fish populations are positively related to habitat heterogeneity. Faster stream flows and coarse substratum downstream of dam structures increase the array of fluvial habitats available. These changes can be critical for the propagation of fish, whose life cycles depend on slow water to spawn, fast water to grow, and hard substrata which trap small sediments and improve water quality (Bouwes et al., 2016).

Based on available historical aerial imagery at Lame Deer Creek, beaver have produced wide, shallow ponds around the headwaters in the past. These shallow ponds likely serve as a boost to infiltration and groundwater storage in the immediate area. Additionally, water retention from beaver activity can be an effective strategy to combat drought and wildfires. Wetlands act as natural fuel breaks, giving firefighters a chance for containment.

4.1.2 Negative

Despite their important roles, western states have a long history of viewing beavers as a nuisance species. Where beavers occupy developed or agricultural areas, their behavior often comes into conflict with human land uses.

Destruction to Vegetation

The construction and maintenance of a beaver complex can be damaging to riparian vegetation, especially if the local ecosystem is already stressed. Vegetation composition can change drastically with beaver occupancy. An adult beaver can cut 200 to 300 trees per year, most of which are within 30 meters of the water's edge (Wohl et al., 2019). In areas where landowners view riparian trees as a beneficial component of a stream corridor, the removal of canopy and a large number of trees may be viewed as deleterious to the land. Beavers alter vegetation communities by selectively removing preferred, dominant trees (e.g., cottonwoods) which can drive species diversity and structure in riparian vegetation. Further, the invasive potential of exotic introduced species, such as Russian olive (*Eleagnus angustifolia*) or tamarisk (*Tamarix* spp.), can be increased because of preferential herbivory (Lesica & Miles, 2004).

Once trees are cut, there is the potential for large woody debris to become mobile in streams and obstruct flows or damage infrastructure. Foraging activity may also result in damage to timber, crops, or ornamental plants (Boyle & Owens, 2007). Riparian habitat destruction is thought to be more pronounced in low-elevation areas subject to intensive agriculture or urban development (Boyle & Owens, 2007).

Destruction to Private Property, Flooding, and Dam Blowouts

Beavers construct and maintain dams with a variety of materials available near the water's edge. In addition to woody vegetation, dam building materials can consist of fencing material, bridge planking, wire, metal, plastic, crops, and ornamental plants (MFWP, 2023). Elevated water levels from beaver dams can jeopardize the integrity of septic systems, roads, structures, or land use activities. Subsurface, lateral channel migration from beavers can expose or undermine infrastructure such as pipelines, bridges, roads, or buildings near active channels (Boyle & Owens, 2007). Repair to damaged or impaired property (e.g., culverts) is often difficult, time-consuming, or expensive to landowners. Although there are beaver deterrence methods for landowners to mitigate damage to private property (see **Section 6.0** and **Section 7.0**), preventative strategies are not always feasible.

Beaver dams can increase backwater flooding or inundation of adjacent bottomlands. Beavers respond to the sound of moving water by damming narrow channels and culverts to impound water, potentially causing flooding of roads. Beaver-cut trees and shrubs that dislodge and become mobile in streams during high water events can create stream blockages in culverts, diversion intakes, bridges, or natural features. Beaver ponds increase the stream surface area as water expands laterally. Despite the ecological benefits of expanding wetlands and reducing stream velocity, the increase in surface and subsurface flow can become a flooding hazard when adjacent to human land use. Another potential flood hazard is the risk of a dam blowout. Dam blowouts are high energy and high-volume events that can temporarily result in damaging increases in stream flow and erosion and can increase sediment loading downstream.

Barriers to Fish Migration

Numerous positive effects of beaver modification on fish species have been reported. However, the most cited negative impact of beaver dams on fish species is the creation of barriers to fish movement (Pollock et al., 2023). Beaver dams have the potential to create barrier effects, posing a threat to upstream migration. Upstream passage of fish over beaver dams is strongly correlated with hydrologic conditions (Cutting et al., 2018). Beaver dams on small streams, coupled with land use alteration and increased prevalence of drought are likely more at risk for creating barriers to fish movement. Localized barriers can impede fish passage to spawning habitat, a predicament worsened by low flows during migration (Cutting et al., 2018). Though fish can jump over barriers, vertical jump height is highly variable across species and is a major factor influencing passage success or failure at barriers (Cutting et al., 2018).

According to the NCT WQSs, Lame Deer Creek is a Class I Cold Water Fishery and salmonid propagation and growth is listed as a designated use (NCT, 2022a). A non-point source assessment of Lame Deer Creek was completed by the Tribe in 2021 (NCT, 2021). The assessment evaluated macroinvertebrate biodiversity at nine sites within a 14.2-mile stream reach. At the time of the assessment, fish were absent at all nine sites evaluated within the watershed (NCT, 2022b). Numerous compounding factors are likely contributing to an absence of fish at the time of assessment including land use change, wildfire activity, or climate. A National Oceanic and Atmospheric Administration (NOAA) summary for weather and precipitation in Montana in 2021 shows that temperature averaged well above normal, with several records for extreme heat. Similarly, precipitation was below normal, at record dryness at several locations. For example, Billings and Miles City were at 13 percent and 43 percent of normal precipitation during the month of July in 2021, respectively.

Impacts to Water Characteristics

Beaver impoundments change the spatial and temporal distribution of water in a watershed (Pollock et al., 2023). Beaver dams across small streams can interfere with the water regime and diminish flow down-gradient creating intermittent or ephemeral stream conditions. Reduced longitudinal connectivity can have deleterious effects on aquatic ecosystems and land uses downstream. Upstream, ponding at beaver impoundments increases water retention and decreases water velocity through small channels. Surface water ponding changes a streams thermal regime and is likely to result in slighter warmer stream temperatures, especially in shallower ponds (Wohl et al., 2019). Though ponds can provide deep, cold-water refugia for fish species, down-stream warming can push cold-water taxa to their physiological limits (Stevenson et al., 2022).

Warmer stream temperatures and flow are associated with declines in concentrations of dissolved oxygen (DO), leading to potentially interacting stresses on cold-water species (Stevenson et al., 2022). These combined effects can increase breeding areas for mosquitoes or harbor disease organisms such as *Giardia* *lamblia* (Boyle & Owens, 2007). The effect of beaver activity on stream temperature is highly dependent on pre-existing conditions including stream width, depth, and hydrology (Boyle & Owens, 2007; Stevenson et al., 2022). Alterations to riparian vegetation can have an initial warming effect on stream temperatures due to the loss of canopy cover.

Ponding at beaver impoundments can increase the volume of organic matter in the system. Beaver dams function as sediment and pollutant traps due to the rapid decrease in stream velocity when water enters a pond (Ciuldiene et al., 2020). Organic and mineral particles of soil typically accumulate in sediment in ponds which can cause water chemistry alterations (Ciuldiene et al., 2020). Excess nutrients from agricultural practices that accumulate in the slower water can trigger algae blooms and even hypoxic conditions for aquatic species. Although beaver dams are known to improve water quality overall by acting as a filter and pollutant sink; beaver ponds can be a hotspot for excess nutrients, organic carbon, and methyl mercury concentrations in water and sediments (Ciuldiene et al., 2020).

Along Lame Deer Creek, beaver activity near the headwaters may be responsible for reducing flows downgradient (NCT, 2022b). However, factors such as the expansion of anthropogenic land use, such as for development, livestock, or agriculture, combined with undersized, misaligned, or unmaintained culverts significantly contribute to altered hydrology and diminished flows. According to DNRC Water Rights Query System (2023), there are numerous levees located on South Fork of Lame Deer Creek that impound water for stock and are utilized for irrigation. The artificially created ponds are visible in aerial imagery. Discharge in the lower reaches of the watershed has been greatly reduced and is causing abnormally high readings in turbidity, specific conductance, water temperature, and low total dissolved oxygen concentrations (NCT, 2022b). Based on a 2021 assessment of the Lame Deer Creek Watershed, no section of the stream reach is supporting the uses or goals defined in the NCTs WQSs (NCT, 2022b).

5.0 BEAVER RESTORATION ASSESSMENT TOOL RESULTS

The Montana Natural Heritage Program (MTNHP) BRAT was used as a decision support and planning tool to guide beaver management within the impacted area of Lame Deer Creek Watershed. BRAT is an ArcGIS-based modeling tool developed at Utah State University that was developed to address two perceived needs in supporting beaver-based restoration: the need to quantify riverscapes in terms of habitat to support dam building activity (capacity model); and to identify the spatial extent and degree of potential interaction between dam building and anthropogenic land use activities (conflict model) (Kornse & Wohl, 2020). BRAT calculates the capacity of beaver dams per 300-meter stretch of stream based on existing vegetation, land cover and use, availability of suitable dam building material, stream gradient, stream discharge, and baseflow discharge. The map product of beaver dam capacity can be used to estimate the carrying capacity for a stream or watershed and can assist with evaluating the suitability for beaver reintroduction or relocation.

Beaver Dam Capacity and Beaver Management Model Outputs from BRAT Analysis

A total of two stream reaches with a combined 7.7 stream miles (12,335 meters) of Lame Deer Creek were assessed using BRAT to determine beaver capacity and management ratings. The two reaches used in the analysis include: the upper reach of Lame Deer Creek (approximately 6.9 miles or 11,135 meters) from the headwaters site to the confluence of Spotted Elk Creek at the town of Lame Deer; and the headwaters reach of the South Fork of Lame Deer Creek (approximately 3/4-mile or 1,200 meters) (**Figure 2**). A total of seven outputs were generated in the BRAT (see **Table 1**)**.** Within each categorical output, the stream length and percentage of reach by their respective BRAT rating was tabulated into **Table 1** below. The generated map outputs are in **Appendix B.**

The entire reach (100 percent) is rated as 'dam building possible' meaning that natural vegetation, land use, slope, stream size, and stream velocity are not limiting factors preventing dam building. The 'existing dam building capacity' and 'historic dam building capacity' model outputs represent the beaver dam capacity per kilometer or mile of a stream segment. Historically, 100 percent of the reach was rated as 'pervasive' with a capacity to support 24 to 64 dams per mile (see **Figure B-1**). Today, the dam building capacity of the reach is rated as 16 percent 'pervasive', 50 percent 'frequent' (8 to 24 dams per mile), and 34 percent 'occasional' (2 to 9 dams per mile) (**Figure B-2**). These values are used to model the 'existing dam complex size capacity' and 'historic dam complex size capacity,' which represent a modeled maximum number of dams a particular segment of the stream network can support. Historically 95 percent of the reach had a capacity rating of supporting a 'large complex' of greater than five dams (**Figure B-3**). Today, 9 percent of the reach has a large complex capacity, 19 percent supports a medium complex (3 to 5 dams), 38 percent supports a small complex (1 to 3 dams), and 34 percent supports a single dam (**Figure B-4**).

The output, 'Conservation and Restoration Opportunities,' identifies the level of effort required to establish beaver dams on the landscape. Fourteen percent of the reach is considered the 'easiest' effort, indicating that the reach is already suitable for beavers and just the presence of beavers is needed for restoration, if not already inhabiting the area (**Figure B-5**). Eighty-six percent is rated as 'Other' potentially due to the 'Risk of Undesirable Dams' rating (**Figure B-6**) that is incorporated into the model. The 'risk of undesirable dams' rating is based on land use layers and anthropogenic proximity to features including roads, railroads, canals, ditches, and bridges. There are no portions of the reach that are considered a major risk if dams are present. Five percent of the reach is at considerable risk, 57 percent is at minor risk, and 38 percent is of negligible risk if beaver dams are present. The 5 percent of stream that is at considerable risk if dams are present is a 600-meter stream segment that is adjacent to and within 50 feet (15 meters) of Lame Deer Divide Road (Highway 4).

Table 1. Results of BRAT Analysis of the Upper Reach of Lame Deer Creek and Headwaters Reach of South Fork of Lame Deer Creek

BRAT Management or Capacity Layer	BRAT Rating				
	Large Complex (>5 dams)	**Medium Complex (3-5 dams)**	**Small Complex (1-3 dams)**	**Single Dams**	**No Dams**
Existing Complex Size Capacity	1,090 m	2,400 m	4,709 m	4,136 m	0 m
	9 %	19 %	38 %	34 %	0 %
Historic Complex Size Capacity	11,735 m	600 m	0 m	0 m	0 m
	95 %	5 %	0 %	0 %	0 %
	Pervasive: 14-40 dams/km (24-64 dams/mi)	**Frequent: 5-15 dams/km (8-24 dams/mi)**	**Occasional: 1-5 dams/km (2-8 dams/mi)**	**Rare: 0-1 dams/km (0-2 dams/mi)**	**None: 0 dams**
Existing Dam Building Capacity	1,990 m	6,209 m	4,136 m	0 m	0 m
	16 %	50 %	34 %	0 %	0 %
Historic Dam Building Capacity	12,335 m	0 m	0 m	0 m	0 m
	100 %	0 %	0 %	0 %	0 %
	Major Risk	**Considerable Risk**	**Minor Risk**	**Negligible Risk**	
Risk of Undesirable Dams	0 m	600 m	7,045 m	4,690 m	
	0 %	5 %	57 %	38 %	
	Easiest	**Straight Forward, Quick Return**	**Strategic Long-Term Investment**	**Other**	
Restoration or Conservation Opportunities	1,690 m	0 m	0 m	10,645 m	
	14%	0%	0%	86%	

Source: MTNHP, 2020

Note: See **Appendix B** for generated map outputs.

Beaver Observations Within the Rosebud Creek Watershed

The MTNHP Beaver Observations layer shows three beaver observations within the Rosebud Creek Watershed (MTNHP, 2020). In 2009 a beaver was observed 3.8 miles south-southeast of the convergence of Rosebud Creek and Indian Creek approximately 40 miles south of the confluence of Lame Deer Creek. In 1999 and 2000, two beavers were killed approximately 1-mile apart on U.S. Route 212 (US 212) at Alderson Creek, located approximately 9 miles from the convergence of Lame Deer Creek. According to a wetland monitoring report in 2004 (MDT) beaver dams were observed along Alderson Creek and US 212 causing obstructed stream flow downstream below the wetland.

There have been numerous beaver observations on the Tongue River, which forms the eastern boundary of the Northern Cheyenne Reservation. Along the Reservation boundary, there have been 5 beaver observations on the Tongue River.

Beaver Reintroduction

BRAT modeling is a highly valuable tool that has implications for beaver reintroduction or stream restoration (Kornse & Wohl, 2020). BRAT can provide a rapid overview of the spatial distribution and abundance of potentially suitable beaver habitat in a stream network to aid in project planning. Stream morphology, vegetative characteristics, and hydrology are major characteristics that influence beaver occupancy and successful reintroduction. If conditions are inadequate at the release site, transplanted beavers can move significant distances after reintroduction or suffer high mortality rates (Ritter, 2018). Despite inherent challenges with reintroduction, beaver restoration is a passive, low cost, minimal maintenance stream restoration option that can provide benefits at a large spatial scale.

6.0 BEAVER DETERRENCE METHODS

EPD will consider all options for resolving beaver conflict within the Lame Deer Creek Watershed. Techniques will range from no action to habitat modifications and from moving beaver to lethal actions. Each of these techniques is described below. A flowchart that summarizes when each of the actions below is a valid method is included in **Appendix C**. In some cases, multiple methods may be required.

6.1 No Action

In areas where no adverse effects are currently observed or anticipated, beaver activities should be monitored. Continual sampling for changes in water quality and stream flow would be useful to identify potential trends related to the no-action alternative.

6.2 Habitat Modification

When using habitat modification methods to manage beaver activity within a leveed area, it is important that migratory fish passages remain open to the extent practicable. Outside the leveed area, fish passage must be maintained.

6.2.1 Habitat Modification Regulations and Consultations

Under MCA 87-6-601(3), it is unlawful to "willfully destroy, open or leave open, or partially destroy a house of any beaver". Therefore, disturbance to beaver dens and lodges is a trapping and snaring offense enforced by MFWP on non-tribal land. The Northern Cheyenne EPD should be contacted if habitat modification is likely to disturb beaver dens or lodges.

Under Section 404 of the Clean Water Act (CWA), the U.S. Army Corps of Engineers regulates all Waters of the United States, including Lame Deer Creek. When a dam is breached or removed by humans, debris could be discharged into the water. The debris that ends up in the water would be considered "incidental fallback" or discharge fill. However, exemption 33 CFR 323 allows beaver dams to be breached without a permit where they have resulted in damage to roads, culverts, bridges, or levees if done in a reasonable amount of time. If beaver dams cannot be breached or removed under exemptions in 33 CFR 323, then the landowner would be responsible for seeking the necessary permits under Section 401 and Section 404 of the CWA.

If wetland characteristics exist at a location where a beaver dam occurs, breaching or removal could result in the degrading or removal of a wetland. If water impounded by a beaver dam persists for an extended period, hydric soils and hydrophytic vegetation could eventually form. The regulatory definition of a wetland stated by the U.S. Army corps of Engineers and the Environmental Protection Agency (EPA) (40 CFR 232.2) is:

> *"Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."*

As stated in NCT's WQSs (2022), the EPD shall review all proposed activities subject to wetland water quality standards and shall determine whether the project component has shown if activities are in conformance with the provisions of water quality standards for wetlands. According to the *No* NCT's WQSs*,* Lame Deer Creek is classified as a Class I Cold Water Fishery, which provides protection, propagation, and growth of Salmonid fishes, as well as protection, growth, and propagation of associated aquatic life. Any proposed habitat modification that has the potential to impact wetlands may require consultation with the EPD which will administer the water quality standards for NCT.

Flow devices, such as pond levelers or beaver deceivers proposed on Lame Deer Creek would also be regulated under Section 404 of the CWA due to the activities resulting in alterations or modifications to the bed or banks of a jurisdictional stream and potential loss of wetlands. Depending on the waterbody, this could also include an Endangered Species Act (ESA) impact assessment. The National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service are two federal agencies that oversee the recovery of species listed under the ESA and recognize the importance of beaver-created habitat. Thus, management of beavers within the range of endangered species often requires consultation from such agencies (Castro et al., 2015). According to the Information for Planning and Consultation (IPaC) U.S. Fish and Wildlife Service Database, there are two listed endangered species potentially within 50 meters of Lame Deer Creek: monarch butterfly (*Danaus plexippus*) and northern long-eared bat (*Myotis septentrionalis*). Prior to any planned restoration or other activities involving land disturbance, a habitat assessment must be done by a qualified biologist in order to determine the likelihood of effects to ESA-listed species in the affected environment.

It is worth mentioning that on July 19, 2023, the U.S EPA announced a proposed rule to revise the CWA Section 404 Tribal and State Program Regulations (40 CFR Parts 123, 123, 232, and 233). The EPA's proposal would address key barriers identified by Tribes to assuming and administering CWA section 404 while expanding opportunities for Tribes to meaningfully engage in permitting actions.

Table 2 provides a summary of actions and regulatory approvals and consultations related to beaver management on the Northern Cheyenne Reservation.

Table 2. Summary of Actions and Regulatory Approvals and Consultations

Action	Regulatory Approvals or Consultations
Dam Breaching	1. Consult Northern Cheyenne Department of Environmental Quality for compliance with water quality standards for wetlands.
Dam Removal	1. Permit from U.S. Army Corps of Engineers required. 2. Consult Northern Cheyenne Department of Environmental Protection and Natural Resources for compliance with wetland water quality standards
Culvert Fences or Pond Leveler	1. Consult U.S. Army Corps of Engineers regarding a removal/fill permit. 2. Consult Northern Cheyenne Department of Environmental Protection and Natural Resources for compliance with wetland water quality standards.
Eviction/Relocation	1. Consult MFWP. Possible approval from Fish and Wildlife Commission may be required. 2. Consult Northern Cheynne Department of Environmental Protection and Natural Resources

Action	Regulatory Approvals or Consultations
Lethal Trapping	1. Trapping permit from Northern Cheyenne Department of Environmental Protection and Natural Resources required.

Note: There are exemptions to the required permits listed above (e.g., emergency actions) that are site specific and circumstantial. It is recommended that the regulatory agencies be contacted as it is possible that a permit is not required as stated above.

The actions listed in **Table 2** are discussed in detail below.

6.2.2 Dam Breaching and Removal

Dam breaching (i.e., notching) involves damaging or removing a portion of the dam to allow the passage of water enough to begin draining the pond to a desired extent. Typically, breaching only requires hand tools and is a cost-effective method to alleviate or mitigate damage. Breaching can be an immediate, but generally temporary solution to flooding problems caused by beaver activity. Beavers will rapidly begin rebuilding dams as soon as within 24 hours (MFWP, 2023). However, breaching can be an effective short-term, emergency approach to relieve dangers to property and/or infrastructure during periods of high flow. Breaching might also be an appropriate strategy if a dam has been abandoned but is still creating an unacceptable risk of flooding or diminished flow downstream. The possibility of downstream flooding or dam collapse should be considered.

Dam removal can take significant effort in some cases and often requires the use of heavy machinery or explosives. After removing a beaver dam, beaver ponds are typically drained entirely but can restore the flow of water over time. However, dam removal can cause stored sediment, organic material, and contaminants to become mobile, degrading water quality downstream. Removing dams can transform intricate, braided channels to a simplified, incised channel with increased water velocity and turbidity (Castro et al., 2023). Loss of beaver ponds and manipulating water levels can cause a reduction in wetlands or prevent wetland establishment.

Beaver dam breaching or removal can be effective strategies to restore flows downstream of impounded areas. Additionally, potential fish barriers are removed, and fish migration may be improved. Increased stream velocity increases the total dissolved oxygen concentration and improves aquatic habitat for numerous species. Common methods for breaching or removing beaver dam are:

- Secure necessary permits prior to initiating any disturbance below the ordinary high-water mark (see **Table 2**).
- Remove material from the dam slowly by hand and/or using hand tools such as pitch forks, potato hooks, shovels, or chainsaws to dislodge and remove material.

- Slowly excavate material using a backhoe or excavator to breach or remove large dams. Station machinery at the top of the bank, road, or bridge above the ordinary high-water mark where practicable. Remove the dam from the top down in layers, scraping off six inches to one foot of material to reduce the potential for flooding or stream scouring. Wait for water levels to stabilize and for the flow to clear before removing the next layer. Remove material to desired depth of substrate level if necessary. Ponds should be lowered only to the level necessary to eliminate risk and restore flows.

6.3 Removal via Non-Lethal Means

Increases in both human and beaver populations are likely to increase human-beaver conflicts over time. Shifts in public perception toward wildlife conservation and recognition of the ecosystem services that aquatic habitats provide as a result of beaver activity have redirected management efforts toward non-lethal means.

6.3.1 Trapping and Relocation

Beaver relocations are often proposed as a non-lethal means of dealing with so-called “nuisance” beaver that are in conflict with humans, usually because they are flooding property, damming culverts, or cutting down trees (Castro et al., 2023). In general, relocation is not a recommended management method and is often prohibited in many states (Taylor et al., 2017). On lands, such as the Northern Cheyenne Indian Reservation, that allow beaver relocation under certain circumstances, the Tribe should consider both the benefits and risks involved before initiating relocation.

According to the NCT Competitive 319 Application (2022), Program staff plan to contract with Little Dog Wildlife LLC to perform a site assessment of the beaver colony potentially located at the headwaters site. Upon implementation, one year would be allocated to identifying the size and extent of the beaver impoundment as well as to describing how and where beaver would be relocated within the Reservation. Beaver would be relocated the following year and monitoring would continue in subsequent years to track the progress at the site.

Beaver removal is rarely a lasting solution as other beavers in the area tend to resettle the desirable habitat (MFWP, 2023). In some cases, trapped beavers relocated to their original site within 1 to 2 years (MFWP, 2023). Most relocation projects have establishment success rates of less than 50 percent (Woodruff & Pollock, 2020). Two primary reasons for beaver relocation failure are that (1) relocated beaver often move great distances from release sites and (2) relocated beaver have a low survival rate because of predation and disease (Taylor et al., 2017).

There are numerous challenges with successfully relocating a beaver including: finding suitable habitat that is conducive to beaver; finding an environment unoccupied by beavers; and finding an area where beaver activity will not result in human-wildlife conflicts. Beavers have complex family dynamics and intricate relationships. Thus, when multiple beavers are present in a colony, it is best to trap all members, which is an inherent challenge in many cases (COP, 2020). Often, the best approach is to develop a long-term solution for living with beavers, such as the alternatives listed above in **Sections 7.0**. In some cases, however, beaver relocation may be necessary and is a more ecologically sound alternative to lethal trapping.

Relocation can be effective to restore beavers in areas where they were previously extirpated (Taylor et al., 2017). Some relocation efforts have shown that beavers are a flexible, productive, and tolerant species that can adapt to new situations and locations, so long as basic habitat requirements are accessible (Woodruff & Pollock, 2020). Habitat requirements were discussed in previous sections. Additional habitat considerations for relocation within the Rosebud Watershed include available water supply, recreational trapping pressure, proximity to roads and infrastructure, landowner cooperation, and exposure to stochastic events (e.g., floods).

The Beaver Restoration Guidebook (2023) can be used as a valuable tool for relocation procedures. In summary, ongoing relocation projects across the western states often include the following key steps to beaver relocation methodology:

1. Identify suitable habitat using remote sensing.
2. Assess current beaver population status and distribution.
3. Evaluate individual release locations.
4. Pursue acquisition of beavers.
5. Collect information about beavers captured (or recaptured).
6. Care for beavers temporarily and ensure that beavers are grouped as families or compatible units with both males and females.
7. Prioritize and prepare release locations.
8. Deliver beavers to selected sites.
9. Conduct follow-up monitoring and provide support.

6.3.2 Evictions

Eviction generally involves moving animals very short distances (less than 1,000 feet) within the same property ownership (COP, 2020). The intent with eviction is that beavers are moved within their own existing territory but are removed from a problematic site (e.g., culvert). Preventing reentry (e.g., culvert fencing) is paramount to successful eviction, as beavers are likely to return. Eviction typically involves deterring or hazing methods, such as the use of strobe lights or loud noises to encourage beaver to temporarily relocate (COP, 2020). On Lame Deer Creek, eviction could potentially lead to similar conflicts within the watershed at the new site due to stream proximity to roads, agricultural land, and Lame Deer townsite.

6.4 Lethal Removal

On sites where repeated habitat modification and management techniques have not been successful, lethal removal by shooting or trapping might be appropriate. As stated previously, tribal members may lethally trap beaver during the open season with a permit, or outside the open season with a damage permit obtained from the EPD.

The use of lethal methods could result in local population reductions and a loss of ecosystem services in the Lame Deer Watershed. Another concern with lethal removal is that an individual and/or colony can be replaced in subsequent years and potentially become a nuisance in the future. Additional measures should be taken to prevent future conflict with beaver activity, if feasible. According to the U.S. Forest Service (2005), several factors that need to be considered when developing a trapping program include:

- The behavioral and biological characteristics of beaver (e.g., family dynamics, reproductive stage).
- Number of beavers in colony.
- Access to the target site.
- The experience and skill of the trapper and the type of trap to be used (i.e., lethal versus live).
- Nontarget animals in the vicinity (e.g., otter, muskrat, dogs).
- Tribal trapping laws and regulations.
- Other site-specific considerations.

6.5 Unexpected Beaver Encounters

If during the course of management strategies, beaver are encountered in an enclosed space (e.g., culvert) landowners should not actively harass the beaver. If multiple points of egress are available to the beaver, it will likely exit the area. If personnel are blocking the only exit for beaver, they should exit the site and allow the beaver to leave. In circumstances where newborn kits are present and not mobile (typically occurring between April and June), personnel should consider rescheduling management activities.

Beavers can carry parasites and diseases, such as Tularemia, yersinia, and leptospirosis that are part of their ecology (Castro et al., 2023). Further, giardiasis is a chronic, intestinal protozoan infection seen worldwide in most wild animals and is common in waterways. Beaver can also carry the rabies virus, and, although rare, attacks on humans by rabid beavers do occur (Castro et al., 2023). Beavers that are acting erratically or aggressively should be avoided. Precautions against infection are necessary for everyone who handles beavers.

7.0 ALTERNATIVE STRATEGIES

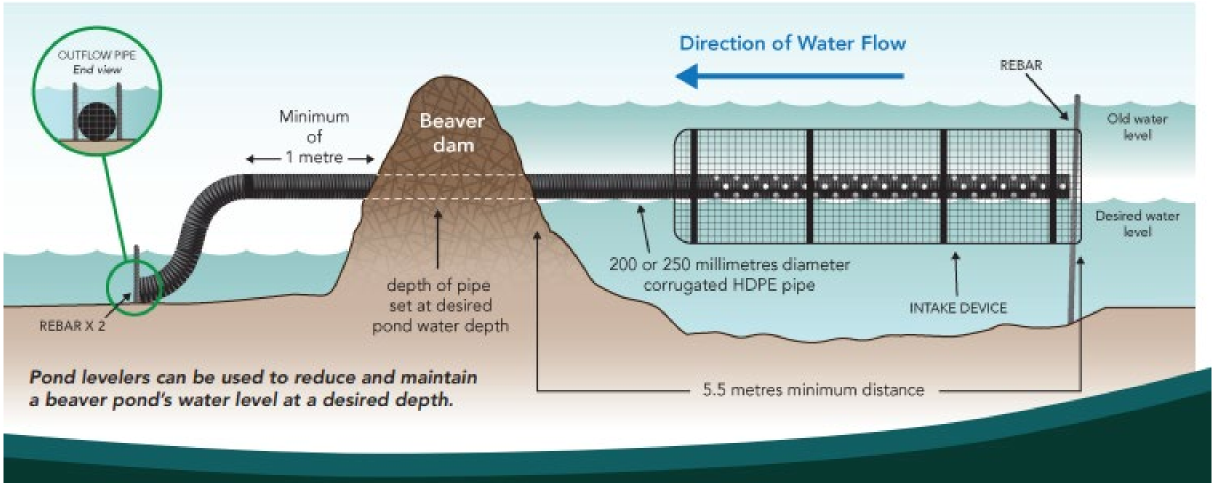
The goals and objectives for Lame Deer Watershed are derived from the EPA approved NCT's WQSs(2013) and the Northern Cheyenne Reservation Nonpoint Source Assessment (2021). The Assessment states that, "Lame Deer Creek cannot attain or maintain NCT's WQSs, particularly those pertaining to beneficial and designated uses of the drainage as a cold-water fishery, without the control of nonpoint sources of pollutants into the drainage and improvements in instream flows." Given the benefits of beaver activity on overall stream health and ecosystem function, alternative or supplemental strategies should be considered as a management strategy.

7.1.1 Pond Levelers

When flooding from a free-standing beaver dam threatens human property, stream health, or safety, a pond leveler can be an effective, long-term management solution to control water levels. Pond levelers (e.g., The Clemson Beaver Pond Leveler) are flexible, perforated pipes placed in the dam that allow passage of water, slow the velocity, and eliminate the sound of moving water (see **Figure 2**). The end of the pipe extending upstream is caged to prevent beaver from damming the intake. The fence is typically a large cylinder of wire material that prevents beavers from getting close enough to the pipe to detect water movement. A pond depth of at least 3 feet is required for the system to function properly (MTFWP, 2023). The height of the pipe placed in the dam determines the desired pond level and can be adjusted as desired. During high-water storm events that rapidly increase the water level, water simply flows over the dam. Pond levelers are a strategy that allows the ecologically important beaver to remain at the site and maintain the beaver dam. In contrast to dam removal, pond levelers allow for retention of some water, mitigating degradation to wetland and riparian areas. In contrast to dam breaching, these devices are still effective at moderating the water table despite dam building activity. Pond levelers require a site-specific design that is tailored to meet the needs of each site. In general, the specifications are:

- 40-foot length of 12- or 18-inch diameter high density polyethylene (HDPE) pipe, double-walled and not perforated, with vent holes cut along the top side and a notch cut in the bottom of the intake end.
- 6x6x6-foot wire mesh cage with domed top surrounding intake, constructed of 6x6-inch wire mesh fabric and 3/16-inch diameter wire (non-galvanized). One fabric sheet is used for the floor.
- Metal "T" style posts to secure pipe and intake cage to the pond bed.
- 2x2x2-foot wire mesh cage on downstream end of pipe with 6x6-foot mesh fabric.
- The upstream end of the pipe is placed in the bottom center of the cage and is placed in the deepest water feasible.
- The downstream end of the pipe is placed in the beaver dam, extending a few feet past dam, with the pipe invert placed at a desired surface elevation.

Jpeg 1. Pond Leveler Illustration



Source: wildlife@gov.mb.ca

A site evaluation and technical assistance is often required during installation to improve the success rate. Pond levelers can become clogged from debris and may require routine monitoring and maintenance, especially in colder climates when ice builds up. It is important to only lower the water table enough to protect human interests, as beavers will build a new dam up- or downstream to raise the water table to meet their needs (MFWP, 2023).

7.1.2 Culvert Fences

Beavers have an instinctive auditory response to flowing water to build dams and impound water to improve habitat (Nolte et al., 2005). When beaver damming activity creates nuisance flooding or damage, installing culvert fences or flow devices (e.g., "beaver deceivers") can be an effective strategy to prevent dam construction and maintain the functionality of culverts. Culvert fences are used to prevent beaver dams from blocking culverts, flow paths, or other openings. They consist of a non-galvanized wire mesh fencing staked upstream of a culvert to be protected (see **Figure 3**). The fencing should be located far enough away from the opening to prevent it from being used as dam material by beaver. Generally, the structure is trapezoidal in shape and at least 8 feet from the culvert opening. The fencing is staked around the perimeter, and tall enough to prevent beaver from placing wood within the caged area; typically, 2 to 3 feet above the high-water mark is adequate (Nolte et al., 2005). The bottom of the fenced area is enclosed with mesh and embedded into the streambed to prevent entry from below. It is important to avoid creating seams on the floor where the two adjoining sheets of wire fabric come together. Seams such as this can unintentionally ensnare animals.

Jpeg 2. Beaver Deceiver Fencing Illustration

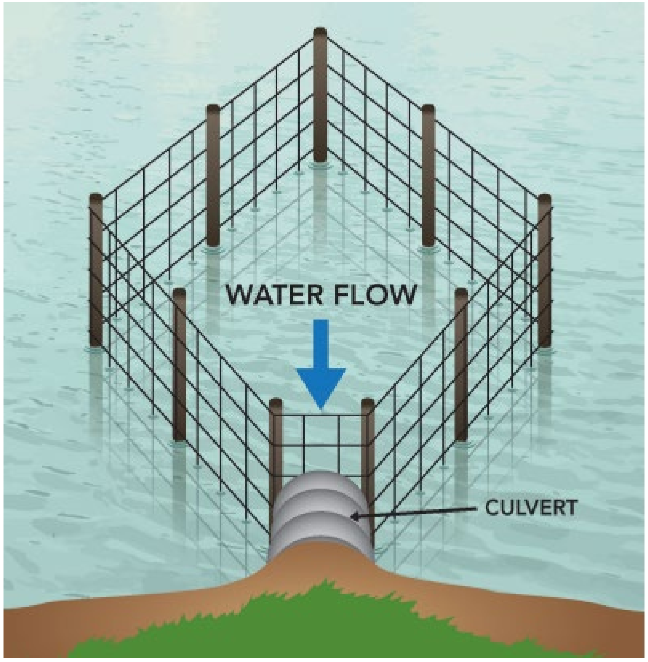


Image: Beaver deceiver fencing can be used to lower the risk of culvert blockage by beavers.
Source: wildlife@gov.mb.ca

Site conditions play a key role in fence design. Sites with rapid waterflow may require larger enclosures (Nolte et al., 2005). Typically, a design that fences off an area of 10 x 20 feet on each side of the culvert is adequate. In some cases, beavers will build dams on the fence, requiring periodic maintenance. In northern latitudes, ice flow can destroy culvert fences or become a flood hazard. Blocking passage for wildlife or fish species can be an unintended risk with beaver deceivers or culvert fencing strategies. Blocking passage through culverts can force medium to large sized aquatic mammals (e.g., otters and muskrats) out of waterways and onto roadways to bypass the obstruction.

7.2 Vegetation Management

Beavers prefer to cut deciduous fast-growing trees including cottonwood, willow, aspen, and alder. Generally, cutting occurs within 50 feet of the water's edge (MFWP, 2023). In areas where beaver are undesirable or have removed a significant portion of the overstory tree canopy, the planting of unpalatable vegetation (e.g., conifer species) within 50 feet of a stream can achieve increased tree species cover, if desired. Planted species should be capable of tolerating inundation (i.e., hydrophytic vegetation) if placed along streams or in wetland areas. Upland species planted upgradient of the typical high-water mark could potentially increase canopy cover and restore riparian area habitat. However, beavers are generalist feeders and have been known to consume a variety of tree and shrub species outside their preferred diet. Further, beaver may use the base of large trees of both palatable and unpalatable species for gnawing (Pollock et al., 2022). When trees have been cut, it is beneficial to leave the trees down so that beavers are not driven to cut more (MFWP, 2023).

7.2.1 Wire Mesh Cages

In areas where the Tribe are interested in protecting key trees or stands, wrapping species with wire mesh cylindrical cages can be a simple, effective method of preventing loss (Pollock et al., 2022; MFWP, 2023). Individual large trees can be loosely wrapped with 3-foot high, galvanized welded wire fencing or hardware cloth. Grouped trees and shrubs can be surrounded with 4-foot-high barriers of wire or electric fencing that are flush to the ground. Painting wire mesh green or brown is an aesthetic strategy that can make them less noticeable. The *Beaver Restoration Handbook* (2023) makes the following recommendations for cages:

- Wire mesh gauge should be reasonably heavy (e.g., 6 gauge) to prevent beaver from chewing through it. Chicken wire is not recommended.
- Mesh size should be 6 x 6 inches or smaller.
- The cage should be 1 to 2 feet in diameter larger than the tree trunk so that beaver are not able to contact the tree.
- The cage should extend 3 to 4 feet above the ground or, in colder climates, above the anticipated snow line. In flood-prone areas, mesh cages should extend above the high-water mark.
- Wire fencing can be used to encircle multiple trees.

Cages require monitoring, maintenance, removal, and reinstallation as trees grow. Although this method has been effective, in some cases beavers managed to harvest trees inside enclosures, presumably by climbing the cages (Pollock et al., 2022).

7.2.2 Abrasive Paint

In areas where trees should be protected from gnawing or felling, but where costs for material and labor are a hindrance, abrasive paint can be used as a deterrent. Painting tree trunks with a sand and paint mix is somewhat effective at protecting trees due to the undesirable gritty texture of the abrasive paint (MFWP, 2023). This method requires minimal material, manual labor, or skill but requires annual repainting. Numerous beaver conservation groups and city beaver management plans (COP, 2020) recommend that the abrasive paint should consist of the following mixture:

- 8 ounces of fine sand (30 mil, 70 mil or masonry sand).
- 1 quart of oil or latex paint to match the base of the tree or is clear.

Once the abrasive paint mixture is combined, the mixture is painted on the tree at ground level to 4 feet above the ground or from the approximate snow level. If abrasive paint is used as a deterrent, routine monitoring should be conducted to understand its applicability and effectiveness for consecutive use.

7.3 Livestock Management

Riparian ecosystems are critical for water quality and quantity, temperature regulation, streambank stability, fish and wildlife habitat, and aesthetics. Threatened or rare species of concern are often associated with wetland and riparian systems as they generally harbor a more diverse plant community. Yet, these areas are also vital to the livestock grazing industry.

According to the *Northern Cheyene Competitive 319 Application* (2022), agricultural impacts including cattle grazing and nutrient loading in the riparian areas are responsible for over 80 percent of observed water quality impacts in the Lame Deer Creek Watershed. Cattle graze year-round within the Lame Deer Creek corridor and are not fenced out of the creek. Stream banks were visibly and significantly eroded along approximately 6.3 miles of Lame Deer Creek in 2021 during the Tribe's assessment. Livestock grazing in riparian areas can reduce riparian vegetation cover due to browsing and trampling. Overgrazing in riparian areas is well documented for the impacts on soil compaction, vegetation, stream bank stability, water quality, and habitat (Kinch, 1989; Boyle & Owens, 2007; Oestreich, 2006). Cattle can down-cut stream banks by shearing bank material resulting in setback banks (Oestreich, 2006). Feces and urine deposited in or near streams can cause elevated concentrations of nitrogen and phosphorous as well as increase prevalence of fecal coliforms and fecal streptococci (Oestreich, 2006).

Intensive land uses (e.g., cattle grazing) in riparian zones can limit beaver activity (Kornse & Wohl, 2020). Beaver activity can improve water quality and reduce nonpoint source pollution from agricultural runoff by trapping sediment, excess nutrients, and pollution from leaching downstream (Boyle & Owens, 2007).

Implementing BMPs can be effective at restoring riparian areas or preventing degradation. For example, providing off-stream water sources and mineral supplements are effective methods of luring cattle away from riparian areas and improving distribution patterns (Oestreich, 2006). Water development in upland areas is considered a key factor in reducing livestock use in streams (Kinch, 1989). Another strategy is to create shade in upland areas to reduce the amount of time livestock spend in riparian areas. In some cases, total exclusion of cattle grazing might be necessary. Fencing can be an effective tool in controlling livestock distribution. Fencing can also impact wildlife movement, having an undesirable effect; however, wildlife-friendly fencing allows for wildlife to move freely over or under.

7.4 Culvert Maintenance/Replacement

The hardened embankment of culverts creates an ideal condition and a foundation for beavers to construct dams. Replacing small culverts with oversized culverts can be an effective long-term strategy to prevent blockage. Oversized culverts reduce stream velocity, decreasing the likelihood that beavers will be encouraged to dam them (Nolte et al., 2005). Oversized culverts also increase fish passage and reduce likelihood of clogging from debris. Currently, the South Fork of Lame Deer Creek flows are impeded by four crushed culverts that historically conveyed water under a residential road into the mainstem of Lame Deer Creek (see **Photos 5, 6, 7; Appendix A).** The crushed culverts have altered the functionality of the water system by reducing flow, trapping sediment, and increasing stream temperatures. Repairing or replacing culverts can be a long-term effective strategy to restore flows and improve stream health while mitigating damage to property and conflict with human land use.

8.0 CONCLUSIONS

Though the effects of beaver occupying an area can vary, in smaller headwater stream systems beaver activities expand and maintain healthy and productive wetland and riparian habitats that provide numerous ecosystem services. Yet, when beaver activities conflict with anthropogenic land use, and flows, adaptive or alternative management strategies might be needed. Given the capacity of Lame Deer Creek to support beaver activity (as quantified using the BRAT tool), multiple management strategies and routine monitoring may be required to achieve goals. Deciding on the best course of action will likely be a dynamic process that is dependent on the site conditions, desired outcomes, feasibility, regulations, and effectiveness. Given the benefits that beaver provide, adaptive and alternative strategies, such as vegetation management, in-water habitat modifications, livestock management, or culvert replacement and fencing may be effective at improving water quality standards and overall stream health. In cases where alternative or adaptive strategies are not producing desirable outcomes and improving water quality within the Lame Deer Creek Watershed, beaver relocation might be warranted.

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Appendix A Site Photos

Photo 1
Photo taken 8/8/23

Location:
Facing north; East Fork Lame Deer Creek downstream of culvert.

Description:
Dense riparian and wetland vegetation at pond

Photo 2
Photo taken 8/8/23

Location:
Facing southwest. South Fork of Lame Deer Creek upstream of culvert

Description:
Pond upstream of crushed culvert with wetland and riparian vegetation

	**Photo 3** *Photo taken 8/8/23* **Location:** Facing southwest. South Fork of Lame Deer Creek upstream of crushed culvert on roadway **Description:** Pond Behind crushed culvert with obligate wetland vegetation
	**Photo 4** *Photo taken 8/8/23* **Location:** Facing southwest. Ponded South Fork of Lame Deer Creek upstream of levee **Description:** Pond behind crushed culvert with habitat change in background

Photo 5
Photo taken 8/8/23

Location:
Facing south. Roadway at headwaters and crushed culverts

Description:
Water flowing around crushed culvert with white algae.

Photo 6
Photo taken 8/8/23

Location:
Facing South. Roadway at headwaters

Description:
Crushed Culvert surrounded by roadbed substrate

Photo 7
Photo taken 8/8/23

Location:
Facing south. Roadway at headwaters

Description:
Multiple culverts buried under road.

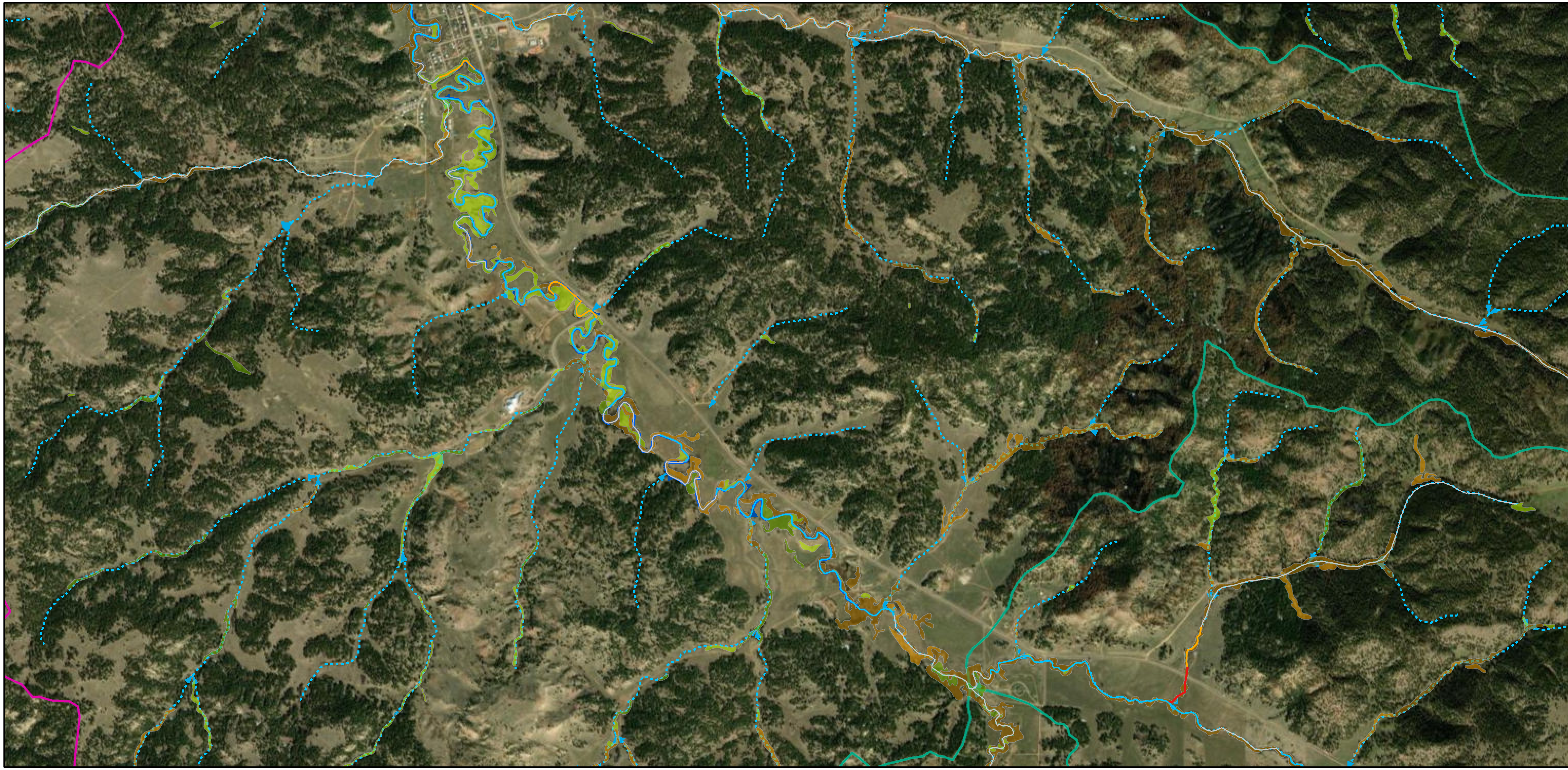
Photo 8
Photo taken 8/8/23

Location:
Facing southwest. Tributary of the South Fork of Lame Deer Creek

Description:
Mature ponderosa pine trees along tributary

Appendix B BRAT Map Outputs

BRAT: Risk of Undesirable Dams



10/12/2023, 1:05:30 PM

Risk of Undesirable Dams
- Major Risk
- Considerable Risk
- Minor Risk
- Negligible Risk

Wetland and Riparian Mapping
- Freshwater Pond
- Freshwater Emergent Wetland
- Freshwater Scrub-Shrub Wetland
- Riparian Emergent
- Riparian Scrub-Shrub
- Riparian Forested
- Montana
- Ramps
- Urban
- Secondary
- Primary
- NHS Non-Interstate
- NHS Interstate

WBDLine
- 2-digit Hydrologic Unit
- 4-digit Hydrologic Unit
- 6-digit Hydrologic Unit

1:36,112

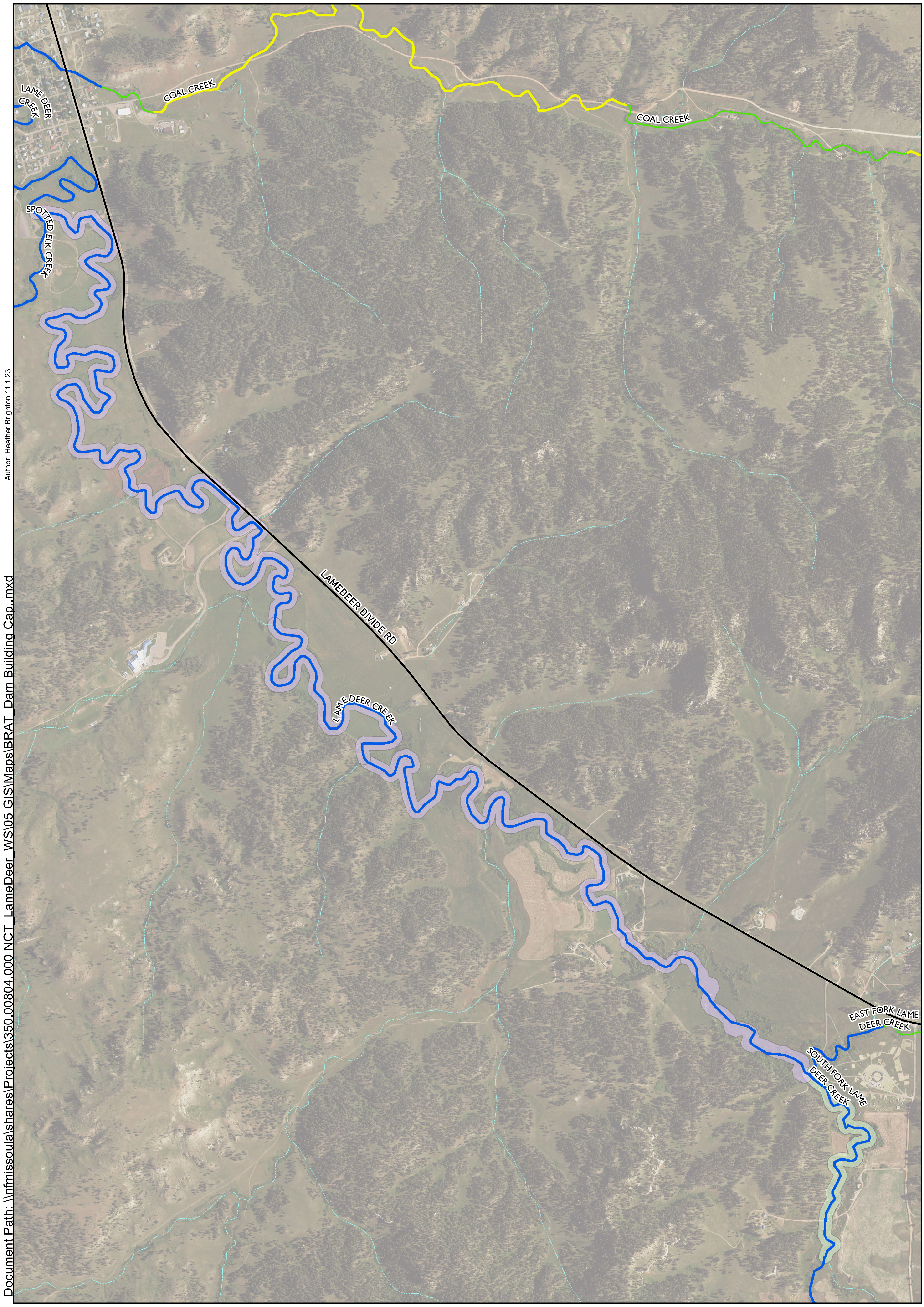
0 0.28 0.55 1.1 mi

0 0.45 0.9 1.8 km

USGS, MSL, MSL, MDT, County Govt, Federal, Tribal, Maxar, USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023.

MTNHP

Maxar | Montana State Library | USGS, MSL | USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023. | MSL, MDT, County Govt, Federal, Tribal | US Bureau of Land Management, Geographic Coordinate Database, US Geological Survey 1:24,000 Digital Raster Graphics, Montana State Library |

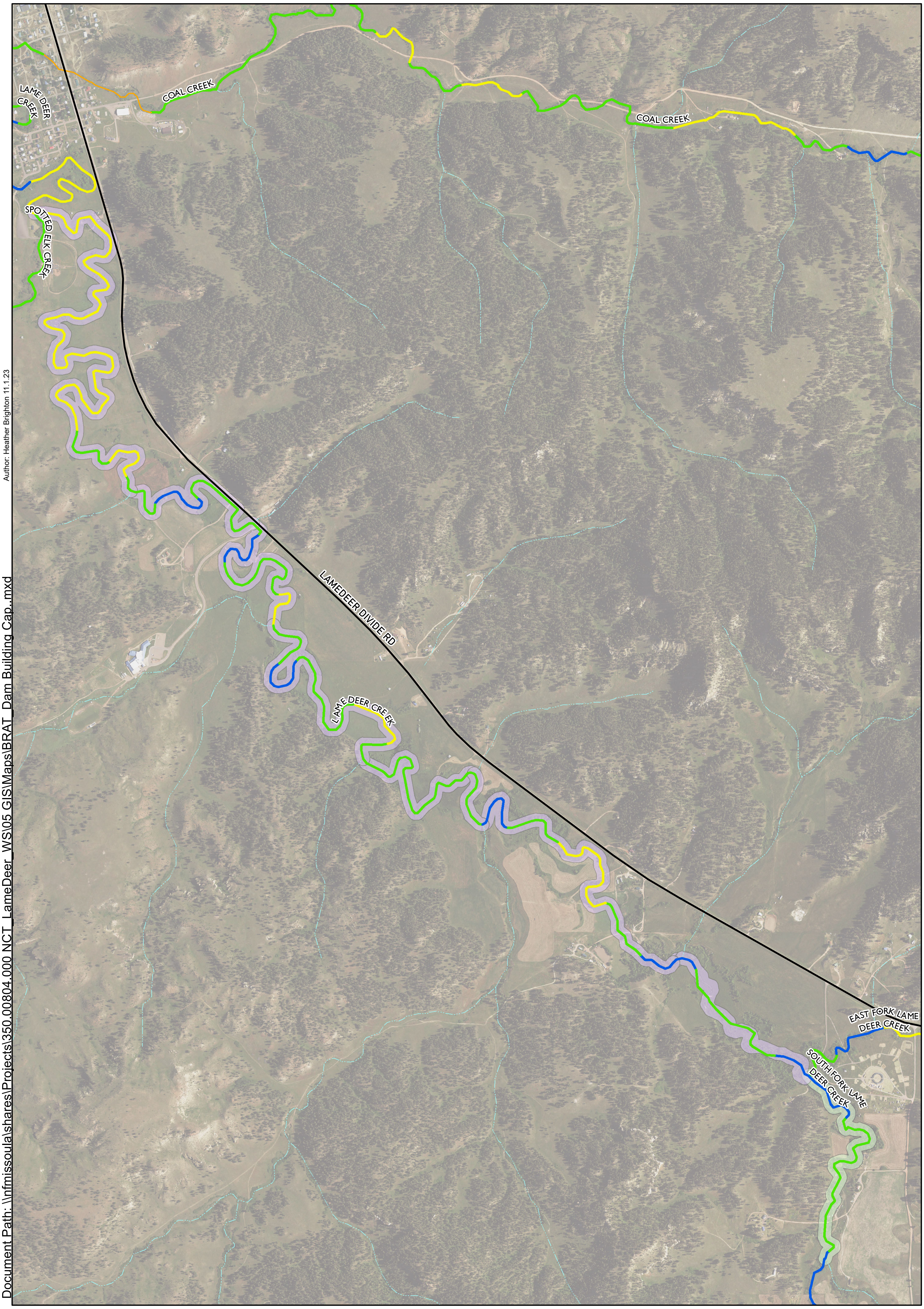


Meters
0 1,000

Figure B-1
BRAT: Historic Dam Building Capacity
Lame Deer, MT

- None: 0 dams
- Rare: 0 - 1 dams/km (0 - 2 dams/mi)
- Occasional: 1 - 5 dams/km (2 - 8 dams/mi)
- Frequent: 5 - 15 dams/km (8 - 24 dams/mi)
- Pervasive: 15 - 40 dams/km (24 - 64 dams/mi)
- Upper Reach
- Headwaters Reach

Data Sources: Maxar | Montana State Library | USGS, MSL | USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023. | MSL, MDT, County Govt, Federal, Tribal | US Bureau of Land Management, Geographic Coordinate Database, US Geological Survey 1:24,000 Digital Raster Graphics, Montana State Library |



Author: Heather Brighton 11.1.23

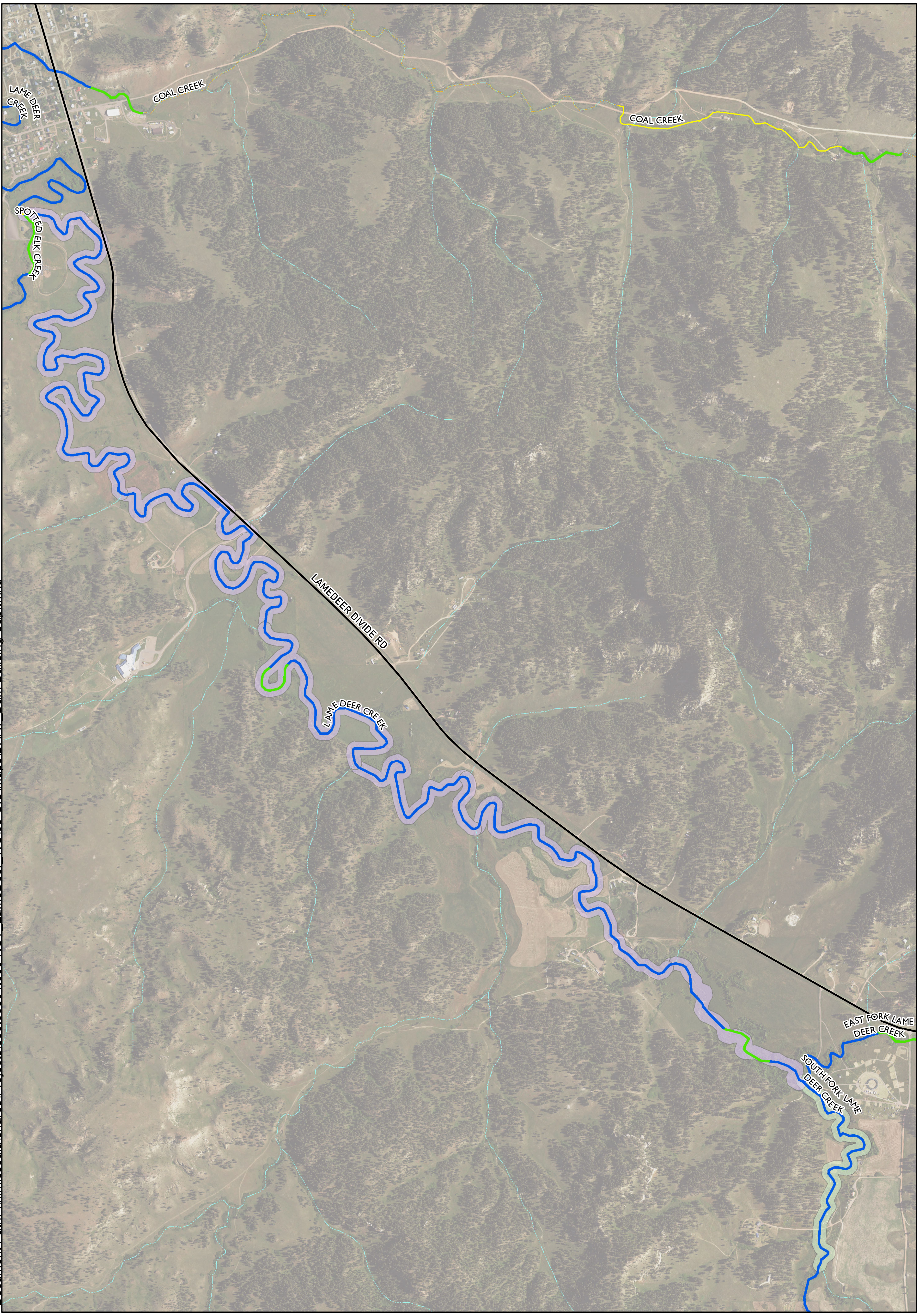
Document Path: \\nfmissoula\shares\Projects\350.00804.000 NCT_LameDeer_WS\05 GIS\Maps\BRAT_Dam Building Cap..mxd

Meters
0 1,000

Figure B-2
BRAT: Existing Dam Building Capacity
Lame Deer, MT

- None: 0 dams
- Rare: 0 - 1 dams/km (0 - 2 dams/mi)
- Occasional: 1 - 5 dams/km (2 - 8 dams/mi)
- Frequent: 5 - 15 dams/km (8 - 24 dams/mi)
- Pervasive: 15 - 40 dams/km (24 - 64 dams/mi)
- Upper Reach
- Headwaters Reach

Data Sources: Maxar | Montana State Library | USGS, MSL | USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023. | MSL, MDT, County Govt, Federal, Tribal | US Bureau of Land Management, Geographic Coordinate Database, US Geological Survey 1:24,000 Digital Raster Graphics, Montana State Library |



Author: Heather Brighton 11.1.23

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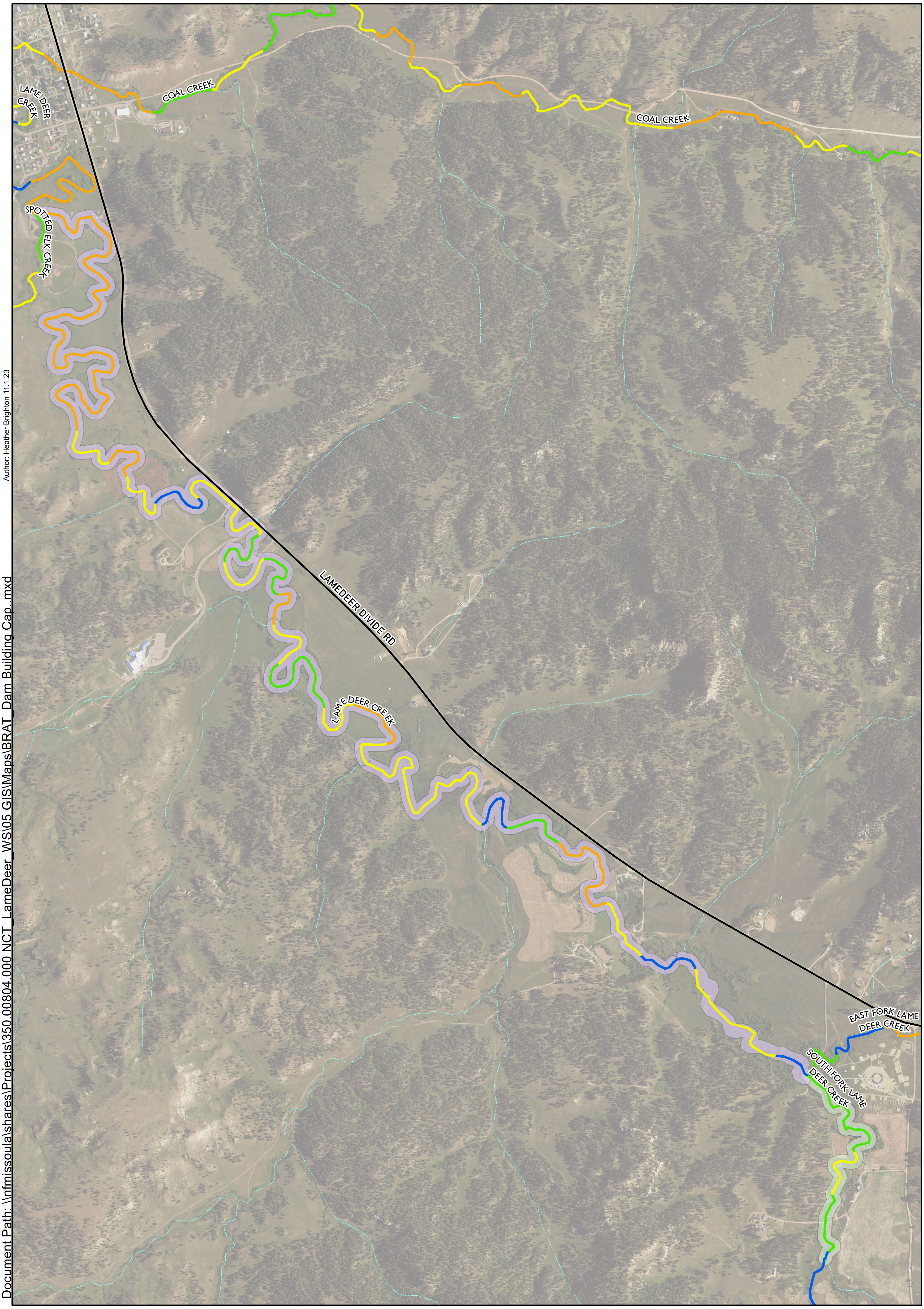
Figure B-3
BRAT: Historic Dam Complex Size
Lame Deer, MT

No Dams
Single Dams
Small Complex (1 - 3 dams)
Medium Complex (3 - 5 dams)
Large Complex (> 5 dams)
Upper Reach
Headwaters Reach

Data Sources: Maxar | Montana State Library | USGS, MSL | USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023. | MSL, MDT, County Govt, Federal, Tribal | US Bureau of Land Management, Geographic Coordinate Database, US Geological Survey 1:24,000 Digital Raster Graphics, Montana State Library |



Author: Heather Brighton 11.1.23

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Meters
0 1,000

Figure B-4
BRAT: Existing Dam Complex Size Capacity
Lame Deer, MT

No Dams
Single Dam
Small Complex (1 - 3 dams)
Medium Complex (3 - 5 dams)
Large Complex (> 5 dams)
Upper Reach
Headwaters Reach

Data Sources: Maxar | Montana State Library | USGS, MSL | USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023. | MSL, MDT, County Govt, Federal, Tribal | US Bureau of Land Management, Geographic Coordinate Database, US Geological Survey 1:24,000 Digital Raster Graphics, Montana State Library |

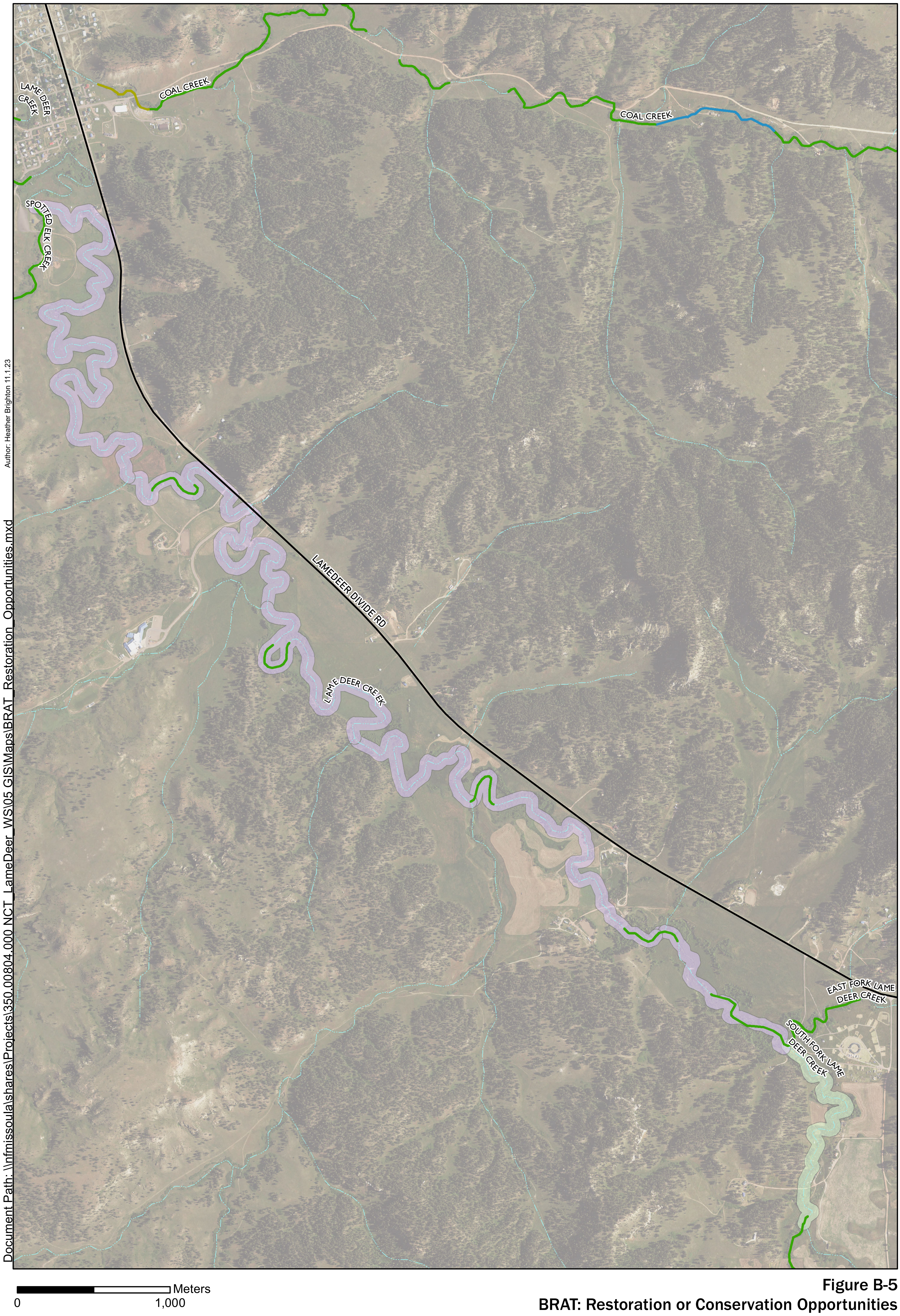


Figure B-5
BRAT: Restoration or Conservation Opportunities
Lame Deer, MT

Easiest - Low-Hanging Fruit

Strategic - Long-Term Investment

Straight Forward - Quick Return

Upper Reach

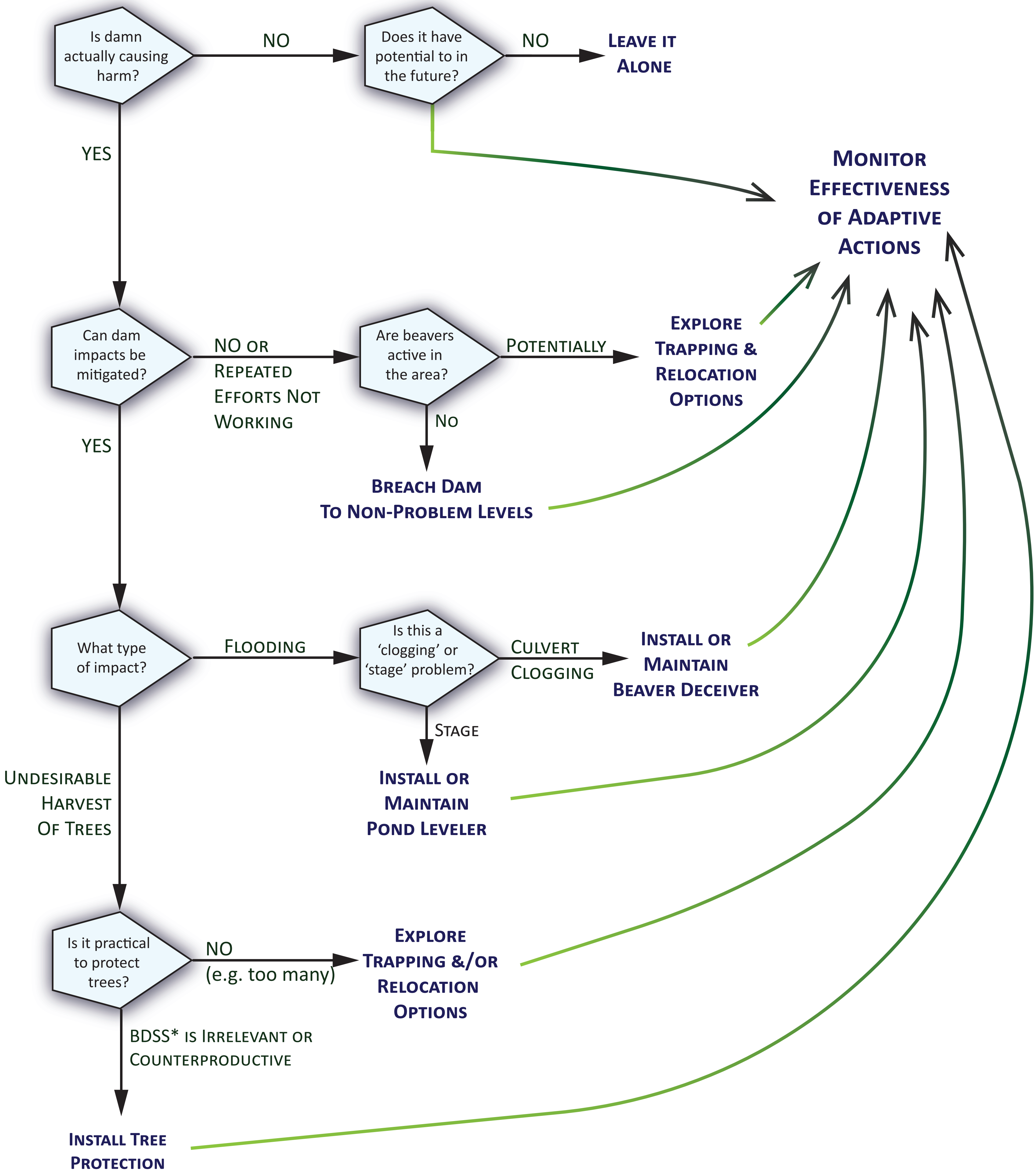
Headwaters Reach

Data Sources: Maxar | Montana State Library | USGS, MSL | USGS WBD - Watershed Boundary Dataset. Data refreshed October, 2023. | MSL, MDT, County Govt, Federal, Tribal | US Bureau of Land Management, Geographic Coordinate Database, US Geological Survey 1:24,000 Digital Raster Graphics, Montana State Library |

Appendix C Beaver Management Decisions Flowchart

Evaluation of Individual Potential Problem Dams

Always consider dam in context of surrounding dams and/or dam complexes prior to removal of any dams.



*BDSS - Beaver Dam Support Structure

NewFields

Evaluation of Individual Potential Problem Dams
Northern Cheyenne
Lame Deer, Montana
FIGURE C-1

Appendix D

TECHNICAL MEMORANDUM

DATE:	October 10th 2023	**PROJECT NO.**	350.00804
TO:	Joe Walksalong, Cheyenne Nation / Northern Cheyenne Tribe Charlene Alden, Cheyenne Nation / Northern Cheyenne Tribe		
FROM:	Heather Brighton, Project Scientist, NewFields Matt Peterson, PE, NewFields		
REVIEWED:	Marie Pare, Partner, NewFields Daniel Hoffman, NewFields		
SUBJECT:	**Lame Deer Creek Culvert Replacement Recommendations**		

INTRODUCTION

NewFields has been retained by the Northern Cheyenne Tribe to conduct assessment and planning work related to water quality improvements in the Lame Deer Creek watershed. Under this contract NewFields will develop a Nine Element Watershed Plan, a Beaver Relocation and Alternatives Plan, and Culvert Replacement Recommendations for a driveway crossing South Fork Lame Deer Creek. This document addresses Deliverable 3 from the Contract (Culvert Replacement Recommendations Memo).

The culvert (Project Site) is approximately 4.5 miles south of Lame Deer near the intersection of Hwy 4 and Powwow Lane and directly west of the Kenneth Beartusk Memorial Pow Wow grounds as shown in **Figure 1**. The study area addressed by this memo includes the driveway crossing of South Fork Lame Deer Creek and the immediate upstream and downstream reaches of the stream that have been modified by man-made features.

This memo provides site reconnaissance information gathered by NewFields' representatives, a conceptual plan and recommendations for culvert replacement, and a discussion of our recommended approach to replacing the driveway culvert(s) and restoring the surrounding reach of South Fork Lame Deer Creek.

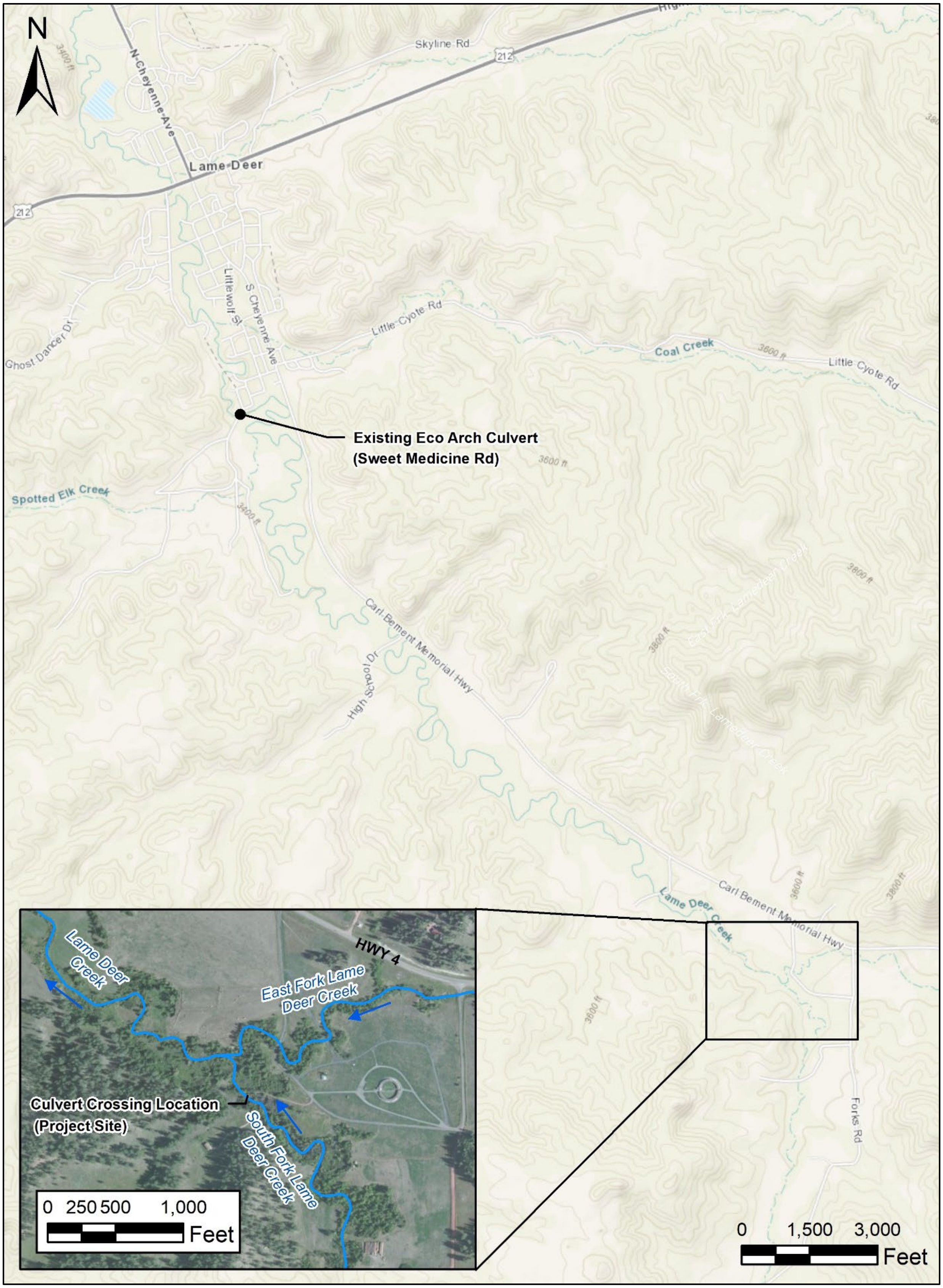


Figure 1. Project Location Map

SITE VISIT FINDINGS

Dan Hoffman and Heather Brighton of NewFields visited the Project Site and surrounding area on August 8, 2023, accompanied by Joe Walksalong.The site visit included a visual observation of the existing culverts at the Project Site and the upstream and downstream reaches along with discussion about project goals and objectives. During the site visit NewFields' team members observed multiple parallel damaged, partially clogged, and likely undersized culverts extending through the driveway at the Project Site. The water both upstream and downstream of the driveway crossing was impounded (ponded) and minimal water was flowing through the culverts. A detailed listing of observations is provided in **Table 1** and **Figure 2** provides a map of the site configuration. Several photos from the site visit are included in **Attachment A**.

Table 1. South Fork Lame Deer Creek – Driveway Crossing Site Visit Observations

ID	Observation
1	The driveway crossing is comprised of multiple parallel 12-to 18-inch diameter culverts.[1] The culverts are partially crushed and partially filled with sediment. Only one culvert inlet was visible (on the upstream side of the driveway).
2	Flow through the South Fork Lame Deer Creek driveway crossing was estimated to be 5 gallons per minute (gpm) (0.01 cubic feet per second [cfs]).
3	Two embankments constructed in series across the South Fork Lame Deer Creek valley just upstream of the Project Site have created two impoundments (ponds). Joe Walksalong noted the furthest upstream dam has a structure that can be used to control pond elevations and flow through the embankment, although it was not found during the site visit due to thick vegetative growth.
4	Active channel width near the driveway crossing, where the stream is not impounded, is approximately 2 - 4 feet wide and heavily vegetated. Vertical and lateral migration rates appear to be low.
5	Perennial (continuous), intermittent (during wet seasons), and ephemeral (resulting from a precipitation event) flow regimes were noted. Flows upstream of the Project Site appear to be ephemeral and intermittent. Flows between the Project Site and the town of Lame Deer appear to be intermittent. All crossings upstream of the Project Site were dry.
6	South Fork Lame Deer Creek is a small, low gradient, single thread channel comprised primarily of fine-grained silts.
7	Lame Deer Creek remains low gradient downstream of the East Fork / South Fork Lame Deer Creek confluence. (D_{50} ~30mm). The reach downstream of the existing eco arch pipe is higher gradient and has a coarser bed.
8	An arch-type (eco arch), open bottom culvert (8-foot span) is installed where Lame Deer Creek crosses under Sweet Medicine Rd, approximately 8 stream miles downstream from the Project Site. Joe Walksalong noted fish have been observed at this crossing and expressed that this type of crossing, designed to facilitate fish passage, is desired at the Access Road crossing.
9	Flow at the arch culvert crossing Sweet Medicine Rd (**Figure 1**) was estimated to be 50 gpm (0.11 cfs).

[1] Three confirmed culverts were observed and a fourth culvert was partially visible on the downstream side of the driveway. Culvert diameters were not measured due to accessibility limitations.

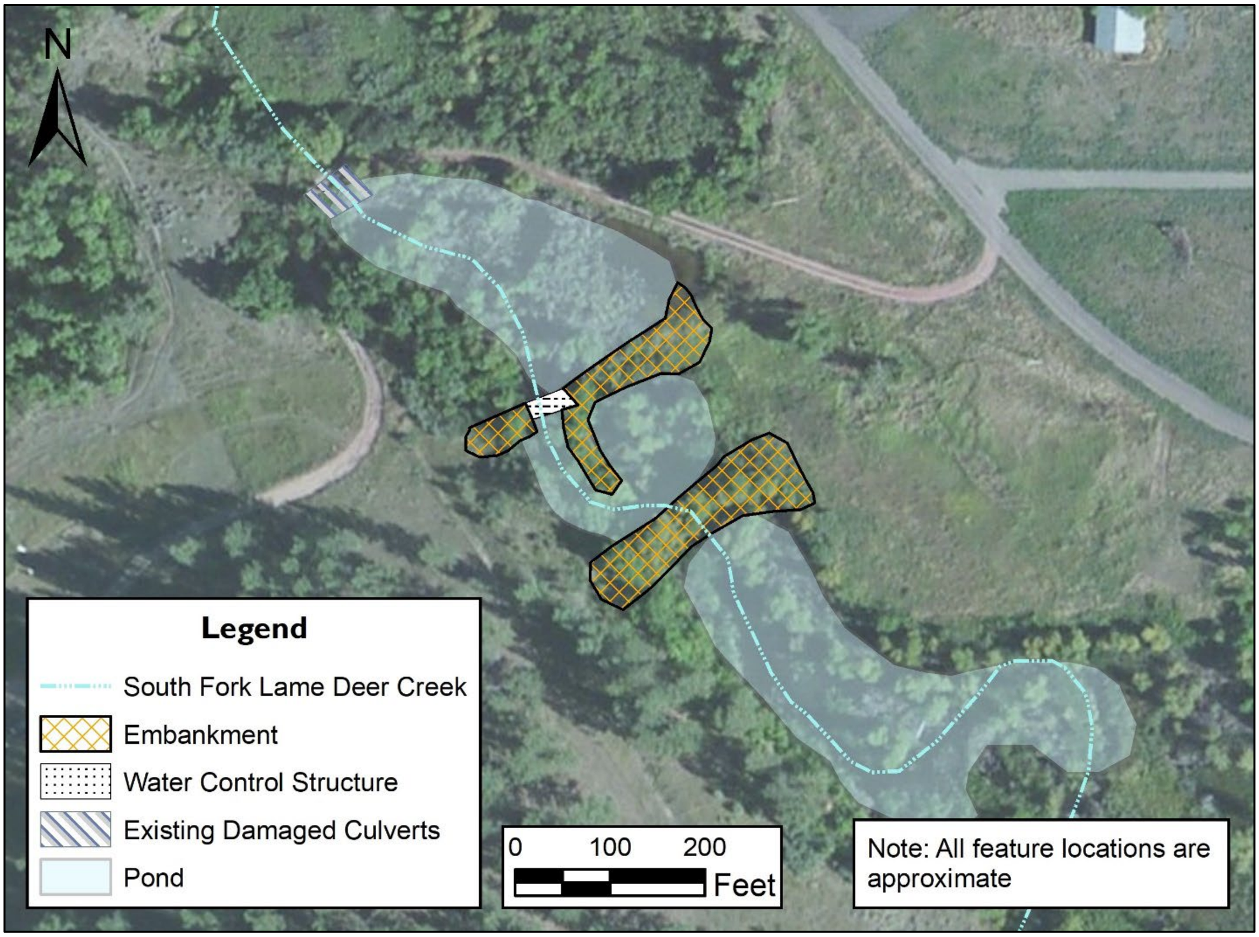


Figure 2. Site Visit Findings Map

CONCEPTUAL CULVERT REPLACEMENT RECOMMENDATIONS

Replacement of this crossing would improve the driveway at the Project Site and could potentially provide benefits to South Fork Lame Deer Creek. Benefits to the driveway would include a reduced risk of piping and sediment loss resulting from non-functional culverts that may be leaking flows into the driveway embankment. Benefits to South Fork Lame Deer Creek could include restoration of the pre-existing stream gradient, reduction of upstream ponding, reduction of stream temperatures, and aquatic organism passage through the culvert; however, the existing upstream embankments and downstream flow obstructions would severely limit the potential to achieve these benefits. The remainder of this section provides general recommendations for replacement of the driveway crossing. Additional discussion on realizing benefits to South Fork Lame Deer Creek is provided in the Overall Project Considerations section of this memo.

Preliminary Design Criteria

Recommended design criteria are as follows:

- The culvert shall pass the 10-year flood event (design flow event) without overtopping the driveway;

- The crossing should be designed to withstand a larger flood event (e.g., 50- or 100-year); this could be accomplished with a hardened road surface with upstream and downstream scour protection;
- The culvert shall maintain natural flow patterns without creating unexpected flood hazards both upstream and downstream; and
- The culvert shall meet allowable headwater criteria per Figure 11.3-1 of the Montana Department of Transportation's Hydraulics Manual (2022), copied as **Table 2** below.

Table 2. Maximum Allowable Headwater[1]

Equivalent Pipe Size (in)	Headwater at Design Flow	Headwater at 100-Year Flow
≤ 42	< 3.0 D or 3.0 R	< 4.0 D or 4.0 R
48 – 108	< 1.5 D or 1.5 R	< D + 5ft or R + 5ft
≥ 120	< D + 2ft or R + 2ft	< D + 4ft or R + 4ft

Note: For arch pipes and boxes, R is equal to the rise of the pipe; for round pipes, D is the diameter of the pipe

Additional discussion on design criteria considerations is provided in the Overall Project Considerations section of this memo. These criteria should be revisited during final design.

Preliminary Hydrologic Analysis

Peak discharge data for South Fork Lame Deer Creek was estimated using the United States Geological Survey's (USGS) StreamStats application. These peak flows are based on regression equations that account for the geographical location and physical characteristics of the delineated watershed (SE Plains Region, Basin C, 2015 5019F). Regression equation input values (extracted from the StreamStats application) are provided in **Table 3** and the predicted peak flows are provided in **Table 4**. We recommend employment of additional hydrology methods to confirm or revise the design flow rates during final design.

Table 3. Regression Equation Input Values

Basin Characteristic	Minimum Allowable Value	Maximum Allowable Value	South Fork Lame Deer Creek Characteristics
Contributing Drainage Area (square miles)	0.10	1,962.05	18.3
Percent Forest Cover (%)	0.00	57.64	29.6
Mean Spring Evapotranspiration (inches per month)	0.96	1.67	1.48

[1] South Fork Lame Deer Creek Characteristics were determined using the USGS StreamStats program. The StreamStats report is provided in **Attachment B**.

Table 4. Predicted Peak Discharges for South Fork Lame Deer Creek[1]

Annual Exceedance Probability (%)	Return Period (years)	Discharge - South Fork Lame Deer Creek (cfs)
50	2	23
20	5	73
10	10	137
2	50	374
1	100	508

[1] Calculated using regional regression equations presented in USGS Scientific Investigations Report 2015-5019-F

Preliminary Hydraulics Analysis

NewFields conducted preliminary hydraulics analysis using the Federal Highway Administration's HY-8 software program to evaluate potential culvert sizes to achieve the design criteria. We assumed a single corrugated metal pipe (CMP) culvert at 1 percent culvert slope and 50-foot length with a minimum cover of 1.5 feet (distance from top of road surface to the top of the pipe). Based on these assumptions, a 54-inch diameter circular pipe or 64-inch span by 43-inch rise arch pipe is recommended.

Given that a topographic survey has not been conducted, we cannot confirm whether these pipe sizes would fit (vertically) within the existing channel profile without raising the road. Based on site visit observations we believe the upstream pond bottom is likely too high (i.e., too close to the road elevation), but topographic survey is needed to confirm. If survey data confirms that vertical constraints exist, then the options include a road raise, multiple smaller parallel culverts, and lowering of the stream bed elevation. Additional discussion on this topic is provided in the Overall Project Considerations section below.

Preliminary Culvert Recommendation

The Project Site preliminary culvert design recommendations are summarized as follows:

- Design Flow: 10-year flow = 137 cfs
- Culvert Type: CMP
- Culvert Size: 48 inches circular pipe or 64 inch span x 43 inch rise arch pipe
- Culvert Slope: Match Natural Grade (estimated 1%)

OVERALL PROJECT CONSIDERATIONS

Based on discussions with Joe Walksalong, we understand the Northern Cheyenne Tribe is interested in pursuing an alternative that would restore the natural stream gradient, eliminate upstream ponding through removal of the man-made embankments, reduce creek water temperatures, and facilitate aquatic organism passage through the culvert (through use of an eco arch pipe similar to the culvert at Sweet

Medicine Rd). A more comprehensive desktop and field investigation is needed to define the topography and bathymetry upstream and downstream of the Project Site, estimate the natural stream profile, and better understand the overall project goals site constraints. We anticipate the upstream ponds have accumulated sediment over time and artificially raised the streambed elevations immediately upstream of the culvert. Installation of a large natural bottom (eco arch) culvert would likely allow sediments trapped within the upstream pond to begin traveling downstream which could lower the channel bed elevation through the culvert. This could undermine the culvert foundations and cause failure of the structure. For these reasons, we've recommended a traditional circular or arch style closed bottom culvert in this memo.

Ultimately, we recommend the Northern Cheyenne Tribe revisit the goals for the full stream segment near the Project Site (shown on **Figure 2**) prior to pursuing a culvert replacement to ensure this project is successful in achieving the desired outcomes. Our recommended next steps include developing a scoping document that addresses the entire reach of concern from upstream of the impoundments to downstream of the Project Site. The scoping document should address unknowns that are needed to develop a design that will restore the reach to the desired natural condition. Those unknowns should include at a minimum:

- Topographic and bathymetric survey of the area surrounding the Project Site, and extending upstream and downstream of the reach into un-affected portions of South Fork Lame Deer Creek to establish the natural gradient of the stream and facilitate detailed design;
- A hydrologic study calibrated and/or confirmed by field observations for development of accurate peak flow estimates and culvert sizing;
- A soil classification of the existing streambed for culvert substrate design;
- An investigation of fish species and fish size found within Lame Deer Creek to adequately design for fish passage;
- A plan for keeping and managing, or removing and restoring the existing embankments and impoundments upstream of the Project Site; and
- An investigation on the natural ecology of the site to help inform the restoration design of the disturbed areas to its natural state.

We recommend that design and replacement of the existing culvert proceed only once the unknowns listed above have been identified. The culvert replacement design could then move forward as one component of a comprehensive plan that will seek to restore the entire reach and achieve the goals of the Northern Cheyenne Tribe.

Aquatic Organism Passage Design

The Alaska Department of Fish and Game (ADFG) and the Alaska Department of Transportation (ADOT&PF) have developed a memorandum of agreement for design and construction of fish passage systems across roadways. The principals and design criteria discussed in the memorandum are applicable to any fish-bearing stream and have been successfully implemented thousands of times. The US Fish and Wildlife Service also provides a document titled Culvert Design Guidelines for Ecological Function which are nearly identical to the guidelines presented in the ADFG / ADOT&PF memorandum of agreement. The culvert design and fish passage principles presented in these two documents are summarized in **Table 5**.

Table 5. Culvert Design Criteria for Aquatic Organism Passage

Criteria	Condition
Fish Passage Design Flow	Q_2 (AEP = 50%)
Culvert Design Flow	To be determined with the Northern Cheyenne Tribe, Consider Q_{10} (AEP = 10%)
Culvert Diameter	Minimum 5-foot Culvert Width at Ordinary High Water State > 0.9 * OHW
Culvert Slope	Within 1% of the natural grade of the undisturbed, natural channel
Culvert Substrate Material	Gradation should approximate natural stream substrate material and be designed to be a dense, well grade mixture to ensure the majority of stream flows on the surface, the minimum water depth is maintained, and the material is stable at Q_{50} (AEP = 2%). Refer to Fuller-Thompson Method for determining substrate gradation.
Burial Depth	Circular Culverts: 40% of diameter; Arch Culverts: 20% of rise
Culvert Material	Corrugated Metal (for retaining culvert infill material)

A potential design for South Fork Lame Deer Creek Access Road culvert using the estimated peak discharge data from **Table 4** and the culvert design criteria is provided below. This proposed culvert was sized to pass the USGS-calculated ten-year flood (Q_{10}), is similarly sized to the existing arch culvert located downstream of the Project Site at Sweet Medicine Rd (where design flows are greater), and meets the fish passage criteria established in **Table 5**. An additional detail that should be accounted for in the design of the culvert is the channel geometry and composition within the arch or barrel. These components should be designed to facilitate and maintain surface flow and aquatic organism passage during low discharge conditions as depicted in **Figure 3** and **Figure 4**.

Preliminary Culvert Design – South Fork Lame Deer Creek

- Culvert Type: CMP Arch
- Culvert Rise: 48 inches (38 inches exposed, 10 inch burial depth)
- Culvert Span: 96 inches (encompasses observed 4-foot wide channel)
- Culvert Slope: Match Natural Grade (estimated 1%)
- Design Flow, Fish Passage: Q_2 = 23 cfs, 3 ft/sec

- Design Flow, Culvert Sizing: Q_{10} = 137 cfs, 10 ft/sec
- Design Flow, Substrate: Q_{50} = 374 cfs, 15 ft/sec

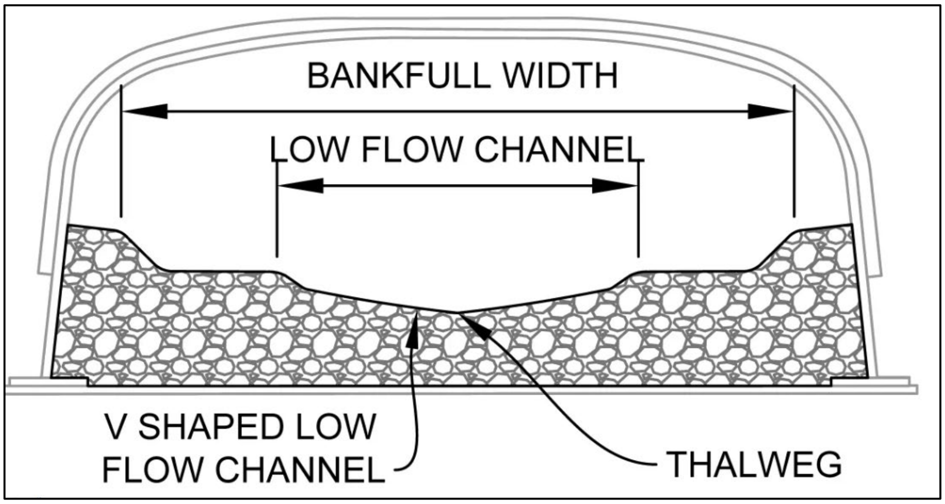


Figure 3. Channel Grading – Excerpt from US Fish and Wildlife Service, Culvert Design Guidelines

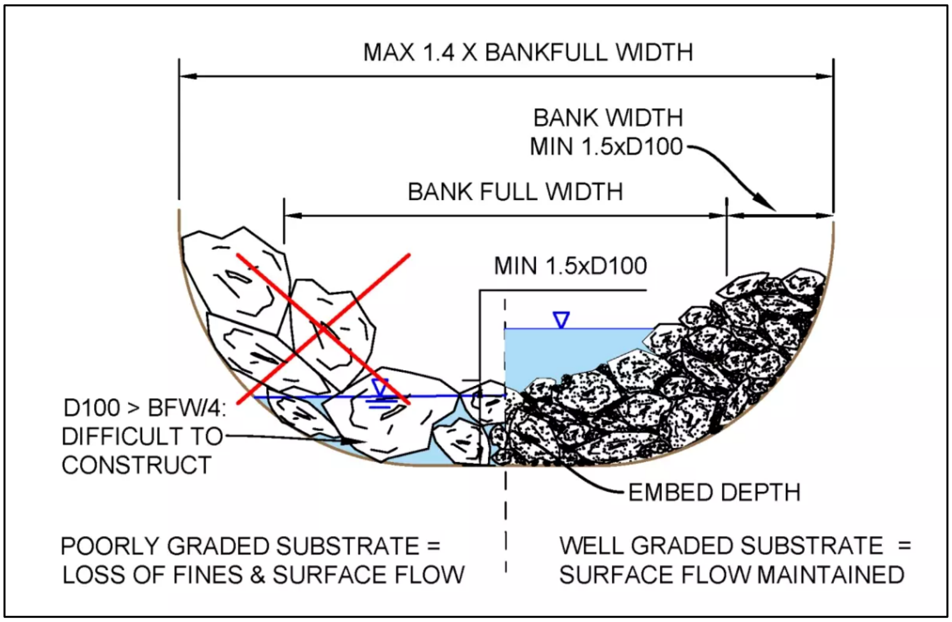


Figure 4. Culvert Substrate Material and Placement – Excerpt from US Fish and Wildlife Service Culvert Design Guidelines

REFERENCES

ADF&G and ADOT&PF, 2001. Memorandum of Agreement between Alaska Department of Fish and Game and Alaska Department of Transportation and Public Facilities for the Design, Permitting, and Construction of Culverts for Fish Passage.

Montana Department of Transportation, 2022. Hydraulics Manual.

US Fish and Wildlife Service, 2022. Culvert Design Guidelines for Ecological Function. https://www.fws.gov/alaska-culvert-design-guidelines#_Toc75597660

USGS, 2016. Methods for Estimating Peak-Flow Frequencies at Ungaged Sites in Montana Based on Data through Water Year 2011. Scientific Investigations Report 2015-5019-F.

USGS StreamStats, 2023. https://streamstats.usgs.gov/ss/

ATTACHMENT A

Select Site Visit Photos

SITE VISIT PHOTOS

Photo 1. Culvert Outlet at Project Site

Photo 2. Culvert Outlet at Project Site

Photo 3. Impoundment Upstream of Project Site

Photo 4. Arch-Type Stream Crossing at Sweet Medicine Rd