Upper Clark Fork Aquatic Restoration Strategy II

Update to 2011 *Aquatic Restortion Strategy for the Upper Clark Fork Basin*, found **here**.

Prepared by

CLARK FORK COALITION

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I. Introduction

The Clark Fork River is located in the northwest region of the United States and flows approximately 330 miles from its headwaters along the Continental Divide in southwest Montana to its mouth at Lake Pend Oreille in Idaho. The Clark Fork is the largest river by volume in Montana and also contains the most distant headwaters of the Columbia River, the fourth-largest river in the U.S. (CFWEP, 2016). The 23,000 square mile Clark Fork watershed is roughly equivalent in area to the state of West Virginia, and contains significant topographic and hydrologic variability. The Clark Fork basin is key to overall aquatic health in the northern Rockies, as its health and resilience affect all of western Montana including the people and wildlife that call it home. The Upper Clark Fork watershed (UCF) is the headwaters of that entire basin. The UCF is the focus of this report, which builds upon our 2011 *Aquatic Restoration Strategy for the Upper Clark Fork Basin* (Clark Fork Coalition, 2011).

The UCF encompasses the portions of the watershed from Garrison, Montana, above the confluence of the Little Blackfoot River, to the headwaters of Silver Bow Creek near Butte, Montana. It includes major parts of Powell, Deer Lodge, and Silver Bow Counties (Figures 1 & 2). The approximately 1,120 square-mile UCF watershed comprises the uppermost 43 miles of the Clark Fork River and several tributaries that have been identified as high priority for restoration by the Clark Fork Coalition.

The Clark Fork Coalition (CFC) is a nonprofit, grassroots watershed restoration group based in Missoula, Montana that works to protect and restore the Clark Fork River basin. Along with its many partners, CFC works to achieve this mission by using a science-based, community-focused approach to engage people in the crucial work of cleaning up and caring for their watershed. CFC implements on-the-ground river restoration work, protects water quality, reviews and comments on policies and proposals impacting water quality and quantity, and works to heal the dewatered Clark Fork River and its tributaries through innovative water conservation activities.

The Coalition is guided by a 15-member board of directors, whose backgrounds and interests represent wildlife and environmental groups, recreation and tourism, livestock and agriculture, private property owners, and responsible land and economic development within the basin. The Coalition's work is informed by a diverse base of supporters who include landowners, businesses, students, teachers, families, rural and urban watershed residents, foresters, state and federal employees, environmental advocates, wildlife and fisheries experts, river guides, anglers, boaters, and other water recreationists, industry representatives, local leaders, elected officials, and many others. CFC routinely partners with local, state, federal, and tribal entities, gleaning their input and cooperation on projects and policies that contribute to the ecologic, social, and economic health of the Clark Fork River watershed.

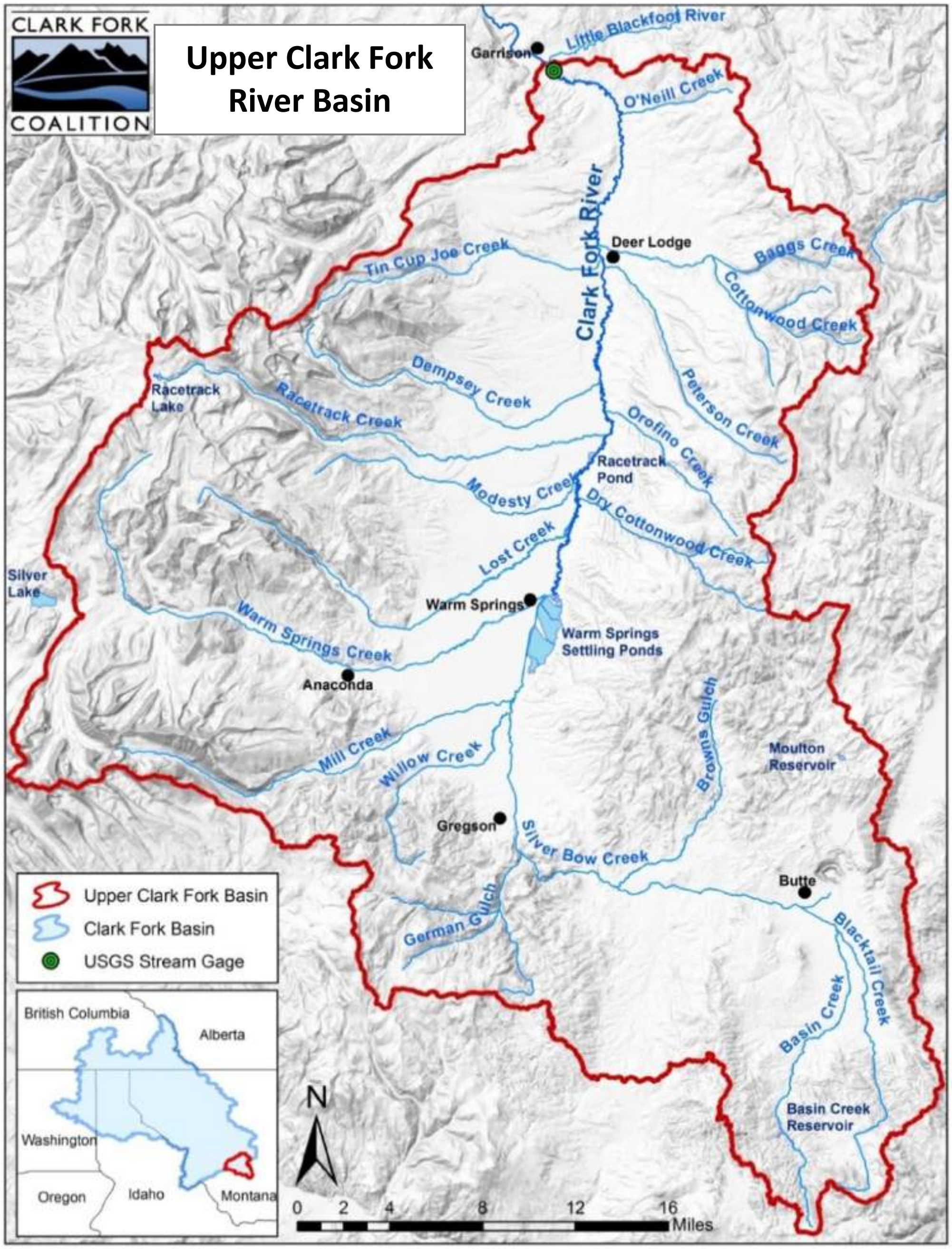

Figure 1- Upper Clark Fork Basin. Data Sources: Montana State Library, MT GIS Clearinghouse.

The UCF has a long history of mining-related impacts that have negatively affected the fishery and aquatic resources along much of the river. Fish population surveys completed by Montana Fish Wildlife and Parks (MT FWP) in 2015 indicated that brown trout dominate the UCF fishery above Drummond, with approximately 300-400 trout per mile (Cook et al., 2015). Montana FWP has calculated that this section of the Clark Fork could potentially support five times the current trout density (Saffel, 2011). Nearby streams such as Rock Creek and the Blackfoot River, which were less impacted by mining pollution, currently support 5-7 times as many trout per mile as the Upper Clark Fork, and a more diverse array of fish species.

Current remediation and restoration efforts by the State of Montana are addressing many of the water quality problems related to the area's mining legacy. But this is only one of the challenges facing the UCF. Montana's mining boom also triggered parallel booms in the agricultural, rail, and timber industries to supply food and materials to mining communities. Agricultural development was especially impactful to the Upper Clark Fork, as extensive irrigation systems were created to sustain crops in this semi-arid region.

Today, agricultural irrigation is by far the largest water use in the basin, and widespread over-appropriation of streams, seasonally dewatered stream channels, and disconnected tributaries have significant impacts on the fishery. Irrigation infrastructure is underdeveloped, with few formal irrigation organizations and a widespread dependence on rustic diversions and earthen canal systems.

This lack of investment in agricultural infrastructure creates both problems and opportunities for aquatic restoration. On one hand, antiquated irrigation systems are inefficient and can pose significant migration barriers to fish. On the other, irrigation infrastructure improvements can gain greater local support and are more likely to succeed because they can simultaneously benefit both agriculture and fishery interests. Pursuing a "win-win" strategy for irrigation and fisheries is crucial to successful work with private landowners in the Upper Clark Fork, and underlies all the recommendations contained in this report.

A. Bio-Physical Characteristics

The Upper Clark Fork basin is comprised of two intermontane valleys and surrounding mountain ranges in west-central Montana near the Continental Divide. The Deer Lodge Valley trends south-north from approximately the communities of Gregson to Garrison, flanked by the Flint Creek Range to the west and the Boulder (or Deer Lodge) Mountains to the east (Figure 3). The Summit Valley formed by Silver Bow Creek trends east west at the very top of the watershed, and is flanked by the Highland and Anaconda Ranges. Elevations range from around 4,400 feet in the valley bottoms to over 10,000 feet in the peaks of the Flint Creek, Highland, and Anaconda Ranges.

Precipitation patterns in the region vary depending on elevation and location and are a significant driver of land use. Higher elevations in the Anaconda, Flint Creek, and Boulder ranges receive the greatest average annual precipitation in the UCF (some locations average > 40 inches per year) and effectively function as a rain shadow, capturing much of the moisture bound for the rest of the watershed. These highland areas are covered with coniferous forests and accumulate a winter snow pack that is critical to the annual water balance of the basin. In contrast, the valley bottom locations are classified as a semi-arid climate with precipitation totals varying between 10 and 14 inches annually, depending on location and aspect (Figures 3 & 4).

The aridity of the more fertile valley soils spurred the development of extensive individually-owned irrigation canal systems in the 1860s and 1870s. Many of the original diversions and canals still play a role in today's agricultural infrastructure in the UCF, with some systems nearly identical to what they were 130 years ago (although sprinkler irrigation has gained in popularity since the 1970s). The semi-arid valley climate, coupled with the lack of major reservoir storage, means that the UCF water use system is largely snowmelt-driven. As a result, water scarcity and frequent drought define the land's agricultural potential and create one of the area's biggest natural resource challenges.

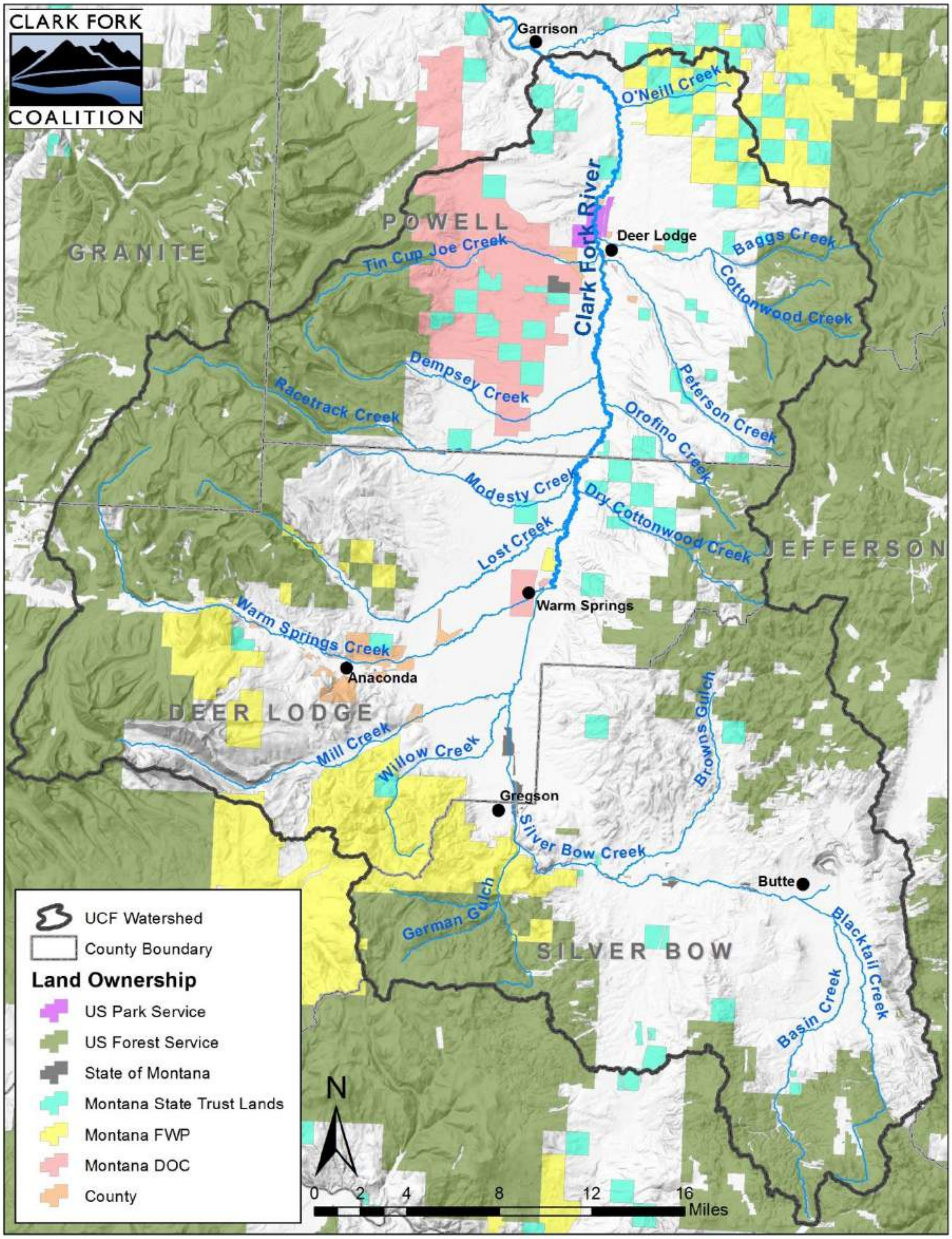

Figure 2- Land ownership in the Upper Clark Fork Basin. Data Sources: Montana State Library, MT GIS Clearinghouse.

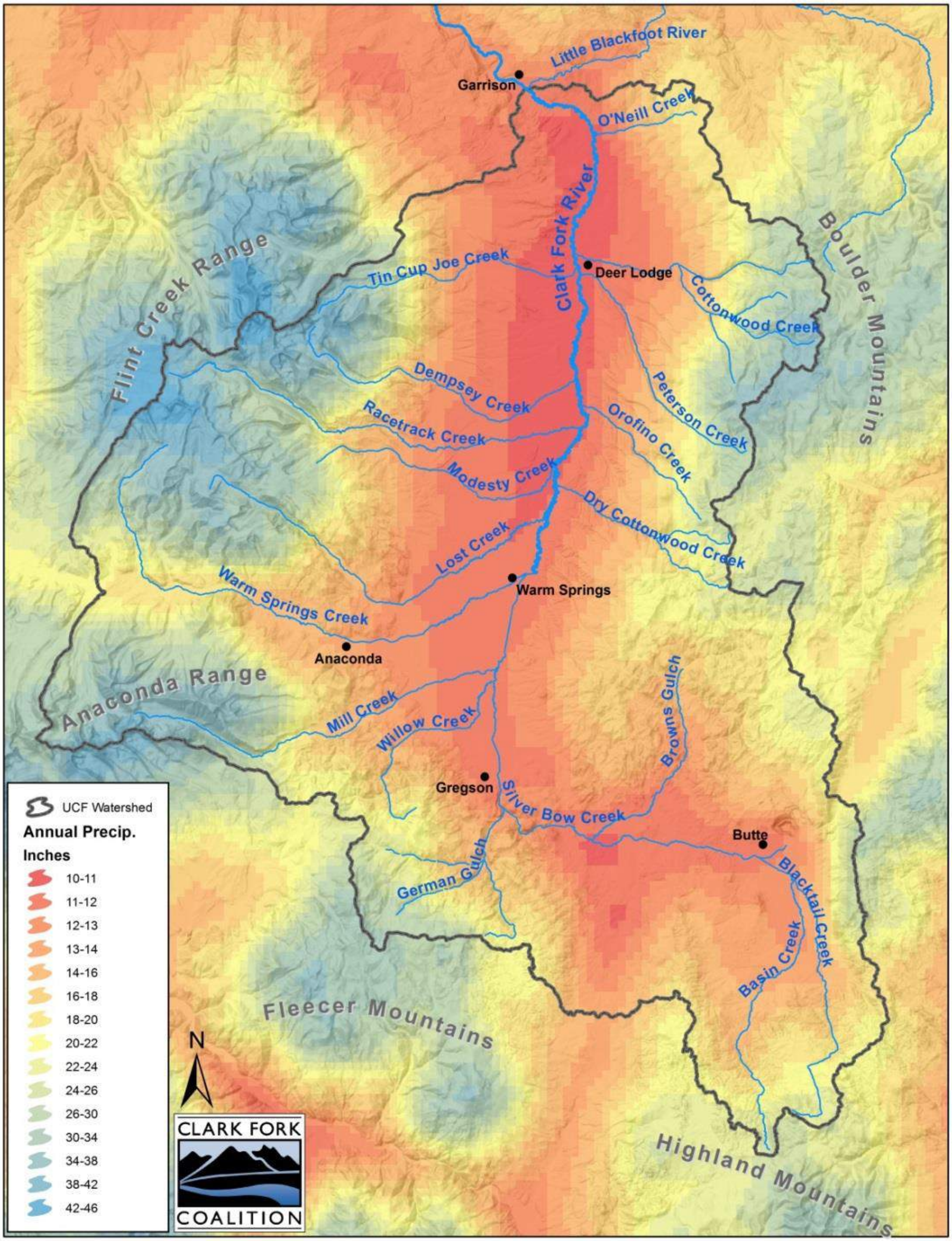

Figure 3- Average annual precipitation in the Upper Clark Fork Basin (1970-2000). Data Sources: PRISM, Montana State Library, MT GIS Clearinghouse.

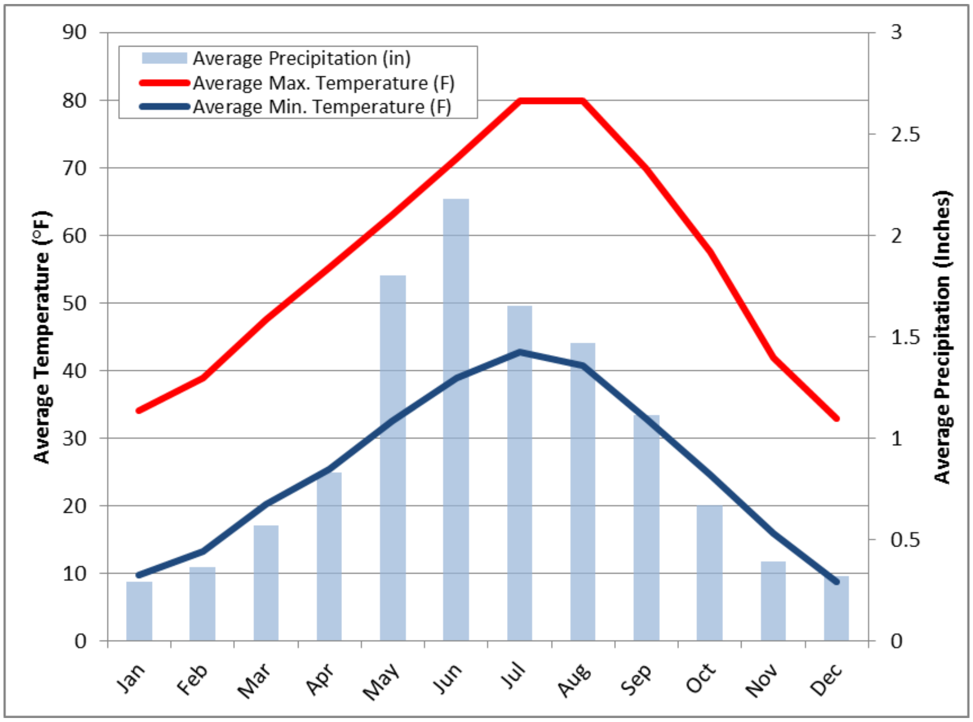

Figure 4- Monthly climate summary for Deer Lodge, MT. Deer Lodge averages 11.6 inches and Butte 12.8 inches of precipitation annually. Averages are for the period 1980-2010. Data source: Western Regional Climate Center.

B. Social Context

The Mountain West recently has been the fastest-growing multi-state region in the U.S. with a growth rate of approximately 28% from 1990-2014. With a projected population of 1.2 million by 2050, Montana will experience increasing population pressures in the coming decades (MT Census and Economic Information Center [CEIC], 2014). Much of Montana’s growth has come to urban areas proximate to the UCF, such as the Missoula and Bozeman valleys, while smaller cities and towns in the UCF have seen stagnant or declining growth over the same period (Figure 5).

According to the Headwaters Economics Economic Profile System, the economy of the UCF basin is largely based on service industry and public sector jobs. The Montana State Prison in Deer Lodge and the State Hospital in Warm Springs are significant regional employers, and local, state and federal government jobs compose a substantial portion of total employment in the UCF (30% in Powell, and 22% in Deer Lodge counties). Extractive industries still play an important role in Powell County, with agriculture representing ~10% of total employment and timber 27% of total private employment. Because agriculture continues to be a significant portion of the work force in Powell County, water is a critical resource to the economy of the Upper Clark Fork.

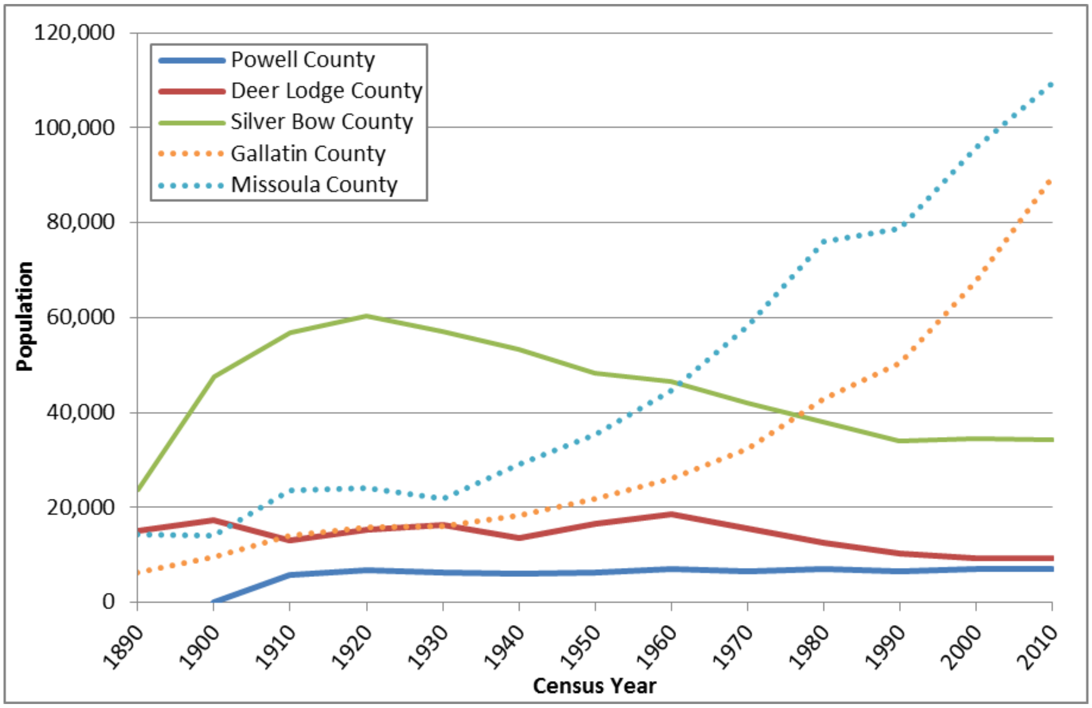

Figure 5- Population trends in counties that comprise the UCF compared to those within MT's urban growth bubbles 1890-2010. Data source: Montana CEIC.

C. Water and Land Use

The history of water use in the UCF basin is closely tied to regional economic development. The earliest water rights recorded in the basin have priority dates beginning in 1862 and represent mostly surface water diversions from perennial tributaries. As regional mining districts (such as Gold Creek, Garnet, and Butte) exploded in the 1860-1890 period, individuals developed irrigation systems on smaller tributaries (i.e. diversions, gravity-fed canals and ditches) to supply agricultural products to the mining camps. The water appropriated in the UCF from around 1875-1900 grew to include surface diversions from larger streams such as the mainstem of the Upper Clark Fork River. The initial water extraction boom in the UCF Basin ended in the 1920s following a period of severe drought and a crash in international commodity prices. By that time, most of the surface water in the basin had been appropriated, and water users were already in conflict over limited water supplies.

Excessive demand for limited water resources has been a challenge in the basin for more than a century. Land uses in the UCF basin are largely driven by climate and soil types. Today, livestock grazing and forestry primarily occur on more arid upland bench areas in the UCF, as they provide productive grasslands and forests. The rich soils found in the valley bottoms are irrigated for livestock pasture or cultivated crops, such as alfalfa and grass hay, and, to a lesser extent, wheat and barley. Clark Fork River tributaries supply the bulk of the water used for irrigation in the valley.

As a whole, the UCF basin has been over-appropriated and water right claims greatly exceed available flows. In most years the lower reaches of streams are completely dewatered during the late summer peak irrigation season, impacting aquatic ecosystems and junior water right holders. In response to excessive demands placed on water resources in the UCF, the state of MT officially restricted new water permits in the basin in 1995, officially closing the basin to new appropriations.

D. Industrial Development

From the 1870s to the 1970s the Butte area, which encompasses the headwaters of the Clark Fork River, was mined as one of the richest copper sulfate deposits ever developed in North America, earning Butte its moniker, "Richest Hill on Earth." During that 100-year period industrial mining activities in Butte and Anaconda required massive volumes of high quality water and necessitated expansive water use infrastructure and conveyance systems. Water demands during the mining heydays of the early 1900s were so high that engineers constructed a pipelines and pumps that transported water 1,000 feet uphill from the Big Hole River over the Continental Divide and from Warm Springs Creek over the hill to the mines in Butte.

During much of the mining boom, the Anaconda Copper Mining Company was the dominant industrial force in Butte and the entire state of Montana. But, after a series of financial difficulties in the early 1970s, Anaconda Copper was sold to the Atlantic Richfield Company (ARCO) in 1977. A drop in international copper prices in the late 1970s further weakened the mining industry, and in 1983 ARCO permanently closed the Berkley Pit – the literal and figurative heart of Butte's mining industry. Mining, and its heavy water demands, didn't end there, however. Montana Resources, a MT based mining firm that acquired some of ARCO's holding in the Butte area, restarted copper mining activities in the mid-1980s (although at a much smaller scale) and is at present the largest user of Butte's industrial water supplies.

Municipal and industrial water deliveries in Butte are routed through a complex system that includes water sourced from the Big Hole River (outside the Clark Fork River watershed), Basin Creek and Moulton Reservoirs in the Silver Bow Creek drainage and Silver Lake/Storm Lake in the Warm Springs drainage.

Significantly, the largest water storage reservoir in the UCF, Silver Lake, is used as an industrial water supply (not for irrigation). Located at the headwaters of Warms Springs Creek and Flint Creek, Silver Lake was constructed by the Anaconda Copper Mining Company (AMC) early in the 20th century to supply water to the copper smelters in Anaconda, and for mining purposes in Butte. At present, water from Silver Lake is diverted through a series of pipelines to the Montana

Resources Continental Mine in Butte. In 1996, Butte-Silver Bow County (BSB) acquired ownership of the Silver Lake water system and its associated senior water rights (Haffey, 2001). Montana's Natural Resource Damages Program (NRDP) has also proposed that water from Silver Lake be used as a drought management tool to augment instream flows on the Upper Clark Fork River (NRDP, 2012).

E. Legal and Institutional Setting

In addition to the physical, social, and industrial characteristics of the UCF, some unique regulations, policies, and legal decisions have far-reaching implications for management and use of water resources in the basin.

i. Basin Closure History

Both the Montana Department of Natural Resources (DNRC) and the MT Legislature have the authority to close over-utilized basins to new water appropriations (MCA 85-2-319). This authority is an effort to protect existing water rights and maintain water quality on streams that could be adversely affected by future appropriations (Montana Water Resources Division [MTWRD], 2003). On April 14th, 1995 the Montana Legislature used this authority to officially close the Upper Clark Fork River Basin (above the Blackfoot confluence) to new surface water appropriations.

This closure includes waters and tributaries of the Clark Fork River above the site of the former Milltown Dam near Bonner, Montana. In closed basins such as this, groundwater appropriations are also restricted (to protect senior water rights), and require that a complete hydro-geologic assessment be completed before groundwater certificates are issued (MTWRD, 2003). As a result, this closure has helped to limit further appropriation of already scarce water resources. In order to dedicate water to uses such as instream flow it is necessary to work with existing (typically irrigation) water rights and seek temporary changes in use.

ii. Superfund Designation

As the site of Montana's largest mining boom, the headwaters of the Upper Clark Fork paid a heavy price for the immense wealth it helped extract. For decades, Silver Bow Creek and the Clark Fork River essentially served as waste conveyance systems for mine tailings. While this caused extensive damage and contamination in the basin, one of the greatest and most lingering impacts occurred as a result of a single event: a massive 500-year flood in 1908. The 1908 event washed approximately 100 billion kilograms of heavy metal-laden mine tailings sourced from Butte and deposited it along the floodplain of Silver Bow Creek and the Clark Fork River – an area stretching from Butte to Milltown Dam near Missoula. These wastes were laced with toxic levels of arsenic, cadmium, copper, lead and zinc, and distribution by the flood left widespread contamination in the floodplains of Silver Bow Creek and the Upper Clark Fork River (NRDP, 2006).

As a result of the heavy metals contamination in the basin, water quality and associated aquatic ecosystems were severely impacted. From the late 19th Century to the early 1970s the Clark Fork River occasionally "ran red" with acid and smelting wastes discharged from the Butte mines and the AMC smelter in Anaconda (Figure 6).

Figure 6- Upper Clark Fork River running red in the 1970s. Photo Credit: Clark Fork Coalition

These extensive and long-term water quality impairments also raised concerns about human health impacts (Andrews, 1987). In a 1986 decision the U.S. Environmental Protection Agency (EPA) gave Superfund designation to the Clark Fork River upstream from the Milltown Dam near Missoula to Silver Bow Creek in Butte, making it part of the largest Superfund site in the United States.

While the basin was being evaluated for Superfund designation, in 1983 the state of Montana pursued legal action to address the widespread injuries to the state's natural resources in the

Upper Clark Fork basin. Because the Atlantic Richfield Company (ARCO) had acquired AMC, ARCO was determined to be liable for those environmental damages.

After 25 years of litigation, the lawsuit was resolved through a series of three settlement agreements, the last of which was finalized in 2008 and resulted in ARCO paying the State more than $168 million (NRDP, 2008). Settlement funds have typically been divided between restoration and remediation. Remediation is primarily the process of cleaning up mining waste while restoration involves returning natural resources back to a healthy condition. Since the U.S. Environmental Protection Agency and the State of Montana began suing ARCO in 1983, the company has paid out approximately $500 million for restoration and remediation projects in the Upper Clark Fork River Basin (Chaney, 2009; Table 1)

UCF Environmental Damage Settlements with ARCO				
Settlement year	**Amount**	**Type**	**Focus**	**Comments**
1999	$230M	Restoration	UCF basin, Butte to Milltown	$129M funds NRDP program; $86M funded cleanup of Silver Bow Creek.
2005	$120M	Remediation and restoration	Milltown Dam	Removal of dam and associated contaminated sediments.
2008	$168M	Remediation and restoration	UCF River floodplain (from below the Warm Springs holding ponds to Garrison)	$130M to DEQ; $30M to NRDP. Most used to remediate and restore UCF.
TOTAL	**$518M**			

Table 1- Summary of environmental lawsuit settlements in the UCF that resulted in funds for remediation and restoration.

iii. NRDP Restoration Plan

Following the 2008 settlement with ARCO, the Montana Natural Resource Damage Program (NRDP) developed a restoration strategy for the Upper Clark Fork River Basin: *Final Upper Clark Fork Aquatic and Terrestrial Resources Restoration Plan* (NRDP, 2012). This plan describes the State of Montana’s proposed actions to restore aquatic and terrestrial resources in the UCF basin, as well as methods to enhance recreational opportunities. The comprehensive planning document also establishes priority stream reaches and land areas that would potentially benefit from restoration activities.

The primary goals of the aquatic restoration efforts are to: “restore trout populations and associated angling opportunities to levels similar for other area rivers.” More specific goals laid out in the Aquatic Prioritization Plan include:

- enhancing recruitment of fish from tributaries;
- placing lost angling opportunities in the mainstem by augmenting trout population in tributaries; and
- maintaining native trout populations in the Upper Clark River Basin.

Although restoration actions are anticipated to enhance aquatic resources in the Basin, the NRDP has acknowledged that there are practical limits to how well the river basin can be restored. Over 100 years of intensive mining and mineral processing have damaged the natural resources of the Basin so extensively that “no amount of money can restore fully all the injured resources of the UCFRB” (NRDP, 2012).

In 2013 DEQ and NRDP began remediation and restoration of contaminated floodplain soils along a 43-mile reach of the Clark Fork River from Warm Springs to Garrison. This cleanup and restoration work in the floodplain forms the essential backdrop for any aquatic restoration work to be done in this Basin. All rewatering, reconnection and habitat restoration work done on tributaries or the mainstem must be done in coordination with the cleanup. An essential assumption of this report is that the clean-up of legacy mining damage in the Upper Clark Fork is necessary but not sufficient to bring back the fishery. Besides the mining damage, the irrigation-related constraints on water resources form a second challenge to aquatic restoration in this Basin. Hence, the work recommended in this report all is designed to complement and enhance the clean-up work which is ongoing.

II. Watershed Needs and Issues

As a result of the conditions and history described above, water resources, the fishery and agricultural infrastructure in the UCF basin today face a number of issues; the most relevant to our work are discussed below.

A. Water Supply

The Upper Clark Fork Basin covers 1,130 square miles (forming part of USGS Hydrologic Unit 17010201), and drains the western side of the Continental Divide, including the Boulder, Flint Creek, and Anaconda Ranges. Precipitation falls primarily as winter and spring snow, with a substantial portion of the annual rainfall occurring in April through June (Figure 4). Runoff patterns are typical of a western snowmelt-driven river system, with flows rising in March-April, peaking in May-June, and receding to baseflow levels by late July. For this reason, water supply stress in the UCF basin is highest from late July to early September, when snowmelt has been depleted and irrigation demands are still high.

i. Streamflow Variability

US Geological Service (USGS) gage data, beginning at the most upstream reaches of the basin and moving downstream toward Garrison, provide a good overview of how streamflow in the UCF basin changes due to both natural hydrogeological conditions and irrigation-related (human) influences. These changes can have big implications for agricultural producers as well as significantly impact stream health and aquatic conditions.

For example, average daily discharge on the Clark Fork River at Galen, the uppermost USGS gage on the mainstem of the river, ranges from roughly 50-400 cfs through the year (Figure 7). This is a fairly healthy flow, but it is measured *above* a large portion of the roughly 65 square miles of irrigated lands in the Deer Lodge Valley.

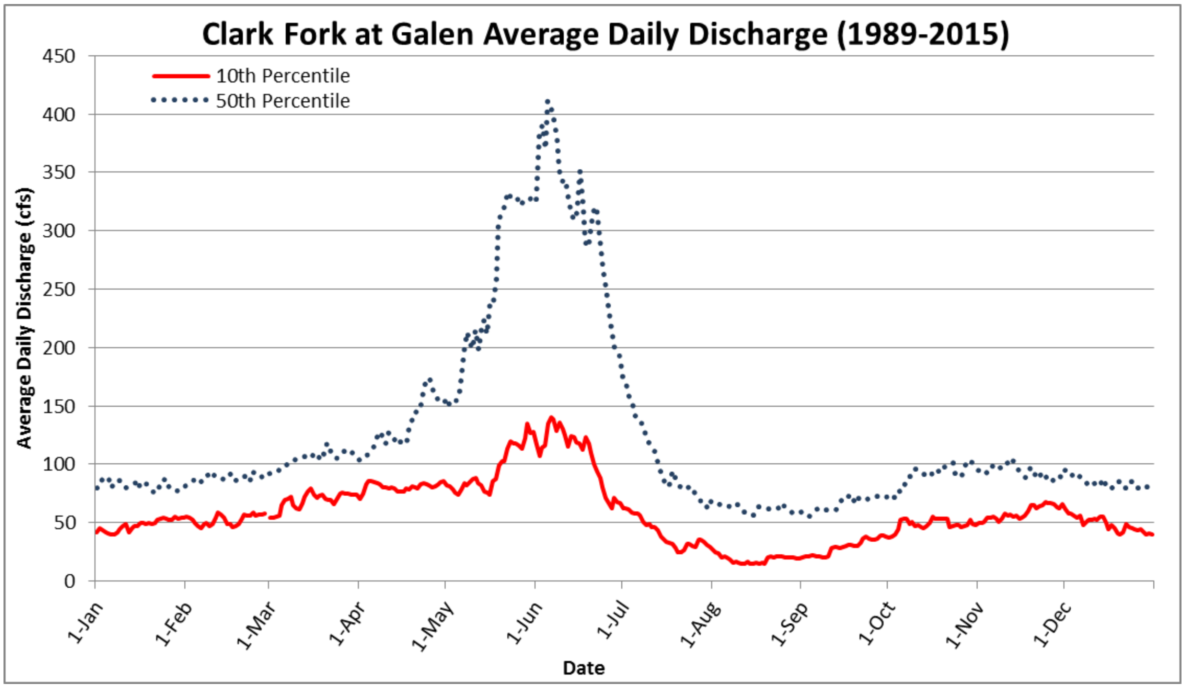

Figure 7- Average daily discharge on the Clark Fork River at Galen. The solid line represents an average 10th percentile "drought flow"; the dotted line is the 50th percentile "median" flow. Data source: USGS, National Water Information System.

Below the Galen gage, flows become significantly reduced as irrigation water is pulled from the system. This span of river – between Galen and Deer Lodge – is the most stressed and dewatered reach in the Upper Clark Fork, as it contains many of the largest irrigation diversion canals on the mainstem of the river. Synoptic runs done in this section by the Clark Fork Coalition in 2013 and 2015 show that five irrigation canals (Alvi Beck, Whalen, West Side, Valiton, and Sager) divert up to 75% of the available river water in late summer between Racetrack Road and Sager Lane (Figure 8). At the lower end of this reach, near Sager Lane, late summer flows can be depressed to as low as 12 cfs – far below levels that can sustain healthy aquatic life (Figures 8 & 9).

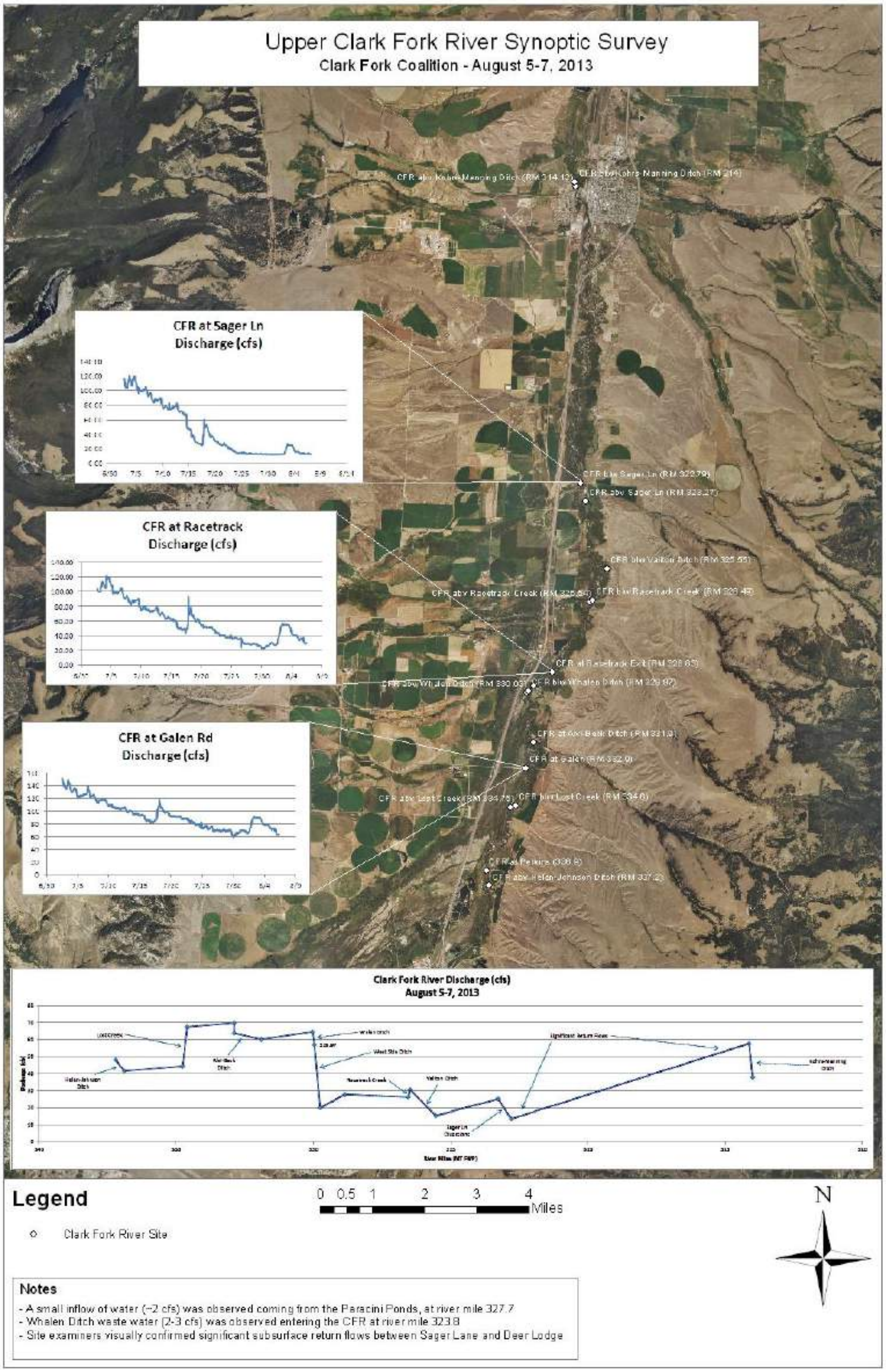

Figure 8- Upper Clark Fork Synoptic Survey. Stream flow measurements were completed by CFC staff over August 5-7th 2013 in order to illustrate the exact locations of low flows in the river system.

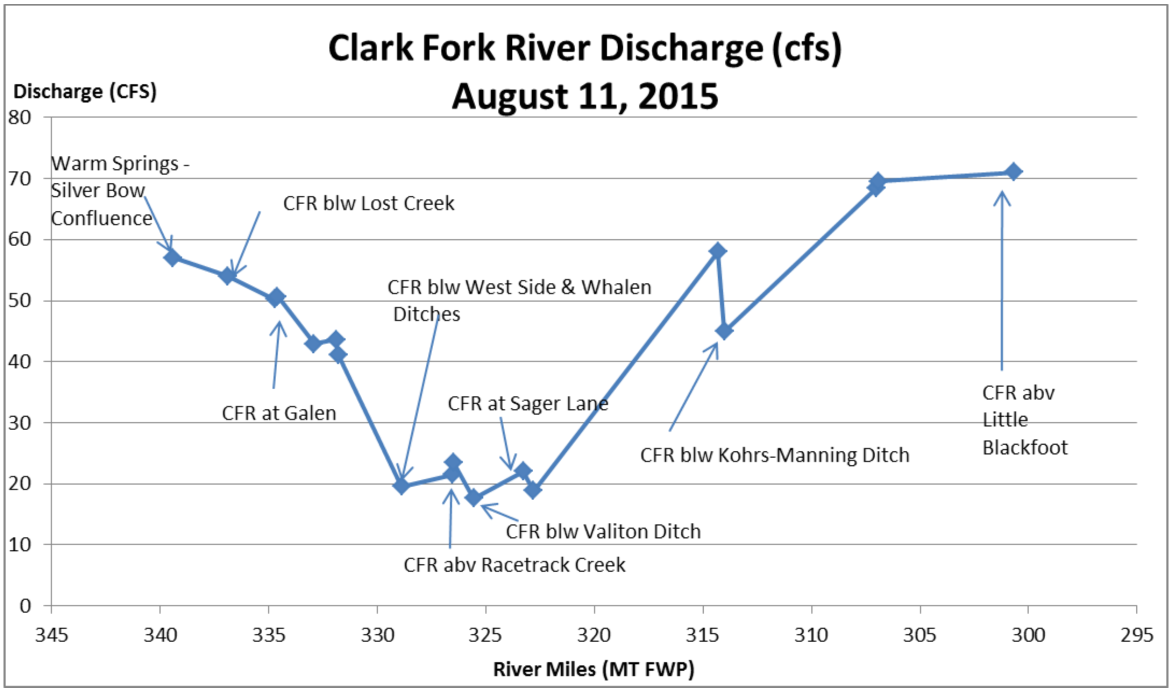

Figure 9- Graph showing CFC's synoptic stream flow measurements from August, 2015 on the reach of the Upper Clark Fork River from the confluence of Silver Bow and Warm Springs Creeks downstream (north) to just above the mouth of the Little Blackfoot River near Garrison. Downstream of Sager Lane the river goes through a gaining reach, and recovers rapidly as return flows become the dominant hydrologic process. Much of these return flows are attributable to leaky ditches and inefficient irrigation techniques. Flows are still impaired at Deer Lodge at times but to a much smaller degree than upstream locations. Gage data from Deer Lodge show a mean annual flow rate of 287 cfs, or ~200,000 acre feet per year (USGS, 2016b). August shows the lowest mean monthly flow at 109 cfs (July and August flows often dip below aquatic habitat-derived flow targets – see Fig. 10) but the river experiences a marked recovery of flows from late September to mid-November. This is likely due to a combination of reduced irrigation demand, irrigation return flows, fall precipitation, and overall reduced basin evapotranspiration as air temperatures drop. Mean monthly flows between November and March remain fairly stable, at 200 - 250 cfs (Figure 11).

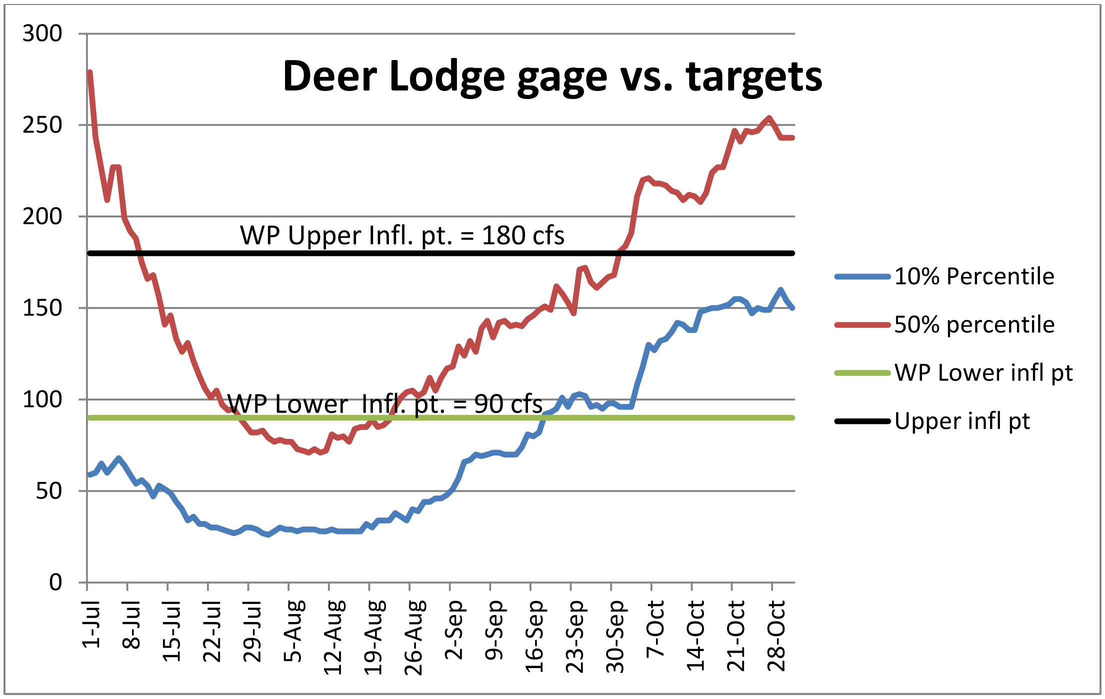

Figure 10- Average daily summer (Jul 1-Nov 1) discharge on the Clark Fork River at Deer Lodge. Flows at Deer Lodge dip well below aquatic habitat-derived flow targets in July-September (wetted perimeter method) even in median flow years**.** Wetted perimeter (WP) inflection points derived from *Application for Reservations of Water in the Upper Clark Fork River Basin*, 1986 (MT FWP, 1986).

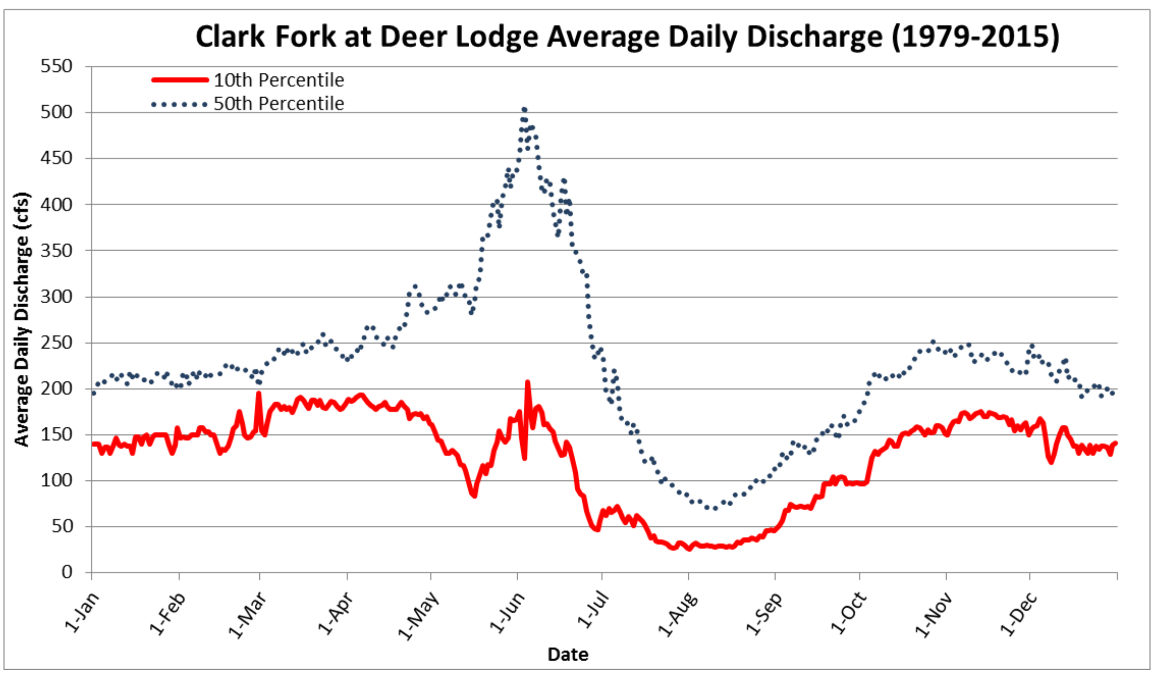

Figure 11- Average daily discharge on the Clark Fork River at Deer Lodge. The solid line represents an average 10th percentile “drought flow;” the dotted line is the 50th percentile “median” flow. Data source: USGS, National Water Information System.

These irrigation return flows continue to increase river flows downstream of Deer Lodge. Near Garrison, the valley narrows substantially, and it is likely that groundwater inflows also contribute to the river's flow in this last reach (see synoptic run data, Figures 8 & 9).

Gage data from 1975 to 2015 indicate considerable variability in UCF flows over time. In the northern Rocky Mountains much of the observed year-to-year variability in snowfall and streamflow volumes has been attributed to changes in larger-scale drivers of climate, such as the Pacific Decadal Oscillation (PDO) and El Nino Southern Oscillation (ENSO) (Pederson et al., 2011).

These influences have caused frequent episodes of late-summer drought over the period of record (Figure 12). Two distinct periods of extended summer streamflow drought anomalies occurred from 1985-1992 and 1999-2008 (USGS, 2016b). During those prolonged periods of summer streamflow droughts, August discharge was below average for periods of 8 and 10 consecutive years. The summer of 1988 was the most severe streamflow drought on record with discharge averaging just 28 cfs for the month of August at the Deer Lodge gage (representing a drainage area of 1,000 square miles).

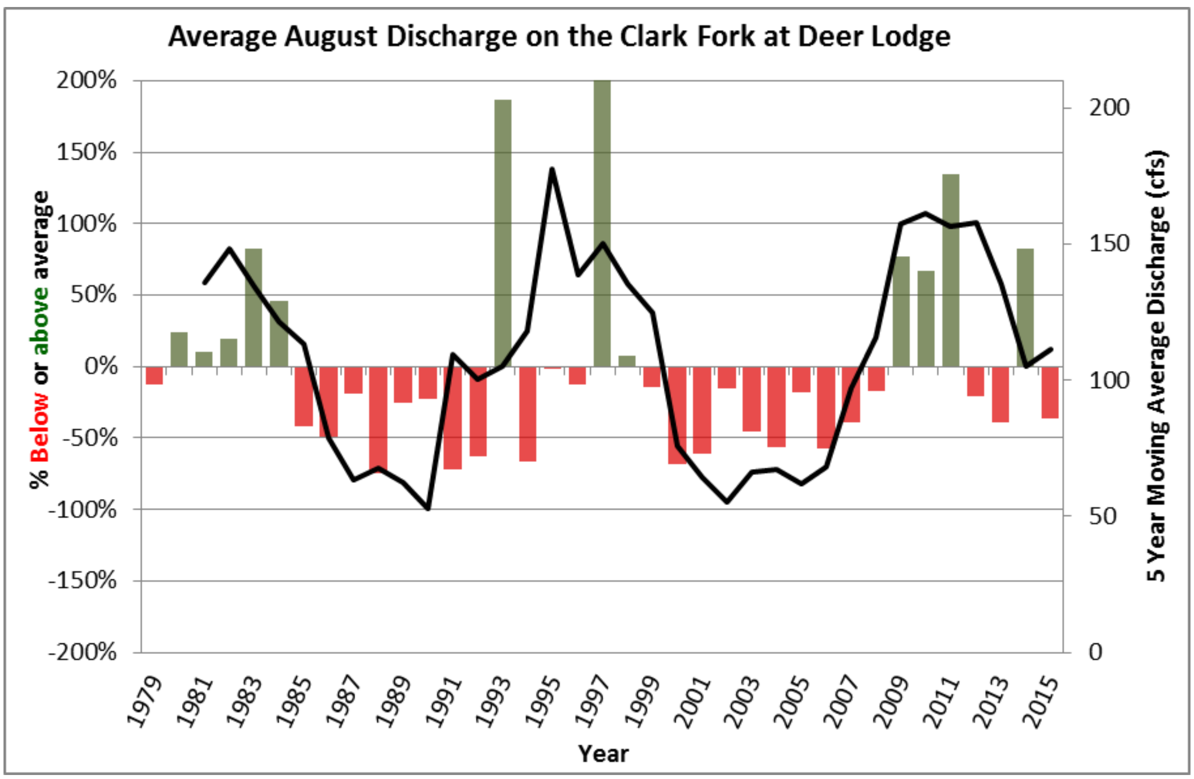

Figure 12- Average monthly discharge for August on the Clark Fork River at Deer Lodge. Red/green bars represent the percent above or below the long term average for August (108 cfs). The black line depicts a 5 year moving average discharge for August. Flow fell below the long-term average 24 out of the past 35 years. Data source: USGS, National Water Information System.

Such reoccurring drought conditions, in combination with existing annual irrigation demands, not only deplete water resources available for agricultural use, they put enormous stress on the fishery, degrade water quality, and harm all aquatic resources.

ii. Water Usage

Irrigation is the predominant type of water usage in the Upper Clark Fork Basin and is largely concentrated on surface water sourced from perennial tributaries that drain the Flint Creek, Anaconda, and Boulder Mountains. At present the UCF basin includes approximately 45,500 acres of irrigated farmland. Of that, about half (~22,500 acres) are flood irrigated; 16,000 acres are irrigated via center pivot sprinklers; and 7,000 acres are irrigated via traditional sprinklers, such as wheel lines & hand lines (Figure 13).

As Figure 13 shows, there is a substantially larger amount of irrigated acreage on the west side of the valley. This is because tributaries on the west side of the UCF basin generally sustain larger runoff volumes due to higher annual precipitation (snowfall) accumulations in the Flint Creek and Anaconda Ranges. Demands placed on these tributary systems during the post-runoff summer season are high and many of the larger tributary systems are completely dewatered (almost annually) in their lower reaches.

The amount of irrigated land in the basin has remained stable or declined slightly over the last 75 years (Figure 14), but irrigation methods have changed dramatically since the 1950s. Historic Montana Water Resource Surveys from the 1950s and U.S Department of Agriculture census data show that in in the 1950s the majority of irrigated acreage in the three counties that comprise the UCF basin was under gravity-fed flood methods. Over the last 35 years, Montana has experienced a large-scale conversion of irrigation techniques, as advanced center-pivot sprinkler systems have replaced more traditional water delivery methods, such as flood irrigation (Figure 15).

This shift in irrigation practices (from flood to sprinkler) has had a direct impact on overall availability of water in the Upper Clark Fork basin. Compared to sprinkler irrigation, flood irrigation results in less consumptive use. Flood irrigation’s inefficient nature results in water percolating below the root zone and into groundwater reservoirs rather than being transpired by plants. Furthermore, plants are less productive and less water is lost to evapotranspiration than under sprinkler conditions.

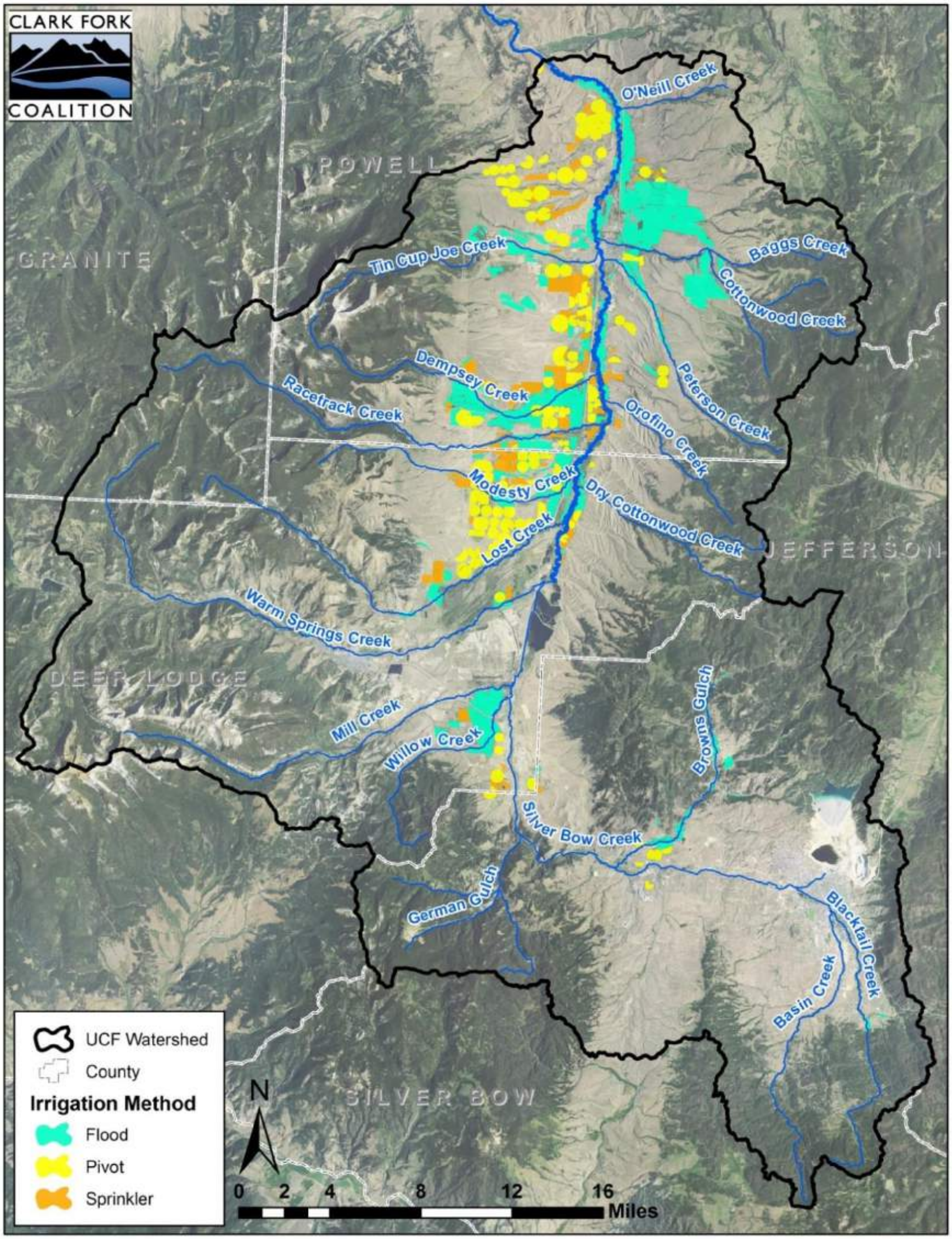

Figure 13- Estimate of irrigated land in the Upper Clark Fork Basin (2016) by method of irrigation. Higher snowfall in the Flint and Anaconda ranges leads to more irrigated land on the west side of the valley, as streams on this side sustain higher runoff. Data sourced from MT Department of Revenue land use data and orthophoto interpretation by CFC staff and contains rough estimates of irrigated areas.

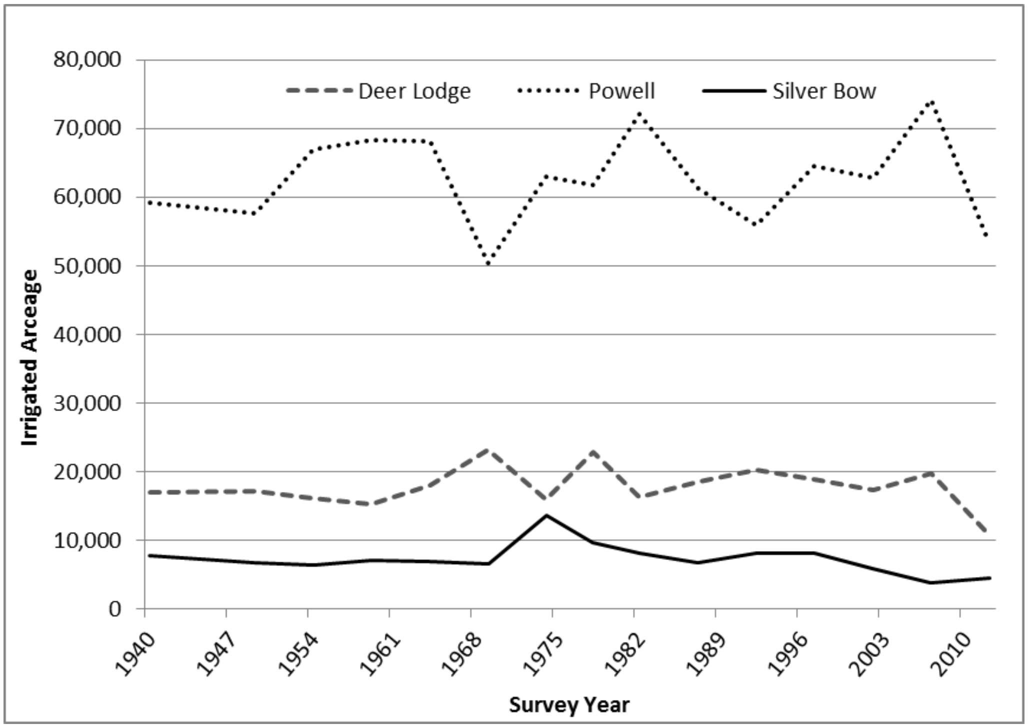

Figure 14- Irrigated acreage in the three counties that comprise the UCF basin over the period 1940-2012. Data is compiled from the National Agricultural Statistical Service, Farm and Ranch Irrigation Surveys.

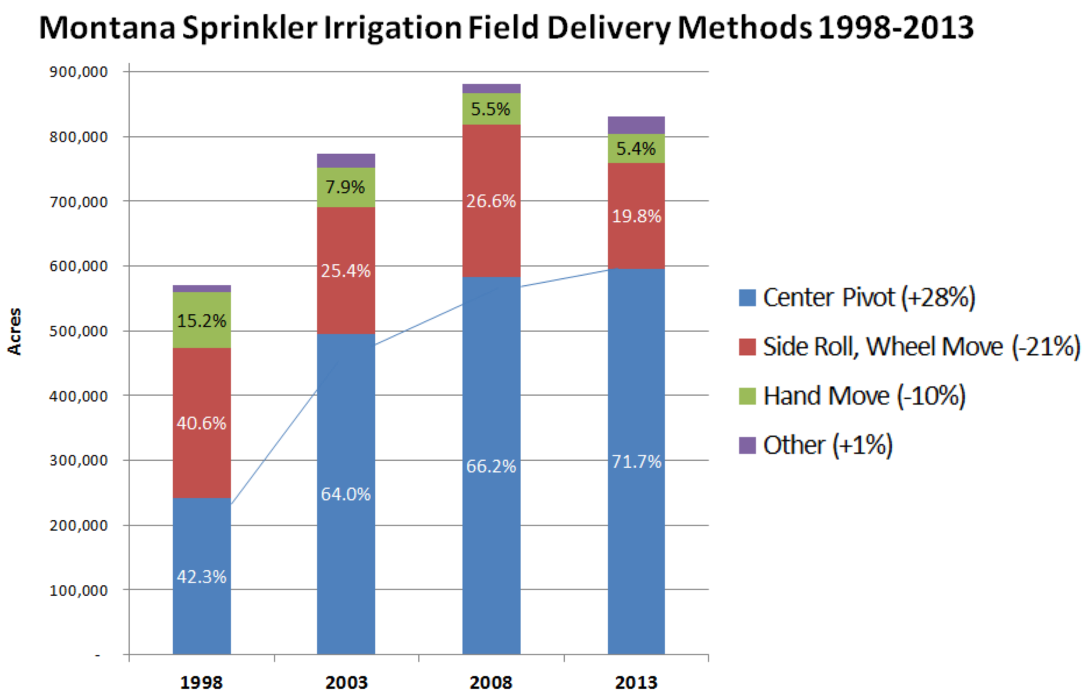

Figure 15- Breakdown of sprinkler irrigation techniques and the amount of acreage under each method in Montana, 1998 - 2013. Center pivot irrigation increased significantly in this period; from 241,287 acres to 595,590 acres. Data source: NASS Farm and Ranch Irrigation Surveys

CFC estimates that prior to 1960, most of the approximately 60,000 acres under irrigation in the Upper Clark Fork were flood-irrigated (Table 2), an estimate based on interpretation of aerial images and MT Water Resources Survey. This means that the total annual historic crop consumptive use for the Upper Clark Fork Basin prior to 1960 was approximately 52,412 acre-feet (Table 2).

Since the 1960s, sprinklers and center pivots have been incorporated into the majority of irrigated alfalfa acres in the Upper Clark Fork. Meanwhile, total irrigated acreage dropped by about 25% to roughly 45,000 acres. Alfalfa under center pivot irrigation consumes approximately 20% more water than historic flood practices, which may cancel out water savings created by the lower number of irrigated acres.

Because more water is being consumed for alfalfa irrigation, less is available for other uses because less water returns to the source of supply, creating water shortages. Currently, we estimate that irrigation in the Upper Clark Fork Basin consumes 55,126 acre-feet annually – slightly more than what was consumed prior to 1960. As a result, the demand for limited water supplies has increased, which impacts the aquatic ecosystems that rely upon these creeks and rivers to survive.

Comparison of Consumptive Use in Deer Lodge and Powell Counties				
Pre-1960 vs. 1960-Present				
Irrigation Technique and Crop	Pre-1960		1960-Present	
	Acres	Consumptive Use (Acre-feet)	Acres	Consumptive Use (Acre-feet)
Flood/Sprinkler (Hand and wheelines)				
Alfalfa	18,944	16,902	3,943	4,533
Other (mostly grass)	41,671	35,510	25,750	28,277
Pivot				
Alfalfa/Other	0	0	15,891	22,316
TOTAL	**60,615**	**52,412**	**45,584**	**55,126**

Table 2- Consumptive use estimates for the Upper Clark Fork Basin utilizing State of MT DNRC method (County management factor X irrigation water requirement). Table compiled using historic weather data from the Deer Lodge Agrimet weather station. Estimates of consumptive use also consider the county management factor and irrevocable losses due to evaporation. Historic acreages estimated based upon the Water Resource Survey information and current acreages were interpreted through the use of aerial imagery.

iii. Conveyance Losses

Ditch systems can result in substantial loss of water from an irrigation system. Conveyance loss, or ditch seepage, is influenced by a variety of factors, such as soil type, canal roughness, gradient, and aquatic vegetation. The UCF includes 10 major ditch systems that draw from both the mainstem of the river and major tributaries (Figure 16). The Clark Fork Coalition, consultants, and agencies have conducted numerous ditch seepage studies on these major canal systems, as summarized in Table 3.

Ditch Name	Water Source	Ditch Length (miles)	Seepage Quantity (cfs)	Seepage Rate (%)	Data Source
Gardiner Ditch	Warm Springs Creek	8.12	9.92	40	Clark Fork Coalition
Helen Johnson Ditch	Clark Fork River	2.7	5.75	48	Clark Fork Coalition
West Side Ditch	Clark Fork River	11.4	19.1	55	Pioneer Preliminary Design Report, 2014
Whalen Ditch	Clark Fork River	3.5	4.2	53	Pioneer Preliminary Design Report, 2014
Cement Ditch	Racetrack Creek	4.3	4.59	13	Clark Fork Coalition
Morrison Ditch	Racetrack Creek	7.5	12	38	MT DNRC
Valiton Ditch	Clark Fork River	4.5	6.0	25	State of MT DNRC
MSP Tin Cup Joe	Tin Cup Joe Creek	2.9	3.15	24	Clark Fork Coalition
Upper Peterson	Peterson Creek	1.7	1	20	State of MT
Kohrs Manning Ditch Company	Clark Fork River	3.3	4.5	25	WRC

Table 3- Ditch losses in the UCF basin displaying both seepage quantities (cfs) and seepage rates (%).

These studies reveal that ditch seepage percentages vary greatly across the Upper Clark Fork – from 13% to 55%. Most major canal systems (all earthen canals) appear to have ditch seepage rates from 40% to 50%. In most cases water that is lost to ditch seepage returns back to the source of supply, but whether this can positively influence the system is determined by when, where, and how much water is returned. Strategies to pipe or line ditches to enhance low summer flow must consider the timing, location, and quantity of seepage if they are to be effective.

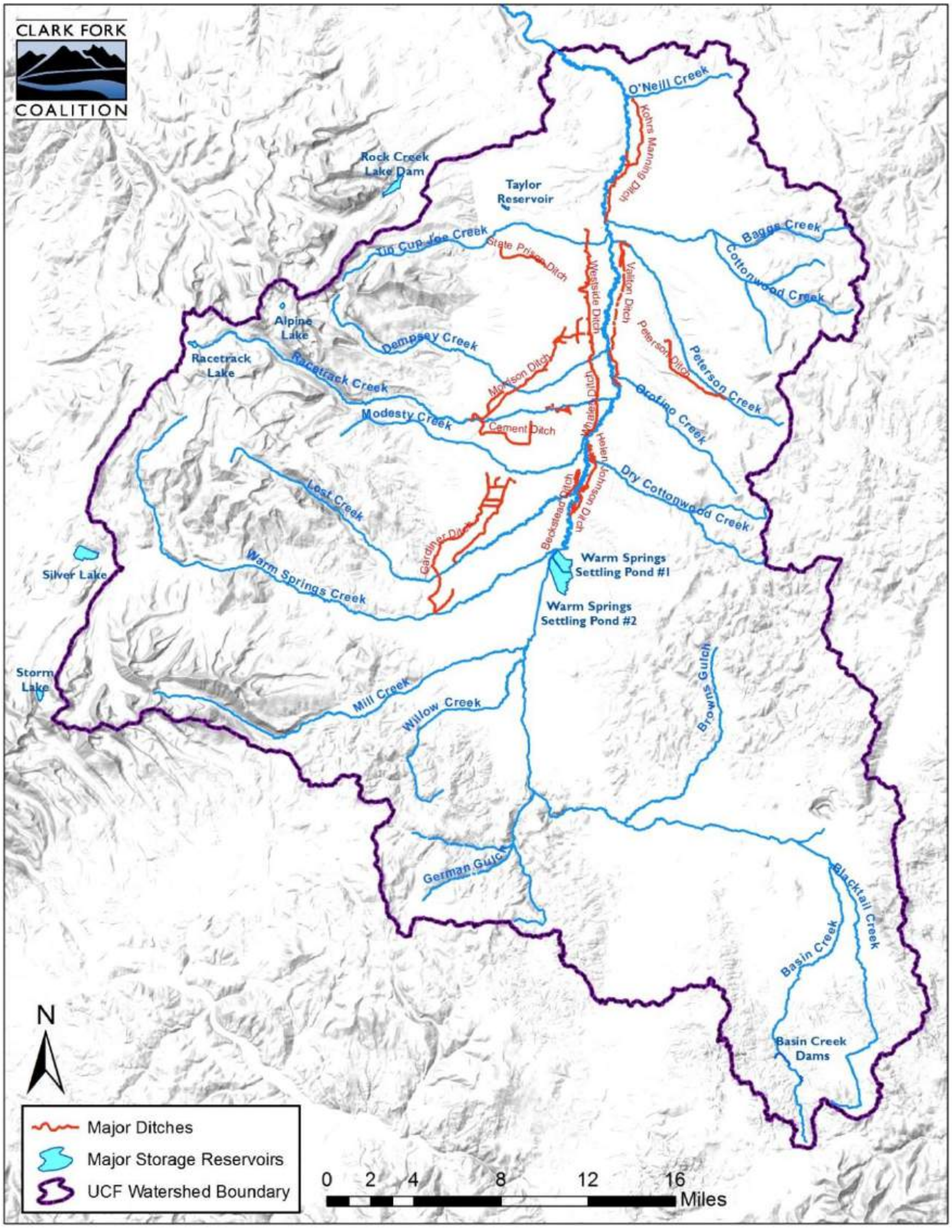

Figure 16-Major ditches and reservoirs in the Upper Clark Fork Basin (both Storm Lake and Silver Lake drain into the Warm Springs-Clark Fork drainage).

iv. Irrigation Water Storage

The Upper Clark Fork Basin study area has limited surface water storage capacity. Some of the largest existing impoundments in the basin were developed in early to mid-20th century to either supply industrial water to mining/smelting operations in Butte and Anaconda, or to manage and mitigate the effects of mine waste and tailings on surface water quality. In Table 4 the existing surface water impoundments in the basin are listed in order of their gross storage capacity.

The largest impoundment by far in the basin is Silver Lake; at over 17,000 ac-ft. Silver Lake was created by the Anaconda Copper Company to store industrial process water. It sits squarely on the Warm Springs Creek/Flint Creek divide, and so it was necessary to build two dams, one on each potential outlet stream, to create the storage. Water that fills Silver Lake is diverted from Storm Lake Creek and Twin Lakes Creek, two drainages within the upper Warm Springs Creek drainage. The storage water rights and dam maintenance responsibilities were obtained by Butte-Silver Bow local government from the Anaconda Company/ARCO in the 1990s. A few basic facts regarding Silver Lake storage capacity and management are included in the bulleted list below. All data compiled from Silver Lake planning documents (City and County of Butte-Silver Bow, 2011a, 2011b, 2011c).

- Silver Lake is listed as having 17,100 ac-ft of storage. However this counts 8,175 acre feet (ac-ft.) of dead storage (below pumping levels).
- Storage available to be extracted by pumps is 7,025 ac-ft. Storage above pumping level, which can be extracted by opening spillways to Warm Springs Creek is 1,900 ac-ft.
- The direct flow in late summer from the Warm Springs Creek watershed dwarfs the Silver Lake reservoir outflow--4,500 to 7,400 ac-ft/month direct flow vs. 500-800 ac-ft/month from Silver Lake in the July- Sept time frame.

Regarding other large storage reservoirs in the basin, the Storm Lake Dam holds up to 2,150 ac-ft of water in the upper Storm Lake Creek watershed, which feeds into Silver Lake. The Warm Springs Settling Dams #1 and #2 are large shallow facilities which have been used for nearly 100 years to detain, impound and treat (with lime) metals contaminated water from lower Silver Bow Creek, before it is discharged just above the confluence of Silver Bow Creek and Warm Springs Creek. Although Silver Bow Creek has been substantially restored by CERCLA, the Warm Spring impoundments remain and their future is unclear. These impoundments have some mitigating effect on storm water peaks from Silver Bow Creek, but are unlikely to have a major effect on overall water supply into the Upper Clark Fork Basin.

The Basin Creek Dams #1 and #2 are municipal water supply storage facilities for Butte, in the upper Silver Bow Creek drainage, as are the Moulton Reservoir dams.

The largest pure irrigation storage reservoir in the Basin is Racetrack Lake which has 800 ac-ft of gross storage of which about 650 ac-ft is active storage owned by three different irrigators in the Racetrack area. The largest portion of that storage (about 433 ac-ft) is in process of being changed to an instream flow beneficial use by the Clark Fork Coalition and Natural Resource Damage Program. A number of other smaller irrigation water storage reservoirs exist, mostly in the Racetrack, Dempsey, and Tin Cup Joe drainages on the east side of the Flint Creek Range west of Deer Lodge. These are small, rustic reservoirs in alpine lake basins high in the Flint Creek Mountains. Most of these reservoirs each have a single distinct owner (irrigator) who manages their outflow, principally to enhance late summer streamflows which are diverted in the valley to irrigate hay crops.

NAME	OWNER	YEAR BUILT	RIVER	STORAGE (AF)
SILVER LAKE EAST DAM	BUTTE-SILVER BOW	1918	TR-STORM LAKE CREEK	17920
ROCK CREEK LAKE DAM	CASTLE MOUNTAIN RANCH	1960	*ROCK CREEK	2552
STORM LAKE DAM	BUTTE-SILVER BOW	1898	STORM LAKE CREEK	2150
WARM SPRINGS TAILING DAM #1 DAM	ATLANTIC RICHFIELD CO	1911	SILVER BOW CREEK	1950
WARM SPRINGS TAILING DAM #2 DAM	ATLANTIC RICHFIELD CO	1919	SILVER BOW CREEK	1650
BASIN CREEK DAM #1 DAM	BUTTE-SILVER BOW	1897	BASIN CREEK	1170
RACETRACK LAKE DAM	BUD JACOBSON & SONS INC ET AL	1975	RACETRACK CREEK	800
ALPINE LAKE DAM	LOUBREN CORPORATION	1933	NORTH FORK RACETRACK CREEK	376
TAYLOR, UPPER (POWELL) DAM	STATE OF MONTANA, D.O.C.	1951	TAYLOR CREEK	372
BASIN CREEK DAM #2 DAM	BUTTE-SILVER BOW	1907	BASIN CREEK	290

Table 4- Overview of the 10 largest water storage facilities (ranked by storage volume) in the UCF basin. Data source: MT FWP (MT Dams GIS dataset, 2003). *Rock Creek Lake Dam is located outside of the study area but is an important source of irrigation water in the Deer Lodge Valley.

v. Groundwater

Groundwater is an important component of the water use cycle in the Upper Clark Fork Basin with wells providing a significant volume of high quality water for both municipal and industrial uses in communities in the Upper Clark Fork.

Estimating total surface and groundwater use precisely is difficult due to split jurisdictions within the project area. Both agricultural and water use statistics are typically summarized at the county level making finer scale analysis challenging. According to water use data compiled by the USGS, surface water comprises the majority of total water use in Deer Lodge, Powell and Silver Bow Counties.

A study completed by the Montana Bureau of Mines and Geology (MBMG) in 2007 investigated groundwater use in Deer Lodge, Powell, Silver Bow and Granite counties. Figure 17, copied from that report, shows the distribution of well types and the estimated consumptive use of groundwater in the four county region. Although domestic wells account for the majority of total wells, the public water supply represents the majority of groundwater use. It is important to keep in mind that Montana does not allow further development of groundwater for irrigation in a closed basin like the Upper Clark Fork.

Long-term well monitoring data in the UCF indicates that groundwater levels have remained relatively stable over that period and it appears that current consumptive groundwater use levels in the UCF are sustainable at the moment, although that could change as municipalities and outlying areas continue to grow and increase groundwater withdrawals. The contamination of groundwater sources from historic mining waste continues to be problematic for some of the major communities in the Upper Clark Fork. The City of Deer Lodge for example is in the process of trying to identify new groundwater wells that do not exceed water quality standards for arsenic. Clean-up efforts in the UCF may help reduce further contamination groundwater sources.

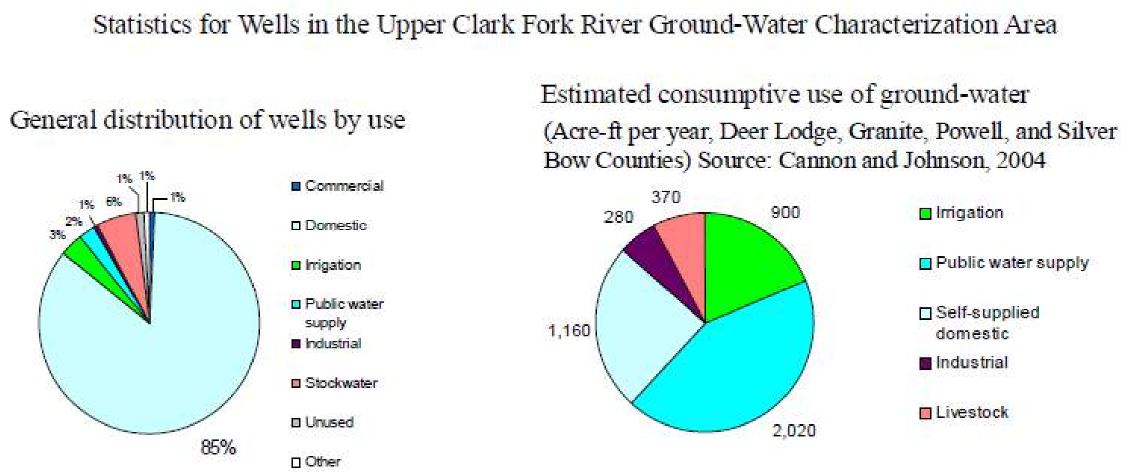

Figure 17- Statistics for wells in the UCF groundwater characterization area. Data source: Montana Bureau of Mines and Geology, *Ground-Water Resource Development in the Upper Clark Fork River Ground-Water Characterization Area, Deer Lodge, Granite, Powell, and Silver Bow Counties, Montana.*

vi. Changes in Climate

Following national and global trends, over the last 100 years, average annual temperatures in the UCF have increased by approximately 2°F. At the same time, average annual precipitation in the region has remained stable or decreased slightly (Figure 18). In west-central Montana, this increase has resulted in earlier snowmelt and a corresponding advance in spring runoff (Pederson et al., 2011). In addition to these impacts, warm temperatures have also been shown to increase evapotranspiration demand in terrestrial ecosystems (including planted crops); boosting potential plant growth while at the same time increasing the amount of water needed for growth.

The link between increased emissions of greenhouse gasses, rising global temperatures, and regional scale impacts on hydrologic processes is well established (Barnett et al., 2008; Rosenzweig et al., 2008). A 2016 U.S. Bureau of Reclamation (BOR) study on the impacts of climate change on river flows in the Columbia River Basin (CRB) further reinforce that link, showing that it may result in several drastic changes to the region's hydrologic cycle. The UCF basin comprises the most distant headwaters of CRB.

For example, in many CRB sub-basins snowpack is anticipated to decline in conjunction with earlier snowmelt runoff. This projected shift in runoff has the potential to stress water use systems designed around historical hydrologic patterns. Increases in late winter and early spring runoff events will limit supplies of water available during the irrigation season. The BOR also estimates that summer maximum temperatures will be significantly warmer in the future, increasing evapotranspiration demand during the growing season. Although a warming climate may extend the growing season and boost agricultural productivity, it will require addition supplies of water (BOR, 2016).

While climate models cited by BOR vary in their projections of future precipitation regimes, they generally agree that there is potential for drier summers and wetter autumns and winters in the future, meaning future water supplies may be reduced (compared to historical averages) when demand is greatest during the summer irrigation season.

In the UCF, climate-related impacts already observed are likely to continue and are a major consideration for our goals related to flow and water quality improvements. Water supplies during the past two summers (2015 and 2016) may be considered precursors of future conditions, with earlier than normal snowmelt resulting in mid-summer water deficits and extremely low streamflows in late summer.

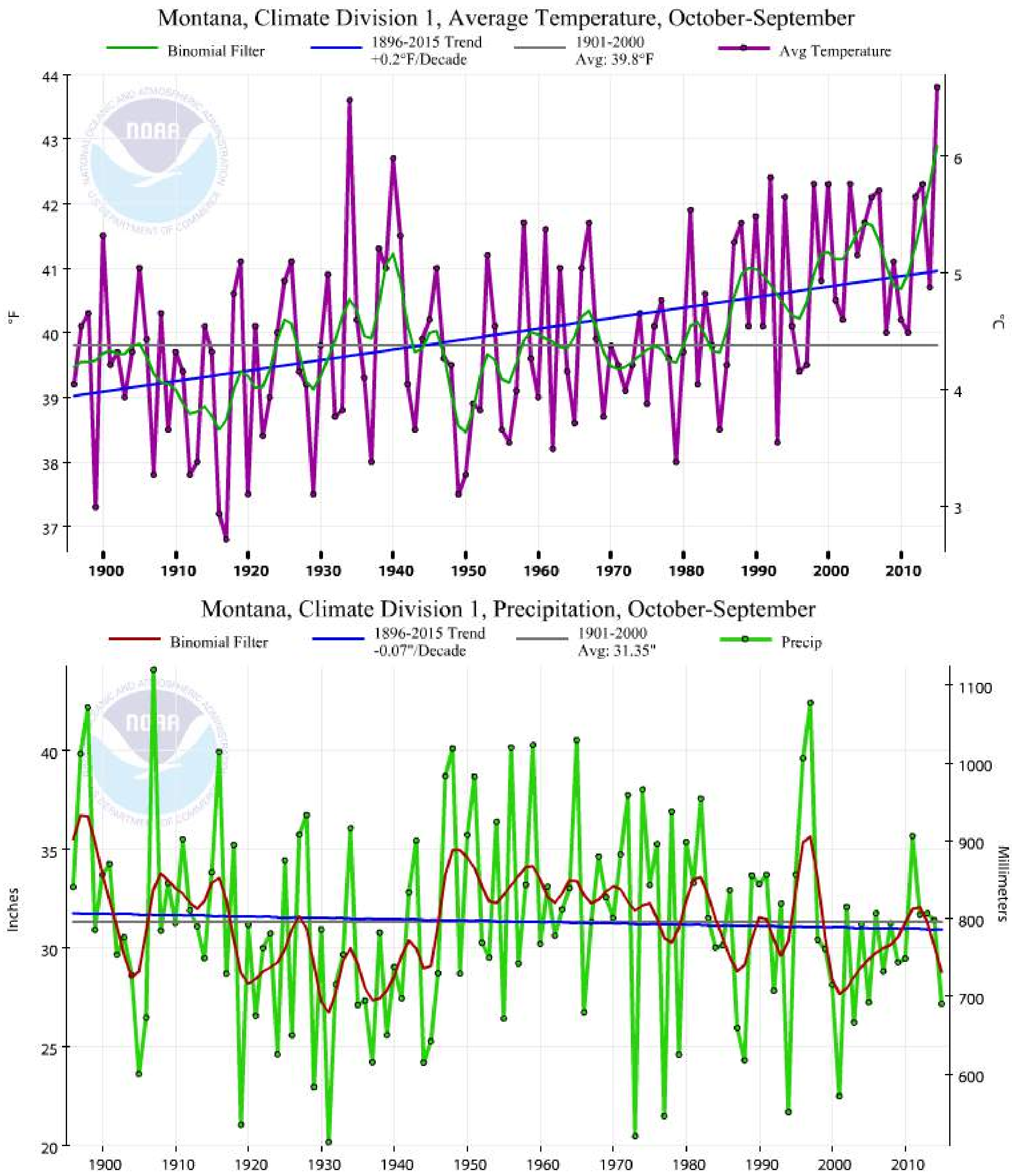

Figure 18- Average annual (water year) temperature (top pane) and precipitation (bottom pane) totals for MT Climate Division 1 (western MT) from 1895-2015. A simple linear regression of the data (blue line) shows an average increase in temperatures of approximately 2°F (over the period of record) and a slight decrease in water year precipitation totals. Data source: National Climatic Data Center, 2016.

B. Water Quality

The Upper Clark Fork River suffers from chronic water quality issues that, for more than a century, have impacted fish populations and aquatic ecosystems. Historic mining activities added large quantities of heavy metals (copper, cadmium, lead, zinc) and metalloids (arsenic) into the UCF watershed, which are the primary cause of impaired water quality. In addition, agricultural activities and municipal/residential wastewater contribute to sediment and nutrient loads in streams, which also degrade water quality. Further, peak summer air temperatures and irrigation withdrawals that reduce streamflows combine to increase water temperatures in the late summer, reducing oxygen levels for fish.

Stream	Reach	Causes of Impairment				
		Low Flow	**Metals**	**Sediment**	**Nutrients**	**Water Temp**
BROWNS GULCH	*Headwaters to mouth*			X		
CABLE CREEK	*Headwaters to mouth*			X		
CLARK FORK RIVER	*Cottonwood Creek to Little Blackfoot River*	X	X	X	X	
CLARK FORK RIVER	*Warm Springs Creek to Cottonwood Creek*	X	X	X	X	
DEMPSEY CREEK	*National forest boundary to mouth*	X		X	X	
GERMAN GULCH	*Headwaters to mouth*		X			
LOST CREEK	*South boundary of Lost Creek State Park to mouth*	X	X		X	
MILL CREEK	*Headwaters to section line between Sec 27 and 28, T4N, R11W*		X			
MILL CREEK	*Line between Sec 27 and 28, T4N, R11W to Mill-Willow Bypass diversion*	X	X			
MILL WILLOW BYPASS	*Mill and Willow Creek diversions to Silver Bow Creek*		X			
MODESTY CREEK	*Headwaters to mouth*	X	X			
PETERSON CREEK	*Headwaters to Jack Creek*	X	X	X	X	
PETERSON CREEK	*Jack Creek to mouth*	X	X	X	X	X
RACETRACK CREEK	*National forest bounday to mouth*	X				

SILVER BOW CREEK	*Blacktail Creek to Warm Springs Creek*		**X**	**X**	**X**	
TIN CUP JOE CREEK	*Tin Cup Lake outlet to mouth*	**X**		**X**		
WARM SPRINGS CREEK	*Meyers Dam T5N R12W S25 to mouth*	**X**	**X**			
WILLOW CREEK	*Headwaters to T4N R10W S30*		**X**	**X**		
WILLOW CREEK	*T4N R10W S30 to mouth*	**X**	**X**	**X**	**X**	

Table 5- MT DEQ impaired waterbodies in the Upper Clark Fork TMDL Planning Area (as identified in the 2016 biennial Water Quality Integrated Report). As evidenced by the table above, both the mainstream Clark Fork and its tributaries face many water quality challenges, but most widespread are low streamflows and metals contamination.

i. Low Streamflows

Many of the water bodies in the Upper Clark Fork are impaired due to low streamflows, and are chronically dewatered during the late summer period of peak irrigation demand. Montana DEQ, Montana Fish, Wildlife and Parks, and the Clark Fork Coalition have all classified (or identified) tributaries that experience frequent dewatering (Figure 19).

Although the Upper Clark Fork River is the most important waterbody in the Deer Lodge Valley, its larger tributaries, especially Warm Springs, Lost, Racetrack, and Cottonwood Creeks, supply a significant portion of the irrigation water to area agriculture. As illustrated in Figure 19, these creeks are typically dewatered by irrigation in late summer in their lower reaches (Frontage Road location is near the mouth of Racetrack Creek). Typical hydrographs for Racetrack Creek above the irrigation diversions and near its mouth (below irrigation diversions) is shown in Figure 20. Note that the increases in the flows at USFS boundary during July and August are due to releases from a battery of small, high elevation irrigation reservoirs in the Flint Creek Range.

In nine out of the last 16 years irrigation demand and anomalously warm summer temperatures have resulted in extremely low streamflows on the Upper Clark Fork (Figure 12). In 2015 average daily flows at the Deer Lodge USGS gage (a drainage area of 1,000 sq miles) dropped below 100 cfs for 47 days during July and August (USGS, 2016b). During the summer of 2016, CFC measured some of the lowest flows on record in the Upper Clark Fork. On August 4th, a measurement of just 2.6 cfs was recorded on the mainstem of the river at the Gemback Road Bridge near the confluence with Racetrack Creek (Figure 21). This amounts to the entire river being reduced to flows only a few inches deep.

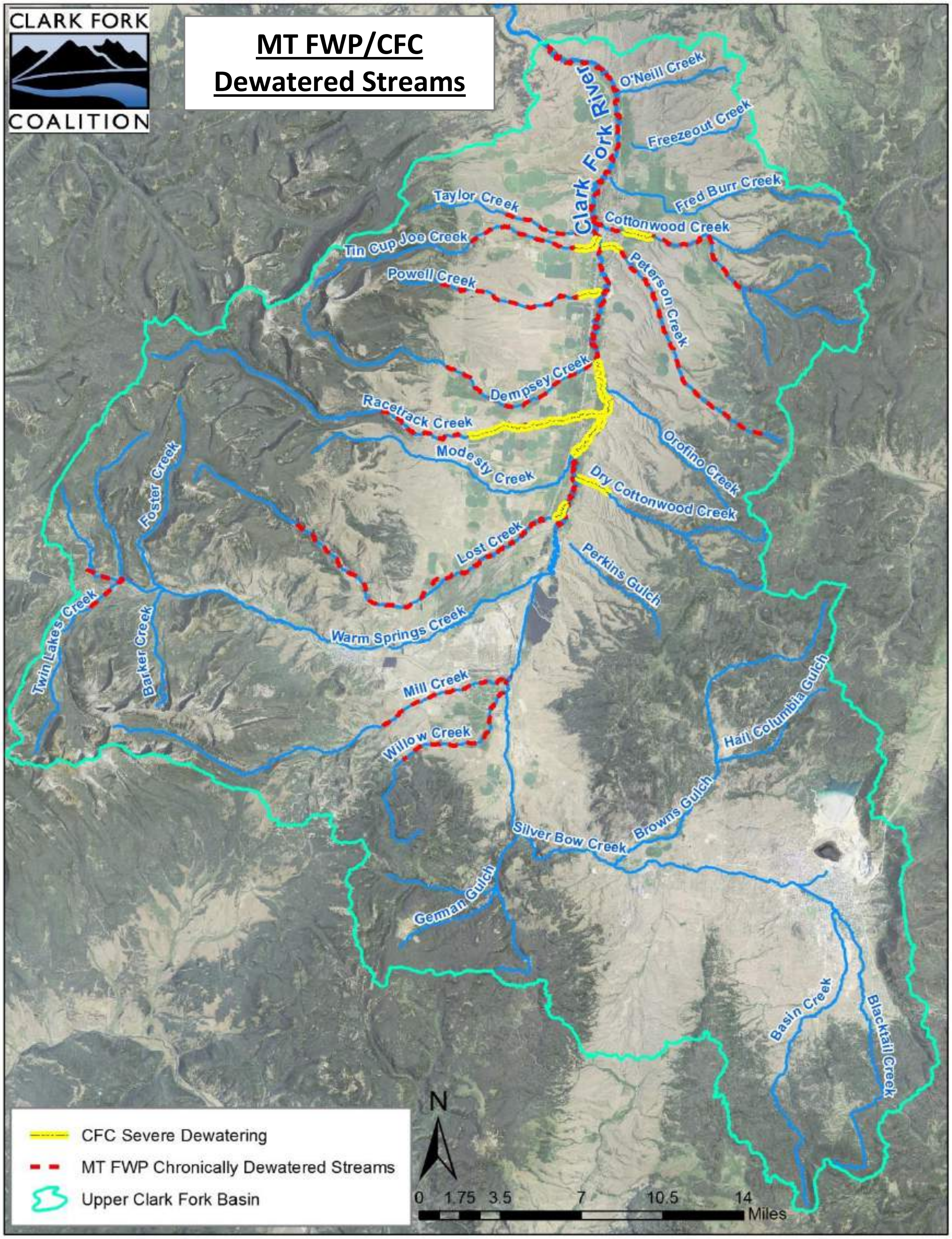

Figure 19- Low and dewatered streams in the UCF basin per FWP and CFC. Streams with red dashes are classified by MT FWP as "chronically dewatered" (lacking sufficient water in virtually all years). The yellow dashed line indicates areas the CFC staff identified as the most severely dewatered stretches. Data Source: MT GIS Clearinghouse, CFC staff observations.

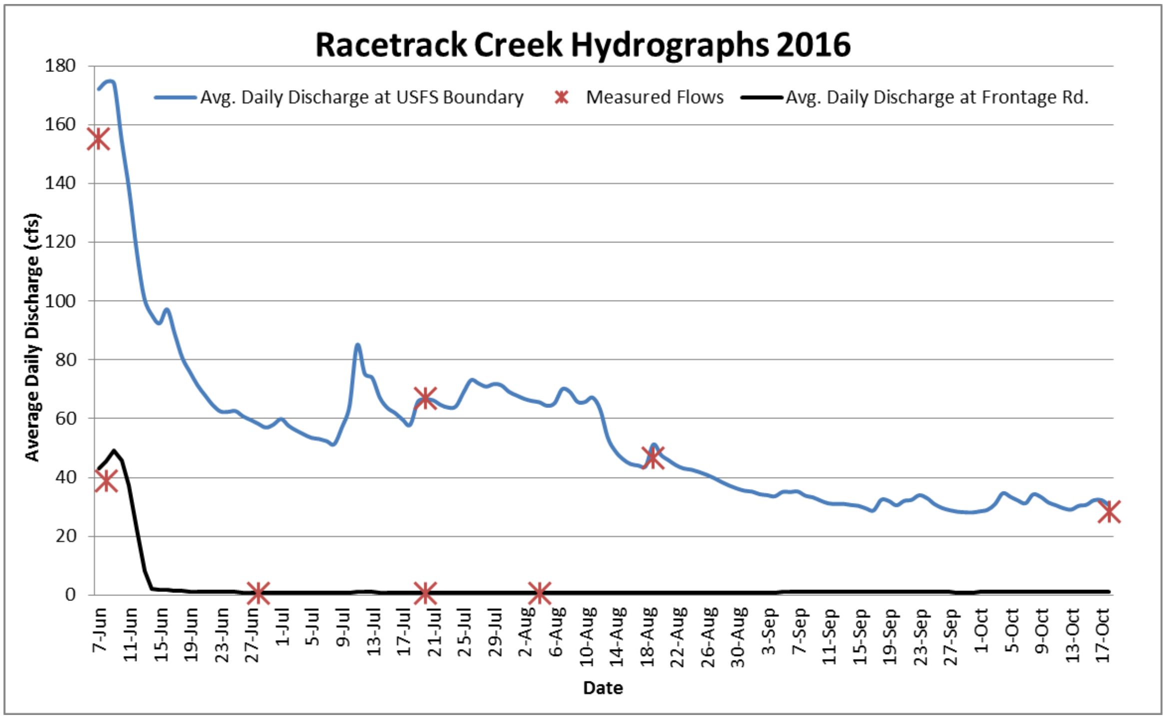

Figure 20- Hydrograph displaying discharge on Racetrack Creek during the summer of 2010. The measurement site was located above the major irrigation diversions (although controlled reservoirs are located above this location).


Figure 21- Clark Fork River near Gemback Bridge (near Racetrack), 2.6 cfs, 8/4/2016. Photo Credit: Clark Fork Coalition.

In 1986, MT FWP established recommendations for the quantity of water needed to sustain a healthy aquatic ecosystem and vibrant sport fishery for streams in the Upper Clark Fork River Basin (MT FWP, 1986). A recommended volume of 180 cfs for the Clark Fork River at Deer Lodge was calculated using the wetted perimeter method (MT FWP, 1986). The wetted perimeter method utilizes cross sectional streambed measurements and flow rates to determine relationships between streamflow and the proportion of a river channel covered with water. The FWP study identified two important flow thresholds on streams throughout the UCF that result in a relatively rapid increase in streambed exposure with declining flows.

Streamflow below the upper inflection point (180 cfs at the Deer Lodge gage) result in amplified channel exposure, with flows below the lower inflection point (90 cfs at Deer Lodge) resulting in a rapid degradation of aquatic habitat (MT FWP, 1986). As illustrated in Figure 10 from the beginning of this report, median discharge volumes during the summer in the Upper Clark Fork River Basin frequently fall below the MT FWP flow targets. Consistent low summer flows on the UCF River are a contributing factor to depressed trout populations and degraded aquatic habitat conditions (Cook et al., 2016; CFRBTF & DNRC 2015). Table 6 below displays the upper and lower streamflow inflection points identified by the 1986 MT FWP report for waterbodies in the UCF.

Flow targets established by the 1986 report have become important goals for water managers and conservation groups attempting to restore aquatic habitat and enhance trout populations. A recent study completed by the USGS further emphasizes the importance of instream flows for the maintenance of fisheries and other aquatic ecosystems. The comprehensive 2015 study investigated 42 trout ecology studies from North American and Europe and found that streamflow, not water temperature, was the most powerful predictor of fish survival (Kovach et al., 2015).

River	Reach	Upper Inflection Point (cfs)	Lower Inflection Point (cfs)
Clark Fork River	*Warm Springs to the Little Blackfoot*	180	90
Dempsey Creek	*Caruthers Lake to the mouth*	3.5	2.5
Lost Creek	*Headwaters to mouth*	16	8
Racetrack Creek	*North Fork to Deelodge NF boundary*	26	13
Warm Springs Creek	*Middle Fork to Meyers Dam*	50	24
Warm Springs Creek	*Meyers Dam to the mouth*	40	16
Warm Springs Creek	*Barker Creek: lake to mouth*	12	9
Warm Springs Creek	*Cable Creek: headwater to mouth*	10	N/A
Warm Springs Creek	*Twin Lakes Creek: lower lake to mouth*	13	7

Table 6- Flow targets established by the 1986 MT FWP report, *Application for Reservations of Water in the Upper Clark Fork River Basin.*

The CFC and Trout Unlimited have analyzed a set of flow restoration scenarios for the Upper Clark Forks' Warm Springs to Deer Lodge reach that achieves the Natural Resources Damage Program's (NRDP's) range of flow targets in most years. The NRDP's flow targets range from the lower inflection point to the upper inflection point of the Department of Fish, Wildlife, and Parks' 1986 wetted perimeter analysis. The FWP/NRDP's lower flow target range is:

- 40 cfs at Perkins Lane (Galen USGS gage)
- 60 cfs at Sager Lane
- 90 cfs at Deer Lodge

ii. Metals Contamination

Due to its rich geology and high mineral content, the Upper Clark Fork basin was the site of numerous mining operations over the last 100 years (Figure 22). These mines generated large amounts of waste materials laden with metallic contaminants (cadmium, copper, lead, zinc and arsenic) that continue to plague water quality and harm the basin's trout fishery.

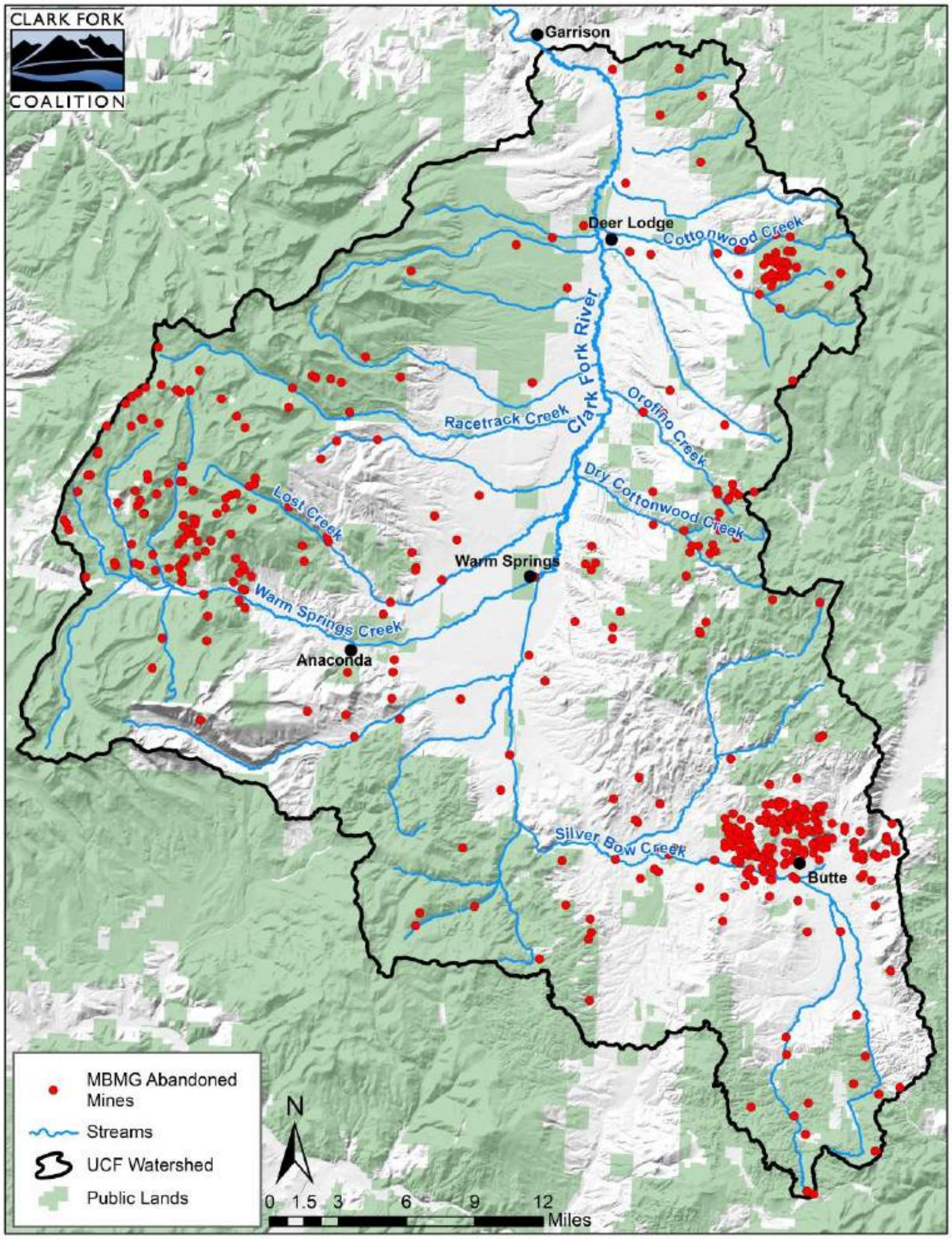

Figure 22- Locations of abandoned mines in the Upper Clark Fork Basin. Historic mining operations are spread throughout the Basin but are concentrated in the Silver Bow, Warm Springs, Lost, Cottonwood and Dry Cottonwood drainages. Data source: Montana Bureau of Mines and Geology (2007).

The upper reaches of Silver Bow Creek near Butte contain numerous mining shafts, tailings piles, and smelter remnants that, during more than a century of mining activities, generated a substantial volume of contaminated water, waste rock, and smelter emissions (Sando et al., 2014). A series of several large floods in the in the late 1800s and early 1900s (especially the flood of record for the valley in 1908) transported and deposited these mining wastes in the floodplain of the Upper Clark Fork basin from Butte to 120 miles downstream near Missoula. The toxic “slickens” that were deposited suppress plant growth along portions of the streambank, and when they erode into the river, cause increases in metals-loading in the water column – negatively impacting aquatic and terrestrial ecosystems (Figure 23).

Figure 23- A “slicken” of toxic waste deposited on the riverbank of the Upper Clark Fork River near Racetrack. Photo source: Tom Bauer of the *Missoulian*. These dense, toxic mats of contaminated soil have inhibited plant growth for more than 100 years and continue to leach heavy metals into the river.

Approximately 25 stream miles downstream from Butte, Silver Bow Creek enters the Warms Springs Settling Ponds, which were constructed by the Anaconda Mining Company between 1911 and 1959 to contain, precipitate, and treat contaminated sediments transported from the upper portions of the basin. Heavy metals sourced from the Warm Springs Settling Ponds, and particularly the UCF floodplain, have been shown to “mobilize” during periods of high flows and summer season thunderstorm runoff events, spreading contaminated sediments and damaging aquatic ecosystems (Sando et al., 2014). Due to this contamination, the mainstem of the Upper Clark Fork River (above the confluence with Rock Creek) was devoid of fish life from the 1890s to the late 1950s (Mayfield, 2013, CFRBTF & DNRC, 2015).

Water quality data collection in the UCF began in 1985 with the establishment of the first long-term monitoring station, and has grown to include 22 study sites on the Clark Fork River and several tributaries. Data from these sites is used by natural resource agencies to estimate contamination levels and measure response to cleanup efforts.

In three recent studies by the Montana Department of Environmental Quality (MT DEQ, 2010; MT DEQ, 2014a; MT DEQ, 2014b) aquatic impairments from heavy metals that exceeded TMDL guidelines were noted on numerous waterbodies in the UCF basin, including Mill, Modesty, Peterson, Willow, Warm Springs, and Silver Bow Creeks, as well as German Gulch, the Mill-Willow Bypass channel, and the mainstem of the Upper Clark Fork.

In 2014, the U.S. Geological Service (USGS) released a report (*Water-Quality Trends for Selected Sampling Sites in the Upper Clark Fork Basin, Montana, Water Years 1996-2010*) identifying numerous sites that, between 2001 and 2010, exceeded EPA water quality standards, including the arsenic human health standard (10 ppb) and the aquatic life ambient water quality criteria for cadmium, copper, lead, and zinc (Figures 24 & 25).

Copper and arsenic are of particular concern due to their potential toxicity. Encouragingly, USGS found that copper and suspended sediments concentrations decreased substantially from 1996-2010 in the reach of Silver Bow Creek upstream from Warm Springs, as a result of the massive Superfund clean-up effort executed there.

However, while Silver Bow Creek metals concentrations have been drastically reduced, the Clark Fork River floodplain clean-up just began in 2013. Copper and suspended sediment (suspended sediment data provides information on the transport of particulate materials), which have mobilized from floodplain tailings and eroding streambanks, is currently found in high concentrations in the section of the Upper Clark Fork between Galen and Deer Lodge. The USGS report notes that the copper and suspended sediment in this reach account for 40 and 20 percent, respectively, of the loads for the Clark Fork at Turah Bridge (93 river miles downstream), though streamflow from this reach only accounts for about 8 percent of flow at that site (Sando et al., 2014).

The USGS report found that locations downstream of Deer Lodge contribute lesser quantities of metallic elements and generally saw slight decreases in concentrations over the period investigated. Still, suspended sediment, copper, and arsenic throughout the floodplain downstream of Warm Springs Settling Ponds severely impacts water quality, which is why this stretch of river (from Warm Springs to Garrison) is the focus of large-scale remediation and restoration activities today.

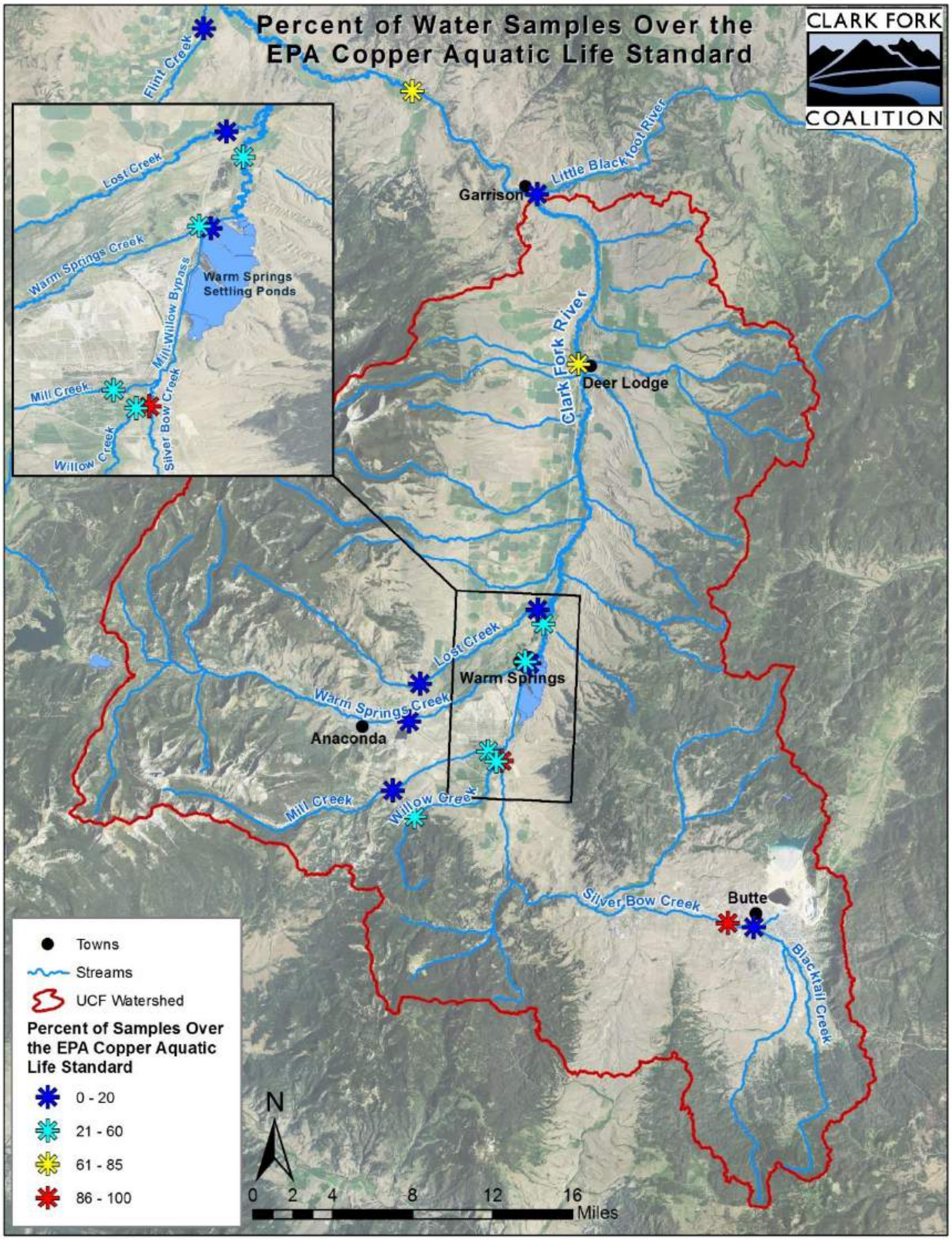

Figure 24- Water quality sampling locations that exceeded EPA aquatic life standards for copper (1996-2010). Data Source: *Water-quality trends for selected sampling sites in the upper Clark Fork Basin, Montana, water years 1996–2010*, U.S. Geological Survey.

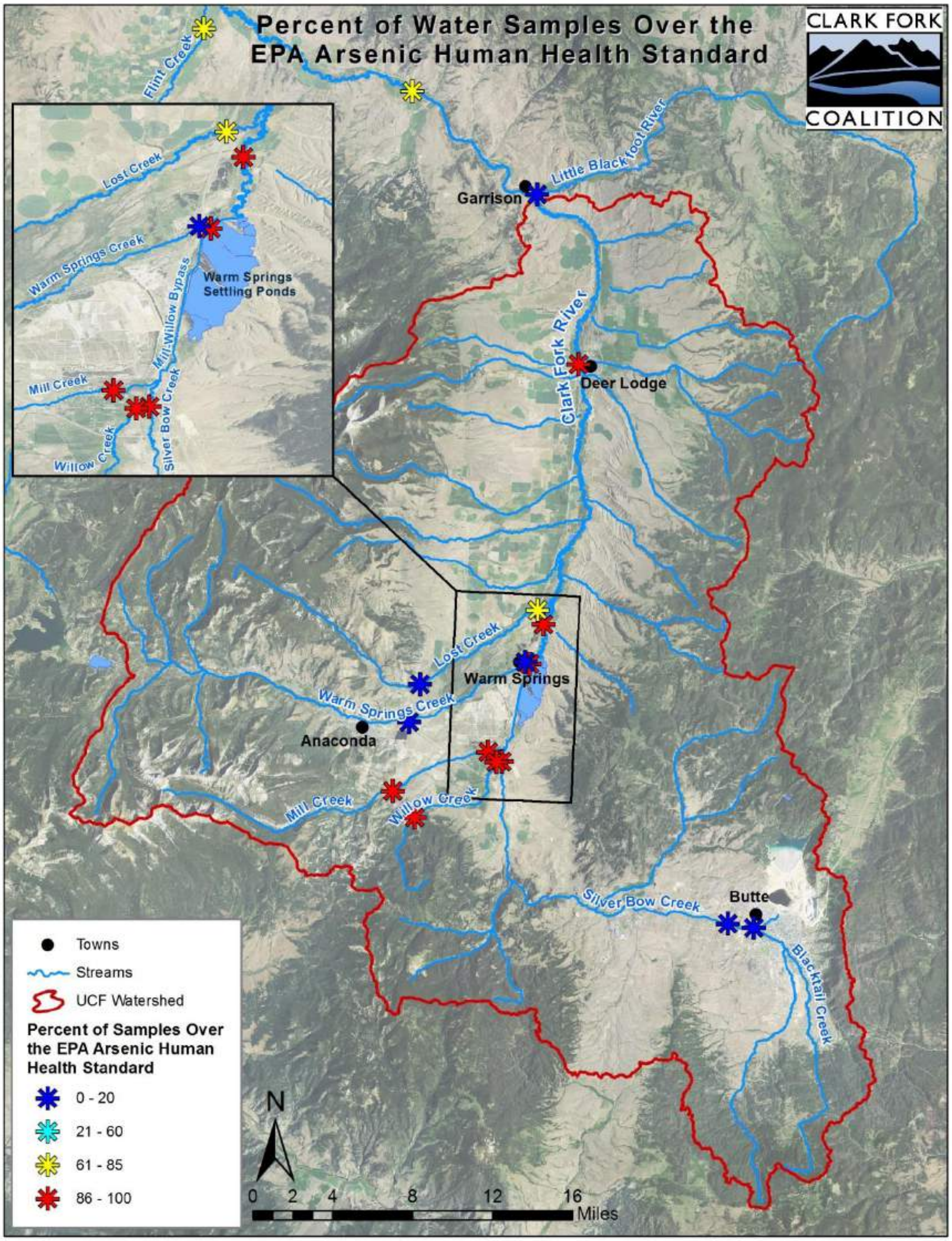

Figure 25- Water quality sampling locations that exceeded EPA human health arsenic standards (1996-2010). Data Source: *Water-quality trends for selected sampling sites in the upper Clark Fork Basin, Montana, water years 1996–2010*, U.S. Geological Survey.

iii. Nutrients and Sediment

Excessive sediment and nutrients are a widespread problem in the UCF, impacting water quality, fishery health, and human use of the river and its tributaries.

Sediment loads detrimentally impact aquatic stream ecosystems in several ways:

- Excessive sediment often changes the substrate quality of a stream, filling interstitial space in gravel and cobbles bars, which degrades habitat for aquatic insects, reduces spawning success for fish, and negatively impacts oxygen-producing plants.
- When suspended in the water column (i.e. turbidity), sediment absorbs incoming solar energy, increasing water temperatures.
- Sediment decreases light penetration in the water column, impacting aquatic plant growth and affecting the ability of fish to find and capture prey.
- Trout and other fish species are physically affected by excessive suspended sediment, as it may clog gills and interfere with aquatic respiration.

Similarly, excessive nutrient loads impair aquatic resources by:

- decreasing macroinvertebrate diversity
- increasing net primary productivity in the water column, resulting in decreased levels of dissolved oxygen (USGS, 2014)
- stimulating the growth of algae, such as the filamentous green *Cladophora*, which in turn clogs the water column and stream bed and further reduces dissolved oxygen

Although algae species such as *Cladophora* are native to the UCF, anthropogenic inputs of nutrients such as nitrogen stimulate excessive algae growth relative to baseline conditions in nearby waters (Lohman & Priscu, 1992). Nutrient loads in the UCF originate from both point sources (i.e. Butte and Deer Lodge wastewater treatment plants) and non-point sources, such as fertilizer, animal wastes, and subsurface septic systems associated with residential development (USGS, 2014; Figure 28).

Figure 26- *Cladophora* bloom on the Clark Fork River near Clinton, MT in July 2016.

In a 2010 report (*Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs and Framework for Water Quality Restoration*), Montana DEQ identified five UCF creeks (Cable, Dempsey, Tin Cup, Peterson, and Willow) in which sediment was a cause of "impairment of aquatic life, coldwater fisheries, and/or public contact recreation" (Figure 27). A 2014 addendum to this report (MT DEQ, 2014a) also details sediment impairments on Browns Gulch, and separate, 2014 studies (MT DEQ, 2014b; MT DEQ, 2014c) list Silver Bow Creek, portions of the Upper Clark River, and eight tributaries as failing to meet sediment TMDLs (Figure 27).

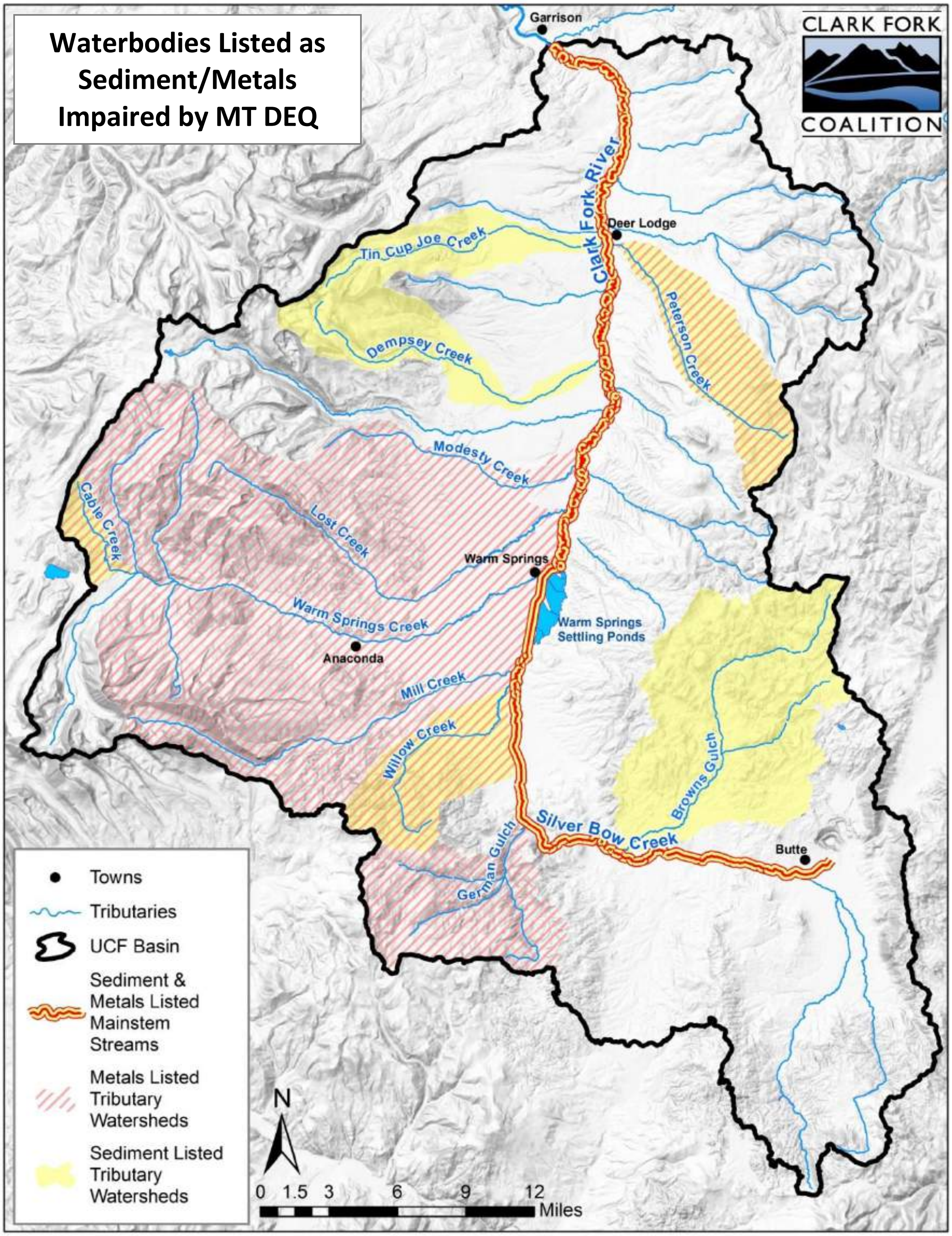

Figure 27- UCF tributaries (excluding Silver Bow Creek) listed by Montana DEQ as impaired due to sediment and/or metals loading. Data source: MT DEQ, CWAIC (2016).

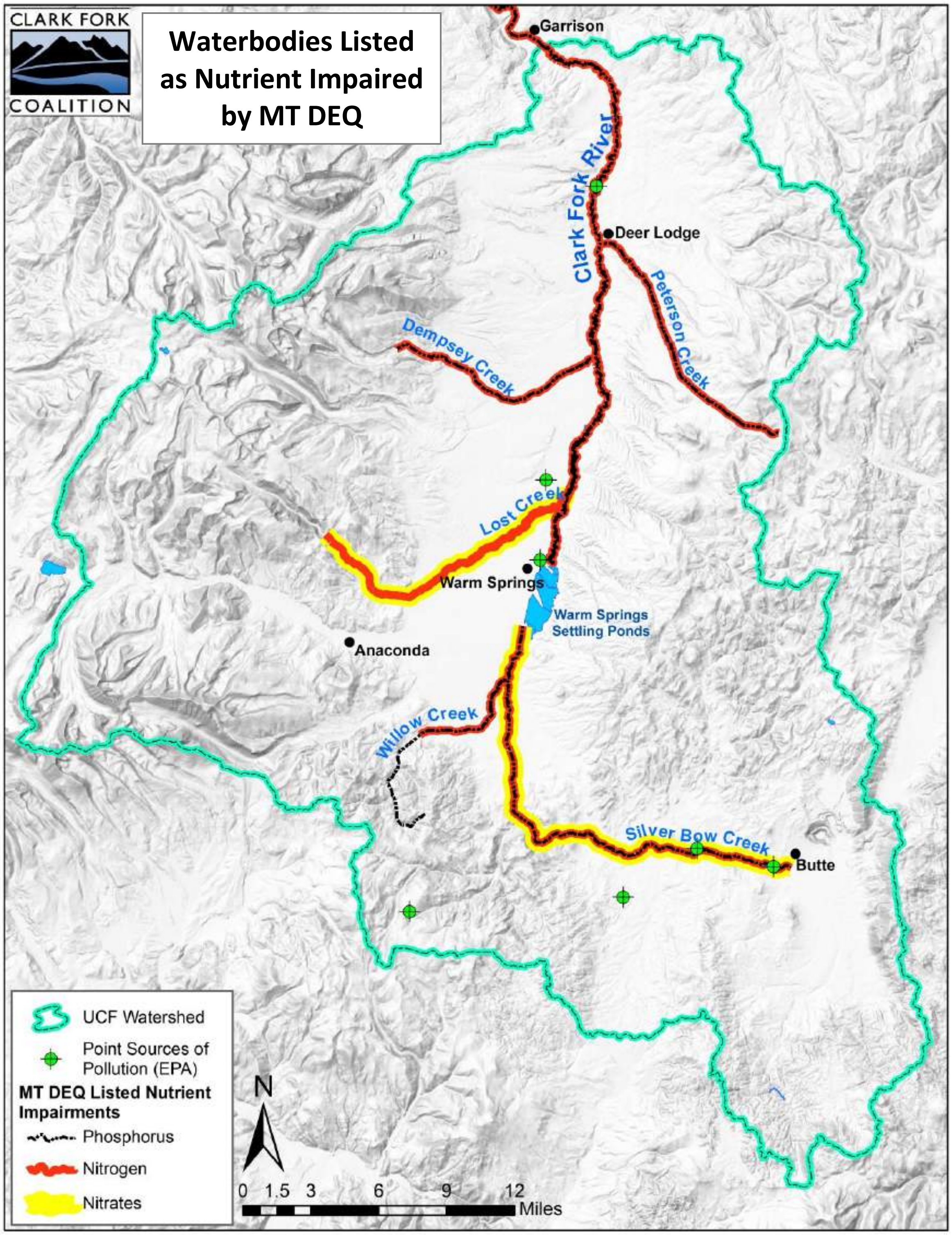

Figure 28- Waterbodies in the UCF classified as impaired by MT DEQ for excessive nutrient loading. Impairment data retrieved from the Montana Clean Water Act Information Center (CWAIC). Data Source: http://svc.mt.gov/deq/dst/#/app/cwaic. Point sources of pollution data retrieved from the US EPA.

iv. Water Temperatures

As noted above, average annual temperatures in the Montana have increased by roughly 2°F over the last century, while average annual precipitation has remained stable or decreased. Furthermore, many locations in MT have seen a substantial increase in the annual number of extremely warm summer days (> 85°F) over the past 100 years (Pederson et al., 2010). These extreme conditions have occurred with greater frequency over the last 50 years and have significant implications for aquatic conditions in the UCF. For example, three out of the top five warmest years on record in MT occurred within the last 5 years.

Warm air temperatures, increased irrigation, and higher evapotranspiration rates are often concurrent with low streamflows and warm water temperatures, detrimentally impacting aquatic ecosystems. When water temperatures approach 20°C, (68°F) non-native rainbow and brown trout become stressed. At 25°C and higher, conditions are often fatal for these species. Native salmonids, such as bull trout and westslope cutthroat, are much more sensitive and have lower thermal tolerance requirements than non-native browns and rainbows. For these species, temperatures in excess of 18°C (64°F) are stressful and prolonged conditions over 20°C may be fatal (Selong et al., 2001; Bear et al., 2005).

Although MT DEQ lists only one stream reach in the UCF as being "impaired" due to water temperatures (Peterson Creek below the Jack Creek confluence), several of the streams in the report area, as well as the mainstem of the Upper Clark Fork itself, frequently experience water temperatures in excess of the thresholds that threaten fish and damage aquatic ecosystems.

Warm water temperatures in the Upper Clark Fork River have negatively impacted trout. Native trout (cutthroat and bull) cannot tolerate the mid-summer water temperatures currently typical in the river above Deer Lodge. Water temperatures are also believed to be one of the contributing factors to the declines in brown trout populations documented since 2014 (Cook et al., 2016; Mayfield, 2013). Water temperatures in excess of 24°C (75°F) have been recorded during July and August in the Upper Clark Fork River in consecutive summers between 2012 and 2016. Extended periods of anomalously warm water were recorded by MT FWP in 2015 at several caged fish monitoring locations in the UCF. The caged fish monitoring study logged temperatures in excess of 19°C for between 53-83 days in the stretch of river between the Warm Springs Ponds and Kohrs Bend (Cook et al., 2016). Warm water temperatures contributed to high mortality rates at several of the caged fish locations. At the Kohrs Bend location, over 30% of the caged fish perished during a three day period of peak water temperatures (in excess of 25°C).

Water temperature monitoring by the Clark Fork Coalition, MT FWP and the USGS in 2015 also documented extended periods of seasonally warm water in the Upper Clark Fork and its tributaries (Figure 29). Although most of the "cooler" monitoring sites were located at higher elevations on tributaries, there appear to be stretches of stream at lower elevations where temperature conditions improve. Monitoring sites near the mouths of Racetrack Creek and Cottonwood Creek recorded fewer days of warm water temps than locations directly upstream. These "cooler" reaches are likely being influenced by tributaries and groundwater return flows (sourced partially from flood irrigation) and may act as locations of thermal refuge for trout during periods of peak water temperatures.

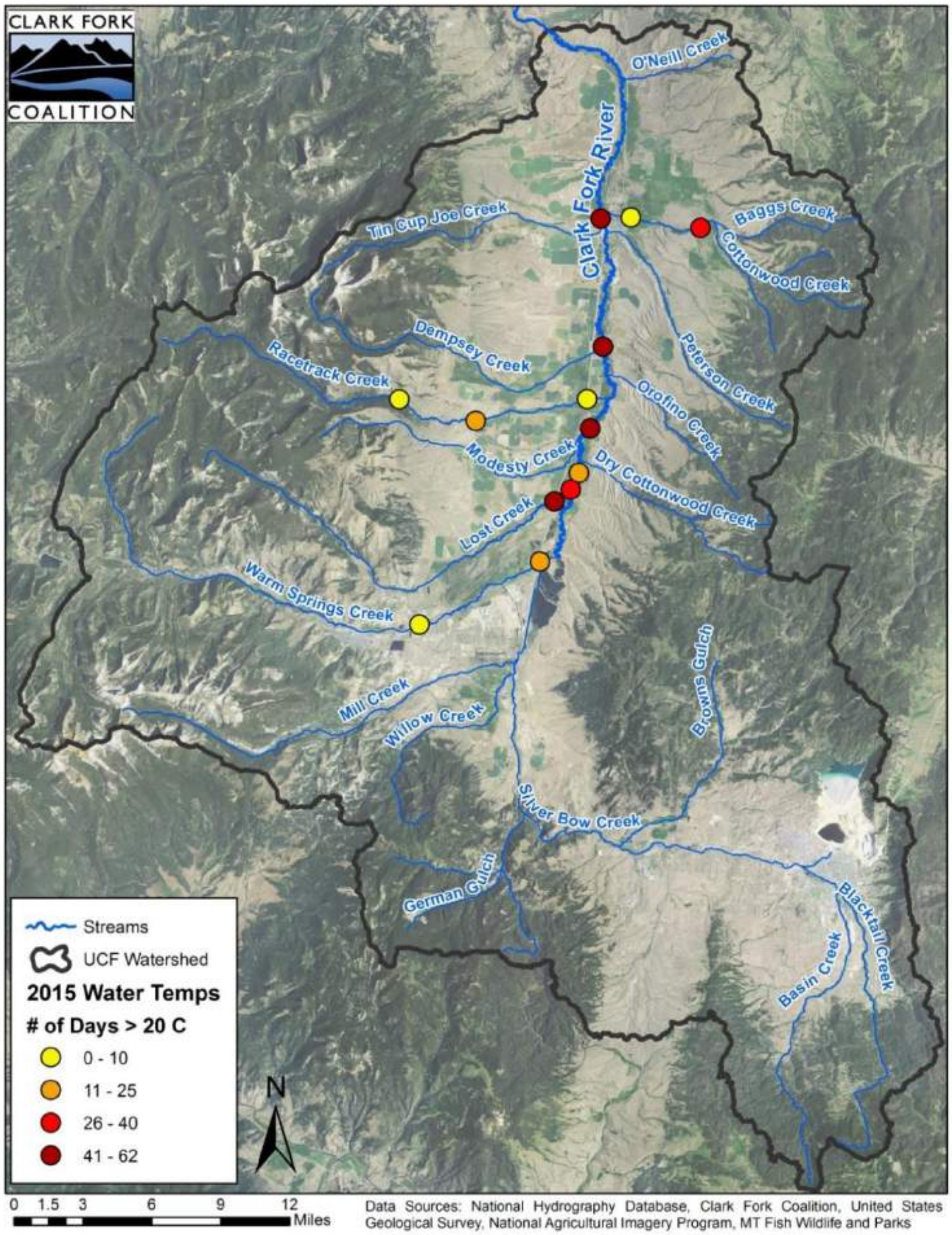

Figure 29- Location and number of days water temperatures exceeded 20°C during the summer of 2015. Temperature data was sourced from monitoring sites maintained by the Clark Fork Coalition, MT FWP and the USGS.

C. Fishery Challenges

As a result of over a century of mining contamination in the waterway and the over allocation of surface water supplies, the Upper Clark Fork fishery faces severe challenges. Scientists estimate that the Clark Fork River fishery currently function at 1/5th of its potential, with nearby streams of similar size supporting much more robust populations of fish. In addition, a compromised fishery can undermine the substantial economic benefits derived from Montana's commercial recreational fishing industry. In 2013 Montana's lakes and streams generated more than 1.2 million non-resident angler days, contributing an estimated $713 million to the state's economy (MT FWP, 2014). According to Montana FWP angler use surveys, in 2013 the Upper Clark Fork River (above the confluence of the Blackfoot) generated approximately $4.5 million in resident and nonresident angler-related revenues (Figure 30).

Though the state's more celebrated fisheries generate much larger revenues, the contributions of the UCF fishery are a substantial and growing revenue source for a relatively economically depressed area. In addition, because the UCF is the headwaters of the entire Clark Fork system, the health of this fishery can directly impact more heavily-used downstream waters.

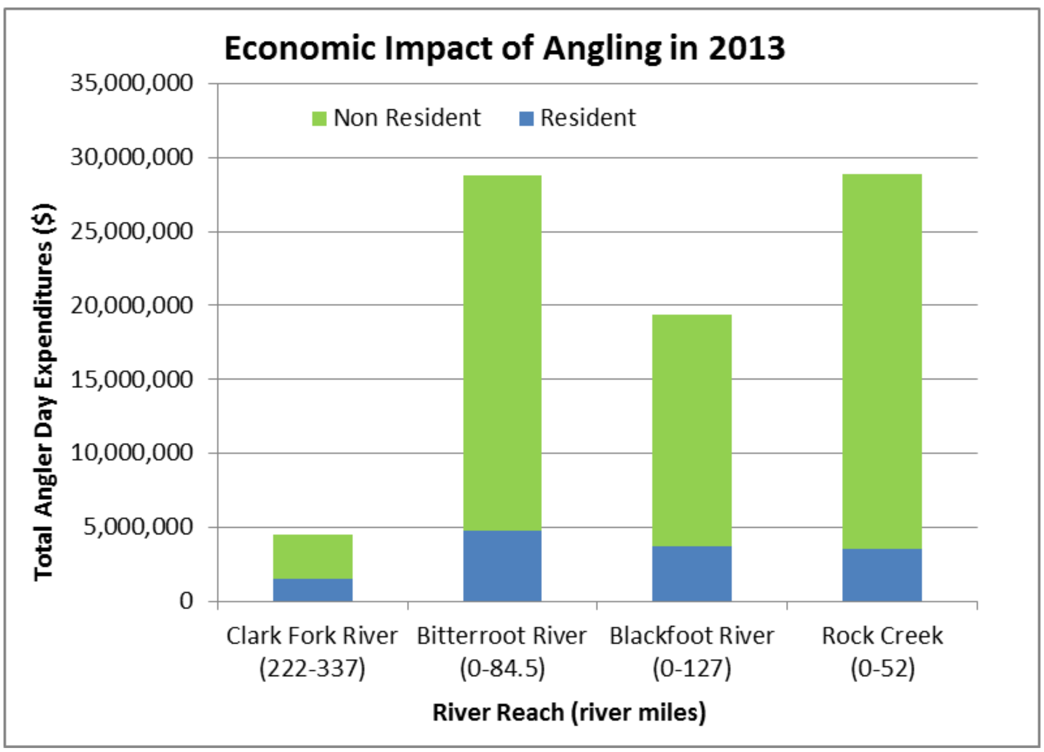

Figure 30- Economic impact of angling in 2013 on the Clark Fork River and selected tributaries. Values calculated using biennial angler day survey data compiled by MT FWP and a 2014 MT FWP report on angler and hunter expenditures in Montana. Data sources: MT FWP, 2014; MT FWP, 2015.

i. Water Quality

Industrial pollution and contamination from mining activities at the headwaters of the UCF basin have severely impacted ecological function in the Clark Fork River. Fishery surveys from Deer Lodge in 1891 indicated that the UCF was already too polluted to support fish. Trout populations were essentially nonexistent until the 1970s (Mayfield, 2013, CFRBTF & DNRC, 2015), when improvements in mining wastewater treatment led to the establishment of a fickle brown trout fishery on the mainstem of the Clark Fork.

In the 1980s and the 1990s, heavy metals from the banks and floodplain of the river continued to be mobilized during high discharge events, impacting the river’s ecosystem and resulting in documented fish kills on the UCF (Mayfield, 2013). Restoration work completed in the 1990s directly below the Warm Springs Ponds along with renovations to Butte’s municipal wastewater treatment facility improved water quality significantly in the upper Clark Fork River, but not enough to make water quality suitable for cold-water fisheries to thrive.

Remediation and restoration efforts completed along Silver Bow Creek for the last 17 years have improved water quality and habitat, and fisheries have responded. The State of Montana’s clean-up of Silver Bow Creek started in 1998 and was completed in 2015. The results are significant, and hopeful. Reaches of Silver Bow Creek which were so metals contaminated in 1998 that they had no fish and almost no aquatic invertebrates now have a thriving population of various native and sport fish, including westslope cutthroat trout and brook trout. In fact, the recovery of the westslope trout fishery was so dramatic that the State had to impose new fishing regulations to protect the large healthy cutthroat that colonized the newly cleaned up creek.

ii. Species Makeup

The fishery in the Upper Clark Fork River currently is dominated by brown trout, mountain whitefish, and two sucker species, with native trout (westslope cutthroat and bull trout) mostly restricted to the higher elevation tributaries (Figure 32). Nonnative rainbow trout inhabit the reach of the UCF directly below the Warm Springs Ponds, and brook trout are common in some headwater streams.

Figure 31- Brown trout observed during a snorkel survey on a tributary of the upper Clark Fork in 2016

Bull trout (listed as “threatened” under the Endangered Species Act) are rare in the mainstem of the Upper Clark Fork River, with the species isolated primarily to the Warm Springs drainage. Although westslope cutthroat are present in many of the tributary streams of the UCF, they are uncommon in the mainstem. Research has shown that brown trout have a higher tolerance to metals, high water temperature and degraded habitat than other species and is likely this reason that they dominate the trout community in much of the UCF (MT FWP, 2013).

Both bull trout and westslope cutthroat trout are migratory species, which makes them particularly vulnerable to the problems associated with degraded aquatic habitat (due to either low streamflows or water quality impairments). Migratory bull trout in the larger Clark Fork River drainage have been shown to travel great distances (up to 156 miles) in response to spawning, rearing, and habitat needs (Swanberg, 1996). Westslope cutthroat trout are also a migratory species that ascend tributary systems for spawning during spring high flows. Tributary connectivity and suitable habitat (water temperatures below 60°F) are critical for survival of both species.

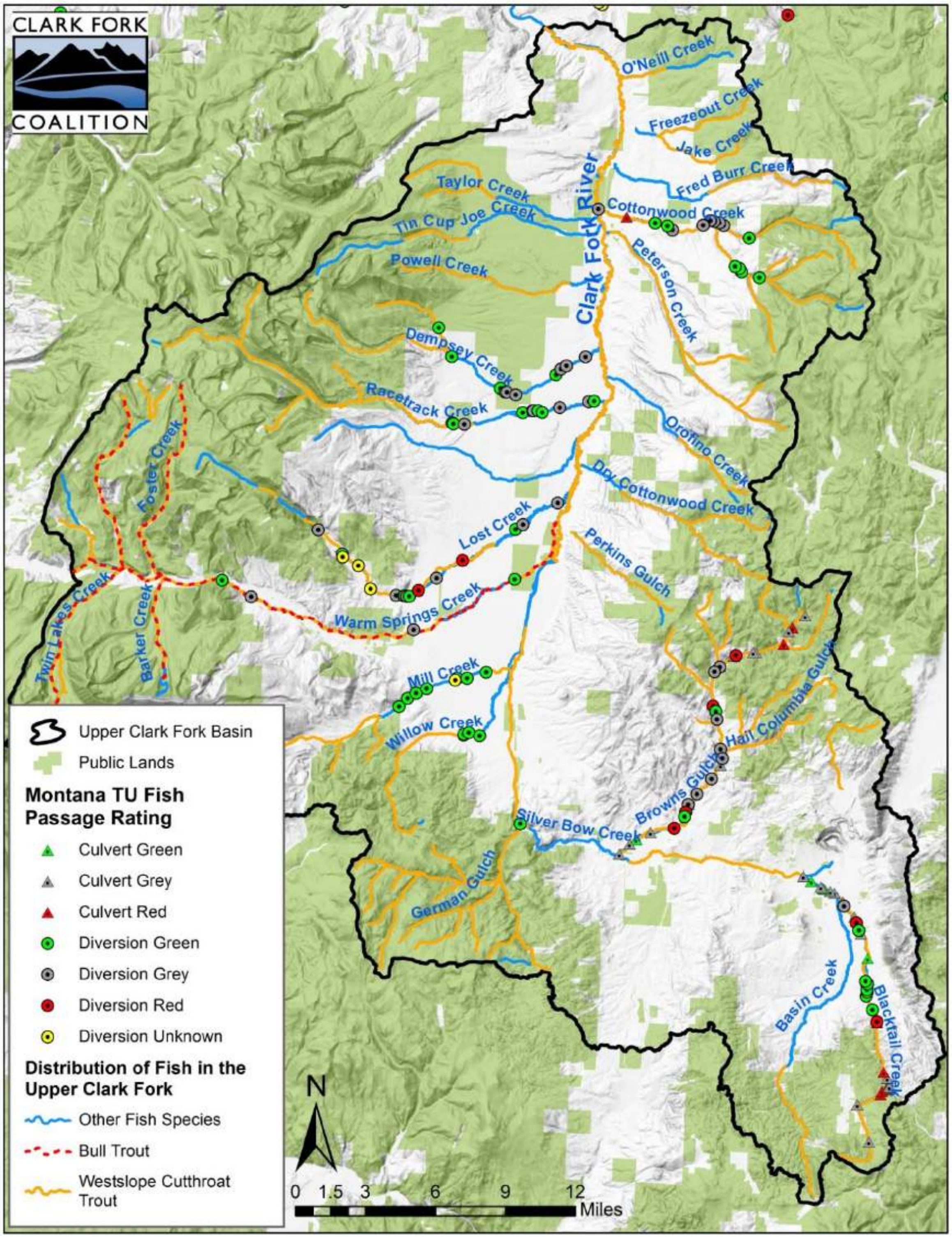

Figure 32- Distribution of native fish species on streams in the Upper Clark Fork River Basin and locations of fish barriers that impede trout migration. Fish barrier data compiled by Montana Trout Unlimited. The color of the diversion/culvert represents the overall impact the barrier has on fish passage (green being the smallest impediment, red being the greatest). Fish distribution data compiled and maintained my Montana FWP (2016).

iii. Population Densities

The trout fishery in the mainstem of the upper Clark Fork has historically experienced large fluctuations in population densities. For example, Montana FWP surveys indicated that the two-mile stretch of the river directly below the Warm Springs Settling Ponds contained approximately 500-1,500 brown trout (over 7 inches in length) per mile from 2007-2013. Following an outbreak of the saprolegnia fungus in 2014, numbers dropped significantly and FWP tallied only around 300 brown trout per mile in 2015 (Cook et al., 2016).

The fungus, combined with extremely low flow conditions experienced during the summer of 2015, is believed to be the leading factor in the localized population declines. Surveys from other reaches on the UCF and even other nearby rivers such as the Big Hole, reflect a similar pattern, with population numbers peaking after the high flow years in 2010 and 2011 and declining since 2013 (Cook et al., 2016). It is possible that degraded fishery conditions, including high stream temperatures, trigger or exacerbate such outbreaks. While that is not yet known, it is clear that much remains to be learned about these fluctuations, as well as about how lingering contamination, habitat conditions, restoration efforts, and other factors impact species composition and densities in the UCF fishery.

iv. Fish Passage Barriers

Both native and non-native fish species in the upper Clark Fork (UCF) rely on tributaries for spawning and rearing habitat (CFRBTF & DNRC, 2015; Mayfield, 2013, NRDP, 2012). Barriers to fish passage, such as dewatered reaches or irrigation diversion structures, inhibit migration in the UCF and detrimentally impact trout populations. Understanding the spatial distribution of both fish populations and obstacles to migration (Figure 32) enables conservation strategies to be focused and prioritized.

In 2011 Montana Trout Unlimited (TU) inventoried major physical fish passage barriers on private lands in several important tributaries in the UCF. The fish barrier database that was compiled by TU contains descriptions of the structures and other information about how each barrier impacts fish passage. As shown in Figure 32, numerous obstructions hinder both native and non-native trout migration on streams throughout the UCF. In its assessment TU also recorded the number and species of fish entrained by the diversion structures. At some locations impacts on fish populations were severe, with substantial numbers of fish captured in ditches. For example, the fish barriers surveyed on Lost Creek contained over 120 entrained fish and included brown trout, brook trout, westslope cutthroat and sculpins.

The removal of barriers to fish passage is a major focus of the CFC's restoration efforts in the UCF. Existing barriers limit available habitat for fish and reduce the resilience of cold water ecosystems in the UCF. Furthermore, the most substantial fish passage barriers in the UCF are located in tributary systems that also suffer from chronic dewatering and water temperature issues. Establishing connectivity in these headwater systems will not only increase available habitat but also provide resilience from warming water temperatures. The CFC has documented an extreme disparity in water temperatures between fish bearing tributaries such as Baggs Creek and Dry Cottonwood Creek and the mainstem of the Clark Fork River during period of peak water temperatures. In 2015 and 2016, water temperatures on the Clark Fork River exceeded 75°F, while water temperatures on Baggs Creek and Dry Cottonwood Creek (headwater tributaries of the Clark Fork) remained below 65°F throughout the summer.

D. Inefficient and Outdated Irrigation Infrastructure

Much of the irrigation infrastructure in the Upper Clark Fork is outdated, inefficient and in some cases, in desperate need of repair. This often results in less than ideal situations for managing water. Due to aging diversions, headgates pumps and leaky ditches, significantly more water is often diverted than the crops require (as much as 10 times more in some cases).

Since 2009, the Clark Fork Coalition has worked closely with the agricultural community and partner organizations to identify irrigation infrastructure needs in the upper Clark Fork Basin, with a particular focus on the Deer Lodge Valley. The focus of this work has been projects with the potential to improve instream flow and fish passage. This survey and analysis work has intensified from 2015 to 2016 as part of this revised Upper Clark Fork restoration plan. The CFC believes that improving irrigation infrastructure is the key to building sustainability into UCF agriculture, and one key to restoring connectivity and flows essential to local fisheries.

The CFC and partners have identified a number of potential projects, performed some initial feasibility studies, and have invested in some small-scale instream flow, fish passage, and habitat improvement projects that benefit both agriculture and fisheries. A short summary of the irrigation improvement needs, sorted by stream, follows.

- **<u>Mainstem Clark Fork River</u>**

Location:	Irrigation Infrastructure Needs:
Perkins Lane Pumps	Large inefficient pumps and inefficient water application on some fields. Improvements could yield water and energy savings.
Helen Johnson/Alvi Beck Ditches	Inefficient ditches and application methods. Direct diversions and improvements to water application efficiency are potential solutions.

West Side Ditch Company and Whalen Ditch	High ditch seepage rates and ditch maintenance. Partial ditch piping is being considered in addition to possible screening of diversion to conserve large amount of flow and reduce entrainment of fish.
Valiton Ditch	High water losses, ditch maintenance and aging diversion structure. Further engineering and scoping with water right holder are needed to identify preferred options and costs for conserving water and improving fish passage.
Sager Lane Pumps	Large, inefficient pumps and diversion is a fish passage barrier. Further research is needed to identify if improvements that could conserve water and improve fish passage.

- **<u>Warm Springs Creek</u>**

Location:	Irrigation Infrastructure Needs:
Gardiner Ditch	Ditch screening and diversion improvements have been identified at this location. Water loss studies have also identified high levels of seepage in sections of the ditch and some irrigated lands have soils which are poorly suited for irrigation.
Silver Lake	Refer to section A (iv). This 17,000 AF reservoir has numerous possible infrastructure needs including ditch piping, flume replacement and the replacement of aging pumps, which could all improve water management and conserve water.
Other Small Diversions	Numerous direct diversions exist along the creek which could provide flow benefits through improved water management, diversion improvements and on-farm water efficiency.

- **<u>Lost Creek</u>**

Location:	Irrigation Infrastructure Needs:
Gardiner Ditch	An aging diversion structure and inefficient ditch could be improved at this location to enhance passage and improve flows.
Beckstead Ditch	Improved water measurement and management at this location in addition to proposed water leasing activities could result in improved instream flow and connectivity to river in late summer.
Other Private Diversions	Numerous direct diversions exist along the creek which could provide flow benefits through improved water management, diversion improvements and on-farm water efficiency.

- **<u>Racetrack Creek</u>**

Location:	Irrigation Infrastructure Needs:
Cement Ditch	Cement lined canal is past its useful life and is cracking and falling apart. Replacement of the canal with a pipe or further lining is needed and could result in a flow savings and improved water management.
Morrison Ditch	Inefficient earth ditch that would benefit from piping or lining.

Other Private Diversions	Improving diversions for fish passage is underway and needs to continue. Further yet to be identified water conservation measures may be possible at some of these diversions. Improvements to aging high mountain reservoirs are also needed to improve late season water supplies.

- **Dempsey Creek**

Location:	Irrigation Infrastructure Needs:
Upper Dempsey Diversion	Replace existing leaky earth canal with a pipeline and improve application efficiency of water from flood to pivot.
Other Private Diversions	Numerous direct diversions exist along the creek which could provide flow benefits and fish passage through improved water management, diversion improvements and on-farm water efficiency.

- **Cottonwood Creek**

Location:	Irrigation Infrastructure Needs:
Kohrs Manning Ditch Company	Inefficient and aging diversion and crossing of Cottonwood Creek. Improved water control structure could conserve water and improve fish passage.
Other Private Diversions	Numerous direct diversions exist along the creek which could provide flow benefits through improved water management, diversion improvements and on-farm water efficiency. Several major irrigation fish passage projects have been completed or are in design.

- **Smaller Drainages**

Location:	Irrigation Infrastructure Needs:
Dry Cottonwood Creek	Headgate replacement, improved water measurement structures and water efficiency measures have been identified.
Peterson Creek	Pipe or line a leaky ditch to conserve irrigation water.
Mill/Willow Creek	Numerous direct diversions exist along the creek which could provide flow benefits through improved water management, diversion improvements and on-farm water efficiency.
Tin Cup Joe Creek	Ditch lining or piping of a leaky irrigation canal.
German Gulch	Water management, diversion improvements and on-farm water efficiency.
Little Modesty Creek	Inefficient diversion structure. Improve water management and fish passage by relocating where this creek is diverted by the ditch.

Figure 33- Restoration work underway on the CFC's Dry Cottonwood Creek Ranch in 2015.

III. Restoration and Cleanup Progress To Date

A. Restoration Progress

In 2011 the Coalition completed a comprehensive blueprint to guide its restoration activities in the Upper Clark Fork (*Aquatic Restoration Strategy: Elements of an Integrated Approach).* This document laid out CFC's integrated aquatic ecosystem restoration approach for the UCF (including flow restoration, fish passage-connectivity, habitat enhancement, and forest-watershed management projects) and how those strategies will be applied to high-priority creeks. CFC put forth the following priorities for tributaries in the basin:

1) Restore flows to reconnect, form, & sustain healthy, diverse aquatic and riparian habitat.
2) Reconnect tributary streams to the mainstem river and provide fish passage.
3) Enhance aquatic and riparian habitat through better management in all reaches.

4) Improve upland watersheds (roads, forestry) to restore riparian habitat conservation areas, protect native fish habitats, and reduce the input of sediment and nutrients to the aquatic system.

The eight streams selected included: (north to south): Cottonwood Creek, Peterson Creek, Dempsey Creek, Racetrack Creek, Modesty / Galen Spring Creeks, Dry Cottonwood Creek, Lost Creek, and Warm Springs Creek.

The Coalition's *Aquatic Restoration Strategy* has guided CFC's work in the basin since 2011. A summary of progress to date is found in Table 7 below.

Restoration Milestones		
Activity:	**Quantity accomplished (2011-2015)**	**Streams where work done to date (by all partners):**
In-stream flow secured	20 cfs	Cottonwood Cr., Dry Cottonwood, Clark Fork River
Fish passage barriers removed:	7	Cottonwood Cr., Racetrack Cr., Modesty Cr., Galen Spring Cr., Perkins
Tributaries reconnected:	4	Cottonwood, Modesty, Galen Spring Creek, Dry Cottonwood
Aquatic/riparian habitat improved:	31 miles	Cottonwood, Peterson, Dry Cottonwood, Clark Fork mainstem, Lost, Racetrack
Road or watershed projects (USFS or local government):	2	Dry Cottonwood, Browns Gulch

Table 7- The Clark Fork Coalition has been working with a broad array of partners to achieve these milestones in the Upper Clark Fork since 2011. The CFC, NRDP, WRC, TU, USFS and other partners have realized the above accomplishments to date.

The strategy outlined below updates the 2011 ARS, incorporating lessons learned, changing conditions and the findings of this report (above); and integrates the geographic priorities of the Natural Resource Damage Program (NRDP), Montana Fish Wildlife and Parks (FWP), US Forest Service (USFS), and local partners. As with the earlier strategy document, project priorities within each tributary were developed in conjunction with partner organizations and funders.

B. Cleanup Progress

Cleanup activities on waterbodies in the Upper Clark Fork Basin began with remediation work on Silver Bow Creek, which was initiated in 1999 and completed in 2015. The entire cleanup cost was approximately $86 million and included the construction of the Silver Bow Creek Greenway, a 26-mile recreational path that accesses remediated portions of the stream. Remediation work was performed along the entire stretch of Silver Bow Creek (~27 miles) with the contaminated soil removed from the streambanks/floodplains and hauled to the Opportunity Ponds waste repository.

At the initiation of the remediation work in the late 1990s Silver Bow Creek had been devoid of fish for many decades. As remediation and restoration progressed, the fishery responded. Complementary work done on fish passage and flow in a key tributary, German Gulch, allowed native fish to recolonize Silver Bow Creek. By 2006, fish were reported in Silver Bow Creek for the first time in more than 100 years. A fishery assessment from 2015 found both native westslope cutthroat and brook trout along most of the length of Silver Bow Creek below Butte. Although fish numbers were generally low (under 100 fish per mile in most reaches) the sampling location near the mouth of Blacktail Creek recorded a significant population of Eastern Brook Trout ranging in size from 2-15” (Cook et al., 2016). The return of westslope cutthroat trout, a species sensitive to water quality issues, is a tremendous achievement of the Silver Bow Creek restoration process (Figures 33-36).

Figure 34- Silver Bow Creek floodplain pollution before cleanup (left) and post cleanup (right).

Figure 35- Young angler with Silver Bow Creek westslope cutthroat trout (post restoration)- picture courtesy of Matt Vincent.

The restoration work completed on Silver Bow Creek, and subsequent return of native fish populations, may be seen as precursor of the potential response to current restoration and remediation work being completed on the Upper Clark Fork River. Superfund cleanup of the floodplain along the mainstem of the Clark Fork River (named the "Clark Fork River Operable Unit") began with planning and sampling in 2009. Removal of contaminated soils and reconstruction and revegetation of floodplains on the Clark Fork began in 2013. To date, by end of 2016, over six miles of the river had been remediated and restored (Figure 37).

Figure 36- Aerial photo of the remediation and restoration of Phases 5 and 6 (part of the Upper Clark Fork River Reach A). This photo is facing due south from Galen Road (at the bottom of the picture) near the Dry Cottonwood Creek Ranch which is operated and owned (part owners) by the Clark Fork Coalition. White patches indicate where contaminated soil has been removed and hauled away. No remediation was carried out *in* the river (just banks and floodplain), and its natural course was left intact. The light blue "pond" is where source gravels were removed to help rebuild parts of the floodplain. Smaller potholes in the foreground were added as wetland features to help improve habitat diversity in the recovering floodplain. In 2016 hundreds of migrating snow geese were observed using these features.

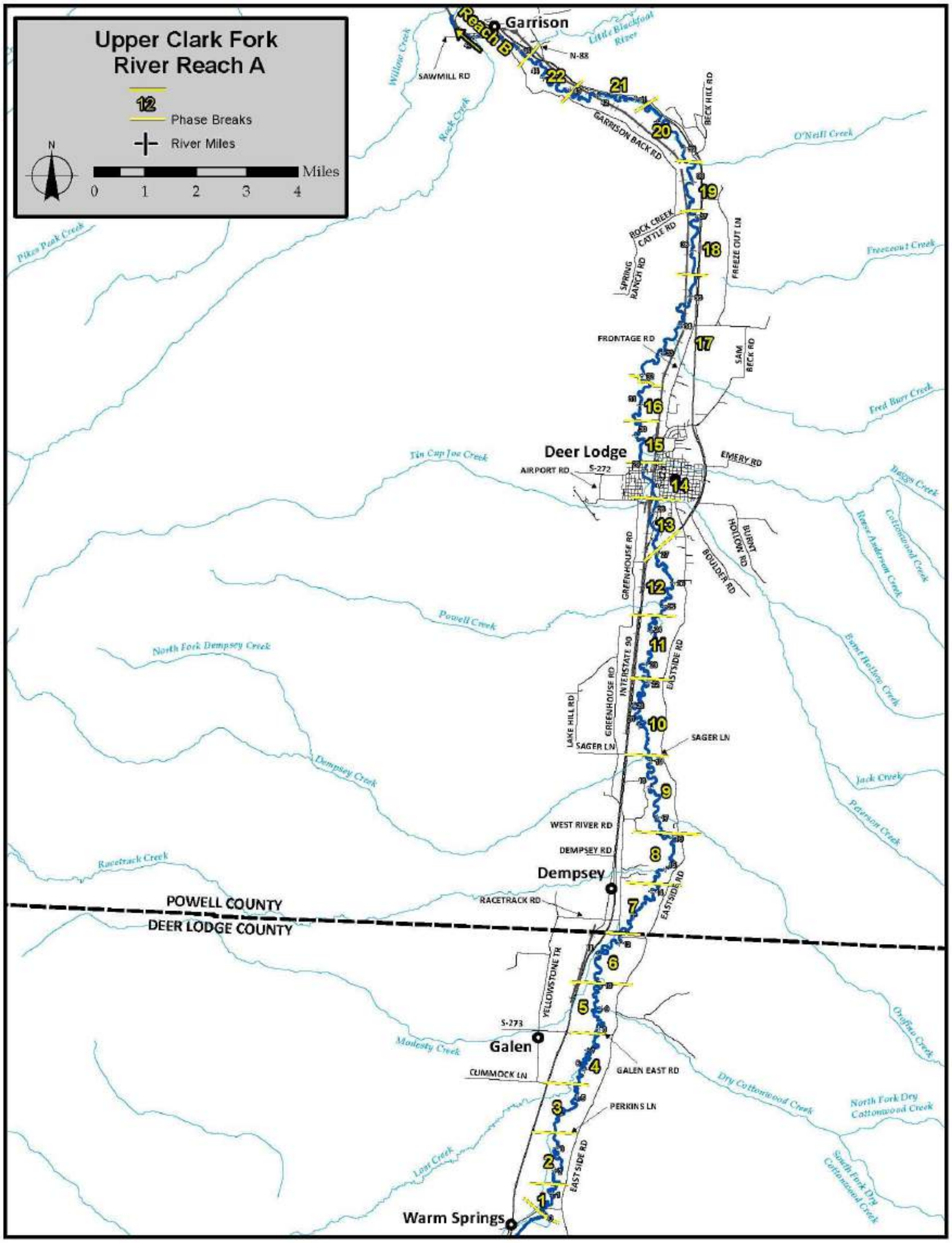

Figure 37- Map of the cleanup phases of the Upper Clark Fork River Reach A. Cleanup will "leapfrog" among these phases to minimize concentrated impact and protect restored areas against potential flood events. Map source: MT DEQ. http://deq.mt.gov

V. Aquatic Restoration Strategy for the Upper Clark Fork River Basin

Significant progress has been made since 2012 in cleaning up and restoring the Upper Clark Fork River and its tributaries, although much more work is necessary to address water quality and fishery issues still plaguing this hard working river.

The CFC's general strategy for sub-basin restoration work is based on the following guidelines:

1) Focus on priority river reaches, and the associated tributaries, and address the problems at a watershed scale.
2) Commit to a long-term investment in priority tributaries.
3) Develop integrated solutions that address multiple objectives in a tributary.
4) Build from ecological strength—support the natural process of repopulation from relatively intact or less-damaged areas in the tributary watersheds.
5) Understand the problems and restoration potential at a tributary-by-tributary scale, and develop a good baseline for monitoring change.

To maximize the impact of the restoration investments, the CFC has prioritized river reaches and tributaries in the Deer Lodge Valley, starting in 2011, with the *Aquatic Restoration Strategy: Elements of an Integrated Approach* document. Priorities for the 2011 document were selected based upon monitoring and outreach conducted by the Coalition and our partners. The current effort updates that work, and integrates the geographic priorities of the Natural Resource Damage Program (NRDP), Montana Fish Wildlife and Parks (FWP), US Forest Service (USFS), and local partners. Project priorities within each tributary are developed in conjunction with partner organizations and funders.

A. Ecological Strategy

The ongoing remediation and restoration of the upper Clark Fork River will dramatically change its potential to support healthy fish populations, including native trout. Experience is showing that significant native fish populations can be naturally restored when connectivity is re-established between healthy native fish populations in the headwaters and the remediated and restored habitats in the valley streams. Pre and post project monitoring at Silver Bow Creek indicates that effective habitat restoration of even intensely contaminated environments can restore the potential for a variety of native fish, including westslope cutthroat trout to re-inhabit these streams (Naughton et.al, 2010).

<u>Flow restoration</u> refers to the full-range of ecological flows: re-establishing summer base flows in dewatered reaches, enhancing winter base flows, and improving spring high flows, which are vital to fish migration and to the healthy functioning of channels, floodplains and riparian

vegetation. Flow restoration goals are tied to the specific ecological functions that the CFC is hoping to achieve in particular streams. For example, in an intermittent tributary stream, our flow goal may be to improve spring high flows and reconnect the tributary to the river during westslope cutthroat migration in May-June.

Reconnecting habitats is critical, especially when high-quality habitats, such as a headwater streams in a National Forest watershed, do not connect to the river. Reconnection establishes the river continuum for all ecological functions, and provides upstream and downstream fish passage. Reconnection often involves flow restoration, replacing road culverts, re-engineering irrigation diversions, installing fish screens, or overcoming water temperature barriers. Small spring creeks are also important to reconnect to the mainstem to provide water temperature refugia in summer.

Enhancing aquatic and riparian habitat refers to various active and passive restoration activities, including restoring channel stability and integrity, improving riparian vegetation through grazing programs and fencing, or increasing woody debris or other fish habitat features in-stream. Passive restoration through changes in stream-side land use are effective in many cases, but some streams which have had their stream form (pattern, dimension or profile) drastically altered will not return naturally to a stable state, and will remain a sediment source, and/or a poor quality habitat for many decades. In these cases, active reconstruction of sections of a stream may be justified.

Improving upland watersheds is vital for protecting habitat in streams with native fish populations. One of the key constraints in many tributaries is sediment or nutrient input from forested uplands, due to road density, fires, or other forest management issues.

B. Community and Institutional Strategy

Establishing good landowner partnerships is central to restoration success. The CFC conducted a coordinated effort to contact landowners in our priority drainages to learn more about the history of water use in these areas, attitudes towards restoration and project opportunities that exist. The CFC learned that the organization has a long ways to go before it can expect to secure full participation from landowners. Securing cooperation and building trust with private landowners is essential to the success of this restoration effort and will take time. Pilot irrigation upgrade projects completed to date have helped landowners appreciate the benefits of collaborative work on fishery restoration.

The long-term success of the restoration strategy depends on how the local landowners steward the river and manage private lands after the Superfund cleanup is over, and tributary restoration projects are installed. When we set out to “balance flows between fisheries and agriculture,” or “improve management” of riparian areas, we are talking about capital investment in agricultural practices, and education. Investment in irrigation, stock water, or fencing technology allows agricultural producers to sustain or even improve their productivity, while lessening impacts on streams.

This process also must address the delicate issue of cultural assumptions about the environmental impact of traditional agricultural practices, and potential trade-offs between fish/ wildlife habitat and agricultural productivity. We are constantly challenging ourselves to be more innovative in how we approach projects with the goal of maintaining or enhancing agricultural productivity while also improving the fish and wildlife habitat.

Leaders in the agricultural community (i.e. the Conservation Districts) have a vital role to play in supporting a long-term commitment to conservation, and the CFC will seek their advice and collaboration. The CFC will also use local networks—including radio, newspapers, and schools—to emphasize the compatibility of ecological restoration with agriculture, and to provide support to long-term education on land management that includes an appreciation of aquatic and riparian habitat values. Developing strong partnerships with organizations like the WRC, Montana FWP, Natural Resource Conservation Service, USFS, Conservation Districts, Montana DEQ, and the Natural Resource Damage Program , is also crucial for successful project implementation.

C. Integrated Strategy and Goals for the Upper Clark Fork River

After strategic assessment of basin-scale needs and opportunities, and meetings over the past six years with partners, the CFC has identified the upper Clark Fork River in the Deer Lodge Valley from Warm Springs to Garrison Junction as the first priority for restoration work. The CFC plays a support role in the headwaters sub-basin (Silver Bow Creek), where NRDP, Montana FWP, TU, the WRC, conservation districts, local governments and other partners are taking the lead on restoration work.

The CFC's Restoration Program intends to focus much of its effort over the next ten years (2016-2025) towards achieving high-quality ecological restoration from Warm Springs to Garrison through systematic work on improving flows, connectivity and fish passage, habitat and watershed management in the mainstem of the river and tributaries within this reach.

Montana DEQ's ongoing remediation of metal-contaminated stream banks and floodplain soils in the Clark Fork River Operable Unit must be integrated with systematic restoration of tributary streams in this reach to achieve the best possible ecological results. The mainstem of the river is also seasonally dewatered, and impaired by high summer water temperatures, high nutrient levels and noxious algae. The CFC will work to address these problems with our partners through a combination of flow, passage, and tributary projects which provide cumulative water quality and habitat benefits to the river itself.

At least seven designated westslope cutthroat trout conservation populations exist in our priority tributaries, particularly on USFS lands. Reconnecting some of these tributary populations to restored habitats in the valley reaches of tributaries, and on to the mainstem Clark Fork River, is a critical indicator of landscape-level aquatic restoration success. This will require re-watering the lower reaches of tributaries and reconnecting good-quality tributary habitat to the river, by reconstructing culverts and irrigation infrastructure which currently constitute major fish passage barriers, while improving water quality and aquatic habitat.

i. Goals and Objectives

The CFC is working with many partners, including NRDP, TU, WRC, and USFS, who share in some measure, similar aquatic restoration goals. These goals and objectives are the particular focus for CFC activities in the project area from present until 2025.

Goal: **Restore a vital and diverse fishery, improved water quality, and healthy riparian corridors to the river and its tributaries in the UCF planning area.**

Objective 1: Meet ecological flow targets in the mainstem Upper Clark Fork River.

Objective 2: Set and meet ecological flow targets in at least five key tributaries (Cottonwood, Dry Cottonwood, Warm Springs, Lost, Racetrack), eliminating dewatered reaches and hydrologically reconnecting these tributaries to the mainstem in the UCF.

Objective 3: Provide habitat diversity and cold-water temperature refuge in minor tributaries to the upper Clark Fork (Modesty, Galen Spring Creek, others).

Objective 4: Coordinate with partners to resolve all priority physical fish passage barriers in five key native fish tributaries (Cottonwood, Peterson, Dry Cottonwood, Perkins, Warm Springs), permitting upstream and downstream salmonid passage from mainstem to National Forest, and improve fish passage in key reaches of sport fish spawning tributaries (Racetrack, Lost).

Objective 5: Meet water quality standards, TMDL targets and INFISH requirements for water temperature, nutrients, sediment and habitat on public lands in at least five major tributaries.

Objective 6: Improve the riparian health in all ten tributaries, so that 30% of reaches are "sustainable," and less than 10% of reaches are "unsustainable" according to NRCS assessments.

ii. Opportunities in the UCF:

Effective partnerships with landowners, Watershed Restoration Coalition, Trout Unlimited, Natural Resource Damage Program, Department of Environmental Quality and Beaverhead Deer Lodge National Forest will be required to achieve these goals and objectives in the Deer Lodge Valley. Some of the opportunities that can be seized immediately are listed in the following sections.

iii. Large and Medium-scale Flow Restoration Projects:

A limited number of critical senior water rights and diversion sites exist that could significantly benefit flow restoration in the river's mainstem. The following have been identified and investigated by the CFC:

- Westside Ditch Canal Lining/Piping: this proposed salvage water project could save 10-20 cfs diverted from the upper Clark Fork River south of Racetrack. This is the most severely dewatered portion of the UCF, and probably the largest potential water savings project in the UCF planning area.
- Racetrack Lake: Purchasing water from this storage reservoir, and converting it to instream flow could provide over 400 acre-ft of water, most of which is protectable into the Clark Fork River, and would benefit the dewatered sections of Racetrack Creek as well as the river. The CFC has purchased a water right in this Lake.
- Helen Johnson Ditch Lining/Flood to Pivot Project: This salvage water project is underway. Once complete it could provide 4-6 cfs of additional flow in the river above Galen, as well as instream flow benefits to Dry Cottonwood Creek.
- Water rights in Warm Springs Creek (headwaters sub-basin) may also present further opportunities to enhance in-stream flows in the UCF. Silver Lake water owned by Butte-Silver Bow has been released to Warm Springs Creek in recent years, with a significant beneficial impact on flows and nutrient concentrations in the Creek and the upper river—this water needs to be secured long-term.

iv. Tributary Restoration Opportunities:

Assessment is ongoing to determine each tributary's specific issues within the UCF, but a number of opportunities have been identified and are tabulated below (Table 8 & 9) for prioritized tributaries. Two tributaries in the UCF (Racetrack and Warm Springs) have been assigned a Tier 1 "high" priority for aquatic restoration by Montana FWP-NRD (2010), and three others (Cottonwood, Dempsey and Lost) have been assigned a Tier 2 priority. The CFC, however, will work on restoration of all 10 of the following tributaries, in order to re-establish a larger variety of connected aquatic and riparian habitats in the UCF, and yield a greater cumulative benefit to the water quality and native fisheries and wildlife in this reach. It is significant for riparian conservation that four of these UCF tributary watersheds are partly or wholly within Tier 1 "high" priority terrestrial conservation areas, and parts of the other four are within a Tier 2 priority terrestrial conservation areas designated by NRDP-FWP (NRD-FWP, 2010b).

The following nine CFC priority tributaries are listed by geographic location (refer to Figure 38), starting in the upper west side of the Deer Lodge Valley (Lost) and proceeding clockwise around to the upper east side of the Valley (Perkins).

Tributary Restoration Goals					
STREAM:	**Flow Restoration (cfs)**	**Fish Passage Barriers Removed**	**Reconnect to mainstem**	**Riparian or aquatic habitat restoration (miles)**	**USFS watershed/ road projects**
Lost Cr.	4 to 6	2	Yes	(complete)	none
Modesty Cr.	2 to 3	1	Yes	1	none
Racetrack Cr.	8 to 10	4	Yes	13	none
Dempsey Cr.	3 to 4	3	Yes	8	none
Cottonwood Cr.	2 to 4	7	Yes	10	YES
Peterson Cr.	1 to 3	3	Yes	6	YES
Dry Cottonwood	2 to 4	4	Yes	11	YES
Perkins/Girard	0	2	No natural connection	6	YES
Warm Springs Cr (Anaconda):	5 to 9	2	Connected	0	YES
Other Small Creeks	1-4	1	Yes	2	YES
SUBTOTAL:	**28 to 57 cfs**	**29**		**57**	
Clark Fork River mainstem:	20 to 25	2	n/a	43 (DEQ-EPA)	none
TOTAL:	**48 to 82 cfs**	**31**		**100**	

Table 8- Summary of restoration milestones in the Upper Clark Fork for 2025.

The **ecological and economic outcomes** of this work will:

- Reconnect five tributaries (Modesty, Racetrack, Dempsey, Cottonwood, Dry Cottonwood) that currently do not flow to the river in summer back to the Clark Fork mainstem, through flow restoration, fish passage structures, and channel improvements.

- Provide flow and fish passage improvements to connect four conservation populations of westslope cutthroat trout (Cottonwood, Peterson, Dry Cottonwood, Dempsey) back to the Clark Fork River, facilitating potential new fluvial runs of native trout.
- Improve in-stream flows in the Clark Fork mainstem for 43 miles. Projected improvements in flow during late summer vary from 10% to 40% by reach. Improved flows from tributaries will help dilute metals, nutrients, and temperature problems in the river.
- Improve in-stream flow conditions for spring, summer, and fall/winter on 7 different tributaries, dramatically improving habitat and water quality for fish and other aquatic life.
- Restore riparian and/or aquatic habitat in 57 miles on seven UCF tributaries to improve habitat quality and productivity for fish and riparian wildlife. These projects are critical to reconnecting landscape-level habitats by providing migration corridors from the National Forest uplands to the restored floodplain and the Clark Fork mainstem.
- Reduce entrainment of juvenile fish in large irrigation canals on the Clark Fork mainstem and major tributaries in at least ten different sites through the installation of fish screens.
- Improve irrigation efficiency, save energy, and reduce energy and labor costs for dozens of farms and ranches in the UCF who will benefit from infrastructure upgrades to irrigation systems, improved pasture fences and off-stream watering systems. The sustainability of agricultural operations in the Deer Lodge valley will improve.

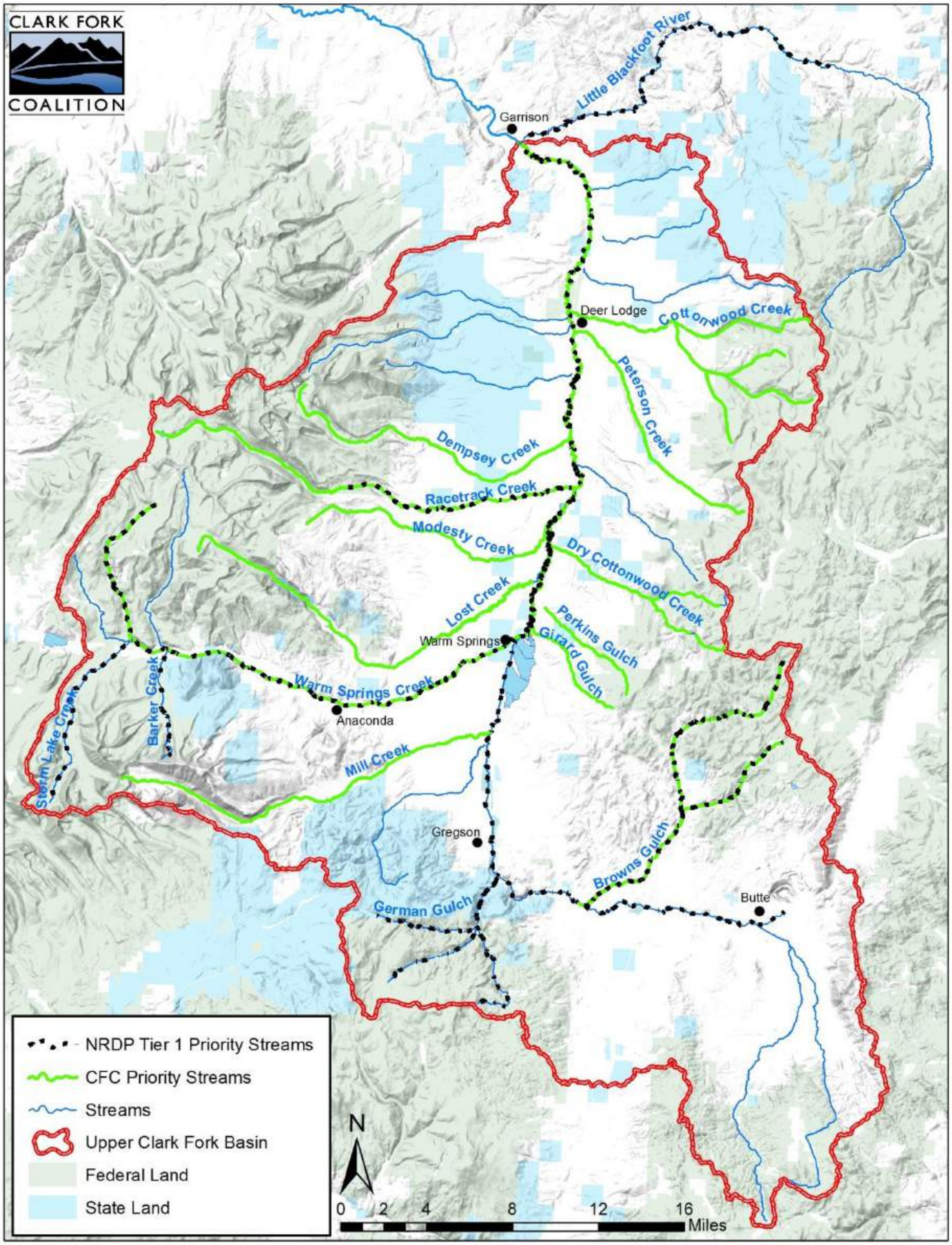

Figure 38- Map of top restoration priorities identified by the Clark Fork Coalition (in green) and NRDP tier 1 priority streams (black dashes) for fisheries enhancement.

Flow Project Opportunities in the Upper Clark Fork							
Stream	**Location**	**# of Projects**	**Benefit (CFS)**	**Status**	**Cost**	**Priority (1-3)**	**Other Needs:**
Lost Creek	Below Gardiner Ditch	3	4-8 cfs	Identified	$200,000-$800,000	2	Passage/Entrainment/ Habitat
Modesty Creek	Dry Cottonwood Ranch	1	2-4 cfs	Complete	$250,000	3	Passage/Entrainment/ Habitat
Racetrack Creek	Below Cement Ditch	2	5-10 cfs	Identified/ Pending	$1,000,000-$2,000,000	1	Passage/Entrainment/ Habitat
Dempsey Creek	Prison Ditch	1	2-4 cfs	Identified	$200,000-$400,000	2	Passage/Entrainment/ Habitat/Stability
Cottonwood Creek	Below Baggs	3	2-10 cfs	Identified/ Pending	$1,000,000-$1,250,000	1	Passage/Entrainment/ Habitat
Peterson Creek	Below Upper Diversion	1	1-4 cfs	Identified	$200,000-$400,000	3	Passage/Entrainment/ Habitat
Dry Cottonwood Creek	Dry Cottonwood Ranch	2	2-4 cfs	Pending	$150,000-$250,000	2	Passage/Habitat/ Sediment
Mill/Willow Cr.	Lower 8 Miles	2	2 cfs	Pending	$50,000-$150,000	2	Passage/Entrainment/ Habitat
Warm Springs Creek	Below Gardiner Ditch	2	5-20 cfs	Identified	$1,000,000-$5,000,000	1	Passage/Entrainment/ Habitat
Other Small Streams	Multiple	3	5-10 cfs	Identified	$200,000-$500,000	3	Passage/Entrainment/ Habitat
Clark Fork River	West Side/Whalen Ditch	2	10-20 cfs	Identified	$4,000,000-$7,000,000	1	Passage/Entrainment/ Habitat
Clark Fork River	Valiton Ditch/Sager Pumps	2	5-10 cfs	Identified	$1,000,000-$2,000,000	1	Passage/Entrainment/ Habitat
Clark Fork River	Helen Johnson/Alvi Beck	2	10-15 cfs	Pending/ Identified	$250,000-$500,000	1	Entrainment/ Habitat
Total:	**Projects**	**26**	**55 cfs-120 cfs**	**Varied**	**9,500,000-$20,500,00**	**Multiple**	**Multiple**

Table 9- Flow project opportunities in the Upper Clark Fork.

VI. Conclusions and Recommendations

The Deer Lodge valley segment of the upper Clark Fork River provides a unique opportunity for basin-scale restoration of fisheries, water quality and ecosystem health while investing in infrastructure that benefits the local economy. The ongoing clean-up of the Upper Clark Fork river floodplain under the Superfund program will provide the water quality improvements that are vital to re-establish a healthy watershed.

But clean-up of metals contamination is not enough—re-watering the mainstem of the river and connecting it to healthy tributaries is vital to watershed health. The clean-up must be accompanied by complementary investments in irrigated agriculture and land management to realize the full potential for ecological restoration. These investments will improve water management, reconnect streams, and restore riparian habitats while renovating and improving infrastructure for agriculture and public land managers. The Clark Fork Coalition has worked for seven years to identify and begin constructing these critical investments. Although significant progress has been made, some of the most important, expensive, and complex projects lie ahead.

Rewatering the mainstem of the Clark Fork River from Galen to Deer Lodge requires major improvements to the larger irrigation conveyance systems in this reach. The West Side Ditch and Whalen Ditch piping project is a critical need which could restore nearly 20 cfs to the most dewatered section of the mainstem of the Clark Fork, more than tripling the dry season low flows. The CFC believes this project will be the lynch-pin of success in re-watering the Clark Fork River in the Deer Lodge valley. Complementary re-watering projects which will also benefit this reach include the Clark Fork-Helen Johnson Ditch, Racetrack Creek, and Clark Fork-Valiton Ditch projects. These projects require upwards of $9 million in investments.

Reconnection of vital tributaries in this reach is already underway. Recently-completed projects have initiated improvements to flow and fish passage in lower reaches of Lost Creek, Modesty Creek, Dry Cottonwood Creek, Racetrack Creek, and Cottonwood Creek, partly resolving connectivity issues in these tributaries in the last six years. At least $5 million more in investments are needed to complete the reconnection process on these streams, and include Racetrack Creek into the “reconnected” category.

Strategic investments in the uplands, particularly on National Forest Lands, to improve riparian and aquatic habitat, upgrade roads which degrade water quality, and improve prioritized fish passage issues on tributary headwaters, will require another $3 million in the next 10 years.

The Clark Fork Coalition and its partners are working on leveraging significant state resources (Natural Resources Damage Program), to generate further funding for these restoration investments from other State of Montana grant programs, federal sources (USDA-NRCS, USDA-USFS, BOR), National Fish and Wildlife Foundation (Columbia Basin Water Transactions Program), private foundations, and local supporters and landowners. The momentum is building, and we believe that 2025 is a reasonable goal to accomplish the majority of the goals and objectives of this strategy.

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Appendix A
Role of Partner Groups in the Upper Clark Fork

Clark Fork Coalition (CFC)

- Dedicated to protecting and restoring the watershed
- Implements instream flow, habitat enhancement and fish passage projects
- Conducts youth education, community outreach and policy initiatives

Watershed Restoration Coalition of the Upper Clark Fork (WRC)

- Local watershed group focused on habitat improvement projects and watershed planning

Montana Department of Justice, Natural Resource Damage Program (NRDP)

- Created in 1990 to prepare the state's lawsuit against the Atlantic Richfield Co. for injuries to the natural resources in the Upper Clark Fork River Basin
- Performs natural resources damage assessments and allocates funds for actions that restore or replace injured resources
- Responsible for the implementation of the *Final Clark Fork River Basin Aquatic and Terrestrial Restoration Plans*, which involve investing in a combination of flow, habitat, passage and terrestrial projects in the Upper Clark Fork through damage funds secured from a settlement with ARCO
- Project monitoring coordination and funding

Trout Unlimited (TU):

- Project coordination with NRDP, NRCS, other partners & landowners for fish passage projects, particularly on Warm Springs Creek and parts of Silver Bow Creek watershed.

Montana Fish Wildlife & Parks (FWP):

- Biologists provide project review/advice on fisheries and wildlife issues with NRDP, NRCS & other partners
- Ongoing fisheries assessments inform future restoration effort and project effectiveness
- Administers Future Fisheries grant program, which supports fisheries restoration projects

National Center for Appropriate Technology (NCAT)

- Technical assistance in on-farm water management and energy conservation

Deer Lodge Valley Conservation District (DLVCD):

- Local support and outreach to area landowners with education and grant funding.

Mile High Conservation District (MHCD):

- Local support and outreach to area landowners with educaton and grant funding.

Bureau of Reclamation (BOR)

- Watershed strategic planning
- Engineering technical assistance and project planning
- Financial assistance

US Fish and Wildlife Service (USFWS)

- Biologists provide technical information regarding bull trout distribution and recovery

Natural Resource Conservation Service (NRCS)

- Offers technical and financial assistance to farmers, rancher and forest managers to improve their operations and the environment

National Fish and Wildlife Foundation (NFWF)

- Works with public and private sectors to protect and restore our nation's fish, wildlife, plants and habitats
- Financial assistance

Columbia Basin Water Transactions Program (CBWTP)

- Technical and financial assistance for water conservation, water leasing and acquisitions

West Side Ditch Company

- Irrigation district that is the largest water user group in the Upper Clark Fork
- Assists in project identification and development of water conservation measures

Montana Department of Natural Resource and Conservation Water Resources Division (DNRC)

- Responsible for overseeing water right changes and water rights adjudication
- Hydrologic technical assistance

Montana Department of Environmental Quality (DEQ)

- Manages the Montana Nonpoint Source Management Program and development and implementation of water quality improvement plans and TMDLs
- Oversees Superfund Clean-up activities in the Upper Clark Fork
- Financial assistance through the 319 Grant Program