Carbon County, Montana

Multi-Jurisdictional Hazard Mitigation Plan

Draft for Public Review

January 2020

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Chapter 1. Introduction

Purpose and Authority

Carbon County, Montana, including the participating jurisdictions of the Town of Bearcreek, Bridger, Fromberg, Joliet and the City of Red Lodge have prepared this local hazard mitigation plan to guide hazard mitigation planning to better protect the people and property of the County from the effects of hazard events.

This plan demonstrates the community's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed to make Carbon County and the Towns of Bearcreek, Bridger, Fromberg, Joliet and the City of Red Lodge eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance (HMA) grants including the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) program, as well as to make the County and the participating jurisdictions more disaster resistant. This plan demonstrates the County's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources.

Background and Scope

Each year in the United States, disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated.

Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $4 in avoided future losses in addition to saving lives and preventing injuries (National Institute of Building Science Multi-Hazard Mitigation Council 2005). An update to this report in 2017 (Natural Hazard Mitigation Saves: 2017 Interim Report) indicates that mitigation grants funded through select federal government agencies, on average, can save the nation $6 in future disaster costs for every $1 spent on hazard mitigation.

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies to lessen impacts are determined, prioritized, and implemented. This plan documents Carbon County's hazard mitigation planning process identifies relevant hazards and risks and identifies the strategy the County and the participating jurisdictions will use to decrease vulnerability and increase resiliency and sustainability.

This plan underwent a comprehensive update in 2019 in fulfillment of the five-year update requirement. This plan was originally prepared in 2005, pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002 (44 CFR §201.6) and went through a plan update process in 2014. Hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act, or DMA. While the act emphasized the need for mitigation plans and more coordinated

mitigation planning and implementation efforts, the regulations established the requirements that local hazard mitigation plans must meet in order for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Because the Carbon County planning and response area is subject to many kinds of hazards, access to these programs is vital.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to the community and its property owners by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruption. The Carbon County planning area has been affected by hazards in the past and is thus committed to reducing future disaster impacts and maintaining eligibility for federal funding.

Multi-Jurisdictional Planning

This plan is a multi-jurisdictional plan. The planning area encompasses all of Carbon County, the incorporated Towns of Bearcreek, Bridger, Fromberg, and Joliet as well the City of Red Lodge. All local units of government in the County were invited to participate in the planning process. The decision whether or not to participate in this process was a local decision, based on local community needs. Local governments have the options to not prepare a plan, to prepare a stand-alone plan for their jurisdiction, or to participate in a multi-jurisdiction or county-wide plan. The following entities meet the definition of a local government per the DMA regulations and have opted to participate in this effort and are seeking FEMA approval of the 2020 updated version of this plan. Entities that participated in the plan are noted below. Additional detail about participation can be referenced in Chapter 2 and Appendix B.

Participating Jurisdictions

- Town of Bearcreek
- Town of Bridger
- Town of Fromberg
- Town of Joliet
- City of Red Lodge

Plan Organization

This plan is organized into five chapters.

Chapter 1. Introduction and Community Profile: This chapter provides background material to put the plan and mitigation strategies in context.

Chapter 2. Planning Process: This chapter describes how the plan was developed including public involvement. Chapter 2 also identifies the local plans that were reviewed in the preparation of this update to the HMP.

Chapter 3. Hazard Identification and Risk Assessment: This chapter gives information about historical disaster occurrences in the county then lists potential hazards, hazard profiles, critical facilities, and vulnerabilities. Chapter 3 also provides information about asset values.

Chapter 4. Mitigation Strategy: This chapter takes the hazard information and develops goals, objectives and projects that can be accomplished to lessen the chances and/or severity of a potential disaster. Recognizing the limitation of resources to accomplish all projects identified, Chapter 4 also provides the priorities for the projects.

Chapter 5. Plan Implementation and Maintenance: This chapter describes how this plan is to be kept current, how the public will be involved in plan updates, and how other local plans can incorporate goals and projects from this plan.

Appendices

Appendix A: Hazard Mitigation Planning Committee Members

Appendix B: Planning Process

Appendix C: Local Plan Adoptions

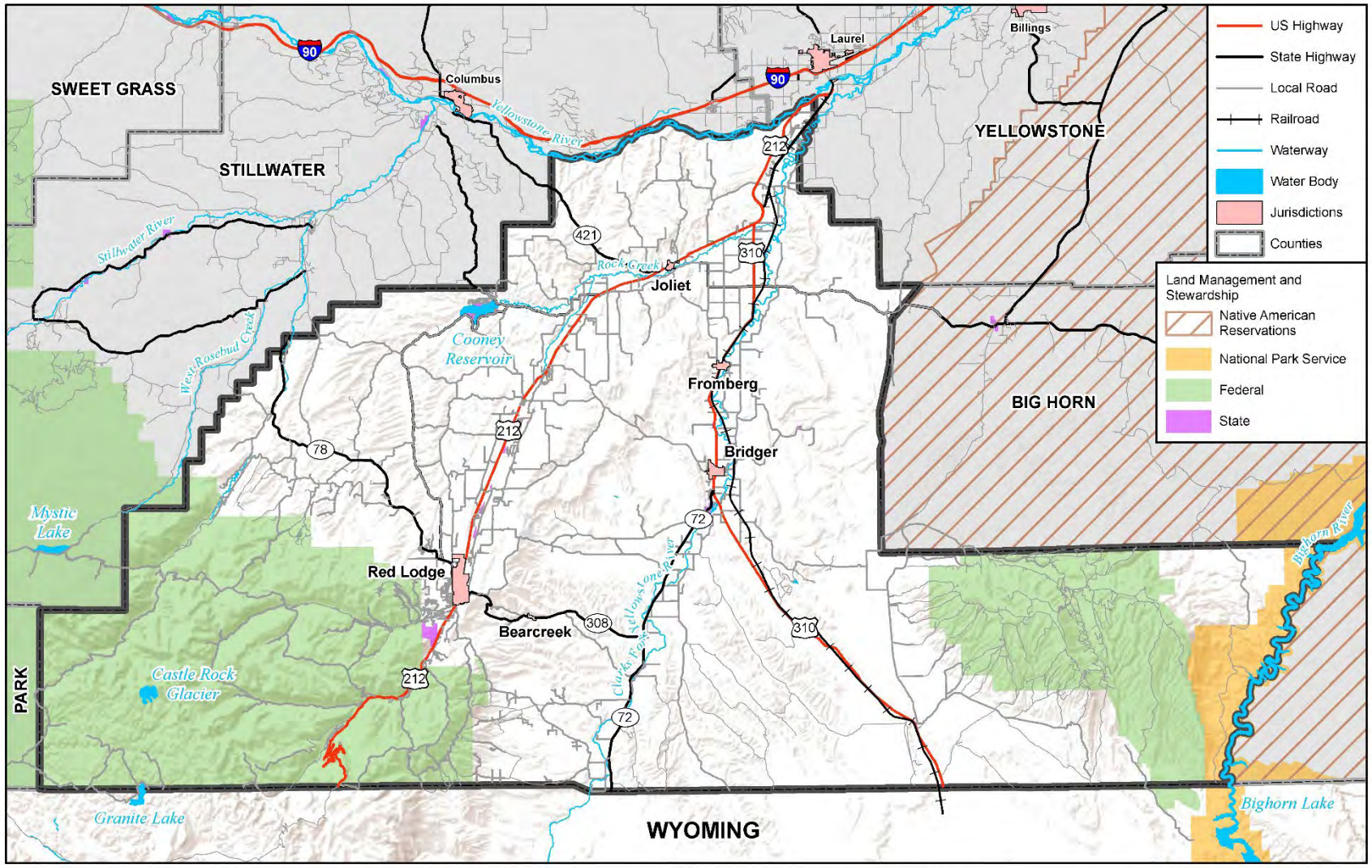
Appendix D: Community Wildfire Protection Plan

Community Profile

Project Area

The project area for this plan is Carbon County, Montana. Carbon County is located in south central Montana and includes approximately 1,313,859 acres or 2,048.79 square miles. Natural landscapes define the County's character with the Absaroka-Beartooth Mountain range to the south and west, the Pryor Mountains and the Big Horn River to the east. The following figure depicts the Planning Area.

Figure 1-1 Carbon County Planning Area



Map compiled 7/2019;
intended for planning purposes only.
Data Source: Carbon County, Montana
State Library, US Census TIGER Database,
ESRI World Terrain Base

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Carbon County

Climate and Weather

"*Carbon County has a continental climate, modified by the pattern and contours of the mountains, valleys, and plains*" according to the USDA Soil Survey, Carbon County Area, Montana, 1975.

Consistent with the variation in elevation and topography across the county, precipitation ranges from over 70 to less than 6 inches annually. The heaviest precipitation occurs in the southwestern area of the county at higher elevations and much of the precipitation falls in the form of snow. The driest area of the county is situated just north of the Wyoming border, south of Belfry, in the south-central portion of the county. (Beartooth RC&D Project, 1970) According to the Soil Survey, "The Belfry section of the Clarks Fork Valley, in the rain shadow of the very high mountains, is probably the driest section of Montana."

In the winter, the precipitation falls as snow which accumulates in the foothills and mountains but generally melts off in the lower elevations in the central and northern portions of the county. Snowpack melting contributes to sustained runoff along all major streams. "Occasionally, heavy rains in late May or June coincides with periods of peak runoff, and about 1 year in 10 this combination causes some stream overflow." (Soil Survey, Carbon County Area, Montana, 1975) Exceptionally heavy snowpack in the winter of 2010-2011 caused high runoff and widespread flooding across the county.

The range in temperatures is also fairly large. Four weather stations located at Belfry, Bridger, Joliet, and Red Lodge monitor temperatures in the county. Monthly extreme averages have ranged from 20.0 degrees Fahrenheit in Belfry in January of 1974, to 70.5 degrees Fahrenheit in Bridger in July of 1933. The frost-free season at Red Lodge is about 104 days, but along the Yellowstone River on the northern edge of the county it can extend to 130 days. Carbon County is also situated so that it experiences Chinook winds which can drive winter temperatures upwards dramatically in a short period of time. Chinook winds can reach 75 miles per hour. Carbon County has experienced extreme weather in all four seasons, from blizzards to rainstorms to hail to tornadoes. Refer to the severe weather profiles in Chapter 3: Hazard Identification and Risk Assessment, for additional information on weather related hazards in the county.

History

Carbon County is named for the abundant coal deposits found in area during the 19th century. Coal was first discovered in the area that is today the City of Red Lodge. Shortly after, more areas were discovered, and portions of the Crow Indian reservation were ceded to allow for coal development in 1877. Additional agreements with the Crow Tribe in 1882 and 1892 allowed for an additional 160 acres of settlement. Carbon County was created on March 4, 1895 from portions of Park and Yellowstone counties.

Many early residents of the County worked in the coal mines include the largest mines, Smith Mine near the Town of Bearcreek. In 1943 an accident at the Smith Mine resulted in the deaths of 74 mine workers and many see the event as marking the start of the end of the coal industry in Carbon County. The Smith Mine incident is considered the deadliest coal mine disaster in the State of Montana. As the coal industry began to dwindle the agricultural industry particularly in the foothill areas began to pick up. Livestock and ranching cattle and growing hay dominated as the main agricultural products out of the County. The County's economy continued to diversify with resort developments such as the Shangri-La Ski Area in 1946 and the Red Lodge Mountain Ski Area, formally Grizzly Peak Ski Area, in 1960. The Shangri-La Ski Area was destroyed by a wildfire in 1949 but the Red Lodge Mountain Ski Area continues to be a popular tourist destination.

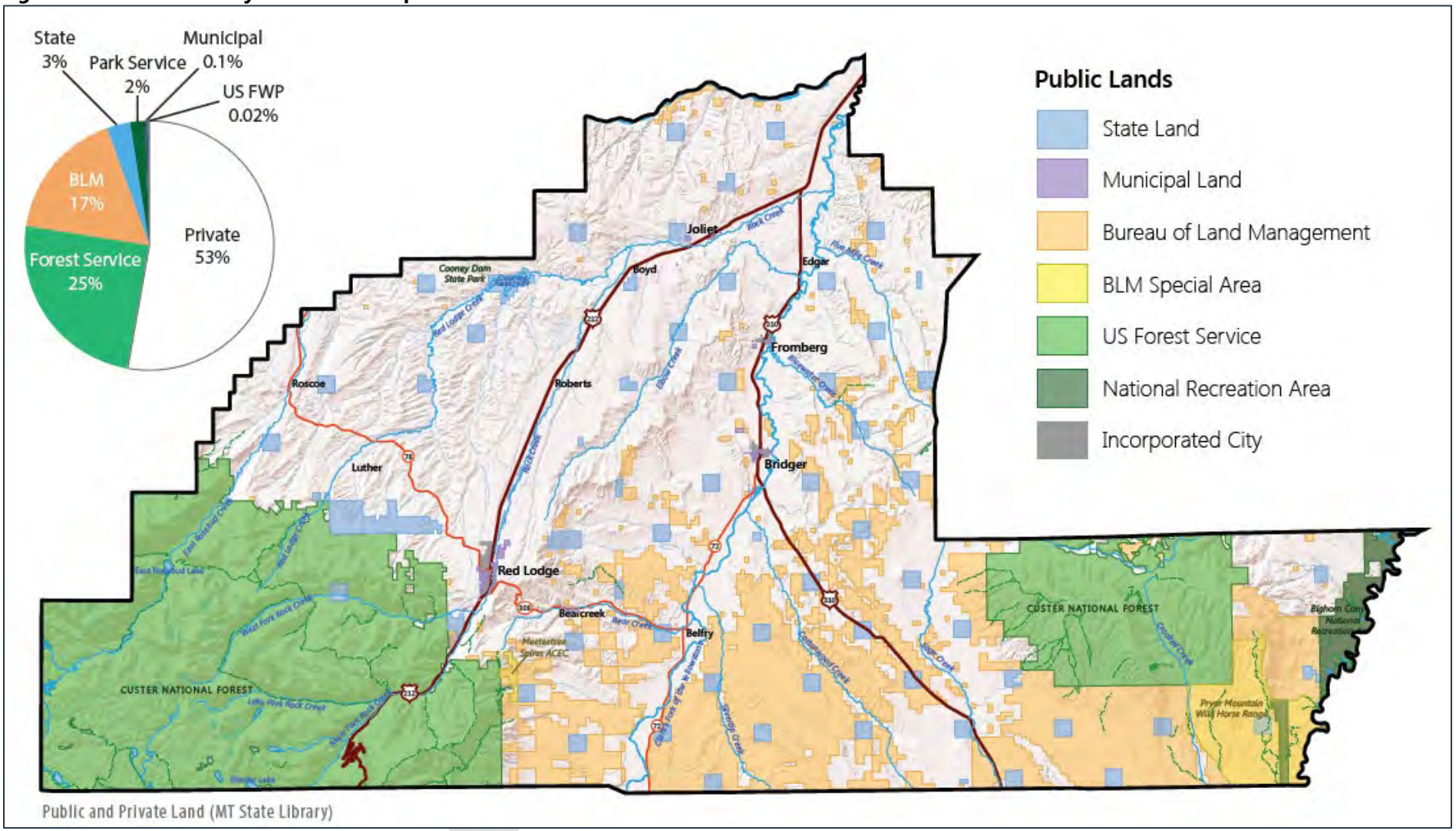
Land Use

The county has tremendous diversity in elevation, topography, vegetation, and precipitation. Granite Peak, Montana's highest peak at 12,799 feet above sea level is situated on the western county boundary. By contrast, the lowest point in the county, in the northeast corner, has an elevation of only 3,300 feet. Approximately 53% of the land in the county (696,500 acres) is in private ownership. Land that is privately owned is generally located in the northern portion of the county along the Clarks Fork and Rock Creek Valley bottoms and is lower in elevation, drier climate and considered to have more productive soils compared the publicly owned lands (Carbon County 2015). Approximately, 47% of land in the County is public and managed by the Bureau of Land Management, State of Montana, National Park Service, U.S. Fish and Wildlife, and municipal owners.

Of the platted subdivision in the County, 80% were platted outside of incorporated communities and cover 12,000 acres in the county. According the Carbon County Growth Policy, the dominate development pattern in the County is widespread subdivision of land along Highway 212 between Red Lodge and Joliet. Subdivisions have increasingly been one- or two-lot subdivisions dispersed throughout the county compared to 10-15 years ago when the development pattern tended to be large subdivisions. Also, the use of divisions of land exempt from subdivision review, such as family transfers, create development that has an impact on development patterns, as well as local services, but is not required to meet the typical standards or conditions associated with subdivision review.

Nearly 41% of land is used for agricultural production. Public and private lands throughout the county are used in livestock (beef cattle and sheep) and hay production, both dryland and irrigated hay. The major crops produced in the county are sugar beets, wheat, barley, oats, and corn. According to the 2017 USDA National Agricultural Census—the most recent year for which farm information is available-- Carbon County had 815,758 acres of land used for farming, a 25,000 acre increase from 2012. The largest acreage of farmland is located near the confluence of Rock Creek and Clark's Fork (Carbon County 2019).

Figure 1-2: Carbon County Land Ownership



Source: Carbon County Growth Policy

Public lands are primarily situated in the higher elevation Beartooth Mountains on the west side of the county, the Pryor Mountains on the east, and in the south-central area of the county. Public lands are undeveloped with the exception of mineral production, recreational facilities, and dispersed range improvements. National Forest lands in the western portions of the county abut private lands, some with residences, creating wildland-urban interface areas with potential for wildland fire.

The county contains five incorporated communities, Red Lodge, the county seat, Bearcreek, Bridger, Fromberg, and Joliet. There are also a number of unincorporated communities including; Belfry, Boyd, Edgar, Luther, Roberts, Rockvale, Roscoe, and Silesia. Approximately forty-five percent of the population resides within the incorporated communities.

Transportation infrastructure in the form of railroads, state highways, and state bridges is concentrated in these two valley bottoms. County roads and bridges also move traffic across the valley bottoms and from the valley bottoms to the foothills and bench areas. Other than the residential development associated with individual subdivisions--mostly in the southwestern area of the county, there are no major developments of land proposed outside of existing communities. Carbon County has some small-scale manufacturing, but no major concentrated manufacturing or industrial areas.

Carbon County has no county-wide zoning. The County has a Growth Policy, Subdivision Regulations and Development Regulations. The County adopted the Development Regulations in July 2016 and separates the types of permits into three types; Group 1 Development Permit is require for new residential construction, Group 2 Development permit is require for new commercial construction or new commercial activity and a Conditional Use Permit is required for development not defined under Group such as wind energy development, oil and gas exploration and shooting ranges (Carbon County 2019). According to the County's 2020 draft Growth Policy update, applications for development have increased every year since the regulations were adopted in 2016 and are expected to continue this trend as people become more familiar with the permit process.

Demographics

According to the 2018 census estimates, the county is home to an estimated 10,714 people. There are five incorporated communities within the county – the City of Red Lodge and the towns of Bearcreek, Bridger, Fromberg and Joliet. The countywide population increased 6.48% from 2010 to 2018. The population density of the county in 2017 was 4.9 people per square mile. Carbon County is bordered by Park, Big Horn, Yellowstone, and Stillwater Counties in Montana, and Park and Big Horn Counties in Wyoming.

Population

The following table shows the breakdown of population characteristics for Carbon County and the participating jurisdictions from the American Community Survey five-year estimates (2013-2107). Further discussion related to vulnerable populations in the county can be found in Chapter 3.

Table 1-1 Demographic and Social Characteristics

Characteristic	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Gender/Median Age						
Median Age	50	47	46	55	46	47
Male, percentage	50.4%	47.1%	42.%	50.1%	49.0%	47.6%
Female, percentage	49.6%	52.9%	57.3%	49.9%	51.0%	52.4%
Race/Ethnicity (percentage)						
White	94.6%	96.1%	93.9%	93.6%	91.4%	92.6%
Hispanic or Latino (Any Race)	2.4%	0%	3.8%	5.5%	8.0%	4.0%
Asian	0.3%	0%	0%	0%	0%	0.4%
Some Other Race alone	0.3%	0%	0%	0%	0%	0%
Black or African American	0.2%	0%	0%	0%	0%	0.4%
American Indian/Alaska Native	0.8%	3.9%	1.7%	0%	0%	0.3%
Educational Attainment (percentage)						
High School Graduate or Higher	93.9%	99.2%	89.8%	89%	95.6%	94.8%
Bachelor's Degree or Higher	21%	20.3%	16.6%	14.3%	15%	38.9%

Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates

According to population projections from the State of Montana Census and Economic Information Center (CEIC) countywide population is estimated to increase by almost 20 percent by the year 2050. The following table shows the population growth estimates for the next six decades.

Table 1-2 Carbon County Population Projections, 2020-2060

Year	Estimated Population
2020	11,066
2030	12,365
2040	12,869
2050	12,800
2060	12,664

Source: State of Montana Census and Economic Information Center, data was obtained from a Regional Economic Models, Ince (REMI) released July 2019.

Housing

Housing tenure for Carbon County and participating jurisdictions was obtained through the American Community Survey, five-year estimates (2013-2017). The following table shows the breakdown of owner occupied and renter occupied units, a majority of residents county-wide live in a home they own. According to the County's 2020 draft Growth Policy, most the housing stock in the county was built in the late 19th and early 20th century, with nearly 22% of housing units being built before 1939.

Table 1-3 Carbon County and Participating Jurisdictions Housing Tenure, 2017

Characteristic	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Occupied Housing Units	4,565	51	306	196	212	1,062
Owner Occupied	3,608	35	206	172	174	726
Renter Occupied	957	16	100	24	38	336

Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates

Income and Employment

The following table shows the economic characteristics for unincorporated Carbon County and the participating incorporated jurisdictions. Changes in total population since 2010 as well as further discussion related to County-wide economic assets can be found in Chapter 3.

Table 1-4 Carbon County and Participating Jurisdictions Comparative Economic Characteristics, 2017

Characteristic	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Median Family Income	$56,988	$54,583	$46,167	$43,611	$38,929	$46,786
Median (Nonfamily) Household Income	$31,126	$31,126	$16,429	$31,875	$25,556	$31,607
Population in Labor Force	5,353	69	350	192	238	1,284
Employed	5,127	65	331	183	221	1,284
Unemployment Rate	4.0%	5.8%	5.4%	4.7%	7.1%	0.0%

Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates

Per capita income in the county in 2016 was $42,153 (in 2017 dollars), slightly lower than the state average of $42,947 (Montana Department of Labor and Industry). The proximity of Carbon County to Billings, Montana's largest city means that goods and services are procured by Carbon County residents in Yellowstone County as well as in Carbon County.

The following tables show breakdown of employment by industry and the top ten employers in the county. Note, only private employers in the county are represented in the tables.

Table 1-5 Employment by Industry, 2018

Industry	Number of Establishments	Average Number Employed
Agriculture, Forestry, Fishing and Hunting	22	158
Mining, Quarrying, and Oil and Gas	6	36
Utilities	7	26
Construction	82	168
Manufacturing	13	67
Wholesale Trade	25	55
Retail Trade	49	269
Transportation and Warehousing	18	41
Information	9	28
Finance and Insurance	16	58
Real Estate and Rental and Leasing	13	15
Professional and Technical Services	43	79
Administrative and Waste Services	28	84
Educational Services	4	10
Accommodation and Food Services	24	281
Other Services, Except Public Administration	36	115

Source: State of Montana Department of Labor & Industry, Quarterly Census of Employment and Wages

Table 1-6 Top Ten Private Employers in Carbon County

Business Name	Employment Range
Bank of Bridger	20-49
Beartooth Hospital and Health Center	100-249
Bogarts Restaurant	20-49
Downings IGA	20-49
Montana Wildfire	20-49
Pollard Hotel	20-49
Red Lodge Healthcare	20-49
Red Lodge Mountain Resort	100-249
Red Lodge Pizza Company	50-99
Rock Creek Resort	20-49

Source: State of Montana Department of Labor & Industry

Capability Assessment

As part of the Hazard Mitigation Plan update in 2019, Carbon County and participating jurisdictions developed a more robust mitigation capability assessment. Capabilities are those plans, policies and procedures that are currently in place and contribute to reducing hazard losses. Capabilities also include staffing and financial considerations, including the ability to leverage funding for mitigation projects. Combining the risk assessment with the mitigation capability assessment results in "net vulnerability" to disasters and more accurately focuses the goals, objectives, and proposed actions of this plan. The purpose of this effort was to identify policies and programs that were either in place or could be undertaken, if appropriate. Second, the HMPC conducted an inventory and review of existing policies, regulations, plans, projects, and programs to determine if they contribute to reducing hazard related losses. Opportunities to expand or improve upon these capabilities were considered during the development of the Hazard Mitigation Plan in 2019 and noted in the mitigation strategy where applicable.

Carbon County has six incorporated jurisdictions, the County, one city, and four towns. Each of these jurisdictions has a relatively small population and very limited resources in terms of policy and staff. The County has one part-time planner, the City has one fulltime planner. None of the other jurisdictions has a planner. The County Planner works with these communities as requested and his time allows. The County Planning Board has representation from four incorporated communities in the County, (City of Red Lodge has its own Planning Board) as well as the Conservation District. Each community has paid staff responsible for public works, and a police chief. Each community has a volunteer Fire Chief with the exception of Red Lodge which has a part-time paid Fire Chief. All of the jurisdictions rely upon the County Disaster and Emergency Services Coordinator for emergency coordination and response. The County's EOP describes emergency response resources in the county which are primarily volunteers. The County also has a Local Emergency Planning Committee or LEPC.

The capabilities listed in Table 1-7 displays the existing regulatory framework as well technical, administrative, and financial capabilities for the jurisdictions.

Table 1-7 Carbon County and Participating Jurisdictions Capability Assessment

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Planning Capabilities						
Comprehensive Plan	No	No	No	No	No	Yes – Growth Policy (2015)
Capital Improvement Plan	Yes – Update in progress	Yes (2008)	No	No	Yes –In progress	Yes (2015 - 2019)– Annual assessment
Emergency Operations Plan	Yes (June 2010)	No	No	No	No	No
Recovery Plan	No	No	No	No	No	No
Mitigation Plan	Yes – Update in progress	Yes (County)	Yes (County)	Yes (County)	Yes (County)	Yes (County)
Debris Management Plan	No	No	No	No	No	No
Economic Development Plan	No	No	No	No	No	No
Transportation Plan	No	No	No	No	No	No
Flood Mitigation Assistance (FMA) Plan	No	Yes (2013)	No	No	Yes	No
Watershed Plan	No	No	No	No	No	No
Community Wildfire Protection Plan or other fire mitigation plan	Yes – 2013	No	No	No	No	No
Critical Facilities Plan (Mitigation/ Response/ Recovery)	No	No	No	No	No	No
Other	Historic Preservation Plan (1987)					Comprehensive Parks Plan (2015); Active Transporation Plan
Ordinances/Regulations						
Zoning Ordinance	No	Yes (2008)	Yes	Yes	Yes	Yes (2016)
Building Code	No	No	No	No	No	Yes (2012 IBC)
Floodplain Ordinance	Yes - 1996	Yes (4/2013)	Yes (2016)	Yes (2016)	Yes (2017)	Yes

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Subdivision Regulations	Yes – 2018	No	No	Yes	Yes	Yes (2011)
Tree Trimming Ordinance	No	Yes – included in Nuisance and Street ordinance	No	No	No	Yes (2017)
Nuisance Ordinance	No	Yes (2008)	Yes	Yes	Yes	Yes
Storm Water Ordinance	No	Yes (2008)	No	No	No	Yes (included in zoning ordinance)
Drainage Ordinance	No	Yes – included in Nuisance ordinance	No	No	No	No
Site Plan Review Requirements	No	Yes – (2008)	Yes	No	No	Yes (included in zoning ordinance)
Historic Preservation Ordinance	No	No	No	No	No	Yes (included in zoning ordinance)
Landscape Ordinance	No	Yes – included in zoning ordinance	No	Yes	No	Yes (included in zoning ordinance)
Other	Development Regulations (2016); Code of the New West (Resolution #05-20)					Tall Grass Ordinance – Hazardous Vegetation (No. 939); Ridgeline Setback Ordinance
Programs						
Codes Building Site/Design Program	No	No	No	Yes – Included in Zoning Ordinance	Yes	Yes
National Flood Insurance Program	Yes – entry 11/4/1981	Yes – entry 6/27/2013	No – no SFHA, not required	Yes – entry 11/4/1981	Yes – entry 5/19/1981	Yes – entry 5/19/1981
Community Rating System (CRS)	No	No	No	No	No	No
National Weather Service (NWS) Storm Ready Certification	No	No	No	No	No	No
Firewise Community Certification	No	No	No	No	No	NO

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Building Code Effectiveness Grading (BCEGs)	No	No	No	No	No	No
ISO Fire Rating	Yes – most rural areas ISO rating 10	Yes - 10	6 within 5 miles of the station, otherwise 10	6 within 5 miles of the station, otherwise 10	6 within 5 miles of the station, otherwise 10	4 within 5 miles of the station, otherwise 10
Economic Development Program	No	No	Yes	No	Yes	No
Land-use Program	No	No	No	No	Yes	Yes
Property Acquisition	No	No	No	No	No	No
Planning/ Zoning Boards	Yes – Planning Board	Yes – Representative on County Planning Board	Yes – Representative on County Planning Board	Yes – Representative on County Planning Board	Yes – Zoning Commission and Town representative on County Planning Board	Yes – Planning Commission and Zoning Board
Stream Maintenance Program	No	No	No	No	No	Yes
Tree Trimming Program	No	No	No	No	No	Yes
Engineering Studies for Streams (Local)	Yes – only some streams	No	Yes	Yes	No	No
Mutual Aid Agreements	Yes – Neighboring Counties; DNRC; Federal agencies	Cooperative Fire Control Program w/DNRC in effect; Agreements between RFDs out of date	Cooperative Fire Control Program w/DNRC in effect; Agreements between RFDs out of date	Cooperative Fire Control Program w/DNRC in effect; Agreements between RFDs out of date	Cooperative Fire Control Program w/DNRC in effect; Agreements between RFDs out of date	Cooperative Fire Control Program w/DNRC in effect; Agreements between RFDs out of date
Other	County Growth Policy (2015) – 2020 update in progress; Ice Jam Monitoring (winter only); Emergency Operations Plan					Main Street Program

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
	(2010); CWPP (2012)					
Studies/Reports/Maps						
Flood Insurance Rate Maps (FIRM) and Study (FIS)	Yes – 7/5/2017	Yes – 7/5/2017	No SFHA	Yes – 7/5/2017	Yes – 7/5/2017	Yes – 7/5/2017
Hazard Analysis/Risk Assessment	Yes	Yes	Yes	Yes	Yes	Yes
Evacuation Route Map	No	Yes	No	Yes	No	No
Critical Facilities Inventory	Yes – Identifies and mapped; not inventoried	Yes	Yes	Yes	No	Yes
Vulnerable Population Inventory	No	No	No	Yes	No	No
Land-use Map	No	No	No	Yes	No	Yes
Zoning Map	No	Yes	Yes	Yes	Yes	Yes
Other	Clarks Fork of the Yellowstone Channel Migration Study (in process 2019)					Red Lodge Subsidence Monitoring and Analysis report
Staff/Department/Boards						
Building Code Official	No	No	No	No	No	Yes
Building Inspector	No	No	No	No	No	Yes
Mapping Specialist (GIS)	Yes	Yes – County	Yes – County	Yes – County	Yes – County	Yes
Engineer	No	Yes – consultant	No	Yes – consultant	Yes – consultant	Yes
Development Planner	Yes	No	No	Yes – County	Yes – County	Yes
Public Works Official	Yes	Yes	Yes	Yes – in training	Yes	Yes
Emergency Management Coordinator	Yes	Yes – County	Yes – County	Yes – County	Yes – County	No
NFIP Floodplain Administrator	Yes	Yes	No	Yes – Mayor and County	Yes	Yes

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Bomb and/or Arson Squad	No	No	No	No	No	No
Emergency Response Team	No	No	Yes – Fire and Ambulance	Yes – Fire only	No	No
Hazardous Materials Expert	No	No	No	No	No	No
Local Emergency Planning Committee	Yes	No	Yes	Yes – County	Yes – County	No
Emergency Management Commission	No	No	No	No	No	No
Sanitation Department	Yes	Yes	Yes	Yes – County	Yes – County	Yes – Public Works
Transportation Department	No	No	No	No	No	Yes – Public Works
Economic Development Department	No	No	No	No	No – Beartooth Resource Conservation & Development (RC&D) provide services	No
Housing Department	No	No	No	No	No	No
Historic Preservation Department	Yes	Yes	Yes	No	No	Yes
Other	Airport Board; Conservation District; Historic Preservation Commission		Zoning Administrator			
Non-Governmental Organizations (NGOs)						
American Red Cross	No	No	No	No	No	No
Salvation Army	No	No	No	No	No	No
Veterans Groups	No	Yes	No	No	Yes	No
Local Environmental Organization	Yes	No	No	No	No	Yes

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Homeowner Associations	Yes	No	Yes	No	Yes	Yes
Neighborhood Associations	No	No	No	No	No	Yes
Chamber of Commerce	Yes	No	No	No	No	Yes
Community Organizations (Lions, Kiwanis, etc.)	Yes	No	Yes – Masons	Yes – American Legion	Yes	Yes
Other						
Financial Resources						
Apply for Community Development Block Grants	Yes	Yes	Yes	Yes – DNRC, Rural Development and CDBG	Yes	Yes
Fund projects through Capital Improvements funding	Yes	Yes	Yes	No	Yes	Yes
Authority to levy taxes for specific purposes	Yes	Yes	Yes	Yes	Yes	Yes
Fees for water, sewer, gas, or electric services	No	Yes	Yes – water and sewer	Yes – water and sewer	Yes – Water, Sewer, Garbage	Yes
Impact fees for new development	No	Yes	Yes	Yes – Not set in process of updating	No	Yes
Incur debt through general obligation bonds	Yes	Yes	Yes	Yes	Yes	Yes
Incur debt through special tax bonds	Yes – Resort tax	Yes	Yes	No	Yes	Yes – Resort tax
Incur debt through private activities	No	Yes	No	No	Yes	No
Withhold spending in hazard prone areas	No	Yes	Yes	No	No	No
Other						
Additional Information						

Element	Carbon County	Bearcreek	Bridger	Fromberg	Joliet	Red Lodge
Public education/ information programs	Yes – Noxious Weed Awareness program; Emergency preparedness program; Fire Safety programs	No	No	No	Yes – Water use and Fire safety	
Past or ongoing programs to reduce disaster losses	Yes – Implementation of the PDM plan	No	No	No	No	
Outdoor warning sirens	Yes – 3 Manual activations by Town/City employees	Yes, Town Bell - Town employees continually ring the town bell in park to alert citizens of emergency	Yes	No	Yes – 1 Activated by Town Clerk and Public Works	Yes
Other public warning systems	Yes – CodeRED	Yes - CodeRed	Yes – Reverse 911, CodeRed IPaws (countywide)	Yes - CodeRed	Yes – Reverse 911 through County dispatch	
Designated public tornado shelters/saferooms	No	Yes - basement of Town Hall	No	Yes – School (319 School St.)	No	
New facilities or infrastructure planned in the next 5 years	Yes – Possible County jail	Yes – Water projects to include firefighting hydrants and replacing 51-year-old lines	No	No	Yes – Water Project. Include new mains, new water tanks and refurbish well	
Other						

Opportunities for Enhancement

The 2019 update provided the County and participating jurisdictions an opportunity to review and update the capabilities currently in place to mitigate hazards. This also provided an opportunity to identify where capabilities could be improved or enhanced. Specific opportunities could include:

- Integrate hazard information into future updates of the following policies and plans:
  - County's 2020 Growth Policy
  - Development Regulations
  - Subdivision Regulations
  - County's Historic Preservation Plan
  - Capital Improvement Plans
  - County's Emergency Operations Plan
  - Community Wildfire Protection Plan
- Join Community Rating System Program to make flood insurance more affordable
- Become StormReady and Firewise certified communities
- Identify locations of storm shelters
- Carbon County Planning Board taking natural hazards into consideration when reviewing development applications

Chapter 2. Planning Process

Background on Mitigation Planning in Carbon County

DMA Requirements §201.6(b) and §201.6(c)(1):
An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: *(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;* *(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and non-profit interests to be involved in the planning process; and* *(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.* *[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

Carbon County originally developed this Hazard Mitigation Plan in 2006. The first update to the plan was completed in 2013, which was subsequently approved by FEMA and adopted by the County in January. The plan underwent a comprehensive update in 2019 to comply with the five-year update cycle required by the DMA 2000. The planning process and update of this plan was originally initiated in the summer of 2019 under the coordination of the Carbon County Disaster and Emergency Services Coordinator. Funding was secured through a FEMA Pre-Disaster Mitigation planning grant to enable a consultant to be hired to facilitate the process and develop the plan. Wood Environment and Infrastructure Solutions (Wood) of Denver, Colorado contracted with the County to provide professional planning services during the development of the original plan.

The development of the plan followed a structured planning process that involved various local government departments and other public and private stakeholders. The planning process followed during the update was similar to that used in the original plan development. The process is described further in this section and documented in Appendix B.

What's New in the Plan Update

DMA Requirement §201.6(d)(3):	*A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding.*

The updated LHMP complies with Federal Emergency Management Agency (FEMA) guidance for Local Hazard Mitigation Plans. The update followed the requirements noted in the Disaster Mitigation Act (DMA) of 2000 and FEMA's 2013 Local Hazard Mitigation Planning Handbook.

This HMP update involved a comprehensive review and update of each section of the 2013 plan and includes an assessment of the progress in evaluating, monitoring and implementing the mitigation strategy outlined in the initial plan. The planning process provided an opportunity to review jurisdictional priorities related to hazard significance and mitigation action, and revisions were made where applicable to the plan. Only the information and data still valid from the 2013 plan was carried forward as applicable into this HMP update. The County's Community Wildfire Protection Plan (CWPP) was moved from the 2020 base plan and placed in Appendix D. Information from the CWPP was incorporated into Chapter 3. New to the 2020 plan update was the addition of climate change considerations within each hazard profile in particular in areas where the frequency and intensity of hazards might change in the future, where applicable.

2013 Plan Section Review and Analysis

During the 2019-2020 update process, the HMPC updated each section of the previously approved plan to include new information and improve the organization and formatting of the plan's contents. The HMPC and Wood analyzed each section using FEMA's local plan update guidance to ensure that the plan met the latest requirements. Upon review the HMPC and Wood determined that nearly every section of the plan would need some updates to align with the latest FEMA planning guidance and requirements. The overall format and structure of the plan changed to align the plan with modern hazard mitigation planning practices. The Risk Assessment in Chapter 3 was substantially revised to incorporate recent events and expand on information, including a GIS-based risk assessment. Information within has been updated throughout the plan where appropriate. The mitigation strategy in Chapter 4 has been updated to reflect current priorities and mitigation actions moving forward from the 2013 plan.

Local Government Participation

The Disaster Mitigation Act (DMA) planning regulations and guidance stress that each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the Hazard Mitigation Planning Committee (HMPC),
- Detail areas within the planning area where the risk differs from that facing the entire area,
- Identify specific projects to be eligible for funding, and
- Have the governing board formally adopt the plan.

For the Carbon County Multi-Hazard Mitigation Plan's HMPC, "participation" meant:

- Attending and participating in the HMPC meetings,
- Providing available data requested of the HMPC,
- Reviewing and providing comments on the plan drafts,
- Advertising, coordinating, and participating in the public input process, and
- Coordinating the formal adoption of the plan by the governing boards.

Carbon County's Hazard Mitigation Plan is a multi-jurisdictional plan that geographically covers everything within Carbon County, shown in Chapter 1. Unincorporated Carbon County and the incorporated Towns of Bearcreek, Bridger, Fromberg, Joliet and the City of Red Lodge participated in the planning process and are seeking FEMA approval of this plan.

The 10-Step Planning Process

Carbon County and Wood worked together to establish the planning process for Carbon County's plan update using the DMA planning requirements and FEMA's associated guidance. The original FEMA planning guidance is structured around a four-phase process:

1. Organize Resources
2. Assess Risks
3. Develop the Mitigation Plan
4. Implement the Plan and Monitor Progress

FEMA's March 2013 Local Mitigation Planning Handbook recommends a nine-step process within the original four phase process. Into this four-phase process, Wood integrated a more detailed 10-step planning process used for FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. Thus, the modified 10-step process used for this plan meets the funding eligibility requirements of the Hazard Mitigation Assistance grants (including Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, Flood Mitigation Assistance), Community Rating System, and the flood control projects authorized by the U.S. Army Corps of Engineers (USACE). Table 2-1 summarizes the four-phase DMA process, the detailed CRS planning steps and work plan used to develop the plan and the nine handbook planning tasks from FEMA's 2013 Local Mitigation Planning Handbook. The sections that follow describe each planning step in more detail.

Table 2-1 Mitigation Planning Process Use to Update the Plan

FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process	FEMA Local Mitigation Planning Handbook Tasks
1) Organize Resources		
201.6(c)(1)	1) Organize the Planning Effort	1: Determine the planning area and resources
201.6(b)(1)	2) Involve the Public	2: Build the planning team - 44 CFR 201.6 (C)(1)
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies	3: Create an outreach strategy - 44 CFR 201.6(b)(1)
		4: Review community capabilities - 44 CFR 201.6 (b)(2)&(3)
2) Assess Risks		
201.6(c)(2)(i)	4) Identify the Hazards	5: Conduct a risk assessment - 44 CFR 201.6 (C)(2)(i) 44 CFR 201.6(C)(2)(ii)&(iii)
201.6(c)(2)(ii)	5) Assess the Risks	
3) Develop the Mitigation Plan		
201.6(c)(3)(i)	6) Set Goals	6: Develop a mitigation strategy - 44 CFR 201.6(c)(3)(i); 44 CFR 201(c)(3)(ii) and 44 CFR 201.6(c)(3)(iii)
201.6(c)(3)(ii)	7) Review Possible Activities	
201.6(c)(3)(iii)	8) Draft an Action Plan	
4) Implement the Plan and Monitor Progress		
201.6(c)(5)	9) Adopt the Plan	7: Review and adopt the plan
201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan	8: Keep the plan current
		9: Create a safe and resilient community - 44 CFR 201.6(c)(4)

Phase 1: Organize Resources

Planning Step 1: Organize the Planning Effort

Wood worked with Carbon County's Disaster and Emergency Services (DES) Coordinator to establish the framework and organization for the update of this Plan. Wood and the DES Coordinator identified the key county, municipal, and other local government and initial stakeholder representatives. Invitations were emailed to invite them to participate as a member of the HMPC and to attend a kickoff meeting. Representatives from the following County and participating jurisdiction's departments and boards participated on the HMPC and the update of the plan:

Carbon County

- Disaster and Emergency Services Coordinator
- County Commissioners
- Floodplain Administrator/DES Deputy
- County Planner
- Public Health Emergency Preparedness Coordinator

Town of Bearcreek

- Clerk

Town of Bridger

- Clerk/Treasurer
- Public Works

Town of Fromberg

- Mayor

Town of Joliet

- Clerk/Treasurer
- Fire Fighter - Joliet Volunteer Fire Department

City of Red Lodge

- Community Development
- Assistant Fire Chief

A list of specific HMPC representatives is included in Appendix A. Other local, state, federal, and private stakeholders invited to participate in the HMPC are discussed under Planning Step 3.

During the plan update process, the HMPC communicated with a combination of face-to-face meetings, phone interviews, and email correspondence. Three planning meetings with the HMPC were held during the plan's development between May 2019 and October 2019. The meeting schedule and topics are listed in the following table. The kick-off meeting was a combination of in-person and a webinar delivered through Skype by the planning consultant. Meetings two and three were held at the Personal Services Building in the City of Red Lodge. The sign-in sheets and agendas for each of the meetings are included in Appendix B.

Table 2-2 Schedule of HMPC Meetings

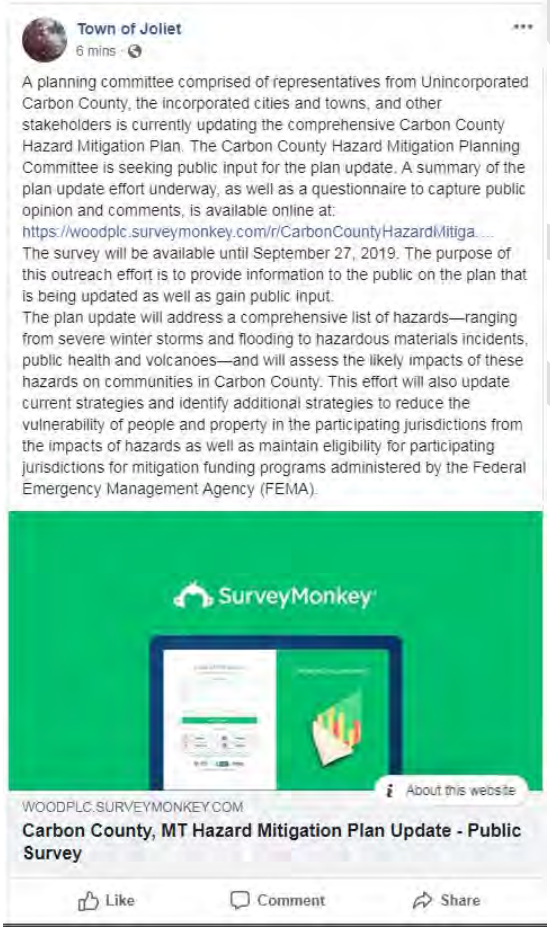
HMPC Meeting	Meeting Topic	Meeting Date
1	Kickoff Meeting: Introduction to DMA Planning and overview of Update Process, Hazard Identification Review Meeting	May 31, 2019
2	Risk Assessment Summary/Goals Development	August 9, 2019
3	Mitigation Strategy Development	October 30, 2019

During the kickoff meeting, Wood presented information on the scope and purpose of the plan, participation requirements of HMPC members, and the proposed project work plan and schedule. A plan for public involvement (Step 2) and coordination with other agencies and departments (Step 3) was discussed. Wood also revisited the hazard identification section of the plan with the HMPC members.

Planning Step 2: Involve the Public

At the kickoff meeting, the HMPC discussed options for soliciting public input on the mitigation plan and developed an outreach strategy by consensus. Public and stakeholder input was done through a combination of a public meeting and an online survey. During the plan update's drafting stage, the HMPC provided links to a public survey via SurveyMonkey. The survey was advertised by the County and the participating jurisdictions through social media.

Figure 2-1 Public Survey Announcement Posted on the Town of Joliet Social Media

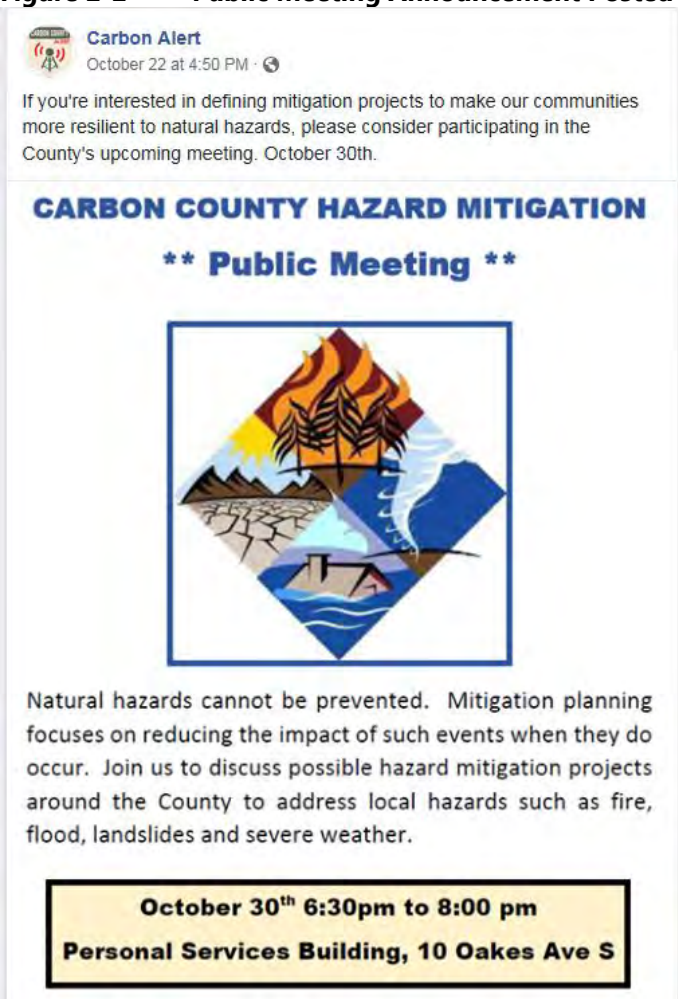


The survey provided an opportunity for public input during the planning process, prior to finalization of the plan update. The public survey received responses from 29 individuals. Responses reflect the public perception that the most significant hazards to be winter storms, followed by wildland fires and summer storm hazards: hail, severe thunderstorms, and wind.

Question 3 of the survey asked respondents to consider potential mitigation actions and to indicate which types of actions should have the highest priority in the updated County Mitigation Strategy. These results were considered during the planning process and in the development of new mitigation actions. The highest priority action items identified as needing to be considered in the updated mitigation strategy include: public education and awareness, wildfire defensible space projects, planning and zoning, wildfire fuels treatment projects, evacuation route development and indoor/outdoor warnings. Further results of the public survey are provided in Appendix B.

As part of the planning process, a public meeting was held on October 30, 2019 at the Personal Services Building in the City of Red Lodge. News releases announcing the public meeting were provided to the newspaper in the county— the Carbon County News as well as posted on the County's social media sites. The paper also printed the county commissioners' agendas. Town and city council meetings were noticed in town and city buildings and local post office. The County DES coordinator and the planning consultant were present, but no members of the public attended.

Figure 2-2 Public Meeting Announcement Posted on Carbon County's Social Media



Prior to finalizing the update, the Plan was made available for public review and comment. Hard copies of the draft plan were made available at the five town/city halls, county courthouse, and libraries in Bridger, Red Lodge, and Joliet. The plan was also posted on the county's website. The public comment period was open from January 10 through 27, 2020. The availability of the draft plan was announced in the local newspaper.

[Placeholder text for comments received and if any changes resulted in the plan.]

Planning Step 3: Coordinate with Other Departments and Agencies

There are numerous organizations whose goals and interests' interface with hazard mitigation in Carbon County. Coordination with these organizations and other community planning efforts is vital to the success of this plan's update and implementation. The HMPC determined that data collection, mitigation strategy development, and plan approval would be greatly enhanced by inviting state and federal agencies and power and communications organizations to participate in the process. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities was provided either through invitation to meetings, phone and email communication during the process, or provided an opportunity to review and comment on the plan prior to finalization. The following agencies

were present at HMPC meetings as indicated by an asterisk (*) and/or supplied information to the HMPC that was used to inform the risk assessment:

- Bureau of Land Management*
- District Conservationist - Natural Resources Conservation Service -USDA*

Special Districts

- Joliet Rural Fire District
- Red Lodge Rural Fire District

Non-profit

- Red Lodge Area Community Foundation

Local Business and Industry

- Red Lodge Chamber of Commerce
- Beartooth Billings Clinic

Neighboring Jurisdictions

- Park County, WY
- Big Horn, MT
- Stillwater, MT
- Yellowstone, MT

Integration with Other Community Planning Efforts and Mitigation Activities

Coordination with other community planning efforts is also paramount to the success of this plan. Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability from natural hazards. Carbon County uses a variety of comprehensive planning mechanisms, such as master plans and ordinances, to guide growth and development. Integrating existing planning efforts and mitigation policies and action strategies into this plan establishes a credible and comprehensive plan that ties into and supports other community programs. Table 2-3 below provides a summary of the key existing plans, studies, and reports that were reviewed during the update process. Information on how they informed the update are noted where applicable. Other sources consulted are cited in the appropriate text, and include but are not limited to:

- Hazus-MH
- FEMA NFIP
- U.S. Census data
- National Climate Data Center
- NOAA National Integrated Drought Information Center
- Montana Bureau of Mines and Geology
- Montana Dam Safety Bureau
- National Dam Inventory
- Montana Disability and Health Program
- NOAA Storm Prediction Center
- National Weather Service
- U.S. Forest Service
- Natural Resources Conservation Service
- Farm Service Agency
- Montana Department of Transportation
- U.S. Departments of Transportation
- Gallatin National Forest Avalanche Center

- National Park Service
- U.S. Army Corp of Engineers (CRREL)
- U.S. Geological Survey
- Bureau of Land Management

Table 2-3: Summary of Key Plans, Studies and Reports

Plan, Study, Report Name	How Plan, Study or Report Informed the HMPC
State of Montana Multi-Hazard Mitigation Plan (2018)	Informed past disaster declarations history in the state and county. The state's dam failure vulnerability assessment informed the County's HIRA update. Provided climate change information for the HIRA.
Carbon County 2015 Growth Policy and 2020 Draft Growth Policy	Informed the Community Profile providing background information on "current conditions" in the County and demographic and economic breakdown.
The Impact of Climate Change on Montana's Agricultural Economy (2016) – Montana Farmers Union	Informed climate change impacts in the drought section.
Carbon County Community Wildfire Protection Plan (2013)	Informed various aspects of the wildland fire chapter such as background information on the hazard.
Subsidence Monitoring and Analysis Final Report – Montana Department of Environmental Quality Remediation Division, (2017)	Provided by the HMPC. Used to inform the earth movement/subsidence profile.
2017 Montana Climate Assessment	Informed climate change considerations for all hazards but in particular drought and flood sections.
2016 City of Red Lodge Zoning Map	Provided background information on the City and informed the vulnerability assessment.
Carbon County Emergency Operations Plan – Hazard Specific Annex (2010)	Informed the capability assessment and the hazard profiles in the HIRA.
Carbon County Floodplain Regulations (2016)	Informed the capability assessment and flood section.
Carbon County Historic Preservation Plan	Informed the Community Profile and Asset Summary
Yellowstone River Channel Migration Zone mapping, Final Report (2009) – Custer County Conservation District and Yellowstone River Conservation District Council	Provided background on channel migration zone mapping on the Yellowstone river and the components that go into the mapping process.

Other documents were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment.

Phase 2: Assess Risks

Planning Steps 4 and 5: Identify the Hazards and Assess the Risks

Chapter 3, Hazard Identification and Risk Assessment is the result of a comprehensive effort to identify and document all the hazards that have, or could, impact the planning area. This section was updated to reflect recent hazard events and current assets within the County and jurisdictions. Where data permitted, Geographic Information Systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities. The HMPC conducted a capability assessment update to review and document the planning area's current capabilities to mitigate risk and vulnerability from natural hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC can assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. A more detailed description of the risk assessment process and the results are included in Chapter 3. The capability assessment is included in Chapter 1 Introduction.

Phase 3: Develop the Mitigation Plan

Planning Steps 6 and 7: Set Goals and Review Possible Activities

Wood facilitated a brainstorming and discussion session with the HMPC during their second meeting to update the goals and objectives from the 2013 plan. During the third HMPC meeting Wood facilitated a discussion session with the HMPC around a comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. This included a review of progress on each action identified in the 2013 plan. Some new mitigation actions resulted from this process that were added to the plan in 2019. This process and its results are described in greater detail in Chapter 4.

Planning Step 8: Draft an Action Plan

Based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7, Wood produced a complete first draft of the plan. This complete draft was shared electronically for HMPC review and comment. Other agencies were invited to comment on this draft as well. HMPC and agency comments were integrated into the second draft, which was advertised and distributed to collect public input and comments. Wood integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for the Montana Disaster and Emergency Services (MTDES) and FEMA Region VIII to review and approve, contingent upon final adoption by the governing boards of each participating jurisdiction.

Phase 4: Implement the Plan and Monitor Progress

Planning Step 9: Adopt the Plan

To secure buy-in and officially implement the plan, the plan was adopted by the governing boards of each participating jurisdiction on the dates included in the adoption resolutions in Appendix C.

Planning Step 10: Implement, Evaluate, and Revise the Plan

The HMPC developed and agreed upon an overall strategy for plan implementation and for monitoring and maintaining the plan over time. A discussion on the progress with implementation is included in Chapter 4. Each recommended action includes key descriptors, such as a lead manager and possible funding sources, to help initiate implementation. An overall implementation strategy is described in Chapter 5.

Finally, there are numerous organizations within the Carbon County planning area whose goals and interests' interface with hazard mitigation. Coordination with these other planning efforts, as addressed in Planning Step 3, is paramount to the ongoing success of this plan and mitigation in Carbon County and is addressed further in Chapter 5. An updated overall implementation strategy and maintenance and a strategy for continued public involvement are also included in Chapter 5.

Chapter 3. Hazard Identification and Risk Assessment

DMA Requirement §201.6(c)(2):
[The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Risk, for the purposes of this plan and as defined by FEMA, is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment builds upon the methodology described in the 2013 FEMA Local Mitigation Planning Handbook, which recommends a four-step process for conducting a risk assessment:

1) Describe Hazards
2) Identify Community Assets
3) Analyze Risks
4) Summarize Vulnerability

In essence, the risk assessment evaluates potential loss from hazards by assessing the vulnerability of the county's population, built environment, critical facilities, and other assets. Data collected through this process has been incorporated into the Asset Summary, hazard profiles and vulnerability assessment for each identified hazard.

This risk assessment covers the entire geographical area of Carbon County. Since this plan is a multi-jurisdictional plan, the HMPC was required to evaluate how the hazards and risks vary from jurisdiction to jurisdiction. These differences are noted in this chapter and if no additional data is provided, it should be assumed that the risk and potential impacts to the affected jurisdiction are similar to those described here for the entire Carbon County planning area.

Methodology and Results

Using existing natural hazards data and input gained through planning meetings during both the 2012 HMP and 2019 update, the HMPC agreed upon a list of hazards that could affect Carbon County. The following is a list of hazards profiled in this plan. Only Public Health Emergency is new to the 2019 HMP, while severe weather, hail, thunderstorms, wind and tornado have been combined into Summer Storms

- Avalanche
- Dam Failure
- Drought
- Earthquake

- Earth Movement
- Flood
- **Public Health Emergency**
- Hazardous Materials
- **Summer Storms:** Hail, Severe Thunderstorm, Wind, Tornado
- Winter Storm
- Volcano
- Wildland Fires

The 2019 HMP update included a significant re-evaluation of the hazards with the latest, best available data. Hazards data from the State of Montana Disaster and Emergency Services (MTDES), FEMA, the National Oceanic and Atmospheric Administration, and many other sources were examined to assess the significance of these hazards to the planning area. The update process included a comprehensive, parcel-level risk analysis with GIS where available data permitted. Many new maps and tables were added that capture the potential losses. Also new in 2019 is the addition climate change considerations, which were added to each hazard profile and taken into consideration in the vulnerability assessments for the natural hazards.

Carbon County is susceptible to a number of hazards; this HMP profiles the most significant of these hazards. Historical data, catastrophic potential, relevance to the jurisdiction, and the probability and potential magnitude of future occurrences were all used to reduce and prioritize the list of hazards to those most relevant to Carbon County.

Overall Hazard Significance Summary

Overall hazard significance was based on a combination of Geographic Area, Probability of Future Occurrence and Potential Magnitude/Severity as defined below. The individual ratings are based on or interpolated from the analysis of the hazards in the sections that follow. During the 2019 Carbon County HMP update the individual ratings and significance of the hazards was revisited and updated. Public concern was also considered through the use of an online survey.

Table 3-1 Carbon County Hazard Significance

Hazard	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Avalanche	Limited	Likely	Limited	Medium
Dam Failure	Significant	Unlikely	Limited	Medium
Drought	Extensive	Likely	Critical	High
Earthquake	Significant	Occasional	Limited	Medium
Earth Movement	Limited	Occasional	Limited	Medium
Flood	Significant	Likely	Limited	High
Summer Storm: (Hail, Severe Thunderstorm, Wind, Tornado)	Extensive	Highly Likely	Limited	Medium
Winter Storm	Extensive	Highly Likely	Limited	Medium
Volcano	Extensive	Unlikely	Catastrophic	Low
Wildland Fires	Significant	Likely	Critical	High
Hazardous Materials	Limited	Likely	Negligible	Low
Public Health Emergency	Extensive	Occasional	Catastrophic	Medium

Geographic Area
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

Magnitude/Severity (Extent)
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

Disaster Declaration History

One method the HMPC used to identify hazards was the researching of past events that triggered federal and/or state emergency or disaster declarations in the planning area. Federal and/or state disaster declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors.

Based on the disaster declaration history provided in the table below, Carbon County is among the many areas in Montana susceptible to disaster. Details on federal disaster declarations were obtained by the HMPC from FEMA, USDA and Montana Disaster and Emergency Services and compiled in chronological order in Table 3-2. A review of federal declared disasters indicates that in the past 40 years (1978-2018) Carbon County has received 35 disaster declarations. Of these, 5 were Governor's proclamations, 1 was a Federal emergency declaration, 4 were for major disaster declarations, 1 for a fire suppression order, 1 for a small business administration declaration, and finally 22 were USDA Selectorial Declarations. Drought events have received 10 disaster declarations and was the most common hazard to receive a declaration followed by wildfire which has received 6 declarations. Other declarations included 2 disaster declarations as a result of severe storms, 1 as a result of flooding, and 1 for a wildfire event.

Since 1998, there have been 22 disaster declarations issued by the Secretary of Agriculture for Carbon County related to drought, wildfires, freeze, hail, high winds or the combined effects of multiple hazards. Of the declarations related to drought 9 were Fast Track Secretarial disaster designations. According to the Secretary of Agriculture, a Fast Track designation is for a severe drought and provides an automatic designation when during the growing season any portion of the county meets the severe drought intensity value for eight consecutive weeks. Refer to the Drought hazard profile for more information of Disaster Declarations from the Secretary of Agriculture related to drought events.

This disaster history (combined federal and state) suggests that Carbon County experiences a major event worthy of disaster declaration every 2 years. The County has an 85 percent chance of receiving a disaster declaration in any given year. With the exception of the declarations for wildfire and drought, every declaration resulted directly or indirectly from severe weather. Further, a review of these events helps Carbon County and its jurisdictions identify risk reduction targets and ways to improve capabilities to avoid large-scale hazard events in the future.

Table 3-2 Carbon County Disaster Declarations, 1953-2018

Event/ Hazard	Date	Disaster #	Declaration Type
Severe Storms & Flooding	5/29/1978	DR-558	Presidential – Major Disaster Declaration
Drought Emergency	6/1992	EO 13-92	Executive Order
Severe Storms, Ice Jams, Snow Melt	7/25/1997	DR-1183	Presidential – Major Disaster Declaration
Drought	11/24/1998	S1269	Secretarial Disaster Designation
Drought, Wildfire	9/22/1999	S1354	Secretarial Disaster Designation
Wildland Fires	7/27/2000	EO 18-00	Executive Order
Wildland Fires	8/16/2000	EO 20-00	Executive Order
Willie Fire	8/28/2000	FS-232	Fire Suppression Authorization
Wildfire	8/30/2000	DR-1340	Presidential – Major Disaster Declaration
Drought	1/11/2001	S1468	Secretarial Disaster Designation
Drought	5/29/2001	S1538	Secretarial Disaster Designation
Drought, Wildfires	11/1/2001	S1579	Secretarial Disaster Designation
Drought	3/27/2002	S1624	Secretarial Disaster Designation

Event/ Hazard	Date	Disaster #	Declaration Type
Wildland Fires	7/18/2003	EO 14-03	Executive Order
Drought	9/7/2004	S1951	Secretarial Disaster Designation
Drought	10/28/2004	S1972	Secretarial Disaster Designation
Hurricane Katrina Evacuation	9/13/2005	EM-3253	Emergency Declaration
Beartooth Highway Landslide	5/27/2005	SBA #10130	Small Business Administration Declaration
Wildfire	8/21/2006	EO 39-06	Executive Order
Drought	10/10/2006	S2406	Secretarial Disaster Designation
Combined effects of Excessive Heat, High Winds, Drought, Wildfires, and Freezes	8/15/2012	S3350	Secretarial Disaster Designation
Drought – FAST TRACK	8/29/2012	S3365	Secretarial Disaster Designation
Drought – FAST Track	9/12/2012	S3391	Secretarial Disaster Designation
Drought - FAST TRACK	4/10/2013	S3508	Secretarial Disaster Designation
Drought – FAST TRACK	5/8/2013	S3521	Secretarial Disaster Designation
Hail, High Winds, Severe Storms	8/28/2013	S3579	Secretarial Disaster Designation
Freeze	12/17/2014	S3778	Secretarial Disaster Designation
Drought – FAST TRACK	6/2/2016	S3982	Secretarial Disaster Designation
Drought – FAST TRACK	10/5/2016	S4066	Secretarial Disaster Designation
Drought – FAST TRACK	10/5/2016	S4070	Secretarial Disaster Designation
Drought – FAST TRACK	8/25/2017	S4210	Secretarial Disaster Designation
Drought – FAST TRACK	9/11/2017	S4217	Secretarial Disaster Designation
Drought	4/1/17	EO 11-17	Executive Order
Hail Storm and High Winds	9/17/2018	S4396	Secretarial Disaster Designation
Flooding	10/31/2018	DR-4405	Presidential – Major Disaster Declaration

Source: FEMA, 2018 State of Montana Hazard Mitigation Plan

Overview of Hazard Identification and Risk Assessment

The following hazard profiles cover all-natural hazards identified at the first Hazard Mitigation Planning Committee (HMPC) meeting regardless of the priority they were assigned. Each hazard profiled begins with a description of the hazard and associated issues followed by details on the hazard specific to the Carbon County planning area. As well as a spatial description of the potential location or areas of the County where the hazard is expected to impact. Each hazard profiled also includes the following subsections:

- Hazard/Problem Definition—This section gives a description of the hazard in question and associated issues followed by details on the hazard specific to the Carbon County Planning Area.

- Geographic Area – This section gives a spatial description of the potential location or areas of Carbon County where the hazard expected to have an impact or generally occur, as well as across any of its five incorporated jurisdictions (if applicable): Town of Bearcreek, Town of Bridger, Town of Fromberg, Town of Joliet, and City of Red Lodge.
- Extent (Magnitude/Severity)– This section gives a description of the potential strength or magnitude of the hazard as it pertains to Carbon County.
- Historic Occurrences—This section contains information on historical incidents, including impacts where known. Historical incident worksheets were used to capture information from participating jurisdictions on past occurrences.
- Likelihood of Future Occurrence—The frequency of past events is used in this section to gauge the likelihood of future occurrences. Where possible, frequency was calculated based on existing data. It was determined by dividing the number of events observed by the number of years on record and multiplying by 100. This gives the percent chance of an event happening in any given year (e.g., three droughts over a 30-year period equates to a 10 percent chance of a drought in any given year). The likelihood of future occurrences is categorized into one of the following classifications:
  - Highly Likely—Near 100 percent chance of occurrence in next year or happens every year.
  - Likely—Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
  - Occasional—Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
  - Unlikely—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.
- Climate Change Considerations - This section describes the potential for climate change to affect the frequency and intensity of the hazard in the future
- Vulnerability - A vulnerability assessment was conducted for each identified hazard. The assessment was conducted through the study of potential impacts to the following specific sectors:
  - People
  - Economy
  - Built Environment
  - Critical Facilities and Infrastructure
  - Historic, Cultural and Natural Resources
  - Future Development
  - Risk Summary - Each vulnerability assessment includes a risk summary of the key issues/problems based on threat, vulnerability and consequence to the planning area and jurisdictions from the specific hazard.

Assets Summary

Methodology

The vulnerability assessments throughout the HIRA portion of the plan attempts to quantify assets at risk, by jurisdiction where possible, to further define populations, properties, critical facilities, and other

important assets at risk to hazards identified throughout this plan. The methods of analysis vary by hazard type and data available, and it begins with an inventory of people and buildings (in terms of total assets exposed) in the County to provide a baseline for evaluating vulnerabilities by hazard.

Data to support the vulnerability assessment was collected and compiled from the following sources:

- GIS data (spatial data such as hazard threats, base layers like hydrology, boundaries, roads, etc., Carbon County's assessor data)
- Written descriptions of inventory and risks provided by participating jurisdictions and the HMPC
- Existing plans, studies, and reports with relevant information
- Input from the hazard mitigation planning committee and stakeholders

Property Assets and Parcel Exposure Values

Parcel data with value attributes was pulled from the Carbon County Assessor's Office and provided in geospatial format by the County's Disaster & Emergency Services Department (DES). This data should only be used as a guideline to estimate overall values in the County's property assets, as the information has some limitations due to continuous internal updating by the county as well as the nature of the analysis being performed.

Carbon County categorizes their parcels according to land use, using 16 property type categories. The categories are represented in Table 3-3 which shows the original category of the particular parcel alongside a "simplified" version of the parcel type, performed in order to arrive at more standardized, comparable, and aggregated parcel summaries. It is important to note that, in the event of a disaster, it is generally the value of the infrastructure or improvements to the parcel that is of concern and at risk. Generally, the land itself is not a loss, which is why land value is excluded from this table and only those imprved parcels are pulled into the parcels assets being assessed.

NOTE: The V601 Structure Values were assumed to correspond to improved values within parcels. Parcels with a vacant use code description as well as 0 building/structure counts and a $0 structure value (i.e. not improved) were queried and assigned a type of "vacant" parcel, to be distinguishable between those that may be presently vacant (in terms of their current type) but do have improvements to them due to valuations of $1 or more.

In Table 3-4 parcel totals and exposure values were estimated for the entire county and its jurisdictions in order to obtain an estimated number of total parcels and their values potentially at risk of the hazards being described and assessed in this Plan. To arrive at the total values, the following methodology was followed using GIS analysis with the parcel data and improved structure values, obtained from Carbon County's Disaster & Emergency Service and GIS department. (Note that improvement values are the values of the developments, or improvements, to a parcel and its properties based on enhancements outside of those solely tied to the land or structural value.) First, the parcel polygons layer was cleaned up to have the right-of-way and other non-valued and vacant parcels removed, again to only leave those categorized and improved (or exempt/government owned) parcels used in the remainder of the analysis.

Once the parcel layer contained all those property types and valuations that were useful for hazard overlay and risk assessments, parcel centroids were generated as single points to intersect with hazard layers. For context, hazard overlay assessments in GIS help determine the number, type, and improvement values of the parcels found within those threat or hazard layers (by accounting for what is either in or outside of a hazard layer), but each hazard's vulnerability and risk assessments will be described in more detail in each of the profile chapters.

Once all parcels were converted to centroids (i.e. points) then the number of those parcels with improved structure values were summarized by parcel type (based on the classifications in Table 3-3), and content values were calculated by applying the following formulas based on FEMA guidelines: a) commercial, agricultural, and farmstead parcels were given content values worth 100% of the improvement values; b) Industrial parcels were given content values worth 150% of their improvement values; and, c) residential structures (i.e. manufactured homes, multi-family, and improved property parcels) were given content values worth 50% of the improvement values. Golf course and Vacant parcels were not given any content values. Then, total values were computed by adding (totaling) both improvement values and the content values just generated. These total values are shown in the last column of Table 3-4 and represent the total exposure values across the county and its incoroporated jurisdictions.

Table 3-3 Simplified Property Types Based on Carbon County Parcel Data

Original Parcel Type Description	Simplified Parcel Type Description
Apartment Rural	Multi-Family
Apartment Urban	
Condominium Urban	
Townhouse Urban	
Agricultural Rural	Agricultural
Commercial Urban	Commercial
Exempt Property	Exempt
Partial Exempt Property	
Farmstead - Rural	Farmstead
Farmstead Rural	
Golf Course	Golf Course
Gravel Pit	Industrial
Industrial Rural	
Improved Property - Rural	Improved Property
Improved Property - Urban	
Manufactured Home Park - Rural	Manufactured Home
Manufactured Home Park - Urban	
Vacant Land - Rural	Vacant
Vacant Land - Urban	
Vacant Land Urban	

Table 3-4 Total Exposure Values in Carbon County by Jurisdiction and Parcel Type (Improved Parcels Only)

Jurisdiction	Parcel Type	Parcel Count	Improved Value	Content Value	Total Value
Bearcreek	Exempt	21	$153,920	--	$153,920
	Improved Property	63	$5,511,197	$2,755,599	$8,266,796
	Vacant	2	$34,400	--	$34,400
TOTAL		**86**	**$5,699,517**	**$2,755,599**	**$8,455,116**
Bridger	Exempt	42	$7,800,928	--	$7,800,928
	Improved Property	337	$31,692,185	$15,846,093	$47,538,278
	Manufactured Home	4	$137,097	$68,549	$205,646
TOTAL		**383**	**$39,630,210**	**$15,914,641**	**$55,544,851**
Fromberg	Exempt	30	$4,107,660	--	$4,107,660
	Farmstead	1	$520	$520	$1,040
	Improved Property	202	$13,446,185	$6,723,093	$20,169,278
	Manufactured Home	2	$87,024	$43,512	$130,536
	Vacant	1	$132,700	--	$132,700
TOTAL		**236**	**$17,774,089**	**$6,767,125**	**$24,541,214**
Joliet	Commercial	1	$51,310	$51,310	$102,620
	Exempt	24	$9,484,292	--	$9,484,292
	Improved Property	249	$25,794,308	$12,897,154	$38,691,462
	Manufactured Home	3	$139,167	$69,584	$208,751
	Multi-Family	2	$632,784	$316,392	$949,176
TOTAL		**279**	**$36,101,861**	**$13,334,440**	**$49,436,301**
Red Lodge	Exempt	108	$32,490,904	--	$32,490,904
	Golf Course	6	$2,856,480	--	$2,856,480
	Improved Property	1,349	$269,836,660	$134,918,330	$404,754,990
	Multi-Family	29	$8,082,419	$4,041,210	$12,123,629
TOTAL		**1,492**	**$313,266,463**	**$138,959,540**	**$452,226,003**
Unincorporated	Agricultural	1	$2,320	$2,320	$4,640
	Exempt	1,552	$13,387,670	--	$13,387,670
	Farmstead	928	$189,821,343	$189,821,343	$379,642,686
	Improved Property	2,784	$667,741,953	$333,870,977	$1,001,612,930
	Industrial	5	$10,758,110	$16,137,165	$26,895,275
	Manufactured Home	10	$1,762,199	$881,100	$2,643,299
	Multi-Family	1	$53,250	$26,625	$79,875
	Vacant	25	$4,536,124	--	$4,536,124
TOTAL		**5,306**	**$888,062,969**	**$540,739,529**	**$1,428,802,498**
GRAND TOTAL		**7,782**	**$1,300,535,109**	**$718,470,872**	**$2,019,005,981**

Source: Carbon County Assessor's Office, Wood Plc

Critical Facilities and Infrastructure

The following section discusses critical facilities, infrastructure, and property assets (based on parcel data) around Carbon County.

For the purposes of this plan, a critical facility (CF) is defined as one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Carbon County uses the following four categories to describe critical assets:

- **Emergency Services –** Facilities or centers aimed at providing for the health and welfare of the whole population (e.g., hospitals, police, fire stations, emergency operations centers, evacuation shelters, schools, government facilities/buildings).

- **Lifeline Utility Systems –** Facilities and structures such as potable water, wastewater, oil, natural gas, electric power, sewer treatment facilities, or communications systems.
- **High Potential Loss Facilities –** These include nuclear power plants, dams, and levees.
- **Transportation Systems or Other/Miscellaneous–** These include railways, highways, waterways, airways and general transportations systems which enable effective movement of services, goods and people. In addition, miscellaneous facilities or those without well-defined classifications (i.e. those labeled as "Other") are also summarized under this section/category.

Figure 3-1 Location of Critical Facilities in Carbon County displays the location of various critical facilities across the County, differentiated by the four categories described above. These facilities are summarized in Table 3-5, Table 3-6, Table 3-7, and Table 3-8 to include the County's 171 critical facilities by category, type and jurisdiction totals. The unincorporated portions of Carbon County contain the largest number of the facilities, followed by the City of Red Lodge, Town of Joliet, Town of Bridger, Town of Fromberg, and Town of Bearcreek. A total of 86 critical facilities are classified under the Emergency Services category, 22 are High Potential Loss Facilities, 54 are Lifeline Utility Systems, and 27 fall under the Transportation System or Other/Miscellaneous type.

Figure 3-1 Location of Critical Facilities in Carbon County

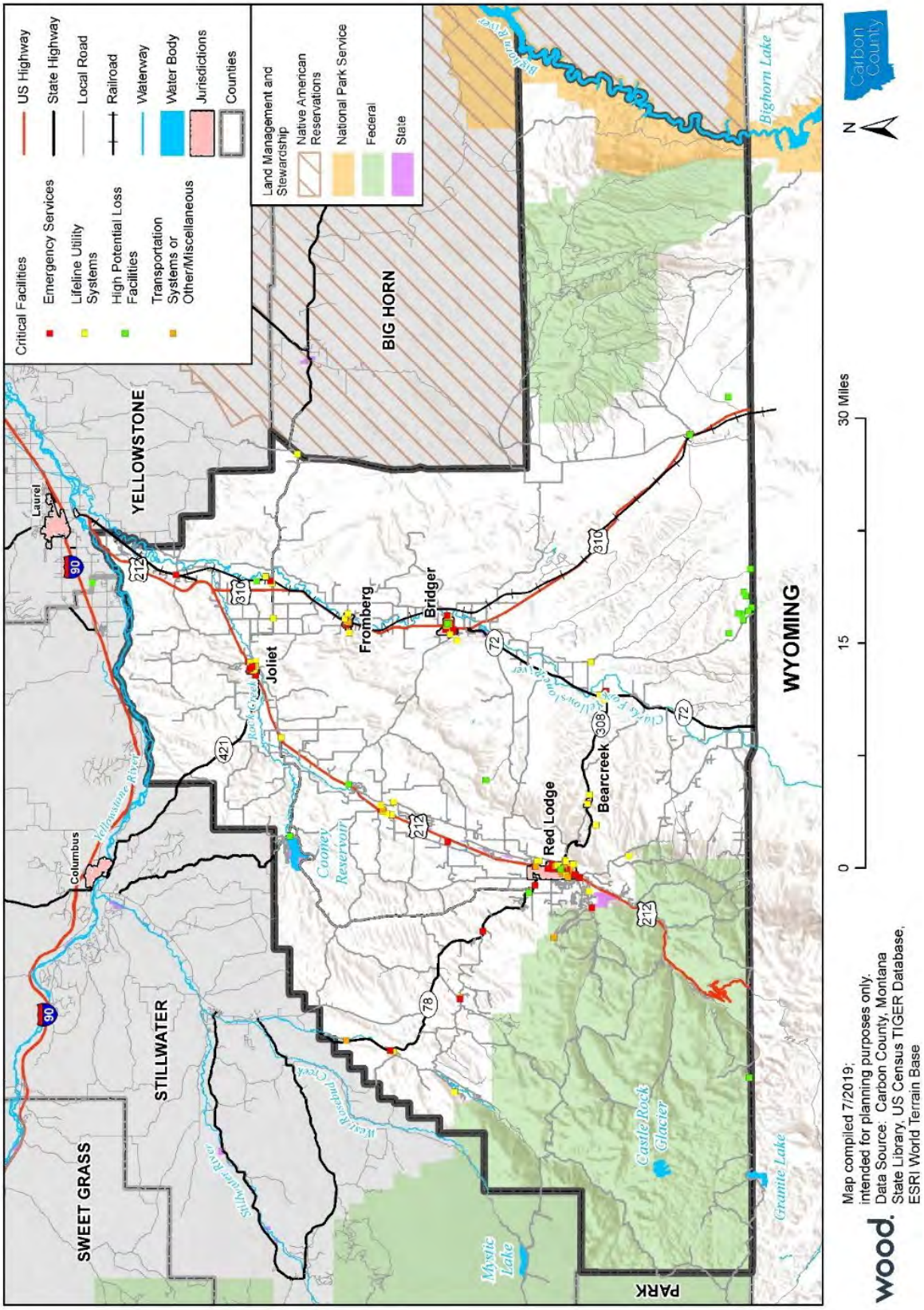


Table 3-5 Critical Facilities and Infrastructure Types in Carbon County

Emergency Services	Lifeline Utility Systems	Transportation Systems or Other/Miscellaneous	High Potential Loss Facilities
Animal Care/Shelter	Communications/Utilities Facility	Airport	Dams
Community Center	Electric Substation	Miscellaneous/Other	Hazardous Materials (HazMat) Facilities
Elementary School	Energy Facility	Religious Institution	
Emergency Medical Service (EMS) Station	Post Office		
Fire Station	Radio Tower		
Government/Administrative	Sewer Lagoon		
Government/Law Enforcement	Sewer Treatment Facility		
High School	Water Pump Facility		
K-12 School	Water Tank		
Medical Clinic	Water Tower		
School	Water Treatment Facility		
Senior Center	Water Well		
Sheriff's Office			

Source: Carbon County Disaster & Emergency Services/GIS, 2019

Table 3-6 Critical Facility Summary by Jurisdiction and Category

Jurisdiction	Critical Facility Type	Total Critical Facilities
Bearcreek	Emergency Services	2
	Lifeline Utility Systems	1
Bridger	Emergency Services	11
	High Potential Loss Facilities	2
	Lifeline Utility Systems	4
	Transportation Systems or Other/Miscellaneous	2
Fromberg	Emergency Services	6
	Lifeline Utility Systems	5
	Transportation Systems or Other/ Miscellaneous	3
Joliet	Emergency Services	9
	Lifeline Utility Systems	7
	Transportation Systems or Other/ Miscellaneous	4
Red Lodge	Emergency Services	18
	High Potential Loss Facilities	1
	Lifeline Utility Systems	5
	Transportation Systems or Other/ Miscellaneous	12
Unincorporated	Emergency Services	22
	High Potential Loss Facilities	19
	Lifeline Utility Systems	32
	Transportation Systems or Other/ Miscellaneous	6
TOTAL		**171**

Source: Carbon County Disaster & Emergency Services/GIS, 2019

Table 3-7 Critical Facility Summary by Type and Category

Critical Facility Type	Critical Facility Category	Total Critical Facilities
Emergency Services	Animal Care/Shelter	1
	Community Center	5
	Elementary School	4
	Emergency Medical Service Station	1
	Fire Station	10
	Government/Administrative	23
	Government/Law Enforcement	4
	High School	4
	K-12 School	1
	Medical Clinic	3
	School	7
	Senior Center	4
	Sheriff's Office	1
TOTAL		**68**
High Potential Loss Facilities	Dam	2
	HazMat Facility	20
TOTAL		**22**
Lifeline Utility Systems	Communications/Utilities Facility	13
	Electric Substation	1
	Energy Facility	3
	Post Office	10
	Radio Tower	1
	Sewer Lagoon	8
	Sewer Treatment Facility	1
	Water Pump Facility	1
	Water Tank	3
	Water Tower	3
	Water Treatment Facility	3
	Water Well	7
TOTAL		54
Transportation Systems or Other/Miscellaneous	Airport	2
	Miscellaneous/Other	13
	Religious Institution	12
TOTAL		**27**
GRAND TOTAL		**171**

Source: Carbon County Disaster & Emergency Services/GIS, 2019

Table 3-8 Critical Facility Summary by Jurisdiction

Jurisdiction	Total Critical Facilities
Bearcreek	3
Bridger	19
Fromberg	14
Joliet	20
Red Lodge	36
Unincorporated	79
TOTAL	**171**

Source: Carbon County Disaster & Emergency Services/GIS, 2019

Natural Assets and Historic/Cultural Resources

Natural resources are important for protection from hazards, and they also can help mitigate hazards. For instance, protecting wetlands areas protects sensitive habitat as well as attenuates and stores floodwaters. The County's natural, cultural, and historical assets in addition to the overall tourism activities, provide the economic lifeblood of the county. As such their vulnerability to natural and human-caused hazards are of great concern for the planning committee. A significant fire event, for example, would not only have huge implications on the landscape, watersheds, and fisheries; it would also have a tremendous economic impact on the county through the loss of visitor revenues or via impacting the other key econimc sectors discussed in the sections that follow. For more specifics on how each individual hazard has affected (or has the potential to affect) natural, historic, cultural, and economic assets in Carbon County please refer to vulnerability assessment for each of the identified hazards.

Carbon County's fauna, flora, spectacular views, and natural assets draw visitors from around the world every year. The county was founded in 1895 after aquiring portions of Park and Yellowstone Counties. There are public lands in the Beartooth Mountains on the west side of the county as well as in the Pryor Mountains to the east, and in the south central areas. Many National Forest lands in the western portions of the county abut private lands.

Many tourists visit the planning area seeking spectacular vistas such as those available from Beartooth Highway, within the Custer Gallatin National Forest. Both locals and visitors enjoy outdoor activities such as camping, hiking, wildlife viewing, hunting, skiing, snowshoeing, and golfing. Carbon County also provides a gateway to the northeast entrance of Yellowstone National Park, drawing tourists passing through on their way to this national landmark.

Wetlands are another important natural asset to the County that provide support to an incredible amount of biodiversity and provide natural flood protection through the storing of floodwaters and maintiaining surface water flows during dry period. Wetlands are also vulnerable to many of the identified hazards in this plan as well as impacts from human activities such as mining, construction of reservoirs, water diversions, agriculture, grazing, and general community development.

Valuable mineral deposits brought early settlers to this area (per the county's name, which came from the abundant amounts of coal in the area), and these continue to be an important natural resource for the community. For more information on the County's assets, economy, and main employment industries refer to the Economic Assets section of this chapter.

Endangered and Threatened Species

To further understand natural resources that may be vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities and development efforts, it is important to take into account identified at-risk species (threatened and endangered species) in the planning area. A

threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. An endangered species is any species of plant life or wildlife (birds, fish, mammals, etc.) that is in danger of extinction throughout all or most of its range. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. Candidate species are plants and animals that have been proposed as endangered or threatened but are not currently listed.

According to the U.S. Fish and Wildlife Service there are six Federally endangered, threatened, recovering, or candidate species that may roam around or have its habitat in Carbon County.

Table 3-9 Endangered and Threatened Species in Carbon County

Species Group	Common Name	Scientific Name	Species Protection Status
Birds	Bald eagle	Haliaeetus leucocephalus	Recovery
Conifers and Cycads	Whitebark pine	Pinus albicaulis	Candidate
Mammals	Grizzly bear	Ursus arctos horribilis	Threatened/Under Review
	Gray wolf	Canis lupus	Recovery
	Canada Lynx	Lynx canadensis	Threatened
	North American wolverine	Gulo luscus	Proposed Threatened

Source: U.S. Fish & Wildlife Service, Environmental Conservation Online System, Species by County Report

Historic and Cultural Resources

There are many important historic and cultural resources within Carbon County. A historic property not only includes buildings or other types of structures such as bridges and dams but can also refer to prehistoric or Native American sites, roads, byways, historic landscapes, and cultural points of interest. Given the history of the County, these types of historic properties exist throughout the planning area; some are inventoried and listed in this plan.

Historic properties and cultural resources are also valuable economic assets that increase property values and attract businesses and tourists. Preservation of these historic and cultural assets is often an important catalyst for economic development (e.g., historic downtown revitalization programs leading to growth in heritage tourism).

Information about historic assets in Carbon County came from the HMPC, the County's Growth Policy document, adopted in 2015, and the National Park Service's National Register of Historic Places, described in more detail below.

National Register of Historic Places: The Nation's official list of cultural resources worthy of preservation. The National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. Properties listed include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.

Table 3-10 lists the properties and cultural resources in Carbon County that are on the National Register of Historic Places.

Table 3-10 Historic and Cultural Properties in Carbon County

City	Property Name	Location	Listing Date
Bearcreek	Bearcreek Bank	Main and Second Sts.	3/31/2004
	Bearcreek Cemetery	One Mile east of Bearcreek	1/18/2011
	Smith Mine Historic District	West of Bearcreek on Hwy 308	9/30/2009
Belfry	Kose Hall	216 Broadway Ave.	4/9/13
	Montana, Wyoming & Southern RR Depot	403 Broadway Ave.,	10/3/2012
Bridger	Bridger Opera House	E. Broadway	9/15/1987
	Corey House	106 N. E St.	7/21/1987
	Demijohn Flat Archeological District	Address Restricted	11/20/1974
	Gebo, Henry, House	E of Bridger	7/21/1987
	Glidden House	112 N. E St	7/21/1987
	Glidden Mercantile	02 N. Main	9/15/1987
	Heatherington Boarding House	209 E. Broadway	9/15/1987
	Marcus Dr. Carl House	210 S. Second	9/15/1987
	Methodist Episcopal Church and Parsonage	220 W. Broadway	9/15/1987
	Nutting Rental	Carbon Ave.	9/15/1987
	Wool Warehouse	E. Bridger	7/21/1987
	Bridger Coal Company House	307 W. Broadway	9/15/1987
	Forsman House	406 E. Carbon Ave	7/21/1987
	Hough, Raymond House	312 S. Second	9/15/1987
Dead Hill	Lockhart Caroline Ranch	Davis Creek 70 mi. S. of Hardin	11/3/1989
Dryhead	Ewing-Snell Ranch	S of Dryhead	5/12/1977
Fromberg	Baldwin Building	Jct. of W. River St. and Harley Ave	1/28/1993
	Blewett John, House	2411 E. River St.	1/28/1993
	Fromberg Concrete Arch Bridge	River St. over the Clarks Fork of the Yellowstone River	1/28/1993
	Fromberg High School	Kids Ct	1/28/1993
	Fromberg Methodist-Episcopal Church,	Jct. of N. Montana Ave. and School St	1/28/1993
	Fromberg Opera House	Jct. of Harley Ave. and C St	1/28/1993
	Gibson, John House	219 W. River St	1/28/1993
	IOOF Hall and Fromberg Co-operative Mercantile Building	123 W. River St	1/28/1993
	McCall Tracy House	110 N. Montana Ave	1/28/1993
	Northern Pacific Railroad Depot	Fromberg Jct. of U.S. 310 and River St.	1/28/1993
	Rahrer, Francis, House	309 School St	1/28/1993
	Suydam, Hester E, Boarding House	209 W. River St.	1/28/1993
	Benson Dr. Theodore J.House	10 N. Montana	1/28/1993
	Brooder Frank House	303 North St	1/28/1993
	Greenblatt Samuel House	215 W. River St.	1/28/1993
Fromberg vicinity	Bluewater Creek Bridge	Milepost 8 on Bluewater Cr. Rd	4/28/2011
	Gebo Barn	2.5 mi. S. of Fromberg on River Rd.	6/1/2005
Gebo vicinity	Gebo Cemetery	County Rd. linking Gebo and Fromberg	4/8/1993
Hardin	Pretty Creek Archaeological Site	Address Restricted	1/17/1975

City	Property Name	Location	Listing Date
Hillsboro	Cedarvale	The present town of Hillsboro and its environs in Bighorn Canyon National Recreation Area	8/19/1975
Joliet	Baker and Lovering Store	Main St. Joliet	5/2/1986
	House on Railroad Avenue	Railroad Ave.	5/2/1986
	Joliet Bridge	carries Main St. over Rock Creek,	5/2/1986
	Joliet Fire Hall	Main St	5/2/1986
	Joliet High School	Main St.	5/2/1986
	Joliet Residential Historic District	Roughly bounded by Northern Pacific RR and US State St. Carbon Ave. & Second St.	5/2/1986
	Rock Creek State Bank	Main St	5/2/1986
	Smith, T. W. House	Front St	5/2/1986
	Southern Hotel	Main St	5/2/1986
Red Lodge	Camp Senia Historic District	Custer National Forest	4/4/1988
	Hi Bug Historic District	Roughly bounded by W Third St. N. Villard Ave., W. Eight St., and N. Word Ave	7/23/1986
	Kent Dairy Round Barn	US 212, 2 mi. N. of Red Lodge	4/7/1995
	Red Lodge Brewing Company/Red Lodge Canning Company	904 N. Bonner Street	9/5/07
	Red Lodge Commercial Historic District (Boundary Increase)	S Broadway between Eighth and Fifteenth Sts.	8/28/1986
	Yodeler Motel	601 South Broadway Avenue	3/26/2014
	Calvary Episcopal Church	9 N. Villard Ave	10/23/1986
	Warila Boarding House and Sauna	20 N Haggin	10/24/1985
Red Lodge Vicinity	Camp Senia Historic District Boundary Increase and Addendum	Custer National Forest	8/10/2015
	Red Lodge Communal Mausoleum	Montana HWY 78	3/21/2011
	Red Lodge--Cooke City Approach Road Historic District	US 212	5/8/2014
	Rock Creek Ranger Station Historic District	Custer National Forest, Beartooth Ranger District	10/17/2016
Roberts vicinity	Kero Farmstead Historic District	223 West Bench Road	8/16/07
Warren	Bad Pass Trail	E of Warren along Big Horn River in Bighorn Canyon National Recreation Area	10/29/1975
	Petroglyph Canyon	Address Restricted	11/20/1975

Source: The National Park Service National Register of Historic Places, 2019

Economic Assets

Every community has specific economic drivers that are important to understand when planning to reduce the impacts of hazards and disasters to the local economy. Economic assets can be described in terms of direct or indirect losses; for example, building or inventory damage is direct, but functional downtime and loss of employment wages are indirect losses that can be calculated. The following details have been gathered from sources such as the Carbon County Growth Policy document from 2015, the U.S. Census Bureau, Headwaters Economics socioeconomic and demographic reports, and HMPC input.

The economic sectors in Carbon County and its jurisdictions include tourism and travel sectors, agriculture, mining and extraction, timber industry, non-labor income (e.g. government transfer payments, investment and retirement income, rental properties), and government. Carbon County's primary occupations and industries are: management, professional and related; services; sales and office; production and transportation; construction, extraction, maintenance and repair; and, farming, fishing, and forestry. Education, health care, and social assistance programs employ about 20% of the total county population, while agriculture, forestry, fishing, hunting, and mining employ 14.4%. Retail trade jobs are fulfilled by a 10.8% of the county's population.

The economy has been shifting away from agriculture, manufacturing and retail into the professional, financial and management sectors. The largest private employers in the county, not accounting for government or tribal employers, are: Beartooth Billings Clinic, Red Lodge Mountain Resort, Pollard Hotel, Red Lodge Pizza Company, Rock Creek Resort, Bank of Bridger, Beartooth Food Farm, Beartooth Industries, Cedar Wood Villa, and Town & County Supply. Direct loss of these major private employers as well as schools, medical center, County, or Town offices, tourist destinations such as hotels or resort facilities, or other such economic drivers in the county would have severe impacts on the County's ability to recover from a disaster or conduct economic activities as usual, hence affecting the county's way of life.

As noted in the sections above, many of the County and Town or City facilities, buildings, and points of interest are of historic and cultural importance. Direct or indirect losses of these structures and businesses would have an impact on the area's economy due to potential reduction in tourism or to related industries and major employers.

Carbon County's spectacular natural scenery is a major asset to the communities, hence why the tourism-based economy is of critical to the County. Many of the County's natural treasures that draw visitors are highly vulnerable to the effects of natural hazards such as flooding, avalanches, earth movement issues, and wildfire. Impacts to natural assets could result in reduced tourism related revenues and associated employment as well.

Development and Population Trends

As part of the planning process, the HMPC looked at growth and development trends in Carbon County. These trends are examined further in the context of each significant hazard, and how the changes in growth and development can affect loss estimates and overall vulnerability of property and populations.

The County has seen fluctuations in populations throughout its history. An initial surge of population in the 19th century and early 20th century was caused by prospectors and miners descending on the area. Based on past population trends, it is probable that growth rates will fluctuate during the next 20 years. However, periods of slow growth or negative growth (i.e. population losses) could be sustained if the state and national economies stagnate, resulting in fewer newcomers and second homebuyers. The HMPC noted that rural residential development has seen an increase in the last 5 years, and more development along the U.S. Highway 310 corridor, Red Lodge, and Joliet areas is also expected to continue in the near future (particularly dry/irrigated pasture areas with some potentially in mapped floodplains). The HMPC also mentioned that there is the potential that a County jail may be built in the next few years, though more details on this prospect are currently unavailable.

With regards to commuting trends, most people living in Carbon County actually travel elsewhere for jobs, so that the top work destination for workers living in the county is Billings, MT. The average commuting time is 27.5 minutes based on the 2013-2017 ACS figures from the U.S. Census Bureau. Based on these census metrics, in addition, there were over 400 employer establishments total in the county, and the median household income (based on 2017 dollars) was $56,988. Around 9.4% of the county population was deemed to live in poverty as of 2017. An estimated 10% of the population reported

having a disability (for those under 65 years of age), while 11.7% of the population lived without health insurance (also for those under 65 years of age).

Table 3-11 below summarizes the population change for Carbon County by comparing the total population in each of the years between 2010 and 2018. Table 3-12 summarizes the same type of population change information but this time broken down by each of the incorporated jurisdictions in Carbon County.

Table 3-11 Population Change in Carbon County in Recent Years (2010-2018)

Year	Total Population	Change
2010	10,062	--
2011	10,090	0.28%
2012	10,135	0.45%
2013	10,324	1.86%
2014	10,423	0.96%
2015	10,389	-0.33%
2016	10,498	1.05%
2017	10,696	1.89%
2018	10,714	0.17%

Source: Montana Department of Commerce, U.S. Census Bureau 2019

Table 3-12 Population Change in Carbon County's Jurisdictions in Recent Years (2010-2018)

Location	2010 Population	2018 Population	Overall Percent Change
Bearcreek	77	82	6.49%
Bridger	707	754	6.65%
Fromberg	439	462	5.24%
Joliet	584	656	12.33%
Red Lodge	2,125	2,294	7.95%
Carbon County, MT	10,062	10,714	6.48%

Source: Montana Department of Commerce, U.S. Census Bureau 2019

The HMPC also noted that future development and redevelopment needs to take safety into consideration as well as historic preservation considerations. Carbon County's first Historic Preservation Plan was prepared back in 1987 to conform with 36 CFR 6177 guidelines set for State Preservation Plans. This document continues to be relevant in Carbon County's development strategies and other planning mechanisms especially as related to hazard assessments and considerations.

Based on Carbon County's population change trends in the last 8 or so years, which show a 6.3% change, it is expected that population may continue to grow slowly but steadily in the next decade.

Vulnerable Populations

The U.S. Census Bureau statistics point out certain vulnerable populations in Carbon County. A few vulnerable population groups are summarized in Table 3-13 below, and these vulnerable populations are addressed in more detail in the Carbon County Growth Policy document from 2015, among other planning mechanisms.

In addition, the HMPC has noted that 25% or more of the County's population is aging, meaning they are aged 65 and over. This is important to note because of the implications associated with warning, evacuating, and caring for older populations with potential health issues or mobility/accessibility limitations.

Table 3-13 Vulnerable Populations in Carbon County

Census Designation	Percent of Population Using 2018 Estimates
Population under 5 years of age	3.6%
Population under 18 years of age	17.4%
Population 65 or older	25.8%
Population 25 years or older without High School degree	6.1%
Population that speak English less than "very well"	1.3%
Population with a disability under the age of 65	10%
Population without health insurance under the age of 65	11.7%
Population in poverty	9.4%

Source: U.S. Census Bureau; Headwaters Economics Report for Carbon County MT, 2019

Another useful source of data about vulnerable populations, particularly those with health issues or electricity requirements for health machines, has been gathered from the U.S. Department of Health and Human Services' (HHS) emPOWER Map site. In particular, details were pulled for Carbon County for total numbers of Medicare beneficiaries per zip code, and for total electricity-dependent person per zip code (i.e. those who rely on health machines for oxygen or other medical services), with the results displayed in map form in Figure 3-2 and Figure 3-3 below. Both figures show that the highest numbers of these medically vulnerable populations are found in the Red Lodge and Joliet zip codes, followed by the Bridger zip code on the eastern slope.

Figure 3-2 Total Medicare Beneficiaries per Zip Code in Carbon County

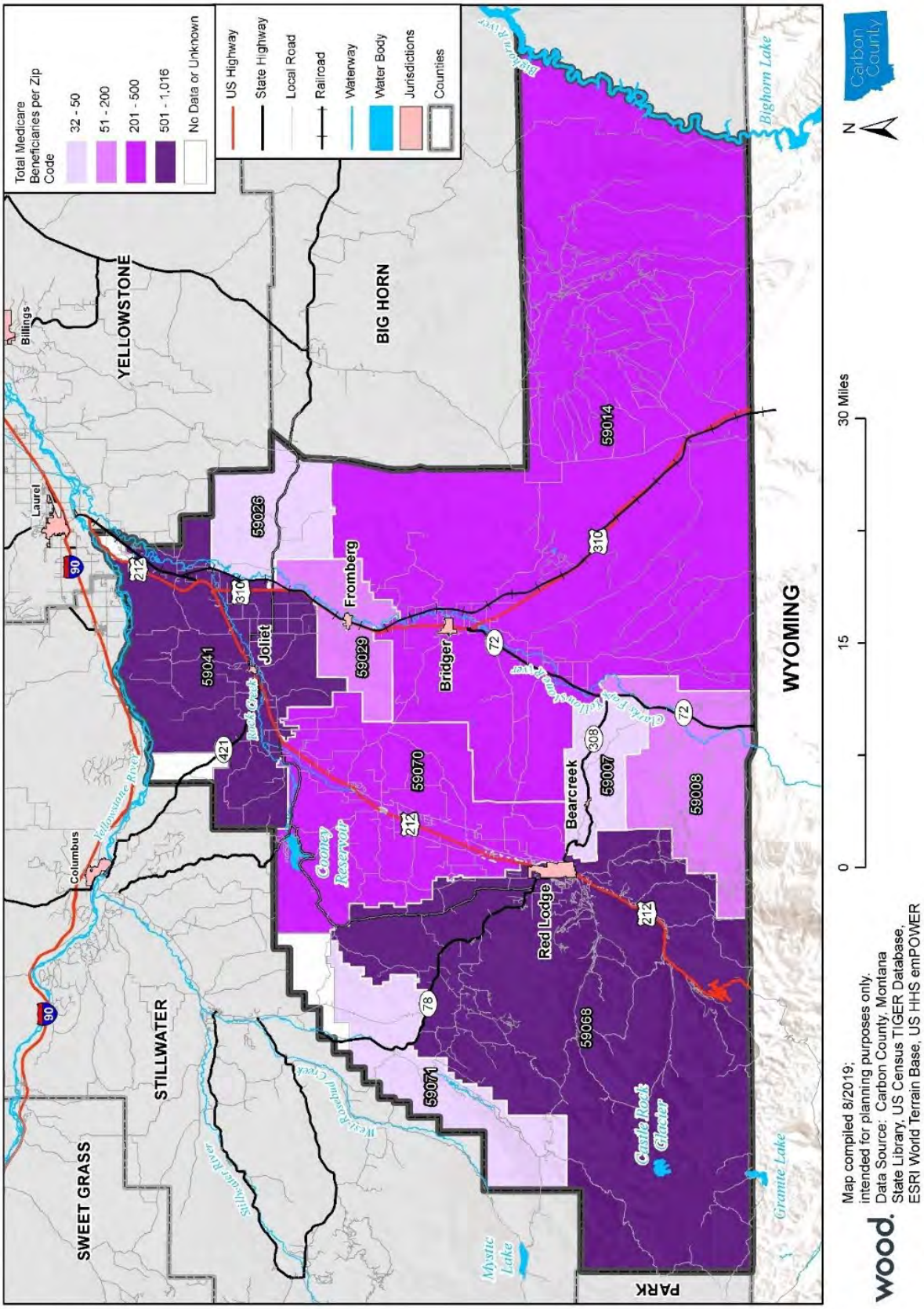
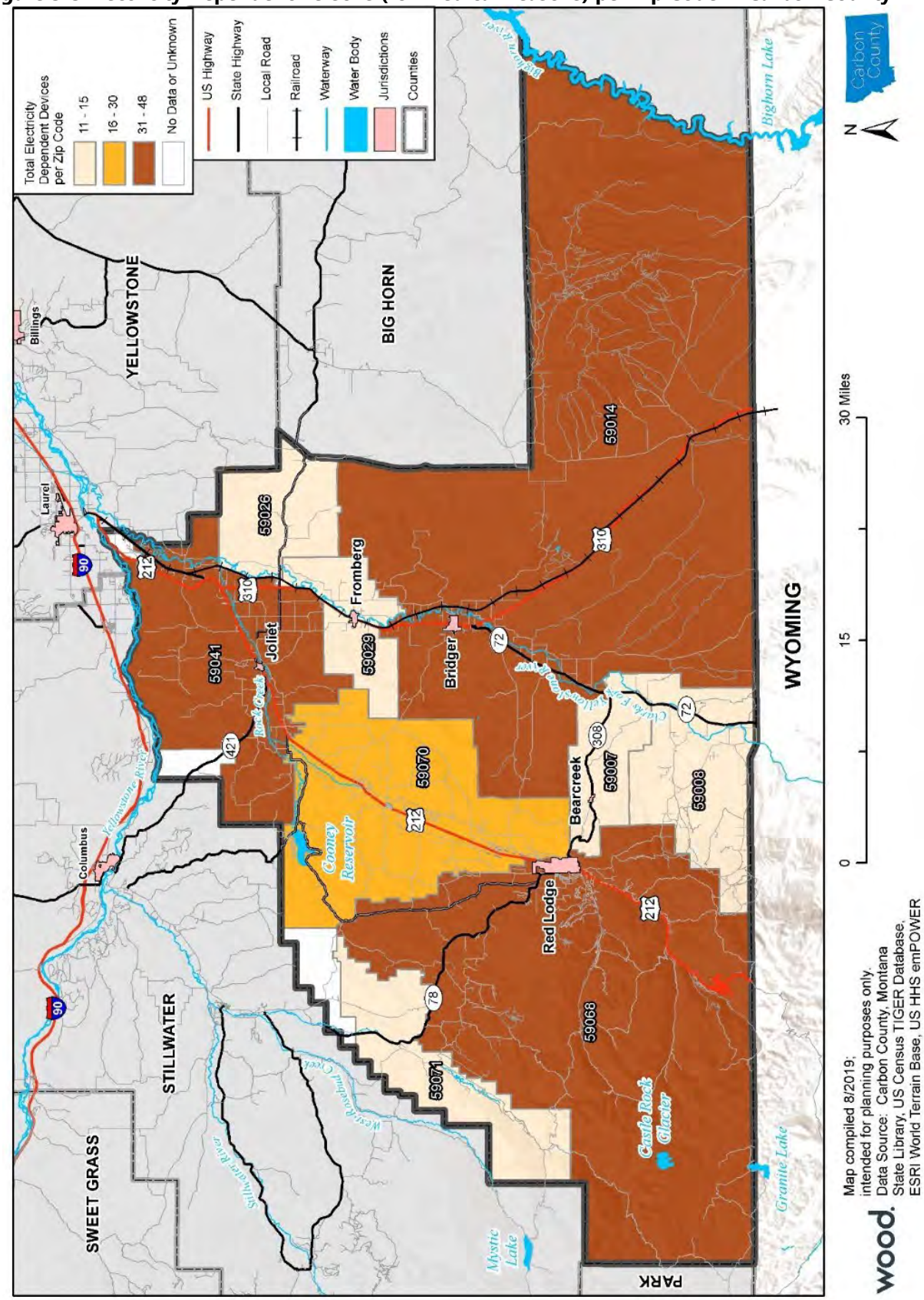


Figure 3-3 Electricity Dependent Persons (for Medical Reasons) per Zip Code in Carbon County



Avalanche

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Limited	Likely	Limited	Medium

Hazard Description

An avalanche is a mass of snow sliding down a steep slope. The vast majority of avalanches occur during and shortly after winter storms. Avalanches occur when loading of new snow increases stress at a rate faster than strength develops and the slope fails or when an unstable snowpack is triggered by addition of an external weight, i.e. skier or snowmobiler. Critical stresses develop more quickly on steeper slopes and where deposition of wind-transported snow is common. The combination of steep slopes, abundant snow, weather, snowpack, and an impetus to cause movement, creates an avalanche. About 90 percent of all avalanches start on slopes of 30-45 degrees.

Avalanches release most often on slopes above timberline that face away from prevailing winds (leeward slopes collect snow blowing from the windward sides of ridges). Avalanches can also run on small slopes well below timberline, such as gullies, road cuts, and small openings in the trees. Very dense trees can anchor the snow to steep slopes and prevent avalanches from starting; however, avalanches can release and travel through a moderately dense forest. An average-sized avalanche travels around 80 mph; the typical range of impact pressure from an avalanche is from 0.5 to 5.0 tons per square foot.

The complex interaction of weather and terrain factors contributes to the location, size, and timing of avalanches. In the absence of detailed scientific observation, any accumulation of snow on an open slope steeper than 20 degrees should be considered a potential avalanche hazard.

The most certain sign of avalanche hazard is recent avalanche activity and resulting debris. Usually when one slope is hazardous, many of the nearby slopes are also hazardous. The historical record shows numerous cases where rescue parties searching for avalanche victims themselves become victims of the same avalanche cycle.

Geographic Area

The geographic extent of avalanche areas in Carbon County is limited, mostly to the west of the county in areas that remain largely undeveloped. There are several steep slopes with potential for avalanches in various areas within the Beartooth and Pryor Mountains, however, particularly where the terrain slopes are 20 degrees or higher. Avalanches occurring outside of Carbon County can still impact transportation routes in and out.

Extent (Magnitude/Severity)

Overall, avalanche impacts would likely be limited in Carbon County, with 10-25 percent of the planning area affected. However, a road closed due to avalanche activity can result in serious transportation disruptions as well as limited emergency response capabilities due to the limited number of roads in the County and minimal personnel. Beartooth Pass can experience avalanche closures, thus obstructing all access at the Montana- Wyoming border. Avalanches have the potential to cause death and serious injury. Backcountry avalanche incidents involve search and rescue teams and resources, which can put these personnel in areas of risk.

Historic Occurrences

The NCEI storm events database has records of seven avalanche events between 2010 and 2018; all occurred in the Beartooth Mountains but not within the County itself. Carbon County Search and Rescue periodically responds to avalanche incidents where skiers have triggered an avalanche on Beartooth Pass. The Carbon County News reported on May 3, 1973, that an avalanche knocked a youth half a mile off Vista Point on Beartooth Pass with a wall of snow eight feet high and twelve feet wide. An avalanche on the Forest Service's Hell Roaring Plateau Road in 2002 severely damaged a bridge and closed the road to vehicle traffic. Although the foundation remained in place, the decking was swept down drainage. The bridge was replaced in 2005 for a contracted amount of $24,430 that included removal of the old decking and replacement of the superstructure and signing.

The previous HMP noted an avalanche event on January 3, 2010. No damages, injuries, or fatalities were attributed to this avalanche. According to the Gallatin National Forest Avalanche Center website:

"This avalanche was triggered from a skier ascending an adjacent ridge. The slide was on the ESE of Yellow Mountain on a 34-degree slope. The crown was 18 inches deep and ran on facets putting debris 700-1000 feet down the slope."

Likelihood of Future Occurrence

Likely - Due to the topography and high elevations of the western portion of the County, avalanches are likely to occur in those areas in the future during the winter months, or during the spring with late season snowfall. Avalanches that affect roads or persons happen less frequently, roughly once every 10 years.

Climate Change Considerations

The likelihood and nature of future avalanches may be affected by climate change. As winter is taking longer to descend, weaker snow accumulates at the very bottom of the snow pack. As more snow piles on top of the weak layer, and temperatures remain warm, the upper, moisture-laden layers became vulnerable to sliding, creating a delicate situation. More extreme precipitation events that deposit large amounts of snow in a short period of time could also periodically increase the potential for large avalanches.

Vulnerability

Carbon County is vulnerable to avalanches, however, most winters the vulnerability is limited to several areas of the County, specifically the higher elevation public lands in the southwest. Overall, public safety is the primary concern regarding avalanche hazards and vulnerability. Building impacts are often limited. The following sections will discuss in more detail the specific impacts that property, populations, critical facilities and infrastructure, and other aspects of the county's way of life (the economy, local resources of interest, and future development) that may be affected negatively by this hazard.

People

During the winter and spring months, individual and small groups of recreational skiers and snowmobile riders are exposed to avalanche danger primarily up the Lake and West Forks of Rock Creek, on areas accessed from the Beartooth Highway, and on areas out of bounds of the Red Lodge Mountain ski area. Montana Department of Transportation employees who clear snow from the road in the spring are also exposed to avalanche danger. Most of the avalanches that release in the County do not affect people and none of the communities in the County are situated in avalanche paths.

Economy

Avalanche activity inside or outside the County (along connecting roadways) can disrupt transportation in and out of the local communities and even the state, which could result in a wide range of economic impacts. Tourism is the main economic driver for Carbon County, and a major closure of roads could leave portions of the County without this vital sector.

Built Environment

Roads could be obstructed or shut down, causing issues with transportation of goods, commuting, and emergency response and service provision. Avalanches do occur along the Beartooth Highway, but the highway is closed to the public during these periods. None of the communities in the County are situated in avalanche paths.

Critical Facilities and Infrastructure

Key infrastructure at risk would include transportation routes in and out of the state to the west, and other systems surrounded by steep slopes; as previously noted in this analysis, critical infrastructure is mostly located far away from avalanche risk areas. The HMPC noted that roads have been closed due to avalanches in the past and the most impact avalanches occur on roads between Carbon and Yellowstone, leading to secondary impacts on the local economy.

Historic, Cultural, and Natural Resources

While natural spaces and environmental resources are generally resistant to hazards such as avalanches, ecological systems could be disturbed, species habitats destroyed, and animals hurt or killed during a large snow downfall event. According to the HMPC, Camp Senia, a cultural site on the National Register, is at risk of avalanche events. This group of cabins is located in the upper West Fork of Rock Creek basin. Despite this, the lack of more detailed data makes it difficult to assess specific risk or potential losses from avalanche hazards, and as such there are no quantitative loss estimations for this category.

Future Development

Avalanche vulnerability could increase with future development and population growth as there will be a higher number of people driving on roadways and taking part in backcountry recreation, as well as potentially requiring search and rescue and emergency response and services. It is unlikely that risk to structures will increase as long as future development is planned outside of mapped or suspected avalanche hazard zones.

Risk Summary

Overall, avalanche hazards have a medium significance in Carbon County based on historical evidence and the potentially impacts an avalanche event could have on the local economy, specifically the tourism sector. More heavily trafficked routes and areas that have experienced events in the past are also at risk of experiencing damages or even closures which can contribute to economic impacts in the County. Generally, impacts are isolated to the western portion of the county in the backcountry and snow activity users and possibly first responders.

- The NCEI Storm Events Database has seven recorded damaging avalanche events in the Absaroka/Beartooth Mountains zone; four fatalities are attributed to these events, though none took place in Carbon County
- Road infrastructure most vulnerable; road closures due to avalanches can have significant impact on the local economy including interstate travel

- Avalanches cause a danger to backcountry skiers, snowshoers, snowmobilers and other outdoorsmen in the mountains
- Due to topography and slopes, the southwestern portion of the county is more vulnerable compared to eastern; the greatest risk of physical impacts is in the Unincorporated County
- *Related Hazards:* Winter Storms

Avalanche Hazard Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Limited	Likely	Limited	Medium
City of Red Lodge	Limited	Unlikely	Limited	Medium
Town of Bearcreek	Limited	Unlikely	Negligible	Low
Town of Bridger	Limited	Unlikely	Negligible	Low
Town of Joliet	Limited	Unlikely	Negligible	Low
Town of Fromberg	Limited	Unlikely	Negligible	Low

Dam Failure

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Significant	Unlikely	Limited	Medium

Hazard Description

Dams are man-made structures built for a variety of uses including flood protection, power generation, agriculture, water supply, and recreation. When dams are constructed for flood protection, they are usually engineered to withstand a flood with a computed risk of occurrence. For example, a dam may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any one year. If prolonged periods of rainfall and flooding occur that exceed the design requirements, that structure may be overtopped and fail. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can also result from any one or a combination of the following causes:

- Earthquake
- Inadequate spillway capacity resulting in excess overtopping flows
- Internal erosion caused by embankment or foundation leakage, or piping or rodent activity
- Improper design
- Improper maintenance
- Negligent operation
- Failure of upstream dams on the same waterway
- Targeted vandalism and/or terrorism

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result as well as potentially catastrophic effects to roads, bridges, and homes. Electric generating facilities and transmission lines could also be damaged and affect life support systems in communities outside the immediate hazard area. Associated water supply, water quality and health concerns could also be an issue. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

In general, there are three types of dams: concrete arch or hydraulic fill, earth-rockfill, and concrete gravity. Each type of dam has different failure characteristics. A concrete arch or hydraulic fill dam can fail almost instantaneously; the flood wave builds up rapidly to a peak then gradually declines. An earth-rockfill dam fails gradually due to erosion of the breach; a flood wave will build gradually to a peak and then decline until the reservoir is empty. And, a concrete gravity dam can fail instantaneously or gradually with a corresponding buildup and decline of the flood wave.

Dams and reservoirs have been built throughout Montana to supply water for agriculture and domestic use, to allow for flood control, as a source of hydroelectric power, and to serve as recreational facilities. The storage capacities of these reservoirs range from a few tens of acre-feet to nineteen million acre-feet.

Dam failures are usually associated with intense rainfall or prolonged flood conditions but can occur during an earthquake due to structural failure and/or ground rupturing. Dam failure may be caused by faulty design, construction and operational inadequacies, intentional breaches, or a flood event larger than the design flood. The greatest threat from dam failure is to people and property in areas immediately below the dam since flood discharges decrease as the flood wave moves downstream.

Dam failure floods in Montana have primarily been associated with riverine and flash flooding. The potential for a major flood occurring solely as a result of dam failure due to structural problems is also a possibility.

Aging infrastructure is often to blame for dam failure in Montana. There have been numerous small failures primarily related to deterioration of corrugated metal pipe outlet works, which caused slow releases of reservoir contents along the outside of the outlet pipe though thankfully with minimal downstream property damage (but serious damage to the structure).

Geographic Area

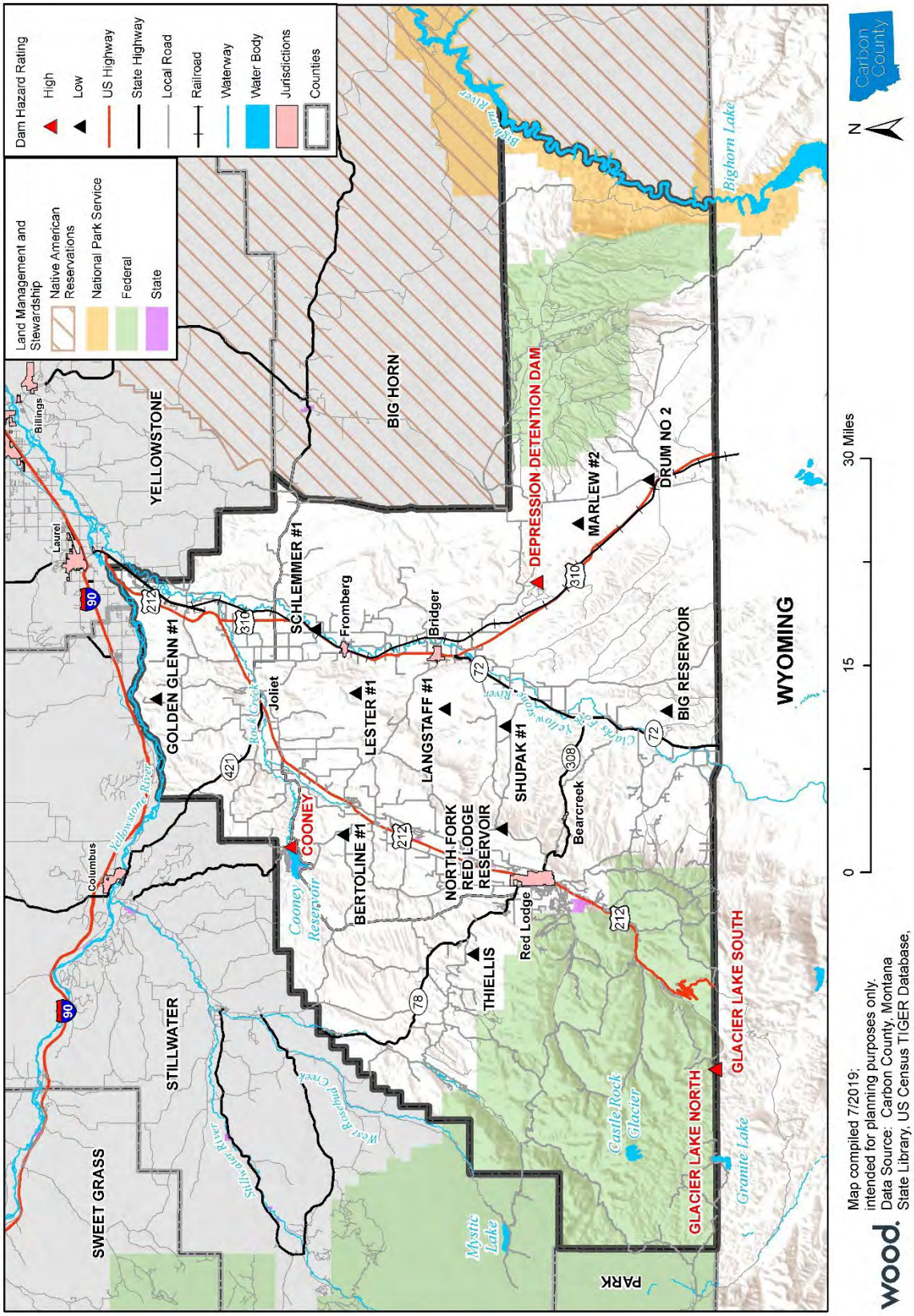
Figure 3-4 displays the location of all 15 dams in the County. The high and low hazard dams (described in more details in Table 3-14 and Figure 3-5 below) are spread across the county, with a few clustered around populated places like Red Lodge, Bridger, and Fromberg. Only four of these dams are classified as high hazard structures while 11 are low hazard dams.

Table 3-14 Low Hazard Dams in Carbon County

Dam Name	EAP	Owner	Dam Type	Dam Height	Storage (acre feet)	Stream	Nearest Community
Bertoline #1	Not Required	Richard L Bertolino	Earth	10	113	Tr-Cottonwood Creek	Boyd
Big Reservoir (Carbon)	Not Required	U.S. D.O.I. B.L.M.	Earth	30	27	Tr-Hollenbeck Draw	Bridger
Drum No 2	Not Required	Dave Drum	Earth	22	70	Sage Creek	Warren
Golden Glenn #1	Not Required	Cole Creek Angus Ranch	Earth	40	136	Cole Creek	Billings
Langstaff #1	Not Required	Brenda/ Russell Anderson	Earth	25	535	Tr-Sand Creek	Fromberg
Lester #1	Not Required	Hallie C Ward	Earth	25	122	Tr-Sand Creek	Fromberg
Marlew #2	Not Required	Connecticut Mutual Life Ins	Earth	18	137	Tr-Sage Creek	Warren
North Fork Red Lodge Reservoir	Not Required	Ron Nelson	Earth	18	98	Tr-North Fork Dry Creek	Golden
Schlemmer #1	Not Required	Rex/Grace Schlemmer	Earth	14	81	Tr-Yellowstone River	Edgar
Shupak #1	Not Required	Aretta/ Wally Papez	Earth	18	146	Tr-Clarks Fork Yellowstone R.	Golden
Thiellis (Big Pond Dam)	Not Required	Ellis Cattle Co	Earth	18	76	Thiel Creek	Joliet

Source: U.S. Army Corp of Engineers National Inventory of Dams, 2018

Figure 3-4 Potential Dams of Concern in or Upstream of Carbon County



Extent (Magnitude/Severity)

Dams are rated as high, significant, or low hazard types. Hazard determinations are based upon the consequences of dam failure rather than the condition, probability, or risk of failure. According to the 2018 State of Montana Multi-Hazard Mitigation Plan, dams are classified into one of three categories, as outlined below."

- **Low Hazard Potential** - Dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- **Significant Hazard Potential** - Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **High Hazard Potential** - Dams where failure/mis-operation will probably cause loss of human life.

According to the U.S Army Corp of Engineers' National Inventory of Dams database, last updated in 2018, there are a total of 15 dams in Carbon County. Of these, 10 are privately-owned, 3 are state-owned, and 2 are federal owned. All of the private dams are low hazard, and none of these dams are of significant hazard type. The 3 state-owned dams (as shown in Table 3-15) are Glacier Lake North, Glacier Lake South, and Cooney Reservoir, all of which are rated as high hazard dams along with one of the federal dams, the Depression Detention dam. Emergency Operations Plans have been prepared by the Department of Natural Resources and Conservation for Glacier Lake North, Glacier Lake South, and Cooney Reservoir. These plans are periodically updated and are housed in the Disaster Emergency Coordination office. Note that the Glacier Lake North and South dams are two separate structures within the same facility (the Glacier Lake Dam), and as such are colloquially known and referred to as one damming structure.

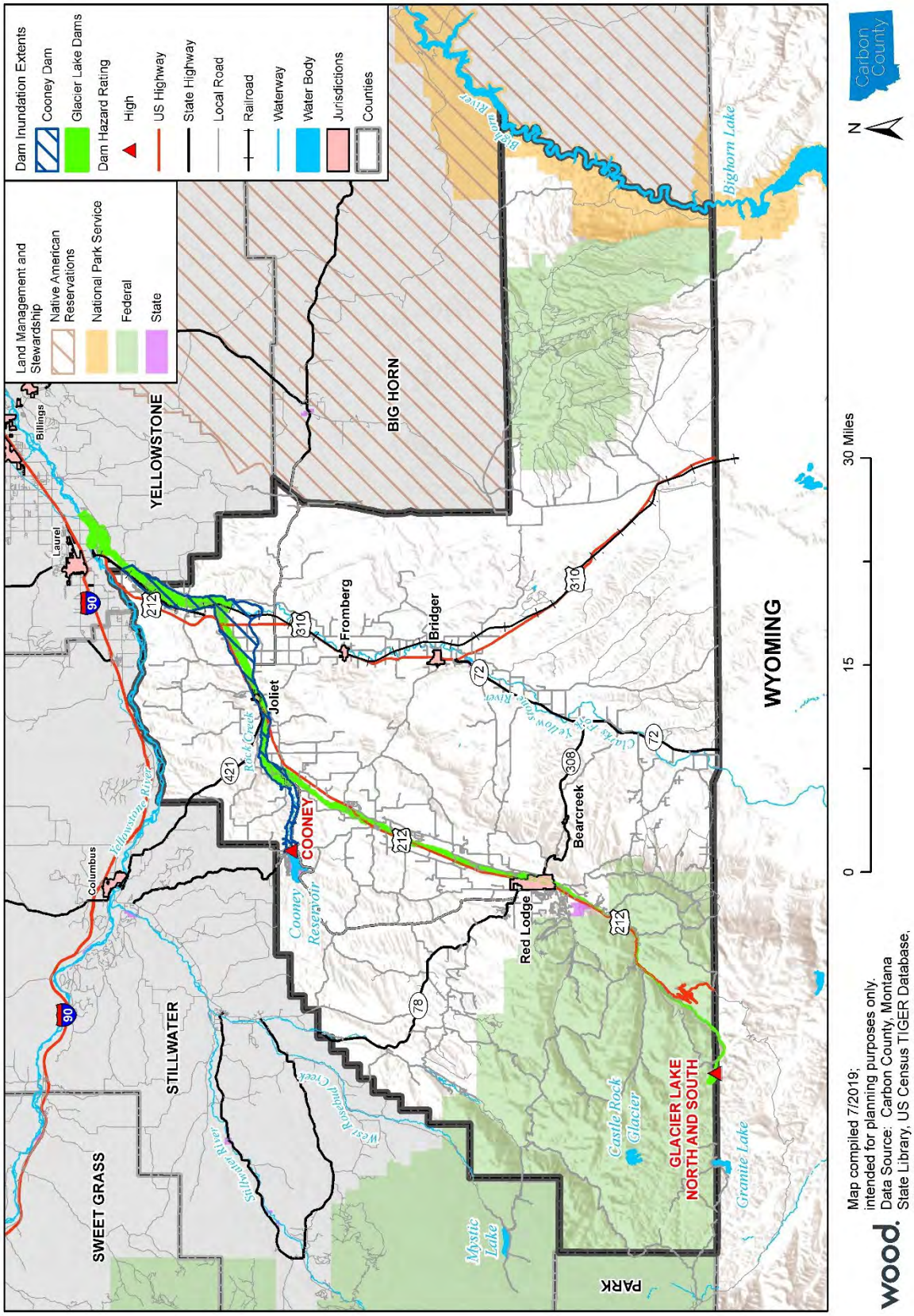
Table 3-15 Carbon County High Hazard Dams

Dam Name	Hazard Class	EAP	Owner	Dam Type	Dam Height	Storage (acre feet)	Stream	Nearest Community
Cooney	H	Yes	State Water Projects	Earth	102	28,140	Red Lodge Creek	Joliet
Depression Detention Dam	H	Yes	DOI BLM	Gravity	42	148	S. Fork Bridger Creek	Bridger
Glacier Lake North Dam	H	Yes	State Water Projects	Rockfill	57	4,980	Rock Creek	Red Lodge
Glacier Lake South Dam	H	Yes	State Water Projects	Rockfill	20	2,850	Rock Creek	Red Lodge

Source: U.S. Army Corp of Engineers National Inventory of Dams, 2018

Figure 3-5, Dam Inundation Extents of the Cooney and Glacier Lake Dams in Carbon County, shows the dam inundation extents for both the Cooney and Glacier Lake Dams.

Figure 3-5 Dam Inundation Extents of the Cooney and Glacier Lake Dams in Carbon County



Historic Occurrences

There have been no major dam failures in Carbon County. However, during the springs of 2005 and 2011, precipitation and runoff events created a full pool at Cooney Reservoir. The emergency spillway was utilized, and no damage occurred.

Likelihood of Future Occurrences

Unlikely - The County remains at risk to dam failures from the three high hazard dams located in the County. In addition, the other low hazard dams could potentially fail and cause issues downstream, though not enough data is available to determine the magnitude or detail how impactful a low hazard dam could be on their surrounding communities. Given the density of population and property, and the age and condition of the high hazard dams, the potential exists for catastrophic dam failure in the County.

Climate Change Consideration

The potential for climate change to affect the likelihood of dam failure is not fully understood at this point in time. With a potential for more extreme precipitation events a result of climate change, this could result in large inflows to reservoirs. However, this could be offset by generally lower reservoir levels if storage water resources become more limited or stretched in the future due to climate change, increasing droughts, and/or population growth. Owners and operators of dams may need to alter current maintenance and operational procedures in order to account for changes in the hydrograph as well as increased sedimentation.

According to the 2018 State of Montana Multi-Hazard Mitigation Plan population and property exposure to dam failure is not likely to change significantly due to climate change.

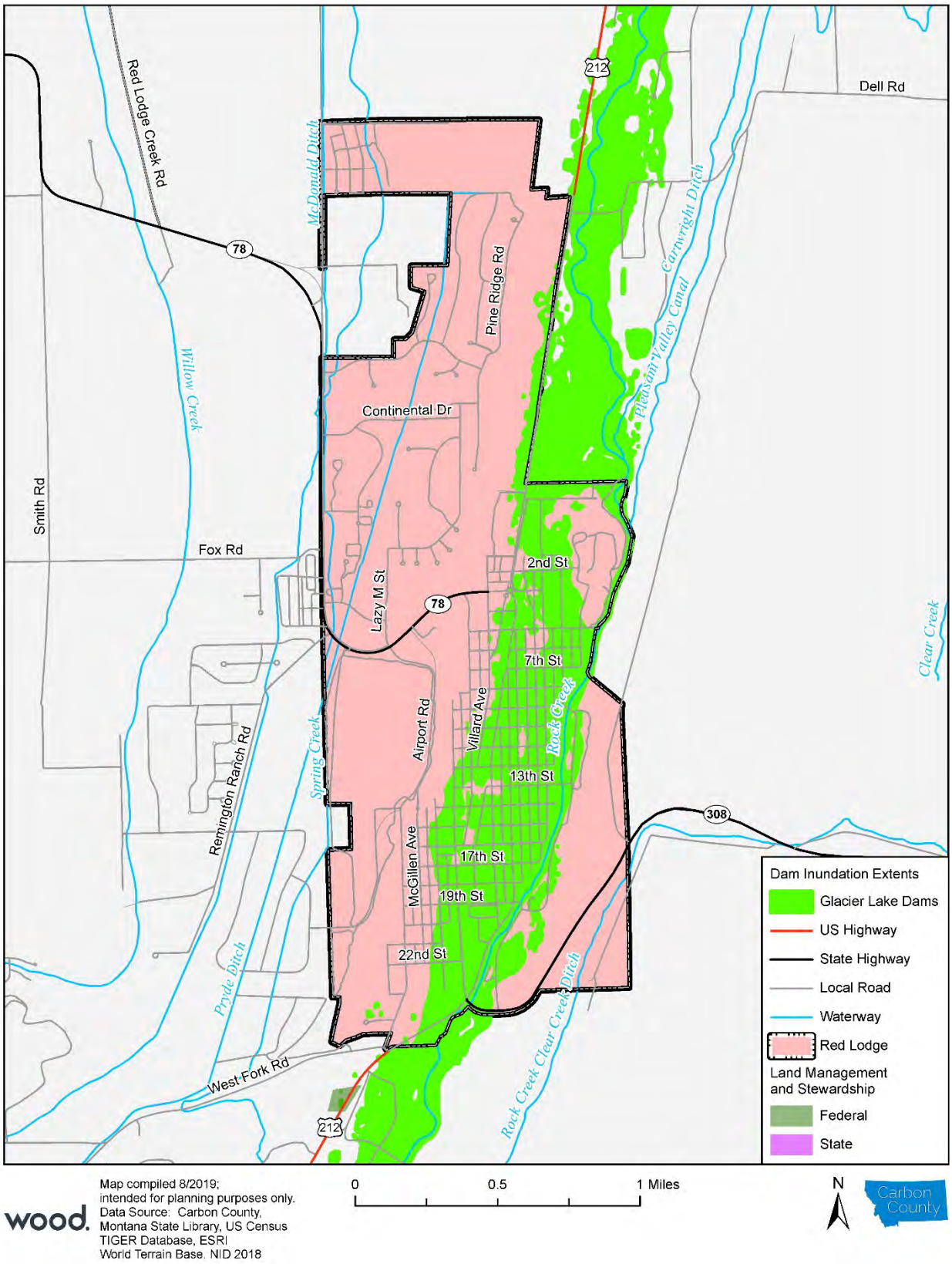
Vulnerability

Numerous factors contribute to determining dam vulnerability including: design standards; construction, operation and maintenance; intense rainfall or prolonged flood conditions; and/or earthquakes or other cascading hazards. The vulnerability of property and population downstream of dams is related to construction in inundation areas.

FEMA's National Dam Safety Program Act required that owners of all high and significant hazard dams prepare Emergency Action Plans (EAP). The objectives of the EAP is to pre-plan the coordination of necessary actions by the dam owner and the responsible local and state emergency management officials; identify conditions which could lead to dam failure in order to initiate emergency measures that could prevent or minimize the loss of life and property; and, provide timely notifications and warnings of a dam emergency and evacuation in the event of potential failure of the dam.

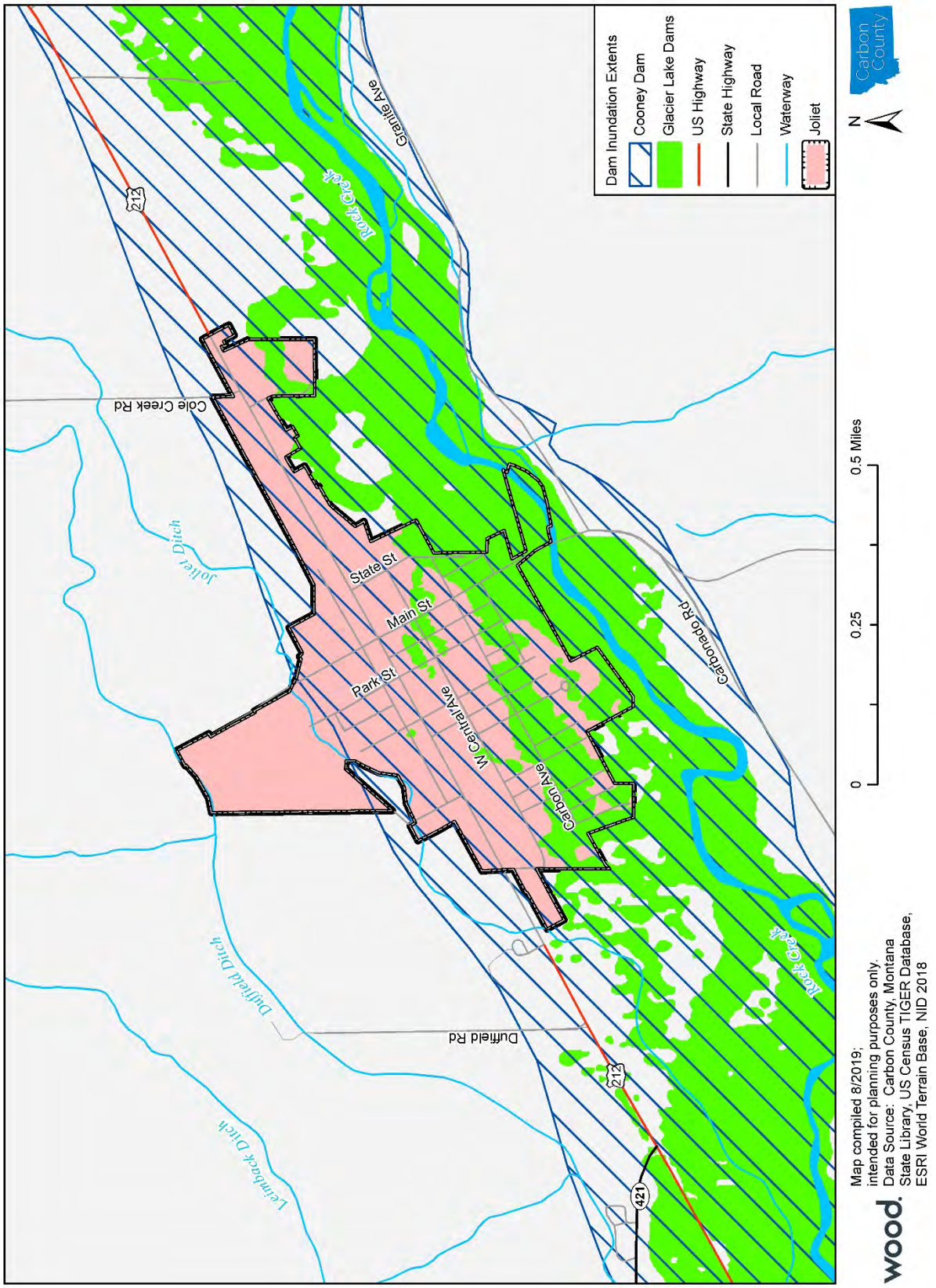
According to the Montana State Hazard Mitigation Plan, the vulnerability of Carbon County to a dam failure is high. Areas vulnerable downstream of Cooney Dam would be along Rock Creek and the Town of Joliet, and vulnerable places downstream of the Glacier Lake Dams would be Red Lodge and Joliet. If one of these two dams were to fail, structures and populations downstream would be affected, as would infrastructure in the water's path.

Figure 3-6 Dam Inundation Extents in the City of Red Lodge



Map compiled 8/2019;
intended for planning purposes only.
Data Source: Carbon County,
Montana State Library, US Census
TIGER Database, ESRI
World Terrain Base. NID 2018

Figure 3-7 Dam Inundation Extents in the Town of Joliet



GIS analysis was conducted using parcel data and improved structure values from Carbon County, along with the dam inundation extent layers for both Cooney Dam and the Glacier Lake Dams. Parcel centroids were generated and then overlaid with the dam inundation layers for the dams mentioned, all in GIS, to determine the number, type, and improvement values of the parcels found within dam inundation areas.

Once the number of parcels with improved structure values was obtained, content values were calculated by applying the following formulas: a) commercial, agricultural, and farmstead parcels were given content values worth 100% of the improved structure values; b) Industrial parcels were given content values worth 150% of their improved structure values; and, c) residential structures (i.e. manufactured homes, multi-family, and improved property parcels) were given content values worth 50% of the improved structure values. Then, total values were computed by adding (totaling) both improved structure values and the content values just calculated. Loss estimates for parcels affected by dam inundation were obtained by taking 50% of the total values in the previous step, as it is assumed that not the entire value of a parcel or property would be damaged or lost in a dam inundation event. For more information on parcel data and analysis methodology, refer to the Assets Summary at the beginning of this chapter.

People

Persons located downstream of a dam are at risk of a dam failure, though the level of risk can be tempered by topography, amount of water in the reservoir/dam, and time of day of the breach (as this could influence where people are located at the time of the breach or failure event). Injuries and fatalities can occur from debris, bodily injury, and drowning. Once a dam has breached, standing water presents all the same hazards to people as floodwater from other sources. People in the inundation area may need to be evacuated, cared for, and possibly permanently relocated. Impacts could include hundreds of evacuations and possibly casualties, depending on the dam involved. The Town of Joliet is noted in the 2018 State Multi-Hazard Plan as being a community that has experienced a fast growth rate and has a high percentage of dam exposure (95.6%) due to both the Cooney and Glacier Lake Dams potential inundation areas.

Specific population impacts are noted in the last columns of Table 3-16 and Table 3-17 below, and total people at risk were calculated by multiplying the average number of persons per household in the county of (which equals 2.27) times the number of parcels overlaid or intersected with the dam inundation extent layers. The Glacier Lake Dams would put the most people at risk, followed by the Cooney Dam. A total of 3,471 people could be at risk of dam inundation impacts based on the calculation methodology used, though again it is unlikely that all the parcels found to overlap with dam inundation extents will be populated by the total persons estimated were a dam failure event to take place.

Economy

Extensive and long-lasting economic impacts could result from a major dam failure or inundation events, including the long-term loss of water in a reservoir, which may be critical for potable water and agriculture needs. Failure of an irrigation dam could also have last impacts on agricultural land and farmstead properties. A major dam failure and loss of water from a key structure could bring about direct business and industry damages and potential indirect disruption of the local economy.

Built Environment

The results of the GIS parcel analysis for the dam inundation hazard layers is summarized by jurisdiction and parcel type in Table 3-16 and Table 3-17. The analysis shows that over $449 million could be at risk of dam inundation events based on the total values computed for parcels of several types, with Red Lodge facing the highest potential risk (followed by the unincorporated portions of the county and then the Town of Joliet). A total of 1,601 parcels could get inundated, and the loss estimate sum surpasses the

$224 million mark. Loss estimates, as summarized in the tables below, were obtained by taking 50% of the total parcel values.

With regards to potential risk by property type the Improved Property parcels will face the most potential damages, as 1,427 parcels described under this category could be inundated in a dam failure event. Improved property parcels are followed by farmsteads, exempt parcels, multi-family parcels, manufactured homes, vacant parcels, and commercial parcels in terms of risk exposure.

Table 3-16 Carbon County Parcels in Dam Inundation Areas, by Jurisdiction

Jurisdiction	Total Parcels in the Dam Inundation Areas	Improved Structure Values	Content Values	Total Values	Loss Estimate (50% of the Total Values)	Population at Risk
Joliet	271	$29,871,131	$12,791,795	$42,662,926	$21,331,463	561
Red Lodge	826	$154,071,756	$70,541,276	$224,613,032	$112,306,516	1,800
Unincorporated	504	$114,738,348	$67,541,091	$182,279,439	$91,139,719	1,110
TOTAL	**1,601**	**$298,681,235**	**$150,874,161**	**$449,555,396**	**$224,777,698**	**3,471**

Source: Carbon County DES/GIS Departments, Wood Plc

Table 3-17 Carbon County Parcels in Dam Inundation Areas, by Parcel Type

Parcel Type	Total Parcels in the Dam Inundation Areas	Improved Structure Values	Content Values	Total Values	Loss Estimate (50% of the Total Values)	Population at Risk
Commercial	1	$51,310	$51,310	$102,620	$51,310	--
Exempt	68	$17,457,886	--	$17,457,886	$8,728,943	--
Farmstead	89	$21,722,120	$21,722,120	$43,444,240	$21,722,120	202
Improved Property	1,427	$256,108,859	$128,054,430	$384,163,289	$192,081,644	3,239
Manufactured Home	5	$474,877	$237,439	$712,316	$356,158	11
Multi-Family	8	$1,617,726	$808,863	$2,426,589	$1,213,295	18
Vacant	3	$1,248,457	--	$1,248,457	$624,229	--
TOTAL	**1,601**	**$298,681,235**	**$150,874,161**	**$449,555,396**	**$224,777,698**	**3,471**

Source: Carbon County DES/GIS Departments, Wood Plc

A third table was generated to summarize property risk to dam inundation, but this time broken out by dam. The Glacier Lake Dam would expose the highest number of parcels and hence values, followed by the Cooney Dam. An area of overlap between the two dams would inundate an additional 148 parcels as displayed in Table 3-18 below.

Table 3-18 Carbon County Parcels in Dam Inundation Areas, by Parcel Type

Dam Causing Inundation	Total Parcels in the Dam Inundation Areas	Improved Structure Values	Content Values	Total Values	Loss Estimate (50% of the Total Values)	Population at Risk
Cooney Dam	446	$70,619,543	$40,055,598	$110,675,141	$55,337,571	965
Glacier Lake and Cooney Dams (overlap area)	148	$29,044,776	$15,787,812	$44,832,588	$22,416,294	302
Glacier Lake Dam	1,007	$199,016,916	$95,030,751	$294,047,667	$147,023,834	2,204
TOTAL	**1,601**	**$298,681,235**	**$150,874,161**	**$449,555,396**	**$224,777,698**	**3,471**

Source: Carbon County DES/GIS Departments, Wood Plc

Critical Facilities and Infrastructure

A total dam failure can cause catastrophic impacts to areas downstream of the water body, including critical infrastructure the county relies on for emergency service provision, transportation systems, lifeline systems, and other key facilities. Of particular risk would be roads and bridges that could be vulnerable to washouts, further complicating response and recovery by cutting off impacted areas.

Based on the critical facility and infrastructure inventory considered in the update of this plan (obtained from the Carbon County DES/GIS departments), a total of 38 facilities were found to intersect with the dam inundation extents obtained in GIS form from Carbon County for the Cooney and Glacier Lake Dams. The critical facility and infrastructure dataset categorize these structures based on their main use or purpose: a) Emergency Services, b) Lifeline Utility Systems, c) High Potential Loss Facilities, and d) Transportation Systems or Other/Miscellaneous. For additional details about the assets used throughout this hazard mitigation plan please refer to the Asset Summary at the beginning of this chapter.

The specific results of the GIS analysis, which took critical facility and infrastructure inventory and overlaid it with the dam inundation extents, is summarized in the tables below for only those dams which did have inundation mapping available.

Table 3-19 Critical Facilities in Dam Inundation Areas, by Jurisdiction

Jurisdiction	Total Critical Facilities at Risk
Joliet	19
Red Lodge	16
Unincorporated	3
TOTAL	**38**

Source: Carbon County DES/GIS Departments, Wood Plc

Table 3-20 Critical Facilities in Dam Inundation Areas, by Facility Type and Category

Critical Facility Type	Critical Facility Category	Total Facilities
Emergency Services	Community Center	1
	Elementary School	1
	Emergency Medical Service Station	1
	Fire Station	1
	Government/Administrative	6
	Government/Law Enforcement	1
	School	1
	Senior Center	1
	Sheriff's Office	1
TOTAL		**14**
High Potential Loss Facilities	Dam	2
	Hazardous Material Facility	1
TOTAL		**3**
Lifeline Utility Systems	Communications/Utilities Facility	2
	Energy Facility	1
	Post Office	1
	Sewer Lagoon	2
	Water Well	4
TOTAL		**10**
Transportation Systems or Other/ Miscellaneous	Miscellaneous/Other	5
	Religious Institution	6
TOTAL		**11**
GRAND TOTAL		**38**

Source: Carbon County DES/GIS Departments, Wood Plc

Historic, Cultural, and Natural Resources

A dam failure has the potential to impact historic buildings and resources downstream, particularly in Joliet and Red Lodge.

Future Development

Areas slated for future development should take into consideration potential impacts from dam failure risk upstream and should attempt to overlay the existing dam inundation maps with proposed future development. Also, of note is that development below a low or undetermined hazard dam could increase its hazard rating.

Risk Summary

- A total of 3,471 people could be at risk of dam failure events based on the dam inundation extent analysis, with the greatest risk in Red Lodge.
- A total of 1,601 parcels could be at risk of dam failure events countywide based on the dam inundation extent analysis.
- A dam failure and loss of water from a critical reservoir or structure could include direct and indirect business and industry damages or disruption of the local economy and key county resources (e.g. potable water)

- A total of 38 critical facilities were found to be at risk of dam inundation extents based on the best available data
- *Related Hazards:* Severe Summer Storms; Flooding; Avalanche; Earthquake; Earth Movement

Dam Failure Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Significant	Unlikely	Limited	Medium
City of Red Lodge	Extensive	Occasional	Critical	High
Town of Bearcreek	N/A	Unlikely	N/A	Low
Town of Bridger	N/A	Unlikely	N/A	Low
Town of Joliet	Extensive	Occasional	Critical	High
Town of Fromberg	N/A	Unlikely	N/A	Low

Drought

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Extensive	Likely	Critical	High

Hazard Description

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events in that most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multi-year period, and it is often not obvious or easy to quantify when a drought begins and ends.

Drought is a complex issue involving many factors—it occurs when a normal amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

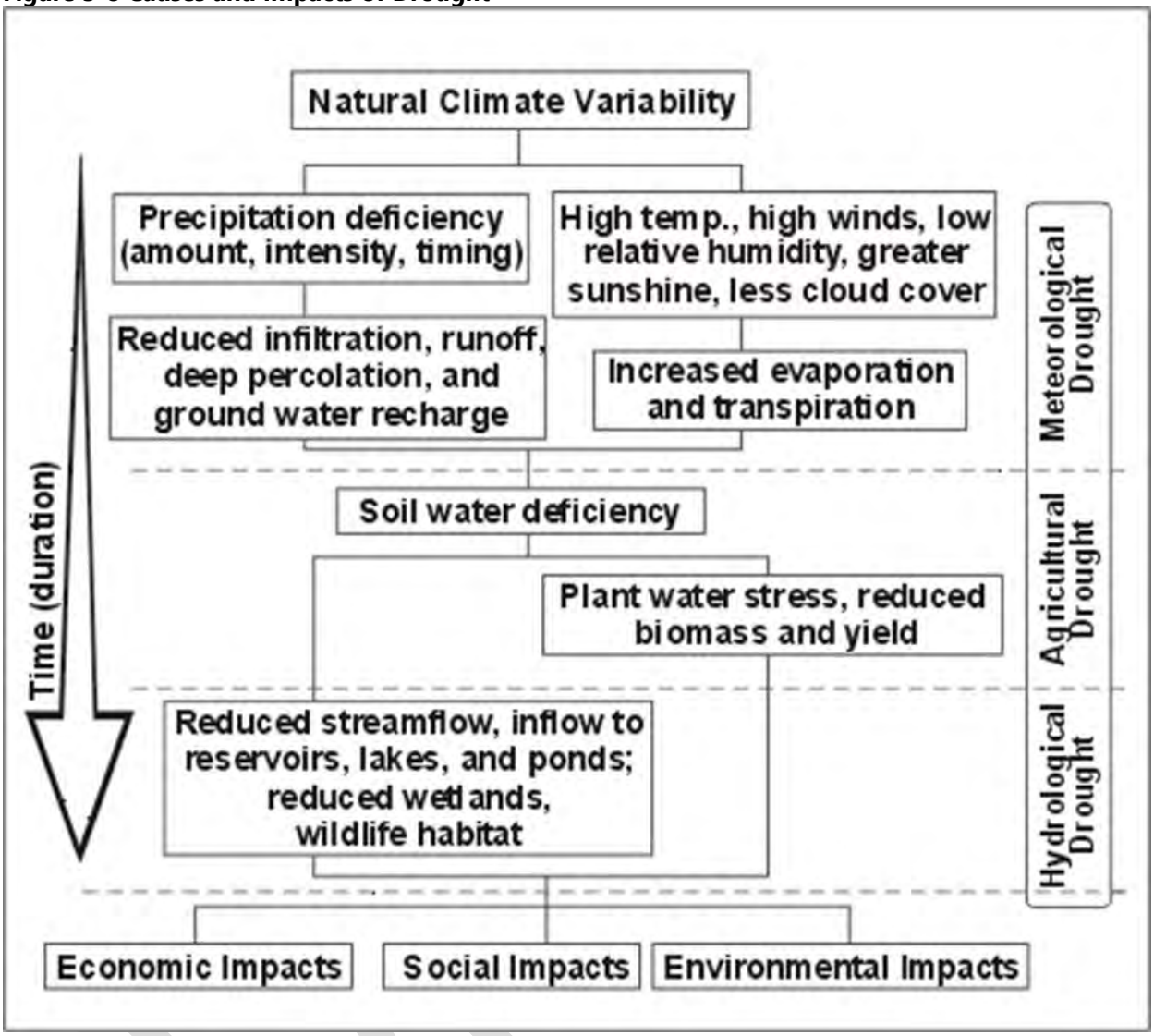
- **Meteorological** drought is usually defined by a period of below average water supply.
- **Agricultural** drought occurs when there is an inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.
- **Hydrological** drought is defined as deficiencies in surface and subsurface water supplies. It is generally measured as streamflow, snowpack, and as lake, reservoir, and groundwater levels.
- **Socioeconomic** drought occurs when a drought impacts health, well-being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in Montana are those related to water intensive activities such as agriculture, wildland fire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. An ongoing drought may leave an area more prone to beetle kill and associated wildland fires. Drought conditions can also cause soil to compact, increasing an area's susceptibility to flooding, and reduce vegetation cover, which exposes soil to wind and erosion. A reduction of electric power generation and water quality deterioration are also potential problems. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

Geographic Area

Drought is a regional hazard, and at its worst can affect the entire state of Montana with varying levels of dryness and drought activity (as will be covered in more detail under the sections to follow). It is safe to assume that unless the drought event is at its very beginning or very end, if any area of the Carbon County is affected by any level of drought, the other areas of the county are experiencing varying effects as well. Therefore, the geographical area affected by drought in Carbon County is extensive.

Figure 3-8 Causes and Impacts of Drought



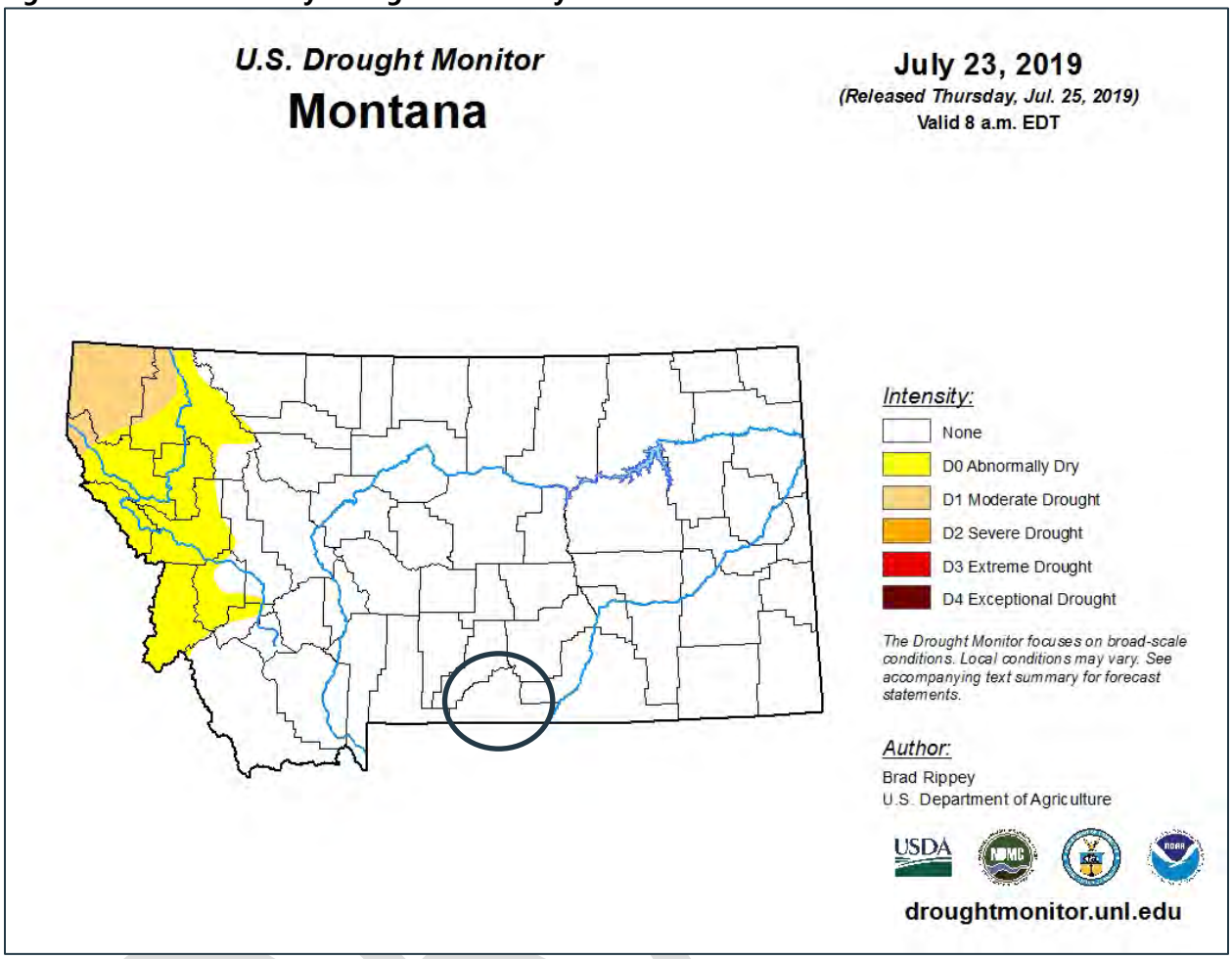
Source: National Drought Mitigation Center

Extent (Magnitude/Severity)

The U.S. Drought Monitor is an accepted and widely used site for obtaining and summarizing drought information, as it integrates data from several other sources including the Palmer Drought Index, Soil Moisture Models, U.S. Geological Survey Weekly Stream Flows, Standardized Precipitation Index, and the Satellite Vegetation Health Index. It includes drought intensity categories for measuring dry conditions across counties, states, and regions of the U.S., so that drought can be quantified. These categories range from "abnormally dry" to "exceptional drought." A snapshot of the drought conditions in Carbon County and the State of Montana can be found in Figure 3-9.

Note: The Drought Monitor maps integrate data from several sources including the Palmer Drought Index (discussed further below), Soil Moisture Models, U.S. Geological Survey Weekly Stream flows, Standardized Precipitation Index, and Satellite Vegetation Health Index.

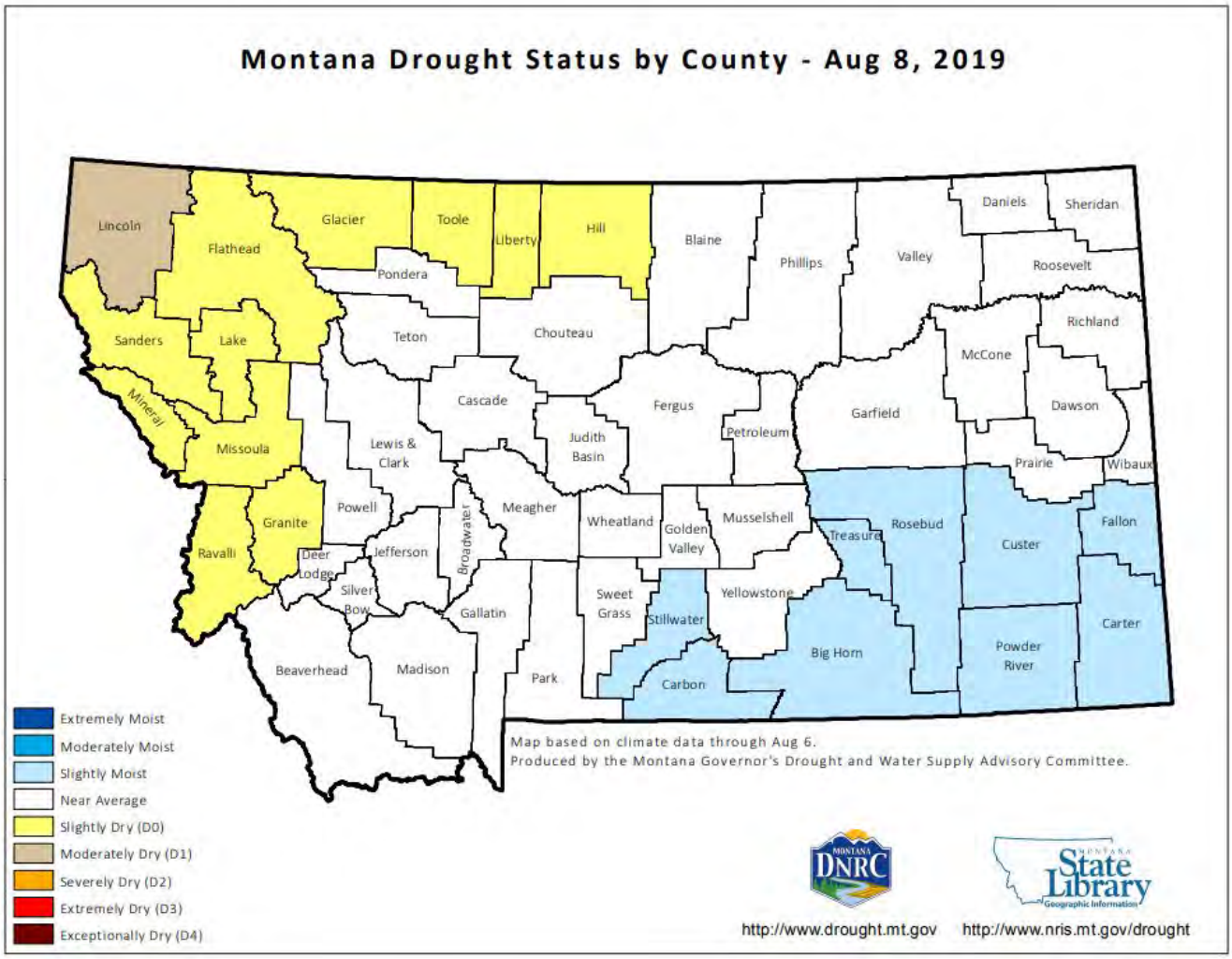
Figure 3-9 Carbon County Drought Status July 2019



Source: US Drought Monitor

The State of Montana tracks the status of drought by county throughout the state. In coordination with the Governor's Drought and Water Supply Advisory Committee the State Library publishes monthly moisture maps by county. Figure 3-10 below shows the moisture map for August 2019 and depicts Carbon County as moderately moist.

Figure 3-10 Carbon County Moisture Status Map August 2019



Source: Montana State Library

Annual precipitation varies greatly across Carbon County. Average precipitation for any given year is greater than 80 inches in areas of the County to less than 6 inches in other areas of the County. The eastern and southern portions of the County are some of the driest areas in the State of Montana. It is not uncommon for temperatures to reach the low 100's in these same dry areas during July and August.

Overall, extent or magnitude/severity of drought impacts are critical for the County. The magnitude of a drought's impact will be directly related to the severity and length of the drought. Secondary effects include increased susceptibility to wildland fires and pine beetle infestations. Fire restrictions in the County and on Public Lands impact agriculture, construction, and outdoor recreation with economic consequences.

Historic occurrences

The State of Montana Farm Service Agency tracks drought and USDA Secretarial Disaster Designations for Carbon County. Past Secretarial Drought Designations and Executive Orders related to drought from the state of Montana Governor's Office for the County are shown in Table 3-21.

Table 3-21 Drought Disaster Declaration (1992-2018)

Designation No.	Date Designated	Type of Disaster	Designation Type
EO 13-92	6/1992	Drought	Executive Order
S1269	11/24/98	Drought	Secretarial
S1354	9/22/99	Wildfire, Drought	Secretarial
S1468	1/11/01	Drought	Secretarial
S1538	5/29/01	Drought	Secretarial
S1579	11/1/01	Drought, Wildfire	Secretarial
S1624	3/27/02	Drought	Secretarial
S1645	5/31/02	Drought	Secretarial
S1951	9/7/04	Drought	Secretarial
S1972	10/28/04	Drought	Secretarial
S2406	10/10/06	Drought	Secretarial
S3350	8/15/12	Combined effects of Excessive Heat, High Winds, Drought, Wildfires, and Freezes	Secretarial
S3365	8/29/12	Drought – FAST TRACK	Secretarial
S3391	9/12/12	Drought – FAST TRACK	Secretarial
S3508	4/10/13	Drought FAST TRACK	Secretarial
S3521	5/8/13	Drought – FAST TRACK	Secretarial
S3982	6/2/16	Drought – FAST TRACK	Secretarial
S4066	10/5/16	Drought – FAST TRACK	Secretarial
S4070	10/5/16	Drought – FAST TRACK	Secretarial
S4210	8/25/17	Drought – FAST TRACK	Secretarial
S4217	9/11/17	Drought – FAST TRACK	Secretarial
EO 11-17	4/1/17	Drought	Executive Order

Source: Montana Farm Services Administration, USDA, State of Montana Governor's Office

The previous HMP reports one drought event for the County. In August of 1994, a combination of low winter snowpack and below normal summer rainfall brought widespread drought conditions to the entire state. Drought emergencies were declared in a number of Montana counties with 83% of the State reported under drought conditions at mid- month. The drought adversely affected stream fisheries due to low water levels and high-water temperatures, lowered crop yields, and exacerbated wildfires.

In 2017 the State of Montana experienced a "flash" drought; a drought event that had a rapid-onset and resulted in significant impacts on public health as well as the economy statewide. Several areas in Montana experienced drier conditions than in the 1930's and in some cases was the driest season on record. The event had significant impacts on the agricultural economy in the State and was a major factor in fueling the state's largest wildfire season in 100 years, burning 1.4 million acres and destroying 141 structures (NIDIS 2019). The smoke from the wildfires led to poor air quality and significant health impacts particularly to vulnerable populations. The Montana Governor issued several Executive Orders to assist in addressing the drought emergency. These included EO 11-2017, which allowed for additional resources for combating the drought event and EO 10-2017 to combat the unprecedented wildfire season statewide.

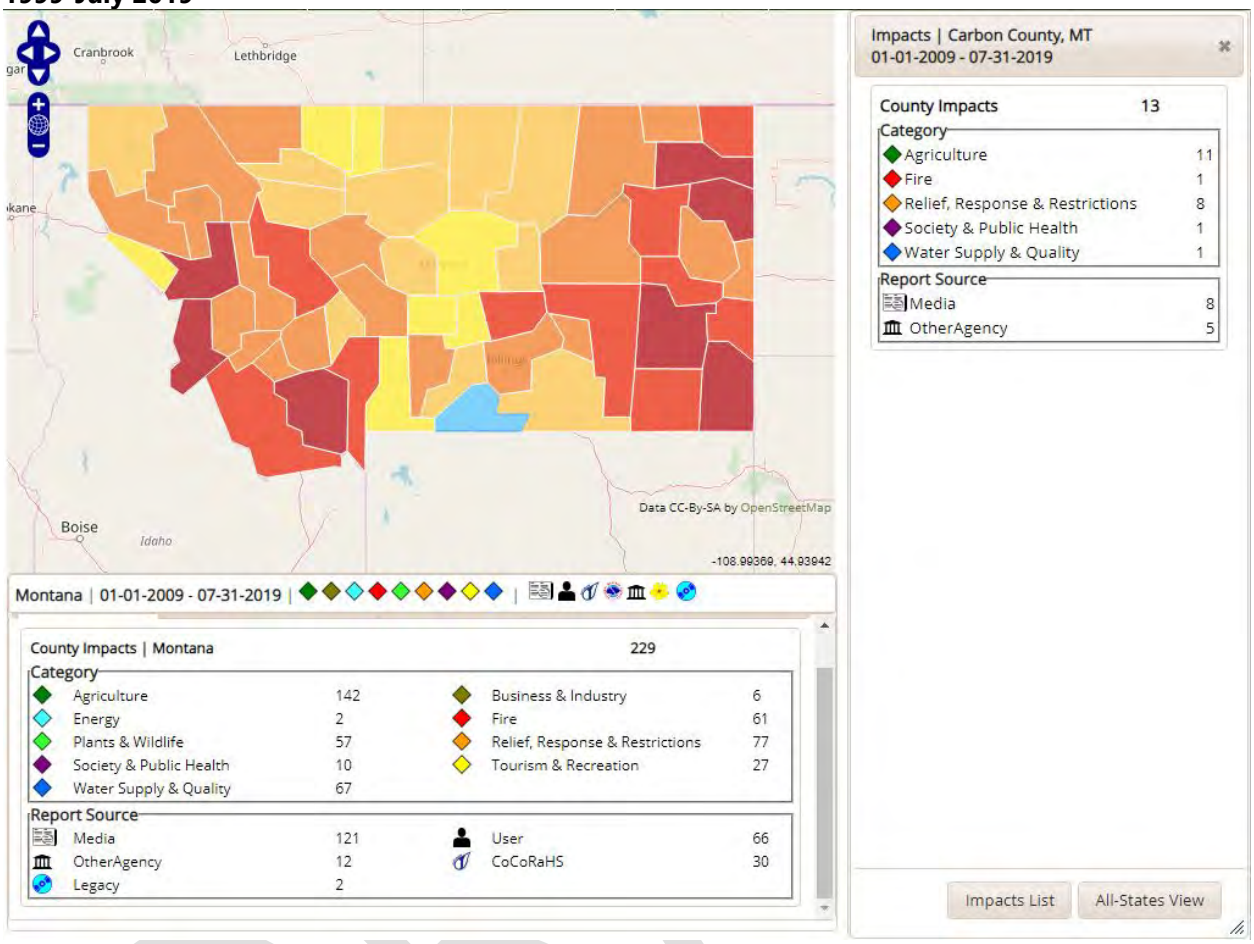
According to the HMPC, in the 2017 portions of the Yellowstone River and its tributaries were closed to fishing due to water temperatures hovering around 70 degrees. The increased water temperature and low flows are believed to be behind another outbreak of Proliferative Kidney Disease caused by a microscopic parasite resulting in the high fish mortality. This type of closure has significant impact to the recreation economy of the area.

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

The Drought Impact Reporter contains information on 13 drought impacts from droughts that affected Carbon County between 1999 and July 2019, refer to Figure 3-11 below. The list is not comprehensive. Most of the impacts were classified as "agriculture" and "relief, response and restrictions." Other impacts include "fire," "society and public health" and "water supply and quality." These categories are described as follows:

- Agriculture—Impacts associated with agriculture, farming, and ranching. Examples include damage to crop quality, income loss for farmers due to reduced crop yields, reduced productivity of cropland, insect infestation, plant disease, increased irrigation costs, cost of new or supplemental water resource development, reduced productivity of rangeland, forced reduction of foundation stock, closure/limitation of public lands to grazing, high cost/unavailability of water for livestock, and range fires.
- Water/Energy—Impacts associated with surface or subsurface water supplies (i.e., reservoirs or aquifers), stream levels or streamflow, hydropower generation, or navigation. Examples include lower water levels in reservoirs, lakes, and ponds; reduced flow from springs; reduced streamflow; loss of wetlands; estuarine impacts; increased groundwater depletion, land subsidence, reduced recharge; water quality effects; revenue shortfalls and/or windfall profits; cost of water transport or transfer; cost of new or supplemental water resource development; and loss from impaired navigability of streams, rivers, and canals.
- Plants and Wildlife—Impacts associated with wildlife, fisheries, forests, and other fauna. Examples include loss of biodiversity of plants or wildlife; loss of trees from urban landscapes, shelterbelts, wooded conservation areas; reduction and degradation of fish and wildlife habitat; lack of feed and drinking water; greater mortality due to increased contact with agricultural producers, as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation; migration and concentration; and increased stress to endangered species.
- Fire—Impacts associated with wildland fires that occur during drought events. The relationship between fires and droughts is very complex. Not all fires are caused by droughts and serious fires can result when droughts are not taking place.
- Social—Impacts associated with the public, or the recreation/tourism sector. Examples include health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations, reduced firefighting capability, etc.), loss of human life (e.g., from heat stress, suicides), public safety from wildland fires, increased respiratory ailments; increased disease caused by wildlife concentrations, population migrations, loss of aesthetic values; reduction or modification of recreational activities, losses to manufacturers and sellers of recreational equipment, and losses related to curtailed activities.
- Other—Drought impacts that do not easily fit into any of the above categories.

Figure 3-11 Drought Impact Reporter Summary of Impacts at the County Level in Carbon County, 1999-July 2019



Carbon County has a history of prolonged dry weather periods that have significant economic and environmental impacts. Vegetation is stressed, vegetative diversity may be altered, and wildfires thrive during drought cycles as was seen in the 2017 "flash" drought event. Farmers and ranchers are hard pressed to grow crops and feed livestock through drought years and show a profit. The areas vulnerability to drought is well documented and discussed further in the Vulnerability section below.

Likelihood of Future Occurrence

Likely — Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less. Historical drought data for the planning area indicates there has been 20 USDA Secretarial Disaster Declarations due to Drought for the County in the past 40 years. This equates to a 48 percent chance of a drought in any given year, which corresponds to a likely occurrence rating. In addition, although drought affects the entire planning equally, the potential impacts may be variable depending on contextual factors such as the degree of assets and activities historically impacted by drought, such as the agricultural and tourism industries.

Climate Change Considerations

The Intergovernmental Panel on Climate has projected dramatic changes in regional climate characteristics between present-day and if global temperatures rise between 1.5 degrees Celsius and 2

degrees Celsius. Drought events specifically are projected to increase in frequency and have longer durations due to shifts in seasonal precipitation patterns leading to dryer summers and less precipitation in the form of snow in the early spring and late fall. According to the State of Montana Climate Assessment (2017), earlier peak runoff due to rapid springtime melting have been observed and document; spring runoff has shifted a week earlier in the Northern Rockies over the past half-century, with most of the changes occurring since the mid-1980s. Climate models shows a larger percentage of water will leave regional watersheds during winter and early spring resulting in less water to support streamflow during the summer and early fall. According to the climate projections for watersheds with high elevations such as the Yellowstone at Billings show an increase in runoff from January – April and streamflow will be reduced during July – September. Changes in water dynamics that are driven by runoff can have significant consequences to water supplies and agricultural production. The 2016 report, "The Impact of Climate Change on Montana's Agricultural Economy" prepared for the Montana Farmers Union, states that by the middle of the century the effects of climate change is projected to have significant economic impacts on the statewide agricultural economy. The report projects a 20 percent decline in rangeland cattle production and 25 percent reduction in grain production, resulting in a loss of about 25,000 jobs and $736 million in labor earnings by mid-century.

Vulnerability

The County is directly vulnerable to drought from two standpoints - the first being lack of precipitation or rainfall in the county itself, the second being when precipitation (primarily snowfall) is below normal in watersheds draining into and through Carbon County. Snowmelt runoff from upstream watersheds is critical to provide adequate water for irrigation and aquifer replenishment in the county.

Wide-spread, long-lasting drought has the potential to cause the most damage by affecting agriculture, domestic water supplies, and fire danger. Dryland and irrigated farming and livestock production provide important sources of income for Carbon County. The County has an extensive system of irrigation ditches that deliver water from the higher elevations across the benches to the valley bottoms and within the tilled valley bottoms. Drought and blight can have adverse effects on farm and livestock production, domestic and municipal water supplies, and wildland fire danger. Drought generally does not directly affect structures.

People

The historical and potential impacts of drought on populations include agricultural sector job loss, secondary economic losses to local businesses and public recreational resources, increased cost to local and state government for large-scale water acquisition and delivery, and water rationing and water wells running dry for individuals and families. As drought is often accompanied by prolonged periods of extreme heat, negative health impacts such as dehydration can also occur, where children and elderly are most susceptible. Other public health issues can include impaired drinking water quality, increased incidence of mosquito-borne illness, an increase in wildlife-human confrontations and respiratory complications as a result of declined air quality in times of drought.

According to the Data Collection Guide completed by the Town of Joliet, that community dispersers public information on water conservation and water usage specific to drought events and lessen the impacts of drought.

Economy

Based on the USDA's Risk Management Agency Crop Indemnity Reports which were collected for the years 2015-2018, crop losses due to drought were reported in every year across the county. Table 3-22

summarizes the agricultural losses experienced across the county communities. A total of $170,684 was indemnified for 6,632 acres of affected crops covering 49 policies since 2015.

Table 3-22 Risk Management Agency Crop Indemnity Reports, 2015-2018

Year	Crop	Month of Loss	Policies Indemnified	Net Determined Acres	Indemnity Amount	Loss Ratio
2015	Wheat	May	2	232	$ 8,272	5.1%
		June	4	505	$ 16,307	5.2%
	Barley	June	1	97	$ 3,424	3.5%
	Forage Production	May	1	61	$ 2,831	1.8%
		June	1	195	$ 1,040	0.2%
		July	2	284	$ 5,889	0.7%
2016	Wheat	May	1	165	$ 2,305	0.7%
		June	5	1,376	$ 54,708	2.2%
		July	2	94	$ 5,575	3.2%
	Forage Production	May	2	393	$ 10,740	1.0%
		June	12	1,593	$ 36,287	6.7%
2017	Wheat	June	2	159	$ 2,785	1.1%
	Forage Production	September	1	53	$ 155	0.2%
		May	5	921	$ 13,196	3.1%
		June	3	425	$ 5,685	3.2%
		July	2	25	$ 216	1.6%
	Forage Seeding	May	1	15	$ -	0.0%
		August	1	7	$ 479	2.5%
2018	Forage Production	October	1	31	$ 790	3.5%
TOTAL			**49**	**6,632**	**$ 170,684**	

Source: USDA Risk Management Agency

Built Environment

Direct structural damage from drought is rare, though it can happen. Drought can affect soil shrinking and swelling cycles and can result in cracked foundations and infrastructure damage. According to the HMPC, sinkholes have been found to be connected to drought events in the past.

Critical Facilities and Infrastructure

Due to the long-lasting nature of the hazard, the biggest impact of drought is on water supply. As a result, critical facilities that rely on a steady supply of water could see the greatest impacts if a long-term drought occurred. Drought can also directly impact water storage, treatment and distribution systems.

Historic, Cultural, and Natural Resources

Severe, prolonged drought can have a negative impact on the natural environment. Wildlife and natural habitats can be affected, including the shrinkage of habitat, dwindling food supplies and the migration of wildlife to more palatable areas. Prolonged drought can cause poor soil quality and increased soil erosion. One of the prevailing impacts of drought to the natural environment is the increased risk of pest

infestations and wildfires that burn larger and more intensely during dry conditions. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. Environmental impacts of drought caused lead to compound effects to the local economy specifically tourism that is directly tied to the different natural resources available in the County.

Future Development

According to the HMPC water restrictions have been put into place in the past due to drought events although the County and incorporated communities have not felt much of the impact of drought in the past, there is an understanding for the potential for large-scale irrigation impacts from a long-term drought. Overall, losses associated with drought and future development are not anticipated to be substantial unless there is more agricultural and housing development.

Risk Summary

- 22 Disaster Declarations due to drought from 1992-2017; two Executive Orders from the Governor's Office and 20 from the USDA Secretary of Agriculture
- Agricultural economy is most vulnerable to effects of drought
- From 2015-2018 drought has led to $170,684 crops indemnified for 6,632 acres and affecting crops covering 49 policies
- Overall hazard significance is high
- *Related Hazards:* Wildfire, Summer Storms

Drought Hazard Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Extensive	Likely	Critical	High
City of Red Lodge	Extensive	Likely	Critical	High
Town of Bearcreek	Extensive	Likely	Critical	High
Town of Bridger	Extensive	Likely	Critical	High
Town of Joliet	Extensive	Likely	Critical	High
Town of Fromberg	Extensive	Likely	Critical	High

Earthquakes

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Significant	Occasional	Limited	Medium

Hazard Description

An earthquake is a sudden, rapid shaking of the ground caused by the breaking and shifting of rock beneath the earth's surface or along fault lines. For hundreds of millions of years, the forces of plate tectonics have shaped the Earth as the huge plates that form the Earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet, commonly called faults; however, some earthquakes occur in the middle of plates.

A fault is a fracture in the earth's crust along which movement has occurred either suddenly during earthquakes or slowly during a process called creep. Cumulative displacement may be tens or even hundreds of miles if movement occurs over geologic time. However, individual episodes are generally small, usually less than several feet, and are commonly separated by tens, hundreds, or thousands of years. Damage associated with fault-related ground rupture is normally confined to a fairly narrow band along the trend of the fault. Structures are often not able to withstand fault rupture and utilities crossing faults are at risk of damage. Fault displacement involves forces so great that it is generally not feasible (structurally or economically) to design and build structures to accommodate this rapid displacement.

Fault displacement can also occur in the form of barely perceptible movement called "fault creep." Damage by fault creep is usually expressed by the rupture or bending of buildings, fences, railroads, streets, pipelines, curbs, and other linear features. In addition, there is also the potential for co-seismic creep, where movement on a fault is triggered by an earthquake on another nearby fault.

Geographic Area

The State of Montana is located within the Intermountain Seismic Belt, a region of active earthquakes that stretches along the Rocky Mountains. This earthquake region comprises of the mountainous west third of the state. Only a small portion of the County is located on the edge of the Belt. Therefore, the geographic area potentially affected by an earthquake event in Carbon County is significant, with 10-50% of the County experiencing damaging earthquake

Extent (Magnitude/Severity)

Earthquakes are measured by magnitude and intensity. Magnitude measures the energy released at the source of the earthquake and is measured by a seismograph. Intensity is a measure of the shaking produced by an earthquake at a certain location and is based on felt affects. A comparison of magnitude and intensity is shown in Table 3-23.

Table 3-23 Magnitude and Modified Mercalli Scales for Measuring Earthquakes

Magnitude	Modified Mercalli Intensity
1.0 – 3.0	I
3.0 – 3.9	II, III
4.0 – 4.9	IV – V
5.0 – 5.9	VI – VII
6.0 – 6.0	VII – IX
7.0 and higher	VIII or higher

Source: USGS Earthquake Hazards Program

Intensity is gauged by how an earthquake affects people, structures and the natural environment. The Modified Mercalli Intensity Scale if the standard scale used in the United States to measure intensity. Table 3-24 provides the abbreviated descriptions for each intensity level.

Table 3-24 Modified Mercalli Intensity (MMI) Scale

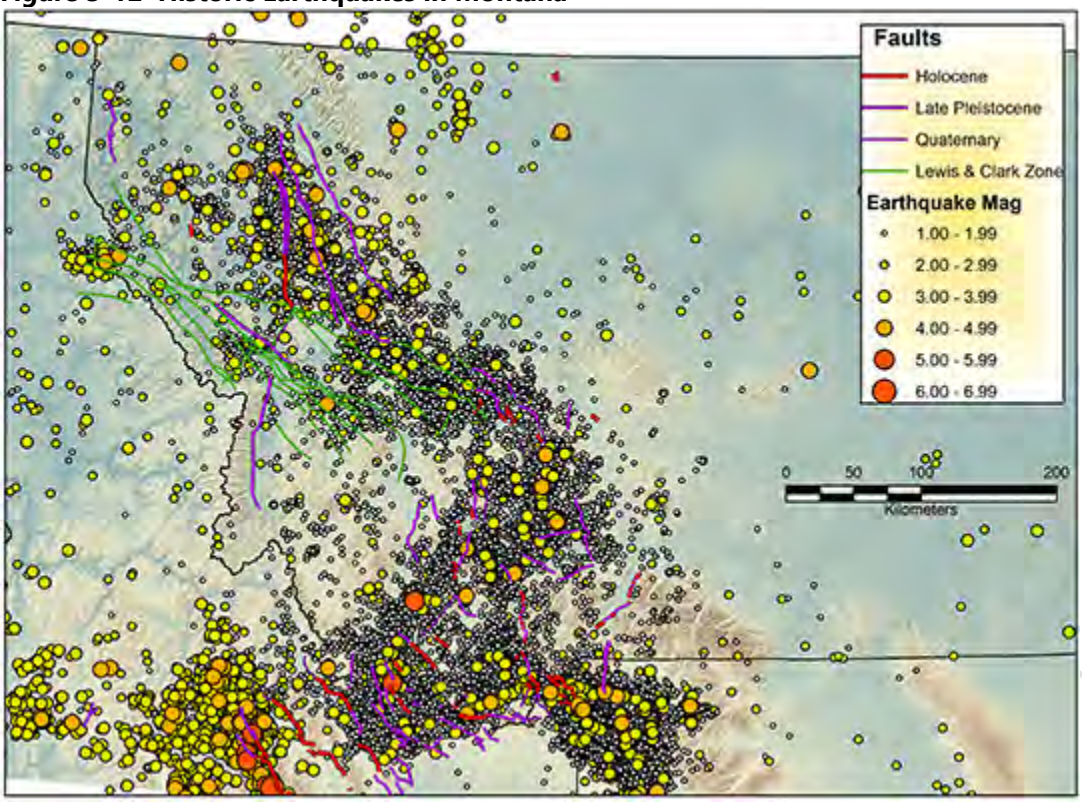
MMI	Felt Intensity
I	Not felt except by a very few people under special conditions. Detected mostly by instruments.
II	Felt by a few people, especially those on upper floors of buildings. Suspended objects may swing.
III	Felt noticeably indoors. Standing automobiles may rock slightly.
IV	Felt by many people indoors; by a few outdoors. At night, some people are awakened. Dishes, windows, and doors rattle.
V	Felt by nearly everyone. Many people are awakened. Some dishes and windows are broken. Unstable objects are overturned.
VI	Felt by everyone. Many people become frightened and run outdoors. Some heavy furniture is moved. Some plaster falls.
VII	Most people are alarmed and run outside. Damage is negligible in buildings of good construction, considerable in buildings of poor construction.
VIII	Damage is slight in specially designed structures, considerable in ordinary buildings, and great in poorly built structures. Heavy furniture is overturned.
IX	Damage is considerable in specially designed buildings. Buildings shift from their foundations and partly collapse. Underground pipes are broken.
X	Some well-built wooden structures are destroyed. Most masonry structures are destroyed. The ground is badly cracked. Considerable landslides occur on steep slopes.
XI	Few, if any, masonry structures remain standing. Rails are bent. Broad fissures appear in the ground.
XII	Virtually total destruction. Waves are seen on the ground surface. Objects are thrown in the air.

Source: USGS Earthquake Hazards Program

Historic Occurrences

According to the U.S. Geological Survey, Montana is one of the most seismically active states in the country. However, Montana's earthquake activity occurs primarily in the western third of the state, as shown in Figure 3-12.

Figure 3-12 Historic Earthquakes in Montana



Source: Montana Bureau of Mines and Geology

The first significant quake on record that would have been felt in Carbon County was on June 27, 1925. Although centered in southwestern Montana, the quake shook locations all over the state and beyond the state boundaries in all directions. The largest quake in Montana's history was the Hebgen Lake earthquake on August 17, 1959. The quake was a magnitude of 7.1. Shocks from the quake were felt in Carbon County and many long-time residents of the County recall the disaster. The largest earthquake swarm since 1973 occurred in the fall of 1985. More than 3,000 earthquakes struck the upper Madison Valley area. None were felt in Carbon County (Tracking Changes in Yellowstone's Restless Volcanic System, U.S.G.S. Website). Interviews of over 25 county residents provided only one recollection of a minor quake that had occurred in the back country, caused no damage, and was never documented. A search of the USGS National Earthquake Information Center database shows 16 events between 2011 and August 2019, ranging from 2.5 to 3.4 on the Richter scale. The epicenters were all greater than 50 miles away, so none of these events were felt inside the County.

According to the HMPC an earthquake was responsible for permanently shutting down the Montaqua Hot Springs. The Committee noted that the area has felt several tremors, but no major impacts have occurred due to an earthquake event.

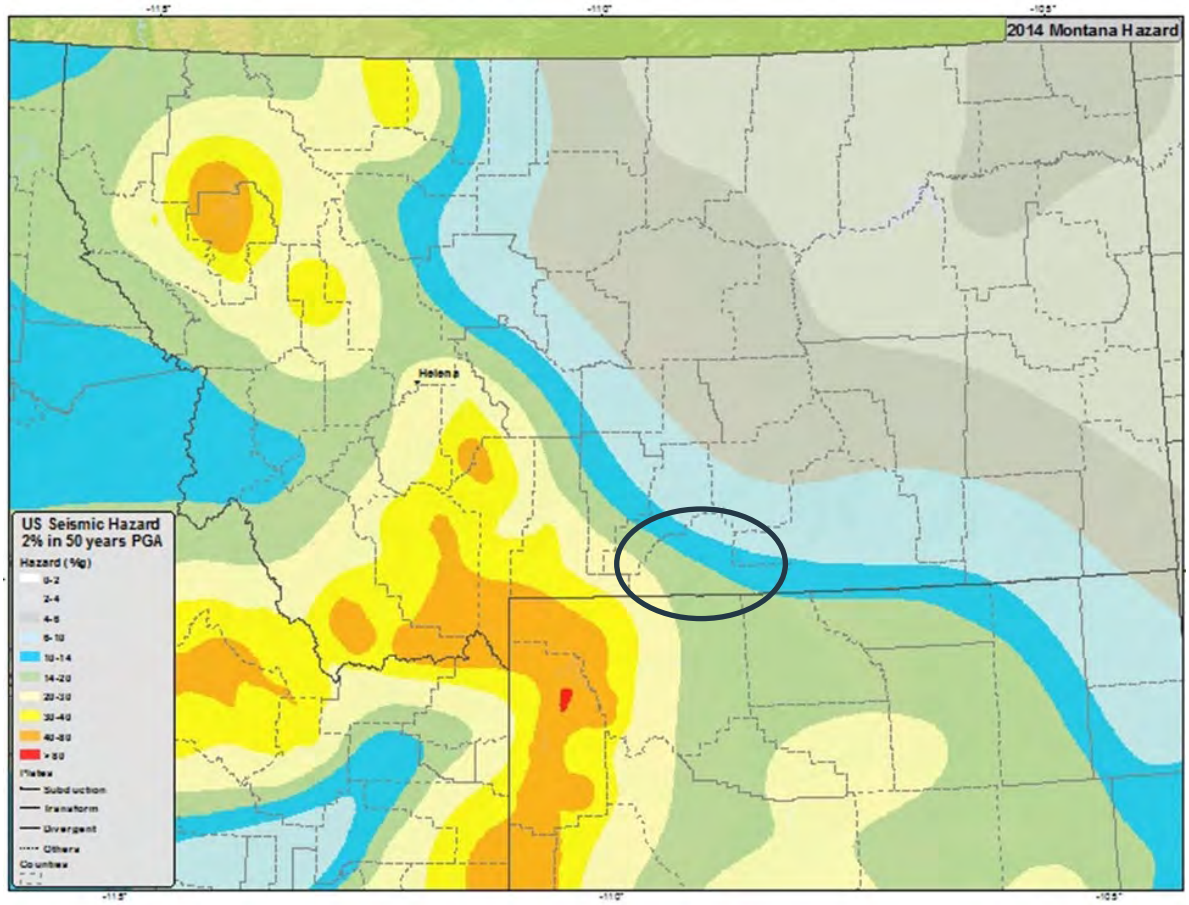
Likelihood of Future Occurrences

Occasional - The U.S. Geological Survey (USGS) issues National Seismic Hazard Maps as reports every few years. These maps provide various acceleration and probabilities for time periods. Figure 3-13 depicts the peak horizontal acceleration (%g) with 2% probability of exceedance in 50 years for the County, also known as the 2,500-year probabilistic map. Until recently, the 500-year map was often used for planning

purposes for average structures and was the basis of the most current Uniform Building Code. The new International Building Code, however, uses a 2,500-year map as the basis for building design.

The figure demonstrates that the County falls in the 6%g to 14%g area. This data indicates that the expected severity of earthquakes in the County is fairly limited, as damage from earthquakes typically occurs at peak accelerations of 30%g or greater. However, the potential, though remote, does exist for damaging earthquakes.

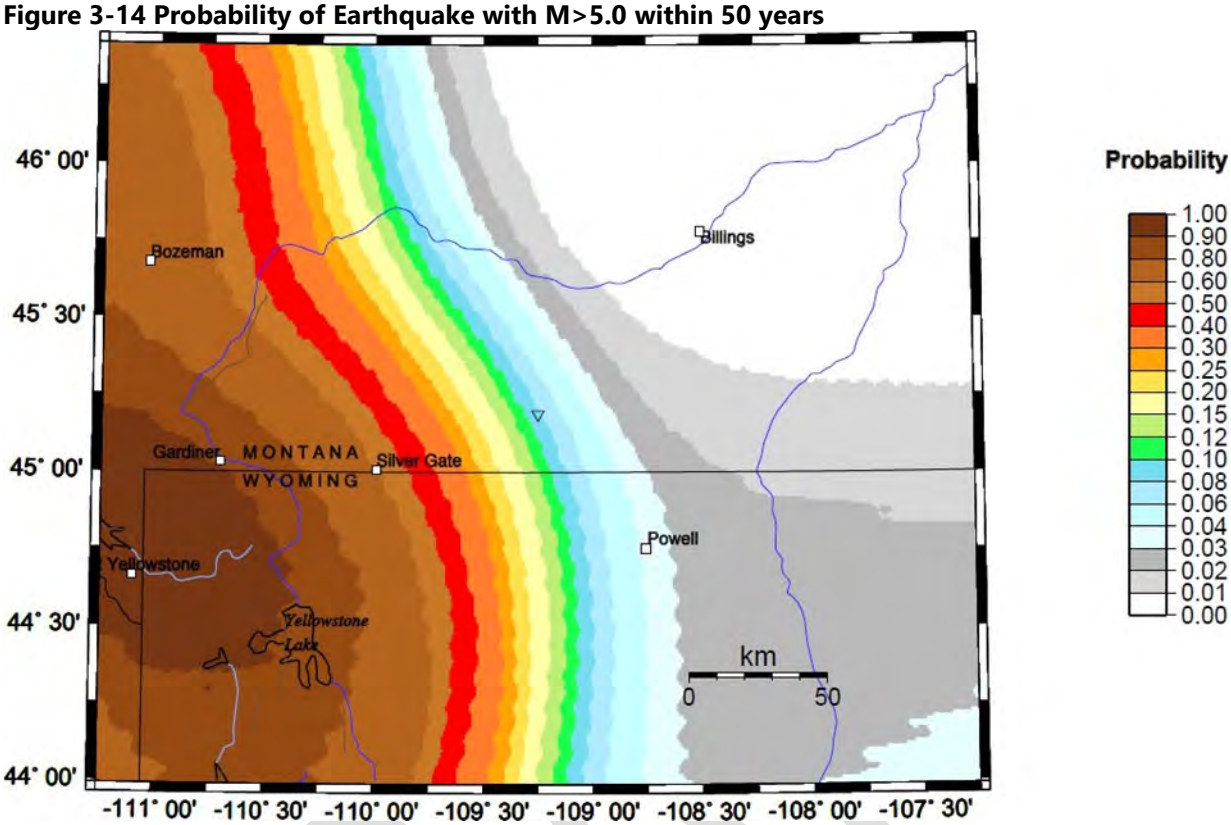
Figure 3-13 Peak Horizontal Acceleration from Earthquake in Carbon County



Source: USGS

In addition, Figure 3-14 from the USGS shows the probability that an earthquake of magnitude 5 or greater will occur in the next 50 years within 50 kilometers of Red Lodge (marked by the triangle in the center of the image). The chance of such an event occurring is 8 to 10%.

Figure 3-14 Probability of Earthquake with M>5.0 within 50 years



Source: USGS 2009 Earthquake Probability Mapping

Climate Change Considerations

Climate change is not expected to directly affect earthquake frequency or intensity.

Vulnerability

Earthquakes will continue to occur in Montana; however, the precise time, location, and magnitude of future events cannot be predicted. As discussed above, earthquake hazard areas in Montana are concentrated in the western portion of the state, which is part of the Intermountain Seismic Belt (Figure 3-12 above). Numerous factors contribute to determining areas of vulnerability: historical earthquake occurrence, proximity to faults, soil characteristics, building construction, and population density, to mention a few.

According to Earthquake Studies Specialist, Mike Stickney at the Montana Bureau of Mines and Geology (MBMG), Carbon County is located east of the most seismically active areas in Montana. The chances of having a major earthquake centered in Carbon County are very small. Carbon County is most likely to feel shaking as a result of an earthquake centered elsewhere if any shaking is felt at all. Damage from an earthquake although unlikely, could conceivably occur in Carbon County if a large magnitude earthquake occurred elsewhere. If the ground was saturated at the time of the earthquake the potential for landslides would be increased. Infrastructure and structures across the entire County would be at risk if an earthquake did occur, particularly unreinforced masonry structures such as the historic buildings in downtown Red Lodge. Impacts to structures could include structural damage, cracked foundations, or collapse. Given the lack of potentially active faults and historic occurrences in Carbon County, earthquakes are a low probability but potentially high consequence hazard to the planning area. A probabilistic Hazus

earthquake scenario was performed as part of this plan's development to show the results of a more worst-case scenario.

Hazus-MH 4.2, FEMA's loss estimation software, was utilized to model earthquake losses for Carbon County. A Level 1 analysis was completed, meaning that only the default data was used and not supplemented with local building inventory or hazard data. There are certain data limitations when using the default data, so the results should be interpreted accordingly; this is a planning level analysis.

The 2,500-year return period analyzes ground shaking estimates with a 2 percent probability of being exceeded in 50 years, from the various seismic sources in the area. The International Building Code uses this level of ground shaking for building design in seismic areas and is more of a worst-case scenario.

The results of the probabilistic scenario are discussed in more detail below. Key losses included the following:

- Total economic loss estimated for the earthquake was $28.88 million, which includes building losses and lifeline losses based on the Hazus-MH inventory
- Building-related losses, including direct building losses and business interruption losses, totaled $28.25 million
- 331 buildings equating to over 5 percent of the buildings in the County were at least moderately damaged. 1 building was completely destroyed
- Over 71 percent of the building- and income-related losses were residential structures. 17 percent of the estimated losses were related to business interruptions
- 4,000 tons of debris will be generated
- The mid-day earthquake caused the most injuries, with six recorded

People

Shelter Requirement: Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 2 that no households to will be displaced due to the earthquake, and 1 person (out of a total population of 10,078) will seek temporary shelter in public shelters.

Casualties: Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related injuries result from collapsing walls, flying glass, and falling objects as a result of the ground shaking, or people trying to move more than a few feet during the shaking. Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four severity levels that describe the extent of the injuries. The levels are described as follows:

- Severity Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy

loads. The 2:00 AM estimate considers that the residential occupancy load is at its maximum. The 2:00 PM estimate considers that the educational, commercial and industrial sector loads are at their maximum. The 5:00 PM represents peak commute time. The estimates show (refer to Figure 3-15) that causalities are not excepted but injuries that require hospitalization but not life-threatening are likely.

Figure 3-15 Hazus Earthquake Causality Estimates for Carbon County

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.06	0.01	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.06	0.01	0.00	0.00
	Other-Residential	0.80	0.09	0.00	0.00
	Single Family	1.08	0.08	0.00	0.00
	Total	2	0	0	0
2 PM	Commercial	3.46	0.52	0.05	0.09
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.59	0.09	0.01	0.01
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.40	0.06	0.00	0.01
	Other-Residential	0.15	0.02	0.00	0.00
	Single Family	0.21	0.02	0.00	0.00
	Total	5	1	0	0
5 PM	Commercial	2.45	0.37	0.03	0.06
	Commuting	0.00	0.00	0.01	0.00
	Educational	0.01	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.25	0.04	0.00	0.01
	Other-Residential	0.29	0.03	0.00	0.00
	Single Family	0.41	0.03	0.00	0.00
	Total	3	0	0	0

Source: Hazus 4.2

Economy

Hazus estimates the long-term economic impacts to the region. The model quantifies this information in terms of income and employment changes within the region. The total economic loss estimated for the earthquake is $28.88 million, which includes building and lifeline related losses based on the region's available inventory. About 17% of the estimated losses were related to the business interruption of the region.

Since the building losses are broken into two categories (of direct building losses compared to business interruption losses), building related losses, which summarize estimates costs to fix or replace structures and damages to properties and their contents are discussed in more detail in the Built Environment section below.

However, business interruption losses are summarized below. They included the temporary living expenses for people displaced from their homes because of the earthquake event. These business-related economic losses are summarized in Figure 3-16.

Figure 3-16 Business-Related Economic Loss Estimated in Millions of Dollars

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.2813	0.6884	0.0172	0.1158	1.1027
	Capital-Related	0.0000	0.1196	0.7216	0.0105	0.0123	0.8640
	Rental	0.2753	0.2643	0.3592	0.0069	0.0191	0.9248
	Relocation	0.9412	0.2563	0.5121	0.0542	0.2012	1.9650
	Subtotal	**1.2165**	**0.9215**	**2.2813**	**0.0888**	**0.3484**	**4.8565**
Capital Stock Losses							
	Structural	1.6194	0.4773	0.6512	0.1176	0.3281	3.1936
	Non_Structural	9.7231	1.6612	1.6320	0.3739	0.6883	14.0785
	Content	3.9843	0.4080	0.9307	0.2355	0.4728	6.0313
	Inventory	0.0000	0.0000	0.0325	0.0408	0.0182	0.0915
	Subtotal	**15.3268**	**2.5465**	**3.2464**	**0.7678**	**1.5074**	**23.3949**
	Total	**16.54**	**3.47**	**5.53**	**0.86**	**1.86**	**28.25**

Source: Hazus 4.2

Built Environment

Unreinforced Masonry Building (URM)s: Unreinforced masonry building type structures consist of buildings made of unreinforced concrete and brick, hollow concrete blocks, clay tiles, and adobe. Buildings constructed of these materials are heavy and brittle, and typically provide little earthquake resistance. In small earthquakes, unreinforced buildings can crack, and in strong earthquakes, they have a tendency to collapse. These types of structures pose the greatest structural risk to life and safety of all general building types. Non-structural items and building components can also influence the amount of damage that buildings suffer during an earthquake. Unreinforced parapets, chimneys, facades, signs, and building appendages can all be shaken loose, creating a serious risk to life and property.

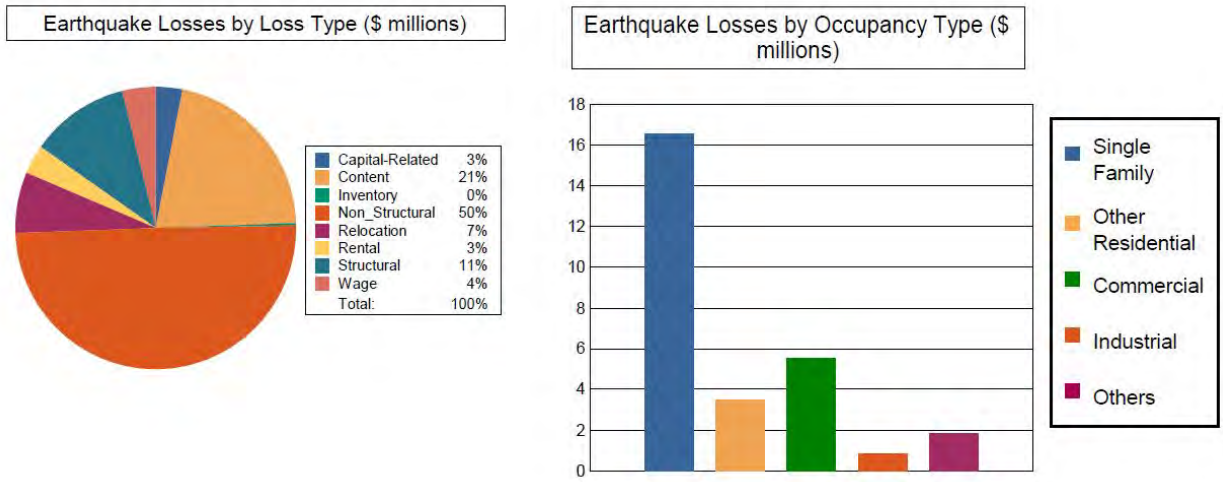
Hazus Results: There are an estimated 6,000 buildings in the region with a total building replacement value (excluding contents) of $1,415 millions of dollars. Of the buildings in the region 94% are associated with residential housing. In terms of building construction types found in the region, wood frame construction makes up 86% of the building inventory.

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building

and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake.

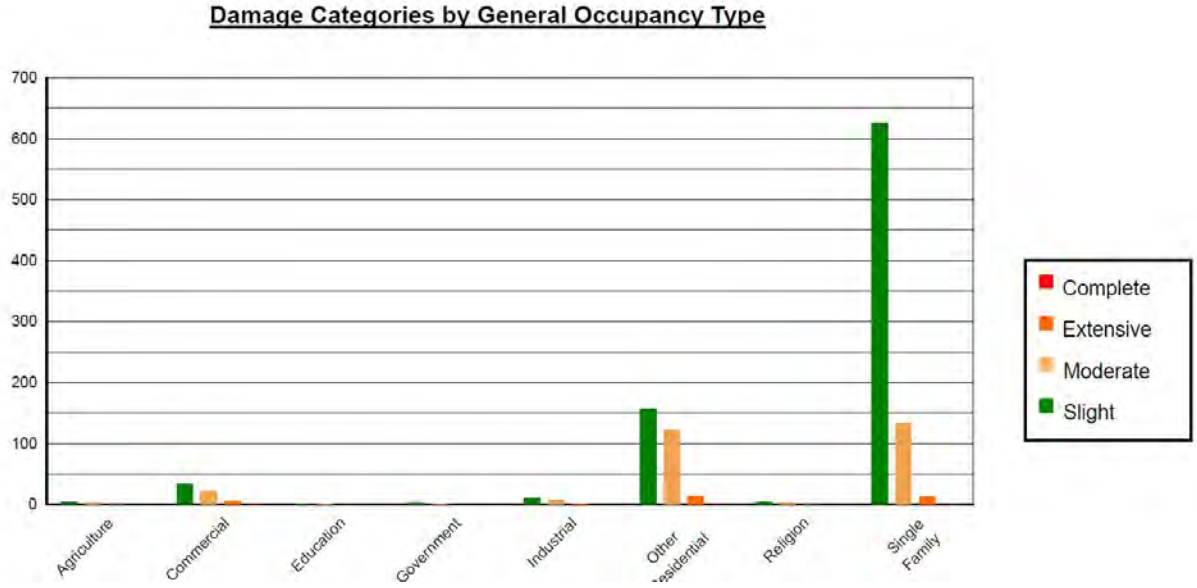
Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake. The total building-related losses were $28.25 million. By far, the largest loss was sustained by the single-family residential occupancies which made up over 85% of the total loss and other residential with 9.5% of total loss. Figure 3-17 and Figure 3-18 provide a summary of the losses associated with the building damage.

Figure 3-17 Earthquake Losses by Loss Type and Occupancy Type (in Millions of Dollars)



Source: Hazus 4.2

Figure 3-18 Expected Structure Damages by Occupancy Type



Source: Hazus 4.2

Hazus estimates that about 331 buildings will be at least moderately damaged. This is over 5% of the total number of buildings in the region. There is 1 building that will be damaged beyond repair. Figure 3-19

summarizes the expected damage by property occupancy class in more detail, whereas Figure 3-20 contains the results of the expected building damage by building material type.

Figure 3-19 Expected Building Damage by Occupancy Class

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	21.73	0.40	3.48	0.42	2.21	0.75	0.54	1.50	0.03	1.98
Commercial	164.21	3.02	33.38	3.98	22.49	7.66	5.53	15.40	0.39	23.12
Education	11.56	0.21	1.91	0.23	1.24	0.42	0.27	0.76	0.02	1.05
Government	14.82	0.27	2.41	0.29	1.48	0.50	0.28	0.77	0.02	1.04
Industrial	52.43	0.96	10.62	1.27	7.83	2.67	2.00	5.58	0.12	6.81
Other Residential	517.01	9.50	156.00	18.62	121.90	41.50	14.37	40.06	0.72	42.40
Religion	23.10	0.42	3.90	0.47	2.46	0.84	0.51	1.43	0.03	2.03
Single Family	4639.98	85.22	626.16	74.73	134.11	45.66	12.38	34.50	0.37	21.57
Total	**5,445**		**838**		**294**		**36**		**2**	

Source: Hazus 4.2

Figure 3-20 Expected Building Damage by Building Material (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4687.25	86.09	637.87	76.13	127.49	43.41	9.18	25.60	0.32	19.15
Steel	64.98	1.19	11.82	1.41	9.53	3.24	1.84	5.14	0.15	9.13
Concrete	50.29	0.92	11.17	1.33	7.30	2.49	1.31	3.64	0.05	3.22
Precast	43.69	0.80	8.36	1.00	9.07	3.09	3.29	9.16	0.14	7.98
RM	139.69	2.57	19.65	2.35	19.24	6.55	5.61	15.63	0.09	5.60
URM	19.31	0.35	5.94	0.71	4.23	1.44	1.32	3.67	0.28	16.50
MH	439.61	8.07	143.07	17.08	116.85	39.78	13.33	37.16	0.65	38.42
Total	**5,445**		**838**		**294**		**36**		**2**	

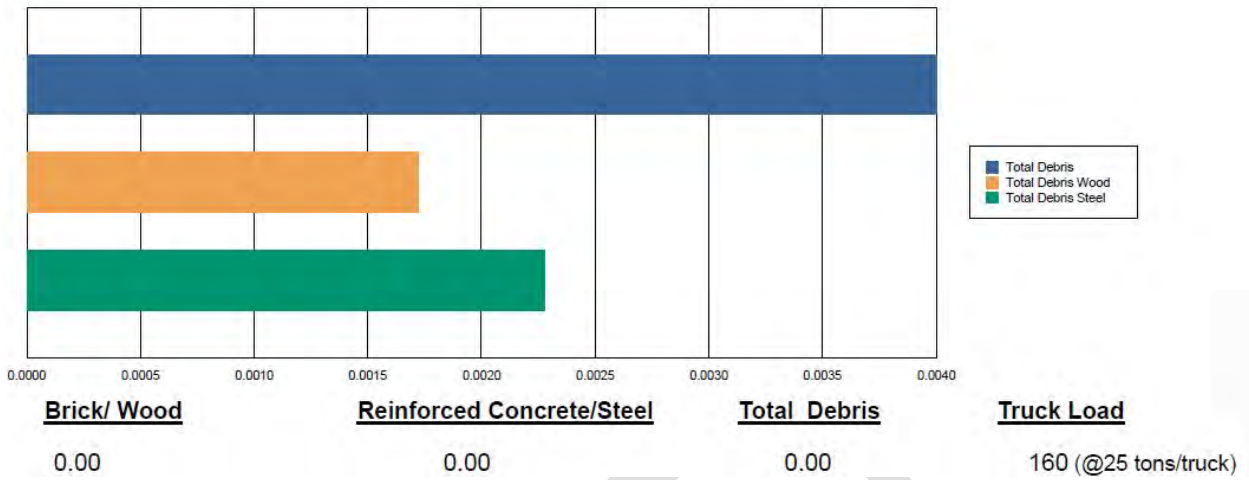
*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Source: Hazus 4.2

Hazus also estimates the amount of debris that will be generated by the earthquake event analyzed. The model subdivides the debris into two general categories: a) Brick/Wood; and, b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4,000 tons of debris will be generated. Of that total amount, Brick/Wood comprises 43% of the debris, while the remainder would be Reinforced Concrete/Steel. If the debris tonnage was converted to estimates of truckloads required to remove it, debris generated would convert to about 160 truckloads, with each truckload carrying 25 tons. Figure 3-21 summarizes the debris generation and material type for this earthquake event.

Figure 3-21 Debris Generation in Millions of Tons and by Material Type



Source: Hazus 4.2

Critical Facilities and Infrastructure

Critical Facility Inventory: Hazus breaks critical facilities into two groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites. Note that Hazus only provides structure and facility estimates based on U.S. Census data from 2010, and so the mentioned inventory results are likely off based on today's actual facility totals.

Essential Facility Damage: The model did not result in expected damages from the earthquake event. The model does estimate that on the day of the earthquake only 71% of hospital beds will be available for those injured by the earthquake. After one week 93% of beds will be back in service and by 30 days the hospital will be 100% operational. Police stations and fire stations are also expected to be back to functionality after day one.

Transportation Systems Inventory: Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are 7 transportation systems that include highways, railways, light rail, bus, ports, ferry, and airports. There are 6 utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power, and communications. According to the Hazus results, the transportation systems inventory and expected damages from the earthquake would be $0 based on the analysis. The transportation systems inventory includes over 183.30 miles of highways and 64 bridges and related economic losses to these systems would be around $1,000 (very minor).

Utility Lifeline Systems Inventory: The replacement value of the transportation and utility lifeline systems combined is estimated to be $1,507 million. The expected utility system facility damages in terms of total structures or systems affected, along with the inventory of this dataset, are summarized in Figure 3-22. Economic losses in millions of dollars are found in Figure 3-23. Site specific expected utility system pipeline damages (including their inventory) are included in Figure 3-23, while the potable water and electric power system performance limitations, damages, and inventory will be in Figure 3-25.

Figure 3-22 Expected Utility Systems Facility Inventory and Damages

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	127.0259
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**127.0259**
Waste Water	Distribution Lines	NA	76.2155
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**76.2155**
Natural Gas	Distribution Lines	NA	50.8104
	Facilities	1	1.0791
	Pipelines	0	0.0000
		Subtotal	**51.8895**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	0	0.0000
		Subtotal	**0.0000**
Communication	Facilities	1	0.0990
		Subtotal	**0.0990**
		Total	**255.20**

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	1	0	0	1	1
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	1	0	0	1	1

Source: Hazus 4.2

Figure 3-23 Utility System Economic Losses in Millions of Dollars

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	127.0259	0.2860	0.23
	Subtotal	**127.0259**	**0.2860**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	76.2155	0.1437	0.19
	Subtotal	**76.2155**	**0.1437**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	1.0791	0.0493	4.57
	Distribution Lines	50.8104	0.0492	0.10
	Subtotal	**51.8895**	**0.0985**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Communication	Facilities	0.0990	0.0056	5.66
	Subtotal	**0.0990**	**0.0056**	
	Total	**255.23**	**0.53**	

Source: Hazus 4.2

Figure 3-24 Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	3,947	64	16
Waste Water	2,368	32	8
Natural Gas	1,579	11	3
Oil	0	0	0

Source: Hazus 4.2

Figure 3-25 Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	4,571	0	0	0	0	0
Electric Power		0	0	0	0	0

Source; Hazus 4.2

Historic, Cultural, and Natural Resources

Earthquake effects on the environment, natural resources, and historic and cultural assets could be very destructive depending on the type of seismic activity experienced and secondary/cascading effects from an event (e.g. wildfire). The biggest impact would likely be on the older historic properties in the municipalities such as wooden or unreinforced masonry buildings.

Future Development

Future development in the county is not anticipated to significantly affect vulnerability to earthquakes when designed according to modern building codes such as 2015 International Building Code guidelines. However, future development will result in a slight increase in exposure of the population, building stock, and related infrastructure to earthquakes.

Risk Summary

- Common for residents to feel tremors but no major impacts have occurred
- The probability of a major earthquake being large enough and close enough to cause significant damage in Carbon County is low
- Hazus results show that a worst-case scenario earthquake would result in $28 million in economic impacts; 71% of building losses would be from residential properties.
- *Related Hazards*: Earth Movement, Dam Failure

Earthquake Hazard Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Significant	Occasional	Limited	Medium
City of Red Lodge	Significant	Occasional	Limited	Medium
Town of Bearcreek	Significant	Occasional	Limited	Medium
Town of Bridger	Significant	Occasional	Limited	Medium
Town of Joliet	Significant	Occasional	Limited	Medium
Town of Fromberg	Significant	Occasional	Limited	Medium

Earth Movement

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Limited	Occasional	Limited	Medium

Hazard Descriptions

The term earth movement includes landslides, slumping, and subsidence. Earth movement may occur suddenly as catastrophic landslides or rockfalls, but more commonly, occurs as the slow creep of soil down gentle slopes. Precipitation, topography, geology, and human activities can all trigger landslides. In landslide-prone areas, anything affecting slope condition, such as construction, seismic activity, or increased soil moisture, may cause movement or may reactivate prior movement.

Recent landslide movements often are the reactivation of smaller sections of older, unstable landslide masses. The USDA has mapped the soils in Carbon County. Soil suitability is considered by the County Planning Board during subdivision review on proposed developments. Earth movement has the potential for causing loss of life and/or property damage.

Landslide/Slumping

The term landslide includes all types of gravity-caused mass movements of earth material, ranging from rock falls, slumps, rock slides, mud slides, and debris flows. Landslides are among the most common geologic hazards in Montana, causing damage in rural and urban areas of the State. Sudden movements are often spectacular and receive much publicity. However, slower movement can also cause severe problems in areas as well. The effects of the very slow movements can be seen along many roadways in the form of leaning trees, misaligned fences and walls, and damaged road surfaces and foundations. Whether caused solely by natural processes or aggravated by human activity, when landslides occur in proximity to human-made structures, repairs and remediation can be costly.

The surface of the earth is constantly undergoing erosion and change. Earth movement may occur suddenly as catastrophic landslides or rockfalls, but more commonly, occurs as the slow creep of soil down gentle slopes. Precipitation, topography, geology, and human activities can all trigger landslides. In landslide-prone areas, anything affecting slope condition, such as construction, seismic activity, or increased soil moisture, may cause movement or may reactivate prior movement. Recent landslide movements often are the reactivation of smaller sections of older, unstable landslide masses.

Slumps are landslides in which the moving material moves in a block. Small slumps are common in roadcuts, but they can also be huge. The most common cause of slumps is excess groundwater, whether from heavy rains or from human activities that affect the drainage.

Debris Flow

Debris flows are among the most destructive geologic processes that occur in mountainous areas. A debris flow is a mass of water and earth materials that flows down a stream, ravine, canyon, arroyo, or gulch. Technically if more than half of the solids in the mass are larger than sand grains (e.g., rocks, stones, boulders) the event is called a debris flow, otherwise it is called a mudslide or mudflow. For the purposes of this plan the term debris flow is meant to be a global term to include mudslides/ mudflows. Debris flows can occur rapidly with little warning during torrential rains.

Debris and mudflows generally occur with floods and downpours associated with the late summer monsoon season. The debris flow problem can be exacerbated by wildfires that remove vegetation that serves to stabilize soil from erosion.

Subsidence

Land subsidence is the sinking of the land over manmade or natural underground voids. Subsidence occurs naturally and also through man-driven or technologically exacerbated circumstances. Natural causes of subsidence occur when water in the ground dissolves minerals and other materials in the earth, creating pockets or voids.

When the void can no longer support the weight of the earth above it, it collapses, causing a sinkhole depression in the landscape. Often, natural subsidence is associated with limestone erosion, but may also occur with other water-soluble minerals. Man-driven or technology-exacerbated subsidence conditions are associated with the lowering of water tables, extraction of natural gas, or subsurface mining activities. As the underground voids caused by these activities settle or collapse, subsidence occurs on the surface.

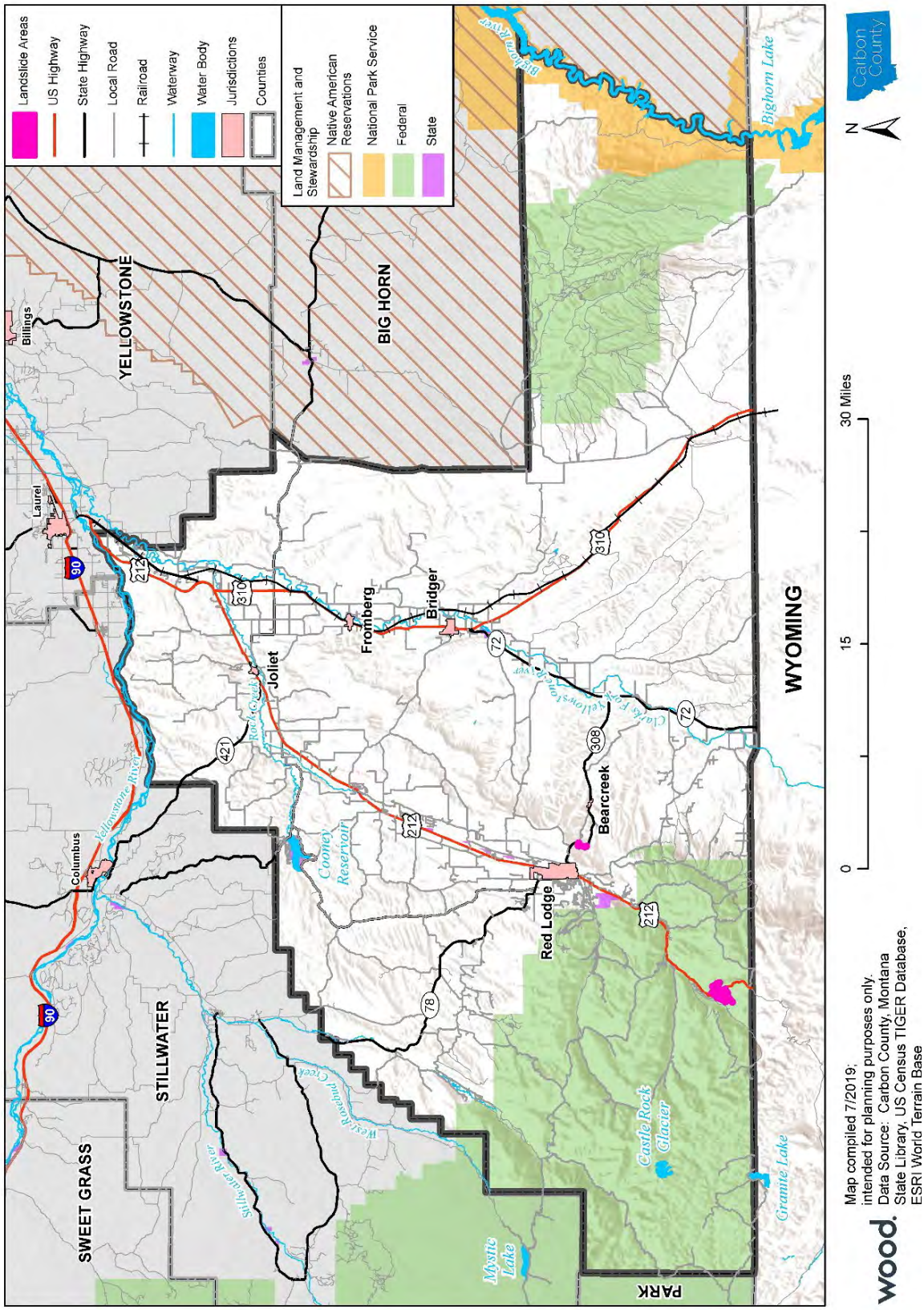
Geographic Area

During the 2019 planning process the HMPC noted that impacts of earth movement hazards have been scattered throughout the County and there are no specific recurrent problem areas. According to the HMPC, past events have occurred in areas with little to no population. Beartooth Pass has experienced earth movement events in the past and mitigation is currently being done on the Pass. Figure 3-26 depicts the landslide areas in Carbon County.

Major subsidence events over historic mine workings appear unlikely because the situation seems to have stabilized over time—in part because underground workings are now filled with water. However, subsidence remains a possibility in locations under the heart of the City of Red Lodge, the area west of Bridger, and in the Bear Creek area.

Another cause of subsidence may be due to the Madison Limestone (Mississippian) that lies under karst areas in western Montana and adjacent parts of Idaho and Wyoming. Passages in a single cave are commonly up to 2 mi (3.2 km) long. Open fissures up to 1,000 ft (300 m) tong and shallow, open joint systems are also common. Fissures and cavern passages extend as much as 1,000 ft (300 m) deep. Large quantities of water are present in the lower parts of the fissures and in some of the deeper cavern passages. Karst features developed at the end of the Mississippian Period are common in the Madison Limestone. Most of the features are solution tubes, caves, and small fissures that have been filled with younger deposits that are now solidified into rock. Because of differences in materials, residual openings, and secondary solution, these features can give rise to foundation problems and leakage.

Figure 3-26 Landslide Areas in Carbon County



Extent (Magnitude/Severity)

The extent of landslides and debris flow events within the county range from negligible to significant. Landslides and rockslides can result in the destruction of infrastructure such as water and sewer lines, electrical and telecommunications utilities and drainage. Disrupted transportation routes occur occasionally, usually during heavy rain storms, and cause considerable inconvenience and result in economic impacts. The potential for death and injury from landslides and debris flow also exists along certain transportation corridors.

Historic Occurrences

Landslide and Debris Flows

Land and rockslides on a very small scale have and continue to occur frequently on the Beartooth Highway. These landslides consisting primarily of rock are generally confined to small stretches of the highway and quickly removed to facilitate traffic flow. Daily freeze-thaw cycles during the spring and fall often trigger these *rockslides*.

The Carbon County News reported that in March of 2005, rain and snow combined to shut down 12 miles of the Beartooth Highway effectively closing the route between Cooke City and Red Lodge and Yellowstone Park. On Thursday, May 19, 2005, weeks of heavy wet snow and rain combined to create the conditions that lead to another massive mud and rock slides along the Beartooth Highway (see Figure 3-27). The road is a crucial link to the western route to Yellowstone Park and is only open to traffic from late-May until mid-October. According to the May 26, 2005, Carbon County News story, "In the worst areas, an avalanche of mud, rocks and debris completely swept away stretches of highway, leaving guardrails and culvert pipes shredded and dangling in mid-air. On less affected sections, dirt, rocks, trees and debris blanketed the road to a depth of several feet." Department of Transportation employees were at work clearing the remaining snow for the upcoming seasonal highway opening when the slides occurred. No one was injured. On May 27, Governor, Brian Schweitzer declared Carbon County a disaster as a result of the slides. An Executive Order was issued declaring an emergency in Carbon County. The order requested assistance from the Federal Highway Administration for the repairs. The $15.2 million repair involved excavating rock and slide debris, reconstructing the drainage, roadway and new alignment, and constructing tie-back walls. Rock fall fences were also constructed at several locations and overall drainage capacity was increased by creating water diversions along stable locations on the mountain and constructing special inlets to allow rock over 3-inch diameter to pass. The highway was reopened on May 27th of 2006.

Figure 3-27 Beartooth Highway Debris Flow May 19, 2005

Source: State of Montana Multi-Hazard Mitigation Plan 2010 Update

On July 27, 2009, heavy rain over the Cascade Fire Area of 2008 caused two debris flows occurred on the south side of the West Fork of Rock Creek covering West Fork Road. In addition, two debris flows occurred on the north side of the West Fork of Rock Creek. Data shows that 1.85 inches of rain fell within three hours over the burn area with additional rainfall occurring beyond three hours. As a result of the debris flows and landslides, large boulders and downed trees covered West Fork Road. No injuries or fatalities were attributed to this event. Property damage and crop damage estimates were unavailable.

Slumping

A drive around the benches and foothills of Carbon County shows ample visual evidence of past localized slumping. Slumping occurs when soils prone to movement are located on slopes which then become saturated. The saturation can occur as a result of snowmelt with or without rain, heavy rain events, and/or seepage from irrigation facilities. Soils with high clay content hold the most moisture and thus become the heaviest and most prone to sliding. The Bear Creek Hill located between Bear Creek and Red Lodge is composed of clay underlain by shale. Three major slumps have occurred on the Bear Creek Hill in the past 22 years, each time necessitating extensive reconstruction and repair of Highway 308 by the Montana Department of Transportation. Localized slumps occur along the vast network of irrigation ditches and canals in the County.

It is challenging to predict the number and frequency of earth slumping events in the County because their occurrence is so dependent on the timing and intensity of precipitation and snowmelt. (G.Hill, Natural Resources Conservation Service) However, because Carbon County has slopes and soils that will slide, slumping will occur in the future. Based upon past slides, vulnerable areas include the edges of east and west benches above Rock Creek and the Bearcreek Hill. Due to the locations of structures in relation to potentially slumping areas, it is most likely that infrastructure (highways) would be damaged rather than structures. Ground saturation during the spring of 2011 caused hillside slips with some deposition of material on county roads. The county is in the process of being reimbursed just under $.5 million from

FEMA for repairs needed to county infrastructure. The majority of the damage was to roads from slumping and sloughing.

Subsidence

A number of underground coal mines were once in production in Carbon County. The mines were located at Red Lodge, Bear Creek, and Bridger. The underground workings have largely filled with water since the cessation of mining operations. Despite no subsidence related to these mines being reported, the risk is not completely absent. The HMPC noted that Montana Department of Environmental Quality (DEQ) Remediation Division conducted a subsidence monitoring and analysis report for the City of Red Lodge in 2017. The study was initiated by the DEQ after residents of Red Lodge reported concerns over the collapse of underground mines that could lead to subsidence and eventually damage their property and pose a risk to public safety. The report concludes there is a potential for mine subsidence, but any earth movement and associated surface settlement would take place over a long period of time. The analysis also states that there is very little risk of a rapid "sinkhole" type subsidence caused by an underground mine collapse.

Likelihood of Future Occurrences

Occasional - When considering all of the earth movement sub-hazards (landslide, slumping, subsidence), it is likely that earth movement will occur in the County. Subsidence rates can vary greatly over time and geographic location, and there is no clear consensus on whether the County will be impacted in the future. Given the topography and geology of the County, it is likely that slumping, and landslides will continue to occur in the County.

Climate Change Considerations

Landslides can result from intense rainfall and runoff events. Projected climate change-associated variance in rainfall events may result in more high-intensity events, which may could increase landslide frequency, particularly debris flows. In addition, the increased potential of wildfire occurrence also escalates the risk of landslide and debris flows in the period following a fire, when slopes lack vegetation to stabilize soils and burned soil surfaces create more rainfall runoff.

Vulnerability

People

People could be susceptible if they are caught in a landslide or debris flow, potentially leading to injury or death. There is also a danger to drivers operating vehicles, as rocks and debris can strike vehicles passing through the hazard area or cause dangerous shifts in roadways. According to the HMPC, past earth movement events have been in areas with little to no population.

Economy

Impacts to transportation routes would have additional impacts on the local economy that is dependent on the tourism sector. Most rock slides that occur in the County are small and localized. Associated costs are generally limited to clean-up which would involve heavy equipment and personnel for short periods of time. The dollar range for dealing with the more common rock slides ranges from several hundred to several thousand dollars.

In the case of the spring 2005 slides on the Beartooth Highway, however, costs were significant. The road repair alone cost approximately $16 million. Business interruption and loss caused additional damages

from this event. Some businesses in Red Lodge received low interest loans from the US Small Business Administration as a result.

Built Environment

Earth movement hazards can directly damage engineered structures in two general ways: 1) disruption of structural foundations caused by differential movement and deformation of the ground upon which the structure sits, and 2) Landslides in particular can have the physical impact of debris moving downslope against structures located in the travel path. Properties and buildings are often damaged by this hazard due to structural foundation instability. According to the HMPC, past earth movement events have usually occurred in areas with little to no population.

Critical Facilities and Infrastructure

In addition to buildings, utilities and transportation infrastructure are also vulnerable to the impact and ground deformation caused by slope failures. They present a particular vulnerability because of their geographic extent and susceptibility to physical distress. Transportation Lifelines are generally linear structures that, because of their geographic extent, have a greater chance of being affected by ground failure due to greater hazard exposure (refer to the discussion on FEMA Lifelines in the Asset Summary section) . According to the HMPC past earth movement events have impacted transportation routes in the past. Secondary impacts have been to the local economy specifically on the tourism sector.

Extension, bending, and compression caused by ground deformation can break lifelines. Failure of any component along the lifeline can result in failure to deliver service over a large region. Once broken, transmission of the commodity through the lifeline ceases, which can have catastrophic repercussions down the line: loss of power to critical facilities such as hospitals, impaired disposal of sewage, contamination of water supplies, disruption of all forms of transportation, release of flammable fuels, and so on. Therefore, the overall impact of lifeline failures, including secondary failure of systems that depend on lifelines, can be much greater than the impact of individual building failures.

Historic, Cultural, and Natural Resources

As primarily a natural process, earth movement hazards can have varying impacts to the natural environment including the potential to permanently alter the natural landscape.

Future Development

The severity of earth movement problems is directly related to the extent of human activity in hazard areas. Human activities such as property development and road construction can also exacerbate the occurrence of earth movement hazards. Future development should take place carefully to prevent landslide damage to property or people. Adverse effects can be mitigated by early recognition and avoiding incompatible land uses in these areas or by corrective engineering. Improving mapping and information on landslide hazards and incorporating this information into the development review process could prevent siting of structures and infrastructure in identified hazard areas.

Risk Summary

- Impacts of past earth movement hazard events have been scattered throughout the County. Past events have occurred in areas with little to no population.
- Beartooth Pass has been affected by landslide and debris flow events in the past. Closures of the Pass hinders interstate travel which has had secondary impacts of the tourism industry and the local economy.

- Historic mines under the City of Red Lodge, areas west of Bridger and the Town of Bearcreek pose some risk of subsidence events but a significant subsidence event (i.e. sinkhole) is unlikely
- *Related Hazards*: Severe Summer Storms, Earthquake, Flood

Earth Movement Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Limited	Occasional	Limited	Medium
City of Red Lodge	Limited	Unlikely	Limited	Low
Town of Bearcreek	Limited	Unlikely	Negligible	Low
Town of Bridger	Limited	Unlikely	Negligible	Low
Town of Joliet	Limited	Unlikely	Negligible	Low
Town of Fromberg	Limited	Unlikely	Negligible	Low

Flood

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Significant	Likely	Limited	High

Hazard Description

Three types of floods are possible hazards in Carbon County, seasonal runoff river floods, ice-jam river floods, and flash-floods. Floods of all types can cause extensive damage to property, crops, and infrastructure; result in evacuations, loss of income, and injury and loss of life. Floods are natural events for rivers and streams and floodplains have historically proven attractive to development. Stretches of the 100-year floodplain have been mapped for both Rock Creek and the Clarks Fork of the Yellowstone.

Floodplain Mapping

FEMA established standards for floodplain mapping studies as part of the National Flood Insurance Program (NFIP). The NFIP makes flood insurance available to property owners in participating communities adopting FEMA-approved local floodplain studies, maps, and regulations. Floodplain studies that may be approved by FEMA include federally funded studies; studies developed by state, city, and regional public agencies; and technical studies generated by private interests as part of property annexation and land development efforts. Such studies may include entire stream reaches or limited stream sections depending on the nature and scope of a study. A general overview of floodplain mapping is provided in the following paragraphs.

Flood Insurance Study (FIS)

The FIS develops flood-risk data for various areas of a community that is used to establish flood insurance rates and to assist the community in its efforts to promote sound floodplain management. The current Carbon County FIS is dated July 5, 2017.

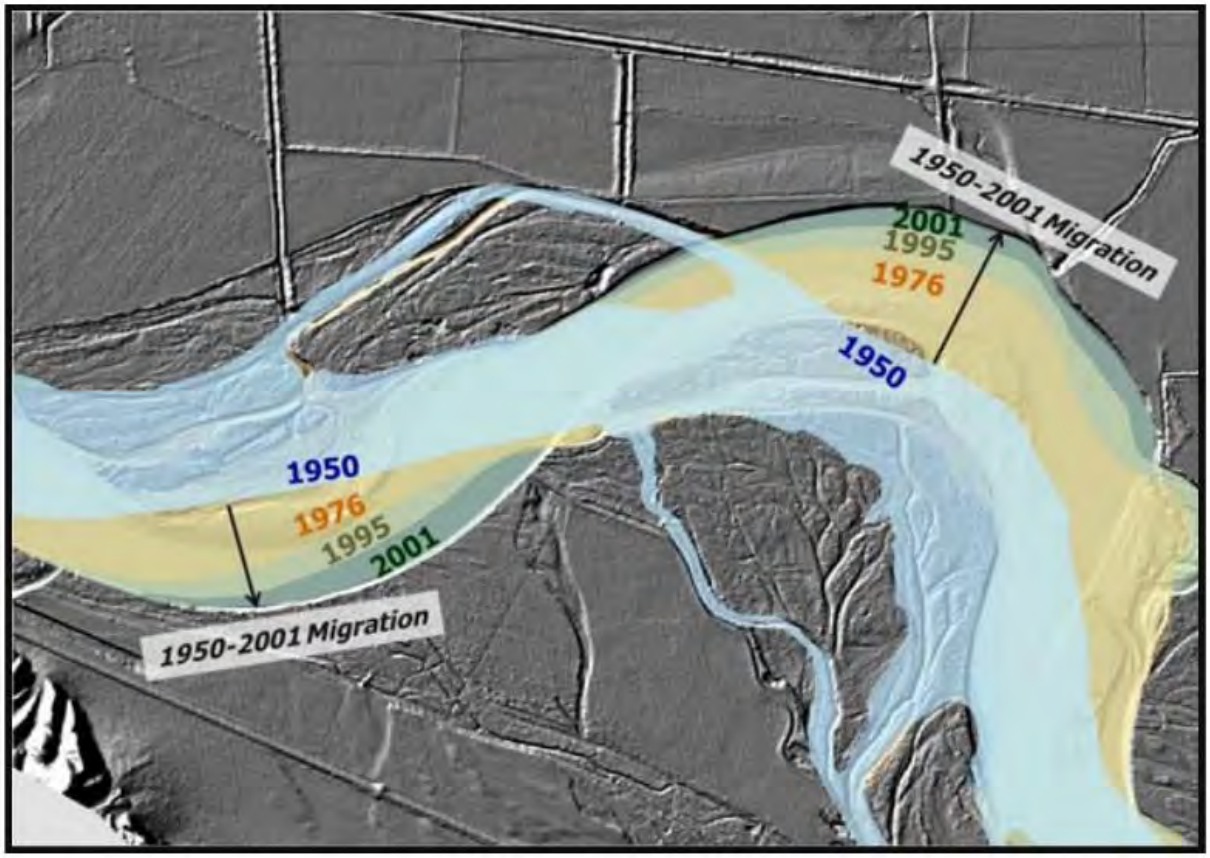
Flood Insurance Rate Map (FIRM)

The FIRM is designed for flood insurance and floodplain management applications. For flood insurance, the FIRM designates flood insurance rate zones to assign premium rates for flood insurance policies. The designated flood zones are based on flood risk in the area. For floodplain management, the FIRM delineates 100- and 500-year floodplains, floodways, and the locations of selected cross sections used in the hydraulic analysis and local floodplain regulations. Land areas that are high risk, within the 100-year floodplain (or with a one percent annual chance of flooding), are called Special Flood Hazard Areas (mapped as A zones.). In communities that participate in the National Flood Insurance Program (NFIP), mandatory flood insurance purchase requirements apply to all Zones A (i.e., those areas subject to a 100-year flood event). The County and jurisdictional FIRMs were updated in 2012 and 2017; the majority of the County has maps with effective dates of 12/04/2012. Some maps in the Upper Yellowstone Lake Basin were updated in 7/05/2017.

Channel Migration

Rivers have dynamic physical processes that lead river channels to migrate or move laterally over time. Migration can be a persistent process of lateral bank erosion and deposition or can occur abruptly as the river carves a new channel in a new location. Channel migration provides ecological benefits but can become hazardous when the migration causes public and private infrastructure to become vulnerable to the effects of flooding and erosion which leads to significant economic impacts. Engineering efforts to alter the channel movement through bank armoring in an attempt to lessen the impacts of migrating rivers. Interferences with the natural processes of channel migrations results in rapid erosion which in turn leads to costly expansions of bank armoring. According to the HMPC, the Clarks Fork of the Yellowstone River in the Carbon County has moved as much as 80 feet in the past year. In general channel migration has been a significant issue for Carbon, impacting irrigation systems throughout the County. Figure 3-28 below is an example of historic channel migration on a portion of Yellowstone River in Rosebud County, Montana between 1950 and 2001.

Figure 3-28 Example of Historic Channel Migration on the Yellowstone River, 1950-2001



Source: Yellowstone River Channel Migration Zone Mapping Final Report February 20, 2009.

To address the impacts of channel migration, efforts to map channel migration zones (CMZ) throughout the State have been ongoing on several rivers since 2005. The CMZ is the area where a river channel is likely to move over a period of time. The fundamental concept of CMZ maps is to identify the area the river channel is expected to occupy over a given timeframe, in most cases CMZ maps have been developed for a 100-year timeframe. The CMZ maps serve as a science-based tool that can be used for outreach and public information purposes as well as a planning mechanism that could be integrated into existing zoning and subdivision regulations. A proposal to create channel migration zone maps for the upper 35 miles of the river that are in Carbon County was submitted to the County in May 2019.

Geographic Area

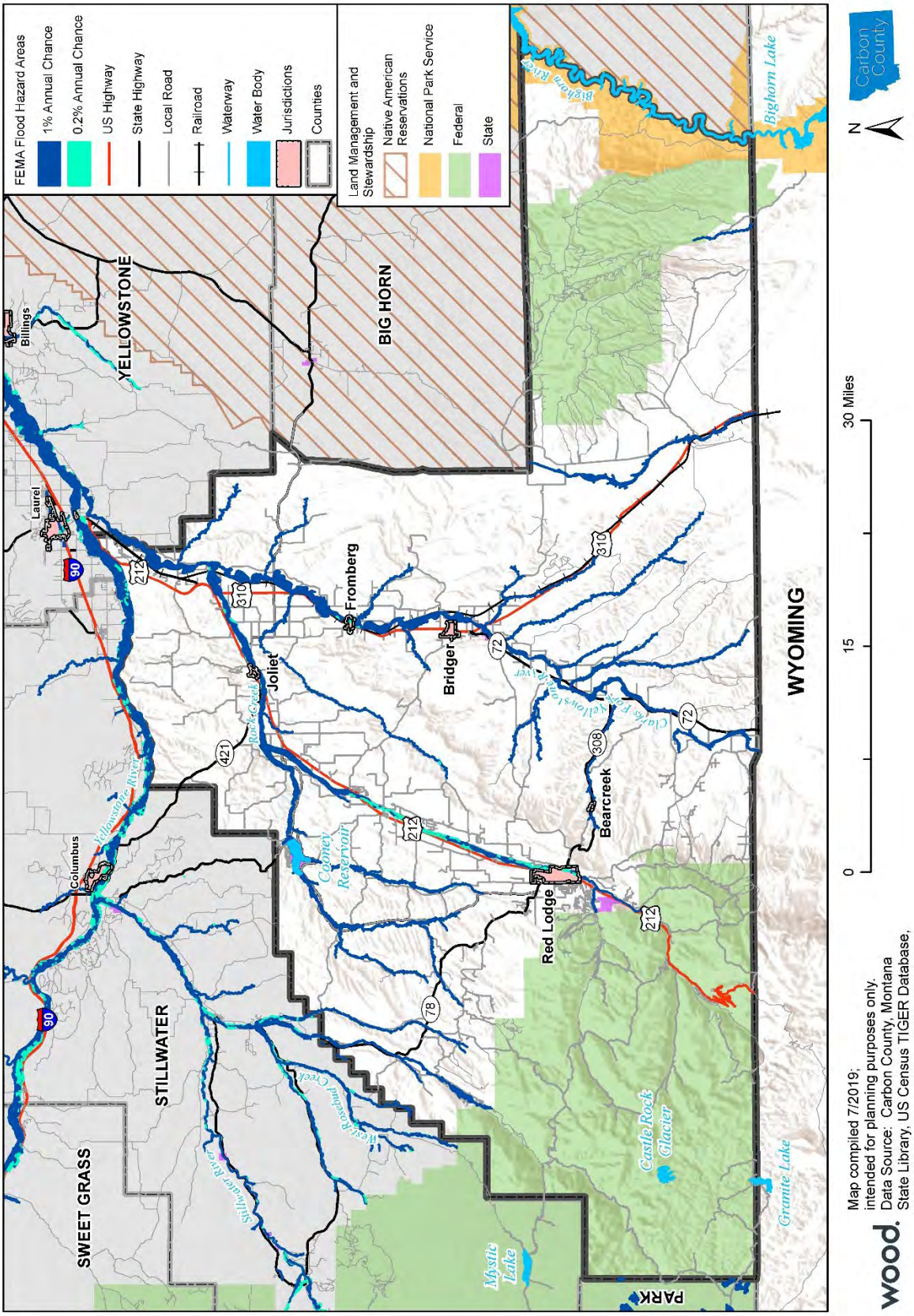
Portions of Red Lodge and Joliet are located within the 100-year floodplain of Rock Creek, and portions of Bridger and Fromberg are located in the 100-year floodplain of the Clarks Fork River. Granitic soils in the southern end of the County are quite porous, but soils throughout the County have the possibility of becoming saturated as occurred in May 2005.

Extent (Magnitude/Severity)

The most serious flood risk in the County occurs when high seasonal runoff, rapid snowmelt due to warm temperatures, and a heavy, prolonged precipitation event occur at the same time. History in the County bears out that these events have generally been the costliest in terms of damage to and loss of property and livestock.

Basement flooding and minor scouring occurred in Roberts, Joliet, and Red Lodge when rain and snow fell on already-saturated ground. This combination of circumstances could occur again in any part of the County during the late spring and early summer months. Flooding has occurred in the past: within the 100-year floodplain and in other localized areas. In addition to damage to area infrastructure, other problems associated with flooding include erosion, sedimentation, degradation of water quality, loss of environmental resources, and certain health hazards. Figure 3-29 shows the mapped floodplains in the County.

Figure 3-29 FEMA Special Flood Hazard Areas in Carbon County



Historic Occurrences

Historically, Carbon County has been at risk to flooding primarily during the winter and spring months when river systems in the County swell with heavy rainfall. Normally, storm floodwaters are kept within defined limits by a variety of storm drainage and flood control measures. But, occasionally, extended heavy rains result in floodwaters that exceed normal high-water boundaries and cause damage.

Past events as noted by the HMPC during the 2012 planning process are list below. These collections were the result of discussions with County Commissioners, Steering Committee members, and long-time residents were all asked to recall flood events for the 2012 planning process. Recollections were then checked against previous newspaper accounts in the Carbon County News, the Clarks Fork Pioneer, the Bridger Times, and the Carbon County Journal. During the 2019 update the NCEI database was checked. None of the sources were 100% complete or accurate when considered individually, nor were they all in agreement with each other.

The NCEI Storm Events database has records of 16 flood and flash flood events that have resulted in $1,600,00 in property damages and 1 death from 1997 to 2018. All recorded damages were a result of the 2011 flood event described below.

What follows is the general picture painted by all of these sources with examples of some specific flood incidents.

The first flooding related disaster appearing in the County Commission notes was in April 1917. The notes reference a bridge lost at Bridger to an ice jam. June 1918 appears to have produced the costliest flood in the history of the County. The Carbon County Journal reported on June 19, 1918 "Carbon County has been for the past week in a state of semi-isolation in so far as traffic with the outside world is concerned because of the swollen streams that have poured their waters over the lowlands." The paper went on to report that rail service failed, there had been no mail for four days, the wagon bridge over the Yellowstone at Laurel was out and the railroad bridge offered the only means to cross the river, and the floods "have caused hundreds and thousands of dollars in damages to farms and bridge and by the paralyzation of train facilities." The area just east of the community of Silesia called the Mason bottom was reportedly under three feet of water and the crops were ruined; a Burlington engine was lost in the river, and land was eaten away. Total losses from the flood in 1918 dollars were estimated at $200,000. During the same storm, a huge channel was cut through Fromberg, several major irrigation canals were damaged, and the Montana Power Company's line broke resulting in a loss of power and subsequently loss of water because the pumps were inoperable. The Bridger Times of June 14, 1918 reported that "incalculable damage" was done from this same event where "rapidly melting snows sent record-breaking torrents, overflowing lowland, destroying irrigation ditches, and impeding transportation." "Old timers say the water this year is the highest it has been in their recollection."

A serious flash flood also occurred in 1918, in Red Lodge and Bear Creek on July 15, 1918 according to the July 17 Carbon County Journal. The deluge washed out water mains from which Bear Creek gets its drinking water, the railroad tracks were damaged, basements were flooded, garden plots were washed out, and water cut channels in the town streets. The Journal reported that "Old-time residents of this vicinity are unanimous in their verdict that it is the heaviest rain they have ever witnessed."

The next major flood occurred in 1932 along the Clarks Fork River. The Bridger Times of June 9 reported "Heavy rains of the past few days have done some damage to the roads and highways and small bridges and culverts have been washed out." After listing all of these results, however, the article goes on to say that the damage was slight. The County Commissioners' minutes on June 11, 1932, state that they passed a resolution creating an "extreme emergency" in the road and bridge budget. This occurred again in June of 1934, when rains and floods damaged roads and bridges creating an "extreme emergency."

The Bridger Times (8/13/36) reported on a flash flood. A cloudburst in the Sand Creek area, four miles west of Bridger took out a bridge, flowed over the highway, and in some places, streets were damaged. Another extreme public emergency was declared by the County Commissioners in July of 1937 due to road damage and culvert washouts.

Clarks Fork Valley resident Jim Yedlicka recalled an ice-jam flood on the Clarks Fork at Fromberg in the 1940's. Jim and his family "turned out the cattle, left the house and went to the neighbor's. The chickens were lost and so were some goods in the cellar when the jam broke overnight." Jim reported that this was the only time in his lifetime of over 50 years living along the Clarks Fork River that he had to leave his home for a natural disaster. Melvin Brown of Belfry remembered a bad flood on the Clarks Fork River shortly thereafter as a result of an ice jam in 1946. The flood caused the family to move their livestock to safety.

On February 19, 1948, "Sudden Warming of Weather Causes Excessive Runoff" was the headline in the Bridger Times. The paper went on to report that ice jams had formed on the Clarks Fork around the bridge leading to East Bridger forcing surface water over the lowlands. Several thousand dollars of stock were lost and there was much property damage. Many farms were covered by water and the bridge was almost lost. "Warm sun, snowmelt, and water in the ditch west of Main Street was frozen, so runoff began to pour in Bridger Streets." Fortunately, this was a short-lived incident with the water receding the following day.

In 1967, a flash flood between Luther and Red Lodge blew out a large culvert as a result of five inches of rain in one storm. A D-4 cat and homestead barn were lost in the flood. (Carl Hansen, Joliet) The Carbon County News reported that eleven consecutive days of rain caused the flash flood that did considerable damage to farms below the highway. Traffic was detoured through Luther. Chickens, a calf, a shed, and farm implements were carried away.

Reuben Steinmetz of the Joliet area reported a spring flood in Joliet in 1967 due to a combination of heavy snow and warm rain that washed out ditch head gates. The same combination of events produced flooding in the City of Red Lodge according to Public Works Director, Orval Boyer.

A flood west of Red Lodge brought down power and phone lines, roads and bridges were washed out and a number of ranch families were stranded according to the Carbon County News on May 15, 1975. "It's going to be real expensive to put the County back in shape. We'll do it ourselves. And we'll get it done" was the reaction of then County Commissioner, Frank Cole.

In 1981, the Carbon County News (6/11/81) reported torrential rains in May. The Bear Creek hill slid, and the Clark Fork roared out of its banks threatened bridges, flooded roads, damaged irrigation intakes, and imperiled two homes. Norm Dewell, the first Disaster and Emergency Coordinator for Carbon County recalled a springtime flood on the Clarks Fork in the late 1980's.

The County Commissioners' minutes for February 1996, make mention of probable emergency road closures due to ice jams in the Rockvale area. The ice jams in the Rockvale-Silesia area are mentioned again in the notes on March 6.

In May of 2005, heavy rains and snowmelt on top of saturated ground caused widespread flooding in the western and west-central portions of the County. No injury or loss of life was reported, but basements were flooded in Roberts and Joliet, roads and culverts were affected, and some areas were scoured.

On June 6 of 2007, a large spring storm moved across the Northern Rockies on the afternoon of June 6th through the morning of June7th. Thunderstorms developed by early afternoon across northern Wyoming and southern Montana, with heavy rainfall beginning in Sheridan, Wyoming and Carbon County, Montana at 330pm and across much of southern Montana by 6pm. By 9pm Wednesday evening, heavy rainfall

became more widespread across southern Montana and continued through the overnight hours. By mid-morning on the 6th, rainfall had ended across the impacted area. Runoff from areas upstream of Rosebud County and the Tongue River Reservoir resulted in flooding downstream of the dam. Several stretches of area roads were under water, including 212 and 78. Homes were flooded in Roberts. Water was over the road on Highway 72 south of Belfry, with the highway closed in Wyoming. Flooding was reported on country roads in the area. Property damage and crop damage estimates were not available. No fatalities or injuries were attributed to this flood.

On July 27, 2009, heavy rain over the Cascade Fire Area of 2008 caused the West Fork of Rock Creek to rise out of its banks. Two debris flows occurred on the south side of the West Fork of Rock Creek covering West Fork Road. In addition, two debris flows occurred on the north side of the West Fork of Rock Creek. The water level on the West Fork of Rock Creek was greater than 4 feet above normal and flowing outside of its banks at the peak of the event. Data shows that 1.85 inches of rain fell within three hours over the burn area with additional rainfall occurring beyond three hours. As a result of the debris flows and landslides, large boulders and downed trees covered West Fork Road. No injuries or fatalities were attributed to this flood. Property damage and crop damage estimates were unavailable.

On May 20, 2011, significant flooding occurred on creeks and streams across Carbon County with numerous county roads flooded, closing roads and resulting in significant damage. Emergency Travel only was advised at one point due to the severity of the flooding. Specifically, Rock Creek flooded, resulting in adjacent lowland flooding and closure of Grape Vine Road near Fromberg. Creeks were running out of their banks from the Beartooth Foothills between McLeod and Red Lodge, as well as tributaries of the Clarks Fork of the Yellowstone River from Belfry to Bridger. Five Mile Creek flooded and washed out the bridge on East Pryor Road between Edgar and Pryor. Blue Water Creek east of Bridger flooded and washed out a county road as well. The heavy rainfall also resulted in water running over the spillway at Cooney Dam. This resulted in several homes flooded along Red Lodge Creek. On May 25th, significant flooding was reported in the Town of Joliet as debris backed up Rock Creek and caused water to stop over the bank and into a ditch which drained directly towards the Town. At the peak of this flooding, Highway 212 was closed from Rockvale to Red Lodge as 18 inches of water was reported on Highway 212 through the town of Joliet. Fifty homes flooded in the area and seven people, mainly elderly, had to leave with the assistance of the fire and sheriff's offices. The Joliet Motel reported a foot of water in each of their rooms. In addition, an 84-year-old woman drowned after she fell into a flooded ditch near her house. She was going to get her newspaper when she slipped and fell. The woman was swept a short distance downstream from her house near Boyd, where authorities found her body. Damage estimates based on FEMA reviews and Individual Assistance approvals and totaled in excess of $1 million.

On June 29, 2011, Carbon County officials reported flooding along Rock Creek near 2 Mile Road which resulted in 2 Mile Road north of Red Lodge being closed. In addition, Rock Creek in Red Lodge rose above flood stage on the 29th and continued above flood stage through the end of the month. The river crested at 7.78 feet on the 29th.

On July 1, 2011 flooding occurred 2 miles NE of Fox. Although no significant synoptic spring system moved across the Billings forecast area, warm late June and early July temperatures resulted in rapid mountain snow melt runoff and flooding. Flooding from June continued into July along Rock Creek near Two Mile Road. Emergency repairs were needed on the Two-Mile Bridge (which was closed) north of Red Lodge. Rock Creek was also reported to have cut a new channel and was as high as it has ever been. As a result, residents in 4 to 5 homes were stranded in the Fox area about 6 miles north of Red Lodge. In addition, another 3 homes were under water in the Wagon Wheel Estates which is about 3 miles north of Red Lodge. Western Ranch Estates near Roberts was flooded. In addition, Grapevine and Cottonwood Roads near Silesia were closed. Rock Creek at Red Lodge rose above flood stage on the 5th and

continued to run above flood stage through the 7th. The creek crested at 7.54 feet on the 5th and again at 7.69 feet on the 6th.

On July 6, 2011, a slow-moving thunderstorm produced heavy rain and large hail across portions of Carbon and Stillwater Counties, especially the Red Lodge area. The Red Lodge fire chief reported water one foot deep flowing down the streets. No fatalities or injuries were attributed to this storm. Property damage and crop damage estimates were unavailable.

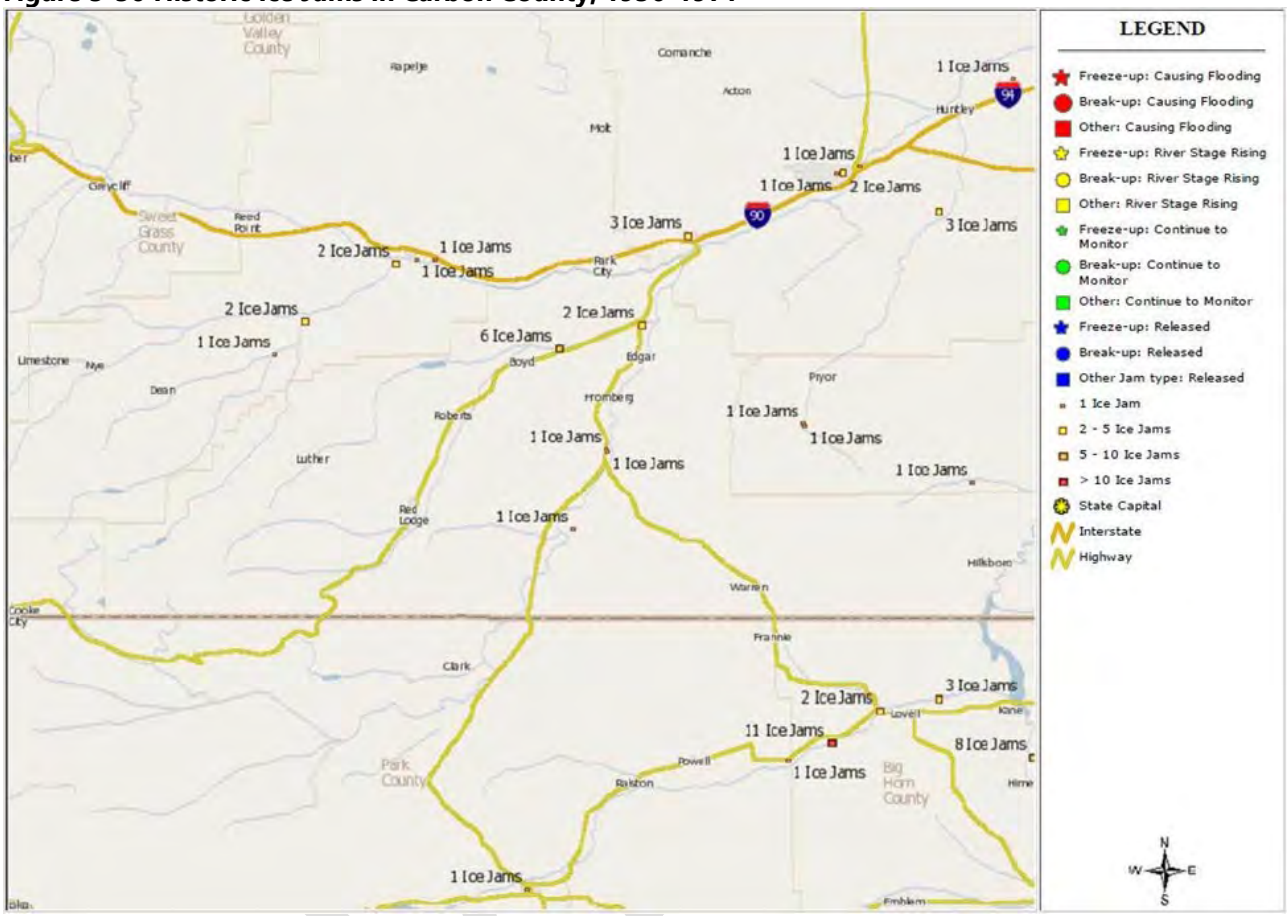
On May 22, 2018 areas of the County received 3 inches of rain which caused localized aerial flooding and washed out several county roads including West Pryor Mountain, Montaqua, and Lone Tree Roads. Damaged also occurred to the abutments of the Silesia Bridge. The County received a Federal Disaster Declaration (DR-4405) for these damages and was awarded nearly $40,000 through FEMA's Public Assistance program.

Ice Jams

Flooding from ice jams is a hazard in the County. The U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) maintains records of ice jams. According to CRREL that State of Montana is ranked as number 1 in having the greatest number of ice jams (4,514) between 1894 and 2017.

The database is organized by City, State and River. Not all towns in the County are included in the database (and not all ice jams are recorded). The City of Red Lodge (11) and the Town of Bridger (2 events) are the only communities to appear multiple times in the database in the past 19 years. The HMPC also noted that the Town of Joliet has also been impacted by flooding due to ice jams. The CRREL data base indicates 13 ice jams in the County between 2000 and 2019. Historic ice jams between the years 1936 and 1971 in the County are shown in Figure 3-30. However, the number of ice jams during this period are likely under.-reported.

Figure 3-30 Historic Ice Jams in Carbon County, 1936-1971



Source: https://rsgis.crrel.usace.army.mil/icejam/

Ice jams have occurred in Carbon County, in both the Clarks Fork and Rock Creek drainages. In the 1960's an ice jam took out the Highway 72 bridge south of Belfry. (Darrel Krum, former County DES Coordinator)

There have been three Federal Disaster Declarations for flooding in Carbon County since 1974. Just under $4 million dollars in federal assistance was provided for flooding in 1978 that occurred in 8 counties including Carbon County. Almost $8 million was provided by local, state, and federal governments for flooding in 1997 covering 22 counties including Carbon County and one reservation. The October 2018 flood event resulted in over $1.6 million in public assistance for 9 counties including Carbon.

Likelihood of Future Occurrences

Likely - Overall, the probability of a flood event (both major and flash flooding) occurring in any given year is likely. NCEI has reported 16 events between 1950 and 2019. This equates to a flood event in the County approximately every 4 years or a 23 percent chance of an event in any given year. There are 3 repetitive loss structures in the county. More details on NFIP insurance and repetitive losses can be found in the Vulnerably section below.

Climate Change Considerations

Flood events happened at any time of year in Montana. Spring floods are generally a result of rapid snowmelt, or rain-on-snow events while summer flooding is a result of heavy precipitation events. Winter

flooding is a result of ice jams. Flooding is expected to be exacerbated by climate change. According to the 2017 Montana Climate Assessment the frequency and variability of precipitation events are projected to increase slightly by mid to late century. These in turn may also lead to levee or dam failure due to overtopping, increased storm-caused damages due to downpours, increasing drought/wet periods which will exacerbate debris dumping and runoff, and accelerated snowmelt events during spring/early summer seasons.

Vulnerability

GIS analysis was conducted using parcel data and improved structure values from Carbon County, along with the latest FEMA National Flood Hazard Layer (NFHL) Special Flood Hazard Area (SFHA) dataset which incorporates the effective mapping dated 7/7/2017 and 12/4/2012. For the purposes of this plan, the 100- and 500-year floodplains were used for mapping and analysis. Parcel centroids were generated to represent each parcel's center point and allow for the counting and general positioning of each parcel polygon to then be overlaid with the flood layers, in GIS. Overlaying these two datasets helps determine the number of parcels, type, and improvement values of those parcel centroids found to overlap with floodplain areas.

Once the number of parcels with improved structure values was obtained, content values were calculated by applying the content formulas outlined in the Assets Summary section of this chapter. Then, total values were computed by adding (totaling) both improved structure values and the content values just calculated. Loss estimates for parcels contained in floodplain areas were obtained by taking 25% of the total values in the previous step.

People

The previously described GIS analysis also helped estimate potential population at risk within flood zones. Those parcels that were classified as residential (e.g. improved properties, manufactured homes, farmsteads) that intersected a floodplain were counted and multiplied by the 2018 U.S. Census estimate average household size for Carbon County (2.27 persons per household). The results were tabulated by jurisdiction and flood zone, as summarized in Table 3-25 below. According to this residential parcel estimation, there are a potential 1,078 people in the floodplains across the county, with 851 people in the 100-year (1% annual chance event) floodplain, and 227 in the 500-year (0.2% annual chance event) floodplain.

Representatives from the Town of Fromberg noted during the 2019 planning process that several individuals in their community with access and functional needs are located on the river bank on the west side of the Clarks Fork of the Yellowstone River.

Economy

Flooding can have a major economic impact on a community, including indirect losses such as business interruption, relocation of employees based on damaged properties, lost wages, and other downtime costs. In addition, failure of key water management, treatment, and other such facilities may also have lasting impacts on agricultural land and farmstead properties. Flooding could incur direct population impacts as well as business and industry damages, depending on the total damages incurred or people affected by inundation-induced debris or similar secondary impacts.

Built Environment

Damage of structures is likely during flooding. Flooding can wash away supporting fill, infiltrate basements, damage contents, and in worst cases wash structures off their foundations. The primary structures at risk from floods in the County are residences and water and sewage treatment facilities.

Portions of the transportation infrastructure, county roads and culverts, and county and state highway bridges could be at risk as well. It is possible future development could be at risk from flooding.

The results of the GIS based parcel analysis using the floodplain layers is summarized in the following tables below. Table 3-25 summarizes the parcels intersecting with the floodplain layers across Carbon County by jurisdiction and property type. The analysis results show that over $165 million could be at risk of flooding based on the total values computed for parcels of several types, with the unincorporated portions of the county facing the highest potential risk (followed by Red Lodge, Fromberg, Joliet, and Bearcreek). A total of 531 parcels were found to overlap with the floodplain areas for both 100- and 500-year flood events, out of which 424 parcels were in the 100-year floodplain and 107 parcels in the 500-year floodplain.

With regards to potential risk by property type the Improved Property parcels will face the most potential damages, followed by farmsteads, exempt parcels, vacant parcels, and finally manufactured homes. The six figures to follow (Figure 3-31, Figure 3-32 , Figure 3-33, Figure 3-34, and Figure 3-35) display the floodplain areas in or near the communities of Bearcreek, Bridger, Fromberg, Joliet, and Red Lodge, in that order.

Table 3-25 Carbon County Parcels Located in 100-year and 500-year Floodplains by Jurisdiction and Parcel Type

Flood Event	Jurisdiction	Parcel Type	Total Parcels	Improved Value	Contents Value	Total Value	Loss Estimate (25% of the Total Value)	Population at Risk
100-year	Bearcreek	Exempt	3	$0	--	$0	$0	--
		Improved Property	2	$317,585	$158,793	$476,378	$119,094	5
	Fromberg	Exempt	2	$7,010	--	$7,010	$1,753	--
		Improved Property	10	$1,024,415	$512,208	$1,536,623	$384,156	23
	Joliet	Exempt	2	$6,940	--	$6,940	$1,735	--
		Improved Property	5	$517,126	$258,563	$775,689	$193,922	11
	Red Lodge	Exempt	4	$0	--	$0	$0	--
		Improved Property	21	$5,185,767	$2,592,884	$7,778,651	$1,944,663	48
	Unincorporated	Exempt	36	$248,280	--	$248,280	$62,070	--
		Farmstead	80	$21,734,790	$21,734,790	$43,469,580	$10,867,395	182
		Improved Property	257	$57,378,133	$28,689,067	$86,067,200	$21,516,800	583
		Vacant	2	$889,500	--	$889,500	$222,375	--
Total			**424**	**$87,309,546**	**$53,946,303**	**$141,255,849**	**$35,313,962**	**851**
500-year	Fromberg	Exempt	4	$0	--	$0	$0	--
		Improved Property	38	$2,043,739	$1,021,870	$3,065,609	$766,402	86
		Manufactured Home	1	$39,912	$19,956	$59,868	$14,967	2
		Vacant	1	$132,700	--	$132,700	$33,175	--
	Joliet	Exempt	1	$598,360	--	$598,360	$149,590	--
		Improved Property	1	$134,927	$67,464	$202,391	$50,598	2
	Red Lodge	Improved Property	38	$8,046,293	$4,023,147	$12,069,440	$3,017,360	86
	Unincorporated	Farmstead	5	$1,139,420	$1,139,420	$2,278,840	$569,710	11
		Improved Property	17	$3,957,507	$1,978,754	$5,936,261	$1,484,065	39
		Vacant	1	$75,160	--	$75,160	$18,790	--
Total			**107**	**$16,168,018**	**$8,250,609**	**$24,418,627**	**$6,104,657**	**227**
Grand Total			**531**	**$103,477,564**	**$62,196,912**	**$165,674,476**	**$41,418,619**	**1,078**

Source: Carbon County DES/GIS Departments, FEMA NFHL, Wood Plc

Figure 3-31 FEMA Special Flood Hazard Areas in Bearcreek

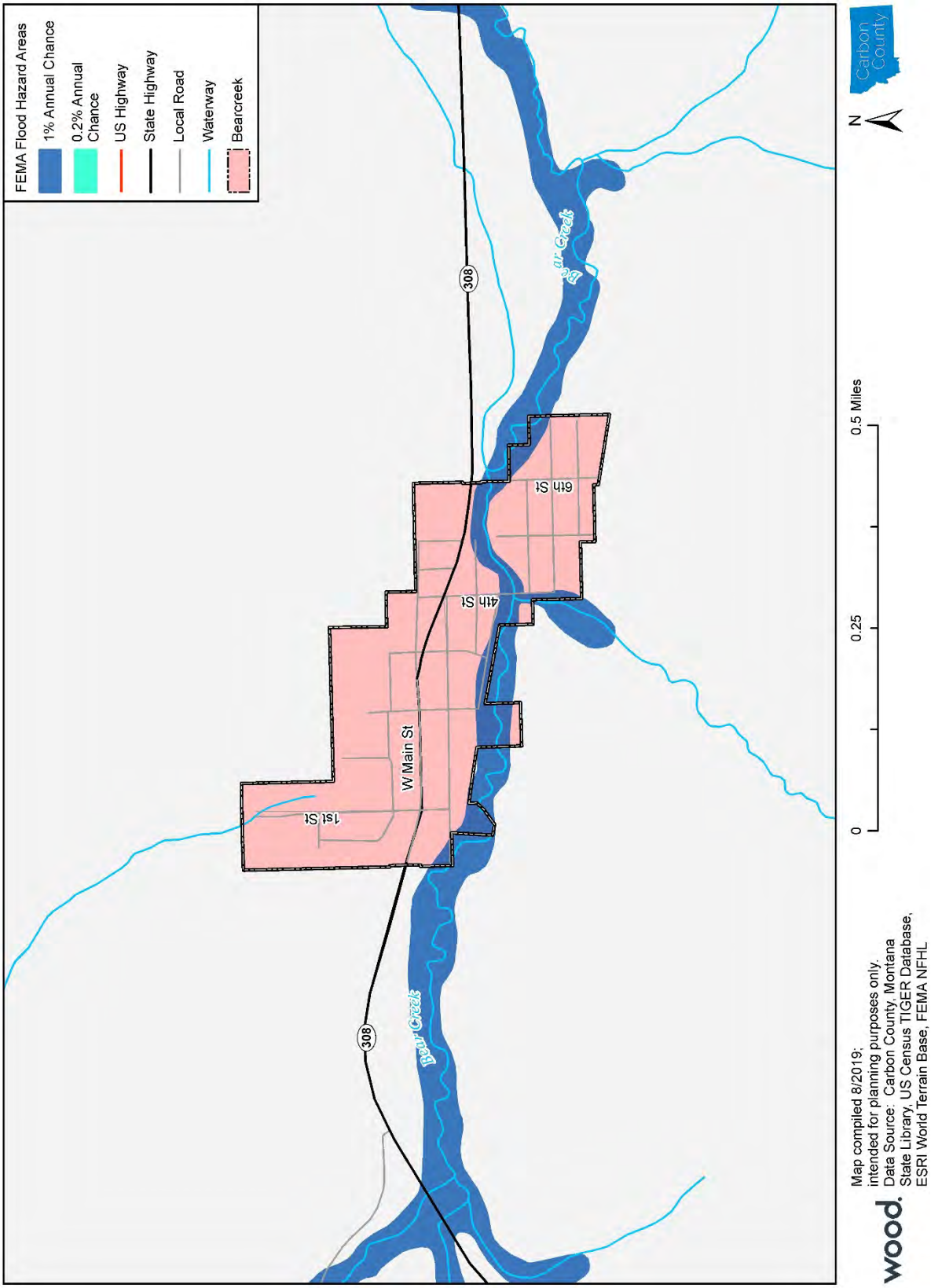


Figure 3-32 FEMA Special Flood Hazard Areas near Bridger

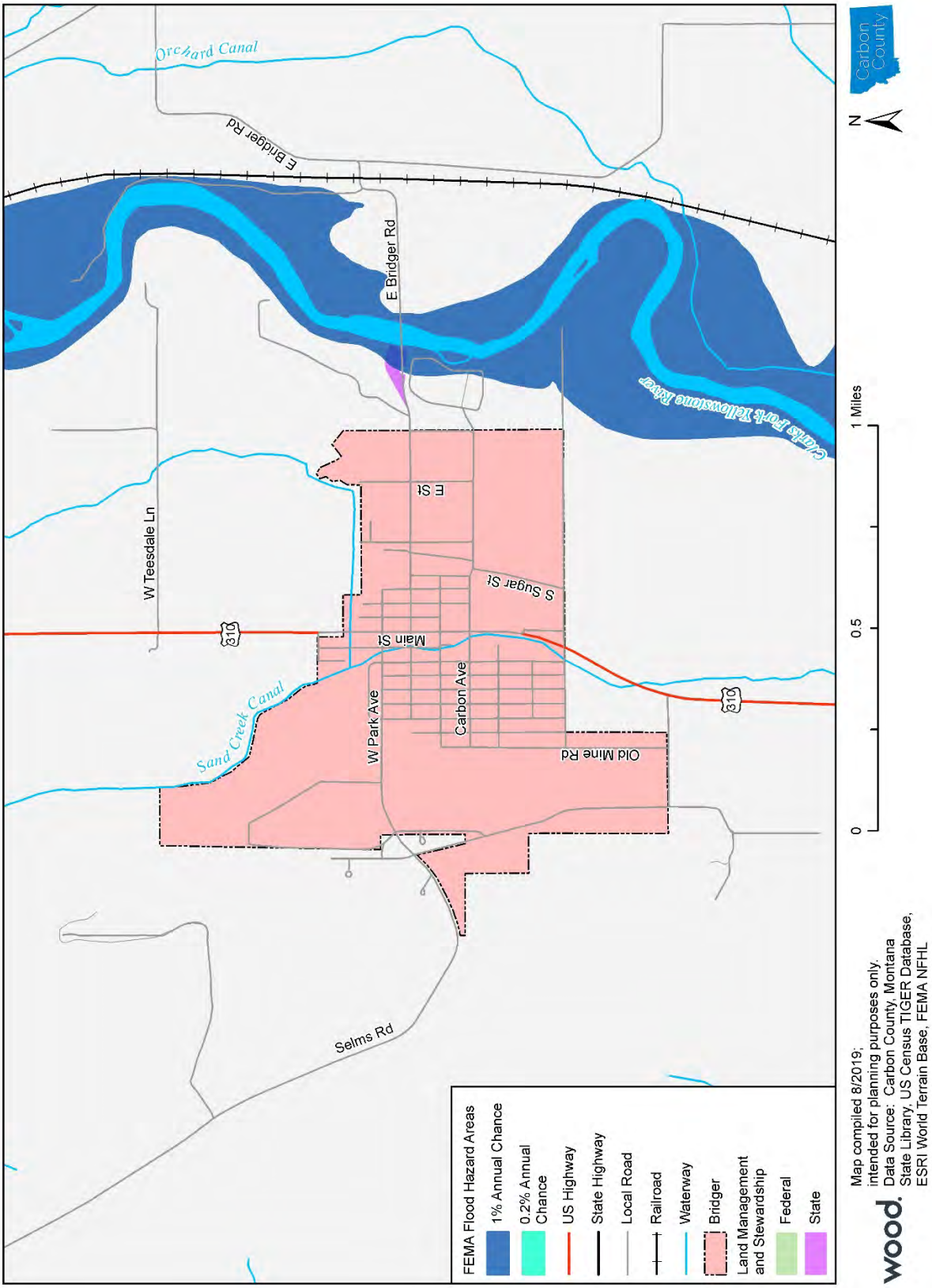


Figure 3-33 FEMA Special Flood Hazard Areas in Fromberg

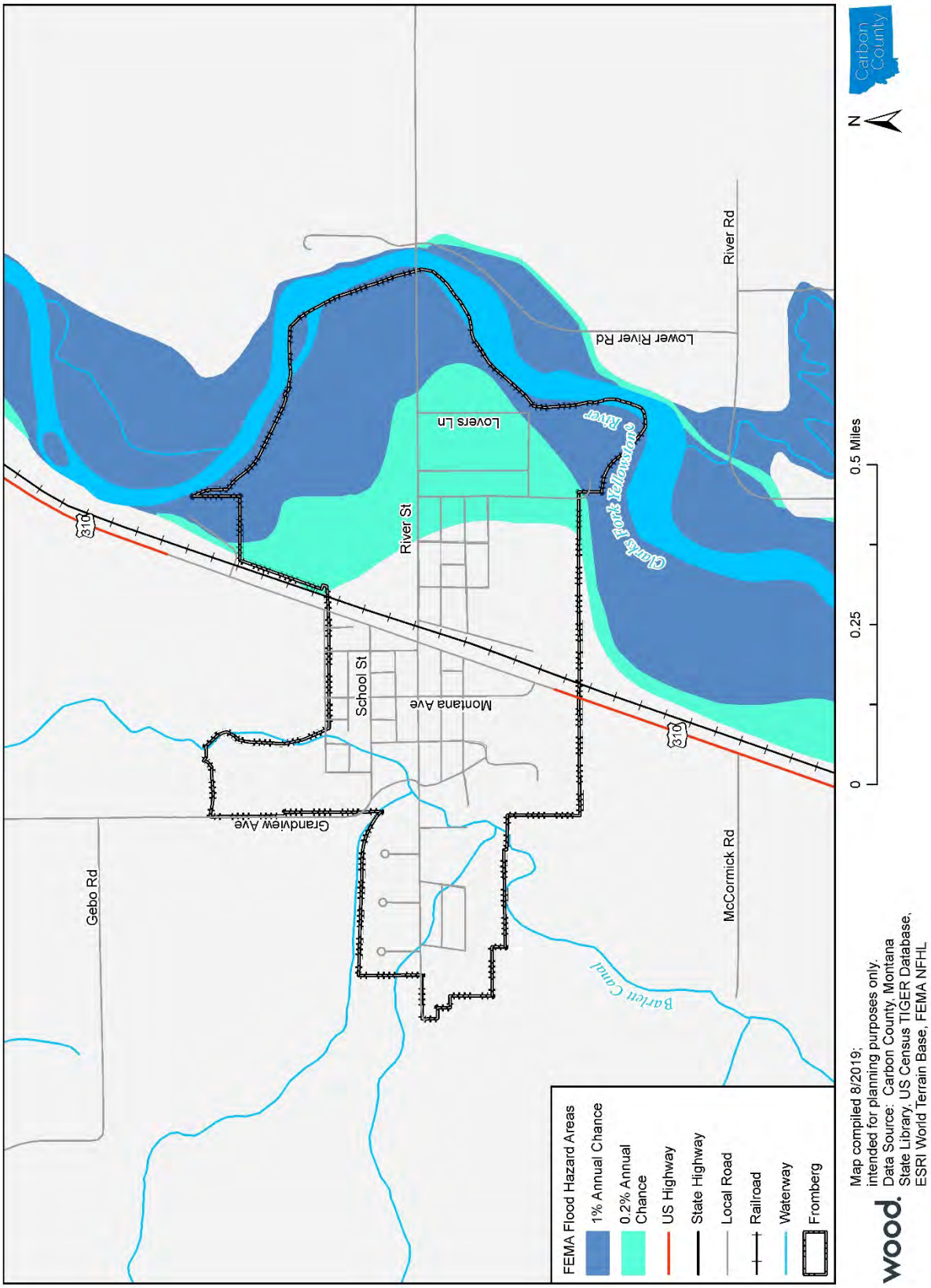


Figure 3-34 FEMA Special Flood Hazard Areas in Joliet

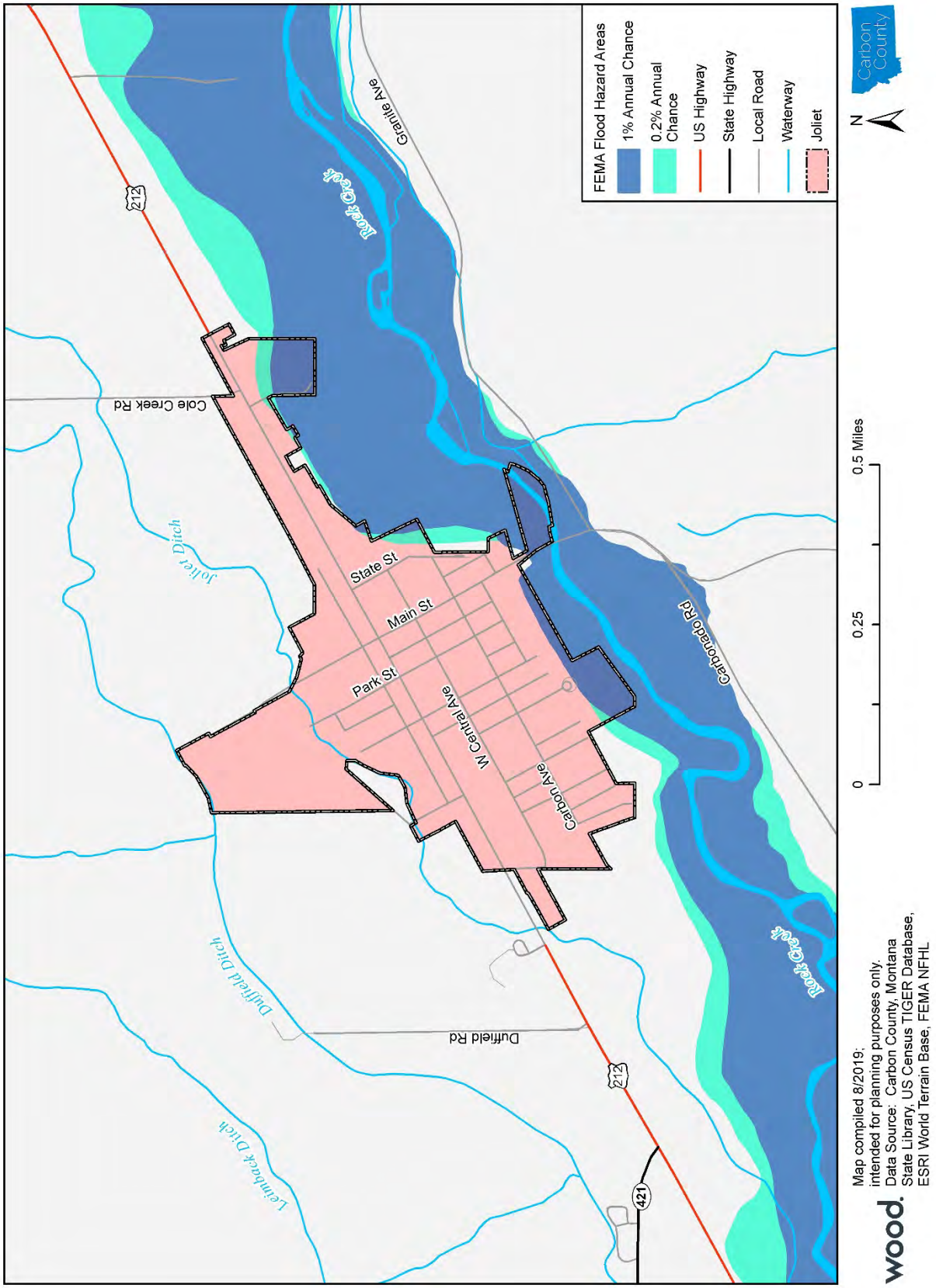
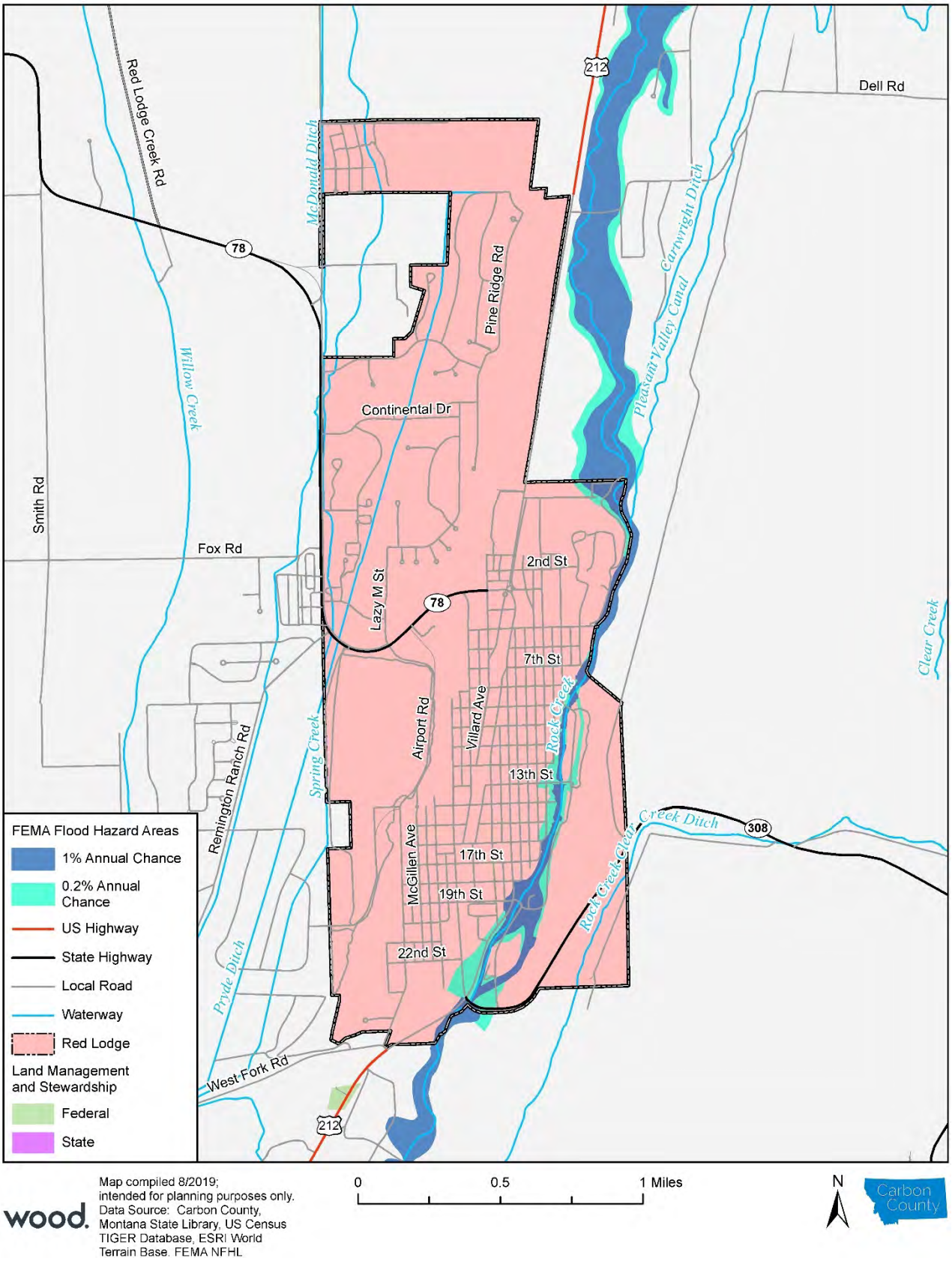


Figure 3-35 FEMA Special Flood Hazard Areas in Red Lodge



Map compiled 8/2019; intended for planning purposes only. Data Source: Carbon County, Montana State Library, US Census TIGER Database, ESRI World Terrain Base, FEMA NFHL

Insurance Coverage, Claims Paid, and Repetitive Losses

Unincorporated Carbon County joined the National Flood Insurance Program (NFIP) in emergency status in March 23, 1978 (though its regular entry date was November 4, 1981 as well as the Town of Fromberg). The City of Red Lodge joined in emergency status June 30, 1975 and regular entry May 19, 1981 as did the Town of Joliet. None of the communities participating in this planning process are members of the Community Rating System (CRS). The Town of Bearcreek joined the NFIP on June 27, 2013 but has not been mapped yet.

FEMA insures properties against flooding losses through the NFIP. Table 3-26 summarizes the number of flood insurance policies by jurisdiction as of 3/31/2019, as well as the number and amount of paid loss claims. The unincorporated areas have had the largest number of paid losses.

Table 3-26 Carbon County and Incorporated Jurisdictions Flood Insurance Details

Jurisdiction	Policies	Insurance in Force	Number of Paid Losses	Total Losses Paid
Carbon (unincorp.)	68	$17,959,700	31	$320.886.24
Fromberg	2	$376,200	1	$6,366.01
Joliet	4	$688,000	--	--
Red Lodge	17	$4,575,500	1	$593.50
Total	**91**	**$23,599,400**	**33**	**$327,845.75**

Source: FEMA National Flood Insurance Program - Community Information System

Per FEMA's Community Information System (CIS) reports, the unincorporated county has 11 properties falling in A Zones, while 38 are in B, C & X preferred Zones. Thirty-four (34) of these properties were determined to be pre-FIRM structures, and the other 34 post-FIRM structures.

In the City of Red Lodge, a total of 7 properties are in A01-30 and AE Zones, while 10 fall in B, C & X Preferred Zones for a total of 17 insured properties in the City. Fifteen (15) of these are single family residences, and 1 is a non-residential property and 1 is designated as all other residential.

The Town of Joliet has 4 insured properties in the Town; 2 properties in the A01-30 and AE Zones, and 2 in the B, C, Z Preferred Zones. All 4 properties are single family residential. The Town of Fromberg has two 2 insured properties that are both single family residential. One of the properties in the Town is within the A01-30 & AE Zones and one fall within the B, C, Z Preferred Zoned.

As part of the process to reduce or eliminate repetitive flooding to structures across the United States, FEMA has developed an official Repetitive Loss Strategy. The purpose behind the national strategy is to identify, catalog, and propose mitigation measure to reduce flood losses to the relatively few numbers of structures that absorb the majority of the premium dollars from the national flood insurance fund.

A repetitive loss property is defined by FEMA as "a property for which two or more NFIP losses of at least $1,000 each have been paid within any 10-year period since 1978". A repetitive loss property may or may not be currently insured by the NFIP. There are no repetitive loss buildings in any of incorporated jurisdictions. There are 3 repetitive loss properties in unincorporated portions of the County. There have been 7 loss claims for the 3 properties, totaling $76,356. There are no properties that meet FEMA's severe repetitive loss property definition anywhere in the County. There are

Critical Facilities and Infrastructure

A flooding event can cause catastrophic impacts to areas downstream of the waterway, including critical infrastructure the county relies on for emergency service provision, transportation systems, lifeline systems, and other key facilities. Of particular risk would be roads and bridges that could be vulnerable to

washouts, further complicating response and recovery by cutting off impacted areas. In addition, negative effects of flooding could include the introduction of debris into critical water systems necessary for potable water or treatment plants, among others.

During the 2019 planning process the HMPC noted that the City of Red Lodge's public infrastructure has been impacted by flash flood events in the past. The City has had manhole covers blown off and the sewer treatment plant has been overrun during past flash flood events. Throughout the County there is extensive ditch and irrigation systems that have exacerbated flood events. The HMPC also noted there is an artificial conveyance which drops water onto Main Street in the Town of Bridger and has resulted in flooding issues for the community.

The same type of GIS overlay analysis as that performed for the built environment (parcel) analysis was performed, but this time on the structures and critical facility inventory in Carbon County and its jurisdictions. Via the intersection analysis method, a determination was made on whether a structure or facility falls within a FEMA NFHL special flood hazard area (floodplain). There are 10 total critical facilities and structures floodplains across the county; 9 of those are in the 1% annual chance floodplain while only 1 fall in the 0.2% annual chance floodplain, as shown in Table 3-27.

Table 3-27 Critical Facilities in the FEMA NFHL Floodplains in Carbon County

Flood Event	Jurisdiction	Critical Facility Type	Critical Facility Category	Total Critical Facilities
100-Year	Unincorporated	Transportation Systems or Other/Misc.	Miscellaneous/Other	1
		Lifeline Utility Systems	Sewer Lagoon	1
		High Potential Loss Facilities	HazMat Facility	1
		High Potential Loss Facilities	Dam	1
		Emergency Services	Government/Administrative	1
	Joliet	Lifeline Utility Systems	Water Well	1
			Sewer Lagoon	1
	Fromberg	Lifeline Utility Systems	Water Well	1
			Water Pump Facility	1
TOTAL				**9**
500-Year	Fromberg	Lifeline Utility Systems	Sewer Lagoon	1
TOTAL				**1**
GRAND TOTAL				**10**

Source: Carbon County DES/GIS Departments, FEMA NFHL, Wood Plc

Historic, Cultural, and Natural Resources

Natural areas within the floodplain often benefit from periodic flooding as a naturally recurring phenomenon. These natural areas often reduce flood impacts by allowing absorption and infiltration of floodwaters. Natural resources are generally resistant to flooding except where natural landscapes and soil compositions have been altered for human development or after periods of previous disasters such as drought and fire. Wetlands, for example, exist because of natural flooding incidents. Areas recently suffering from wildfire damage may erode because of flooding.

Future Development

Flooding and floodplain management are significant issues for Carbon County. The potential or likelihood of a flood event in the county increases with the annual onset of heavy rains in spring and summer months. Potential future growth in the problem areas could be affected by localized flooding, stormwater runoff and channel migration as well as secondary impacts such as degradation of water quality, losses of environmental resources, and certain health hazards. Future annexations of unincorporated areas could add to the number of flood-prone structures in the County. For NFIP participating communities, floodplain management practices implemented through local floodplain management ordinances should mitigate the flood risk to new development in floodplains. Channel migration zone mapping should be considered in land use decisions when this mapping becomes available.

Risk Summary

- 531 parcels in the County are located in both the 100-year and 500-year floodplains with a total value of $165.7 million at risk of flooding. Of the parcels, 424 fall within the 100-year and 107 fall within the 500-year floodplain
- 1,078 people live within a floodplain. 851 within the 100-year floodplain and 227 within the 500-year floodplain
- 10 critical facilities are located within a floodplain
- There is a 23% chance of a flood event in a given year. Between 1997 and 2018 there were 16 flood and flash flood events recorded in the Storm Events Database, resulting in $1,600,000 in property damages and 1 death (both as result of the 2011 flood event)
- There have been 13 ice jam events in the County in the last 19 years There are 91 total NFIP policies in force and a total of $377,845 total losses paid
- Climate change is expected to increase the frequency and variability of precipitation events by midcentury which will lead to greater variability and intensity of flood events
- *Related Hazards*: Severe Summer Storms and Drought

Flood Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Significant	Likely	Limited	High
City of Red Lodge	Significant	Likely	Limited	High
Town of Bearcreek	Significant	Likely	Limited	Medium
Town of Bridger	Limited	Occasional	Negligible	Low
Town of Joliet	Limited	Likely	Negligible	Low
Town of Fromberg	Significant	Likely	Critical	High

Carbon County Severe Weather Summary

"Although severe storms are not common, hailstorms, high winds, heavy snows, freezing rain and sleet, and small tornadoes have been observed at intervals of several years somewhere in the Carbon County Area." (Carbon County Soil Survey, USDA, 1975)

Severe weather is generally any destructive weather event, but usually occurs in Carbon County as localized storms in the summer and spring seasons that bring heavy rain, hail, lightning, strong winds, and tornadoes and as heavy snowfall and severe winter storms during the winter season. For this plan, severe weather is broken down as follows:

- Summer Storms
  - Hail
  - Severe Thunderstorms
  - Tornado
  - High Wind
- Winter Storms

The National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI) has been tracking severe weather since 1950. Their Storm Events Database contains data on the following: all weather events from 1993 to current (except from 6/1993-7/1993); and additional data from the National Hurricane Center. This database contains 366 severe weather events that occurred in Carbon County between January 1, 1950 and July 2019. Table 3-28 summarizes these events and a more detailed analysis can be found within the Severe Weather (Summer Storms and Winter Storms) hazard sections.

Table 3-28 NCEI Severe Weather Reports for Carbon County 1950-2019

Type	# of Events	Property Loss	Crop Loss	Deaths	Injuries
Avalanche	7	$0	$0	4	0
Blizzard	1	$0	$0	0	0
Hail	57	$0	$0	0	0
Heavy Rain	12	$0	$0	0	0
Heavy Snow	69	$0	$0	0	0
High Wind	35	$0	$0	0	0
Lightning	1	$0	$0	1	0
Thunderstorm Winds	25	$53,000	$0	0	0
Tornado	3	$12,250	$0	0	0
Winter Storm	154	$0	$0	0	0
Winter Weather	2	$0	$0	2	0
Total	**366**	**$65,250**	**$0**	**7**	**0**

Source: National Center for Environmental Information Storm Events Database

Summer Storms: Severe Thunderstorms, Hail, Tornadoes and High Wind

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Extensive	Highly Likely	Limited	Medium

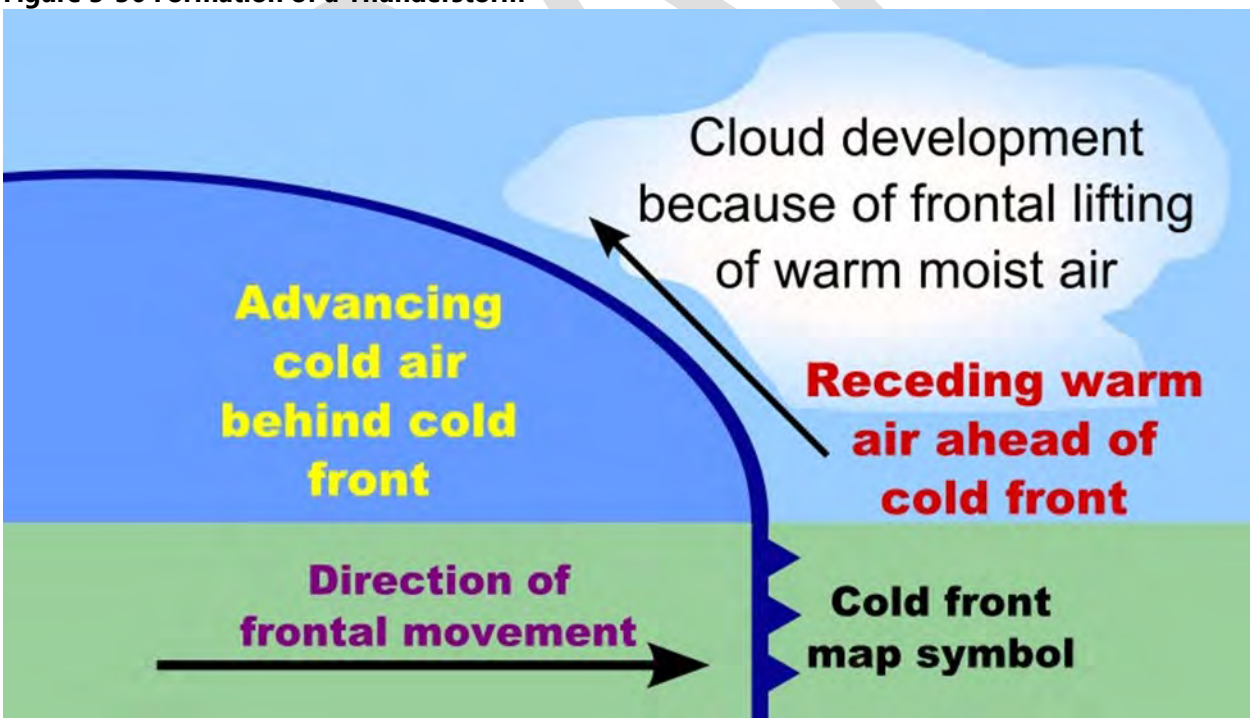
For this plan update summer storms includes the following hazards: severe thunderstorms, hail, tornado, and high wind. In the 2012 HMP, tornado was a stand-alone hazard section, the HMPC decided for this plan update to include this hazard with the other severe weather hazards that are common in the spring and summer seasons. Because of the multiple hazards within the summer storms section, each hazard is profiled separately in terms of the hazard descriptions, extent (magnitude/severity) and historic occurrences.

Hazard Descriptions

Severe Thunderstorms

Thunderstorms result from the rapid upward movement of warm, moist air (see Figure 3-36). They can occur inside warm, moist air masses and at fronts. As the warm, moist air moves upward, its cools, condenses, and forms cumulonimbus clouds that can reach heights of greater than 35,000 ft. As the rising air reaches its dew point, water droplets and ice form and begin falling the long distance through the clouds towards earth's surface. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at Earth's surface and causes strong winds associated with thunderstorms.

Figure 3-36 Formation of a Thunderstorm



Source: NASA. http://rst.gsfc.nasa.gov/Sect14/Sect14_1c.html

There are four ways in which thunderstorms can organize: single cell, multicell cluster, multicell lines (squall lines), and supercells. Even though supercell thunderstorms are most frequently associated with severe weather phenomena, thunderstorms most frequently organize into clusters or lines. Warm, humid

conditions are favorable for the development of thunderstorms. The average single cell thunderstorm is approximately 15 miles in diameter and lasts less than 30 minutes at a single location. However, thunderstorms, especially when organized into clusters or lines, can travel intact for distances exceeding 600 miles.

Thunderstorms are responsible for the development and formation of many severe weather phenomena, posing great hazards to the population and landscape. Damage that results from thunderstorms is mainly inflicted by downburst winds, large hailstones, and flash flooding caused by heavy precipitation. Stronger thunderstorms are capable of producing tornadoes and waterspouts.

The National Weather Service issues two types of alerts for severe thunderstorms:

A **Severe Thunderstorm Watch** indicates when and where severe thunderstorms are likely to occur. Citizens are urged to watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information. Severe Thunderstorm Watches are issued by the Storm Prediction Center in Norman, OK.

A **Severe Thunderstorm Warning** is issued when severe weather has been reported by spotters or indicated by radar. Warnings indicate imminent danger to life and property to those in the path of the storm. Severe Thunderstorm Warnings are issued by the National Weather Service in Billings.

Hail

Hail is associated with thunderstorms that can also bring high winds and tornados. It forms when updrafts carry raindrops into extremely cold areas of the atmosphere where they freeze into ice. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth. Hailstorms occur throughout the spring, summer, and fall in the region, but are more frequent in late spring and early summer. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 mph. Hail causes nearly $1 billion in damage to crops and property each year in the United States. Hail is also one of the requirements which the National Weather Service uses to classify thunderstorms as 'severe.' If hail more than ¾ of an inch is produced in a thunderstorm, it qualifies as severe.

Tornado

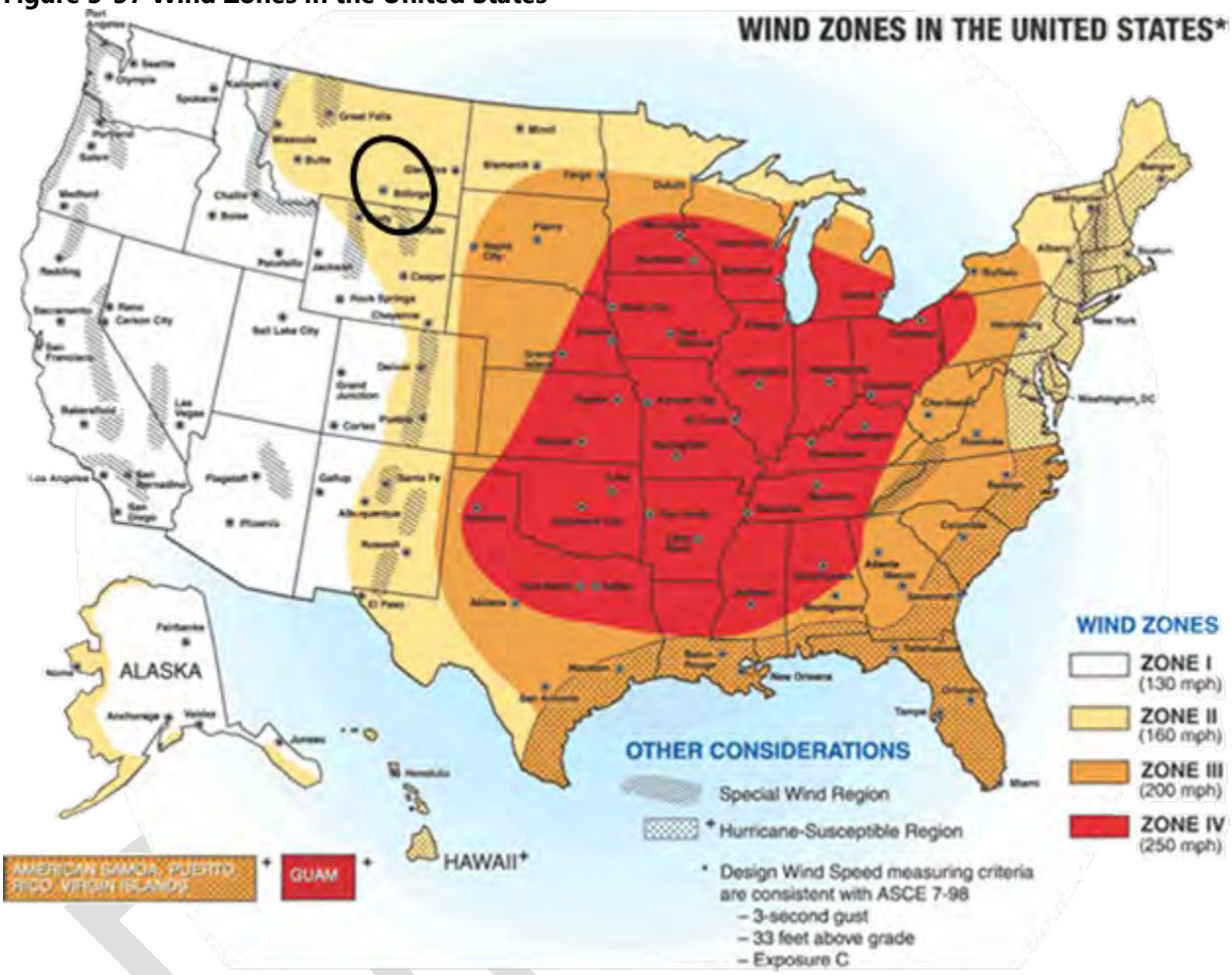
Tornadoes are infrequent, but not unheard-of events in Carbon County. Tornadoes form when cool, dry air sits on top of warm, moist air. Tornadoes are rotating columns of air marked by a funnel-shaped downward extension of a cumulonimbus cloud whirling at destructive speeds of up to 300 mph, usually accompanying a thunderstorm. Tornadoes are the most powerful storms that exist. They can have the same pressure differential across a path only 300 yards wide or less as 300-mile-wide hurricanes.

High Wind

In addition to tornadoes, the County is subject to significant, non-tornadic (straight-line), winds. High winds, as defined by the NWS glossary, are sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration." These winds may occur as part of a seasonal climate pattern or in relation to other severe weather events such as thunderstorms. Straight-line winds may also exacerbate existing weather conditions, as in blizzards, by increasing the effect on temperature and decreasing visibility due to the movement of particulate matters through the air, as in dust and snow storms. The winds may also exacerbate fire conditions by drying out the ground cover, propelling fuel, such as tumbleweeds, around the region, and increasing the ferocity of exiting fires. These winds may damage crops, push automobiles off roads, damage roofs and structures, and causes secondary damage due to flying debris.

Figure 3-38 depicts wind zones for the United States. The map denotes that the entirety of the County falls into Zone II, which is characterized by high winds of up to 160 mph. The far southern edge of the County borders on Zone III, characterized by high winds of up to 200 mph.

Figure 3-37 Wind Zones in the United States



Source: Federal Emergency Management Agency

Geographic Area

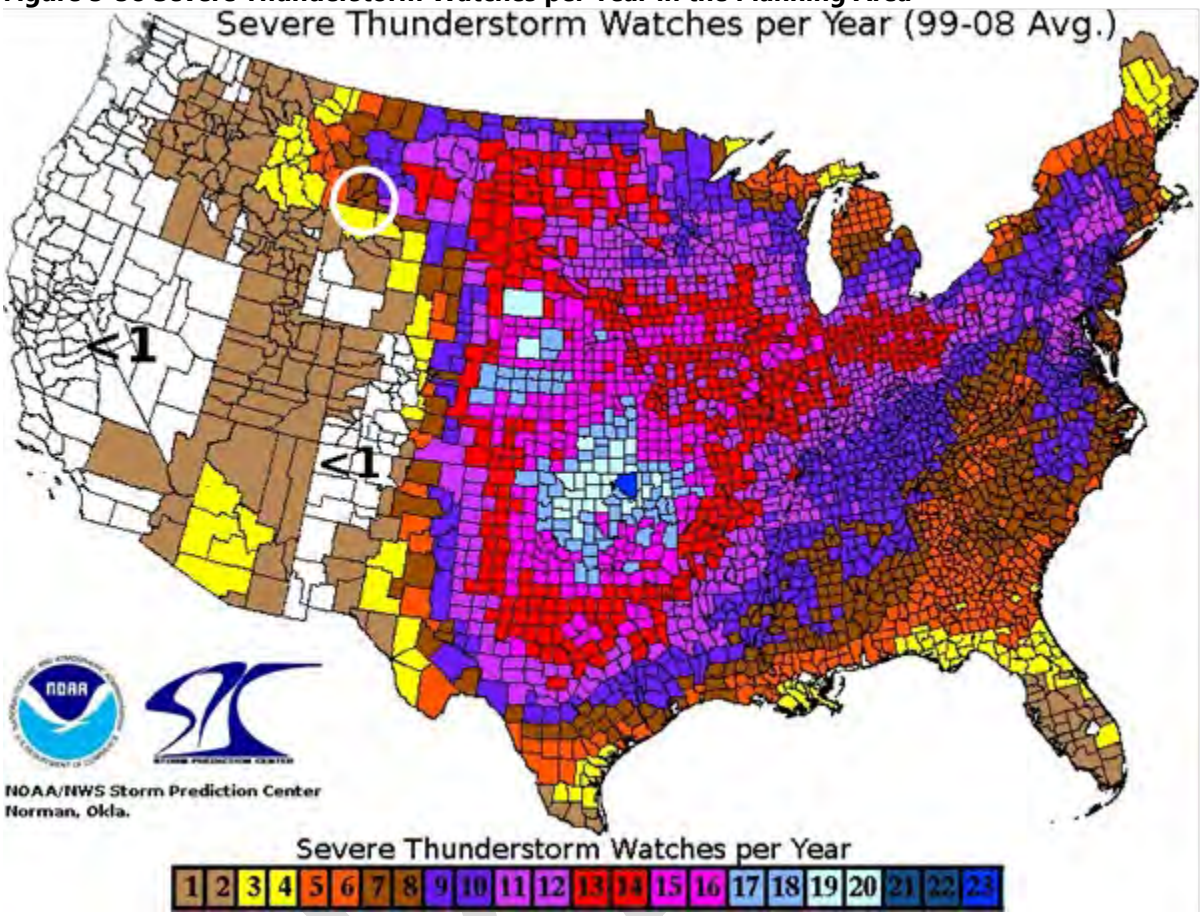
Thunderstorms are generally expansive in size. The entire county is susceptible to any of the effects of a severe thunderstorm, including hail, heavy rain, tornados and high winds.

Extent (Magnitude/Severity)

Severe Thunderstorms

The County sees 7-8 severe thunderstorm watches per year, as shown in Figure 3-39.

Figure 3-38 Severe Thunderstorm Watches per Year in the Planning Area



Source: NOAA/NWS Storm Prediction Center

Flash floods often result from the heavy rainfall of thunderstorm systems and nationally are considered the number one thunderstorm-related killer because they often occur at night and people in affected areas may not be able to see the extent of the rapidly rising water before it is too late to escape. Drivers attempting to cross flood-covered sections of roadways can be swept into deeper water and perish. During daylight hours, children playing in flooded drainage canals and ditches are particularly vulnerable to drowning in flash floods. Flash flooding and flooding from accumulations of rainwater from thunderstorms are addressed in depth in the flooding section above.

Hail

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Table 3-29 indicates the hailstone measurements utilized by the National Weather Service.

Table 3-29 Hailstone Measurements

Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf-Ball
2.0 inch	Hen Egg
2.5 inch	Tennis Ball
2.75 inch	Baseball
3.00 inch	Teacup
4.00 inch	Grapefruit
4.5 inch	Softball

Source: National Weather Service

There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground. Multi-cell thunderstorms produce many hailstones, but not usually the largest hailstones. In the life cycle of the multi-cell thunderstorm, the mature stage is relatively short so there is not much time for growth of the hailstone. Supercell thunderstorms have sustained updrafts that support large hail formation by repeatedly lifting the hailstones into the very cold air at the top of the thunderstorm cloud. In general, hail 2 inches (5 cm) or larger in diameter is associated with supercells (a little larger than golf ball size which the NWS considers to be 1.75 inch.). Non-supercell storms can produce golf ball size hail.

In all cases, the hail falls when the thunderstorm's updraft can no longer support the weight of the ice. The stronger the updraft the larger the hailstone can grow. When viewed from the air, it is evident that hail falls in paths known as hail swaths. They can range in size from a few acres to an area 10 miles wide and 100 miles long.

Hail is a frequent occurrence is Carbon County. Depending on the size of the hail and the seasonal timing of the storm, hail can cause crop damage, property damage, vehicle accidents, and personal injury. Thunderstorms are common as well and are often accompanied by strong winds and electrical activity. These types of storms generally occur from May through September.

Tornado

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis and better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 3-31 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 3-32 shows the wind speeds associated with the Enhanced Fujita Scale ratings.

Table 3-30 Original Fujita Scale

Fujita (F) Scale	Fujita Scale Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown, and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 3-31 Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, the majority of injuries and deaths generally result from flying debris. Property damage can include damage to buildings, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response. Figure 3-37 illustrates the potential impact and damage from a tornado according to the Enhanced Fujita Scale ratings.

Figure 3-39 Potential Impact and Damage from a Tornado

Source: NOAA National Weather Service, Storm Prediction Center

High Wind

Table 3-30 shows the Beaufort Wind Scale. The replication of the scale only reflects land-based effects.

Table 3-32 The Beaufort Wind Scale

Beaufort Number	Description	Windspeed (MPH)	Land Conditions
0	Calm	<1	Calm. Smoke rises vertically.
1	Light air	1 – 3	Wind motion visible in smoke.
2	Light breeze	3 – 7	Wind felt on exposed skin. Leaves rustle.
3	Gentle breeze	8 – 12	Leaves and smaller twigs in constant motion.
4	Moderate breeze	13 – 17	Dust and loose paper raised. Small branches begin to move.
5	Fresh breeze	18 – 24	Branches of a moderate size move. Small trees begin to sway.
6	Strong breeze	25 – 30	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	High wind, Moderate gale, Near gale	31 – 38	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	Gale, Fresh gale	39 – 46	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.

Beaufort Number	Description	Windspeed (MPH)	Land Conditions
9	Strong gale	47 – 54	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.
10	Storm, Whole gale	55 – 63	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	Violent storm	64 – 72	Widespread vegetation damage. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	Hurricane	≥ 73	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris may be hurled about.

Source: National Oceanographic and Atmospheric Association, http://www.spc.noaa.gov/faq/tornado/beaufort.html

Historic Occurrences

The 2012 LHMP noted the following historic event; Gilbert Brown of Bridger remembered an extreme localized hail storm in June of 1957. Although the storm lasted only 30 minutes, he recalled that windows were broken in his house, shingles were torn from the roof, and the wheat crop was knocked down. The storm moved from the northwest to the southeast damaging a narrow swath.

As shown in Table 3-28 the Storm Events Database has recorded 375 severe weather events (includes avalanche and winter weather hazards) in the County 1950. More storms may have gone unrecorded. The following section breaks down historic occurrences by hazard type.

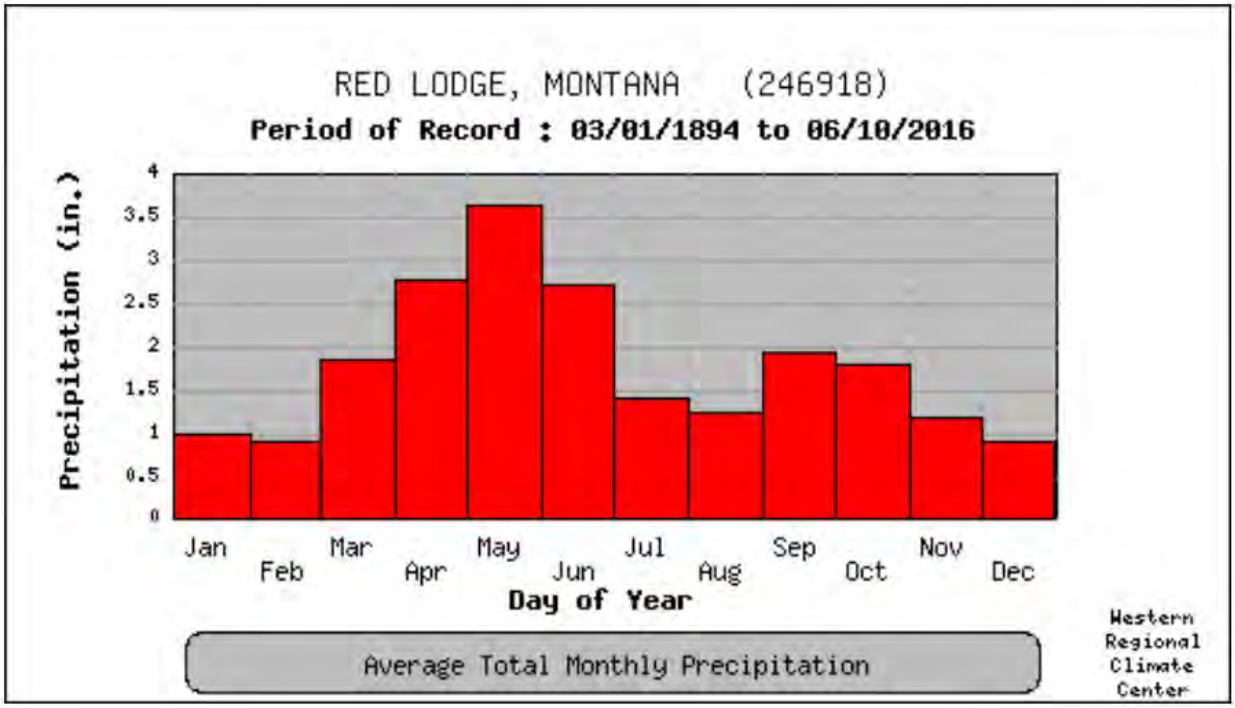
Severe Thunderstorms

To give a holistic picture of the various weather conditions in the County information from three representative weather stations - Red Lodge (COOP #246918), Bridger (COOP #241102), Joliet (COOP #244506) were gathered .

Red Lodge Weather Station (COOP # 246918) – Period of Record 1894 – 2016

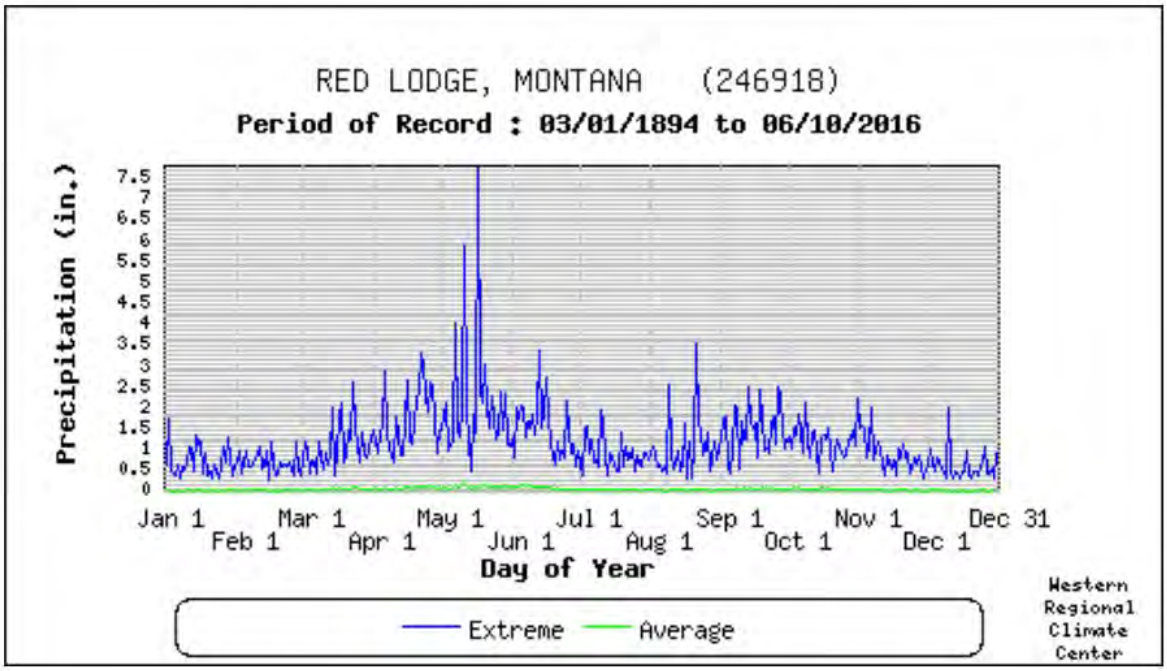
Information from the closest weather station with the most comprehensive data to represent the City of Red Lodge area is summarized below in Figure 3-40 and Figure 3-41. Average annual precipitation recorded at this weather station is 21.31 inches per year. The highest recorded annual precipitation was 36.65 inches in 1975; the highest recorded precipitation for a 24-hour period is 7.75 inches on May 7, 2000. The lowest recorded annual precipitation was 11.17 inches in 1914.

Figure 3-40 Red Lodge Area - Monthly Average Total Precipitation (Period of Record 1894 -2016)



Source: WRCC

Figure 3-41 Red Lodge area - Daily Precipitation Average and Extreme (Period of Record 1894-2016)

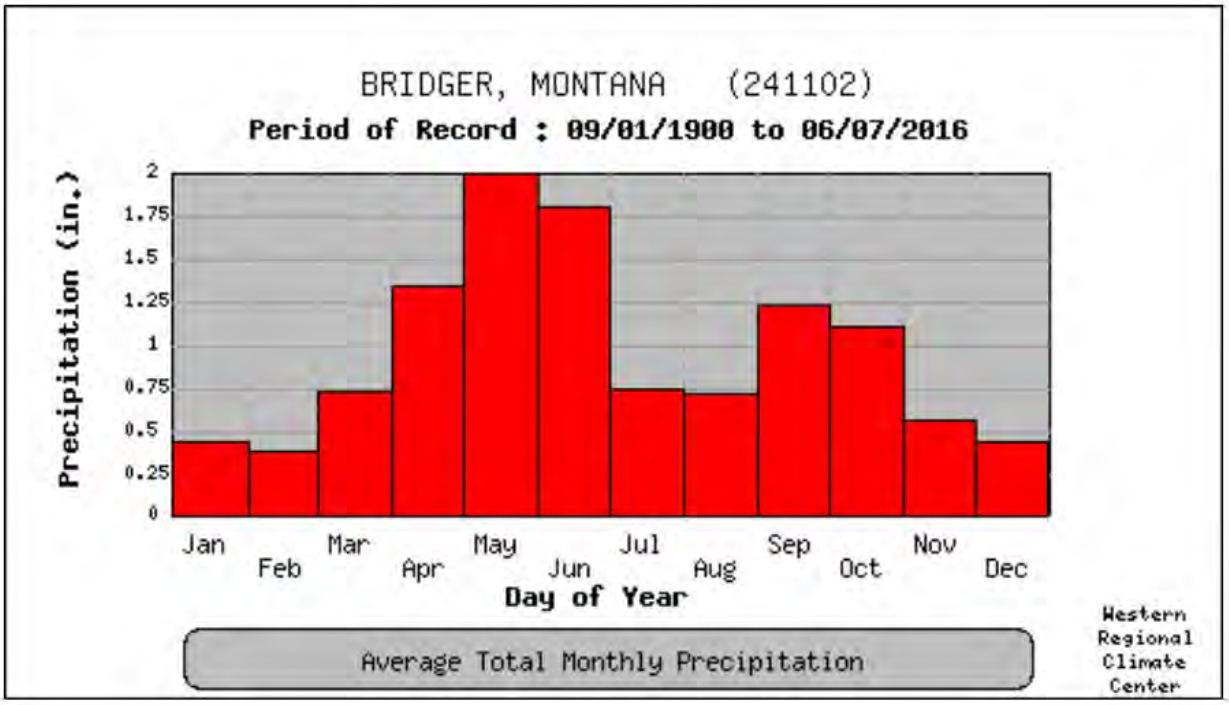


Source: WRCC

Bridger Weather Station (COOP #241102) – Period of Record 1900 - 2016

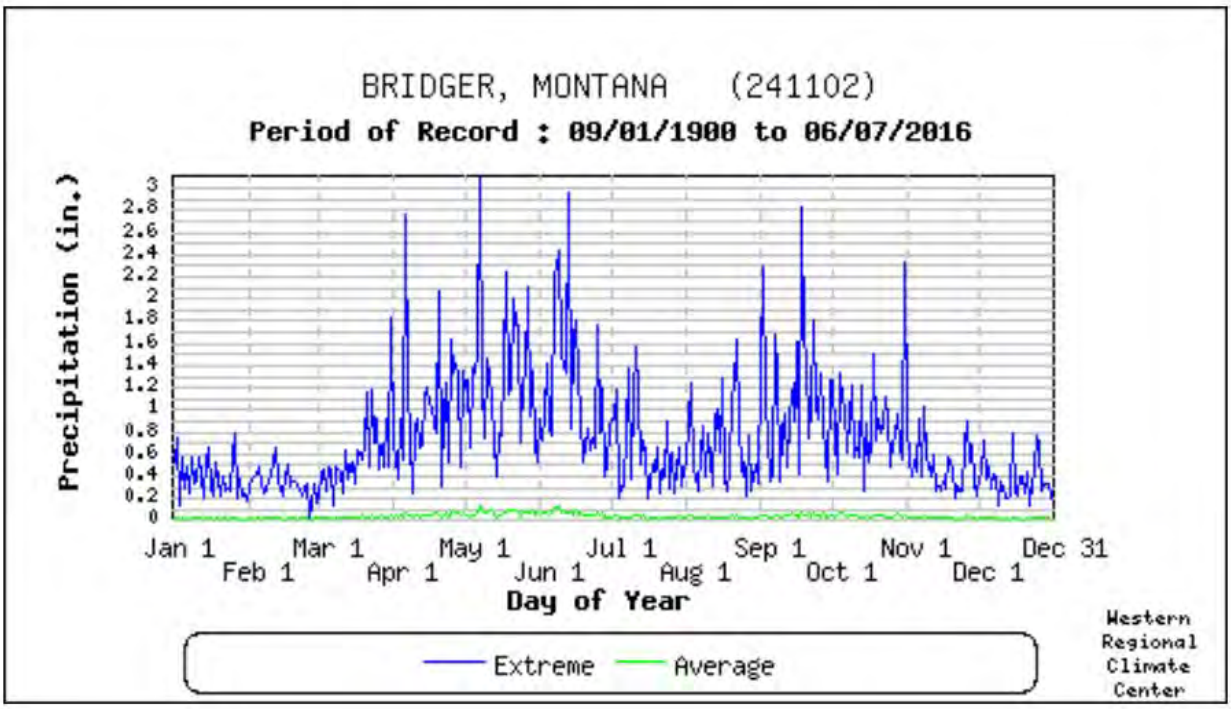
Information from the closest weather station with the most comprehensive data to represent the Bridger area, is summarized below in Figure 3-42 and Figure 3-43. Average annual precipitation recorded at this weather station is 11.44 inches per year. The highest recorded annual precipitation was 20.25 inches in 1978; the highest recorded precipitation for a 24-hour period is 3.08 inches on May 7, 1988. The lowest recorded annual precipitation was 6.77 inches in 1960.

Figure 3-42 Bridger Area - Monthly Average Total Precipitation (Period of Record 1900 - 2016)



Source: WRCC

Figure 3-43 Bridger Area - Daily Precipitation Average and Extreme (Period of Record 1900-2016)

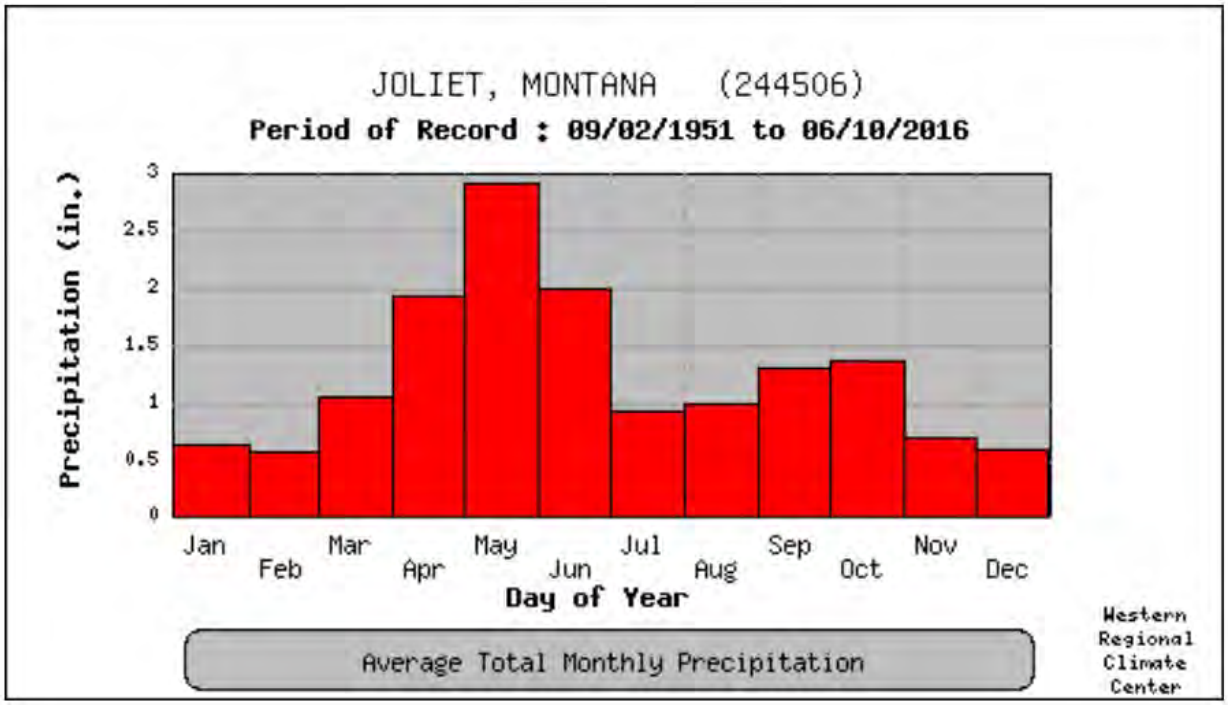


Source: WRCC

Joliet Weather Station (COOP #244506) – Period of Record 1951 - 2016

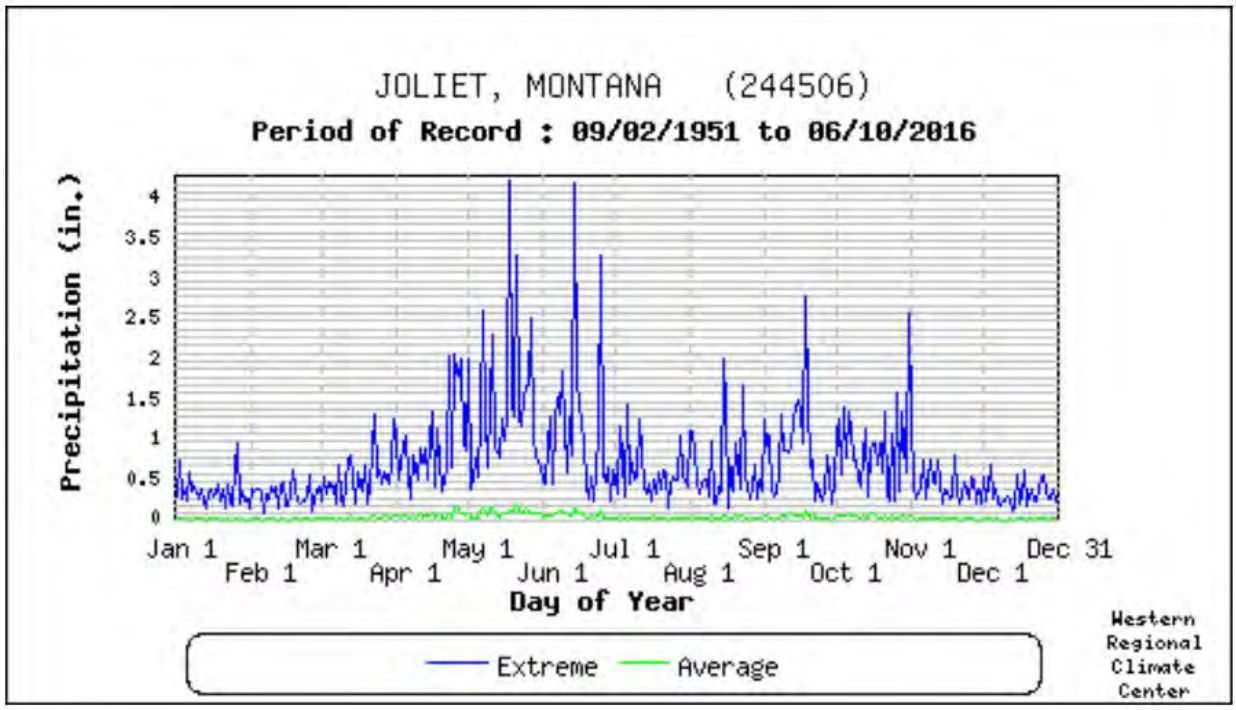
Information from the closest weather station with the most comprehensive data to represent the Joliet area, is summarized below in Figure 3-44 and Figure 3-45. Average annual precipitation recorded at this weather station is 14.91 inches per year. The highest recorded annual precipitation was 28.22 inches in 1978; the highest recorded precipitation for a 24-hour period is 3.08 inches on May 7, 1988. The lowest recorded annual precipitation was 7.82 inches in 1960.

Figure 3-44 Joliet Area - Monthly Average Total Precipitation (Period of Record 1950 - 2016)



Source: WRCC

Figure 3-45 Daily Precipitation Average and Extreme (Period of Record 1950-2016)



Source: WRCC

Hail

Hail storms are frequent events in the County that are usually localized and short-lasting. According to the HMPC a hailstorm in 1985 included baseball sized hail.

The Carbon County News reported on a hail storm that struck near Red Lodge on July 13, 2011. Golf ball sized hail struck, leaving a trail of dented vehicles, damaged roofs, shredded tress, smashed skylights, and killed plants. Manhole covers rattled under the pressure and driving and walking were nearly impossible during the storm. Several hundred roofs in and around Red Lodge have been and are still being replaced because of this hail storm. There was also extensive damage to vehicles including broken windows and severe denting to car bodies.

With 57 recorded events, hail has the most records in the Storm Events Database of the summer storm hazards between 1950-2019. Hail with the diameter of 1.75 (golf ball size) is largest recorded and has been recorded multiple times during different events. Of the incorporated jurisdictions, the Town of Joliet has the most recorded hail events, with 11 events occurring since 1950.

Tornado

According to the NCEI, between 1950 and 2019, Carbon County had 3 tornadoes spotted that were reported. It is extremely likely that additional tornadoes have occurred in the County that were not formally reported. Reported tornadoes are shown in Table 3-33.

Table 3-33 Past Occurrences of Tornadoes in Carbon County

Location or County	Date	Time	Type	Magnitude	Death	Injuries	Property Damage	Crop Damage
Carbon County	03/23/1988	1:30 pm	Tornado	F0	0	0	$250	0
Carbon County	05/24/1990	3:00 pm	Tornado	F1	0	0	0	0
Warren	06/16/2010	4:00 PM	Tornado	EF2	0	0	$12,000	0

Source: NCEI

The 2010 Bowler Flats tornado was on the ground for approximately one mile and lasted for five minutes. The tornado destroyed four transmission structures, damaged a transmission pole, shredded two wooden power poles and damaged some fencing; otherwise, it remained over open areas. The EF-2 designation was based on power and transmission poles being shredded with winds estimated from 111-135 mph.

Although not occurring in the County, an EF-2 tornado in nearby Billings on June 20, 2010 shows the potential for damage should a tornado strike an urbanized area. The damage path was 120 yards wide with a length of about a half mile and on the ground an estimated 12 minutes. The damage assessment and eyewitness accounts indicate significant EF-2 damage to several nearby businesses. Damage included rooftops being blown off of three structures, windows blown out, power poles downed, business signs and billboards blown down along with several trees uprooted. In total, $30,000,000 in damage was attributed to this tornado. Fortunately, no deaths or injuries were reported.

High Wind

According to the Storm Events Database, 60 high wind and thunderstorm winds events have taken place in the county between 1950 and 2019. The highest recorded wind event was 94 miles per hour (mph) on November 13, 2007 west of Red Lodge but did have some impact on the City. All of the recorded high wind events took place in the unincorporated areas of the County The following are brief descriptions on past thunderstorm wind events that have taken place in some of County's incorporated jurisdictions.

City of Red Lodge

June 13, 1994 – Thunderstorm wind event resulting in $50,000 in property damages when a chemical storage shed was blown apart.

August 10, 2008 – An estimated thunderstorm wind gust of 70 mph resulting in damage to a ranger station roof was reported in Red Lodge.

August 29, 2013 – 56mph magnitude. An isolated severe thunderstorm produced strong wind gusts southwest of Red Lodge

Town of Bridger

April 28, 1999 - A spotter reported a 60-mph wind gust with a thunderstorm.

June 21, 2005 - Roofing material ripped off house and 2-inch diameter tree branches down. 65-70 mph recorded.

July 12, 2006 – 59 mph wind speeds recorded

Town of Joliet

July 14, 2001 – 55 mph wind speeds recorded

July 28, 2001 - Wind damage. Roof blown off house and chicken coop blown over. 70 mph winds recorded.

Likelihood of Future Occurrence

Highly Likely - Heavy rain, thunderstorms, and hail are well-documented seasonal occurrences that will continue annually in Carbon County. The Soil Survey published by the Soil Conservation Service reports that "Hail of damaging strength or size occurs about 1 year in 10 at lower elevations."

According to NCEI records, there have been only three recorded tornadoes in the County since 1955. The historical record is most likely incomplete. Historical tornado activity within the County indicates that the area will likely continue to experience the formation of funnel clouds and weak tornadoes during adverse weather conditions. The actual risk to the County is dependent on the nature and location of any given tornado; while tornadoes in the county have historically been weaker, this does not free the county from risk of a much stronger tornado based on atmospheric conditions.

Climate Change Considerations

As average temperatures increase over time, this generally will result in higher extreme temperatures and more warming in the atmosphere can trigger climate changes, which could result in more frequent extreme weather events. Analysis conducted for the 2017 Montana Climate Assessment show that despite there being no historical change in average annual precipitation between 1950 and 2015, there have been changes in the average seasonal precipitation over the same period of time. The State Climate Assessment states that precipitation is projected to increase in winter, spring and fall while precipitation in the summer is projected to decrease. With the greatest increase expected to occur during the spring the southern part of the state. Hail events are also expected to increase in the southwest and eastern Montana in spring and early summer.

There presently is not enough data or research to quantify the magnitude of change that climate change may have related to tornado frequency and intensity. NASA's Earth Observatory has conducted studies

which aim to understand the interaction between climate change and tornadoes. Based on these studies meteorologists are unsure why some thunderstorms generate tornadoes and others don't, beyond knowing that they require a certain type of wind shear. Tornadoes spawn from approximately one percent of thunderstorms, usually supercell thunderstorms that are in a wind shear environment that promotes rotation. Some studies show a potential for a decrease in wind shear in mid-latitude areas. Because of uncertainty with the influence of climate change on tornadoes, future updates to the mitigation plan should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Vulnerability

People

Exposure is the greatest danger to people from severe thunderstorms. People can be hit by lightning, pelted by hail, and caught in rising waters due to heavy rain. Tourists and those enjoying the outdoors who are not familiar with the severe weather risks in the County are particularly vulnerable to thunderstorms in Carbon and the associated hazards of precipitation and the increased risk of the impacts of severe thunderstorms.

Community members are the most vulnerable to high wind and tornado events. The availability of sheltered locations such as basements, buildings constructed using tornado-resistant materials and methods, and public storm shelters, all reduce the exposure of the population. According to the HMPC, Joliet, Red Lodge and Bridger each have outdoor warning sirens. Bearcreek added that the Town has a bell located in the park that Town employees continually ring to alert citizens of an emergency.

The HMPC noted that high wind events have knocked down trees and power lines and power loss due to severe weather is common. There are also segments of the population who rely on constant, uninterrupted electrical supplies that may have a greater, indirect vulnerability to lightning, high winds or tornado events. These populations include the elderly or disabled, especially those with medical needs and treatments dependent on electricity. Senior Centers and Medical Clinics are also vulnerable if electrical outages are prolonged, since backup power generally operates only minimal functions for a short period of time. If they do not have a back-up power source, rural residents and agricultural operations reliant on electricity for heating, cooling, and water supplies are also especially vulnerable to power outages. As described in the Asset Summary section, GIS analysis was conducted using data from the U.S. Department of Health and Human Services on Medicare beneficiaries who rely on electricity-depending medical equipment, such as ventilators. Based on this analysis 7% of Medicare beneficiaries in the County or 188 individuals who rely on electricity to live independently in their homes.

Economy

Economic impact of a severe thunderstorm is typically short term. Lightning, high wind, and tornado events can cause power outages and fires. Generally, long-term economic impacts center more around hazards that cascade from a severe thunderstorm, including wildfires ignited by lightning, and flooding (refer to the Wildfire and Flood sections). In general, all severe thunderstorms pose a risk to the tourism economy in the county. These events can disrupt travel into and out of all areas of the county and create perilous conditions for residents, tourists and nature alike.

Hail poses the greatest risk to the agricultural economy. According to the HMPC past hail events have impacted barley and corn crops. Based on the USDA's Risk Management Agency Crop Indemnity Reports which were collected for the years 2015-2018, crop losses due to hail were reported in every year across the county. Table 3-34 summarizes the agricultural losses experienced across the county. A total of

$387,079 was indemnified for 1,528 acres of affected crops covering 29 policies since 2015. July 2018 had the most crops damages reported due to hail with a total of $370,586 indemnified for 762.42 acres with a majority being barley crops.

Table 3-34 Risk Management Agency Crop Indemnity Reports Due to Hail 2015-2018

Year	Crop	Month of Loss	Policies Indemnified	Net Determined Acres	Indemnity Amount	Loss Ratio
2015	All other Crops	June	1	43.6	$7,426	0.95
2016	Wheat	May	1	14.3	$822.6	3.63
	Barley	May	1	30.7	$4,631.0	6.76
2017	Forage Production	August	2	546.6	$814	0.49
		July	2	130.2	$2,799.6	5.31
2018	All other Crops	June	1	25.6	$1,628.0	3.36
	Wheat	July	1	100.1	$6,081	3.13
	Sugar Beets	July	2	113.9	$6,618	1.1
	Corn	July	3	224.8	$54,703	12.38
	Barley	July	15	298.0	$301,556	14.58
TOTAL			**29**	**1,528**	**$387,079**	

Source: USDA Risk Management Agency

Built Environment

Severe thunderstorm events in Carbon County are seasonal events that are most likely to occur in the summer months of July and August. These thunderstorm events can include significant precipitation as well as high winds, and lighting. These storms have resulted in damages to property in the past. Lightning in particular can cause property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning strikes cause intense but localized damage. Structural fires, localized damage to buildings, damage to electrical powerlines and communications outages are typical consequences of a lightning strike. High winds in the planning area often result in downing of trees and damage to properties as a result. Given the nature of these types of storms, the entire County is potentially at risk of sporadic impacts.

Critical Facilities and Infrastructure

Because of the unpredictability of severe thunderstorm events strength and path, most critical infrastructure that is above ground is equally exposed to the storm's impacts. Due to the random nature of these hazards, a more specific risk assessment was not conducted for this plan.

Red Lodge Mountain experienced a microburst in 2009. The microburst caused timber blowdown that damaged two county radio antennae. Two towers required replacement as a result. The associated costs were $20,000. This type of event is not uncommon. Damaging wind events have caused roof damage,

damage to electric transmission lines, power outages, damage to vegetation (forests and residential landscaping), and injuries. Future events are likely to cause damages in the several hundreds of thousands of dollars.

Historic, Cultural, and Natural Resources

Severe thunderstorms are a natural environmental process. Environmental impacts include the sparking of potentially destructive wildfires by lightning.

Future Development

New critical facilities, such as communication towers should be built to withstand heavy rain, wind, and lighting damage. Future development projects should consider severe thunderstorm hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. Development trends in the County are not expected to increase overall vulnerability to the hazard but all development will be affected by severe thunderstorm events and any population growth will increase potential exposure to hazards such as severe thunderstorms.

Risk Summary

- There have been 375 recorded severe weather events since 1950 in Carbon County
- 60 high wind and thunderstorm events have been recorded. Highest recorded wind event of 94 mph on November 13, 2007 impacted the City of Red Lodge
- 57 hail events have been recorded. The Town of Joliet has the most recorded hail events (11). Hail stones that are 0.75 in diameter or golf ball size hail were most often recorded by the NCEI, although the HMPC noted after a 1985 storm there were reports of baseball sized hail
- A total of $387,079 was indemnified for 1,528 acres of affected crops covering 29 policies since 2015 due to hail events
- There have been 3 tornado events in the County since 1988
- Average precipitation ranges from 11.4 to 21.3 inches
- There are 188 Medicare beneficiaries in Carbon that are dependent on electricity to live independently.
- *Related Hazards:* Flood; Earth Movement

Summer Storm Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Extensive	Highly Likely	Limited	Medium
City of Red Lodge	Extensive	Highly Likely	Limited	Medium
Town of Bearcreek	Extensive	Highly Likely	Limited	Medium
Town of Bridger	Extensive	Highly Likely	Limited	Medium
Town of Joliet	Extensive	Highly Likely	Limited	Medium
Town of Fromberg	Extensive	Highly Likely	Limited	Medium

Winter Storms

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Extensive	Highly Likely	Limited	Medium

Hazard Description

Winter storm hazards present one of the greatest threats to life of any hazard in Montana. Statistics on winter deaths are difficult to obtain, but nationwide there are on average 100 lives directly and indirectly lost to winter weather, more than lightning, hurricanes, or tornadoes. Winter storms are considered to be deceptive killers because most deaths are indirectly related to the storm. People die in traffic accidents on snow- or ice-covered roads, from hypothermia due to prolonged exposure to cold, and from heart attacks due to overexertion. About 70 percent of the winter deaths in the U.S. occur in automobiles and nearly 25 percent are from people caught out in the storm (NOAA, 2001).

Most Montana residents are readily prepared for snow storms each winter. Every community receives snow on an annual basis, so residents expect measurable snow several times each winter. Cold temperatures into the negative numbers are also common throughout the winter months. Major problems typically only occur during record snowfalls and extended periods of below zero temperatures. Rapid snowfall can overwhelm the plowing resources, making roadways impassable, and severely reduce visibility. Particularly heavy snows, early or late season snows, and ice events can damage infrastructure such as power lines, and block roads or damage structures with downed trees. Extended cold periods, especially when coupled with strong winds, can create dangerous situations for those outdoors or those without heat, such as in the case of a utility disruption.

Winter storms are generally slow in developing, often taking one to three days to mature. This does not in any way diminish their importance, nor their potential for causing loss of life and destruction. What it does mean is that the National Weather Service is often able to provide advance notice of winter storms, in some cases, lead times of one to two days.

Blizzards and ice storms occur in Carbon County. A blizzard is defined as a storm with winds over 35 miles per hour with snow and blowing snow reducing visibility to near zero. Blizzards and ice storms pose a great threat to human life, livestock, and wildlife in Carbon County, and in Montana. As evidenced by the failure to recall severe winter storms, residents of the County are accustomed to dealing with winter storms. However, rapid snowfall, extremely low temperatures, and/or strong winds can combine to present especially dangerous conditions.

Geographic Area

The geographic area impacted by this hazard is extensive. The entire County is susceptible to severe winter storms.

Extent (Magnitude/Severity)

Overall, severe winter storm impacts could be limited, but the potential for heavy snow and blizzard events as defined by the National Weather Service are possible. County residents take the weather in stride as part of mountain living. Most property damages with winter storms are related to the heavy snow loads and vehicle accidents. The highest risk will be to travelers that attempt to drive during adverse conditions. Economic impacts occur because of power outages and closures of Beartooth Pass for snow

removal and avalanche control, leaving residents and visitors stranded as well as interrupting the transport of supplies and services into the area for an extended period.

Historic Occurrences

The NCEI Storm Events Database has recorded 226 winter storm events between 1950 and 2018, refer to Table 3-28 above for a complete breakdown of severe weather events in the County in the past 68 years. The City of Red Lodge had the most winter events recorded, this does not include the 2019 State of Emergency for the City.

The following summary of past winter weather events was from the 2012 planning process.

Beartooth Times February 13, 1936 headlines read "Old Man Winter Still in Control." "The present spell now well into its third week, is the most severe experienced in the state in several years." Snowfall was heavy and temperatures were well below zero. "The coldest registered in Bridger was 32 below zero, with many readings from 26-30 below." The Carbon County News reported the following week that "game birds were dying from the cold snap" due to sub-zero temperatures and deep snow. (February 19, 1936) Reuben Steinmetz recalled riding his horse from Montaqua to Rockvale in the storm and freezing his face in the cold. He reported that numbers of wildlife succumbed to the cold temperatures.

Long-time resident, Bob Moran, recalled a heavy snow in the 1940's that crushed the roof on the Bull and Bear in downtown Red Lodge. Jim Yedlicka in the Clarks Fork Valley recalled that there were a number of winter storms in the 1940s that caused power outages. The Carbon County News reported on a number of severe winter weather events in 1949. First, January 1949 was the coldest since 1937. Second, the News reported "High Wind Hits Red Lodge Area." The February 10th edition reported that a warm wind from the south melted snow and left glazed sidewalks, stalled cars, a bus and trucks blown into ditches, and snow drifts that made the roads impassable.

Just a week later the News again reported that wind and snow had caused 250 miles of road in the north end of the County to be blocked by drifts.

In April of 1955 Carbon County News reported that "Carbon County is Snowbound for Two Days. (April 7, 1955) The article further stated that streets and roads were being reopened and "little serious hardship was reported." This despite the fact that there was an 8-foot snowdrift across Highway 212 one mile south of Red Lodge and roads throughout the County were blocked. "Some farmers expected lambing and calving losses, and few were caught with a short supply of feed." Drifts on the Washoe Hill were 8-10 feet, cars were stranded, people were marooned, schools closed, drill rigs shut down, funerals postponed, a greenhouse was damaged, the telephone exchange was swamped with calls, and there was power failure throughout Red Lodge. The article concluded that "There were few reports of acute suffering, although there were tales of heroism as in any disaster." Howard Brown recalled losing stock, lambs, that winter and also losing power. "The whole County was blanketed, Rockvale got 48 inches and the roads in the Clarks Fork Valley were all closed." Reuben Steinmetz recollected four feet of snow at Silesia. With the road to Red Lodge closed, people stayed at Fort Rockvale. The snow came for three days solid and produced huge drifts. Calves were lost.

An ice storm in the late 1960's knocked out power to the town of Fromberg for four days. Rural areas were without power for 5 to 6 days. Heavy ice-coated power lines went down and even broke the power poles off according to rancher, Jim Yedlicka.

According to the Carbon County News on January 20, 1972, the blizzard of 1972 created power outages, buried fire hydrants in Red Lodge, and caused a myriad of vehicle accidents due to poor visibility. Red Lodge was nicknamed "White Lodge" during the winter of 1971-72 as a result of a series of major winter

storms that swept through one after the other. The News reported on February 3rd and 17th that snowfall in Red Lodge in January was 62.5 inches and the snow depth was 180% of average.

According to the Soil Conservation Service, water content of the snow was 207% of average. An April storm in 1973, reported in the April 26, 1973 Carbon County News, knocked down utility poles between Billings and Joliet by the hundreds and dumped drifts of six feet in Red Lodge. The utility companies struggled to respond, but the ski area enjoyed an extra three days of skiing.

January 1984 produced a storm with record snowfall, 73 inches in one storm, according to former County Commissioner, Frank Cole. "We had winters, winters, winters. People couldn't get to their haystacks, ran out of fuel, and we had to deliver fuel."

On February 24, 1994, two storms hit the state. A Pacific storm moved in from the West with an Arctic front which moved southward out of Alberta behind the Pacific Front. The storm first hit Northwest Montana early on the 23rd and moved into Central Montana during the evening and into Eastern Montana early morning on the 24th. Heavy snow...strong winds and bitter cold accompanied the storm across the State. Two feet of snow fell in the mountains with four to eight inches elsewhere. Temperatures dropped below zero at most locations.

A powerful winter storm affected Southern Montana and Northern Wyoming during a three-day period from December 26, 2003 through December 28, 2003. A strong arctic front ushered in colder air across the area as a deep trough moved across Montana. A moist southwest flow aloft moved over this cold airmass at the surface and produced a prolonged period of snow across the area. 14 inches of snow fell at Red Lodge.

In March 2007, the intense upper low over Northern Wyoming and Southeast Montana that resulted in the heavy snow and blizzard conditions during the last three days of the month moved into the western Dakotas during the afternoon of the 30th. As it did, a narrow band of wrap-around moisture moved southwest across portions of South Central Montana. This resulted in moderate to heavy snow across a localized area. 8 inches fell in Bridger with numerous 2-3-foot drifts across many roads.

In October of 2008, a significant snowstorm brought heavy wet and record snowfall to Southern Montana. As an upper low dropped south into southern Nevada Friday, October 10th, before making a turn to the northeast reaching Eastern Montana on October 12th, persistent overrunning and upslope flow brought a long duration snow event to the region. Snowfall began in many areas on the evening of Thursday, October 9th and continued through Sunday, October 12th. The most intense portion of the storm with the heaviest snowfall rates occurred Saturday night October 11th into Sunday morning October 12th as the main upper low ejected out across Montana. With the high-water content of the snow, many large tree limbs and power lines were brought down by the weight of the snow. Temperatures were also well below normal for this time of year. The following snow totals were recorded at stations in Carbon County: Cole Creek SNOTEL 48.8 Roscoe 4SE 45.0 Red Lodge 2S 42.0 Alpine 40.0 Roscoe 6S 38.0 Red Lodge 36.0 Burnt Mountain SNOTEL 35.3 Red Lodge 4N 32.0 Roberts 5.9NNW 22.9 Belfry 16.0 Red Lodge 9ENE 12.0 Joliet 11.0 Bridger 10.0 Bridger 2N 9.0

A major winter storm moved across South Central Montana on the December 13th, 2008. The storm system brought in a period of heavy snow, blowing snow and bitterly cold temperatures. The heaviest snow fell at the time of the strongest winds behind the frontal passage on the 13th, resulting in the greatest impacts. Winds of 25 to 35 mph, with gusts exceeding 50 mph were common, resulting in frequent visibilities at or below a quarter of a mile in many areas. Snowfall amounts were generally in the one to four-inch range with locally higher amounts. In addition, bitterly cold temperatures moved into the area for the remainder of the weekend. On the 15th, record low temperatures were reported at some locations as temperatures dropped to around 20 degrees below zero.

On May 5, 2010, a strong Pacific disturbance brought heavy snow along the north and east facing slopes of the Beartooth Mountains, as well as across portions of Southeast Montana. Fishtail to Cole Creek SNOTEL received anywhere from 17 to 33 inches of snow.

On November 28, 2010, a storm system moved through the Rockies and into the High Plains. Strong upslope flow resulted in accumulating snow in the foothills of the Beartooth and Absaroka Mountains. In addition, bands of moderate snow developed over the Eastern Plains of the Billings Forecast Area. Brisk north winds also caused blowing and drifting snow and poor traveling conditions. Areas around Eastern Carbon County received between 5 and 9 inches of snow.

On April 18, 2011, a strong weather system moved south out of British Columbia and across Idaho into Wyoming. Heavy, wet snow occurred across the upslope areas of the Beartooth and Crazy Mountains. The Red Lodge area received 8-10 inches of snow.

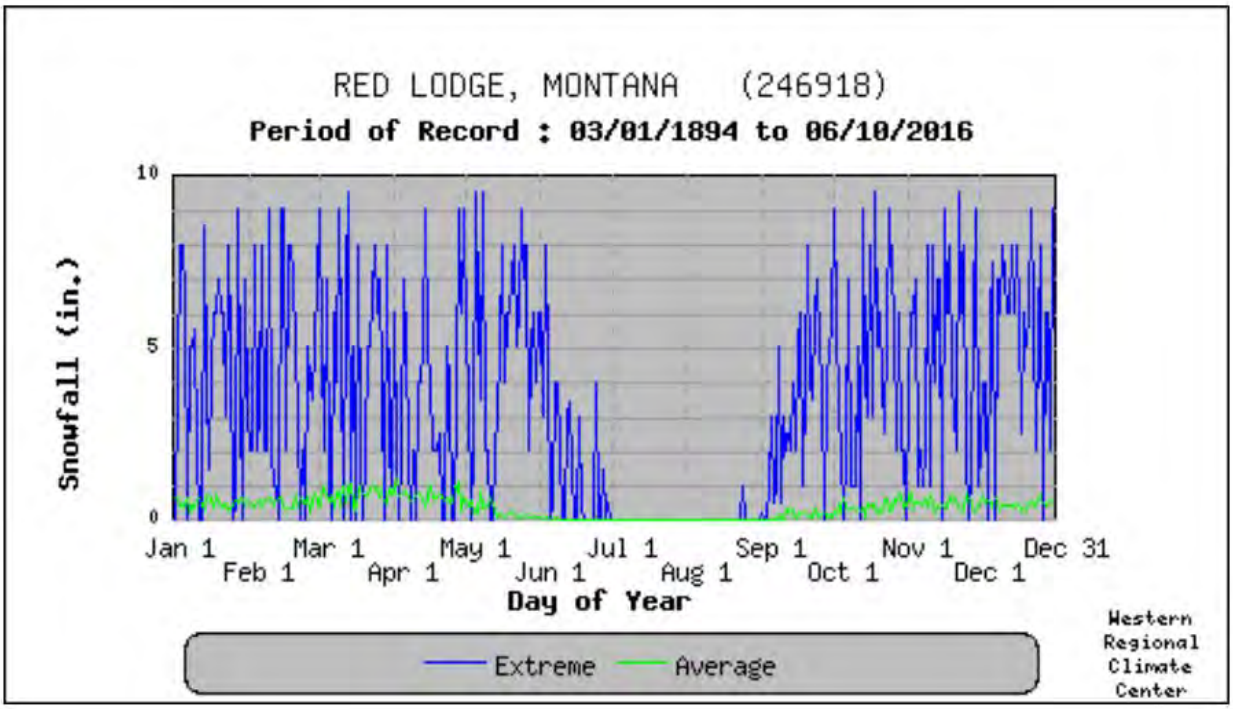
The Western Regional Climate Center reports data from three weather stations in Red Lodge, Bridger and Joliet in Carbon County. Table 3-35 contains snowfall and snow depth summaries for the station. Figure 3-46 through Figure 3-51 show daily snowfall and snow depth averages and extremes.

Table 3-35 Carbon County Snowfall and Snow Depth Summaries

Weather Station	Period of Record	Average Annual Min. Temperature	Lowest Recorded Temperature	Average Snowfall	Highest Annual Snowfall	Average Snow Depth
Red Lodge	1894 -2016	29.4°	-42° 2/3/1989	123.2 in.	283.5 in. 1975	--
Bridger	1900-2016	32.3°	-37° 12/24/1983	37 in.	83.9 in. 1980	1in.
Joliet	1951-2016	31.5°	-39 12/24/1983	52.8 in.	118.8 in. 1955	1 in.

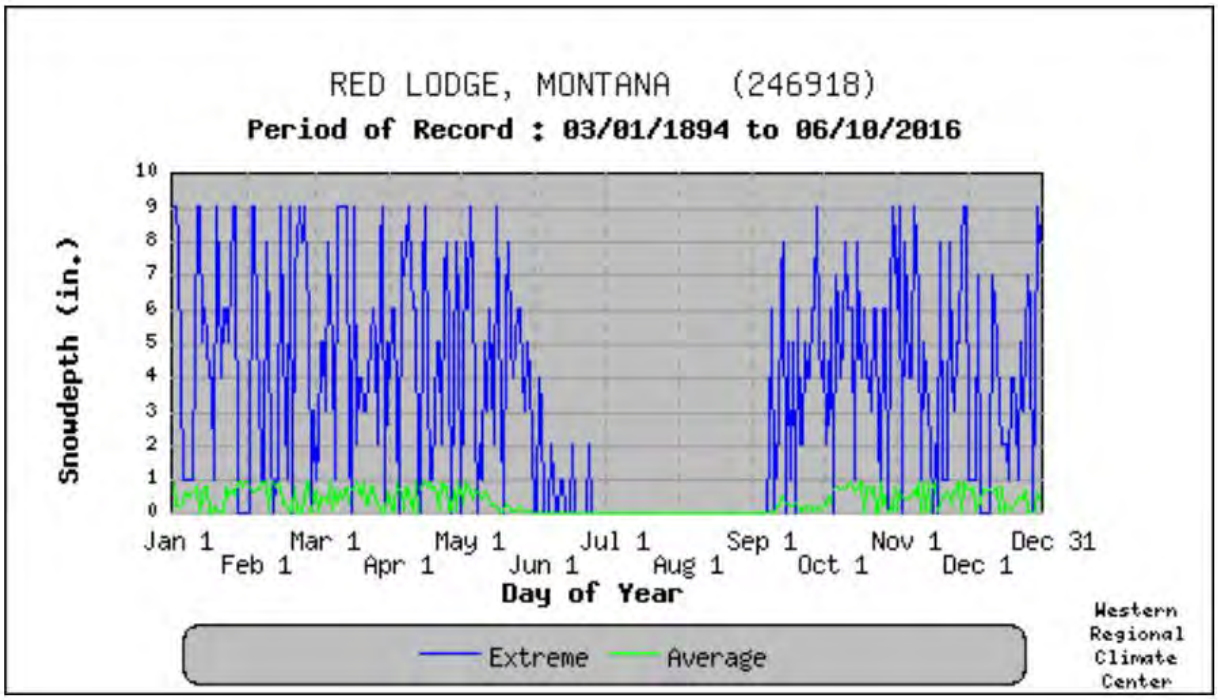
Source: WRCC

Figure 3-46 Red Lodge Daily Snowfall Average and Extreme (Period of Record: 1894-2016)



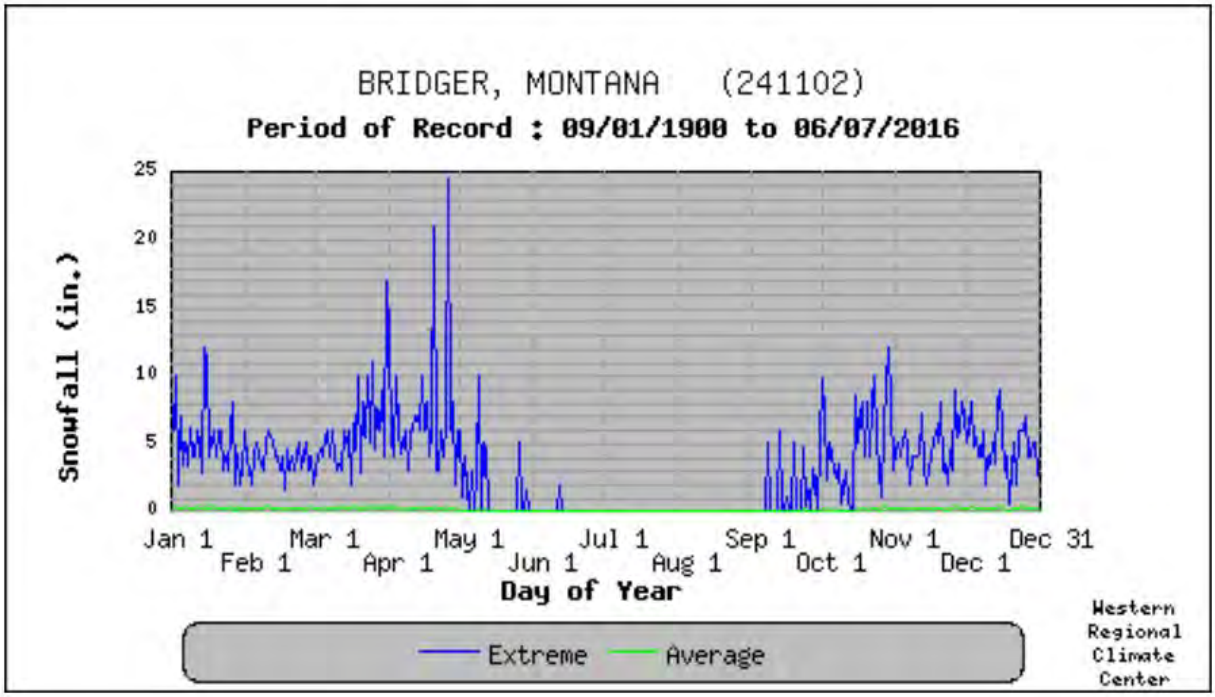
Source: WRCC

Figure 3-47 Red Lodge Snow Depth Average and Extreme (Period of Record: 1894-2016)



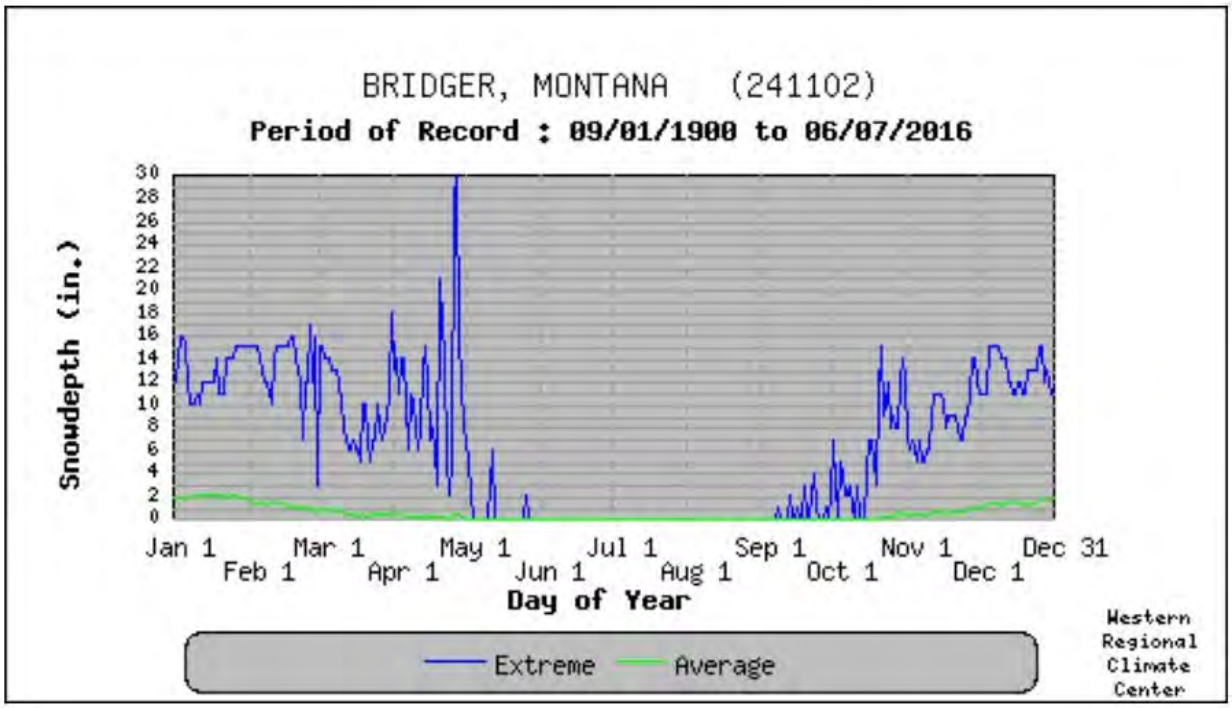
Source: WRCC

Figure 3-48 Bridger Daily Snowfall Average and Extreme (Period of Record: 1900 – 2016)



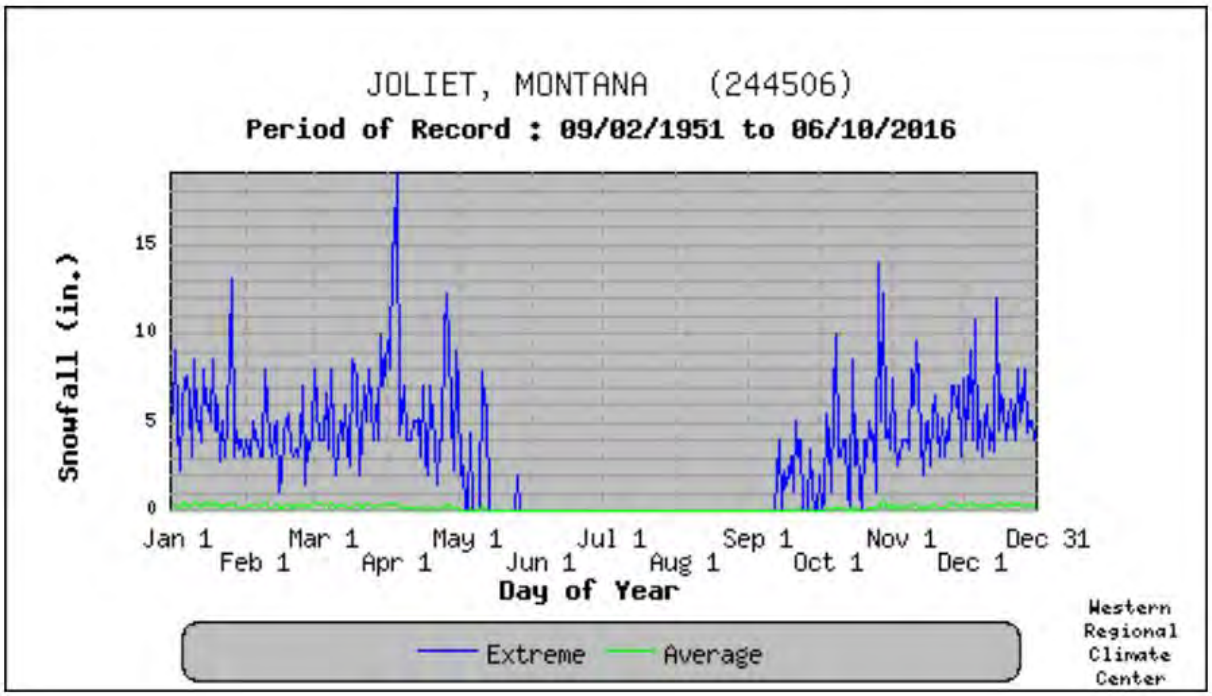
Source: WRCC

Figure 3-49 Bridger Snow Depth Average and Extreme (Period of Record: 1900 – 2016)



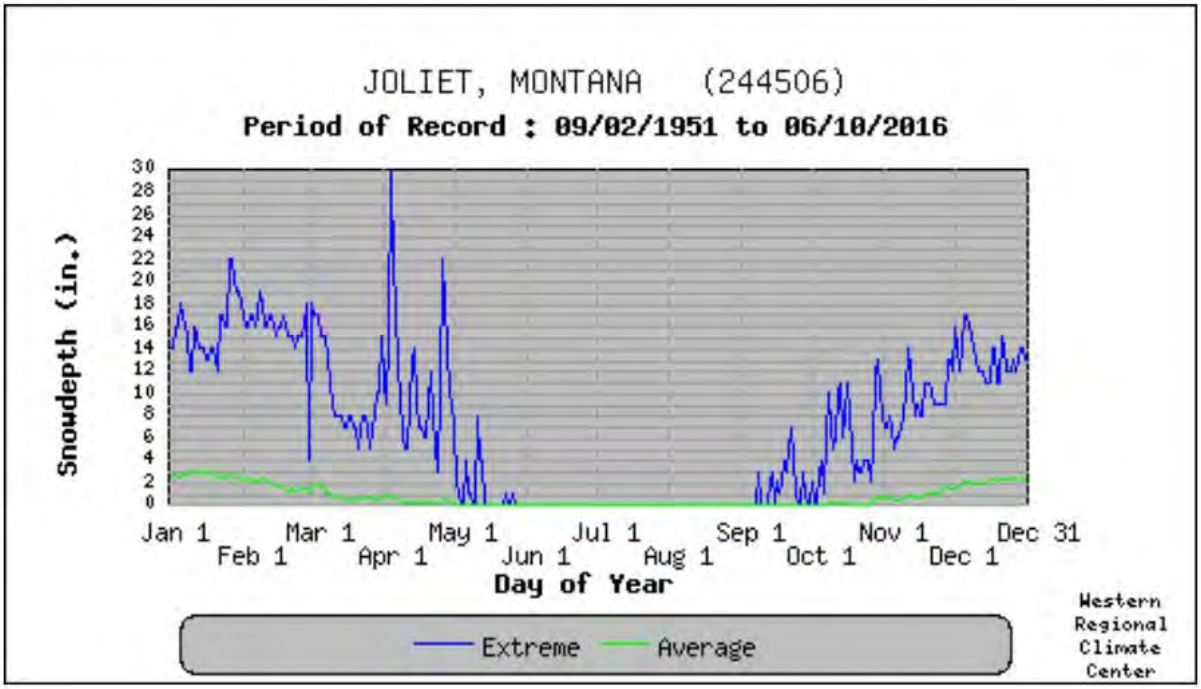
Source: WRCC

Figure 3-50 Joliet Daily Snowfall Average and Extreme (Period of Record: 1951 – 2016)



Source: WRCC

Figure 3-51 Joliet Snow Depth Average and Extreme (Period of Record 1951 – 2016)



Source: WRCC

Likelihood of Future Occurrence

Highly Likely - Winter storms have a recurrence interval of several times each year in the County.

Climate Change Considerations

Climate change has the potential to exacerbate the severity and intensity of winter storms, including potential heavy amounts of snow. A warming climate may also result in warmer winters, the benefits of which may include lower winter heating demand, less cold stress on humans and animals, and a longer growing season. However, these benefits are expected to be offset by the negative consequences of warmer summer temperatures. According to the 2017 Montana Climate Assessment, warming temperatures over the next century will likely reduce snowpack at the mid and low elevations. Observations have already been made that the state's snowpack has declined since the 1930's in the mountain west and east of the Continental Divide.

Vulnerability

The extent of impact or damage will vary with major winter storm events dependent upon the amount and moisture content of snow, wind speeds, temperature ranges, and the duration of the event. Even a moderate winter storms can have significant economic impact. Humans, livestock, structures, and vegetation are all at risk of damage from winter storms.

People

The threat to public safety is typically the greatest concern when it comes to impacts of winter storms. While virtually all aspects of the population are vulnerable to the potential indirect impacts of a winter storm, others may be more vulnerable, such as the elderly, particularly if there is a loss of electrical power.

The weight of heavy continued snowfall and/or ice accumulating on power lines often brings them to the ground causing service disruptions for thousands of customers. This can cause a loss of community water and sewer services, as well as the supply of gasoline, as these services almost always require electrical pumps. In addition, prolonged power outages can mean loss of food to grocery stores and other facilities that provide feeding services such has restaurants.

The region can experience high winds and drifting snow during winter storms that can occasionally isolate individuals and entire communities and lead to serious damage to infrastructure. Travelers on Beartooth Pass in the planning area, or particularly along the many remote stretches of road, can become stranded, requiring search and rescue assistance and shelter provisions. Persons that choose to live in these areas are generally self-sufficient or should be prepared to be self-sufficient for at least 72 hours, as government and emergency services may be limited during a severe winter storm.

Economy

In general, all severe winter storms pose a risk to the tourism economy in the county. Heavy snowfall and extreme cold temperatures can disrupt travel into and out of all areas of the county and create perilous conditions for residents, tourists and nature alike.

Built Environment

Structural losses to buildings are possible and structural damage from winter storms in Montana have resulted from severe snow loads on rooftops. Older buildings are more at risk, as are buildings with large flat rooftops (often found in public buildings such as schools). Vulnerability is influenced both by architecture and type of construction material and should be assessed on a building-by-building basis. "Roof avalanches" are a possibility after heavy snowfall events although it is uncommon, it has occurred in other mountain communities in the Rocky Mountains.

Critical Facilities and Infrastructure

The winter of 2018-2019 the HMPC reported temperatures reach -20 degrees, leading to frozen water service lines that caused 45 homes in the City of Red Lodge to be without water. Other infrastructure such as roads are especially susceptible to the effects of a winter storm, which can temporarily hinder travel and require resources for snow removal.

Historic, Cultural, and Natural Resources

Natural resources may be damaged by severe winter weather, including broken trees and death of wildlife. Unseasonable storms may damage or kill plants and wildlife, which may impact natural food chains until the next growing seasons. Most of these impacts would be short-term. In recent years local volunteers have augmented the efforts of ranchers and State Parks and Wildlife personnel to reduce herd mortality through emergency feeding programs. As noted previously, older, historic buildings could potentially be more vulnerable to roof and structural damage from heavy snow.

Future Development

Future buildings that conform to federal building standards should be able to withstand snow loads from severe winter storms. Given building and population trends in the planning area, it is not anticipated that more persons will be exposed to the winter storm hazard in the future.

Due to the history and severity of past storms within this region, critical infrastructure should be prepared in case power and transportation is disrupted during a storm. Emergency power generation should be available and if not, must be prioritized for future installation of critical facilities such as those operated by the Fire Department. Alternative transportation routes should also be evaluated as well.

Risk Summary

- There are 226 winter storm events recorded in the NCEI Storm Events Database (includes: blizzard, winter weather, winter storm and heavy snow events) in the past 68 years
- Average snowfall varies across the County from 37 inches (Bridger) to 123.2 inches (Red Lodge)
- Of the communities participating in 2019 LHMP planning process, the City of Red Lodge has the highest annual snowfall recorded of 283.5 inches in 1975
- Infrastructure is the most vulnerable to severe winter storms. Past events have led to frozen water service lines and closed roads which can caused secondary impacts of the tourism economy
- *Related Hazards:* Avalanche

Winter Storms Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Extensive	Highly Likely	Limited	Medium
City of Red Lodge	Extensive	Highly Likely	Limited	Medium
Town of Bearcreek	Extensive	Highly Likely	Limited	Medium
Town of Bridger	Extensive	Highly Likely	Limited	Medium
Town of Joliet	Extensive	Highly Likely	Limited	Medium
Town of Fromberg	Extensive	Highly Likely	Limited	Medium

Volcanic Activity

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Extensive	Unlikely	Catastrophic	Low

Hazard Description

Volcanic eruptions are generally not a major concern in Montana due to the relatively low probability of events in any given year. However, Montana is within a region with a significant component of volcanic activity and has experienced the effects of volcanic activity as recently as 1980 during the eruption of Mount St. Helens in the State of Washington.

There are 20 active or potentially-active volcanoes in the United States. The two volcanic centers affecting Montana in recent geologic time are: 1) the Cascade Range of Washington, Oregon and California; and 2) the Yellowstone Caldera in Wyoming and eastern Idaho. Volcanic eruptions in the Cascade Mountains are more likely to impact Montana than Yellowstone eruptions, based on the historic trends of past eruptions. The primary effect of the Cascade volcanic eruptions on Montana would be ash fall.

The distribution of ash from a violent eruption is a function of the weather, particularly wind direction and speed and atmospheric stability, and the duration of the eruption. As the prevailing wind in the mid-latitudes of the northern hemisphere is generally from the west, volcanic ash is usually spread eastward from the volcano. Exceptions to this rule do, however, occur. Ash fall, because of its potential widespread distribution, offers some significant volcanic hazards.

According to the U.S. Geological Survey, Yellowstone National Park has been identified as a prominent hot spot for geologic activity. The hot spot is presumed to exist under the continental crust in the region of Yellowstone National Park and northwestern Wyoming. Large calderas under the park were produced by three gigantic eruptions during the past 2 million years, the most recent of which was approximately 600,000 years ago. That particular volcanic eruption blasted molten rock into the air at 1,000 times the volume of the 1980 Mount St. Helen's eruption subsequently collapsing to create the Yellowstone Caldera (Tracking Changes in Yellowstone's Restless Volcanic System, U.S.G.S. Website). Ash deposits from these volcanic eruptions have been mapped in Iowa, Missouri, Texas, and northern Mexico. Thermal energy from the hot spots fuel hot pools, springs, geysers, and mud pots in the park today. "Recent surveys demonstrate that parts of the Yellowstone region rise and fall as much as 1 centimeter a year, indication the area is still geologically restless. However, these measurable ground movements, which most likely reflect hydrothermal pressure changes, do not necessarily signal renewed volcanic activity in the area." (Kious, Jacqueline and Robert Tilling, The Dynamic Earth: The Story of Plate Tectonics, USGS website)

Geographic Area

All areas of the County would be affected by a volcanic eruption of the Yellowstone caldera. According to the 2018 State of Montana Hazard Mitigation Plan, western and southwestern Montana are most vulnerable to eruptions and ashfall from the Cascade Volcanoes.

Extent

Populations living near volcanoes are most vulnerable to volcanic eruptions and lava flows, although volcanic ash can travel and affect populations many miles away and cause problems for aviation. The USGS notes specific characteristics of volcanic ash. Volcanic ash is composed of small jagged pieces of rocks, minerals, and volcanic glass the size of sand and silt. Very small ash particles can be less than 0.001 millimeters across. Volcanic ash is not the product of combustion, like the soft fluffy material created by

burning wood, leaves, or paper. Volcanic ash is hard, does not dissolve in water, is extremely abrasive and mildly corrosive, and conducts electricity when wet.

Volcanic ash is formed during explosive volcanic eruptions. Explosive eruptions occur when gases dissolved in molten rock (magma) expand and escape violently into the air, and also when water is heated by magma and abruptly flashes into steam. The force of the escaping gas violently shatters solid rocks. Expanding gas also shreds magma and blasts it into the air, where it solidifies into fragments of volcanic rock and glass. Once in the air, wind can blow the tiny ash particles thousands of miles away from the volcano.

Cataclysmic eruptions 2.0, 1.3, and 0.6 million years ago ejected huge volumes of rhyolite magma; each eruption formed a caldera and extensive layers of thick pyroclastic-flow deposits. The caldera is buried by several extensive rhyolite lava flows that erupted between 75,000 and 150,000 years ago. Fortunately for mankind, an eruption comparable in magnitude with those of Yellowstone has not occurred during recorded history. Figure 3-52 shows distribution of ashfall from Yellowstone's giant eruptions 2 million and 630,000 years ago, compared with ashfall from the 760,000- year-old Long Valley caldera eruptions at Mammoth Lakes, California, and the 1980 eruption of Mount St. Helens, Washington (Adapted from Sarna-Wojcicki, 1991).

Figure 3-52 Areas of the US Once Covered by Volcanic Ash

Source: 2018 Update to the State of Montana Multi-Hazard Mitigation Plan

Historic Occurrences

Since the late 1700's, volcanic eruptions in the continental United States have occurred in Oregon, Washington, and California. The most recent volcanic activity in the Yellowstone region occurred 70,000 years ago in the form of a lava flow. One incidence of volcanic ash fallout has occurred in the County in recent times, with the eruption of Mount St. Helens in 1980. The Carbon County News reported on May

22, 1980, that the sky appeared to be foggy and a thin layer of gritty, dull, grey powder was deposited. The 2018 State Hazard Mitigation Plan notes travel was restricted in Western Montana for over a week because of concerns over public health, and that the main hazards associated with ash were reduced visibility (resulting in closed roads and airports), clogging of air filters, and a health risk to children, the elderly and people with cardiac or respiratory conditions.

During discussions with the HMPC regarding volcanic events, several residents remember the Mount St. Helens eruption and the impacts it caused to the planning area. The ash buildup was uneven across the county and caused respiratory issues, as well as darkening the sky for a time. According the HMPC the clean-up was sporadic, with targeted areas being cleaned, while ash in most areas was simply allowed to disappear on its own.

Likelihood of Future Occurrence

Unlikely - Ashfall from a Cascade Volcano is the primary hazard to which the State may be vulnerable at some future time. Eruptions in the Cascades have occurred at an average rate of 1-2 per century during the last 4,000 years, and future eruptions are certain. Seven volcanoes in the Cascades have erupted in the last 200 years. The next eruption in the Cascades could affect hundreds of thousands of people. The effect in Montana would depend on the interaction of such variables as source location, frequency, magnitude and duration of eruptions, the nature of the ejected material and the weather conditions. Therefore, the entire state may be considered vulnerable to ashfall to some degree in the event of a volcanic eruption.

Three major periods of activity in the Yellowstone system have occurred at intervals of approximately 600,000 years, and the most recent was about 600,000 years ago. The evidence available is not sufficient to confirm that calderas such as the one in Yellowstone erupt at regular intervals, so the amount of time elapsed is not necessarily a valid indicator of imminent activity. There is no doubt, however, that a large body of molten magma exists, probably less than a mile beneath the surface of Yellowstone National Park. The presence of this body has been detected by scientists who discovered that earthquake waves passing beneath the park behave as if passing through a liquid. The only liquid at that location that could absorb those waves is molten rock. The extremely high temperatures of some of the hot springs in the park further suggest the existence of molten rock at shallow depth. A small upward movement in the magma could easily cause this magma to erupt at the surface. If a major eruption occurred, the explosion would be "comparable to what we might expect if a major nuclear arsenal were to explode all at once, in one place (Roadside Geology of Montana, Alt and Hyndman, 1986)."

Climate Change Considerations

While most climate change considerations associated with hazards identified in this risk assessment pertain to how climate change might impact specific hazards, the considerations involved between climate change and volcanoes work the opposite way. While climate change is not expected to impact the size or frequency of eruptions, eruptions themselves can have a huge impact on climate. Eruptions can inject millions of tons of gases and debris into the atmosphere, which can circulate far away from the incident site and disrupt normal climate patterns. Large-scale volcanic activity may only last a few days, but the massive outpouring of gases and ash can influence climate patterns for years, influencing both heating and cooling.

Vulnerability

People

Volcanic ash poses a public health risk, especially to children, the elderly, and individuals with cardiac and respiratory considerations. As noted in the Vulnerability Assessment for Summer Storm hazards, GIS analysis was conducted on Medicare beneficiaries who rely on electricity-depending medical equipment, such as ventilators, oxygen concentrator equipment, and implanted cardiac devices. Based on this analysis 7% of Medicare beneficiaries in the County or 188 individuals rely on electricity to live independently in their homes. Many of these same individuals will be vulnerable to effects of volcanic ash. The abrasiveness of the volcanic ash particles can scratch the surface of skin and eyes and in general cause discomfort and inflammation.

Economy

In general, volcanic eruptions pose a risk to the tourism economy in the county. Ashfall can disrupt travel into and out of all areas of the county and create perilous conditions for residents, tourists and nature alike. Ashfall can also lead to widespread power loss which could have lasting impacts on local businesses. The precipitation of risk after a volcanic event could also lead to a downturn in visitors to the County leading the local communities to advertise that they are safe to visit.

The agricultural economy is also vulnerable to the effects of ashfall. According to the 2018 State HMP, crop damage from ashfall can range from negligible to severe, depending on thickness of ash, type and maturity of plants as well as the timing of subsequent rainfall.

Built Environment

According to the HMPC, there were extensive cleanup efforts throughout Carbon County after the Mount Saint Helen eruption in 1980. Ashfall can impact both the interior and exterior of buildings. The interior of buildings can be contaminated with ash that builds up in air vents and filters. The exterior of buildings can have abrasive damage to roofs and gutters can be blocked with ash which could lead to secondary flooding issues. If a rain event was to occur post eruption, it can turn ash into heavy, cement-like sludge that can lead to the collapse of roofs and difficulty when cleaning up.

Critical Facilities and Infrastructure

Critical facilities and infrastructure are most vulnerable to the effects of ashfall. Volcanic eruption with ashfall can cause electricity outages and issues with power supply. The air intakes for generators will also be vulnerable to airborne ash post eruption. Telephone and radio communications can also be interrupted and electronic components and short-circuits especially high-voltage circuits and transformers can fail due to ashfall.

Wastewater collection systems are also vulnerable to damage from ashfall. Buildup of ash in drainage systems can result in stormwater flooding. Ash-laden sewage that makes its way to wastewater treatment plants can cause mechanical damage and if it makes it further through the system it will settle and reduce the capacity of biological reactors increasing the volume of sludge and changing its composition.

Transportation infrastructure is also vulnerable to the impacts of ashfall. Roads, highways and airport runways can be made impassable due to the slippery ash and reduction of visibility. The abrasive volcanic ash can have damaging effects on aircraft including melting the inside of engines and solidifying the turbine blades ultimately causing the engine to stall. Ash can also lead to the failure of critical navigational and operational instruments. The Red Lodge and Bridger Airport would be unable to safely have flight leave or arrive at their airports which could lead to secondary impacts on the local economy.

Historic, Cultural, and Natural Resources

Volcanic ash can call collect carbon dioxide and fluorine gases that can be toxic to humans and have significant impacts on the natural environment. Windblown ash can spread and pollute areas that had previously been unaffected. Vegetation is also vulnerable to the impacts of ashfall that can result in decreased plant photosynthesis and poor pollination if flowers were damaged. Visual inspection of vegetation in a large area in the State of Washington impacted by the Mount Saint Helens eruption showed three broad categories of plant damages: (1) Breakage due to the weight of ash (2) physiological changes such as decreased plant growth and (3) chemical damages to the leaves (Ayris, Delmelle, 2012).

Water bodies are also vulnerable to the effects of ashfall and can cause chemical changes that can affect water quality. The following table from the USGS Volcanic Ashfall Impacts Working Group show the typical effects of ashfall on the quality of surface waterbodies.

Table 3-36 Typical Effects of Ashfall on the Quality of Surface Water Bodies

Turbidity	Ash suspended in water will increase turbidity in lakes, reservoirs, rivers and stream. Very fine ash will settle slowly, and residual turbidity may remain in standing water bodies. In streams, ash may continue to be mobilized by rainfall events, and lahars may be a hazard in some regions.
Acidity (pH)	Fresh ashfall commonly has an acidic surface coating. This may cause a slight depression of pH (not usually below pH 6.5) in low-alkalinity surface waters.
Potentially Toxic Elements	Fresh ash has a surface coating of soluble salts that are rapidly released on contact with water. The most abundant soluble elements are typically Ca, Na, K, Mg, Al, Cl, S and F. Compositional changes depend on the depth of ashfall and its 'cargo' of water-soluble elements; the area of the catchment and volume available for dilution; and the pre-existing composition of the water body. • In rivers and streams, there will be a short-lived pulse of dissolved constituents • In lakes and reservoirs, the volume is usually large enough that changes in composition are not discernible The constituents most likely to be elevated above background levels in natural waters are Fe, Al and Mn, because these are normally present at very low levels. Thus, water is likely to become unpalatable due to discoloration or a metallic taste before it becomes a health hazard.

Source: USGS Volcanic Ashfall Impacts Working Group https://volcanoes.usgs.gov/volcanic_ash/water_supply.html

Future Development

As population increases in southwest Montana and recreational usage continues to expand, more and more people and property are at risk from the effects of volcanic activity.

Risk Summary

- Major points of vulnerability are eruptions in either the Cascade Range in the Pacific Northwest, or the Yellowstone Caldera, but these eruptions have a long recurrence interval.
- Eruptions from distant volcanoes cause ash buildup that may cause issues with infrastructure
- Visibility may be major concern in areas
- Volcanic ash especially impactful on very young, very old, and those with respiratory or cardiac conditions
- *Related Hazards:* Earthquake

Volcanic Activity Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Extensive	Unlikely	Catastrophic	Low
City of Red Lodge	Extensive	Unlikely	Catastrophic	Low
Town of Bearcreek	Extensive	Unlikely	Catastrophic	Low
Town of Bridger	Extensive	Unlikely	Catastrophic	Low
Town of Joliet	Extensive	Unlikely	Catastrophic	Low
Town of Fromberg	Extensive	Unlikely	Catastrophic	Low

Wildland Fires

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Significant	Likely	Critical	High

Hazard Description

Per the National Parks Service's definition, a wildland fire is an encompassing term describing "any non-structure fire that occurs in vegetation and natural fuels. [A] wildland fire encompasses both prescribed fire and wildfire" (NPS Wildland Fire Program, 2016). Focusing on unplanned fires or perhaps escaped prescribed fires, more specifically, a wildfire is an uncontrolled fire spreading through vegetative fuels, posing danger and destruction to property. While wildfires are often the direct result of lightning strikes, many are caused by powerlines or mechanical equipment, or are the result of human activities like debris burns, carelessness, or arson. Wildfires often start in undeveloped areas and public land areas, such as state and national forest lands, but can spread to urban areas where structures and other human development are more concentrated. The predominant dangers from wildfires are:

- Injury or loss of life to people in the affected area
- The destruction of vegetation, property, wildlife

Communities throughout Montana and the western U.S. are increasingly concerned about wildfire safety as increased development in the foothills and mountain areas and subsequent fire control practices have affected the natural cycle of the ecosystem. Wildfire risk is predominantly associated with Wildland-Urban Interface (WUI) areas, a general term that applies to development adjacent to landscapes that support wildfire. However, significant wildfires can also occur in heavily populated areas.

Carbon County is exposed to a variety of wildfire hazard conditions based on fuels, topography, weather, and human behavior. Wildlands need to burn periodically to naturally maintain viable environments. Fuel maintenance (controlled burns, mowing, cattle grazing and other means) is a necessary replacement to uncontrolled wildland fires because of threats to human habitation. Development patterns in rural lands can reduce the ability to manage fuel and defend "values at risk." Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather.

- Fuel—Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and include everything from dead tree leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Also, to be considered as a fuel source are manmade structures, such as homes and other associated

combustibles. The type of prevalent fuel directly influences the behavior of wildfire. Fuel is the only factor that can be modified by humans.

- Topography—An area's terrain and slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement and types of vegetation throughout a hillside can also contribute to increased fire activity on slopes.
- Weather—Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will more readily ignite and burn more intensely. Thus, during periods of drought, the threat of wildfire increases. Wind is the most influential weather factor of the three and its influence can increase rates of spread regardless of temperature and relative humidity. On the other hand, lightning from severe weather events can spark natural wildfire and cause significant damage.

Geographic Area

Carbon County encompasses 2,060 square miles of land ranging from 3,300 to 12,799 feet above sea level. The elevation variation produces significant diversity in vegetative cover, precipitation, topography, and land use. Particular fuel types across the county vary from grasses, to sage brush, to scattered timber, to dense timber depending on aspect and elevation. As such, there is tremendous variety in fuel types and fuel loading across the county.

The most at-risk areas with respect to fuel conditions in comparison to available property, infrastructure and population occurs south and west of Red Lodge, where there are numerous high-value individual homes and subdivisions located in the WUI area in close proximity to the National Forest boundary. While only around 13% of the County is classified as WUI, a significant amount of development has occurred in these areas in recent years.

Carbon County has nine rural fire districts which respond to both structure and wildland fires within 76% of the County. The remaining 24% (or around 489 square miles) of land in the southeast corner of the County has no formal fire protection. Recent studies show that the WUI areas across the U.S. have expanded by more than 46 million acres from 1990 to 2010, which means a 41% percent growth in the number of homes in these intermix areas during this 20-year period (USDA Forest Service, 2018).

Additional details about and mapping of the WUI areas are covered further in the below sections of this hazard chapter. Overall, the areas in Carbon County susceptible to wildland fires, or likely to be affected by these based on historical evidence and data available, is significant.

Extent (Magnitude/Severity)

The Wildland Urban Interface, or WUI, poses tremendous risks to life, property and infrastructure in associated communities and is one of the most dangerous and complicated situations faced by firefighters. WUI fires pose great challenges to fire fighters primarily because access to homes and availability of water are often limited in the WUI. Fire prevention programs such as fuel reduction initiatives and home assessment in WUI areas are extremely important. Homeowners must accept a measure of responsibility and be fully aware of the risks when deciding to locate in such an environment.

Overall, the extent potential of this hazard in the county is critical, which means that wildfires can cause extensive property loss and death and injury.

WUI Definition

In 2001, the Federal Register (Vol. 66, No. 3) defined the WUI community as any place "where humans and their development meet or intermix with wildland fuel." The Federal Register also describes three community categories:

- *Interface Community:* where structures directly abut with Wildland Fuels (3 or more structure per acre);
- *Intermix Community:* where structures are scattered throughout a wildland area (1 or more structures per 40 acres);
- *Occluded Community: where structures abut an island of wildland fuels (often in a city, e.g. park or open space).*

The WUI situation in Carbon County most closely resembles the Intermix Community category although most areas have a structure density less than one per 40 acres. Despite the low density, fire managers are still concerned about these areas because of public and firefighter safety and because of the unique fire suppression tactics that must be deployed. For example, when residences are located in the vicinity of wildfire, typical firefighting techniques, such as the use of backfires, may not be feasible. Additionally, firefighting equipment and personnel may be used for structure protection, instead of being used to fight the fire. This results in the need for additional equipment to effectively minimize structural losses and to control the fire.

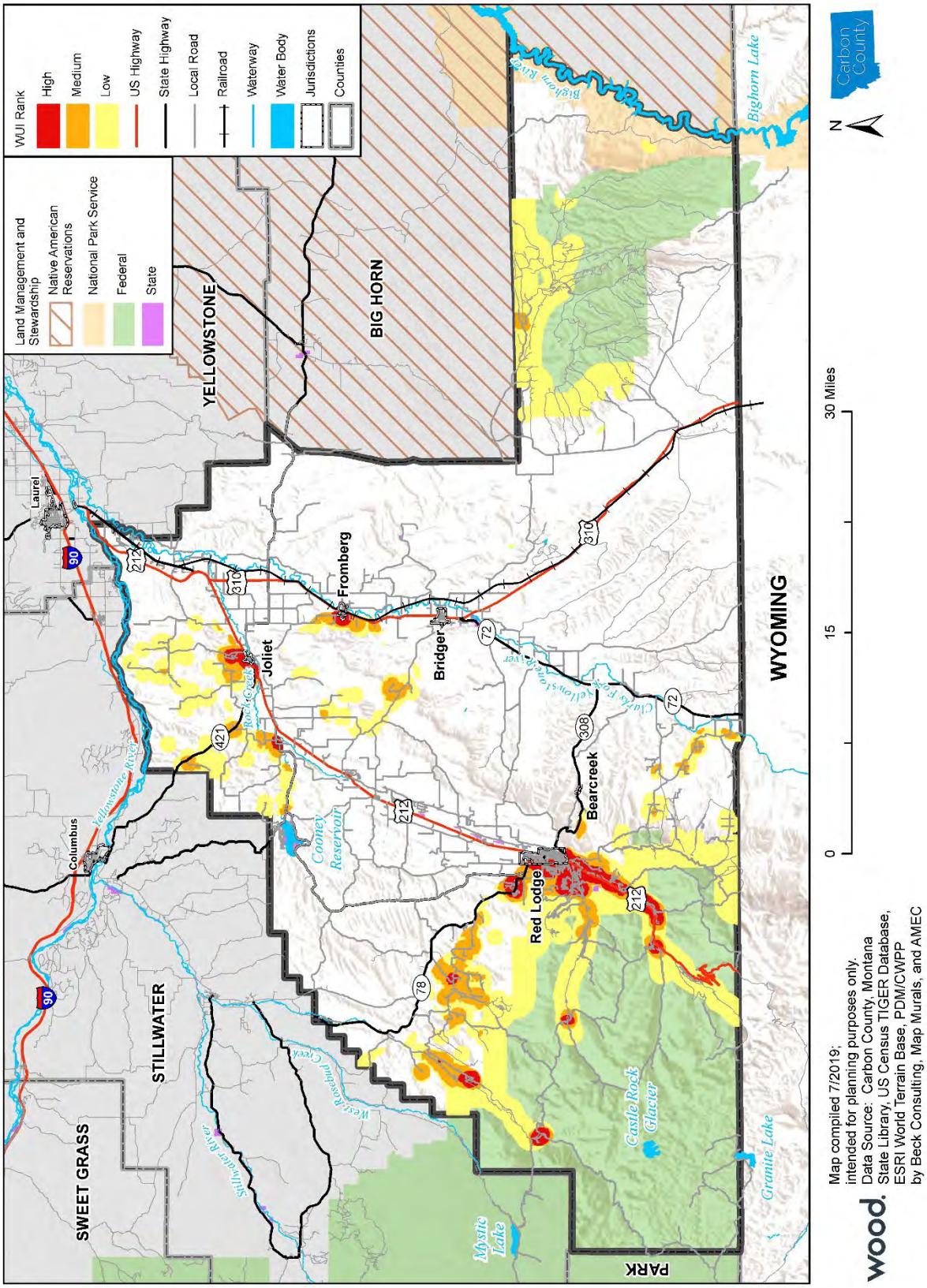
Mapping the WUI

The Federal Register also provided some criteria to consider when delineating WUI:

- Fire behavior potential
  - Crown fire or high intensity surface fire potential
  - Potential of torching and spotting
  - No large fire history or low fire occurrence
- Values at risk
  - High density of structures with lack of defensible space
  - Scattered areas of high-density homes less than one mile apart
- Key infrastructure
  - Access, water availability and firefighting capability is absent or minimal
  - Access, water availability and firefighting capability is limited but present
  - Access, water availability and firefighting capability is adequate and maintained

The WUI areas have been mapped for Carbon County and are shown Figure 3-53.

Figure 3-53 WUI areas in Carbon County



Historic Occurrences

The Federal Fire Occurrence database was queried along with fire records and perimeters from the Geospatial Multi-Agency Coordination Group, or GeoMAC, for fires that have taken place in the last 20 or so years (from 2000-2019). According to these sources, a total of 13 fires burning 27,670 acres of land have impacted Carbon County since 2000. The largest fire in this period of record was the Cascade Fire, which took place in 2008 and was human caused, burning over 10,000 acres.

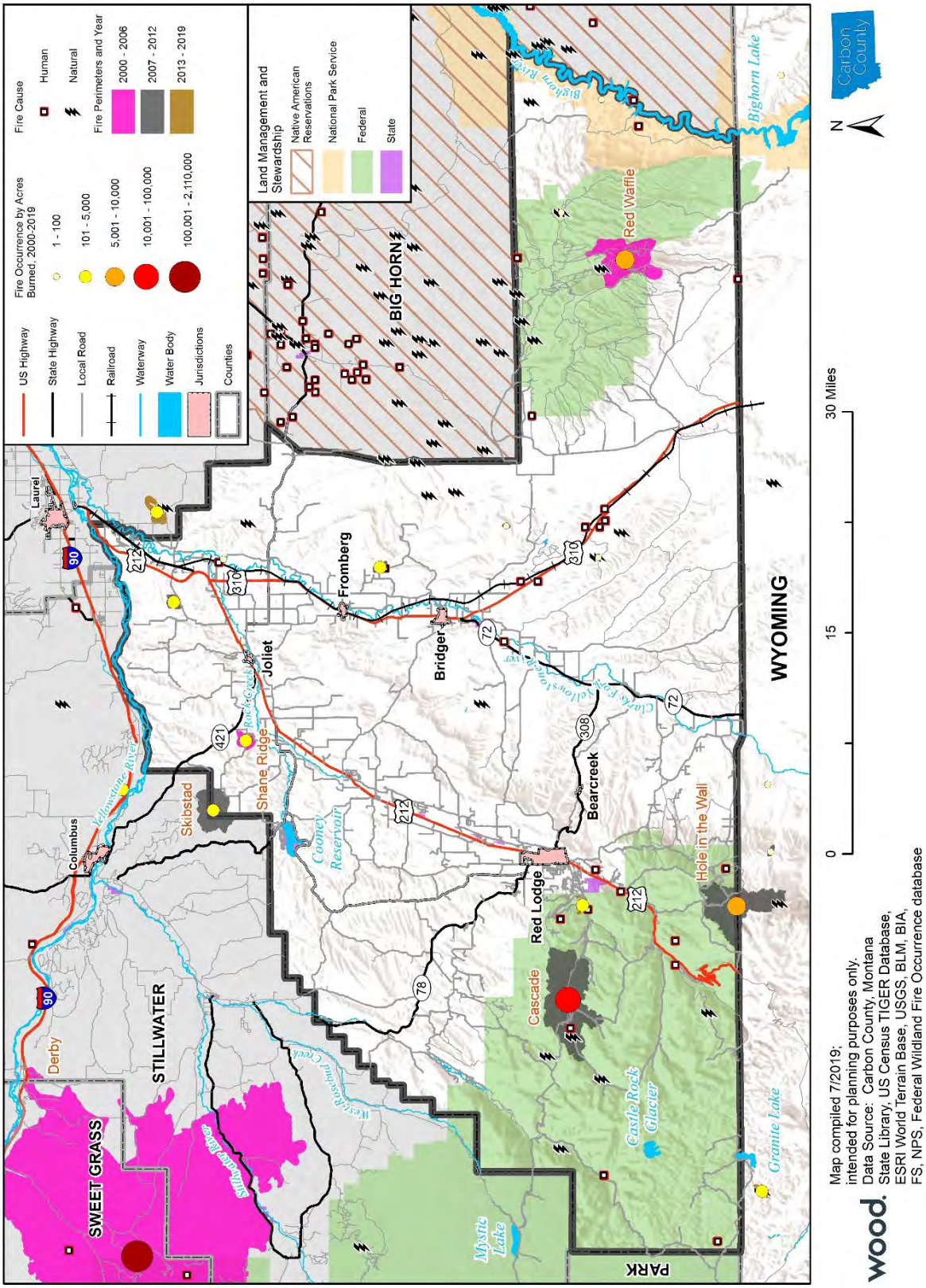
The fire history queried is recorded in Table 3-37 below, while the fire perimeters with ignition locations and cause of fire are displayed in Figure 3-54. Note that the records below may not be comprehensive as the databases includes fires on federal lands and not fires on private or state lands.

Table 3-37 History of Fires in Carbon County from 2000-2019

Fire Code	Fire Name	Year	Cause of Fire	Acres Burned
2002-MT-	Red Waffle	2002	Human	5,860
2006-MT-SOS-CYB4	Shane Ridge	2006	Unknown	634
2007-MT-BID-DPF3	Farewell Mutual Aid	2007	Unknown	435
2008-MT-CNF-EDZ4	Cascade	2008	Human	10,367
2010-MT-SOS-FH6S	Bluewater	2010	Human	274
2010-MT-BID-FN10	Castle Coulee	2010	Natural	13
2011-MT-BID-F7B3	Cherry Springs	2011	Unknown	52
2011-MT-CNF-GBW2	Dry Head	2011	Natural	30
2011-WY-SHF-GBW6	Hole in The Wall	2011	Unknown	6,343
2012-MT-SOS-G3PU	Skibstad	2012	Unknown	3,350
2012-MT-BID-GN9K	River Island	2012	Human	42
2015-MT-CGF-JK2Y	West Fork Road	2015	Human	257
2017-MTBIP-000165	Lockhart	2017	Unknown	14
TOTAL				**27,670**

Source: GeoMAC/USGS, BLM, BIA, FS, NPS, Federal Fire Occurrence Database, 2019

Figure 3-54 Fire Perimeters, Cause, Acres Burned, and Year of Occurrence of Fires in Carbon County from 2000-2019



Likelihood of Future Occurrence

Likely - Based on the historical record there is a high probability that wildland fires will occur in each year, particularly if bad drought conditions take place and worsen vegetative fuel sources. Significant fires are less frequent, as such, a there is a 'Likely' probability of wildfires taking place in the planning area.

Climate Change Considerations

The effects of climate change have the potential to impact fire behavior, the frequency of ignitions, fire management possibilities, and fuel loads. Increasing temperatures may intensify wildfire threat and susceptibility to more frequent wildfires in the county. Forests are also sensitive to variable precipitation events, as droughts can exacerbate wildfire fuel loads and firefighting capabilities (leading to a lack of water resources available, for example). In addition, dry periods may contribute to trees being more susceptible to pests and pathogens, in turn generating greater amounts of standing dead fuels.

Scientific models of the Rocky Mountain region expect states like Montana may be affected by increased numbers of forest fires with added intensity due to longer warmer seasons, reduced distribution of biodiversity, lack of moisture, changes in ecosystems, cascading effects from drought (including the continued spread of invasive species), and other impacts in coming years. The extending of the wildfire season into winter months, coinciding with seasonal high wind patterns, has contributed to severe fires in the last ten or so years across the Rocky Mountain west. These areas have seen many destructive wildfires, whether natural or human caused, in the last decade, and the expectation is that worsening warmer and drier conditions would continue to impact Montana and Carbon County into the future.

The HMPC additionally noted that many areas of the county, particularly the south and southeastern portions, traditionally receive small amounts of precipitation even in average years, and mortality issues due to the stress of continued drought are becoming important in a number of timbered areas of the county.

The impacts of climate change are already being felt in Montana. According to the 2018 State HMP, the 2017 fire season across Montana was the largest in the past 100 years. In total 1.4 million acres burned across the State and over $300 million was spent battling blazes, also making the most expensive fire season since 1999 (MPR 2017). It was fueled by a significant drought event classified under the Drought-Fast Track designation by the USDA Secretary of Agriculture (for more details please refer to the Drought hazard section of this Plan).

Vulnerability

GIS analysis was conducted using parcel data and improved structure values from Carbon County, along with the WUI areas which are broken up into Low, Medium, and High hazard categories (based on the specific WUI development methodology outlined in the County's 2013 Community Wildfire Protection Plan, or CWPP). Parcel centroids were overlaid with the WUI layers, in GIS, to determine the number of parcels, type, and improvement values of those parcels found to overlap with WUI areas.

Once the number of parcels with improved structure values was obtained, content values were calculated by applying the content formulas outlined in the Assets Summary section of this Plan. Then, total values were computed by adding (totaling) both improved structure values and the content values just calculated. Loss estimates for parcels contained in WUI areas were obtained by taking 100% of the total values in the previous step, as wildfires usually result in a complete loss of structure and contents. For more information on parcel data and analysis methodology, refer to the Asset Summary at the beginning of this chapter.

People

Wildland fires often lead to high risk for personal injury as well as potential loss of life to inhabitants of the fire area and firefighters. Wildfires in or near the WUI frequently require emergency evacuation and sheltering, often for many days. Population density can also change based on time of day and time of year, as people change their location and move to their job sites or educational facilities then return back home, or as tourism brings in additional populations seasonally. The potential for extended power outages as a result of a wildfire event could also have impacts on healthcare facilities and medically vulnerable individuals who are dependent on power for medical assessments and treatments. Other at-risk populations include those located in wildland recreational areas such as state and national parks and forests, particularly during warmer months.

Specific population impacts are noted in the last columns of Table 3-38 and Table 3-39 above, and total people at risk were calculated by multiplying the average number of persons per household in the county of (which equals 2.27 per the US Census Bureau) times the number of improved parcels overlaid, or intersected with, the WUI layers. A total of 4,710 people could be at risk of WUI based hazards per the calculation methodology used, though again it is unlikely that all the parcels found to overlap with these WUI zones will be fully populated by the total persons estimated.

The HMPC noted public health impacts from wildfire smoke and ash has been an issue during past events. Previous events have led to street lights to turn on in the middle of day due to darkness from heavy wildfire smoke.

Economy

Tourism is an important component of Carbon County's economy. The HMPC indicated that wildland fires have had impacts on the tourism industry which also adversely affects the ability of the many of County's residents to earn a living from these industries. The Red Lodge Mountain Ski Area is one of the county's largest employers supplying 190 jobs and $4.82 million in labor income to the area each year, it is also located in area prone to wildland fires (USFS 2012). A wildland fire impacting the ski area could have significant impacts on the county's overall economy as well as the identity of the City of Red Lodge . Fire suppression may also require increased cost to local and state government for water acquisition and delivery, especially during periods of drought when water resources are scarce.

Built Environment

The results of the parcel analysis using the WUI layers is summarized in the following tables below. Table 3-38 summarizes the parcels intersecting with the WUI layers across Carbon County by jurisdiction, while Table 3-39 summarizes the same data but this time broken up by parcel type. The analysis results show that over $813 million could be at risk of wildfires based on the total values computed for parcels of several types, with the unincorporated portions of the county facing the highest potential risk (followed by Red Lodge, Fromberg, and Joliet). A total of 2,379 parcels were found to overlap with the WUI areas, out of 1,728 parcels were in the High WUI hazard zone, 360 in the Medium WUI hazard zone, and 291 in the Low WUI hazard zone.

With regards to potential risk by property type the Improved Property parcels will face the most potential damages, followed by exempt parcels, farmsteads, multi-family properties, vacant parcels, manufactured homes, industrial parcels, and commercial parcels.

Table 3-38 Carbon County Parcels in WUI Areas, by Jurisdiction

Jurisdiction	Total Parcels in the WUI	Improved Structure Values	Content Values	Total Values	Loss Estimate (100% of the Total Values)	Population at Risk
Fromberg	148	$13,139,117	$4,536,434	$17,675,551	$17,675,551	295
Joliet	130	$19,167,550	$6,471,498	$25,639,048	$25,639,048	272
Red Lodge	676	$120,430,453	$56,311,095	$176,741,548	$176,741,548	1,410
Unincorporated	1,425	$384,350,087	$208,959,547	$593,309,634	$593,309,634	2,733
TOTAL	**2,379**	**$537,087,207**	**$276,278,573**	**$813,365,780**	**$813,365,780**	**4,710**

Source: Carbon County DES/GIS Departments and CWPP, Wood Plc

Table 3-39 Carbon County Parcels in WUI Areas, by Parcel Type

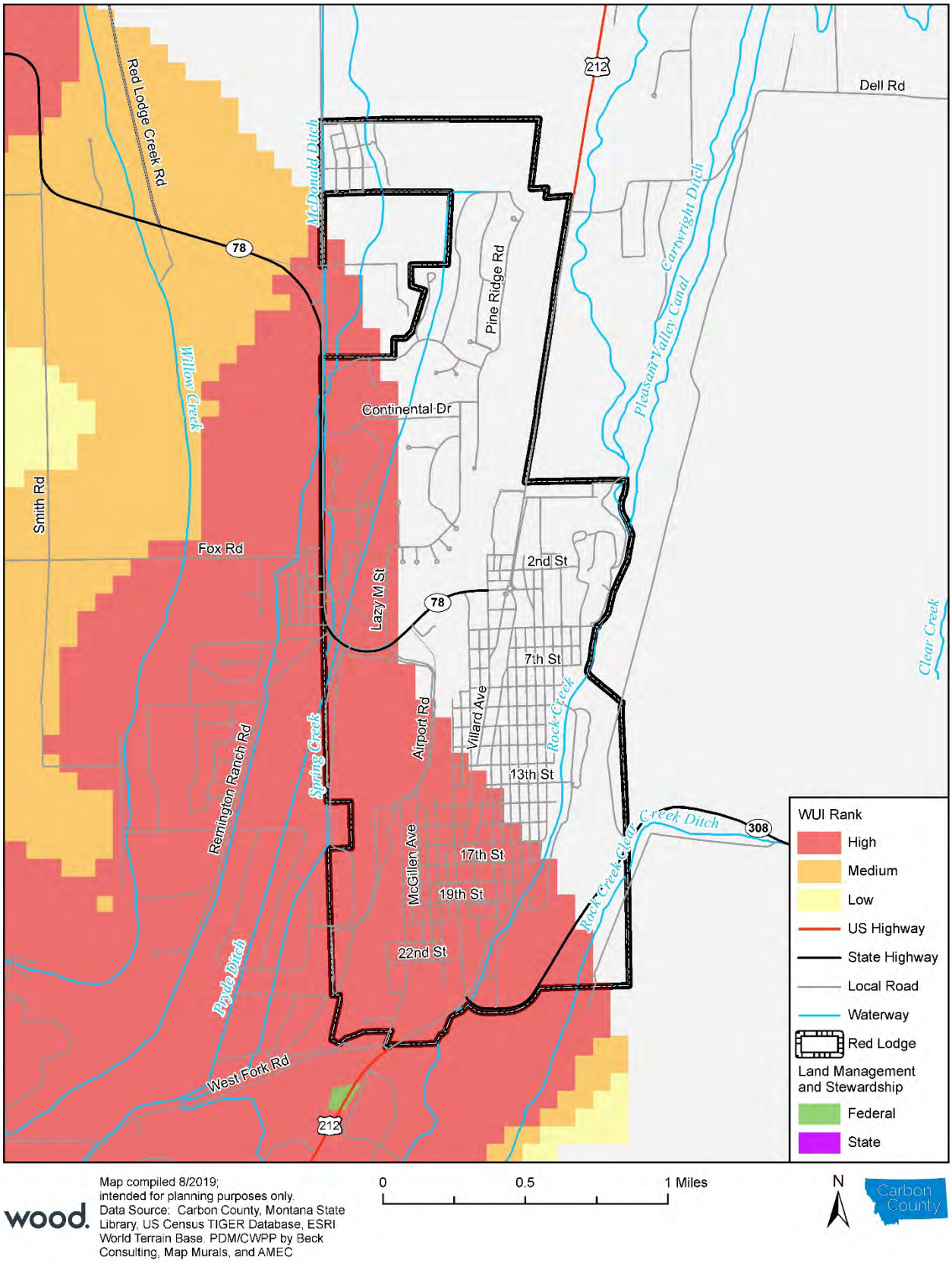
Parcel Type	Total Parcels in the WUI	Improved Structure Values	Content Values	Total Values	Loss Estimate (100% of the Total Values)	Population at Risk
Commercial	1	$51,310	$51,310	$102,620	$102,620	--
Exempt	292	$21,459,419	--	$21,459,419	$21,459,419	--
Farmstead	148	$38,225,123	$38,225,123	$76,450,246	$76,450,246	336
Improved Property	1,899	$468,246,366	$234,123,183	$702,369,549	$702,369,549	4,311
Industrial	2	$157,980	$236,970	$394,950	$394,950	--
Manufactured Home	5	$520,291	$260,146	$780,437	$780,437	11
Multi-Family	23	$6,763,682	$3,381,841	$10,145,523	$10,145,523	52
Vacant	9	$1,663,036	--	$1,663,036	$1,663,036	--
TOTAL	**2,379**	**$537,087,207**	**$276,278,573**	**$813,365,780**	**$813,365,780**	**4,710**

Source: Carbon County DES/GIS Departments and CWPP, Wood Plc

The City of Red Lodge along with the Towns of Joliet and Fromberg were mapped with the WUI hazard zones overlaid, to show the geographic extent (coverage) of those intermix areas with the county jurisdictions. These maps depict the low, medium, and highly ranked hazard each WUI may pose to each jurisdiction based on the CWPP analysis conducted in 2013 to develop these WUI areas. Fromberg and Joliet are almost equally divided between high WUI ranked zones and no WUI hazard potential, while the City of Red Lodge shows a similar pattern of having a large majority of its land in the high WUI ranked zone.

According to the HMPC in 2019, as part of the County's new subdivision regulations wildfire mitigation requirements have been included. The County currently does not have buildings codes to regulate development for wildfire safety. The HMPC also noted that the County actively conducts fuel mitigation and removal throughout the unincorporated areas.

Figure 3-55 WUI Hazard Zones in Red Lodge



Map compiled 8/2019; intended for planning purposes only. Data Source: Carbon County, Montana State Library, US Census TIGER Database, ESRI World Terrain Base. PDM/CWPP by Beck Consulting, Map Murals, and AMEC

Figure 3-56 WUI Hazard Zones in Joliet

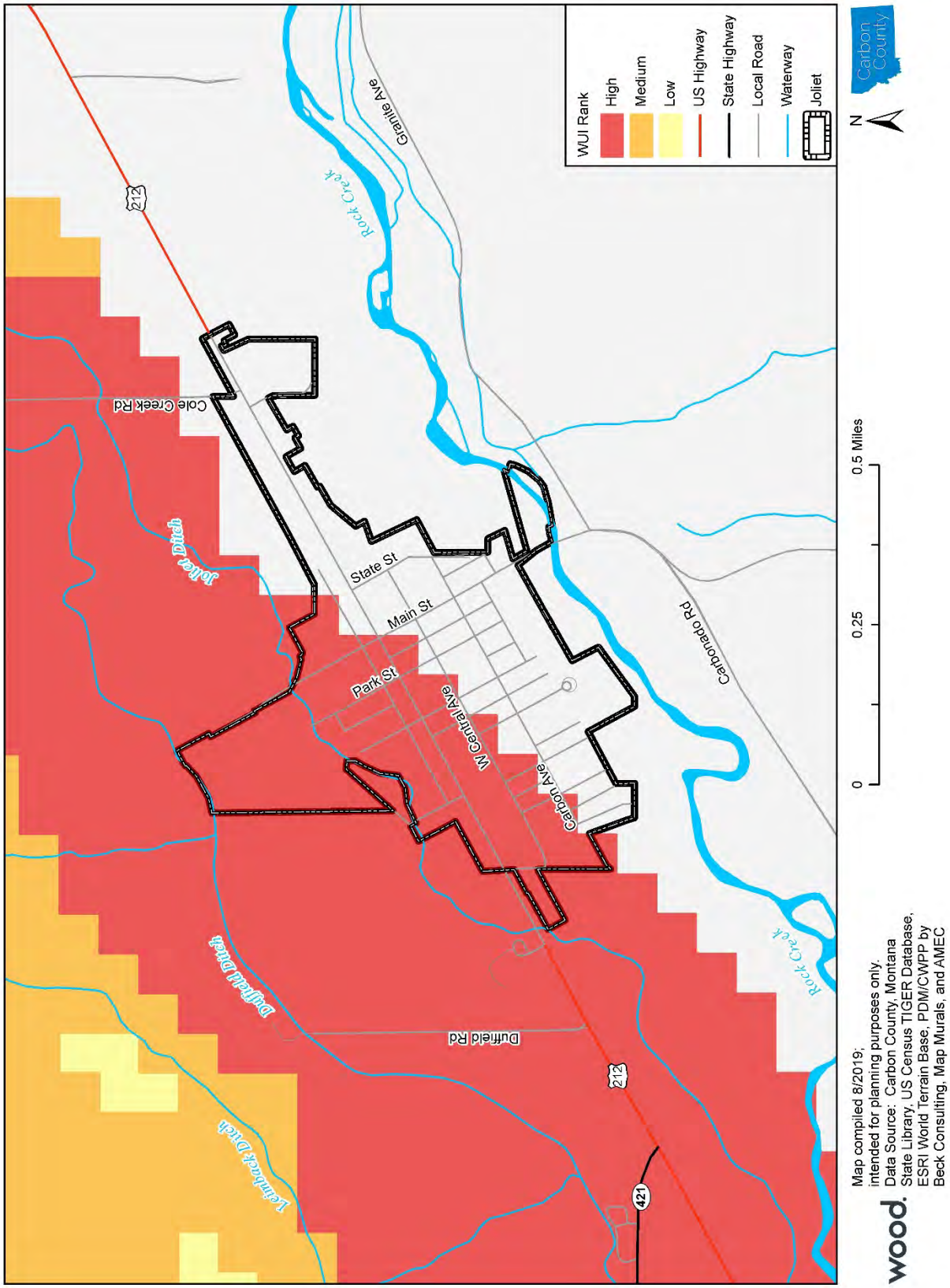
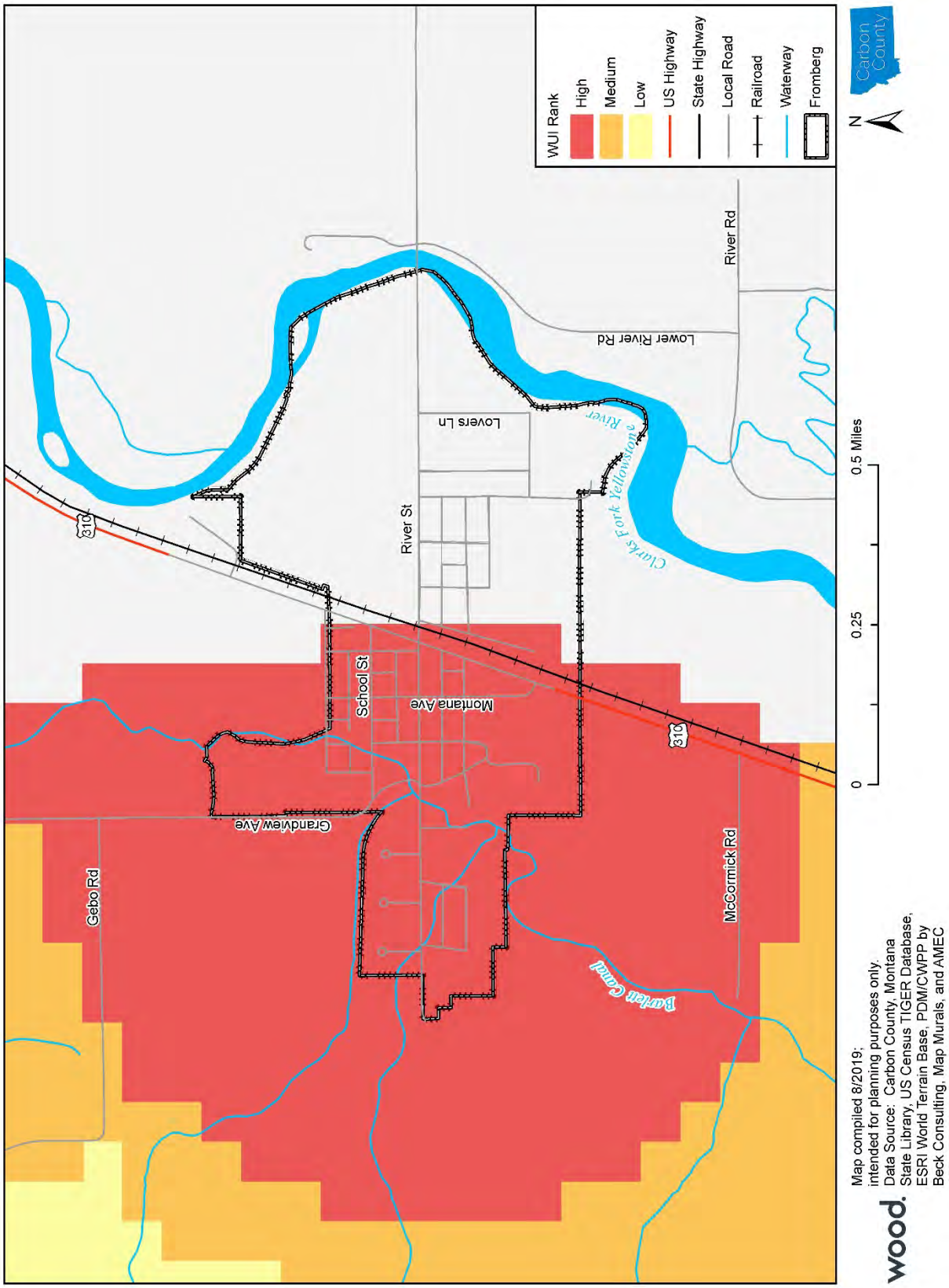


Figure 3-57 WUI Hazard Zones in Fromberg



Critical Facilities and Infrastructure

Critical facilities are those community components that are most needed to withstand the impacts of disaster, as previously described in the Assets Summary Section. Wildfire impacts to critical facilities can include structural damage or destruction, risk to persons located within facilities, and interruption of facility operations and critical functions. GIS analysis consisted of an overlay of the critical facilities in the county with the WUI hazard layers obtained from the county as they were developed for the CWPP. The WUI area overlay analysis showed that 50 facilities are found in these zones (3 in Low hazard areas, 3 in Moderate hazard areas, and 44 in High hazard areas). Table 3-40 below summarizes these facilities for all three WUI zones, by critical facility type and overall category. Figure 3-53 displays the wildfire hazard zones or categories (WUIs) that were determined for Carbon County based on the Carbon County CWPP, as reference.

Table 3-40 Critical Facilities in Carbon County WUI Areas by Type and Overall Category

Critical Facility Type	Critical Facility Category	Total Critical Facilities
Emergency Services	Government/Administrative	1
	Fire Station	2
	Government/Administrative	11
	Government/Law Enforcement	1
	High School	1
	School	6
	Senior Center	2
	Elementary School	2
High Potential Loss Facilities	HazMat Facility	1
Lifeline Utility Systems	Water Treatment Facility	1
	Communications/Utilities Facility	3
	Post Office	1
	Water Tower	1
	Communications/Utilities Facility	1
	Water Well	1
	Water Tank	1
	Water Well	1
	Water Tank	1
Transportation Systems of Other/Miscellaneous	Airport	1
	Miscellaneous/Other	5
	Religious Institution	5
	Miscellaneous/Other	1
TOTAL		**50**

Source: Carbon County DES/GIS Departments and CWPP, Wood Plc

The HMPC additionally noted that Highway 310, which passes through the Clarks Fork Valley, carries a large amount of semi- truck traffic. The volume has been increasing in recent years and there are semis hauling a great deal of potentially hazardous material through the county (Maddox, 2004). This can increase the potential of a hazardous material spill and/or ignition of a wildland fire along the highway, which is considered an important asset of transportation infrastructure due to these possible issues.

Historic, Cultural, and Natural Resources

There are historic mines and ghost towns throughout the county that could be vulnerable to wildfires.

Next to people and property, natural resources impacts from wildfires could be severe and widespread. Wildfires are a common and naturally occurring phenomenon in forested areas and can benefit forest health in many respects. But the trend for hotter, more widespread and destructive fires can make it more difficult for the environment to recover, and lead to increased flood hazards. This can severely impact water quality and watershed health for years after the fire.

Future Development

Additional growth and development in areas of fire risk will continue to increase the exposure of the planning area to damaging wildfires, though behavior and development issues related to fire protection vary across the county. Growth and development are occurring particularly in the north end of the county, along the Rock Creek valley, in the Red Lodge area, and along the mountain front. The challenges presented by development differ depending on the fuel types, terrain, access, and response times.

Generally, the development of most concern in the county from the standpoint of fire protection is occurring south and west of Red Lodge along the wildland urban interface area against the boundary of the National Forest. Previously subdivided lots continue to be built upon and new subdivisions continue to be proposed. Although the number of new developments fluctuates somewhat from year to year. According to the HMPC many of the lots sat vacant following the housing market crash in 2008-2009 and are now beginning to sell again but not at the same rate as before the crash. Nothing indicates this trend will change in the near term and it may even become more pronounced as the baby boom demographic continues to look for retirement property in areas with access to recreational opportunities, wildlife, and scenery. Even without additional subdivision, a large number of lots are already available to be built upon.

New rural residences are typically wood frame construction or in the interface areas, log construction. Many of the subdivisions' covenants require rustic construction materials that fit in visually with the natural landscape. Fortunately, most new homes in interface areas are being constructed with metal or composition shingle, rather wooden shake roofs.

Another factor worth noting is that there a number of second homes near the Red Lodge area, where mitigation and protection efforts are less of a priority given these homes are not inhabited by full time residents. This issue may put adjacent properties at risk.

One disturbing trend based upon the experience of reviewing many proposed major subdivisions and their subsequent development was noted by the HMPC in the previous HMP. There is a trend not to build out subdivisions in the way they were approved. While the county has the ability to ensure public infrastructure such as roads and fire hydrants are built to an appropriate standard, there are no checks to ensure the development occurs as per the requirements of the county in their approval or enforceable code for the maintenance of roads and fire protection systems. In some cases, the problems associated with lack of proper construction and maintenance of roads and fire protection systems may not become evident until the call comes in and responders are forced to do their best in a less than desirable situation. Losses could exceed those that would have occurred had the systems and roads been constructed to standard and properly maintained. In the worst case, firefighters' and residents' lives could be put at additional risk (Kuntz, 2004).

Risk Summary

- A total of 4,710 people could be at risk of wildland fires based on the WUI hazard zone analysis conducted with parcel data
- A total of 2,379 parcels could be at risk of wildfires based on the WUI analysis conducted. Wildfires can destroy homes, businesses, and critical infrastructure as noted herein

- Wildfires impacts can include loss of property, direct agricultural sector job loss, secondary economic losses to businesses, and loss of public access to recreational and income resources such as tourism
- A total of 50 critical facilities were found to fall within WUI hazard zone areas based on the best available data
- *Related Hazards:* Adverse weather/storms; Drought; Earth movement (debris flows); Hazardous Materials

Wildland Fire Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Significant	Likely	Critical	High
City of Red Lodge	Limited	Likely	Catastrophic	High
Town of Bearcreek	Limited	Occasional	Limited	Low
Town of Bridger	Limited	Occasional	Limited	Low
Town of Joliet	Extensive	Likely	Catastrophic	High
Town of Fromberg	Extensive	Likely	Critical	High

Hazardous Material Incident

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Limited	Likely	Negligible	Low

Hazard Description

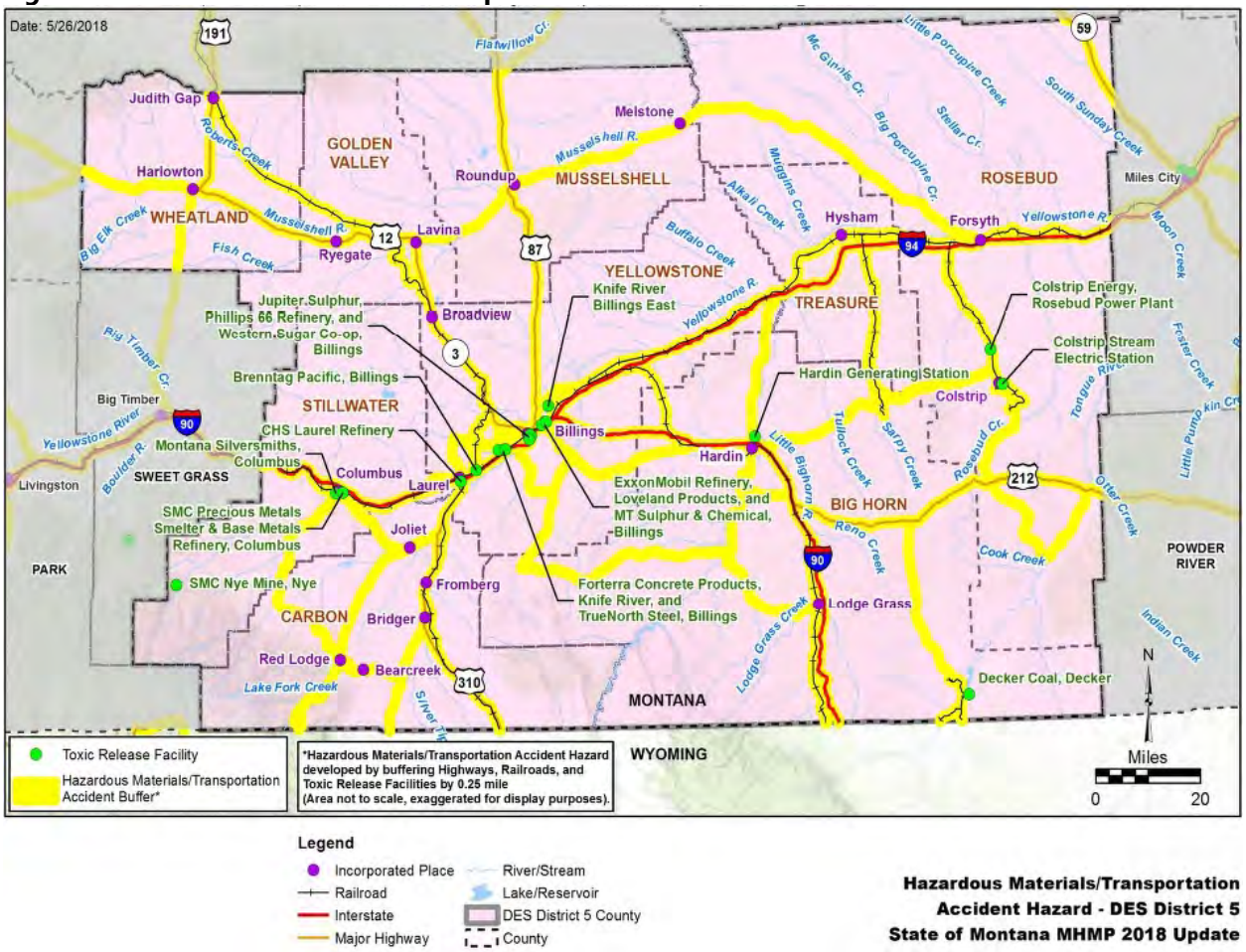
Hazardous materials are chemical substances, which if released or misused can pose a threat to the environment or health. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are often released as a result of transportation accidents or because of chemical accidents in plants or facilities storing hazardous materials. The volume and type of hazardous materials that flow into, are stored, and flow through communities determine exposure to a potential release of hazardous materials.

Geographic Area

Hazmat incidents can occur at a fixed facility or during transportation. Hazardous materials facilities are identified and mapped by the counties they reside in, along with the types of materials stored there; facilities generally reside in and around communities.

Despite Carbon County not having any U.S. Interstate Highway segment crossing the County, hazardous materials move within and through the County on state highways, on Burlington Northern Santa Fe (BNSF) railroad tracks, and within pipelines. A variety of hazardous materials are used or transported in the County. Among those materials used or generated locally are gasoline and oil, fertilizers, mine explosives, medical waste, and weed spraying chemicals. The County is also traversed by oil and gas pipelines. These pipelines access production areas which provide local service and provide long distance transport. The largest of these lines passes through the Clarks Fork Valley. Figure 3-58 shows the toxic release inventory (TRI) facilities as well as the highway and railroad network through the state; no TRI facilities are located in the Planning Area.

Figure 3-58 Hazardous Materials Transportation Routes and Toxic Release Facilities



Source: 2018 State of Montana Multi-Hazard Mitigation Plan Update

Extent (Magnitude/Severity)

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons and radioactive materials. Hazards can occur during production, manufacturing, storage, transportation, use, or disposal. Numerous factors influence the impacts of a hazardous materials release, including method of release, the type of material, location of release, weather conditions, and time of day. This makes it difficult to predict precise impacts. Impacts from hazardous waste releases can include:

- Injury
- Loss of life (human, livestock, fish and wildlife)
- Evacuations
- Property damage
- Air pollution
- Surface or ground water pollution/contamination
- Interruption of commerce and transportation

The release or spill of hazardous materials also requires different emergency response depending on the amount, type, and location of the spill incident.

The Planning Area has energy pipelines, railroad tracks which carry many types of hazardous materials, and state highways running through its boundaries. A variety of hazardous materials originating in the Region or elsewhere are transported along these routes and could be vulnerable to accidental spills. Consequences can vary depending on whether the spill affects a populated area versus an unpopulated but environmentally sensitive area.

Potential losses can vary greatly for hazardous material incidents. For even a small incident, there are cleanup and disposal costs. In a larger scale incident, cleanup can be extensive and protracted. There can be deaths or injuries requiring doctor's visits and hospitalization, disabling chronic injuries, soil and water contamination can occur, necessitating costly remediation. Evacuations can disrupt home and business activities. Large-scale incidents can easily reach $1 million or more in direct damages.

Historic Occurrences

The Montana Department of Environmental Quality maintains records of hazardous material discharges and spills in the state. The County has locations where hazardous materials are present and the Carbon County Weed Control District in Joliet is an active generator. The majority of hazardous waste created in the Carbon is used oil. According to the National Response Center, there have been 37 spills between 1991 and 2018. The types of spills include fixed (20), pipeline (11), storage tank (3), mobile (2), and railroad (1).

The 2018 State of Montana Multi-Hazard Mitigation Update listed the top highway and railroad hazardous materials incidents between 1990 and 2017; a gasoline spill in the unincorporated community of Belfry resulted in over 5,400 gallons of gasoline spilled, costing $310,500 in damages. The list also included a different incident in Belfry on June 10, 2005 in which 270 barrels of crude oil were spilled from a fixed facility, resulting in $163,650 in damages.

Likelihood of Future Occurrences

Low - Due to the number of past events (37 events in 28 years), coupled with the location of pipelines and hazardous materials routes that traverse the County, the likelihood of future occurrence of hazardous materials spills is considered likely.

Climate Change Considerations

There are no known effects of climate change on human-caused hazards, such as hazardous material incidents. However, hazmat incidents may indirectly increase the risk by increasing the frequency, severity, or extent of other hazards, such as wildfire. It is possible that an increase in these other hazards may increase the likelihood of an accidental hazardous materials release.

Vulnerability

The volume and type of hazardous materials that flow into, are stored, and flow through communities will determine exposure to a potential release of hazardous materials. Transportation of hazardous materials on highways, pipelines, and railroads resulting in an accident that would have the potential to impact the Planning Area including, producing a health hazard to those in the immediate area, downwind, and/or downstream.

The County is vulnerable to a hazardous material incident by simple virtue of the presence of the hazardous materials themselves. However, the amounts of waste generated and stored within the County are small and the materials not particularly toxic.

People

Hazardous materials incidents can cause injuries, hospitalizations, and even death to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life. Individuals working with or transporting hazardous materials are also at heightened risk. A large and publicized hazardous material-related events could deter tourists from visiting the County having a secondary impact on the local economy.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. However, there has not been sufficient research done on the subject to allow detailed analysis.

Economy

Some hazardous materials in Carbon County are transported along major highways; an incident could require the closure of roads that are also used for commerce and travel. While this may cause a small economic impact, in most cases the road would not be closed for an extended period of time. An incident at a pipeline or railway would have a similar impact, temporarily closing those modes of transportation, though the timeline to repair and bring those lines back into service is expected to be short.

The primary economic impact of hazardous material incidents would be lost business, delayed deliveries, property damage, and potential contamination. Economic effects from major transportation corridor closures could be significant.

Built Environment

Some hazardous materials are flammable, explosive, and/or corrosive, which could result in structural damages to property. Impacts would be highly localized.

The property impacts of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e. liquid spill) may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the Planning Area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities.

Critical Facilities and Infrastructure

Impacts to critical facilities and infrastructure are expected to be the same as the impacts to the rest of the built environment; while expected to be temporary, a hazardous materials incident that impacts critical infrastructure may result in some level of disruption to systems.

Historic, Cultural, and Natural Resources

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Specific areas of concern include areas where routes intersect or parallel rivers, and areas that present difficulty of access due to topography.

Future Development

When planning future development, proximity and vulnerability to hazardous materials routes and facilities should be taken into consideration. The county has not conducted a commodity flow study, though potential road, rail and pipelines that carry hazardous materials are known and can be planned around.

Risk Summary

- Hazardous materials move across the county via road, rail and pipeline; prevalent materials include gas and oil, mine explosives, fertilizers, medical waste and other chemicals
- The volume and type of hazardous materials that flow into, are stored, and flow through communities will determine exposure to a potential release of hazardous materials
- An accidental or intentional release of materials could produce a health hazard to those in the immediate area, downwind, and/or downstream
- Impacts are affected by type of chemical released
- Impacts are also affected by environmental factors, including weather and topography
- *Related Hazards:* Public Health Emergency, Earthquake, Earth Movement, Wildfire, Flood

Hazardous Materials Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Limited	Likely	Negligible	Low
City of Red Lodge	Limited	Likely	Negligible	Low
Town of Bearcreek	Limited	Likely	Negligible	Low
Town of Bridger	Limited	Likely	Negligible	Low
Town of Joliet	Limited	Likely	Negligible	Low
Town of Fromberg	Limited	Likely	Negligible	Low

Public Health Emergency

Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Extensive	Occasional	Catastrophic	Medium

Hazard Description

Infectious diseases are illnesses caused by organisms such as bacteria, viruses, fungi and parasites. Sometimes the illness is not due to the organism itself, but rather a toxin that the organism produces after it has been introduced into a host. Disease may be transmitted (spread) either by: one infected person to another, from an animal to a human, from an animal to an animal, or from some inanimate object (doorknobs, table tops, etc.) to an individual.

The State of Montana, as well as local counties and tribes, have been involved in pandemic influenza preparedness efforts. States and local communities are responsible under their own authorities for responding to an outbreak within their jurisdictions and having comprehensive pandemic preparedness plans and measures in place to protect their citizens. The focus of these planning efforts is on practical, community-based procedures that could prevent or delay the spread of pandemic influenza and help to reduce the burden of illness communities would contend with during an outbreak. With all "preparedness" plans there is a mitigation component. The Montana DPHHS maintains the State's Pandemic Influenza Emergency Plan and County/Tribal Health Departments maintain local plans.

One of the most common infectious diseases affecting humans is influenza. Influenza is a contagious, upper-respiratory disease caused by many different strains of influenza viruses. It can cause mild to severe illness. Serious outcomes of flu infection can result in hospitalization or death. Some people, such as older people, young children, and people with certain health conditions, are at high risk of serious flu complications.

There have been four major global flu pandemics since 1900. The Spanish flu pandemic (1918- 1919) killed between 50-100 million people worldwide. The Asian flu pandemic (1957-1958) originated in China and is estimated to have killed between one and four million people. The Hong Kong flu (1968-1969) which killed approximately one million people. And, the 2009 swine flu pandemic which killed over 18,000 people. The 2017-2018 flu outbreak in Montana claimed 67 lives. The best way to prevent flu is by getting vaccinated each year.

The single deadliest flu pandemic in history was the Spanish flu pandemic during 1918-1919. Occurring in the three waves of increasing lethality, the Spanish flu killed more people in 24 weeks than AIDS did in 24 years. It also killed more people in one year than smallpox or the Black Plague did in 50 years (Iezzoni, 1999). The Spanish influenza outbreak caused 9.9 deaths per 1,000 people in the State of Montana (Brainerd and Siegler, 2002). Historical records from newspapers show that the influenza outbreak was so bad in 1918 that Montana residents were quarantined from November 30 to December 17 after 18 people died and 53 new cases were discovered. Native Americans died at a rate four times the national average from the Spanish flu (Iezzoni, 1999).

Air travel has significantly increased the speed with which diseases can spread. Most of the world's great cities are now within a few hours of each other. A virus that is in Hong Kong one day can be carried to any point in Southeast Asia within three or four hours, to Europe in 12 hours, and to North America in 18 hours. Nearly 1.5 billion passengers travel by air every year (WHO, 2009). A pandemic is a global disease outbreak.

Diseases that have been eliminated from the U.S. population, such as smallpox, could be used in bioterrorism. The following list gives examples of biological agents or diseases that could occur naturally

or be used by terrorists as identified by the Centers for Disease Control and Prevention (2017). These diseases can infect populations rapidly, particularly through groups of people in close proximity such as schools, assisted living facilities, and workplaces.

Geographic Area

While response actions can contain a public health hazard once detected, the entire county is susceptible to disease and its impacts.

Extent (Magnitude/Severity)

When on an epidemic scale, diseases can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities.

Historic Occurrences

While the U.S. saw outbreaks Ebola virus in 2014 and Zika virus in 2016/2017, the Montana Dept. of Public Health and Human Services (DPHHS) has said the likelihood of these viruses showing up in Montana is small. The impact of Zika in Montana is expected to be confined to individuals returning from or planning travel to Zika-affected areas and Montana's mosquitoes are not expected to be able to transmit the virus.

DPHHS manages a database of reportable communicable disease occurrences. Public health emergencies that have affected Montana include vector-borne disease, such as West Nile Virus, food-borne illness like *E.coli*, and vaccine-resistant illness such as virulent strains of influenza.

Likelihood of Future Occurrences

Occasional - For purposes of determining probability of future occurrence, this plan defines "occurrence" of human disease outbreak as a medical, health or sanitation threat to the general public (such as contamination, epidemic, or plague). In the last century, there have been four pandemic flu events. The possibility of a human disease outbreak causing a threat to the general public to be occasional and more likely in areas of the County that experience an influx of seasonal visitors.

Climate Change Considerations

As noted in the State Hazard Mitigation plan, the effects of climate change on the disease hazard is mainly to the population. Outbreaks of insect- and water-borne infection associated with higher temperatures could increase population exposure; especially vulnerable would be the young and elderly. Although some evidence indicates that warming may be causing infectious disease to spread, predicting how climate change will ultimately influence the incidence of diseases transmitted by insects remains challenging. However, secondary impacts to public health may result due to increased smoke from wildfire activity resulting in poor air quality and respiratory-related issues.

Vulnerability

People

The most vulnerable populations in Carbon County to an outbreak of human disease are the very young and very old, as well as those with compromised immune systems, though depending on the disease and its characteristics, anyone could be threatened. Diseases will spread quickest in areas with dense populations with people in close contact; schools are an example of a prime location for disease transmission. These impacts can be compounded if prophylactics are not readily available, especially if a disease is novel.

The HMPC noted that Carbon County is a gateway to Yellowstone National Park and surrounding areas, and as such, sees a large number of visitors from other areas of the globe. This could introduce disease strains from across the world into the area.

Economy, Built Environment and Critical Facilities and Infrastructure

While an outbreak impacting public health will not physically impact the structure of critical facilities and infrastructure, the operations of these facilities may be impacted. Critical employees may be unable to work, disrupting normal business operations and quickly causing economic impacts as businesses see reduced function.

The HMPC noted during the second planning meeting that an additional impact to critical infrastructure may be a rush of people needing supplies at points of distribution, overwhelming infrastructure.

Historic, Cultural, and Natural Resources

Human disease is not expected to have a long-term impact on historic, cultural and natural resources that is not in line with the impacts outlined in the sections above.

Future Development

Future development would not be directly impacted by disease, but any additional residents would be at risk for disease.

Risk Summary

- Populations already considered vulnerable such as the very young and the elderly are at the greatest risk of public health issues.
- Carbon County is the "Gateway to Yellow National Park" brining a large number of visitors from across the country and all of the world.
- Climate change is expected to increase the intensity of wildfire events in state which will have secondary impacts on public health because of smoke and ash.
- Overall significance is medium.
- *Related hazards:* Haz Mat, Wildfire, Flood

Public Health Risk Summary by Jurisdiction

Jurisdiction	Geographic Area	Probability of Future Occurrence	Magnitude/ Severity (Extent)	Overall Significance
Carbon County	Extensive	Occasional	Catastrophic	Medium
City of Red Lodge	Extensive	Occasional	Catastrophic	Medium
Town of Bearcreek	Extensive	Unlikely	Catastrophic	Low
Town of Bridger	Extensive	Unlikely	Catastrophic	Low
Town of Joliet	Extensive	Unlikely	Catastrophic	Low
Town of Fromberg	Extensive	Unlikely	Catastrophic	Low

Chapter 4. Mitigation Strategy

DMA Requirement §201.6(c)(3):	*[The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

This section describes the mitigation strategy process and mitigation action plan for the Carbon County Multi-Hazard Mitigation Plan. It explains how the County and participating jurisdictions accomplished Phase 3 of FEMA's 4-phase guidance—Develop the Mitigation Plan—and includes the following from the 10-step planning process:

- Planning Step 6: Set Goals
- Planning Step 7: Review Possible Activities
- Planning Step 8: Draft an Action Plan

Mitigation Strategy: Overview

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the hard work of the HMPC led to the mitigation strategy and mitigation action plan for this HMP update. As part of the plan update process, a comprehensive review and update of the mitigation strategy portion of the plan was conducted by the HMPC. As part of this process the original goals and objectives from the 2013 Plan were reviewed and revised. The mitigation actions from 2013 Plan were reviewed and assessed for progress and evaluated for their inclusion in this plan update. The sections below identify the updated goals and objectives of this plan and details the progress on 2013 mitigation actions and summarizes the updated mitigation action plan.

Goals and Objectives

DMA Requirement §201.6(c)(3)(i):	*[The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards*

Up to this point in the planning process, the Hazard Mitigation Planning Committee (HMPC) has organized resources, assessed natural hazards and risks, and documented mitigation capabilities. A profile of the County's vulnerability to natural hazards resulted from this effort, which is documented in the preceding chapter. The resulting goals, objectives, and mitigation actions were developed based on this profile. The HMPC developed the new updated mitigation strategy based on a series of meetings and worksheets designed to achieve a collaborative mitigation planning effort, as described further in this section. The goals for this plan were developed by the HMPC based on the plan's risk assessment. This analysis of the risk assessment identified areas where improvements could be made and provided the framework for the HMPC to formulate planning goals and objectives and the mitigation strategy for Carbon County.

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- Represent basic desires of the community;
- Encompass all aspects of community, public and private;
- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- Are time-independent, in that they are not scheduled events.

Goals are stated without regard for implementation, that is, implementation cost, schedule, and means are not considered. Goals are defined before considering how to accomplish them so that the goals are not dependent on the means of achievement. Goal statements form the basis for objectives and actions that will be used as means to achieve the goals. Objectives are more specific and create a bridge to actions. Actions are specific and measurable over time.

Based upon the risk assessment review and goal setting process, the HMPC re-assessed the goals developed from the 2013 Plan. The 2013 HMP had one goal that was repeated for all six jurisdictions, "Mitigate natural hazards to reduce the potential for property loss or damage, injury and loss of life in the [*community name*]". It was determined the old goals needed to be updated to align with more modern Hazard Mitigation Plan requirements. Three new plan goals were developed with input from the HMPC. Existing objectives from the 2013 Plan were carried forward and re-organized to correspond with the most relevant goal. The HMPC revised the goals to be the following for this plan and all six communities:

Goal 1: Protect lives and reduce injury

- Reduce potential for structure damage and loss of life from natural hazards and hazmat.
- Be prepared for conducting evacuations
- Be prepared for winter storms
- Enhance emergency planning for all-natural disasters

Goal 2: Minimize or reduce damage to property, especially critical facilities and infrastructure

- Protect critical infrastructure
- Address oil and gas pipeline hazards.
- Reduce potential for flood damage
- Reduce vegetative hazard
- Reduce vegetation hazard from wind.
- Improve structural fire protection
- Be prepared for power outages

Goal 3: Strengthen communication among agencies and between and the public regarding mitigation

- Raise awareness to make citizens safer from all-natural hazards.
- Maintain emergency communications
- Improve communications for all hazards

Identification and Analysis of Mitigation Actions

DMA Requirement §201.6(c)(3)(ii):	*[The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.*

In order to identify and select mitigation measures to support the mitigation goals, each hazard identified in Chapter 3: Hazard Identification and Risk Assessment was evaluated. Only those hazards that were determined to be a high significant hazard were considered further in the development of hazard-specific mitigation actions.

The high significant hazards are:

- Drought
- Flood
- Wildland Fires

The medium significant hazards are:

- Avalanche
- Dam Failure
- Earthquake
- Summer Storm: Hail, Severe Thunderstorm, Wind, Tornado
- Winter Storm
- Public Health Emergency

Once it was determined which hazards warranted the development of specific mitigation actions, the HMPC analyzed viable mitigation options that supported the identified goals and objectives. The HMPC analyzed a comprehensive set of viable mitigation alternatives that would support identified goals and objectives. Each HMPC member was provided with the following list of categories of mitigation measures, which originate from the NFIP Community Rating System:

- **Prevention:** Administrative or regulatory actions or processes that influence the way land and buildings are developed and built.
- **Property protection:** Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove them from the hazard area.
- **Structural:** Actions that involve the construction of structures to reduce the impact of a hazard.
- **Natural resource protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.
- **Emergency services:** Actions that protect people and property during and immediately after a disaster or hazard event.
- **Public information/education and awareness:** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.

The HMPC members were also provided with several lists of alternative multi-hazard mitigation actions for each of the above categories via email and at a mitigation strategy meeting in August 2019. Another reference handout document titled "Mitigation Ideas" developed by FEMA was distributed to the HMPC via an online link. This reference provides four categories of mitigation actions that were discussed at the HMPC meeting in addition to the NFIP/CRS categories. These include:

- Plans and Regulations
- Structure and Infrastructure Projects
- Education and Awareness
- Natural systems protection

Other alternatives discussed at the meeting include the four 'A's' of mitigation:

- Alter the physical nature of the hazard
  - Such as wildfire defensible space and fuels treatments, snow fences etc.
- Avert the hazard away from people, buildings and infrastructure
  - Can include engineered solutions, drainage and channel improvements, floodproofing, fuel breaks
- Adapt to the hazard
  - Through land use planning, building codes and design standards, warning systems etc.
- Avoid the hazard
  - Natural systems protection, open space, acquisition or relocation of properties out of hazardous areas

To facilitate the brainstorming process, the HMPC referred to a matrix of typical mitigation alternatives organized by CRS category for the hazards identified in the plan, in addition to a handout that explains the categories and provided examples. These materials are included in Appendix B. HMPC members were encouraged to develop mitigation alternatives that would protect future, as well as existing, development from hazards per the DMA 2000 regulations. A facilitated discussion then took place to examine the existing actions in the 2013 plan and analyze the other possible mitigation alternatives. With an understanding of the alternatives, a brainstorming session was conducted to generate a list of preferred mitigation actions. The result was a number of new and updated project ideas with the intent of meeting the identified goals and mitigating identified hazards.

Prioritization Process

The prioritization of mitigation actions during the 2019 update followed a similar process used during the original development of this plan. Priority rankings of High, Medium, or Low were also assigned. Projects from the 2013 plan that have not been completed, are still appropriate, and are specific enough to bring forward are incorporated into the project lists. Some projects were dropped because they were too vague to determine what was intended.

Generally, the jurisdictions will initiate and depending on the complexity, try to accomplish the High priority projects within two years, the time frame for Medium priority projects will be three to four years, and Low priority projects will be accomplished by the five-year anniversary of this plan if feasible.

All projects were initially ranked by the coordinator and contractor based on the following criteria. The HMPC then validated the rankings.

- Perceived cost effectiveness and feasibility of obtaining funding,
- Level of risk to life and property posed by hazard which project addresses,
- Reasonableness of project and extent to which it provides a long-term solution,
- Potential consequences of not implementing,
- Support from the public and elected officials, and
- Compatibility with other plans and policies.

The HMPC members were provided with several sets of decision-making tools, including FEMA's recommended criteria, STAPLE/E (which considers social, technical, administrative, political, legal, economic, and environmental constraints and benefits). The STAPLE/E factors are noted in more detail below.

- Social: Does the measure treat people fairly?
- Technical: Will it work? (Does it solve the problem? Is it feasible?)
- Administrative: Is there capacity to implement and manage the project?
- Political: Who are the stakeholders? Did they get to participate? Is there public support? Is political leadership willing to support the project?
- Legal: Does your organization have the authority to implement? Is it legal? Are there liability implications?
- Economic: Is it cost-beneficial? Is there funding? Does it contribute to the local economy or economic development? Does it reduce direct property losses or indirect economic losses?
- Environmental: Does it comply with environmental regulations or have adverse environmental impacts?

In accordance with the DMA requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining project priority (the 'economic' factor of STAPLE/E). Other criteria used to recommend what actions might be more important, more effective, or more likely to be implemented than another included:

- Does action protect lives?
- Does action address hazards or areas with the highest risk?
- Does action protect critical facilities, infrastructure or community assets?
- Does action meet multiple objectives (Multiple Objective Management)?

At the mitigation strategy update meeting the HMPC used STAPLEE considerations to determine which of the identified actions were most likely to be implemented and effective. Prioritization of previous mitigation actions identified in the 2013 HMP that are continuing in the updated plan were revisited during a HMPC meeting. New actions identified in 2019 also were prioritized based on the group discussion with the STAPLEE considerations in mind.

Mitigation Action Plan

DMA Requirement §201.6(c)(3)(iii):	*[The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

This section outlines the development of the updated mitigation action plan. The action plan consists of the specific projects, or actions, designed to meet the plan's goals. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals.

Progress of Previous Mitigation Actions

Carbon County and the participating jurisdictions have been successful in implementing actions identified in the 2013 HMP Mitigation Strategy, thus, working diligently towards meeting the 2013 plan goals. Table 4-1 indicates the details for each 2013 mitigation action items that have been completed. Some of the deferred items including projects that will continue forward in the plan and include a mix of projects with some progress and ongoing implementation and others that have been deferred due lack of funding or other priorities.

The 2013 mitigation strategy contained 85 separate mitigation actions. As of November 2019, 18 of these actions have been completed, 29 have been deleted, 12 are considered continuing-in process and 16 are continuing but have not been started yet. Many of the continuing-in process actions include actions that are implemented on a regular or annual basis that contribute to the goals of this plan that will continue to be needed into the future. Table 4-1 provides a status summary of the mitigation action projects completed from the 2013 Plan.

Table 4-1 Completed 2013 Mitigation Actions

Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
Carbon County	Address issues with pressurized natural gas line crossing Rock Creek south of Roberts	HazMat	High	NWE relocated line south of Roberts
	Complete implementation of E-911	All	High	Now working on NG911 implementation
	Complete the conversion of radios to narrow band	All	High	Completed with AFG grant obtained by RLRF
	Develop better communication with the local media about Red Flag warnings	Wildland Fire	High	CarbonAlert Facebook page announces all Red Flag

Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
				Warnings; burn permit system implemented in 2015
	Demolish the grain elevator at Edgar	HazMat	Low	
	Implement the E-911 system	All	Medium	
Town of Bearcreek	Adopt DFIRM for town	Flood	High	Completed in 2017
	Insulate existing shed behind town hall to store portable backup generator	All	Medium	
Town of Bridger	Go live with Bridger Police Department web pages and link to county emergency information	All	Medium	
	Purchase narrowband radio for police to comply with switch from analog	All	High	Completed with AFG grant obtained by RLFR
Town of Fromberg	Adopt new DFIRM	Flood	Medium	Completed in 2017
Town of Joliet	Adopt new DFIRM	Flood	High	Completed in 2017
	Remove unused piers in Rock Creek south of Joliet	Flood	High	Completed in 2015
	Replace warning siren on town hall	All	High	Installed new warning siren with Homeland Security grant in 2018
	Purchase 2 mobile, 3 handheld digital radios for conversion	All	High	County wide radio grant supplied radios
City of Red Lodge	Adopt new DFIRMs	Flood	High	Completed in 2017
	Maintain building inspection program. Adopt revisions to IBC and IRC as appropriate	All	High	

Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
U.S. Forest Service	Develop desired condition maps for Custer Gallatin National Forest	Wildland Fire	High	

During the 2019-2020 update of the plan, the HMPC acknowledged that some actions should not be carried forward. Table 4-2 shows the actions that were deleted during the 2019-2020 update process with a brief justification. It was determined that many of these actions were no longer relevant, duplicated by other projects and programs, or preparedness and not mitigation.

Table 4-2 Deleted 2013 Mitigation Actions

Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
Carbon County	Post DFIRMs on the County website	Flood	High	DFIRMs available through digital mapping services
	Continue to broadcast weather warnings through dispatch	Severe Weather	High	Multiple ways to receive NWS notifications; radio broadcast not necessary
	Invite NWS to make presentations in the schools	Severe Weather	Medium	NWS has own outreach program
	Coordinate with public health emergency planning	Public Health	High	New PHEP coordinator in place; Good relationship with DES/LEPC; Not a mitigation project"
	Participate as requested in the development of public health emergency plans	Public Health	Medium	DES reviewed/participated in last plan revision; Not a mitigation project
	Include public health in disaster response exercises	Public Health	High	Ongoing; Not a mitigation project
	Develop evacuation kits to accelerate evacuation process	Wildland Fire	Low	Sample "Go Kit" and home/auto checklists in place with CarbonAlert public display; Actual evac kit development responsibility of owner

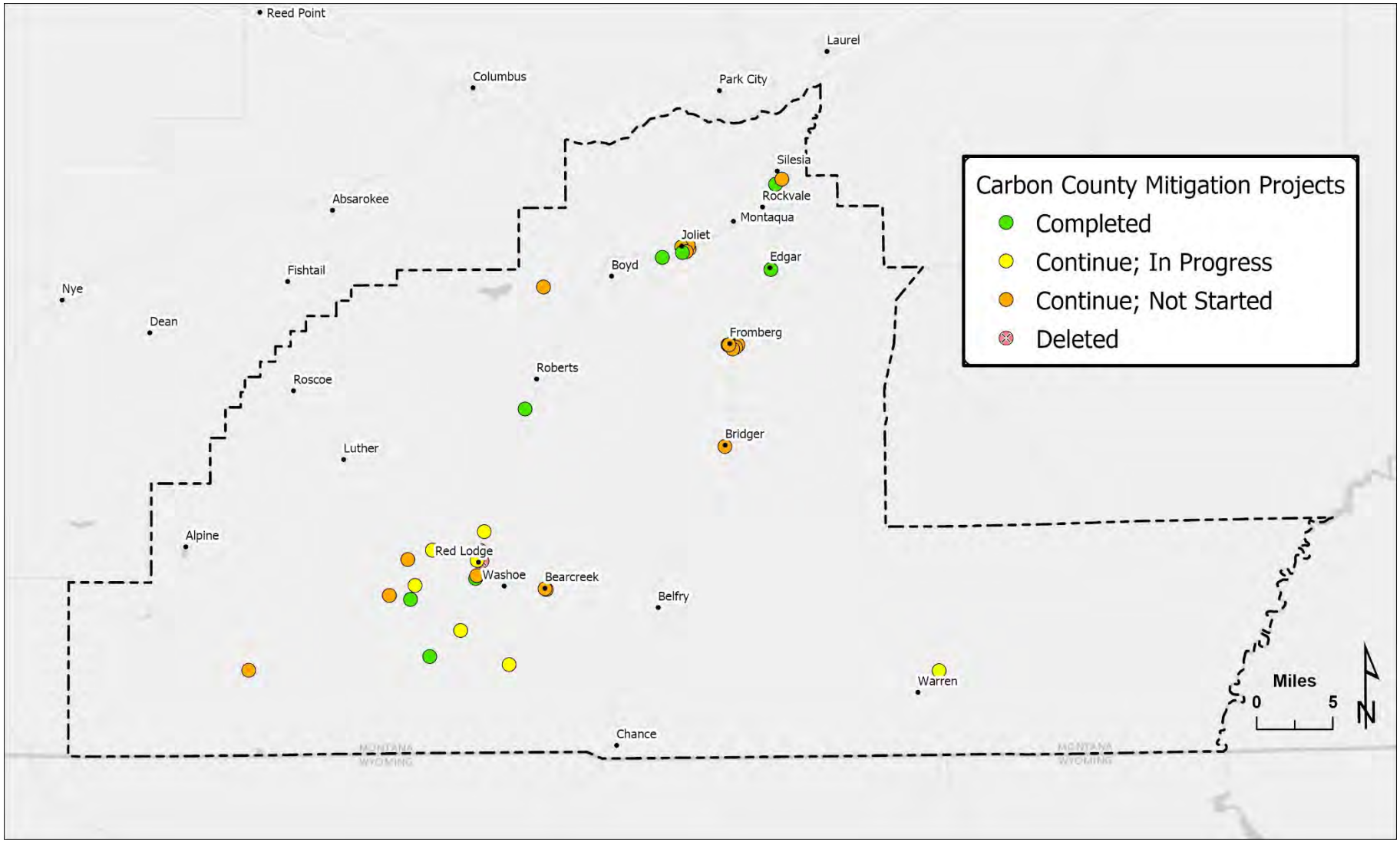
Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
	Work with commercial providers to improve cellular communications in the Clarks Fork Valley	All	Low	Not sure if County or others have influence over cell site locations
	Work with the State of Montana and the Custer Gallatin National Forest to develop a safe area in the West Fork drainage	Wildland Fire	High	Fuel reduction projects; evacuation plan and Cascade fire; would need to better define "Safe Area"
	Jointly develop a fuels reduction project for the Beartooth Face (Grove Creek Areas) area south of Belfry	Wildland Fire	Low	Not a high priority for USFS
	Target rural property owners and second home owners by including a fire prevention message with property tax notices.	Wildland Fire	Medium	
	Meet with individual property owners in USFS recreation areas to discuss fire protection	Wildland Fire	Low	Covered under other mitigation project
	Bury 12 miles of electrical lines in the West Fork of Rock Creek drainage	Severe Weather; Wildland Fire	Low	Not cost effective
	Have county attorney provide a training session for chiefs on providing input to subdivision review process	Wildland Fire	Low	Not considered to be effective
	Ensure that subdivisions are built as approved and fire protection systems are initially and periodically certified	Wildland Fire	High	Covered under other mitigation project
	Host a workshop that would qualify for continuing education credits for architects, engineers, and realtors on defensible space and fire wise principles	Wildland Fire	Medium	Covered under other mitigation project
	Develop and provide a workshop on defensible space and Firewise principles for the	Wildland Fire	Medium	Covered under other mitigation project

Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
	county planning staff and planning board			
	Review new technologies to improve response and communications	All	Medium	CodeRED notification system licensed by County in 2016; otherwise too vague to be mitigation project
	Report all responses to the state as requested	All	Medium	Reporting methods in place
	Set up "call-out" data base in cooperation with dispatch center to document the number of responses	All	Low	Not needed
Town of Bearcreek	Pursue grant for floodplain map above if determined advantageous	Flood	Medium	Not needed, mapping costs covered by State/FEMA/ NFIP
Town of Fromberg	Install separate waterline from storage tank to school.	Other	Medium	Not relevant (Venting, 8/2/16)
	Purchase narrowband radio for police to comply with switch from analog.	Other	High	Carbon County Sheriff's Office (CCSO) now providing law enforcement in Town. CCSO has narrowband radios.
Town of Joliet	Address tree hazard along abandoned ditch, north side	Flood	Medium	Unknown where/what this project consists of
City of Red Lodge	Remove abandoned concrete piers in Rock Creek at Island at Rock Creek to prevent ice jam floods.	Flood	Low	Piers now used as overlook
	Remove abandoned concrete piers in Rock Creek at 8th Street to prevent ice jam floods.	Flood	Medium	Piers not a hazard

Jurisdiction	Mitigation Action	Corresponding Hazard	Priority	Comments
	Encourage owner of natural gas distribution facility to relocate tanks outside of city limits	HazMat	Medium	NWE facility near Coal Miners Park. Not necessarily mitigation
U.S. Forest Service	Develop goals and projects to return those areas determined desirable to their natural fire regime and manage other lands appropriately	Wildland Fire	Medium	Covered under other mitigation project and written in 2020 Forest Plan
	Identify criteria for fire use allowing natural ignitions to continue burning within parameters	Wildland Fire	Medium	Covered under USFS protocols

During the 2019-2020 update the County DES Coordinator established a database of mitigation actions that can be used to track action status moving forward, potentially using GIS to track project implementation countywide. Figure 4-1 shows the location of mitigation projects in Carbon County that have been implemented, are in progress of being implemented, or are continuing from the 2012 mitigation action plan but have not been started since the adoption of the 2012 hazard mitigation plan.

Figure 4-1 Mitigation Projects in Carbon County



Source: Carbon County DES Coordinator

Continued Compliance with the National Flood Insurance Program

Recognizing the importance of the National Flood Insurance Program (NFIP) in mitigating flood losses, an emphasis will be placed on continued compliance with the NFIP by Carbon County and other NFIP participating communities including the towns of Bearcreek, Fromberg, Joliet, and the City of Red Lodge. As NFIP participants, these communities have and will continue to make every effort to remain in good standing with NFIP. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance. As indicated in the Completed 2013 Mitigation Actions table the County and all the participating jurisdictions adopted the revised NFIP maps that became effective in 2017. The Town of Bridger has chosen not to participate in the NFIP for several years due to limited flood risk; the updated NFIP maps show no Special Flood Hazard Area (SFHA) within town limits thus there is no requirement to participate. Other details related to NFIP participation are discussed in the flood vulnerability discussion in Chapter 3 and in the capability assessment in Chapter 1.

Updated Action Plan

The results of the project identification and prioritization exercise are summarized in Table 4-3. These projects detail specific actions for reducing future hazard-related losses within Carbon County and in the participating jurisdictions. The projects are grouped by jurisdiction where the mitigation project will be implemented. Included are notes about the department and partners necessary to implement the project. Also included are the goal(s) that the projects primarily align with, with an understanding that some projects may help to achieve more than one goal. The mitigation projects are marked with their relative level of priority high, medium, and low.

Many of these mitigation actions are intended to reduce impacts to existing development. Those that protect future development from hazards, as required per the DMA 2000 regulations, are indicated by an asterisk '*' in the action identification number. These actions include those that promote wise development and hazard avoidance, such as building code, mapping, and zoning improvements, and continued enforcement of floodplain development regulations.

Table 4-3 Carbon County Mitigation Action Plan

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
Multi-Jurisdictional Mitigation Actions									
MJ-1	1,3	All	Develop evacuation policies and SOGs to increase efficiency of evacuations	County DES	<$10,000	Staff Time/Dept Budget	High	1 year	New in 2019/In-progress
MJ-2	3	All	Ensure agreements and Memorandum of Understanding (MOU) are in place and current to facilitate mutual aid	County	<$10,000	Staff time	Medium	Annual	New in 2019/In-progress MA agreements between RFDs expired. County-County MA agreement executed in 2018; Pursuing agreement with WY counties
MJ-3	1	All	Develop or purchase firefighter and EMS recruitment materials to promote volunteer recruitment at individual departments/districts	Rural Fire District; EMS District; County DES	<$10,000	Staff Time/Dept Budget	High	1 year	New in 2019/In-progress
MJ-4	1	All	Identify access & functional needs populations	County DES; County Sheriff	$10,000-$100,000	Staff Time/Dept Budget	Medium	Ongoing	New in 2019 County will research tools such as Smart911
MJ-5	1,2	Winter Storm	Enhance snow removal capability with impending climate change	County Road Dept.; MDT	$10,000-$100,000	Staff Time/Dept Budget	Low	2 years	New in 2019

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
MJ-6	1,2	All	Secure or acquire UAS (drone) service to assist with all hazard mitigation projects	County DES	$10,000-$100,000	State Homeland Security Grant	Medium	3 years	New in 2019/In-progress The county has used drone footage to monitor stream bank erosion in Rock Creek to support PDM grant applications
Carbon County Mitigation Actions									
C-1*	1,2	Flood	Install gauging device in Rock Creek south of Red Lodge to inform when flood conditions are imminent	County DES	<$10,000	HMA Grants /Staff Time/Dept Budget	Medium	1 year	Continuing/In-progress Automated gauging station unlikely, but survey rod/ruler possible; would enhance public safety and warning.
C-2	2	Flood	Replace the dike in Rock Creek at the end of Grapevine Road	County Road Dept.	$10,000-$100,000	Federal Grant Funding	Low	3-5 years	
C-3*	2	Flood	Remove bridge abutments from floodplain when county bridges are replaced	County Road Dept.; County DES; FEMA	>$100,000	Federal Grant Funding/ Staff Time	Low	3-5 years	Continuing/In-progress
C-4	3	Flood	Continue to provide information to property owners about building in the floodplain	County Floodplain	<$10,000	Staff Time/Dept Budget	High	Ongoing	Continuing/In-progress County now has part-time flood plain

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
									coordinator; office in Joliet
C-5	3	Flood	Provide educational materials about flood insurance—what is covered by what types of policies	County Floodplain; County DES	<$10.000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress County DES distributes literature from MT DES on flood assistance programs
C-6	1	HazMat	Continue to provide training for responders in conjunction with pipeline companies	County DES; Industry; Rural Fire District	<$10,000	HMA Grants/ Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress Several pipeline exercises available in County and region; LEPC toured pipeline in 2015; Pipeline annex added in 2019
C-7	1,3	All	Develop emergency notification system	County DES; County Sheriff	$10,000-$100,000	HMA Grants/ Staff Time/Dept Budget	High	1 year	Continuing/In-progress CodeRED in place for County; additional training needed on system as well as additional authorized personnel to launch messages
C-8	2	Severe Weather	Replicate the fiber optic line from Billings to Red Lodge to reduce vulnerability in communications	Industry	$10,000-$100,000	Federal Grant Funding	Medium	3-5 years	

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
C-9	3	All	Develop the DES page of the county's website to provide information about emergency management	County DES	<$10,000	Staff Time/Dept Budget	Medium	1 year	Continuing/In-progress
C-10	3	All	Purchase mobile generator that can be moved to shelter or critical infrastructure locations	County DES	$10,000-$100,000	State Homeland Security Grant	Medium	2 years	Continuing/In-progress
C-11	3	All	Maintain shelter agreements with American Red Cross	County DES	<$10,000	Staff Time/Dept Budget	High	Ongoing	Continuing/In-progress FEMA Corps inventory complete but agreements not in place
C-12	1,3	Severe Weather	Host NWS weather spotter training in county annually	NWS; County DES	<$10,000	Staff Time/Dept Budget	Medium	Annual	Continuing/In-progress Spotter trainings offered almost every year in different locations throughout the County
C-13	3	HazMat	Prepare a strategic plan for the LEPC	LEPC	$10,000-$100,000	Staff Time/Dept Budget	High	1 year	Continuing
C-14	3	Wildland Fire	Raise awareness of fire danger through an advertising campaign including a series of articles, mailings, and billboards	County Fire Warden	$10,000-$100,000	Staff Time/Dept Budget/ HMA Grants	Medium	Ongoing	Continuing/In-progress 5 new fire danger signs installed in 2019

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
C-15	1,3	Wildland Fire	Develop or purchase evacuation pamphlets and distribute to rural residents	USFS; BLM; County Fire Warden	<$10,000	Staff Time/Dept Budget	Low	Ongoing	Continuing/In-progress Make Ready, Set, Go pamphlets available; evacuation materials/door hangers in development
C-16	1,2	Wildland Fire	Review methodology for defining WUI and revise GIS WUI layer	County DES	<$10,000	Staff Time/Dept Budget	Low	1 year	Continuing/In-progress WUI map completed in 2012; needs revision
C-17		All	Pursue grants for PPE and communications equipment upgrades	Fire Warden; Rural Fire District; EMS District	$10,000-$100,000	Staff Time/Dept Budget/ Federal Grant Funding	High	2 years	Continuing/In-progress PPE often pursued through DNRC Rural Fire Capacity (RFC) grant on annual basis; Upgrades to communication equipment ongoing
C-18	3	HazMat	Conduct training sessions on response to hazmat carried by the railroad / pipelines	Industry; County DES	<$10,000	Staff Time/Dept Budget	Low	Annual	Continuing/In-progress Training sessions held at RFD by railroad and pipeline companies
C-19	3	Wildland Fire	Conduct after action review for all major incidents or at least one annually by the Fire Council.	LEPC; Fire Council; All	$10,000-$100,000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress AARs typically conducted by RFD after incidents; multi-agency AARs discussed at LEPC meetings each month and Fire Council meetings every quarter
C-20	1	Wildland Fire	Continue to pursue grant opportunities for equipment and training	County DES; Fire Warden; County Sheriff	$10,000-$100,000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress Leverage Rural Fire Capacity (RFC), Fire Fighter Property (FFP) and State Homeland

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
									Security grant (SHSG) programs
C-21*	2	Wildland Fire	Inventory/assess water supply infrastructure (e.g., hydrants, pumps, backup generators)	Fire Warden; Rural Fire District	<$10,000	Staff Time/Dept Budget	High	2 years	Continuing/In-progress County resource list more standardized but inventory still ongoing; pursue input of resources in National Mutual Aid System (NMAS)
C-22*	1,2	Wildland Fire	Pursue WUI fuel reduction projects in high risk areas around the county	USFS; BLM; County DES	>$100,000	HMA Grants/ Staff Time/Dept Budget	High	Ongoing	Continuing/In-progress Smaller projects underway including palisades ridge, Ski Run Rd; fuels inventory around RLM
C-23	1,2	Wildland Fire	Continue fuel reduction work in the 400 Ranch	Rural Fire District; County Fire Warden	$10,000-$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress
C-24	1,2,3	Wildland Fire	Continue Forest Service project to offer fuels reduction around recreation residences in the Main Canyon and the West Fork of Rock Creek	Rural Fire District; USFS	>$100,000	Staff Time/Dept Budget/ Federal Grant Funding	Medium	Ongoing	Continuing/In-progress YBRA fuel reduction

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
C-25	3	Wildland Fire	Meet annually with special interests' groups and cabin owners leasing property in the Custer Gallatin National Forest to discuss fire prevention, fire protection, and evacuation plans	USFS; Rural Fire District	<$10,000	Staff Time/Dept Budget	Low	Annual	Continuing/In-progress
C-26	3	Wildland Fire	Host a workshop to educate people on home ignition zones, defensible space and general Firewise principles	Rural Fire District; Fire Warden	<$10,000	Staff Time/Dept Budget	Medium	Annual	Continuing/In-progress
C-27	1,2,3	Wildland Fire	Pursue fuels reduction and create defensible space in the base area of Red Lodge Mountain	Rural Fire District; Fire Warden	>$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	1 year	Continuing/In-progress PDM application pending to reduce fuels and create defensible space around RLM.
C-28	1,2,3	Wildland Fire	Conduct home ignition hazard assessments in WUI areas	Rural Fire District	<$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress Home ignition hazard assessments in need of revision
C-29*	1,2	Wildland Fire	Develop GIS layer of water sources available for fire fighting	Fire Warden	<$10,000	Staff Time/Dept Budget	High	1 year	Continuing/In-progress Most dry hydrants currently mapped
C-30*	1,2	Wildland Fire	Determine locations for additional water supplies and pursue funding to develop	Rural Fire District; Fire Warden	<$10,000	Staff Time/Dept Budget	Low	1 year	Continuing

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
			new water sources available for fire protection						
C-31	1,2	Wildland Fire	Assess best method to address non-functioning or poorly maintained dry hydrants in subdivisions	County; Fire Warden	<$10,000	Staff Time/Dept Budget	Low	2 years	Continuing
C-32	1,2,3	Wildland Fire	Identify subdivisions with constructed assets at risk and no physical access. Meet with property owners or subdivision associations to pursue remedies. (e.g. Bridges at Western Ranch Estates, WRE II and Shane Ridge Rd.)	Rural Fire District; Fire Warden	<$10,000	Staff Time/Dept Budget	Medium	1 year	Continuing Collaborate with subdivision HOAs
C-33	1,2	Wildland Fire	Create fire district or fire service area for southeast Carbon County where no fire protection area exists	Fire Warden; County	<$10,000	Staff Time/Dept Budget	Medium	2 years	Continuing/In-progress Public meeting held to discuss potential for fire district / service area
C-34	3	All	Work with the Carbon County News to feature a first responder volunteer each month	Fire Warden	<$10,000	Staff Time/Dept Budget	Low	Ongoing	Continuing/In-progress Starting in Winter 2019. To include all first responders
C-35	3	Wildland Fire	Raise awareness of benefits of adopting WUI code	County; Rural Fire District; Fire Warden	<$10,000	Staff Time/Dept Budget	Low	1 year	New in 2019

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
C-36	1,2	Flood	Mitigate flooding along Two Mile Bridge and Rock Creek	County; Red Lodge	>$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	3-5 years	New in 2019/In-progress Flooding a common occurrence creating travel hazard; drainage features along road insufficient for volume of water; floodplain very wide at this location
C-37*	1,2	Flood, Earth Movement	Stabilize bank along Clear Creek Canal in vicinity of Highway 308	County DES	>$100,000	HMA Grants	Medium	3-5 years	New in 2019 Earth movement caused canal to flood in 2018
C-38	2	Dam Failure	Research need to enhance spillway plug at Cooney Dam	State Water Projects (Dam Owner), County DES, Other	>$100,000	HMA Grants/ Staff Time/Dept Budget	Low	2 years	New in 2019
C-39*	1,2	All	Implement/revise County codes and regulations to mitigate risk of all hazards	County	<$10,000	Staff Time/Dept Budget	Medium	1 year	New in 2019 No County building codes in place; subdivision regulations offer little mitigation guidelines
Town of Bearcreek Mitigation Actions									
BC-1	1,2	Flood	Investigate benefits of applying for a grant to develop detailed floodplain map	County Floodplain; Town; FEMA	$10,000-$100,000	FEMA	High	1 year	Continuing/In-progress More detailed maps underway as part of 2019 floodplain mapping project

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
BC-2	1,2	Wildland Fire	Pursue grant to replace water main from MM6 on State Highway 308 to intersection of First and Main streets and install fire hydrant at intersection	Town Public Works Director; County DES	>$100,000	HMA Grants/ Staff Time/Dept Budget	High	2 years	Continuing The closest hydrant to the west end of town is 1/2 Mi in the County and not designed for fire protection
BC-3	1,2	Drought, Wildland Fire	Pursue a grant to install a 6" main from 2nd Avenue South to 3rd Avenue South across creek for an alternative route from 5th St. as the existing line has been broken several times and goes under the creek and irrigation ditch	Town Public Works Director; County DES	>$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	5 years	New in 2019 The closest hydrant to the west end of town is 1/2 Mi in the County and not designed for fire protection
Town of Bridger Mitigation Actions									
BR-1	3	Winter Weather, Wildland Fire, Drought	Put a seasonal safety message on the water bills twice/year—suggestions to cover winter weather, drought and wildland fire.	Town of Bridger	<$10,000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress
BR-2	1,2	Flood	Mitigate flooding related to the Sand Creek Canal	Town of Bridger; County DES	$10,000 - $100,000	HMA Grants	Medium	3 years	New in 2019 -In-progress Advance Assistance grant application submitted by Town as part of HMGP 4405 to study the issue and determine appropriate mitigation alternatives

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
Town of Fromberg Mitigation Actions									
F-1	2	All	Obtain back-up power to operate water and wastewater facilities during power outages.	Town of Fromberg	$10,000-$100,000	HMA Grants	High	2 years	Continuing/In-progress New wastewater facility constructed in 2019.
F-2*	1,2	Wildland Fire	Evaluate fire hydrant coverage of town. Add/replace hydrants as indicated. (12)	Town of Fromberg	$10,000-$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	3-5 years	Continuing/In-progress 1 new, 2 replaced in 2015; 2 planned in 2016
F-3*	2	Other	Install additional waterline under RR tracks. (Damage to existing line would leave entire town without water.)	Town of Fromberg	>$100,000	HMA Grants	Low	2 years	Continuing
F-4	2	Flood	Stabilize bank of Clark's Fork River between Lovers Lane and E River Rd to protect private and public property (i.e., Town wells)	Town of Fromberg; County DES	>$100,000	HMA Grants	High	3-5 years	New in 2019 Private property at immediate risk
F-5	2	Other	Install security fencing around storage tank and municipal wells	Town of Fromberg	$10,000-$100,000	Homeland Security Grants	Medium	3-5 years	New in 2019
Town of Joliet Mitigation Actions									

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
J-1	2	Flood	Relocate water pressure tank to the other side of creek	Town of Joliet; County DES	>$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	1 year	Continuing/In-progress This could also entail acquiring additional land for second tank at current location outside of the flood hazard area.
J-2	2	Flood	Protect Town's wastewater treatment facility from Rock Creek channel migration	Town of Joliet; County DES; FEMA	>$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	3 years	Continuing/In-progress County and Town applying for PDM grant to address channel migration towards Town's wastewater treatment system
J-3	2	Flood	Enhance abutments at bridge along Joliet-Fromberg road to prevent additional erosion from Rock Creek	Town of Joliet; MTDES; FEMA	$10,000-$100,000	HMA Grants/ Staff Time/Dept Budget	Medium	2 years	Continuing/In-progress County to fix bridge abatement in 2020
J-4	2	All	Purchase mobile generator	County DES; Town of Joliet	$10,000-$100,000	Federal Grant Funding	Medium	1 year	New in 2019 /In-progress Town applied to SHSG program in 2017 for fixed backup generator but was unsuccessful
J-5	2	Other	Install security fencing around municipal water supply/tanks	Town of Joliet; County DES	$10,000-$100,000	Federal Grant Funding	Medium	2 years	New in 2019 /In progress

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
City of Red Lodge Mitigation Actions									
RL-1*	1,2	Flood	Implement storm water drainage plan for city	City of Red Lodge	>$100,000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress Preliminary engineering for plan in place; Drainage upgrades underway
RL-2	1,2	Summer Storm	Remove hazard trees and branches in city parks	City of Red Lodge	$10,000-$100,000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress Hazard tree limb removal done in Finn and Rotary parks in 2012
RL-3	1,2,3	Dam Failure	Review contents of EAP for failure of Glacier Lake Dam with DES every other year.	City of Red Lodge; LEPC; County DES	<$10,000	Staff Time/Dept Budget	Medium	Ongoing	Continuing/In-progress EAP last updated by DNRC in January 2019; not reviewed jointly by City and County
RL-4	1	Wildland Fire	Develop procedures for evacuation of town from a wildland fire	City of Red Lodge	<$10,000	Staff Time/Dept Budget	Low	1 year	Continuing/In-progress Evacuation procedures enhanced with ArcGIS Online Dashboard, Survey 123 and mobile tablets
RL-5	2	Flood	Monitor Rock Creek channel migration and assess impact to City of Red Lodge wastewater treatment facility	City of Red Lodge; County DES; FEMA	$10,000-$100,000	Staff Time/Dept Budget	Low	Ongoing	New in 2019/In-progress Drone footage captured during spring 2019 flooding

ID	Related Goal(s)	Hazard(s) Mitigated	Description/Background/ Benefits	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status/Implementation Notes
RL-6	2	Flood	Acquire Eagle's Nest Hotel and reclaim land in floodplain	City of Red Lodge; County Floodplain; FEMA	>$100,000	HMA Grants/ Staff Time/Dept Budget	Low	3-5 years	New in 2019
Stakeholder Mitigation Actions									
S-1	2	Drought, Wildland Fire	Increase monitoring of drought, invasive species and disease on the Custer Gallatin National Forest	USFS; BLM	$10,000-$100,000	Staff Time/Dept Budget	Medium	Ongoing	New in 2019/In progress
S-2	1	Wildland Fire	Remove hazardous fuels near Sage Creek in Pryor Mountains	USFS	$10,000-$100,000	Staff Time/Dept Budget	Low	2 years	New in 2019
S-3	1	Wildland Fire	Pursue forest-wide ecotonal categorical exclusion (CATX) to facilitate vegetation management to achieve desired conditions	USFS	<$10,000	Staff Time/Dept Budget	Medium	Ongoing	New in 2019/In progress

*Mitigates impacts to future development

Chapter 5. Plan Monitoring, Maintenance, Revision, and Coordination

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 10 of the 10-step planning process. This chapter provides an overview of the overall strategy for plan implementation and maintenance, and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

Implementation

DMA Requirement §201.6(c)(4)(ii):
[The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

Once adopted, the plan faces the truest test of its worth: implementation. While this plan contains many worthwhile actions, the participating jurisdictions will need to decide which action(s) to undertake first. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost actions most easily demonstrate progress toward successful plan implementation.

Implementation will be accomplished by adhering to the schedules identified for each mitigation action in Table 4-3 in Chapter 4 Mitigation Strategy, and through pervasive efforts to network and highlight the multi-objective, win-win benefits of each project to the Carbon County community and its stakeholders. These efforts include the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community. Accomplishing the projects will be dependent on funding, staff, and technical resources from a variety of sources including the county, towns, city, state and federal government, not-for-profits, and the business community.

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. Implementation will be accomplished by adhering to the schedules identified for each action and through constant, pervasive, and energetic efforts to network and highlight the multi-objective, win-win benefits to each program and the Carbon County community and its stakeholders. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities.

Projects will be accomplished as resources, either at the local, state or federal levels, become available. Those projects with a higher priority ranking would be considered first. In selecting projects to compete for funding whether it is existing internal funding or funding from state and federal sources, emphasis should be placed on the relative benefits compared to the cost of the project. The cost of the project should be considered and weighed against the dollar value or other measure of assets protected or potential reduction of damages. A basic cost benefit and/or value analyses should be completed during the planning of the project.

Implementation of the plan will be the responsibility of the LEPC and the Carbon County Disaster and Emergency Services Coordinator acting on the behalf of the county. Plan implementation also depends on the willingness of other public entities, private business (such as the electric companies), and not-for-profit organizations such as the American Red Cross to participate in specific mitigation actions and projects.

Simultaneously to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements, should grants be pursued. When funding becomes available, the participating jurisdiction's will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, special district budgeted funds, state and federal earmarked funds, and other grant programs, including those that can serve or support multi-objective applications.

The municipalities and county understand that while completion of the plan will make them eligible to compete for additional funds, it is in the best interests of the local jurisdictions and residents to proceed with those projects that can be done within existing resources while exploring avenues to obtain assistance for those projects beyond local capabilities.

Role of the Hazard Mitigation Planning Committee in Implementation and Maintenance

The Carbon County Commissioners in cooperation with the mayors of Bearcreek, Bridger, Fromberg, Joliet, and Red Lodge are responsible for ensuring that the Hazard Mitigation Plan is kept current. With adoption of the plan, the Commissioners designate the Carbon County Disaster and Emergency Services Coordinator--with the assistance of the Local Emergency Planning Committee (LEPC)-- as the lead in accomplishing the on-going responsibility.

The participating jurisdictions, led by the Carbon County Emergency Services Coordinator, agree to:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Maintain a monitoring of multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Report on plan progress and recommended changes to the Carbon Board of County Commissioners, Town Council, and other partners; and
- Inform and solicit input from the public.

Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the County and jurisdictional websites and in the local newspaper.

Plan Maintenance, Monitoring and Evaluation

DMA Requirement §201.6(c)(4)(i):
[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

There are two types of plan monitoring and evaluation; effectiveness and implementation. Effectiveness monitoring looks at whether the plan has addressed needed items. Implementation monitoring looks at

whether projects in the plan are being undertaken and completed. The Carbon County Disaster and Emergency Services Coordinator with the help of the LEPC will ask the following questions to evaluate the effectiveness and implementation of the plan.

- Have any potential hazards developed that were not addressed in the plan?
- Have any natural disasters occurred that were not addressed in the plan?
- Has any unanticipated development occurred that is vulnerable to hazards?
- Are there any additional mitigation ideas that need to be incorporated?
- Have projects been initiated and/or completed?
- What are the barriers to completing projects identified in the plan?
- What other planning process can cross reference or incorporate aspects of the HMP?

Schedule for Review and Updates

Annually the LEPC will meet to ask and answer the questions listed above an LEPC meeting in the winter, prior to flood and wildfire season. The discussion will be documented so that when the plan is revised, the findings of the monitoring can be incorporated into the revision. The Carbon County Disaster and Emergency Services Coordinator will convene the LEPC for this purpose. This process has proven to be effective during the prior 5-year implementation period.

In addition to the annual review, any of the following three situations could trigger a review and update of the plan.

- Occurrence of a major natural disaster in or near the county,
- Passage of five years, or
- Change in state or federal regulations which must be complied with.

This plan will be updated, approved, and adopted within a five-year cycle as per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000. Efforts to begin the update should begin no later than June 2023. The County will monitor planning grant opportunities from the Montana Disaster and Emergency Services (MTDES) and FEMA for funds to assist with the update. This may include submitting a planning grant application to MTDES. This grant should be submitted in 2022, as there is typically a three-year performance period to expend the funds, and there is no guarantee that the grant will be awarded when initially submitted. This allows time to resubmit the grant in subsequent years, if needed. Updates to this plan will follow the most current FEMA and MTDES planning guidance. The next plan update should be completed and reapproved by MTDES and FEMA Region VIII by January 2024. The HMPC members and those entities identified in Appendix A, will be reconvened for this process by Carbon County Disaster and Emergency Services.

The Carbon County Disaster and Emergency Services Coordinator will publish a legal ad in the Carbon County News notifying the public that an update is being initiated and providing information on how and where to get information on the project and how to provide input. The coordinator will then convene the LEPC and with their assistance and/or the assistance of the Montana DES or a contractor as determined necessary, carry out the following tasks:

1) Review the Hazard Mitigation Plan Review Crosswalk form completed by Montana Disaster and Emergency Services (DES) and FEMA during their most recent review of the plan.

2) Examine and revise the risk assessment and development trends data as needed to ensure it is current.
3) Update the mitigation strategies to incorporate completion of actions and add any needed strategies or projects.
4) Identify problems that may be hindering or affecting implementation of the plan, and recommend actions for resolving those problems.
5) Recommend any necessary revisions to the hazard mitigation plan.
6) Comply with all applicable regulations and statutes.

Three months prior to the five-year anniversary date, a final draft of the revised plan will be submitted to the Montana DES. An annual review will be conducted by the Carbon County DES Coordinator for the purpose of summarizing the status and effectiveness of the plan mitigation goals or strategies.

Maintenance Evaluation Process

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Such changes in vulnerability may include:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or
- Increased vulnerability as a result of new development (and/or annexation).

The HMPC will use the following process to evaluate progress, note changes in vulnerability, and consider changes in priorities as a result of plan implementation:

- A representative from the responsible entity identified in each mitigation measure will be responsible for tracking and reporting to the LEPC/HMPC when project status changes. The representative will provide input on whether the project as implemented meets the defined goals objectives and is likely to be successful in reducing vulnerabilities. The County DES Coordinator has established a database of mitigation actions that can be used to track action status moving forward, potentially using GIS to track project implementation countywide.
- If the project does not meet identified goals and objectives, the LEPC/HMPC will select alternative projects for implementation.
- New projects identified will require an individual assigned to be responsible for defining the project scope, implementing the project, monitoring success of the project.
- Projects that were not ranked high priority but were identified as potential mitigation strategies will be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation.
- Changes will be made to the plan to accommodate for projects that have failed or are not considered feasible after a review for their consistency with established criteria, the time frame, priorities, and/or funding resources.

Updates to this plan will:

- Consider changes in vulnerability due to project implementation,
- Document success stories where mitigation efforts have proven effective,

- Document areas where mitigation actions were not effective,
- Document any new hazards that may arise or were previously overlooked,
- Document hazard events and impacts that occurred within the five-year period,
- Incorporate new data or studies on hazards and risks,
- Incorporate new capabilities or changes in capabilities,
- Document continued public involvement
- Document changes to the planning process, which may include new or additional stakeholder involvement
- Incorporate growth and development-related changes to building inventories,
- Incorporate new project recommendations or changes in project prioritization,
- Include a public involvement process to receive public comment on the updated plan prior to submitting the updated plan to MTDES/FEMA, and
- Include re-adoption by all participating entities following MTDES/FEMA approval.

Incorporation into Existing Planning Mechanisms

Another important implementation mechanism that is highly effective and low-cost is incorporation of the hazard mitigation plan recommendations and their underlying principles into other jurisdictional plans and mechanisms. Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. As stated previously in this chapter, implementation through existing plans and/or programs is recommended where possible. Since the 2013 version of this plan the Community Wildfire Protection Plan has been integrated with the HMP. During the 2019-2020 planning process the CWPP element of the plan was not updated but was carried forward as an appendix (Appendix D). This will allow for future updates to the Appendix to occur independently from the HMP, since the CWPP does not have the same requirements for a five-year update. Having the two plans within one document reinforces and recognizes the commonality and synergy of these two planning processes.

As of 2019, the Hazard Mitigation Plan has not yet been incorporated by reference in other planning mechanisms by any of the towns or City. Future incorporation opportunities that exist will be implemented where feasible through the following process: During the annual review meeting noted previously in this section the Carbon County DES Coordinator will ask the LEPC members to note other planning processes that can cross reference or incorporate aspects of the HMP. Opportunities could include:

- Capital Improvement Plan development or updates for each jurisdiction
- Stormwater master plans
- Drought and water resource management plans

Another specific process is through the implementation of mitigation action C-13 "Prepare a strategic plan for the LEPC" which can reference the HMP as the source for hazardous materials vulnerability details.

Opportunity for Continued Public Involvement

To ensure the public will have the opportunity to remain involved in the implementation and annual updates of the plan, the following will take place.

1) The Carbon County DES Coordinator will provide an annual summary presentation/report to the six governing bodies on what has been accomplished during the previous year and to receive guidance from the elected officials for the coming year.
2) Each year following the winter LEPC meeting called for the purpose of reviewing the status of the plan, the county will provide information to the Carbon County News to notify the public of the accomplishments of the previous year and allow comment for any revisions.

APPENDIX A: HMPC MEMBERS

APPENDIX B: PLANNING PROCESS DOCUMENTATION

APPENDIX C: LOCAL PLAN ADOPTIONS

APPENDIX D: CARBON COUNTY CWPP