



CITY AND COUNTY OF BROOMFIELD

2022 Hazard Mitigation Plan

Office of Emergency Management

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1 Introduction

1.1 Executive Summary

Hazard mitigation is the use of long- and short-term strategies to reduce or alleviate loss of life, injuries, and property damage that can result from a disaster. Studies have found that hazard mitigation is extremely cost-effective, with every dollar spent on mitigation saving an average of \$6 in avoided future losses.

This Plan will serve as a blueprint for coordinating and implementing hazard mitigation policies, programs, and projects in the City and County of Broomfield. It provides a list of mitigation goals and related actions to assist the County in reducing risk and preventing loss from future hazard events. The impacts of hazards can often be lessened, or even avoided, if appropriate actions are taken before events occur. By reducing exposure to known hazard risks, the County will save lives and property and minimize the social, economic, and environmental disruptions that commonly follow hazard events.

This Plan was also developed to maintain the County’s eligibility for federal mitigation funds, 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 Building Resilient Infrastructure and Communities (BRIC) grant program. FEMA requires that hazard mitigation plans be updated every five years for the jurisdiction to be eligible for federal mitigation assistance.

The 2022 Broomfield Hazard Mitigation Plan (HMP) is the latest update in a series of mitigation plans Broomfield has participated in going back to 2005. All sections of the 2016 Broomfield Hazard Mitigation Plan were reviewed and updated to address natural hazards for the purpose of saving lives and reducing losses from future disasters or hazard events.

Chapter 1 Introduction contains this Executive Summary, and outlines the background, purpose, and scope of the Plan.

Chapter 2 Planning Process describes the process followed to update the Plan. A broad range of public and private stakeholders, including agencies, local businesses, nonprofits, and other interested parties, were invited to participate. Public input was sought throughout the planning process including online surveys and public review of the draft plan.

Chapter 3 Community Profile describes the planning area, consisting of the City and County of Broomfield, with updated information on demographics, social vulnerability, and changes in development. It includes an assessment of programs and policies currently in place to reduce hazard impacts or that could be used to implement hazard mitigation activities and identifies opportunities to enhance those capabilities.

Chapter 4 Hazard Identification and Risk Assessment identifies the natural and technological hazards of greatest concern to Broomfield and describes the risk from those hazards. The information gathered through the risk assessment helps to prioritize and focus efforts on those hazards of greatest concern and those assets or areas facing the greatest risk(s). The best available information on the impacts of changing weather conditions were taken into account for each hazard. The hazards profiled in this 2022 Plan update and their assessed significance are shown in the following table in order of overall significance.

Table 1-1 Hazards Analysis Summary

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Cyber Attack	Significant	Occasional	Critical	High
Drought	Extensive	Likely	Moderate	High
Extreme Temperatures	Extensive	Likely	Moderate	High



Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Active Threat	Limited	Occasional	Critical	Medium
Aircraft Accident	Significant	Occasional	Moderate	Medium
Critical Infrastructure Outage	Significant	Occasional	Critical	Medium
Dam Inundation	Limited	Unlikely	Critical	Medium
Expansive Soils	Extensive	Likely	Moderate	Medium
Flood	Limited	Occasional	Moderate	Medium
Hail	Extensive	Likely	Critical	Medium
Hazardous Materials Incident	Significant	Likely	Negligible	Medium
Public Health Hazard	Extensive	Likely	Critical	Medium
Severe Wind	Extensive	Highly Likely	Moderate	Medium
Winter Storm	Extensive	Highly Likely	Moderate	Medium
Fire (Structural & Wildland)	Significant	Likely	Moderate	Medium
Earthquake	Extensive	Unlikely	Critical	Low
Land Subsidence	Limited	Occasional	Negligible	Low
Lightning	Extensive	Likely	Negligible	Low
Tornado	Limited	Occasional	Moderate	Low

Chapter 5 Mitigation Strategy describes the actions Broomfield will take to reduce vulnerability to the hazards identified in Chapter 4. It presents the goals and objectives of the mitigation program and details a broad range of targeted mitigation actions to reduce losses from hazard events.

Chapter 6 Plan Implementation and Maintenance details how the Plan will be implemented, monitored, evaluated, and updated as well as how the mitigation program will be integrated into other planning mechanisms.

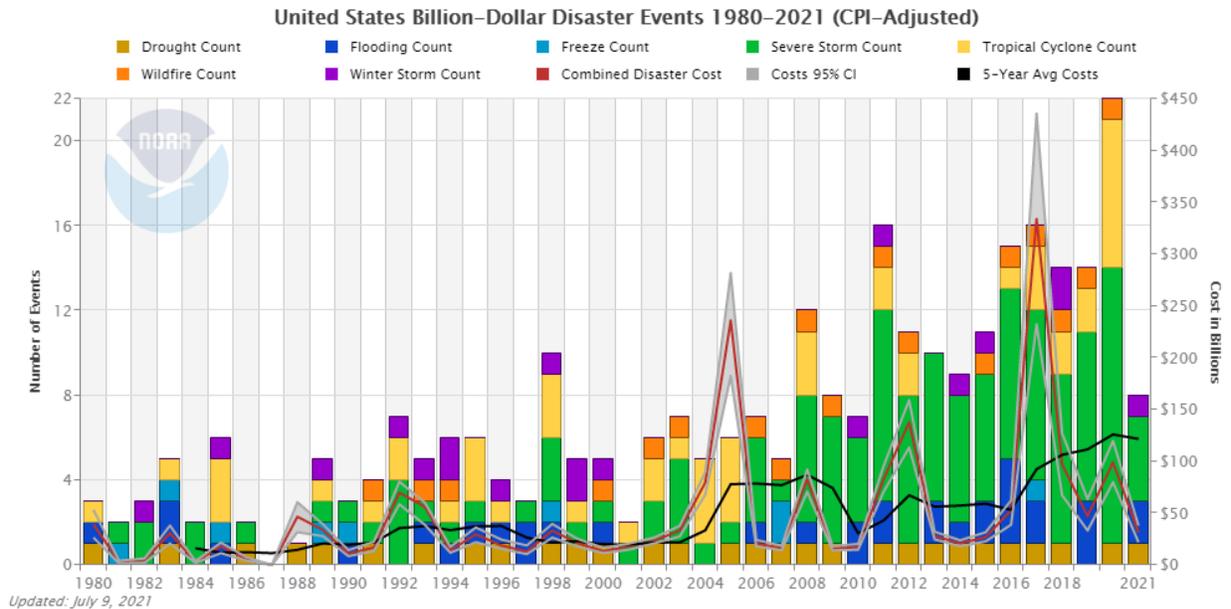
It is important that local decision makers stay involved in mitigation planning to provide new ideas and insight for future updates to the Broomfield HMP. As a long-term goal, the HMP and the mitigation strategies identified within should be fully integrated into daily decisions and routines of County government. This will continue to require dedication and hard work, and to this end, this Plan update continues efforts to further strengthen the City and County of Broomfield’s resiliency.

1.2 Background

While some communities are less hazard-prone than others, there are no hazard-free communities, and all communities face some degree of risk from natural and human-caused disasters. Each year in the United States, disasters take the lives of hundreds of people and injure thousands more. In 2020, the FEMA declared over 300 disasters and emergencies due to natural hazards, including floods, wildfires, earthquakes, and a pandemic. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. Additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars, making the costs of disasters several times higher than calculated amounts. Disasters can also weaken local economies and dramatically reduce local tax bases. In 2020, there were 22 events that caused more than \$1 billion in disaster losses, breaking the previous record of 16 events in a single year. Figure 1-1

shows the number and type of natural disasters in the U.S. that have caused more than one billion dollars in damage since 1980, showing how the frequency and cost of major disasters have risen over the past several decades.

Figure 1-1 Billion-Dollar Disasters in the U.S., 1980–2021



Source: NOAA

The rising cost of natural disasters has sharpened interest in identifying effective ways to reduce vulnerability to hazards. Many disasters are predictable, and much of the damage caused by these events can be mitigated through the use of various zoning, construction, and permitting vehicles and other preventative actions. 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. 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 \$6 in avoided future losses in addition to saving lives and preventing injuries, as illustrated in Figure 1-2.

Figure 1-2 Financial Benefits of Hazard Mitigation

	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
National Institute of BUILDING SCIENCES™					
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost (\$ billion)	\$1/year	\$4/year	\$520	\$0.6	\$27
Benefit (\$ billion)	\$13/year	\$16/year	\$2200	\$2.5	\$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

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Source: National Institute of Building Sciences, Natural Hazard Mitigation Saves: 2019 Report

HMPs assist communities in reducing risk from hazards by identifying resources, information, and strategies for risk reduction. This plan documents the City and County of Broomfield’s hazard mitigation planning process, identifies relevant hazards and risks, and outlines the actions that will be taken to decrease vulnerability and increase resilience and sustainability.

This plan was prepared 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 finalized on October 31, 2007. These regulations established the requirements that local HMPs 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 City and County of Broomfield is subject to many kinds of hazards, access to these programs is vital.

This plan was originally prepared in 2005 and subsequently updated in 2010 as a regional, multijurisdictional plan by the Denver Regional Council of Governments (DRCOG). For the 2016 update, the City and County of Broomfield and other participating counties elected to develop independent county hazard mitigation plans to facilitate more detailed analysis than that in the regional plan. This is a comprehensive update to the 2016 Broomfield plan. 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 by protecting critical community facilities and minimizing overall community impacts and disruption.

1.3 Purpose and Scope

The purpose of this plan is to provide the City and County of Broomfield with a comprehensive hazard mitigation strategy for reducing long-term risks to people, property, and natural resources.

As described in Chapter 5, the goals of the 2022 HMP are:

- Reduce loss of life, property damages, and economic impacts caused by hazard events.
- Improve capabilities to reduce disaster losses.
- Increase public awareness and engagement of potential hazard impacts.

This HMP identifies resources, information, and strategies for reducing risk from technological and natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and the people of Broomfield. This plan will help guide and coordinate mitigation activities throughout the county.



All citizens and businesses of Broomfield are the ultimate beneficiaries of this HMP update. The plan reduces risk for those who live in, work in, and visit the county. It provides a viable planning framework for all foreseeable natural hazards that may impact Broomfield. Participation in development of the plan by key stakeholders in the County helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable throughout the County, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

The City and County of Broomfield remains dedicated to implementing the actions and strategies outlined in this updated Hazard Mitigation Plan. This Plan will be maintained regularly to address changes in hazards or vulnerabilities, track progress in implementation, and will be updated within the next five years.



2 Planning Process

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:

An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

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

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.

2.1 Background on Mitigation Planning in Broomfield

The City and County of Broomfield participated in previous regional HMPs as part of the DRCOG in 2005 and 2010. Starting in 2016, the County decided to develop an independent plan to focus specifically on the hazards that pose a risk to Broomfield. This process resulted in a completely new mitigation plan that focused on the risks and potential mitigation measures that are most relevant to the citizens of Broomfield. The plan underwent a comprehensive update in 2021-2022 to comply with the five-year update cycle required by the Disaster Mitigation Act (DMA) 2000.

This updated HMP complies with FEMA guidance for Local Hazard Mitigation Plans. The update followed the requirements in the DMA of 2000 and FEMA's 2013 Local Hazard Mitigation Planning Handbook.

2.1.1 What's New in the 2022 Plan

This HMP update involved a comprehensive review and update of each section of the 2016 Plan and includes an assessment of the progress in evaluating, monitoring, and implementing the mitigation strategy outlined in the previous plan. The planning process provided an opportunity to add new hazards, review priorities related to hazard significance and mitigation actions, and revisions were made where applicable to the plan. Information and data still valid from the 2016 Plan were carried forward as applicable into this HMP update.

2.1.2 2016 Plan Section Review and Analysis

During the 2021-2022 update process, the Hazard Mitigation Planning Committee (HMPC) updated and expanded each section of the previously approved plan to include new information and improve the organization and formatting of the plan's contents. The HMPC analyzed each section using FEMA's local plan update guidance to ensure that the plan met the latest requirements. Upon review the HMPC 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 4 was substantially revised to incorporate recent events and reflect recent development trends with an updated Geographic Information Systems (GIS)-based risk assessment. Information within has been updated throughout the plan where appropriate. The mitigation strategy in Chapter 5 has been updated to reflect current priorities and mitigation actions moving forward from the 2016 Plan.

2.2 2022 Planning Process

The 2022 update of this plan was guided by a HMPC composed of members of the Broomfield Local Emergency Planning Committee (LEPC). The planning team represented a wide variety of technical expertise and community interests, including public safety, public works, community development, emergency management, public health, floodplain management, and utilities services.

The project was managed by Broomfield Emergency Management and funded entirely with local funds. A contractor, Wood Environment and Infrastructure Solutions, Inc. (Wood), was brought in to facilitate the plan update, including:



- facilitating research and document preparation
- establishing and supporting a management organization for completing plan updates
- identifying data requirements and conducting the research and documentation necessary to integrate the most current data into plan revisions
- developing and facilitating the public input process
- producing the draft and final plan documents and
- ensuring acceptance of the final plan by FEMA Region VIII.

Updates to this plan were based on research from a wide variety of sources, historical perspectives, and future projections of vulnerability and resource capacity. Throughout the process, stakeholders and the general public were provided with opportunities to participate in the development of goals and the identification of mitigation opportunities at the community level.

Updates to this plan were completed using the most current state and federal guidance, including FEMA’s Local Mitigation Planning Handbook (March 2013), to ensure that the plan met federal requirements. The 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 FMA programs. Thus, the modified 10-step process used for this plan meets the funding eligibility requirements of the HMGP, the BRIC grant, the High Hazard Potential Dams (HHPD) grant, and the FMA grant, as well as the CRS 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 Processes Used 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)



2.2.1 Phase 1: Organize Resources

Step 1: Get Organized

This section describes the planning process used during the 2022 update. The HMPC was coordinated by the Broomfield Emergency Manager Broomfield LEPC, a standing multi-hazard committee composed of government officials, fire district representatives, industry representatives, local schools, operators of critical facilities, and the general public. City and County of Broomfield departments that participated in the planning effort included the City and County Manager’s Office, Public Works, Community Development, Information Technology, and Public Health and Human Services. An email invitation was sent with a request to participate as a member of the HMPC and to attend a kickoff meeting. Broomfield staff provided expertise in the areas of planning, engineering, building code administration, housing, GIS, capital improvements, infrastructure, and public health. Other local, state, federal, and private stakeholders invited to participate in the HMPC are discussed under planning step 3.

A full list of HMPC representatives and participating stakeholders can be found in Appendix B.

Planning Team Responsibilities

In conformance with the DMA planning regulations and guidance, members of the HMPC participated in the planning effort in the following ways:

- attending and participating in Planning Team meetings
- providing available data
- evaluating and rating area risks and hazards
- identifying goals and objectives for the mitigation strategy
- reviewing and providing comments on the plan drafts
- assisting in the implementation of the public input process
- identifying specific projects to be eligible for funding, and
- assisting with the formal adoption of the plan by the governing board.

During the plan update process, the HMPC communicated via a combination of virtual meetings, phone calls, and email correspondence. Three planning meetings with the HMPC were held during the plan’s development between April 2021 and August 2021. The first two meetings were held virtually due to the global COVID-19 pandemic that required social distancing; the final meeting was held in person. The meeting schedule and topics are listed in Table 2-2 below. Agendas, attendance rosters, and meeting summaries for each of the meetings are included in Appendix C.

Table 2-2 Planning Meetings and Topics

HMPC Meeting	Meeting Topic	Meeting Date
1	Kickoff Meeting	April 26, 2021
2	Risk Assessment Summary/Goals Development	July 8, 2021
3	Mitigation Strategy Update	August 9, 2021

HMPC Meeting #1 - Kickoff Meeting

During the virtual kickoff meeting on April 26, 2021, Wood presented information on the scope and purpose of the plan update, participation requirements of HMPC, and the proposed project work plan and schedule. Twenty participants attended the kickoff meeting. Plans for public involvement (Step 2) and coordination with other agencies and departments (Step 3) were discussed. Wood also introduced the hazard identification requirements and data. The HMPC discussed past events and impacts and future probability for each of the hazards required by FEMA for consideration in a local hazard mitigation plan. Each jurisdiction provided updates through a data collection workbook created by Wood and mitigation action trackers or provided information directly to Wood for incorporation into the plan update.



HMPC Meeting #2 - Risk Assessment Update

On July 8, 2021, the HMPC convened virtually to review and discuss the results of the risk and vulnerability assessment update. Sixteen members of the HMPC and stakeholders were present for the discussion. Wood updated the committee on progress so far and went over the public survey responses. Wood then presented preliminary risk assessment results for natural and human-caused hazards. The group went through each hazard together and discussed the results as well as shared any local insight to inform the hazard identification and risk assessment (HIRA) update. At the end of the meeting, Wood reviewed the mitigation goals and objectives as well as the mitigation actions from the 2016 Plan and asked the committee to begin thinking of new actions for this plan update. Refer to the meeting summary in Appendix C for notes related to each hazard discussed and results from the post meeting survey.

HMPC Meeting #3 - Mitigation Strategy

The HMPC convened in person on August 9, 2021, with 13 people participating to discuss updating the mitigation action plan from 2016 and finalize the goals and objectives for this planning process. The group reviewed the public survey hazard ratings and noted the differences between the HMPC's ratings and the public's perception of risks to the various hazards. The group brainstormed mitigation action ideas using a worksheet provided by Wood (refer to Appendices C and E) and discussed prioritization. The meeting ended with a review of the next steps and planning process schedule. Wood provided the HMPC with a link to an online form to submit new mitigation actions.

Step 2: Involve the Public

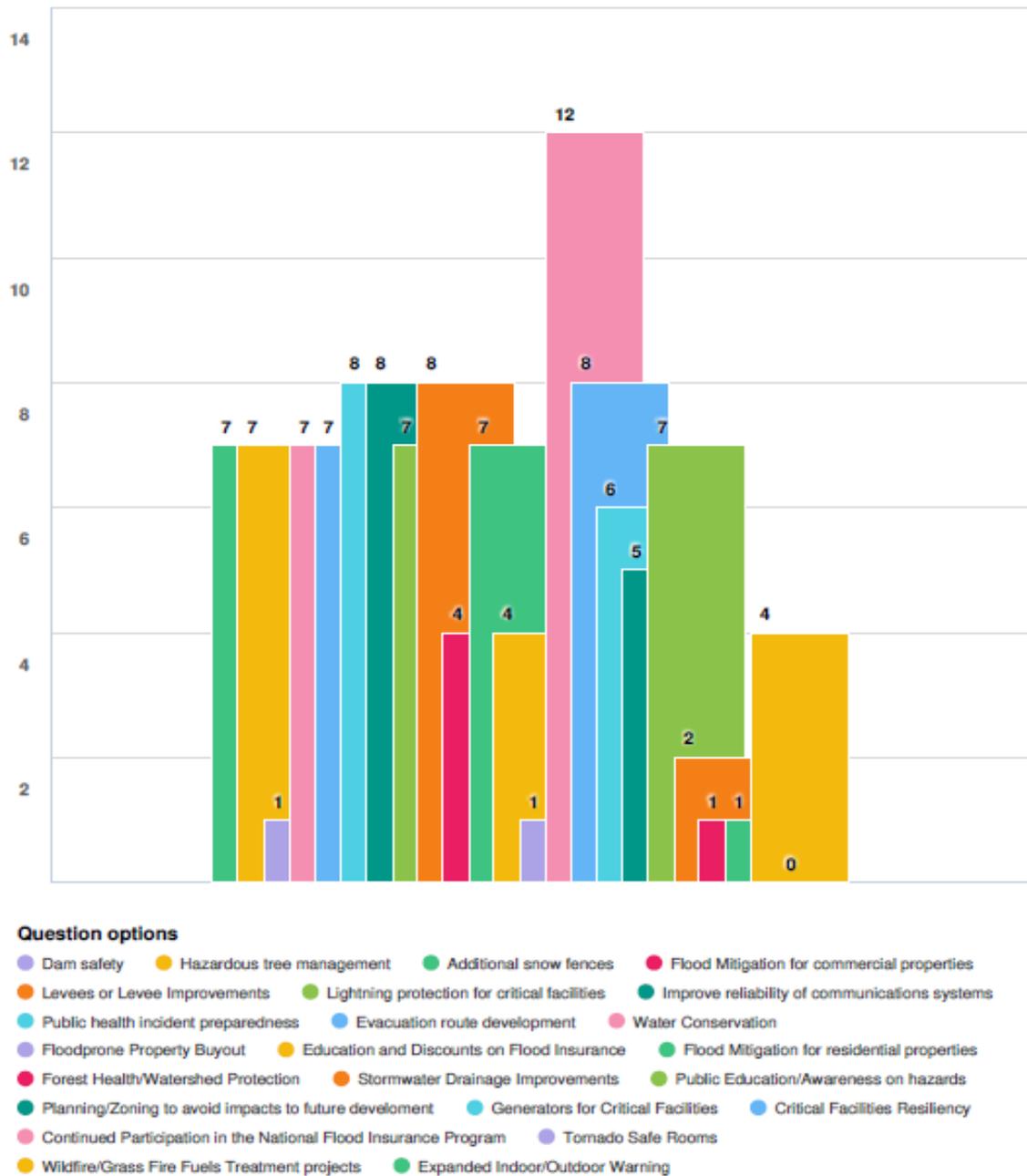
At the kickoff meeting, the HMPC discussed options for soliciting public input on the mitigation plan and developed an outreach strategy by consensus. The fact that the process was conducted during the COVID-19 pandemic, with attendant restrictions on public gatherings, made it difficult to use many traditional outreach methods such as in-person public gatherings or discussion at other forums. The HMPC adapted by leveraging social media and other online messaging. The County developed and advertised a public survey through their public outreach platform, Broomfield Voice, and the County's social media platforms. An announcement of the plan update process is shown in Figure 2-1.

Figure 2-1 City and County of Broomfield HMP Update Public Outreach Homepage



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 15 individuals. Responses reflect the public perception that the most significant hazards to be Cyber Attack, followed by Public Health Hazard, Drought, Critical Infrastructure Outages, and Extreme Temperatures. Figure 2-2 below displays the results from Question 5, which asked respondents to consider potential mitigation actions and to indicate which types of actions should have the highest priority in the updated Mitigation Strategy. The top answers were water conservation, planning/zoning to avoid impacts to future development, generators for critical facilities, stormwater drainage improvements, and evacuation route development. These results were considered during the planning process and in the development of new mitigation actions.

Figure 2-2 City and County of Broomfield Public Survey Results, Question 5



Complete results of the public survey are provided in Appendix D.

The public was also given an opportunity to review and comment on the draft plan in April 2022. The County made copies of the plan available through Broomfield Voice, along with a public comment form. The plan was advertised through Broomfield Voice as well as the County’s Facebook and Twitter accounts. The public was given a four-week period to review and provide comments. In total 20 individuals submitted comments, which are included in Appendix D. The Planning Team reviewed the comments and made a number of clarifying edits to the plan, as well as adding an additional mitigation action (#19) to address concerns raised in public comments.

Record of public advertisements, public input, and sign-in sheets can be found in Appendix C.



Planning Step 3: Coordinate with Other Departments and Agencies

There are numerous organizations whose goals and interests interface with hazard mitigation in the City and County of Broomfield. Coordination with these organizations and other community planning efforts is vital to the success of this plan update. The Broomfield Office of Emergency Management invited other local, state, and federal agencies to the kickoff meeting to learn about and participate in the hazard mitigation planning initiative. Many of the agencies participated throughout the planning process in meetings described in Step 1: Organize the Planning Effort. In addition, the HMPC developed a list of neighboring communities and local and regional agencies involved in hazard mitigation activities, as well as other interested parties to keep informed on the plan update process.

Stakeholders included local and regional agencies involved in hazard mitigation activities or those beyond the County and local government that have the authority to regulate development. Stakeholders could participate in various ways, either by contributing input at HMPC meetings, being aware of planning activities through an email group, providing information to support the effort, or reviewing and commenting on the draft plan. Representatives from the following agencies and organizations were invited to participate as stakeholders in the process. Agencies marked with an asterisk attended planning meetings or provided comments on the draft plan.

Federal, State, and Regional Agencies

- Colorado Division of Fire Prevention & Control
- Colorado Division of Homeland Security and Emergency Management*
- Colorado Department of Local Affairs
- Colorado Department of Transportation
- Colorado Division of Water Resources
- Colorado Parks and Wildlife
- Colorado State Patrol
- Colorado State Forest Service
- Colorado State University Extension Office
- National Weather Service
- Denver Water*

Neighboring Jurisdictions

- Adams County
- Boulder County
- Jefferson County
- Weld County
- City and County of Denver

Integration with Other Community Planning Efforts and Hazard 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. The City and County of Broomfield 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.



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

Plan, Study, Report Name	How Plan, Study or Report Informed the HMPC
2016 Broomfield Comprehensive Plan	Informed the Community Profile and capability assessments.
Broomfield Comprehensive Emergency Management Plan (CEMP), Including Emergency Operation Plan (EOP) & Disaster Recovery Plan	Provided information on disaster response and recovery procedures and how mitigation is integrated.
City and County of Broomfield Citywide Coordination Plan, COVID Risk Assessment and Mid-Action Review (2021)	Provided information on capabilities, particularly related to public health hazards.
Comprehensive Emergency Management Program Recommendations (2021)	Informed Capability assessment and opportunities for enhancement.
Colorado State Hazard Mitigation Plan (2018 Update)	Reviewed information on past hazard events and hazard risk information to inform the risk assessment. Reviewed State goals and objectives.
Colorado Drought Mitigation and Response Plan (2018 Update)	Reviewed information on past droughts and their impacts on the planning area. Incorporated information into the risk assessment.
Colorado Flood Mitigation Plan (2018 Update)	Reviewed information on past flood events and risk analysis for the planning area to inform the risk assessment.
Colorado State Demographer Community Demographic Profiles (ACS 5-Year Estimates 2015-2019)	Provide demographic data and trends for the City and County of Broomfield.
FEMA Flood Insurance Study for the City and County of Broomfield. (2019)	Provided flood risk data for specific hazard areas located within the County.
City and County of Broomfield Drought Response Plan (2012)	Provided context to the Drought profile.
Extraction Oil & Gas, Inc. Risk Management Plan (2022) and Tactical Response Plan (2021)	Provided information on oil & gas assets, protective measures, and existing capabilities

2.2.2 Phase 2: Assess Risk

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

Chapter 4, 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. Where data permitted, 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 4. The capability assessment is included in Chapter 3 Community Profile.

In addition to input from the Planning Team, the primary references, resources and information sources that were used to develop an updated, comprehensive hazard assessment for the 2022 update included the following:

- Colorado Department of Natural Resources



- Colorado Geological Survey
- Colorado Water Conservation Board (CWCB)
- State Engineer’s Office
 - Colorado Department of Public Health and Environment (CDPHE)
 - Colorado Department of Public Safety
- Division of Homeland Security and Emergency Management
- - Colorado Natural Hazards Mitigation Plan (2018)
 - Colorado State Forest Service
 - FEMA
 - FEMA Flood Insurance Study for the City and County of Broomfield (August 15, 2019)
 - Flood Hazard Mitigation Plan for Colorado (2018)
 - Hazus (FEMA)
 - National Centers for Environmental Information (formerly the National Climatic Data Center)
 - Extraction Oil & Gas, Inc.

2.2.3 Phase 3: Develop the Mitigation Plan

Planning Step 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 2016 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 2016 Plan. Several new mitigation actions resulted from this process that were added to the plan in 2021-2022. The HMPC employed the STAPLEE methodology endorsed by FEMA to evaluate and prioritize each proposed action. This process and its results are described in greater detail in Chapter 5.

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 Colorado Division of Homeland Security and Emergency Management (DHSEM) and FEMA Region VIII to review and approve, contingent upon final adoption by the governing boards of each participating jurisdiction.

2.2.4 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 board of the City and County of Broomfield on December 13th, 2022. The adoption resolution is included in Appendix A.



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 5. Each recommended action includes key descriptors, such as a lead agency and possible funding sources, to help initiate implementation. An overall implementation strategy is described in Chapter 6.

Finally, there are numerous organizations within the Broomfield 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 the City and County of Broomfield and is addressed further in Chapter 6. Updated strategies for overall implementation and continued public involvement are also included in Chapter 6.



3 Community Profile

Broomfield is located along the Front Range foothills on the eastern slope of the Rocky Mountains, approximately 13 miles northwest of Denver. Originally incorporated as a statutory city in 1961, following passage of a ballot issue in 1998 the City became the consolidated City and County of Broomfield on November 15, 2001, the State’s 64th and newest county (Sections 10, 11, 12 and 13 of Article XX of the Constitution of the State of Colorado).

The County, part of the Denver-Aurora-Lakewood Metropolitan Statistical Area, is a Home Rule municipality. It operates under a council/manager form of government, where the City Manager acts as the chief administrative officer with guidance from the City Council. The Broomfield City Council, which also serves as the Broomfield Board of County Commissioners, is made up of a Mayor and Mayor-Pro Tem and ten council members, two from each of the five wards.

Land use within the City and County of Broomfield is a mixture of residential, commercial, and light industry, with multiple parks, cultural facilities, and open space areas. Broomfield’s proximity to the high country makes it a “gateway” for mountain recreational activities. Table 3-1 provides additional facts and data about Broomfield.

Table 3-1 Broomfield Facts and Figures

City and County of Broomfield	
Latitude	39° 55' 13" N
Longitude	105° 05' 11" W
Land Area (Square Miles)	33.6
Elevation (George De Ciero City & County Bldg.)	5,344 feet
Elevation - High Point (CO 128/Indiana St)	5,856 feet
Elevation - Low Point (Weld CR 6/Weld CR 11)	5,096 feet
2010 Population	55,889
2019 Population (Estimated)	67,886

Source: U.S. Census Bureau; Broomfield Web Page, www.broomfield.org

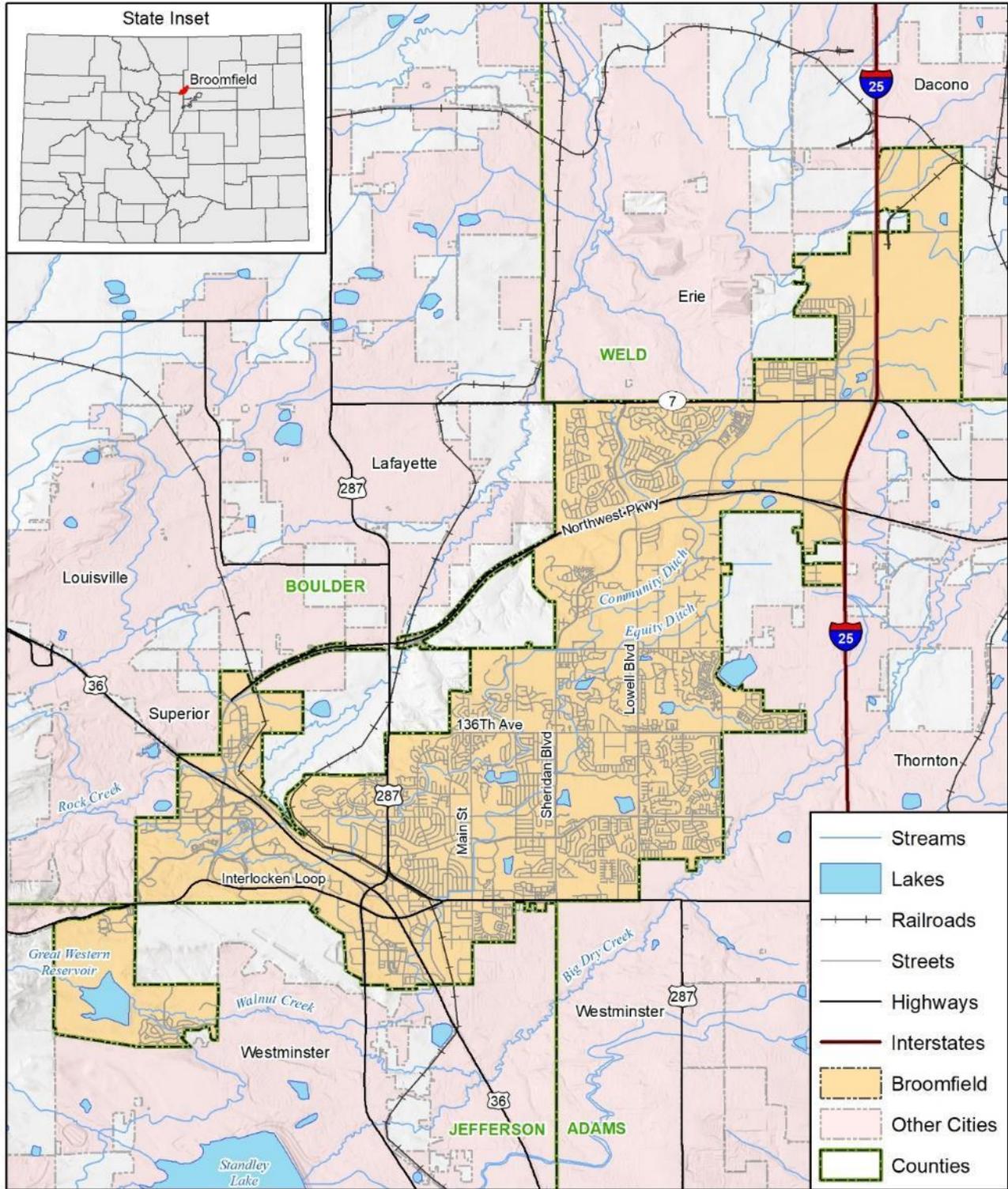
3.1 History

In the late 19th century, present-day Broomfield was a small farming community known as Zang’s Spur, named for A. J. Zang, founder of the Zang Brewing Company. Zang’s Spur was centered at what is now the intersection of 120th Avenue and Wadsworth Boulevard. The first railroad arrived in 1873 followed by a more direct line in 1886. “As the 20th century began, the town’s name was changed to Broomfield to reflect the fields of ‘broom corn’ grown in the area. In the 1950s, Broomfield developed as a ‘bedroom’ community for those employed in nearby Denver.” Construction of the Boulder Turnpike was underway at the same time, one of the first paved roads in the area. The Boulder Turnpike was originally a toll road, with a toll booth in Broomfield. In 1955, Turnpike Land Co. purchased land in the area, and plans for its growth and development were considered. Today’s Broomfield was conceived as a master planned community and marketed as a model city.

At the time of its incorporation in 1961, the population of Broomfield was approximately 6,000. A series of annexations between 1961 and 1990 expanded the County’s borders into surrounding Adams, Jefferson, and Weld Counties from its original location in southeastern Boulder County. In the 1980s and 1990s, Broomfield’s economic growth continued with the attraction of several large high-tech corporations (e.g., Sun Microsystems and Level 3 Communications), the development of Interlocken as an employment center, and the development of the upscale shopping mall Flatiron Crossing.

In 1998, in an effort to consolidate and streamline government services, Broomfield voters approved a measure that added an amendment to the state constitution creating the new City and County of Broomfield, effective November 15, 2001.

Figure 3-1 City and County of Broomfield



wood. Map compiled 5/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT

0 2.5 5 Miles



The organizational chart for the City and County of Broomfield government is shown in Figure 3-2.

Figure 3-2 City and County of Broomfield Government Organizational Chart



revised Jan. 19, 2022



3.2 Geography and Climate

Broomfield is located on the western edge of the Great Plains, nestled in the foothills of the Rocky Mountains, which provide a measure of protection against many of the prevailing storms. Most of Broomfield is residential in nature. Natural grasses are the dominant vegetation in undeveloped areas. Broomfield is primarily a “headwaters” county, meaning streams originate within the borders and flow out of the county, generally in a southeasterly direction before emptying into Big Dry Creek. There are two exceptions - Rock Creek and Walnut Creek each originate up-gradient of Broomfield and flow through the county. The creeks are generally shallow, with no distinct channels. The geology of Broomfield is consistent with the surrounding plains of Colorado. According to the CGS, the plains are characterized predominantly by sedimentary rocks.

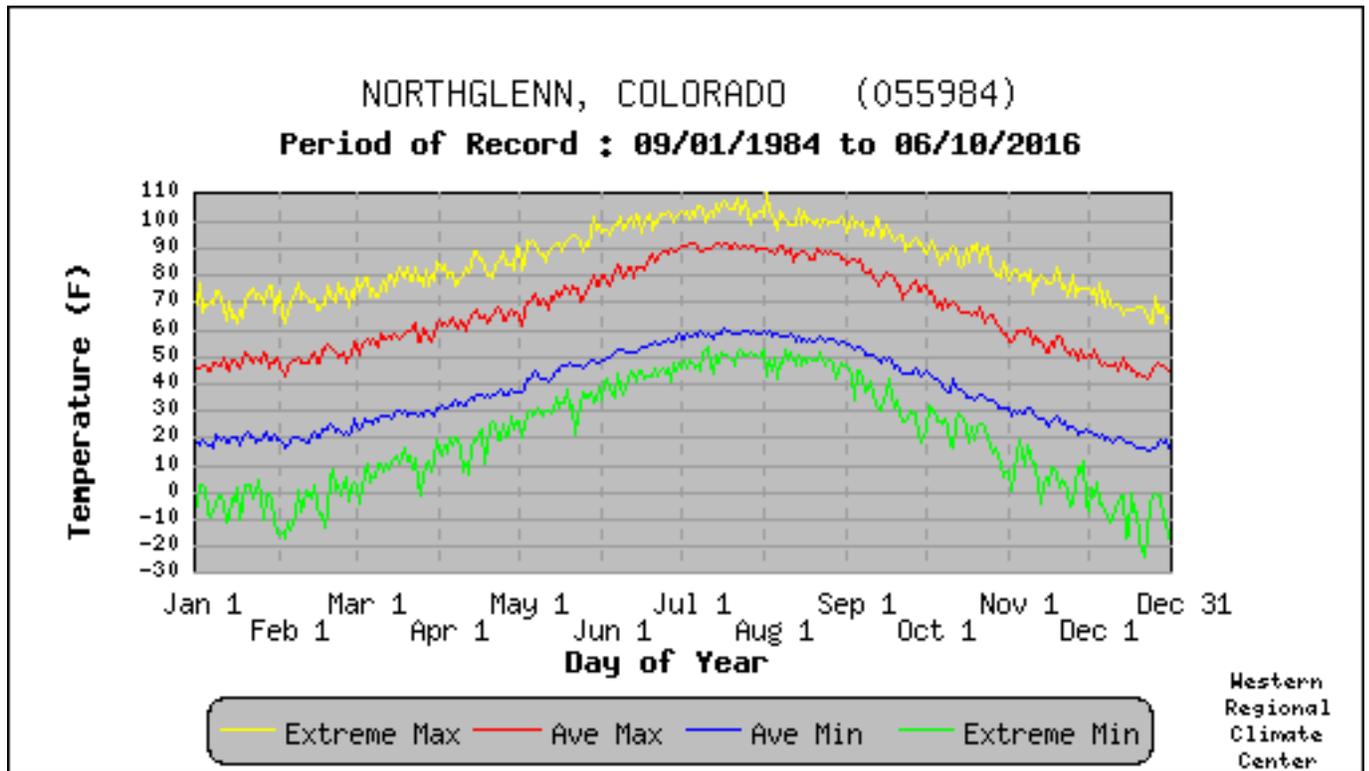
There are seven major highways within Broomfield’s borders: Interstate 25, U.S. 36, U.S. 287, Northwest Parkway, SH 7, SH 121, and SH 128. Freight rail lines parallel U.S. 36 (Boulder- Denver Turnpike).

Broomfield’s semi-arid climate is characterized by low relative humidity, low rainfall, moderate to high winds, moderate temperatures, and abundant sunshine. Summer temperatures have reached as high as 110 degrees Fahrenheit (°F) (recorded in August) and temperatures during winter have registered as low as -30°F (in February) in Broomfield. Average annual rainfall in the area is approximately 14 inches, 71% of which occurs between April and September due to thunderstorm activity and monsoon moisture. The Western Regional Climate Center reports data from the Northglenn Weather Station. Table 3-2 contains temperature summaries for the station. Figure 3-3 graphs the daily temperature averages and extremes.

Table 3-2 City of Broomfield Weather and Climate Summaries

Period of Record	1984 - 2022
Winter Average Minimum Temperature	19.3
Winter Average Maximum Temperature	47.2
Summer Average Minimum Temperature	55.9
Summer Average Maximum Temperature	87.5
Average Annual Minimum Temperature	36.9
Average Annual Maximum Temperature	66.5
Annual Total Precipitation (in.)	14.6
Annual Total Snowfall (in)	45.8
Note - Winter: December, January, February; Summer: June, July, August; Approximated from Northglenn Weather Station Source: Western Regional Climate Center, www.wrcc.dri.edu/	

Figure 3-3 Temperature Patterns for the Broomfield Area (1984-2016)



3.3 Demographics

According to the U.S. Census Bureau, the 2020 population of Broomfield is at 69,444. This represents a 14.41% increase since 2015. The following tables break down key demographic, economic, and social characteristics based on data from the U.S. Census Bureau. Table 3-3 through Table 3-6, as well as Figure 3-4, summarize various demographic and social characteristics of the City and County of Broomfield over time with data from the U.S. Census Bureau American Community Survey. As shown in Table 3-4, there are some categories in which Broomfield differs significantly from the rest of Colorado and the Nation. Broomfield’s median household income is notably higher than that of the State and the country at 34.5% and 55.7% higher, respectively. The County has lower rates of unemployment, poverty, those who speak English less than “very well,” those without health insurance, and homes without vehicles available than both the State and the Country.

Table 3-3 City and County of Broomfield Demographic and Social Characteristics, 2015-2020

City and County of Broomfield	2015	2020	% Change
Population	60,699	69,444	14.41%
Median Age	37.5	38.4	2.40%
Total Housing Units	24,710	28,037	13.46%
Housing Occupancy Rate	95.2%	97.0%	1.89%
% of Housing Units with no Vehicles Available	3.5%	3.3%	-5.71%
Median Home Value	\$295,500	\$450,600	52.49%
Unemployment Rate	5.5%	3.6%	-34.55%
Mean Travel Time to Work (Minutes)	28.3	26.8	-5.30%
Median Household Income	\$81,898	\$101,206	23.58%
Per Capita Income	\$40,135	\$51,461	28.22%



City and County of Broomfield	2015	2020	% Change
% of Individuals Below Poverty Level	6.5%	5.0%	-23.08%
% Without Health Insurance	6.8%	6.0%	-11.76%
# of Households	23,531	27,199	15.59%
Average Household Size	2.57	2.54	-1.17%
% of Population Over 25 with High School Diploma or Higher	95.70%	96.80%	1.15%
% Of Population Over 25 With Bachelor's Degree or Higher	51.90%	56.10%	8.09%
% with Disability	8.20%	7.80%	-4.88%
% Speak English less than "Very Well"	4.30%	3.10%	-27.91%

Source: U.S. Census Bureau, American Community Survey

Table 3-4 Demographic and Social Characteristics Compared to the State and the Nation

Demographic & Social Characteristics (as of 2020)	City	Colorado	U.S.
Median Age	38.4	36.9	38.2
Housing Occupancy Rate	97.0%	90.5%	88.4%
% of Housing Units with no Vehicles Available	3.30%	5.0%	8.5%
Median Home Value	\$450,600	\$369,900	\$229,800
Unemployment	3.6%	4.6%	5.4%
Mean Travel Time to Work (minutes)	26.8	25.8	26.9
Median Household Income	\$101,206	\$75,231	\$64,994
Per Capita Income	\$51,461	\$39,545	\$35,384
% of Individuals Below Poverty Level	5.0%	9.8%	12.8%
% Without Health Insurance	6.0%	7.8%	8.7%
Average Household Size	2.54	2.6	2.6
% of Population Over 25 with High School Diploma or Higher	96.80%	92.1%	88.5%
% Of Population Over 25 With Bachelor's Degree or Higher	56.10%	41.6%	32.9%
% with Disability	7.80%	10.8%	12.7%
% Speak English less than "Very Well"	3.10%	5.6%	8.2%

Source: U.S. Census Bureau, American Community Survey

Table 3-5 Demographics by Race and Sex

City and County of Broomfield	Population	%
Total Population	69,444	
Male	34,704	50.0%
Female	34,740	50.0%
White, not Hispanic	53,076	76.4%
Hispanic or Latino	8,751	12.6%
Black	866	1.2%
Asian	4,556	6.6%



City and County of Broomfield	Population	%
American Indian and Alaska Native	251	0.4%
Native Hawaiian and Other Pacific Islander	0	0.0%
Other Race not listed	51	0.1%
Two Or More Races	1,893	2.70%

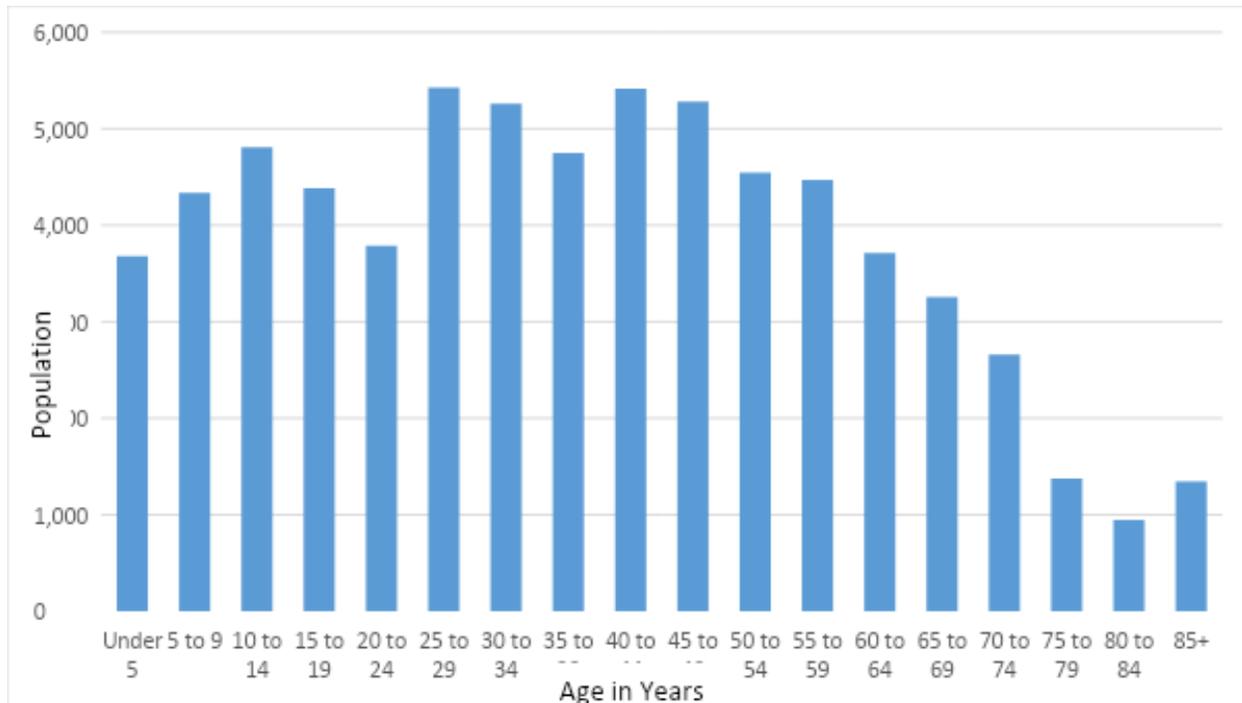
Source: U.S. Census Bureau, American Community Survey

Table 3-6 Types and Total Amounts of Housing Units in the City and County of Broomfield

Type of Housing Units	Total	%
Total housing units	28,037	---
1-unit detached	17,193	61.3%
1-unit attached	1,606	5.7%
2 units	70	0.2%
3 or 4 units	563	2.0%
5 to 9 units	1,230	4.4%
10 to 19 units	1,646	5.9%
20 or more units	5,033	18.0%
Mobile home	696	2.5%
Boat, RV, van, etc.	0	0.0%

Source: U.S. Census Bureau, American Community Survey

Figure 3-4 City and County of Broomfield Demographic Breakdown by Age



Source: U.S. Census Bureau, 2020 American Community Survey

3.4 Social Vulnerability

Local vulnerability to disasters depends on more than the relationship between a place and its exposure to hazards. Social vulnerability to disasters refers to the characteristics and situation of a person or group that influence their capacity to anticipate, cope with, resist, or recover from the impact of a hazard. It is determined by a number of pre-existing social and economic characteristics. Very often, the impacts of hazards fall disproportionately on the most underserved or marginalized people in a community - people with low income, children, people who are aging, people with disabilities, and minorities. During emergencies, for example, self-evacuation can be nearly impossible for individuals who are disabled or institutionalized. Additionally, the willingness of an individual/family to invest in residential mitigation actions is often limited if their home is a rental and they are averse to investing money in long-term mitigation activity. Not only do conditions like this limit the ability of some communities to get out of harm's way, but they also decrease the ability of communities to recover from and thrive in the aftermath of a disaster event.

The term social vulnerability describes communities that are more vulnerable to a risk or hazard, such as high vulnerability due to wildfires or floods based upon geography, topography, hydrology, or weather. Referencing people themselves directly with the term vulnerability causes individual community members to be seen with a deficit lens, leaving the impression that the vulnerability is a result of the lack of responsibility and/or adequate planning of the individual. Instead, vulnerability only occurs when the system that the individual is part of fails to provide equitable accessibility to resources or services, known as access and functional needs, for the individual to survive, respond to, and recover from an event. Barriers that may be exacerbated by certain social and economic factors - including race, age, income, renter status, or institutionalized living - directly affect a community's ability to prepare for, respond to, and recover from hazards and disasters. The concept of social vulnerability helps explain why communities often experience a hazard event differently, even when they experience the same amounts of physical impacts or property loss.

The 2016 Plan discussed disabled populations and racial/ethnic differences that can increase the vulnerabilities of some groups. The 2022 Plan takes a broader look at social vulnerability, including lessons learned from the ongoing COVID-19 pandemic. The social vulnerability assessment is designed to improve local decision making, hazard prioritization, and emergency management activities. By incorporating social vulnerability into the risk assessments of individual hazards, local communities are able to identify more vulnerable areas and tailor their mitigation actions to accommodate all members of their community, including the most sensitive groups.

The Centers for Disease Control and Prevention (CDC) has developed a social vulnerability index (SVI) as a way to measure the resilience of communities when confronted by external stresses such as natural or human-caused disasters or disease outbreaks. The SVI is broken down to the census tract level and provides insight into particularly vulnerable populations to assist emergency planners and public health officials identify communities more likely to require additional support before, during, and after a hazardous event. The SVI index combines four main themes of vulnerability, which are in turn broken down into subcategories for a total of 15 vulnerability factors. The data shows that Broomfield's overall social vulnerability is Low compared to both the State and the Nation. However, the County ranks high or above average in the following areas:

- Percentage of multi-unit housing (defined as more than ten units per structure), which are more difficult to evacuate during emergencies.
- Percentage of racial minorities, who historically are hardest hit by disasters.
- Percentage of people who speak English "less than well," complicating disaster communications.
- Percentage of population aged 17 or younger, who generally have fewer resources to respond to disasters or may need more assistance.

Table 3-7 displays those 15 factors and shows how the City and County of Broomfield compares to the rest of the Nation. The rankings show the percentage of counties nationally that Broomfield is more vulnerable than, i.e. high numbers reflect greater vulnerability.



The data shows that Broomfield’s overall social vulnerability is Low compared to both the State and the Nation. However, the County ranks high or above average in the following areas:

- Percentage of multi-unit housing (defined as more than ten units per structure), which are more difficult to evacuate during emergencies.
- Percentage of racial minorities, who historically are hardest hit by disasters.
- Percentage of people who speak English “less than well,” complicating disaster communications.
- Percentage of population aged 17 or younger, who generally have fewer resources to respond to disasters or may need more assistance.

Table 3-7 City and County of Broomfield Social Vulnerability

Theme	Variable	Ranking Compared to Colorado Counties	Ranking Compared to U.S. Counties	Vulnerability
Socioeconomic status		6%	1%	Low
	Below poverty	6%	1%	Low
	Unemployment	30%	19%	Low
	Income	5%	1%	Low
	No high school diploma	10%	1%	Low
Household composition & disability		24%	3%	Low
	Age 65 or older	22%	10%	Low
	Age 17 or younger	75%	68%	Above Average
	Disability	16%	2%	Low
	Single-parent households	25%	9%	Low
Minority status and language		52%	70%	Above Average
	Minority	56%	60%	Above Average
	Speaking English less than well	46%	71%	Above Average
Housing and transportation		22%	15%	Low
	Multi-unit structures	92%	99%	High
	Mobile homes	11%	10%	Low
	Crowding	32%	45%	Below Average
	No vehicle	35%	10%	Low
	Group quarters	17%	3%	Low
Overall Social Vulnerability		13%	5%	Low

Source: U.S. Centers for Disease Control and Prevention, <https://svi.cdc.gov>

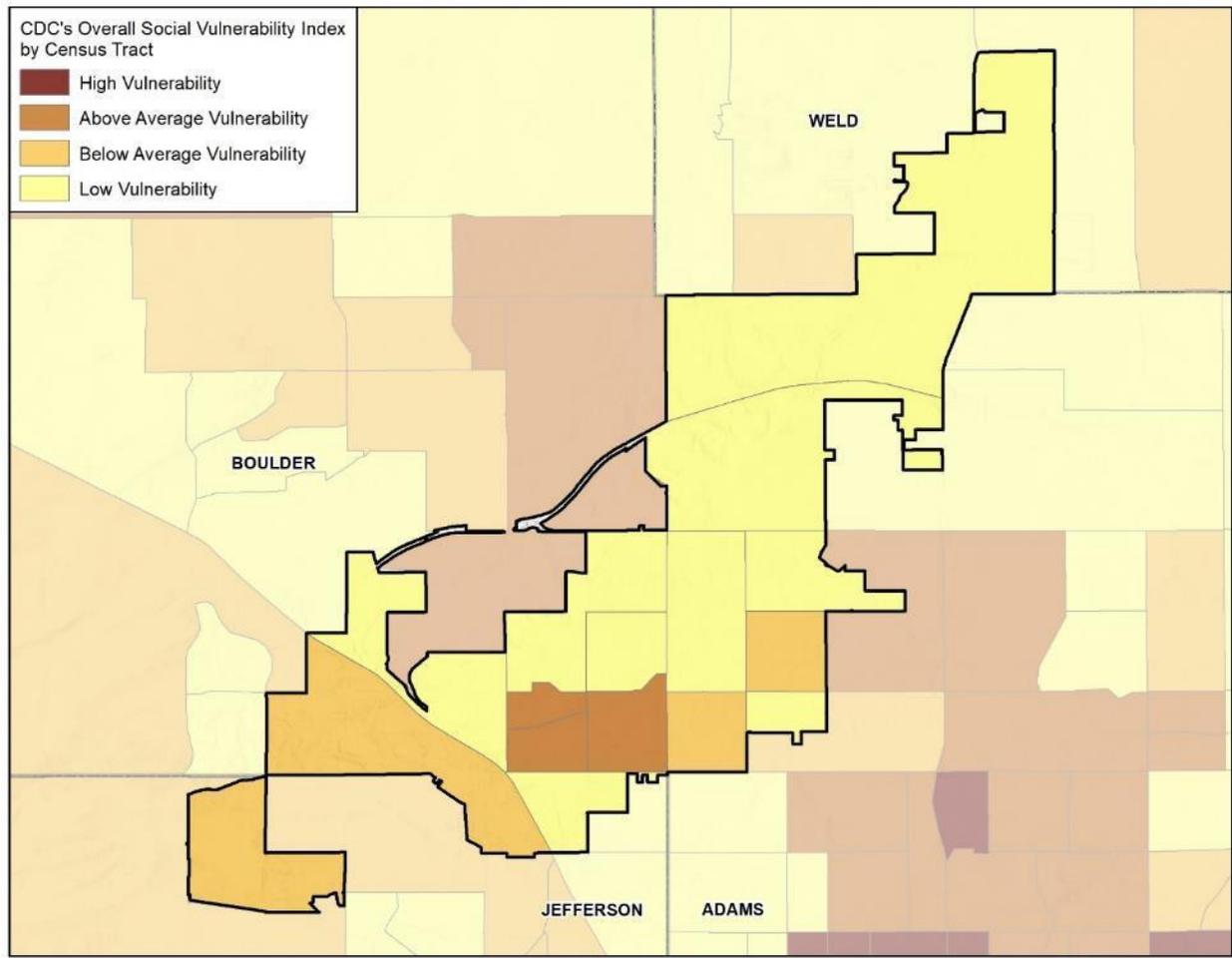
It should be noted that even though the County may have relatively fewer people in a SVI category compared to other counties, there are still people in that category who may be disproportionately impacted by disasters. For example, the County scores relatively low in residents with disabilities, but those residents in the County with disabilities are still highly vulnerable to many hazards.

Figure 3-5 through Figure 3-9 display the SVI data for the City and County of Broomfield broken down by census tract. Based on this data, the areas with the highest level of social vulnerability are primarily located in the southern part of the County. The maps also show above average vulnerability in similar portions of the County.

During the risk assessment and mitigation strategy development phases of the 2021 planning process, the HMPC reviewed the results of the social vulnerability analysis in conjunction with the multi-hazard risk assessment results. The social vulnerability information helped staff uncover unseen risks and better prioritize mitigation actions.

Additional information on the CDC’s SVI can be found at <https://svi.cdc.gov>.

Figure 3-5 Broomfield Overall Social Vulnerability



wood. Map compiled 9/2021; intended for planning purposes only. Data Source: Broomfield City/County, CDC SVI 2018

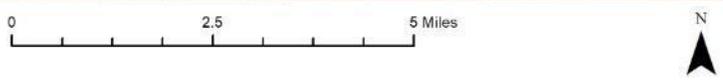


Figure 3-6 Broomfield Socioeconomic Status Vulnerability

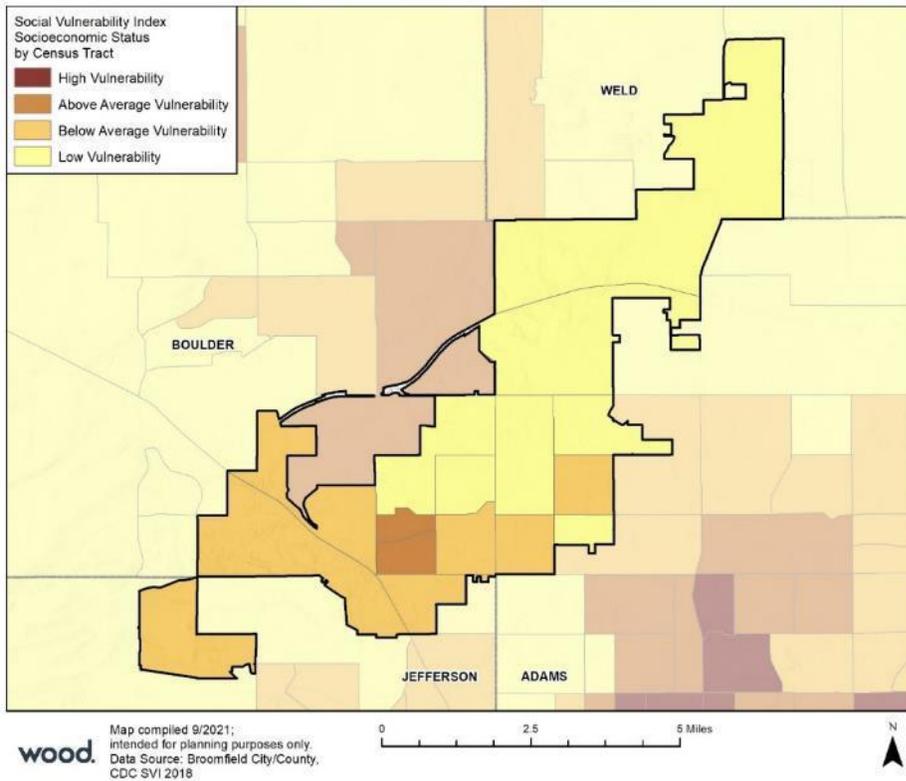


Figure 3-7 Broomfield Minority and Language Status Vulnerability

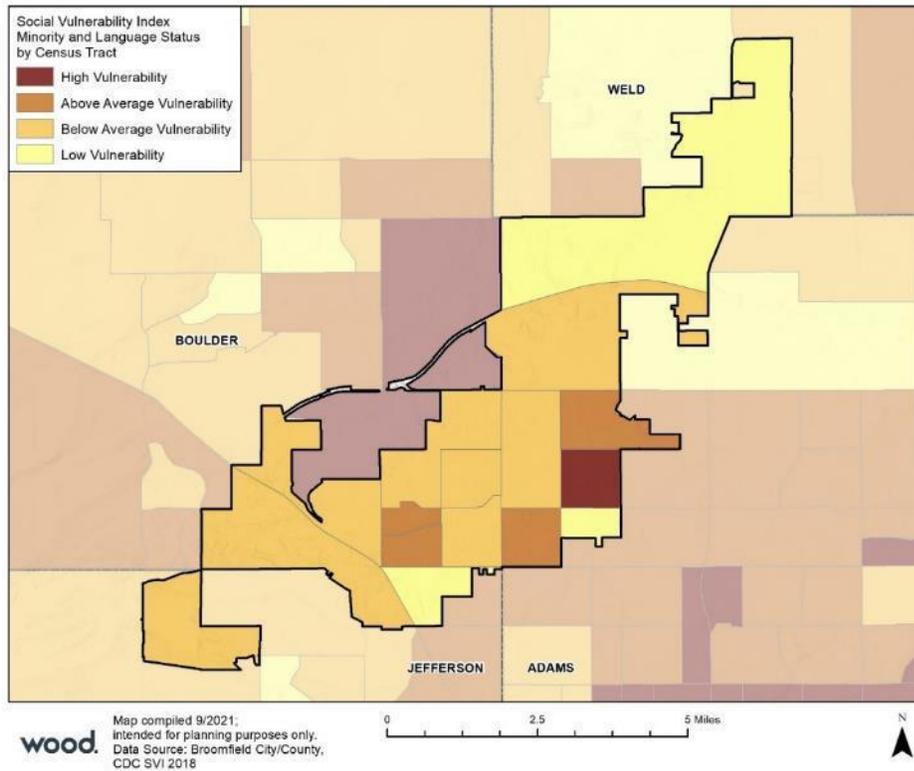


Figure 3-8 Broomfield Household Composition and Disability Status Vulnerability

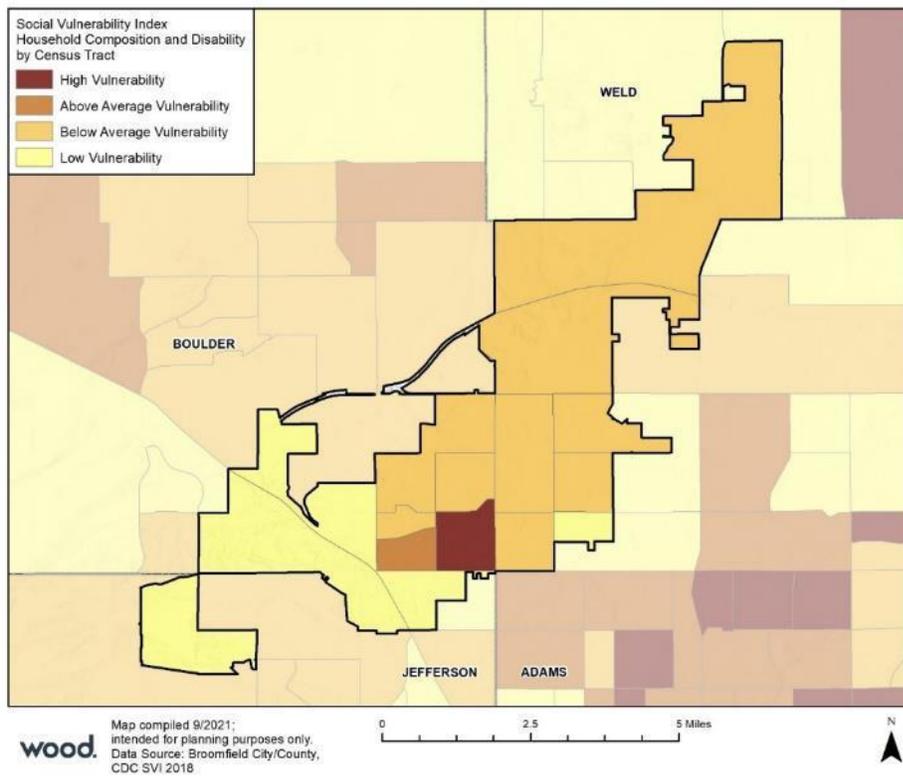
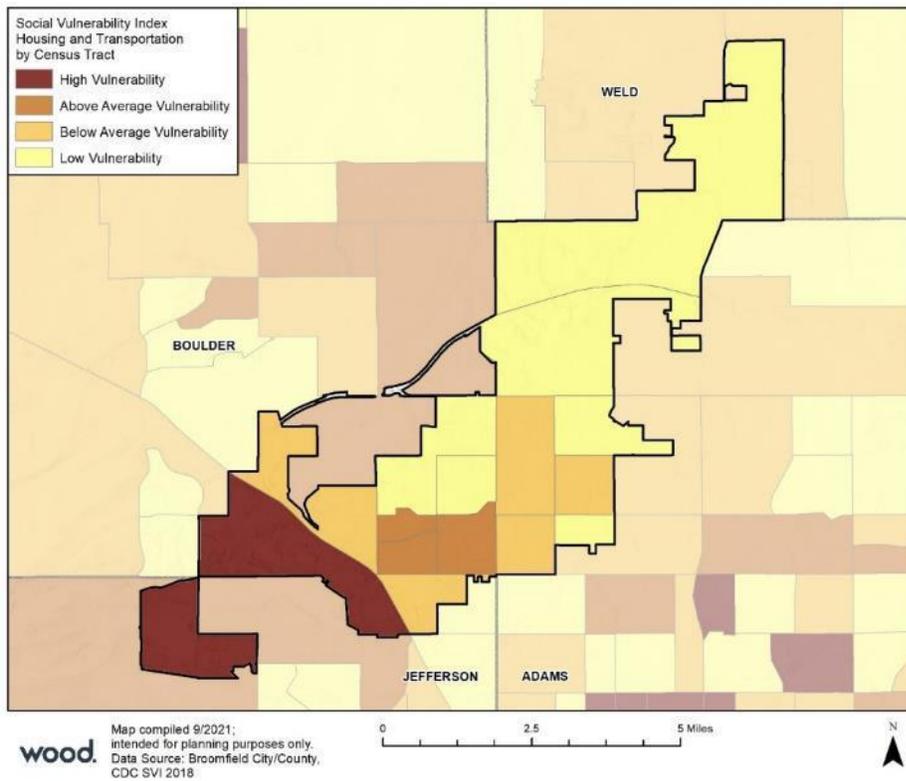


Figure 3-9 Broomfield Housing and Transportation Status Vulnerability



3.5 Economy

Select 2020 economic characteristics estimated for the City and County of Broomfield by the American Community Survey are shown in Table 3-8.

Table 3-8 City and County of Broomfield Economic Characteristics

Economic Characteristics	Value
% of Families below poverty level	2.6%
% of Individuals below poverty level	5.0%
Median Home Value	\$450,600
Median household income	\$101,206
Per Capita Income	\$51,461
% of Population >16 in Labor Force	72.9%

Source: U.S. Census Bureau, American Community Survey

3.5.1 Income

Individual households are expected to use private resources to prepare for, respond to, and recover from disasters to some extent. This makes income a significant factor in the resilience of people, families, and communities. The breakdown of income in Broomfield is shown in Figure 3-10

Figure 3-10 City and County of Broomfield Household Income



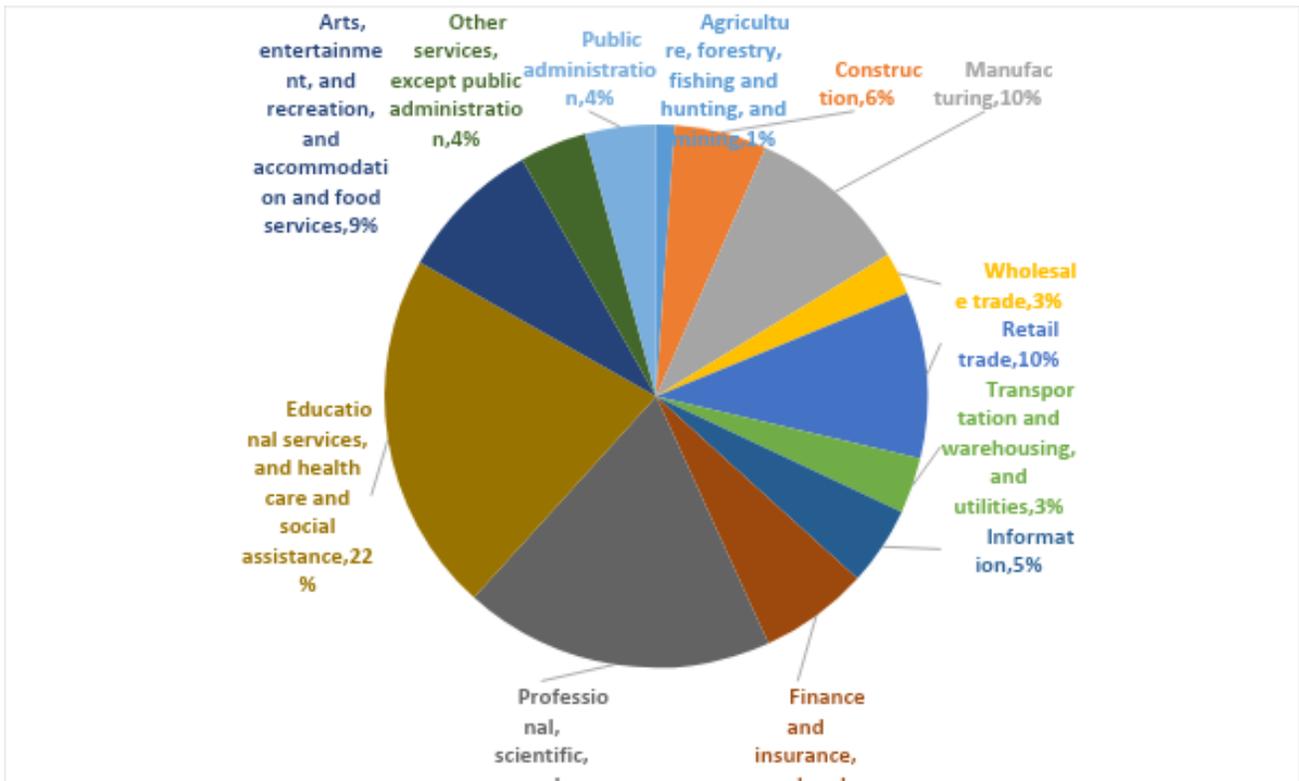
Source: U.S. Census Bureau, 2020 American Community Survey

Figure 3-10 shows the distribution of household income in the City and County of Broomfield. Based on U.S. Census Bureau estimates, per capita income in the planning area in 2020 was \$51,461, and the median household income was \$101,206. It is estimated that 21% of households have an income between \$100,000 and \$149,999 per year and 15% are above \$200,000 annually. Families with incomes below the poverty level in 2020 made up 2.6% of all families.

3.5.2 Occupations and Industries

According to 2020 American Community Survey data, the planning area’s economy is strongly based in the education, health care and social assistance industries (21.5% of total employment), followed by the professional, scientific, and management, and administrative and waste management services (18.5 percent), and retail trade (9.9%). Figure 3-11 shows the distribution of industry types in City and County of Broomfield, based on the share of total employment.

Figure 3-11 Percent of Total Employment by Industry in Broomfield



Source: U.S. Census Bureau, American Community Survey

Table 3-9 shows the largest private employers in Broomfield according to the Metro Denver Economic Development Council (EDC).

Table 3-9 Largest Private Employers in the City and County of Broomfield

Company	Produce/Services	Industry	Employment
Lumen Technologies (formerly CenturyLink)	Communication & Internet Systems	Broadband & Digital Communications	1,650
Oracle	Software & Network Computer Systems	IT-Software	1,620
SCL Health Revenue Service Center	Healthcare	Healthcare & Wellness	1,530
Ball Corporation	Aerospace, Containers	Aerospace, Food & Beverage Production	1,080
Hunter Douglas Window Fashions	Window Coverings Manufacturing		980
Vail Resorts	Leisure & Hospitality		740
TSYS	Transaction Processing Services	IT-Software	580
Danone North America	Food & Beverage	Food & Beverage Production	550
VMware	Cloud Computing	IT-Software	500
Broadcom	Semiconductor Components		500

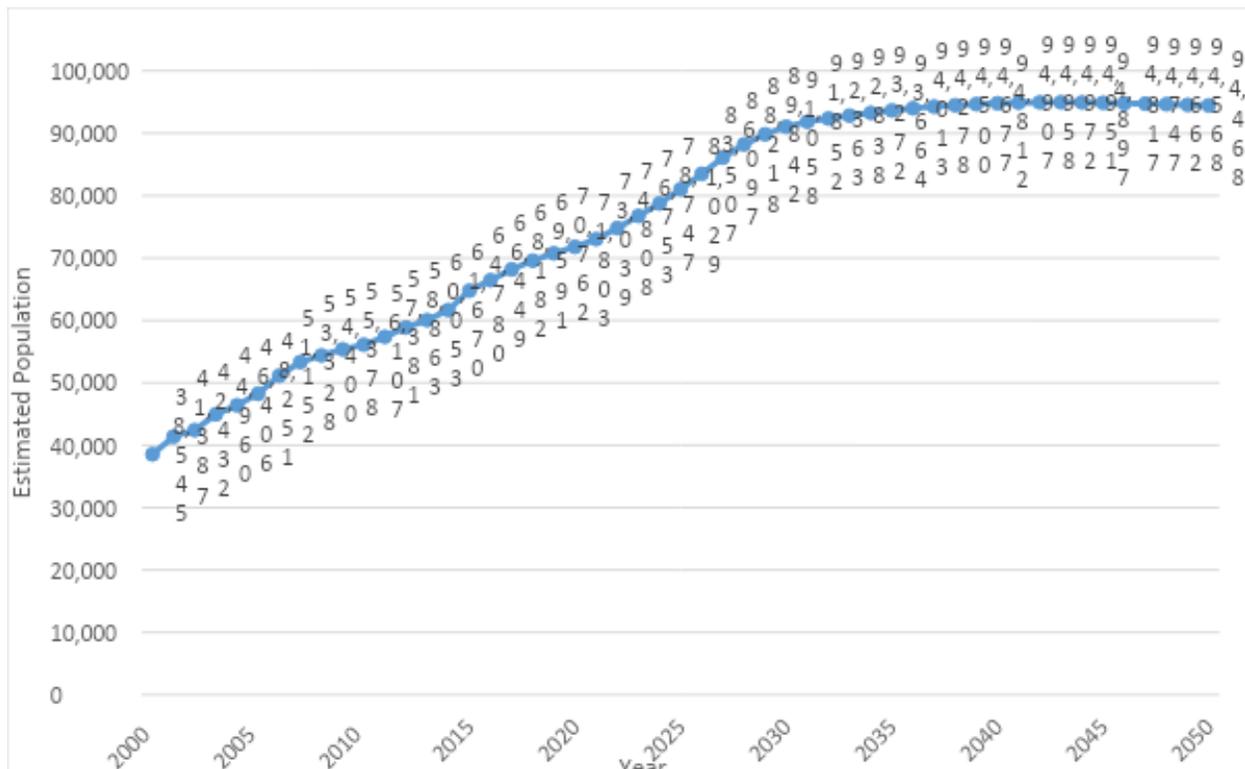
Source: Metro Denver EDC

The U.S. Census estimates that 75.2 percent of Broomfield workers commute alone (by car, truck, or van) to work, and mean travel time to work is 28.1 minutes.

3.6 Future Population Growth and Development Trends

A key strategy for reducing future losses in a community is to avoid development in known hazard areas and to enforce the development of safe structures in other areas. The purpose of this strategy is to keep people, businesses, and buildings out of harm’s way before a hazard event occurs.

Figure 3-12 Broomfield’s Population Counts and Projections, 2000-2050



Source: U.S. Census Bureau, Decennial Census 2010; Colorado State Demography Office

Broomfield has grown significantly in the past few decades and is one of the faster growing communities in the Denver Metro Area. In the Metro Area, Broomfield grew the most from 2000 to 2010, by about 46%. Much of this growth was due to boundary expansion from when Broomfield became a county. Broomfield is projected to remain one of the growing areas until 2030; after that point, the County’s growth rate is expected to decline significantly due to geographic buildout limitations. Figure 3-12 above shows Broomfield’s past and current populations, as well as projected population growth through the year 2050 as calculated by the Colorado State Demography Office. Note that the State Demography Office has not yet completed updated projections based on the 2020 Census; Broomfield’s actual growth over the past 10 years already exceeds these projections.

The City and County of Broomfield has most recently updated its Comprehensive Plan in 2016, which helps to guide land use decisions, growth and development, economic development, and policy making. The City and County of Broomfield Code of Ordinances were most recently adopted/updated in May 2021. The zoning code is contained under Chapter 17 of this code. Decisions on future land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards.

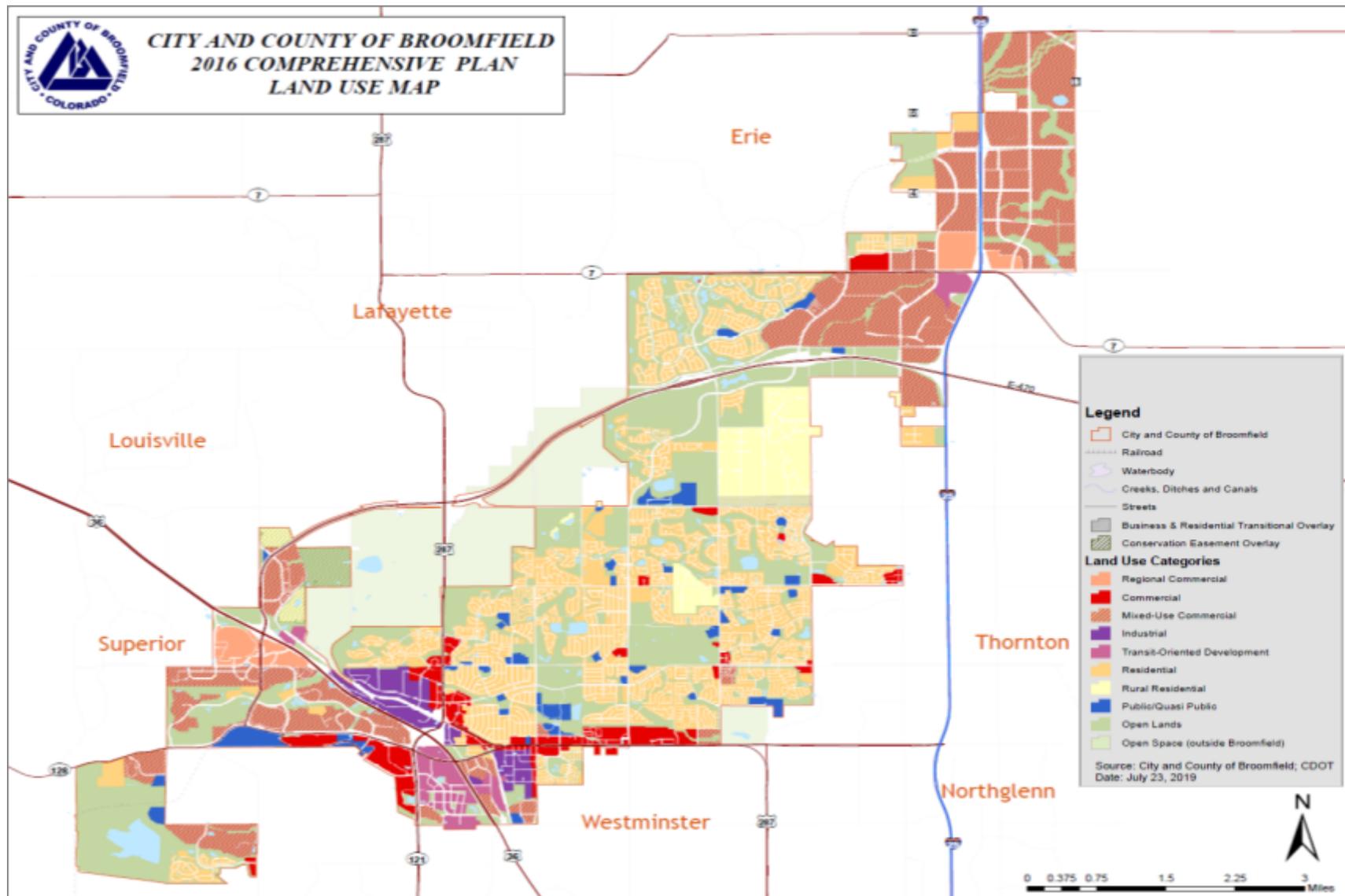
At the point of the 2016 Comprehensive Plan, much of the land area in Broomfield was already developed or had an approved development plan. The predominant land use was low-density residential. Future residential development will occur in the northern portion of the County into vacant



agricultural land in a planned, phased expansion as utilities are concurrently expanded. Much of commercial development was concentrated along U.S. Highway 36 and West 120th Avenue; there are infill and redevelopment opportunities in these areas, but future commercial development is being directed to areas adjacent to Interstate 25 and Colorado 7 interchange. The land use map Figure 3-13 establishes preferred development patterns for Broomfield.

Broomfield will incorporate information from this HMP update to inform strategic decision making. This will help ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

Figure 3-13 Broomfield Comprehensive Plan Land Use Map



Source: Broomfield Comprehensive Plan (2016)



3.7 Capability Assessment

This section examines the County’s ability to implement and manage the comprehensive mitigation strategy laid out in this Plan. The County’s resources, strengths, and weaknesses are identified as a means for evaluating and maintaining effective and appropriate management of the hazard mitigation program.

Capabilities can take the form of regulatory requirements (e.g., building codes or hazard specific zoning ordinances), plans (e.g., hazard mitigation plans or stormwater master plans), certification programs (e.g., Storm Ready or the CRS), personnel (e.g., floodplain administrators and community planners), insurance (e.g., National Flood Insurance Program), and structural projects that protect critical facilities and other property. Hazard awareness and public education programs are also proven measures for preparing citizens to cope with hazard events that cannot be avoided.

In the City and County of Broomfield, the local comprehensive plan, zoning ordinance, floodplain ordinance and building code are the primary tools utilized to regulate development in hazard-prone areas. Broomfield has also acquired a number of potentially hazardous properties that have been designated for use as parks or open space, thereby limiting development of the parcels in perpetuity. A dedicated floodplain administrator enforces the local floodplain ordinance and ensures conformance with National Flood Insurance Program (NFIP) requirements.

The information included in the capability assessment was gathered primarily from HMPC members and other representatives of the participating agencies. The 2021 update process afforded an opportunity to review these capabilities and how those capabilities have changed since the previous plan. Additionally, in summarizing their current capabilities and identifying gaps, plan participants also considered their ability to expand or improve upon existing policies and programs as potential new mitigation strategies. Chapter 5 includes mitigation actions aimed at improving community capability to reduce hazard risk and vulnerability. Together, the capabilities outlined in this plan highlight both strengths and areas of improvement that the County should consider to mitigate hazard impacts, reduce risk to life and property, and build a disaster resilient community.

3.7.1 Legal and Regulatory Capabilities

Table 3-10 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the City and County of Broomfield.

Table 3-10 City and County of Broomfield Regulatory Mitigation Capabilities Matrix

Regulatory Tool	Yes/No	Comments and Changes Since 2016
Building Codes	Yes	City and County of Broomfield Code of Ordinances Title 15: Buildings and Construction. Most recently updated in 2020 under Ordinance No. 2020-2115 to adopt the 2018 International Building Code.
BCEGS Rating	No	
Capital Improvement Plan (CIP)	Yes	
CRS	No	
Community Wildfire Protection Plan (CWPP)	No	As of 2021 a CWPP is currently being created.
Comprehensive Plan	Yes	Broomfield Comprehensive Plan (2016): Adopted 11/1/2016, by Ordinance No. 2016-194.
Economic Development Plan	Yes	
Elevation certificates	Yes	Maintained by the Engineering Department.
Emergency Operations Plan	Yes	Last updated in 2013, at writing of this plan (2021) an update was in progress.
Erosion or sediment control program	Yes	
Fire Department ISO Rating	Yes: 4	Overdue for a reevaluation.



Regulatory Tool	Yes/No	Comments and Changes Since 2016
Floodplain ordinance or floodplain management plan	Yes	City and County of Broomfield Code of Ordinances Title 17, Chapter 17-40: Floodplain: The purpose of this article is to promote public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas. In compliance with State Flood Rule. Updated in 2019 to adopt revised DFIRMS.
Flood insurance study or other engineering study for streams	Yes	Flood Insurance Study for Broomfield City and County, Colorado, and Incorporated Areas dated August 15, 2019. Copies of the Flood Insurance Study (FIS), DFIRMs, FIRMs and/or flood boundary and floodway maps (FBFMs) are on file in the Engineering Department.
Growth Management Ordinance	Yes	Residential focused (1998)
NFIP	Yes	Joined September 7, 1973. Current map dated August 15, 2019.
Other Hazard Specific Ordinances or Plans	No	
Site plan review requirements	Yes	City and County of Broomfield Code of Ordinances Title 17, Chapter 17-38.
Stormwater Program, Plan or Ordinance	Yes	City and County of Broomfield Code of Ordinances Title 13, Chapter 13-40: Stormwater Regulations. This chapter provides a comprehensive system of regulation and enforcement for the control of the quality of stormwater drainage. (2004)
Subdivision ordinance	Yes	Title 16 in City's Code of Ordinances; updated regularly.
Transportation Plan	Yes	Transportation Plan 2016
Zoning ordinance	Yes	Title 17 in City's Code of Ordinances; updated regularly.

Existing laws, ordinances and plans at the federal, state, and local level can support or impact hazard mitigation actions identified in this plan. In addition, federal, state, and local agencies perform functions that support hazard mitigation. HMPs are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). Pertinent local, state, and federal laws and regulations are described below.

City and County of Broomfield

Plans

Significant plans in the City and County of Broomfield that support or are related to this HMP are discussed below.

City and County of Broomfield Comprehensive Plan (2016)

Broomfield's Comprehensive Plan is a long-term policy document adopted in November 2016 in order to provide the framework to ensure a sustainable future for Broomfield. Each section of the plan provides goals and policies that will focus on improving life for citizens and visitors alike while also fostering economic growth and civic pride. The main themes in the 2016 Comprehensive Plan include transitioning from a growth-oriented community to a community focused on maintaining and improving existing neighborhoods and facilities, multi-modal transportation, and the impacts of technology. The 11 components, as described on the comprehensive plan website, are as follows:

- **Community Form and Identity:** Strengthening the county's sense of community by outlining steps to increase connectivity in the area and enhance both natural and manmade features. In addition, the plan focuses on enhancing a diversity of people and a diversity of amenities.
- **Growth, Population, and Change:** Preparing for growth and allowing for adaptability to potential population changes. The comprehensive plan outlines policies that provide for an appropriate rate of growth and the creation of public services to support new residents.

- **Land Use:** Providing a mix of land uses that meet the needs of the citizens of Broomfield is a key aspect of the comprehensive plan. The Land Use section outlines the policies providing for mixed use, denser development projects in the future that meet a variety of needs.
- **Transportation:** Increasing the opportunities for multi-modal transportation is an important aspect of planning for the future. Broomfield seeks to provide safe and efficient travel for people of all ages and abilities.
- **Open Space, Parks, Recreation & Trails:** Protecting and enhancing access to open space while improving recreational opportunities and environmental stewardship. It is important the citizens of Broomfield remain connected to a variety of outdoor spaces.
- **Economic Development:** Growing the local and regional amenities in order to stimulate economic development and meet community needs. It is a priority to provide employment opportunities and support the connections between individuals and jobs.
- **Community Services & Facilities:** Supporting services to meet local demand such as libraries, health care, recreation, education, and cultural facilities. In addition, creating an atmosphere of security by providing necessary emergency response services is a large focus in this section of the plan.
- **Environmental Stewardship:** Conserving and protecting natural resources by encouraging public participation in sustainable practices and utilizing energy saving practices.
- **Housing:** Offering current and future residents diverse housing opportunities while maintaining affordability and attainability. High quality housing functional for seniors, single-parent households, and other special needs residents will continue to grow in Broomfield.
- **Utilities:** Ensuring City and County utilities are equipped to support current populations and future growth. Efficiency, sustainability, and overall aesthetics of utility infrastructure will be improved to promote public health and welfare.
- **Oil and Gas:** Recognizing the many challenges facing our community as technological advances in oil and gas exploration and production evolve, Broomfield desires to focus on the health, safety, welfare, and environment of our community as our top priority.

Capital Improvements Plan (2021)

The Broomfield Capital Improvements Program budget is a result of careful planning and based on priorities set by the 2016 City and County Comprehensive Plan, the Long Range Financial Plan, and collaboration between citizen committees and department staff. The CIP, updated annually, primarily focuses on the next five years but includes details as far out as 20 years. Projects included in the CIP fall into 12 categories: Facilities, Information Technology, Landscaping, Open Space and Trails, Parks and Recreation, Transportation, Vehicles and Equipment, Replacement, Planning and Administration, Drainage and Stormwater, Water, Sewer, and Water Reclamation. Many of these categories can have direct and indirect impacts on hazard mitigation activities in Broomfield.

Continuity of Operations Plan (2015)

The Broomfield Continuity of Operations Plan (COOP) establishes policy and guidance to promote coordinated execution of the prioritized mission essential functions in the event that an emergency threatens or incapacitates normal operations; the COOP compliments the EOP. The COOP enables County government to return to normal operating conditions as soon as practical based on the circumstances.

Emergency Operations Plan (2013)

The Broomfield EOP is meant to provide a framework to enable Broomfield to work together internally as well as with other jurisdictions and the private sector to respond to and recover from the effects of emergencies regardless of cause, size, location, or complexity. The plan reflects the concepts of the National Response Framework (NRF), the National Disaster Recovery framework (NRDF), and the Colorado State Emergency Operations Plan (SEOP). The EOP provides policy options to support emergency operations and recovery activities. The EOP also defines capabilities and assigns responsibilities to effectively respond and recover to hazards. The EOP is currently undergoing revisions as of 2021.



Transportation Plan (2016)

The Transportation Plan was developed at the same time as the Comprehensive Plan and complements the goals and policies put forth in that plan. The plan sets up a vision, goals, and policies to support transportation in Broomfield as well as puts forth transportation framework recommendations. Finally, the plan identifies both key corridors and mobility hubs as well as potential sources of funding for future transportation projects in the County.

Codes and Ordinances

Broomfield Municipal Code

The Broomfield Municipal Code is the primary implementation tool for the Comprehensive Plan. Regulations contained within the Municipal Code dictate allowable uses of land, as well as the physical standards required of new development. The code consists of all the regulatory and penal ordinances and certain administrative ordinances of the City and County of Broomfield, a Colorado municipal corporation and county.

Building Codes

The City and County of Broomfield has adopted the 2018 International Code series, effective April 15, 2020. All permits issued after that date need to have plans reviewed and approved by the Building Division to meet the 2018 Codes, including architectural plans, structural framing plans, structural foundation plans, soils reports, roof truss plans, and energy code documents. Building codes are updated every three years through an open consensus process to adapt to changing technology, current methods of construction and in reaction to situations where codes may have failed to protect the public in the past. Applicable Codes in Broomfield as of February 25, 2020 are as follows:

- 2018 International Building Code
- 2018 International Residential Code
- 2018 International Plumbing Code
- 2018 International Fuel Gas Code
- 2018 International Mechanical Code
- 2018 International Fire Code
- 2018 International Energy Conservation Code
- 2020 National Electric Code
- 2009 ICC A117.1 Accessible and Usable Buildings and Facilities Snow and wind loads in the Building Code are rated as follows:
 - Design roof snow load: 30.0 psf
 - Assigned ground snow load: 30.0 psf
 - Design wind speed for single family dwellings: 110 mph, 3 second gust
 - Design wind speed for other structures depends on the risk category (RC) of the building:
 - RC-I: Vult = 132 mph;
 - RC-II: Vult = 142 mph;
 - RC-III and IV: Vult = 153 mph.

Land Use Planning and Ordinances Related to Hazards

- Broomfield Floodplain Regulations (2019) require a development permit before construction or development begins within any area of special flood hazard. Area of special flood hazard means the land within the 100-year flood boundary as identified in the Flood Insurance Study (FIS) and the Flood Insurance Rate Map (FIRM). The FIRM is the official map, dated August 15, 2019, on which FEMA has delineated both the areas of special flood hazard and the risk premium zones applicable to the community. The Flood Insurance Study is the official report, dated August 15,

2019, provided by FEMA that includes flood profiles, the Flood Boundary Floodway Map, and the water surface elevation of the base flood.

- Broomfield Subdivision Regulations (Title 16) require that a plat be submitted to and approved by the City and County of Broomfield for proposals to divide a lot, tract, or parcel of land into two or more lots, tracts, parcels, or sites for the purpose of sale or building development.
- Broomfield Stormwater Regulations (Chapter 13-40), in addition to protecting water quality, are intended to minimize increases in stormwater runoff from any development in order to reduce flooding, siltation, and streambank erosion, and to maintain the integrity of stream channels.
- Broomfield's Parks and Open Space Programs have protected large parts of the community to support local recreation and open space preservation goals. Broomfield has over 281 miles of trails, more than 700 acres of developed parks and 45 playgrounds (roughly 16 acres of parks and open space for every 1,000 citizens). The Broomfield Comprehensive Plan promotes the ambitious goal of preserving 40% of the community as park space and open space lands. Broomfield has a total of 8,208 acres of open lands, which totals 34% of the community. The strategy is to meet the balance of 6% through purchase of land, joint acquisitions with other communities, the public land dedication, and other innovative funding efforts.

Broomfield Departments

The following departments in the City and County of Broomfield are important components of the County's overall hazard mitigation effort.

Broomfield Office of Emergency Management

The Broomfield Office of Emergency Management is charged with creating a framework in which the community can reduce vulnerability to hazards and cope with disasters. This is more than just a mission of this individual department, but a commitment to finding creative ways to live safely in an environment that is full of risk. Emergency management is a methodical process of identifying community risk, mitigating risk through engineering and preparedness measures; where risk cannot be eliminated, plans are developed to manage consequences and recover. The Office of Emergency Management resides in the City Manager's Office.

The Broomfield Office of Emergency Management has built a comprehensive emergency management program, including citizen volunteers and the Broomfield LEPC, that places the County well on its way to becoming a resilient community that can overcome the challenges of natural, technological, and human-caused disasters.

Broomfield Police Department

The mission of the Broomfield Police Department (BPD) is to enhance the quality of life in the community by protecting life and property and providing services to prevent crime and resolve problems. The police department enriches a safe and secure the city and county through a commitment to partnerships with the community and a respectful and professional workforce. The Broomfield Police Department is organized into two bureaus and seven divisions, The Operations Bureau consists of Patrol, Special Operations, and Investigations. The Support Services Bureau includes Administration, Communications (Dispatch), Information and Court Security, and the Detention Center. As one of the safest communities in Colorado, the BPD continues to implement a community oriented policing philosophy; the department's unique approach to providing both municipal and county law enforcement services has created significant operational efficiencies resulting in a streamlined process for reducing the overall rate of crime.

Broomfield Community Development Department

The Department of Community Development provides one-stop services for all planning, transportation, traffic, engineering, and building activity within Broomfield. The services provided by the department include enforcement of building codes, issuing of building permits, zoning regulation, and construction standards. Community Development staff is also responsible for creating and monitoring engineering requirements for the design and construction of street and traffic systems, water systems, sanitary sewer, park systems and drainage facilities. The department's mission is to improve quality of life and make Broomfield a better place to live, work, play, and stay by fulfilling the community's vision. The



department hosts the County's Building Division, Capital Improvements Program, Engineering Division, Planning Division, and Transportation and Traffic Division. Each of these divisions has an important role in accomplishing the hazard mitigation goals set forth in this plan update.

North Metro Fire Rescue District

The North Metro Fire Rescue District is headquartered in Broomfield and has seven fire stations that serve residents in Broomfield, Northglenn, and unincorporated areas of Adams, Boulder, Jefferson, and Weld Counties; in addition to the headquarters, the district has a large Training Center Complex. Since 1846, the North Metro Fire Rescue District has served to protect its citizens and their property with a high level of care, compassion, and professionalism with the mission to "be a responsive all-hazard organization that works to provide a caring, high quality, professional delivery of service." The department is equipped and committed to ensuring public safety through fire suppression, emergency medical services and patient transportation, hazardous materials response, technical rescues, and wildland firefighting. The District has four different divisions: Fire & Life Safety Education, Fire Prevention, Fleet Maintenance, Operations, and Training.

State and Regional

Colorado Division of Homeland Security and Emergency Management

Pursuant to House Bill 12-1283, the former Division of Emergency Management moved from the Department of Local Affairs to the DHSEM under the Colorado Department of Public Safety, effective July 1, 2012. The division is comprised of four offices:

- Office of Emergency Management
- Office of Grants Management
- Colorado Information Analysis Center
- Chief of Staff Office

The DHSEM operates under the following mission: "To lead and support Colorado's effort to prevent, protect, mitigate, respond to and recover from all-hazards events." The Division vision is: "A prepared, safe and resilient Colorado!"

Colorado Water Conservation Board

The CWCB is an agency of the State of Colorado. The CWCB Flood Protection Program is directed to review and approve statewide floodplain studies and designations prior to adoption by local governments. The CWCB is also responsible for the coordination of the NFIP in Colorado and for providing assistance to local communities in meeting NFIP requirements. This includes CWCB prepared or partnered local floodplain studies. Data from the CWCB informed various sections of the Hazard Identification and Risk Assessment.

Colorado Geological Survey

The Colorado Geological Survey is a non-regulatory state government agency within the Colorado School of Mines. The mission of CGS is to help reduce the impact of geologic hazards on the citizens of Colorado, to promote responsible economic development of mineral and energy resources, provide geologic insight into water resources, provide avalanche safety training and forecasting, and to provide geologic advice and information to a variety of constituencies.

Colorado State Forest Service

The mission of the Colorado State Forest Service is to provide for the stewardship of forest resources and to reduce related risks to life, property, and the environment for the benefit of present and future generations. Its fire preparedness and response strategic priority is to provide leadership in wildland fire protection for state and private lands in Colorado and reduce wildfire-related loss of life, property, and critical resources.

Denver Regional Council of Governments

DRCOG is a planning organization where local governments collaborate to establish guidelines, set policy, and allocate funding in areas of transportation and personal mobility, growth and development, and aging and disability resources. DRCOG includes the following committees and working groups:

- Administrative Committee
- Advisory Committee on Aging
- Citizens Advisory Committee
- Firefighter Advisory Committee
- Metro Vision Planning Advisory Committee
- Regional Transportation Committee
- Transportation Advisory Committee

Federal

Federal Emergency Management Agency

FEMA's mission remains "helping people before, during and after disasters, and our core values and goals help us achieve it." FEMA coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or manmade, including acts of terror.

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-707, was signed into law November 23, 1988; and amended the Disaster Relief Act of 1974, Public Law 93-288. It created the system in place today by which a presidential disaster declaration of an emergency triggers financial and physical assistance through FEMA. The Act gives FEMA the responsibility for coordinating government-wide relief efforts. On March 1, 2003, FEMA became part of the U.S. Department of Homeland Security (DHS).

Disaster Mitigation Act (DMA)

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before HMGP funds are available to communities. This plan is designed to meet the requirements of DMA, improving the County's eligibility for future hazard mitigation funds.

National Flood Insurance Program (NFIP)

The NFIP provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act.

The City and County of Broomfield has participated in the NFIP since 1973. The initial FIRM was completed September 7, 1973, and the current map is dated August 15, 2019. Broomfield is in good standing with the NFIP and has adopted regulations to meet the NFIP requirements. As shown in Table 4-38 in the Flood section, the County currently has 90 NFIP policies in effect, representing \$31,303,200 in coverage. Records show 15 claims have been paid under NFIP policies in Broomfield, totaling \$21,601.

Community Rating System (CRS)

The County *does not* currently participate in the CRS, a voluntary program for NFIP participating communities focused on reducing flood damages to insurable property and encouraging a comprehensive approach to floodplain management. (See Section 3.7.6. for more discussion of the CRS program and its potential benefits.)

3.7.2 Administrative and Technical Capabilities

Table 3-11 identifies the County personnel responsible for activities related to mitigation and loss prevention in.

Table 3-11 Administrative and Technical Capabilities

Administrative/Technical Resources	Yes/No	Department/Position
Emergency Manager	Yes	City Manager’s Office/Emergency Manager
Floodplain Manager	Yes	Community Development/Floodplain Manager
Planner/Engineer: Land Development	Yes	Community Development/Senior Planner and Principal Planner
Planner/Engineer/Scientist: Natural Hazards	Yes	Community Development
Engineer/Professional: construction practices	Yes	Community Development
Resiliency Planner	No	
Transportation Planner	Yes	Community Development/Senior Transportation Planner and Transportation Planning Manager
Full-Time Building Official	Yes	Community Development/Chief Building Official
GIS Personnel and Capability	Yes	Information Technology/GIS Data Administrator
Grant Manager, Writer, or Specialist	Yes	Finance
Warning Systems/Services	Yes	Public Safety Communications Center, CodeRed (transitioning to Rave)

Administration

- City and County Staff deliver a full range of governmental services that support hazard mitigation goals and objectives. Full-time staff include the Chief Building Official, Emergency Management Manager, Public Works Director/Staff, and the Community Development Director and Staff, including the City and County Engineer, Planning Director, Floodplain Manager, GIS Coordinator, and Code Compliance Manager.
- The Broomfield Land Use Review Commission reviews and makes recommendations to Council on rezoning requests, subdivision plats, PUDs and special review applications. The Commission has final decision authority on select plats, special reviews, and site development plans, subject to call-up by the City Council.
- The Neighborhood Board of Adjustment hears requests for variances to the Zoning Code and appeals from decisions of the building official concerning application of the various building, mechanical, and other housing and construction codes.
- The Broomfield LEPC is a standing multi-hazard committee composed of government officials, fire district representatives, industry representatives, local schools, and operators of critical facilities. City and County of Broomfield departments that participated in the planning effort included the City and County Manager’s Office, Public Works, Community Development, Information Technology, and Health and Human Services. The Planning Team assembled to guide, review and approve 2021 updates to the HMP was formed from the LEPC.

3.7.3 Financial Capabilities

Table 3-12 identifies financial tools or resources that Broomfield could use to help fund mitigation activities.

Table 3-12 Fiscal Mitigation Capabilities

Financial Resources	Available/Eligible to Use (Yes/No)	Has This Been Used in the Past?
Authority to Levy Taxes for Specific Purposes	Yes	No
Capital Improvements Project Funding	Yes	Yes
Community Development Block Grants	Yes	Yes
Impact Fees for New Development	No	No
Incur Debt through General Obligation Bonds	No	No
Incur Debt Through Special Tax Bonds	No	No



Financial Resources	Available/Eligible to Use (Yes/No)	Has This Been Used in the Past?
Incur Debt through private activities	No	No
Stormwater Service Fees	N/A*	No
System Development Fee	No	No
Utilities Fees	Yes	No
Withhold spending in hazard-prone areas?	No	No

*A 2021 Utility Rate Study will provide additional guidance.

3.7.4 Education and Outreach

Table 3-13 lists additional education and outreach capabilities, such as specific programs, which the City and County of Broomfield utilizes to implement hazard mitigation activities.

Table 3-13 Education and Outreach Capabilities

Programs	Yes/No
Firewise	No
StormReady	No
Local Citizen Groups That Communicate Hazard Risks	No
Other Public Education Programs	Yes

Broomfield maintains a LEPC, consisting of Broomfield staff from various departments, community volunteers, citizens, and private sector stakeholders. As of March 2022, Broomfield is working with North Metro Fire to become a Firewise community.

Public Education Programs

Preparedness information is provided to Broomfield citizens by a variety of means, including:

- Social media, with emphasis on National Preparedness Week, Winter Weather Awareness and Lightning Awareness campaigns
- Preparedness Guides, one for residents and one for businesses
- Flood Hazard Awareness Brochure containing a map of flood hazard areas and information about flood insurance and personal and property protection
- Training in cooperation with the Citizens Academy, including a Preparedness Essentials element
- Other programs like Neighborhood Watch, which encompasses an All-Hazards Preparedness component based on the Resident Preparedness Guide.

3.7.5 Summary of Capabilities

The City and County of Broomfield has been a mitigation-minded community since its inception as a municipality in 1961. The programs and resources outlined above, as well as the limited local impacts from hazards to date, provide evidence of the local commitment to avoiding and reducing hazard-related losses. The capabilities assessment identifies the plans, regulations, personnel, and funding mechanisms available to the County to mitigate the effects of natural hazards.

The City and County of Broomfield has a robust system of plans, programs, and personnel in place to directly and indirectly address emergency management and the implementation of a proactive HMP. These plans include the County’s Comprehensive Plan, EOP, and several specific ordinances directed at flood damage prevention, zoning, construction, and development. While the County Office of Emergency Management (OEM) (under the Mayor and City Council) has primary responsibility for the implementation of the HMP, it takes cooperation and coordination on the part of all city departments and regional organizations to successfully implement the mitigation plan. In addition to the County’s full-time emergency management staff, the County has GIS, Planning and Development, Engagement and Innovation, Environmental Services (Public Works), and other departments to coordinate the



planning, mitigation, and response to natural hazard events. The County also may coordinate with DRCOG and surrounding counties. In addition to the traditional FEMA funding mechanisms, the County can obtain funds for hazard mitigation projects through community development block grants, capital improvement project funds, taxes, and fees.

The capabilities of the City and County of Broomfield to implement an HMP are strong. These programs should be maintained and reviewed periodically to proactively mitigate natural hazards in the community.

3.7.6 Opportunities for Enhancement

Based on the capability assessment, Broomfield has several existing mechanisms in place that already help to mitigate hazards, including numerous planning tools and many available funding mechanisms.

The 2021-2022 update provided the County 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 the update or development of following plans, which should also cross reference this HMP:

- Explore possible funding of hazard mitigation activities in the annual CIP budget update.
- Update City plans to include linkages to the HMP and consideration of hazards.
- Enhance the County’s education and outreach capabilities.
- Become a Firewise or StormReady certified community.
- Implement Comprehensive Emergency Management Program Recommendations (January 2021).
- Consider joining the CRS - see below.

Community Rating System (CRS)

As noted in Section 3.7.1 above, the CRS is a voluntary program for NFIP participating communities focused on reducing flood damages to insurable property and encouraging a comprehensive approach to floodplain management. The CRS rewards communities that go above and beyond the minimum floodplain management requirements and develop extra measures to reduce flood risk by providing discounts to flood insurance premiums. Credit points are assigned for activities and actions in public information, mapping and regulation, flood damage reduction, and flood preparedness. Participating communities receive a rating from 9 (lowest) to 1 (highest), with each level providing a 5% discount to the community’s NFIP premiums.

The City and County of Broomfield does not currently participate in the CRS. The estimated benefits of joining the CRS program based on the current NFIP policy information are shown in Table 3-14.

Table 3-14 Community Rating System Potential Savings for Broomfield NFIP Policyholders

CRS Class	% Discount	Annual Savings for Broomfield Policyholders	CRS Class	% Discount	Annual Savings for Broomfield Policyholders
10	0%	---	5	25%	\$8,694
9	5%	\$2,074	4	30%	\$10,210
8	10%	\$3,589	3	35%	\$11,725
7	15%	\$5,105	2	40%	\$13,241
6	20%	\$7,178	1	45%	\$14,756

Source: FEMA Community Information System

4 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. The risk assessment shall include:

(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

(ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of:

(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;

(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

4.1 Hazard Identification

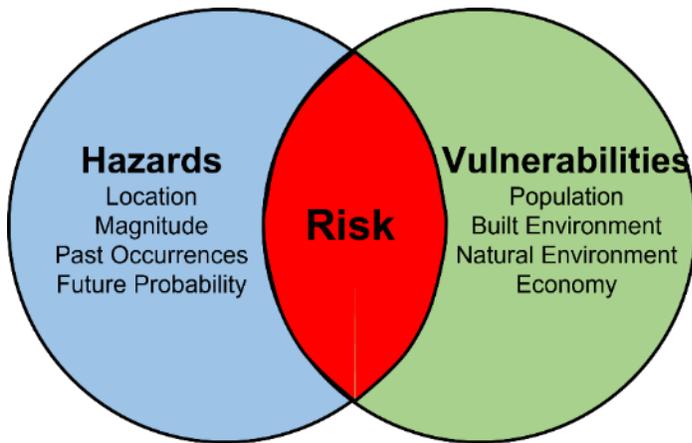
This section of the Broomfield Hazard Mitigation Plan describes the local Hazard Identification and Risk Assessment summary undertaken by the county. The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. 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 hazardous events.

A key step to mitigate disaster losses is to develop a comprehensive understanding of the community's hazards, vulnerabilities, and risks. The following terms are used throughout the Plan to facilitate comparisons between communities.

- **Hazard:** Event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, other types of harm or loss. A hazard may be meteorological (snow, tornado, etc.), hydrological (flood, etc.), or geological (earthquake, subsidence, etc.); or it may be technological or human-caused (active threat, hazmat, etc.).
- **Natural Hazard:** A hazard resulting from a naturally occurring phenomenon such as meteorological, environmental, or geological event. While naturally occurring, the frequency, magnitude, and behavior of natural hazards can be affected by human actions and choices, such as land use and forest management practices.
- **Vulnerability:** Degree of susceptibility to physical injury, harm, damage, or economic loss; depends on an asset's construction, contents, and economic value of its functions.
- **Risk:** The potential for damage, loss, or other impacts created by the interaction of hazards with vulnerabilities.

The relationship between hazards, vulnerabilities, and risk is depicted in Figure 4-1. The risk assessment evaluates potential loss from hazards by assessing the vulnerability of the county's population, built environment, critical facilities, and other assets. Environmental and social impacts are also taken into consideration wherever possible. This risk assessment covers the entire geographical area of the City and County of Broomfield.

Figure 4-1 Risk Graphic



4.1.1 Hazard Significance Summary

Table 4-1 summarizes the risk across the planning area associated with each hazard based on the criteria listed in Section 4.1.4. The individual ratings are based on or interpolated from the analysis of the hazards in the sections that follow. During the 2021 Plan update, the individual ratings and significance of the hazards were revisited and updated. Public concern was also considered from an online survey and public review of the draft Plan.



Table 4-1 Hazard Analysis Summary

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Cyber Attack	Significant	Occasional	Critical	High
Drought	Extensive	Likely	Moderate	High
Extreme Temperatures	Extensive	Likely	Moderate	High
Active Threat	Limited	Occasional	Critical	Medium
Aircraft Accident	Significant	Occasional	Moderate	Medium
Critical Infrastructure Outage	Significant	Occasional	Critical	Medium
Dam Inundation	Limited	Unlikely	Critical	Medium
Expansive Soils	Extensive	Likely	Moderate	Medium
Flood	Limited	Occasional	Moderate	Medium
Hail	Extensive	Likely	Critical	Medium
Hazardous Materials Incident	Significant	Likely	Negligible	Medium
Public Health Hazard	Extensive	Likely	Critical	Medium
Severe Wind	Extensive	Highly Likely	Moderate	Medium
Winter Storm	Extensive	Highly Likely	Moderate	Medium
Fire (Structural & Wildland)	Significant	Likely	Moderate	Medium
Earthquake	Extensive	Unlikely	Critical	Low
Land Subsidence	Limited	Occasional	Negligible	Low
Lightning	Extensive	Likely	Negligible	Low
Tornado	Limited	Occasional	Moderate	Low
Location/Spatial Extent <u>Extensive:</u> 50-100% of planning area <u>Significant:</u> 10-50% of planning area <u>Limited:</u> Less than 10% of planning area Potential Severity <u>Catastrophic:</u> Multiple deaths, shutdown of facilities for 30 days or more, >50% of property is severely damaged <u>Critical:</u> Multiple severe injuries, shutdown of facilities for at least 2 weeks, >25% of property is severely damaged <u>Moderate:</u> Some injuries, shutdown of critical facilities for more than one week, >10% of property is severely damaged <u>Negligible:</u> Minor injuries, minimal quality-of-life impact, interruption of facilities and services for 24 hours or less, less than 10% of property is severely damaged.		Potential of Future Occurrence <u>Highly Likely:</u> Near 100% probability each year. <u>Likely:</u> Between 10 and 100% probability per year or at least one chance in ten years. <u>Occasional:</u> Between 1 and 10% probability per year or at least one chance in next 100 years. <u>Unlikely:</u> Less than 1% probability in next 100 years. Significance (Based on the preceding three factors) <u>High:</u> widespread potential impact <u>Medium:</u> moderate potential impact <u>Low:</u> minimal potential impact		



4.1.2 Disaster Declaration Summary

Federal emergency or disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government; no specific dollar loss threshold has been established for these declarations. A federal disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs.

The President can declare an Emergency Declaration when they determine federal assistance is needed to supplement state, local, or tribal efforts in the protection of lives, property, public health, and safety, or to lessen or avert the threat of a catastrophe. The President can also issue a Major Disaster Declaration for any natural event that has caused damage beyond the combined capabilities of state and local governments to respond. Additionally, The U.S. Department of Agriculture’s (USDA) Secretary of Agriculture can designate disaster areas to facilitate emergency loans to agricultural producers suffering losses from severe weather or other incidents.

Table 4-2 lists past federal declarations impacting Broomfield since 1965. Disasters before Broomfield was created as a separate county in 2001 list the counties affected by the disaster, but it is difficult to know if they impacted Broomfield directly or not. Since its inception as a combined city-county, Broomfield has experienced five events resulting in Presidential emergency & disaster declarations (shown in orange) along with nine USDA declarations (shown in tan). The hazards causing these declarations include seven for drought, two for severe snowstorms, three for severe summer storms, one for influx of refugees, and one for a pandemic.

Table 4-2 Federal Declarations in the City & County of Broomfield

Year	Hazard Event	Declaring Agency & Number
1965	Tornadoes, Severe Storms, Flooding (Adams, Weld Counties)	FEMA DR-200
1969	Severe Storms, Flooding (Adams, Boulder, Jefferson, Weld Counties)	FEMA DR-261
1973	Heavy Rains, Snowmelt, Flooding (Adams, Boulder, Jefferson, Weld Counties)	FEMA DR-385
1976	Severe Storms, Flash Flooding (Weld County)	FEMA DR-517
1997	Flooding (Weld County)	FEMA DR-1186
1999	Severe Storms, Flooding, Mudslides, and Landslides (Weld County)	FEMA DR-1276
2003	Severe Snowstorm	FEMA EM-3185
2005	Hurricane Katrina Evacuation	FEMA EM-3224
2005/06	Drought	USDA S2327
2007	Snow	FEMA EM-3270
2012	Drought, excessive heat, high winds	USDA S3260
2012	Hail, high winds, and flash flooding	USDA S3347
2013	Drought	USDA S3456 USDA S3548
2013	Severe Storms, Flooding, Landslides, & Mudslides	FEMA EM-3365
2017	Drought	USDA S4145



Year	Hazard Event	Declaring Agency & Number
2018	Severe Hail and High Winds	USDA S4365
2018	Drought	USDA S4408
2020	COVID-19 Pandemic	FEMA EM-3436 FEMA DR-4498
2020	Drought	USDA S4798 USDA S4848
2021	Drought	USDA S4917
2021	Marshall Fire	FEMA DR-4634 FEMA FM-5423

Source: FEMA, USDA. Orange: DR = Major Disaster Declaration; EM = Emergency Declaration; Tan = USDA Declaration

A review of these events helps identify targets for risk reduction and ways to increase a community’s capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern. More detailed event tables can be found in the individual hazard profile sections.

4.1.3 Identified Hazards of Concern

For this plan update, the planning team considered the full range of hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude, and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding hazards and the perceived vulnerability of the planning area’s assets to them was also used.

Historical data, catastrophic potential, relevance to the jurisdiction, and the probability and potential magnitude of future occurrences were all used to identify and prioritize the list of hazards most relevant to Broomfield. Hazard data was obtained from various federal, state, and local sources such as FEMA, the Colorado Geological Survey (CGS), the Colorado Division of Water Resources Dam Safety Division, the National Oceanic and Atmospheric Administration’s (NOAA) National Centers for Environmental Information (NCEI), the United States Geological Survey (USGS), and others. Local and national news reports were also used to research historic events. Together, these sources were examined to assess the significance of these hazards to the county. The hazards selected for inclusion in this plan include those that have occurred historically or have the potential to cause significant human and/or monetary losses in the future.

The hazards profiled in the 2016 Plan were reviewed, and the planning team decided to add active threats and cyber threats for 2022 based on recent events and public interest. They also decided to split dam inundation off separately from flooding since additional data was available. Based on the review, this plan addresses the following hazards of concern:

- Active Threat
- Aircraft Accident
- Critical Infrastructure Outage
- Cyber Attack
- Dam Inundation
- Drought
- Earthquake
- Expansive Soils
- Extreme Temperatures
- Fire (Structural & Wildland)
- Flood
- Hail
- Hazardous Materials
- Land Subsidence
- Lightning
- Public Health Hazard
- Severe Wind
- Tornado
- Winter Storm



The HMPC also reviewed the following hazards from the 2018 Colorado State Hazard Mitigation Plan but determined they do not present sufficient risk in Broomfield to justify inclusion:

- Animal Disease
Outbreak
- Avalanche
- Dense Fog
- Erosion & Deposition
- Landslide
- Mine Accident
- Pest Infestation
- Radiological Release
- Radon/CO/Methane/
Other Seeps
- Sinkholes/Subsidence
- Wildlife/Vehicle
Collisions

During GIS analysis of geological hazards data, it was determined that a small portion of the southwest corner of City near Great Western Reservoir does have some potential landslide risk. However, the risk was determined to be relatively minor and only affected 90 parcels, therefore the HMPC decided not to conduct further analysis of this hazard.

4.1.4 Risk Assessment Methodology

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area. The risk ranking was conducted by the planning team based on the hazard risk assessment presented during the second planning team meeting, community survey results, and personal and professional experience with hazards in the planning area. The results are used in establishing mitigation priorities.

Hazard Profiles

Each hazard was profiled as follows:

Description: General description of the hazard and associated problems, followed by details on the hazard specific to Broomfield.

Past Events: Overview history of the hazard's occurrences, compiled from multiple data sources, to include information provided by the planning team and the public. Significant incidents are profiled in greater detail and include scope, severity, and magnitude, and known impacts.

Location: Discusses what parts of the county are most likely to be affected by the hazard.

Magnitude and Severity: Summarizes the anticipated magnitude and severity of a hazard event based largely on previous occurrences and specific aspects of the planning area. Speed of onset and duration are also factored in.

Probability of Future Occurrence: Estimates the likelihood or probability of future occurrences of the hazard.

Climate Change Considerations: Discusses how the projected impacts of climate change may affect the likelihood and severity of the hazard in the future.

Vulnerability: Describes the likely impacts of the hazard on people, property, critical infrastructure, government services, the economy, and historical, cultural, and natural resources.

Development Trends: Summarizes how projected trends in land use, and development have the potential to increase or decrease the impact of the hazard.

Risk Summary: Summarizes the key pieces of information for each hazard.

Vulnerability Assessment

With Broomfield's hazards identified and profiled, the HMPC conducted a vulnerability assessment to describe the impact that the significant hazards would have on the county. The vulnerability assessment quantifies, to the extent feasible, assets at risk to hazards and estimates potential losses. The vulnerability assessment first describes the total vulnerability and values at risk and then discusses vulnerability by hazard.

The vulnerability assessment was conducted based on the significance of the hazard utilizing best available data. This assessment is an attempt to quantify assets at risk to further define populations, buildings, and infrastructure at risk to hazards. The information presented is for planning level assessments only. Data to support the vulnerability assessment was collected and compiled from the following sources:

- Current City GIS data (hazards, base layers, critical facilities and assessor's data).
- 2010 US Census, 2019 American Community Survey, and 2019 CO Department of Local Affairs (DOLA) data.
- 2020 Homeland Infrastructure Foundation-Level Data (HIFLD) data.
- Written descriptions of inventory and risks provided by the County.



- A refined flood loss estimation by jurisdiction with the use of geospatial analysis for both 1% and 0.2% annual chance flooding.
- Modeling of earthquake loss potential with HAZUS-MH using a 2,500-year probabilistic scenario.
- Existing plans and studies, and applicable regulations.
- Personal interviews with planning team members, hazard experts, and County and municipal staff.

The scope of the vulnerability assessment is to describe the risks to the County as a whole. The vulnerability assessment first describes the assets in the City and County of Broomfield, including the total exposure of people and property; critical facilities and infrastructure; natural, historic, and cultural resources; and economic assets. Development trends, including population growth and land status, are analyzed in relation to hazard-prone areas. Next, where data was available, hazards were evaluated in more detail and potential losses were estimated. Data from each jurisdiction was also evaluated and is integrated here but specific variations of risk are noted in the appropriate annex. The methods to assess vulnerability presented here include an updated and enhanced analysis from the 2016 Broomfield Hazard Mitigation Plan. This includes a detailed risk assessment for all hazards based on advanced methods and updated hazard and inventory data. Thus this 2021 Plan should be considered the baseline for measuring changes in vulnerability during future updates, recognizing that vulnerability information should become more refined as data sources and methodologies improve over time.

Hazard Rankings

Hazards then were ranked based on the following factors:

- **Spatial Extent:** How much of the planning area is potentially at risk from the hazard?
 - Extensive: 50-100% of planning area
 - Significant: 10-50% of planning area
 - Limited: Less than 10% of planning area
- **Potential Severity:** What are the likely impacts of the hazard?
 - Catastrophic: Multiple deaths, shutdown of facilities for 30 days or more, >50% of property is severely damaged.
 - Critical: Multiple severe injuries, shutdown of facilities for at least 2 weeks, >25% of property is severely damaged.
 - Moderate: Some injuries, shutdown of critical facilities for more than one week, >10% of property is severely damaged.
 - Negligible: Minor injuries, minimal quality-of-life impact, interruption of facilities and services for 24 hours or less, less than 10% of property is severely damaged.
- **Frequency of Occurrence:** How often is the hazard likely to occur?
 - Highly Likely: Near 100% probability each year.
 - Likely: Between 10 and 100% probability per year or at least one chance in ten years.
 - Occasional: Between 1 and 10% probability per year or at least one chance in next 100 years.



- Unlikely: Less than 1% probability in next 100 years.
 - **Overall Significance:** Based on a combination of the previous three factors.
- High: widespread potential impact.
- Medium: moderate potential impact.
- Low: minimal potential impact.

4.2 Climate Change

The 2021 Broomfield Hazard Mitigation Plan update takes into account considerations of how changing climate conditions may impact the frequency, intensity, and distribution of specific hazards within the County. Because many impacts of climate induced hazards cross county boundaries, some of the discussion looks at impacts on a regional scale. As climate science evolves, future mitigation plan updates may consider including climate change projections in the risk rankings and vulnerability assessments of the hazards included in the Plan.

Climate includes patterns of temperature, precipitation, humidity, wind, and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. “Climate change” refers to changes over a long period of time, and in the present context refers to the measurable warming of the planet over the last century or so as well as the coming century. It is generally perceived that climate change has had and will continue to have measurable impacts on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Snow cover losses will continue, and declining snowpack will continue to affect snow-dependent water supplies and stream flow levels around the world.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to continue to increase.
- More extreme precipitation events will continue to be likely, increasing the risk of flooding.
- The Earth’s average temperature is expected to continue to increase.

In 2018, the U.S. Global Change Research Program released the Fourth National Climate Assessment (NCA4), the authoritative and comprehensive report on climate change and its impacts in the United States. Not only did the report confirm that climate change continues to affect Americans in every region of the U.S., but the report also identifies increased heat, drought, insect outbreaks, wildfire, and flooding as key climate-related concerns for the Southwest region of the U.S., which includes Colorado. The following is a summary of climate change impacts from the Fourth National Climate Assessment.

Recent warming in the southwest region is among the most rapid in the nation and is significantly greater than the global average, and the period since 1950 has been hotter than any comparable long period in at least 600 years. Summer temperatures across the state are expected to warm more than winter temperatures and projections suggest that typical summer months will be as warm as (or warmer than) the hottest 10% of summers that occurred between 1950 and 1999. Under the higher emissions scenario (RCP8.5) climate models predict an increase of 8.6° F in the southwest regional annual average temperature by 2100.

Projected increases in temperatures in the southwest region are also projected to increase probabilities of natural events such as wildfires, drought, and extreme precipitation. These temperature changes have great potential to directly affect public health through increased risk of heat stress and infrastructure through increased risk of disruptions of electric power generation. Water supplies are also vulnerable to impacts of higher temperatures. While water supplies generally change year-to-year due to variabilities in water use and precipitation, higher temperatures are projected to



increase evapotranspiration, reducing the effectiveness of precipitation in replenishing surface water and soil moisture. This will have direct impacts on crop yields and productivity of key regional crops and livestock, a major risk for the agricultural industry and food security nationwide.

The impacts of climate induced hazards already pose a threat to people and property in the southwest region of the United States, including Colorado. Vulnerable populations, in particular those who are low income, children, elderly, disabled and minorities will likely be impacted by the effects of climate induced hazards disproportionately than other populations (Refer to Chapter 3 for more information on social vulnerability in the County). Together, these impacts represent a slow-onset disaster that is likely to manifest and change over time. Current projections predict even more rapid changes in the near future, which are likely to affect many of the meteorological or environmental hazards that Broomfield has historically dealt with.

4.3 Asset Summary

4.3.1 General Property

General property exposure to hazards is based on Broomfield’s parcel data containing assessor information such as total number of parcels, improvement values, and parcel types by jurisdiction. Only those parcels with improvement values greater than \$0, were used for analysis; non-developed or non-improved parcels were excluded for the purposes of conducting the vulnerability assessment. A total of 22,305 parcels were analyzed. A total 24,702 buildings were identified based on the County’s 2020 building footprint records.

Counts and values are based on the latest County assessor’s data (as of January 2021), which was provided in GIS and tabular (spreadsheet) formats. Improvement values and parcel type attributes were joined to the parcel geometries in GIS, to enable spatial analysis and mapping. Values for building contents were estimated as a percent of the improvement value based on parcel type using standard values based on FEMA’s HAZUS loss estimation software: 50% of the improvement value for residential structures (including mobile homes), 150% for industrial and 100% for the other property types. Finally, total values were aggregated by adding the improvement and content values for parcels in each jurisdiction. In all, a combined value of \$20.6 billion was determined to be potentially at risk across the County.

Table 4-3 breaks down property exposure by parcel type. The below information shows that residential parcels account for 96% of improved parcels in the County, and 78% of the total value of properties exposed.

Table 4-3 Property Exposure by Property Type

Property Type	Improved Parcel Count	Building Count	Improved Value	Estimated Content Value	Total Value
Agricultural	10	25	\$3,379,130	\$3,379,130	\$6,758,260
Commercial	441	603	\$1,341,468,760	\$1,341,468,760	\$2,682,937,520
Exempt	121	238	\$455,410,580	\$455,410,580	\$910,821,160
Industrial	241	292	\$332,197,410	\$498,296,115	\$830,493,525
Mixed Use	18	45	\$37,619,530	\$37,619,530	\$75,239,060
Residential	21,474	23,499	\$10,725,067,490	\$5,362,533,745	\$16,087,601,235
Total	22,305	24,702	\$12,895,142,900	\$7,698,707,860	\$20,593,850,760

Source: Wood Analysis of Broomfield Assessor’s Data

For hazards with a geospatial component and where data was available, the parcel layer was overlaid with the hazard layer to determine the parcels exposed to the hazards. The hazards that had enough geospatial data to conduct this parcel level hazard analysis were Dam Inundation, Flood, and Wildfire.

4.3.2 People

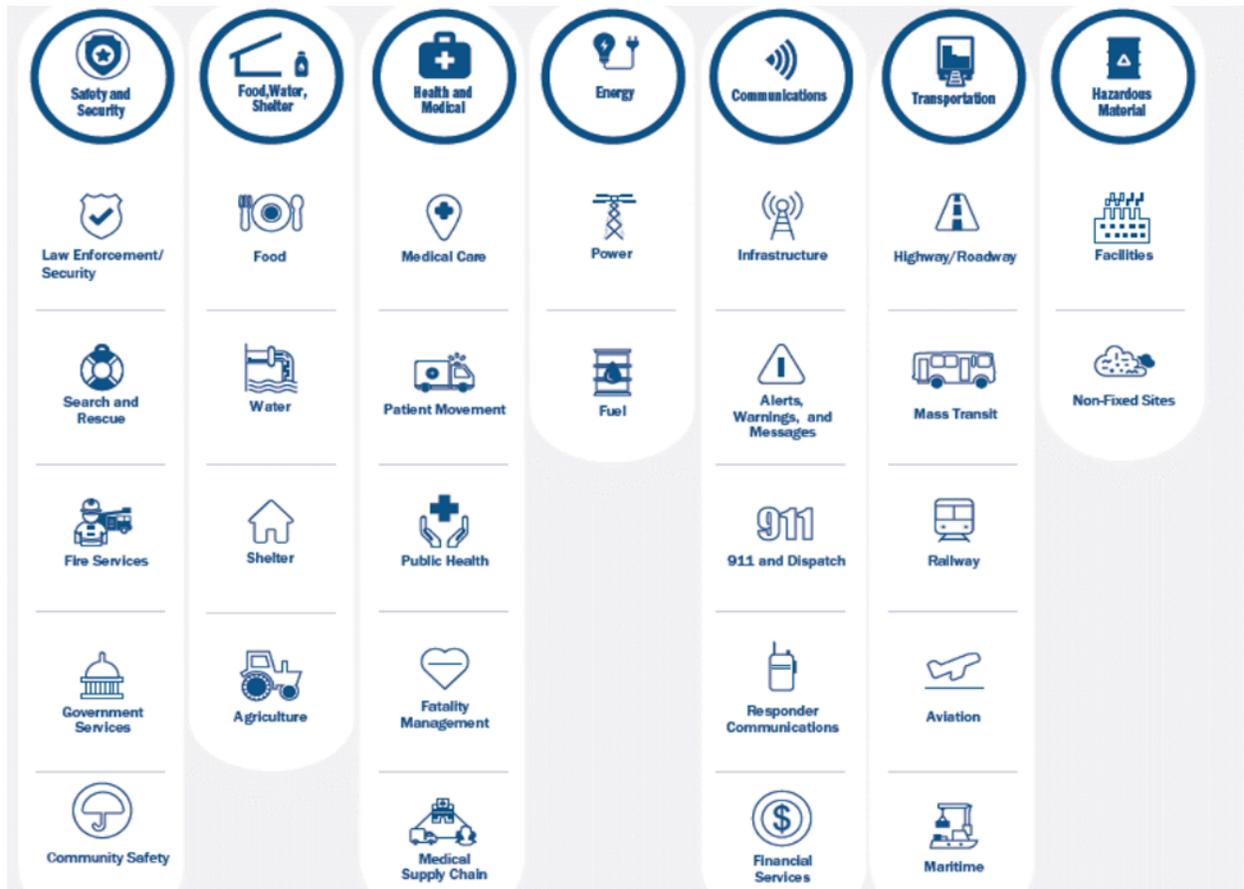
The 2020 Census reported the population of Broomfield to be 74,112. To estimate the number of people in identified hazard areas, the number of residential parcels at risk were multiplied by the Census Bureau’s average household size for Broomfield of 2.6. For more details on economic assets, development trends, and other population and demographic information refer to Chapter 3 Community Profile.

4.3.3 Critical Facilities and Infrastructure

A critical facility is one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. To develop a comprehensive list of critical facilities in Broomfield, several data sources were compiled including GIS databases of critical facilities and infrastructure from the County, and the 2020 HIFLD data.

Lifeline categories are FEMA’s recommended way to standardize the classification of critical facilities and infrastructure which provide indispensable service, operation, or function to a community. A lifeline is defined as providing indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security.

Figure 4-2 Lifeline Categories



Source: FEMA

The inventory of critical facilities identified in the City and County of Broomfield is broken down by type in Table 4-4. Note that this inventory includes some facilities located outside the County boundaries but that are within Broomfield’s sphere of influence. Figure 4-3 maps the general location of these facilities, while Figure 4-4 shows the location and condition of the County’s bridges. Specific information on facilities, names, and other key details may be accessed by permission of the County or infrastructure owner.



Critical facilities located in areas at risk of hazards are listed in the Vulnerability Assessment section of each hazard profile.

Table 4-4 Broomfield Critical Facilities

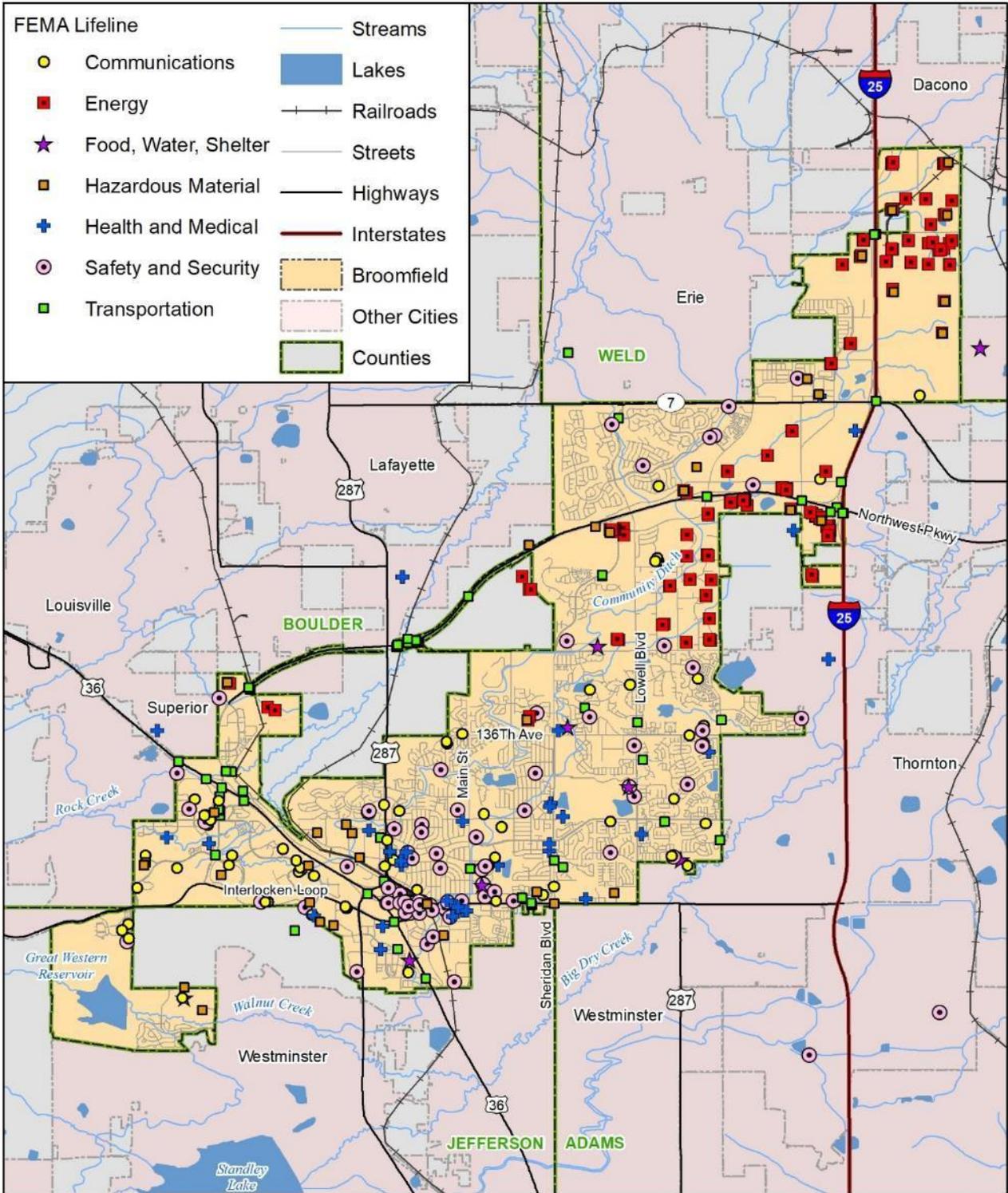
FEMA Lifeline	Facility Type	Count	Total
Communications	Land Mobile Private	44	64
	Microwave Service	20	
Energy	Oil Gas Facility	32	272
	Oil Gas Well	240	
Food, Water, Shelter	City Facility	3	8
	Event Center	2	
	Water Treatment Plant	1	
	Wastewater Treatment Plant	2	
Hazardous Material	Tier II	37	37
Health and Medical	Adult Day Care Facility	1	37
	Assisted Living Residence/Nursing Home	2	
	Cemetery	3	
	City Facility	2	
	Disability Care	1	
	Elderly Care Facility	4	
	Home and Community Based Services	7	
	Home Health	7	
	Hospice	2	
	Medical Facility	7	
	Rehabilitation or Recovery	1	
Safety and Security	City Facility	10	96
	Elementary School	7	
	EOC	1	
	Fire Station	8	
	High School	6	
	Historical Place	44	
	K-12	1	
	K-8 School	3	
	Middle School	2	
	Police Station	4	
	Post Office	2	
	Pre-K-6	2	
	Pre-K-8	2	
	School	2	
Special Needs	2		
Transportation	Airport	2	61
	Park-n-Ride	2	



FEMA Lifeline	Facility Type	Count	Total
	Good Condition Bridge	31	
	Fair Condition Bridge	25	
	Poor Condition Bridge	1	
	Grand Total		575

Source: Wood Analysis of City and County of Broomfield and HIFLD data

Figure 4-3 Critical Facilities in the City & County of Broomfield

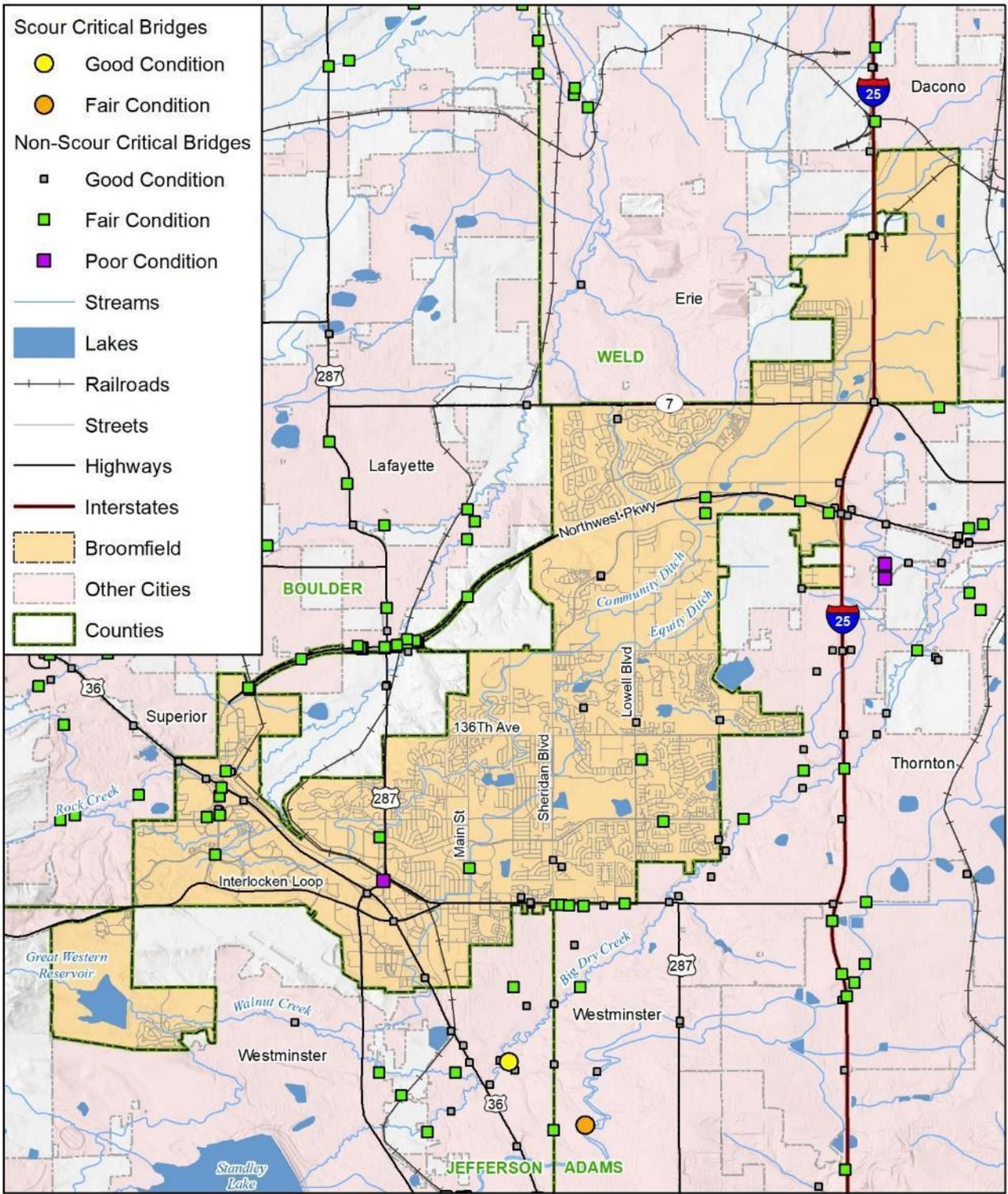


Map compiled 6/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, National Inventory of Bridges, HIFLD, CEPC

0 2.5 5 Miles



Figure 4-4 Bridges in the City & County of Broomfield



Map compiled 6/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, National Bridge Inventory

0 2.5 5 Miles





Oil and Gas Assets

Of the 575 critical facilities listed in Table 4-4, 272 (47%) are associated with the oil and gas industry. Note that this analysis counts pads; many pads have multiple wells. This illustrates the significance of oil and gas drilling in and around Broomfield. Oil and gas wells and related facilities are critical assets, and as such need to be protected from the effects of hazards such as flooding, wildfires, and severe weather. Multi-well pads are a particular planning priority for Broomfield, and the City coordinates closely with oil and gas operators to ensure that risk management plans and response plans are comprehensive and updated regularly (see Planning Step 3 in Section 2.2.1).

The potential impacts of these facilities on people, property, and the environment must also be evaluated, as discussed in Section 4.16 Hazardous Materials.

4.3.4 Historic, Cultural, and Natural Resources

Assessing Broomfield's vulnerability to disasters also involves inventorying the historic, cultural, and natural assets of the area. This step is important for the following reasons:

- The community may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing so ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts are higher.
- The rules and laws for reconstruction, restoration, rehabilitation, and/or replacement are often specific for these types of designated resources (e.g., under the National Environmental Policy Act [NEPA] and Section 106 of the National Historic Preservation Act).
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.

Historic and Cultural Resources

A historic property not only includes buildings or other types of structures such as bridges and dams but can also refer to Native American sites, roads, byways, historic landscapes, and such other features. Historic properties and cultural resources are also valuable economic assets that increase property values and attract businesses and tourists. Far from being at odds with economic development, preservation of these assets is often an important catalyst for economic development (e.g., historic downtown revitalization programs leading to growth in heritage tourism).

Some key information on historic assets and properties in Broomfield was obtained from the National Register of Historic Places (NRHP). The NRHP database, administered by the National Park Service, is the Nation's official list of cultural resources worthy of preservation, and the NRHP overall is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archaeological resources. Properties listed include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. As of July 2021, there are no NRHP properties listed in the City and County of Broomfield.

Colorado has a similar historical resource record version, called the Colorado State Register of Historic Properties (CSRHP). This database contains the State's significant cultural resources worthy of preservation for the future education and enjoyment of Colorado's residents and visitors. Properties listed in the Colorado State Register include individual buildings, structures, objects, districts, and historic and archaeological sites. The Colorado State Register program is administered by the Office of Archaeology and Historic Preservation within the Colorado Historical Society. Properties listed in the NRHP are automatically placed in the Colorado State Register. There are two historic resources in Broomfield listed in the Colorado State Register of Historic Properties, as summarized in Table 4-5.



Table 4-5 Historic and Cultural Resources in Broomfield

Historic Place Name	Date Listed	Data Source
Broomfield Denver & Interurban/Colorado & Southern Railway Depot	1/21/2016	CSRHP
Westlake School	11/9/1994	CSRHP

Source: National Park Service, History Colorado

Another significant historic property is the Broomfield Depot Museum, located in Zang Spur Park, which houses over 4,000 historical objects collectively estimated at over \$100,000. The museum’s collections include: artifacts, photographs, and archival materials associated with the development of Broomfield; the late-20th century growth of Broomfield including the development of neighborhoods and the Boulder-Denver Turnpike; economic activities including local agriculture and agriculture-related, retail, and commercial businesses; health and health care; sports and recreation; faith communities; civic, fraternal, business, and arts organizations; unique community events and organizations; individuals and families; personal collections of local hobbyists; and natural history specimens. Although the museum has train-related artifacts in its collection, most of the artifacts are related to Broomfield history more generally and are meant to interpret and record the history of the Depot as well as of the development of Broomfield and its role as an agrarian community and transportation hub.

Natural Resources

Natural resources are important to include in benefit-cost analyses for future projects and may be used to leverage additional funding for projects that also contribute to community goals for protecting sensitive natural resources. Awareness of natural assets can lead to opportunities for meeting multiple objectives. For instance, protecting wetland areas can protect sensitive habitat as well as attenuate and store floodwaters.

Wetlands are a valuable natural resource for communities due to their benefits to water quality, wildlife protection, recreation, and education, and play an important role in hazard mitigation. Wetlands provide natural floodplain protection by reducing flood peaks and slowly releasing floodwaters to downstream areas. When surface runoff is dampened, the erosive powers of the water are greatly diminished. Furthermore, the reduction in the velocity of inflowing water as it passes through a wetland helps remove sediment being transported by the water. They also provide drought relief in water-scarce areas where the relationship between water storage and streamflow regulation is vital (Wetland Functions and Values, 2016).

Endangered Species

To further understand natural resources that may be particularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (endangered and threatened species) in the planning area. An endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. 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. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. Candidate species are a third category of plants and animals at risk, but these have been proposed as endangered or threatened but are not currently listed.

According to the U.S. Fish and Wildlife Service (USFW) Environmental Conservation Online System (ECOS), there are 16 federally endangered, threatened, or candidate/proposed/ under/other status review species in Broomfield as of July 2021. These are listed in Table 4-6. Resolved Taxon refers to species for which a Not Warranted 12 month finding or Not Substantial 90-day finding has been published in the Federal Register, or which has been removed from the candidate list.



Table 4-6 Endangered Species in Broomfield

Group	Common Name	Scientific Name	Status
Amphibians	Northern leopard frog	<i>Rana pipiens</i>	Resolved Taxon
Birds	American peregrine falcon	<i>Falco peregrinus anatum</i>	Recovery
Birds	Ferruginous hawk	<i>Buteo regalis</i>	Resolved Taxon
Birds	White-faced ibis	<i>Plegadis chihi</i>	Species of Concern
Birds	Swainson's hawk	<i>Buteo swainsoni</i>	Resolved Taxon
Birds	Western burrowing owl	<i>Athene cunicularia ssp. hypugaea</i>	Species of Concern
Birds	Bald eagle	<i>Haliaeetus leucocephalus</i>	Recovery
Birds	Whooping crane	<i>Grus americana</i>	Experimental Population
Flowering Plants	Ute ladies'-tresses	<i>Spiranthes diluvialis</i>	Threatened
Flowering Plants	Western prairie fringed Orchid	<i>Platanthera praeclara</i>	Threatened
Flowering Plants	Colorado Butterfly plant	<i>Gaura neomexicana var coloradensis</i>	Recovery
Insects	Monarch butterfly	<i>Danaus plexippus</i>	Candidate
Mammals	Black-tailed prairie dog	<i>Cynomys ludovicianus</i>	Resolved Taxon
Mammals	Preble's meadow jumping mouse	<i>Zapus hudsonius preblei</i>	Threatened
Mammals	Little brown bat	<i>Myotis lucifugus</i>	Under Review
Reptiles	Eastern short-horned lizard	<i>Phrynosoma douglassii brevirostra</i>	Species of Concern

Source: U.S. Fish & Wildlife Service ECOS



4.4 Active Threat

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Active Threat	Limited	Occasional	Critical	Medium

4.4.1 Description

An active threat can encompass a variety of malicious acts including explosive attacks, conventional firearm attacks, vehicle attacks, or even chemical/biological/ radiological/nuclear/explosive (CBRNE) attacks. Typically, an active threat is a very short-lived incident meant to inflict as many casualties as possible, although recovery from an incident can last days or even months.

The FBI defines an active shooter as “one or more individuals actively engaged in killing or attempting to kill people in a populated area. Implicit in this definition is the shooter’s use of one or more firearms. The “active” aspect of the definition inherently implies the ongoing nature of the incidents, and thus the potential for the response to affect the outcome.” The FBI further defines a mass killing as an incident resulting in three or more fatalities.

The U.S. DHS notes that “in most cases, active shooters use firearms(s) and there is no pattern or method to their selection of victims...situations are unpredictable and evolve quickly...and are often over within 10 to 15 minutes.” However, the presence or suspected presence of secondary devices can lengthen the duration of the event until the attack site is determined to be clear. Although this definition focuses on an active shooter, the elements remain the same for most active threat situations.

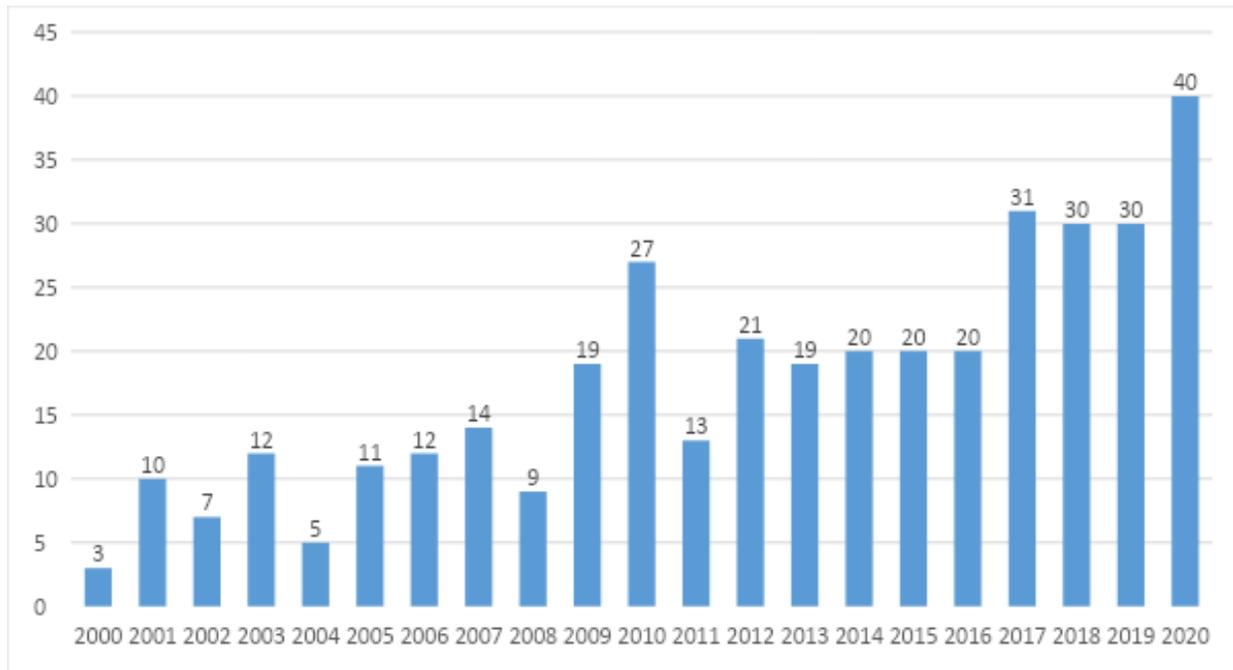
While many terrorist attacks can also be described as active shooter incidents, here the term is used to refer to non-politically motivated incidents such as recent tragic incidents at schools, places of worship, and workplaces; these attacks are also sometimes called mass shootings. Active shooters typically use firearms (although for the purposes of this plan, the definition of active threat is broad and intended to include attacks such as vehicle and knife attacks). The motivations for committing such acts range from retribution for a perceived injustice; to acts of violence against racial minorities, LGBTQ persons, or others; to promoting a specific social or political goal. Typically, active shooters are not interested in taking hostages or attaining material gain, and frequently are not even interested in their own survival. Unlike organized terrorist attacks, most active shooter incidents are carried out by one or two individuals.

For the purposes of this hazard profile, normal law enforcement incidents such as barricaded suspects, hostage negotiations, high risk warrant searches, bomb threats, and other criminal activities are not included.

4.4.2 Past Events

The FBI report *Active Shooter Incidents, 20-Year Review 2000-2019* identified 333 active shooter incidents over that 20-year period. Subsequent FBI data shows 40 such incidents in 2020. These incidents are shown by year in Figure 4-5; the upward trend in the number of incidents per year is obvious from the chart.

Figure 4-5 Active Shooter Incidents in the U.S., 2000-2020



Source: FBI reports Active Shooter Incidents, 20-Year Review 2000-2019 & Active Shooter Incidents in the United States in 2020

The FBI report listed 13 active shooter incidents in Colorado. between 2000-2020; Colorado ranks 7th highest in number of incidents compared to other states. Table 4-7 lists active shooter incidents that have occurred in Colorado in the last 22 years. While none of these incidents occurred within Broomfield, several others took place in neighboring jurisdictions.

Table 4-7 Active Shooter Incidents in Colorado, 1999-2020

Year	Incident	Fatalities
1999	Columbine High School	15
2006	Platte Canyon High School	2
2007	New Life Church Shooting	4
2010	Deer Creek Middle School	0
2012	Aurora Theater Shooting	12
2013	Arapahoe High School Shooting	2
2015	Colorado Springs Shooting	4
2019	STEM School Shooting, Highlands Ranch	1
2021	King Soopers Shooting, Boulder	10

Source: News media

School violence is sometimes considered as a subset of active shooter incidents (although not all school incidents involve the use of firearms). The U.S. Secret Service conducted a study of incidents of “targeted school violence” in the U.S. from 2008 to 2017, which they defined as “any incident in which a current or recently former K-12 school student purposefully used a weapon to cause physical injury to, or the death of, at least one other student and/or school employee in or on the immediate property of the school while targeting in advance one or more specific and/or random student(s) and/or employee(s).” The study excluded spontaneous incidents that resulted from unplanned fights or were tied to other criminal acts such as gang violence or drug trafficking. The Secret Service study found 41

incidents that met the criteria from 2008 to 2017, an average of 4 per year. As with active shooter incidents, the number of incidents has increased. From 2008 through 2012, the nation saw an average of 2.6 incidents per year; from 2013 through 2017, that number had risen to 5.4 per year. 61% of attacks used firearms, while 39% used knives. In the 41 attacks, 98 victims were harmed, including 79 injured and 19 killed; this averages out to 1.9 persons injured and 0.5 killed per incident.

Turning briefly to the threat of terrorism, the Global Terrorism Database (GTD) catalogs more than 200,000 terrorist attacks dating back to 1970. As shown in Figure 4-6, GTD data shows that despite public perception the number of terrorist attacks on U.S. soil decreased for most of past 50 years. From an average of 148 incidents per year in the 1970s, the frequency of attacks had declined to less than 23 per year in the 2000s. An increase in attacks starting around 2014 has brought that average back up to 43 incidents per year for 2011 through 2019 (the most recent year the GTD has analyzed), the highest since the 1980s.

In most years, the number of people killed or injured by terrorists on American soil is fairly low, with a median of 25 casualties per year. (The average is significantly higher due to a handful of high-casualty incidents such as the 9-11 attacks.) According to the GTD data, there have only been 11 years since 1970 where 100 or more Americans were killed or injured in terrorist attacks; however six of those years have been in the last 10 years.

Figure 4-6 Terrorist Attacks in The U.S. 1970-2019

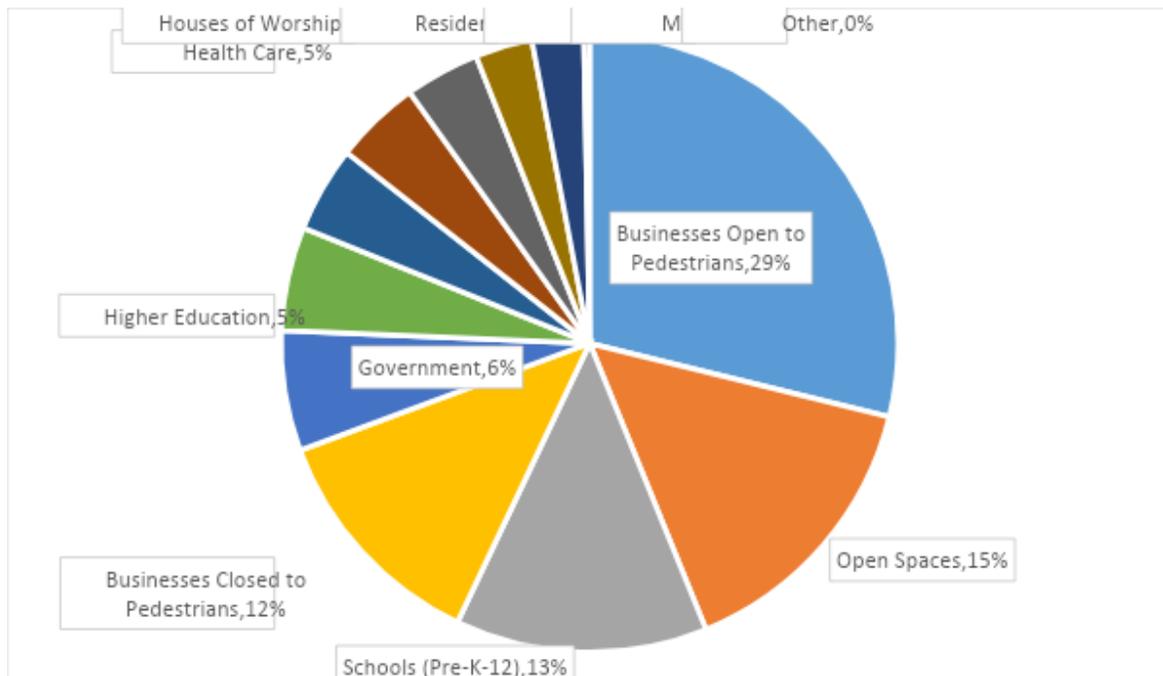


Source: GTD, <https://www.start.umd.edu/gtd/>

4.4.3 Location

Active threats can take place anywhere. While the trend in active threats has been to target high population areas, soft target venues, businesses, and schools, incidents across Colorado and the nation shows they can happen anywhere, as shown in Figure 4-7. While the entire City is potentially at risk of active threat incidents, the extent of most individual incidents is **limited**.

Figure 4-7 Active Shooter Incident Locations, 2000-2019



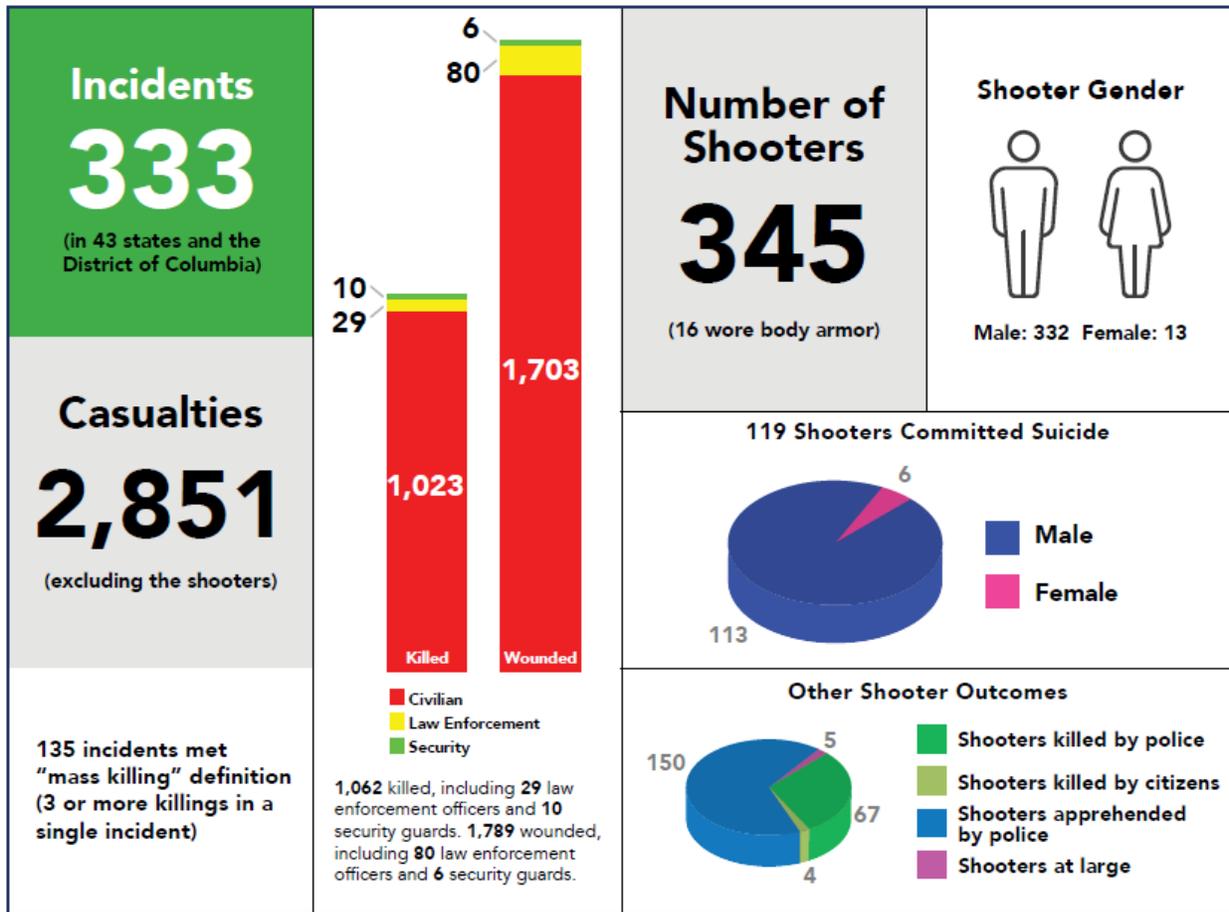
Source: FBI report Active Shooter Incidents, 20-Year Review 2000-2019

4.4.4 Magnitude and Severity

Active threats can be measured in multiple ways including length of incident, casualties, and number of perpetrators. Figure 4-8 summarizes the outcomes of the 333 incidents from 2000-2019. Casualties for active threat incidents vary widely, with an average of three killed and five wounded per incident, excluding the shooter.

Although an active threat may only directly impact one specific piece of infrastructure (i.e., a school, theater, or concert venue), it indirectly impacts the community in many ways. Ongoing closures for investigation, local and national media logistics, VIP visits, mental health concerns, and aversions to similar infrastructure and subsequent impacts to businesses can manifest after an active threat. The psychological impact of these types of incidents is often even worse than the direct impacts and can continue to affect a community for years. Thus, the overall significance of this hazard is **critical**.

Figure 4-8 Active Shooter Incident Outcomes, 2000-2019



Source: FBI report Active Shooter Incidents, 20-Year Review 2000-2019

4.4.5 Probability of Future Occurrence

The probability of occurrence for an active threat can be difficult to quantify, largely due to different definitions of what constitutes an active threat. The 373 active shooter incidents in the FBI report average out to 17.8 incidents per year between 2000-2020; but the increased frequency of incidents means the average for 2011-2020 is actually 24.4 per year. Based on the 13 incidents in Colorado from 2000-2020, there is roughly a 62% chance of an active shooter incident occurring somewhere in the State in a given year. While the odds of an attack specifically in Broomfield are significantly lower, it should be noted that attacks in neighboring counties can still have significant impacts on Broomfield. The overall probability is estimated to be **occasional**.

4.4.6 Climate Change Considerations

There is no established link between climate change and human-caused hazards such as active threats.

4.4.7 Vulnerability

The consequences from an active threat can range from single fatalities to the destruction of critical infrastructure.

People

Most terrorist attacks are primarily intended to kill and injure as many people as possible. Physical harm from a firearms attack or explosive device is not completely dependent on location, but risk is greater in areas where higher numbers of people gather. If a biological or chemical agent were released indoors, it could result in exposure to a high concentration of pathogens, whereas an outdoors release could affect many more people but probably at a lower dose. Symptoms of illness from a biological or

chemical attack could go undetected for days or even weeks. Local healthcare workers may observe a pattern of unusual illness or early warning monitoring systems may detect airborne pathogens. People could also be affected by an attack on food and water supply. In addition to impacts on physical health, any terrorist attack would likely cause significant stress and anxiety.

Similarly, most active shooters primarily target people, attempting to kill or injure large numbers of individuals. The number of injuries and fatalities are highly variable, dependent on many factors surrounding the attack including the location, the number of type of weapons used, the shooter's skill with weapons, the amount of people at the location, and law enforcement response time. Statistics indicate an average of 6.5 casualties per active shooter incident. Psychological effects of the incident on not only victims and responders, but also the general public, may last for years.

Property

Active shooter incidents rarely result in significant property damage. However, active threats can close down property and facilities for days or even months for investigation or rehabilitation of the site. As examples, the Aurora Theater was closed for 6 months after that shooting incident, and transformer replacement after the Metcalf Sniper Attack in California took 5 months.

Critical Facilities and Infrastructure

As noted above, active shooter incidents rarely result in significant property damage, but can close down facilities and infrastructure for days or even months for investigation or rehabilitation of the site.

Government Services

Responders may be the target of secondary attacks meant to exploit the response system. Unless the active threat is directed at a government facility or critical infrastructure, it is unlikely that continuity of operations will be significantly impacted. Potential impacts may include:

- Call priority - Low priority calls for service may be delayed until the incident is over. Property crimes, minor injuries, and transports via ambulance will see an increased response time.
- Delivery of services at government facilities may be impacted if a shelter in place/lockdown/lockout is implemented.

Public confidence in the government is directly related to the ability to respond to an active threat. The response to the Parkland shooting in Florida was widely seen as a failure of both policy and procedure, resulting in multiple lawsuits, a vote of no confidence in the Sheriff, and intense media scrutiny.

Economy

Direct economic impacts from most active threat attacks are minimal. However, indirect costs can be substantial, including:

- Responder costs, including overtime, equipment, resource expenditure, etc.
- Facility damage
- Loss of revenue
- Legal fees
- Mental health/other healthcare related costs
- VIP visits/security
- Policy/legislative changes to increase security

Some statistics from active threats show the different costs, including rebuilding costs. San Bernardino "had to pay \$4 million for the response...Connecticut gave the County of Newtown \$50 million just for the costs of rebuilding...the costs from the 1999 shooting at Columbine High School came to roughly \$50 million." (Delgado, 2018)

Historic, Cultural, and Natural Resources

While historic and cultural facilities are often seen as likely terrorism targets, they are not often targeted by non-political active threats. Most active shooter attacks do not cause widespread damage

to the environment. Atypical attacks utilizing CBRNE materials could significantly impact the environment. Unless an attacker targets a hazardous materials site (fixed facility or rail), or infrastructure such as wastewater or water purification sites, it is unlikely to result in significant impacts to the environment.

4.4.8 Development Trends

The link between increased development and terrorist attacks is uncertain at best. Many terrorist attacks have targeted larger metropolitan areas, so a larger population could potentially make public events more attractive targets. Population growth and development could expose more people and property to the impacts of an explosive or other CBRNE attack.

4.4.9 Risk Summary

- The overall significance of active threats to Broomfield is medium.
- Changes since 2016: active threats were not profiled in the 2016 Plan.
- While the number of terrorist attacks on U.S. soil has been declining since the 1970s, active shooter incidents and school violence have risen in recent years.
- Effects on people: The primary aim of most active shooters is to injure and kill as many people as possible.
- Effects on property: Active shooter incidents rarely cause significant property damage.
- Effects on economy: Most active shooter incidents have minimal impacts on the economy.
- Effects on critical facilities and infrastructure: Crime scene concerns can lead to the loss of use of critical facilities for days or weeks.
- Related Hazards: Cyber Attack, Hazardous Materials Incident.

4.5 Aircraft Accident

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Aircraft Accident	Significant	Occasional	Moderate	Medium

4.5.1 Description

Rocky Mountain Metropolitan Airport (formerly the Jefferson County Airport) is located on the City and County of Broomfield’s southern border in Jefferson County. The airport sits at an elevation of 5,673 feet and covers 17,000 acres. The public-use, general aviation airport is owned by Jefferson County and home to the Jefferson County Tanker Base maintained by the U.S. Forest Service. The airport’s proximity to the nearby Interlocken business district brings a large volume of corporate traffic and business traveler clientele to the airport and surrounding area.

Rocky Mountain Metropolitan Airport services small personal aircraft, helicopter traffic, as well as both small and large commercial jet traffic. Four fixed-wing flight schools and one helicopter training school operate at the airport. Airspace above Broomfield is utilized and controlled by Denver Center, which also services Denver International Airport. A new control tower was dedicated by the Federal Aviation Administration (FAA) on February 7, 2012. The 124-foot tall control tower is located south of the runways and contains space for four air traffic control positions. Total cost of construction of the new tower was \$23.7 million.

There are three primary runways at the airport, measuring 9,000, 7,000 and 3,600 feet in length. Two fixed-base operators provide fuel and other aviation services. As of 2021, Rocky Mountain Metropolitan Airport is the 4th busiest airport in Colorado. For the 12-month period ending September 30, 2018, the FAA estimates that Rocky Mountain Metropolitan averaged 482 flights per day, a 44% increase since 2015. Of those flights, 92% were general aviation, 4% air taxi, 3% military and less than one percent commercial.

Figure 4-9 Approach to Rocky Mountain Metropolitan Airport, looking to the northwest.



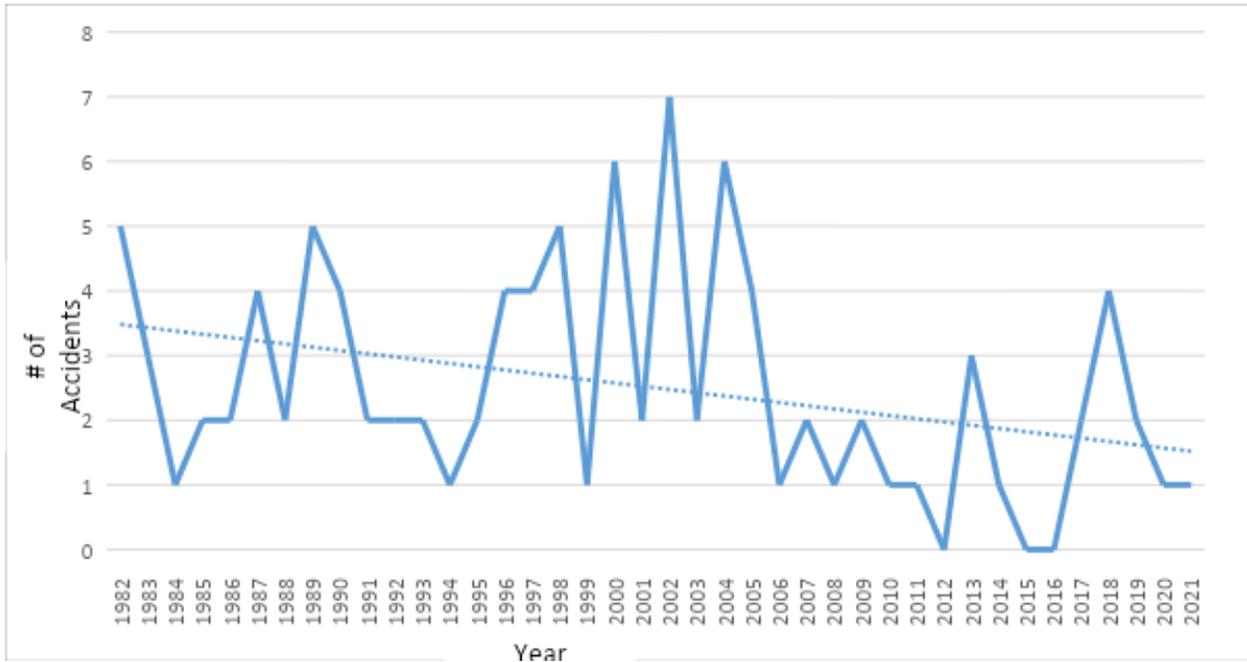
Source: 2016 City and County of Broomfield Hazard Mitigation Plan

The Erie Municipal Airport (formerly Tri-County Airport) is located across Broomfield’s northern border in Weld County, along State Highway 7 approximately 3-4 miles west of Interstate 25. The general aviation airport is owned by the Town of Erie and services mostly light, single-engine aircraft and helicopters, although the 4,700’ runway can accommodate larger turbo props (e.g., King Air, Cheyenne). For the 12-month period ending September 30, 2018, the FAA estimates that Erie Municipal Airport averaged 260 flights per day, on average, a 170% increase since 2015.

4.5.2 Past Events

National Transportation Safety Board (NTSB) data lists a total of 100 aviation accidents in the City & County of Broomfield from 1982 through August 2021, as shown in Figure 4-10. This represents an average of 2.5 accidents per year. This number has declined significantly over the last 40 years, from an average of more than 3 a year in the 1980s to around 1.4 per year in the 2010s.

Figure 4-10 Aviation Accidents in Broomfield 1982-2021



Source: NTSB

Figure 4-11 Aircraft Debris in a Yard Near 13th and Elmwood, February 20, 2021



Source: Broomfield Police Department

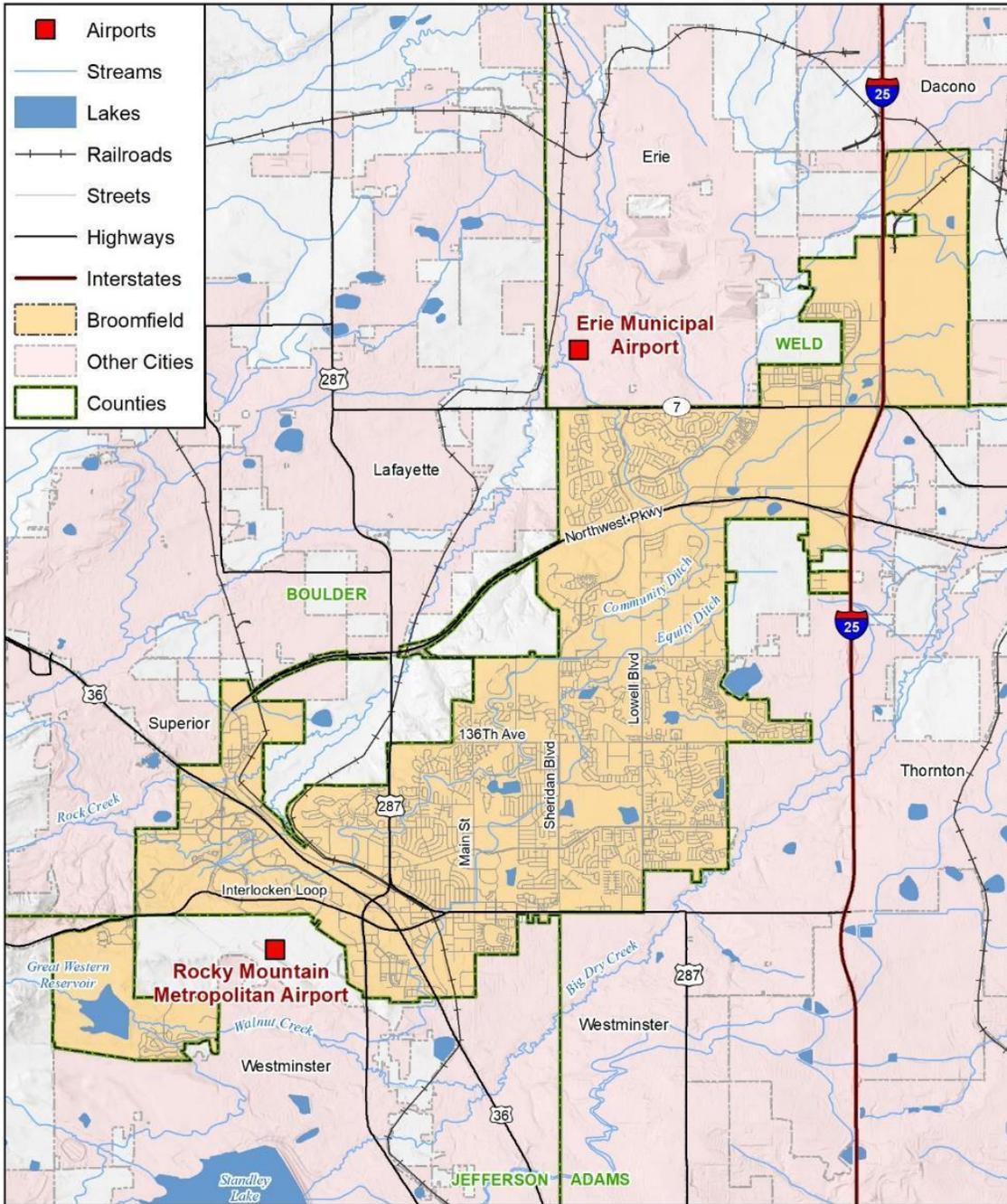
The vast majority of these accidents resulted in no serious injuries. NTSB records show only 12 accidents between 1982 and 2021 that resulted in a total of 12 fatalities and five serious injuries.

On February 20, 2021, a United Airlines commercial passenger flight departing Denver International Airport experienced an engine failure, causing several large pieces of debris to fall across Broomfield. Fortunately, there were no injuries or major damage on the ground, and the flight was able to return to Denver International Airport (DIA) and land safely.

4.5.3 Location

A significant portion of the County is exposed to an elevated risk of aircraft accidents. While air traffic patterns impact all areas of Broomfield, the highest risk is to those areas in the vicinity of airports (southwestern and extreme northern parts of the county), as shown in Figure 4-12. Although an aircraft crash in populated and developed areas is always a possibility, most crashes occur on or near airport grounds.

Figure 4-12 Airport Locations Near the City & County of Broomfield



Map compiled 7/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
HIFLD

0 2.5 5 Miles





4.5.4 Magnitude and Severity

While the impacts of aircraft accidents in Broomfield to date have been relatively minor, the possibility of a more serious accident persists. While aircraft crashes in populated areas are thankfully rare in the U.S., if even a small jet were to crash into a populated section of Broomfield it could potentially lead to dozens of casualties on the ground in addition to the aircraft's passengers. Because of the substantial public safety risk posed by an aircraft accident off airport grounds in the City and County of Broomfield, the Planning Team has rated the Consequence of Occurrence of this hazard as **moderate**.

4.5.5 Probability of Future Occurrence

The probability of future aircraft accidents is **occasional**. As discussed above, Broomfield has experienced 100 aircraft accidents from 1982 through 2021, an average of 2.5 accidents per year. However, the vast majority of those occurred on airport property and involved no injuries. The 12 accidents that resulted in fatalities or serious injuries during this period suggest the County can expect one significant accident every 3.3 years on average. The likelihood of a major off airport crash causing significant casualties on the ground is much lower.

4.5.6 Climate Change Considerations

There are no known effects of climate-induced impacts on human-caused hazards such as aircraft accidents.

4.5.7 Vulnerability

Ensuring that runway protection zones are established and maintained is one common mitigation measure near airports. Airports protection zones can be established by zoning to reduce risk in the airport vicinity. Pursuing property acquisitions, in cooperation with the FAA, on lands adjacent to airport property is another technique.

Public safety agencies in the City and County of Broomfield routinely participate in disaster exercises that simulate potential aircraft-related disasters at and near the airport property in order to evaluate the preparedness for such an incident. These drills also allow the public safety agencies to re-examine their airport emergency response plans and make adjustments as needed to address deficiencies or issues identified during the exercise process. Public safety agencies also perform post-incident critiques of all aircraft-related emergencies that do occur within their jurisdictions.

People

Aircraft accidents can result in injuries or loss of life to passengers and crew, as well as to people on the ground.

Property

Property damage from most aviation accidents is typically limited to the aircraft involved in the accident. An off-airport crash has the potential to do considerable property damage.

Critical Facilities and Infrastructure

Aside from the airports themselves, comparing the critical facilities in Figure 4-3 to the airport locations in Figure 4-12 shows there are a number of facilities that could potentially be impacted by an off airport crash.

Government Services

Aside from response resources, aircraft accidents are unlikely to have significant impacts on Broomfield's ability to deliver government services.

Economy

An incident large enough to shut down one of the airports could have significant economic impacts on the region.

Historic, Cultural, and Natural Resources

Aircraft accidents can potentially damage nearby resources and can start fires that could potentially burn parks or forested areas. This could in turn lead to economic impacts in Broomfield if tourism was affected.



4.5.8 Development Trends

Air traffic, development, and building density are all expected to increase throughout the City and County of Broomfield, magnifying the potential impacts of a future aircraft accident off-site. Much of the land use around and immediately adjacent to Rocky Mountain Metropolitan Airport (RMMA) is commercial. However, some residential subdivisions currently exist near the airport and others may be planned for the area included in the airport influence zone as established by RMMA. Near Erie Municipal Airport, residential and commercial development exists south of State Highway 7 in the City and County of Broomfield and in the vicinity of takeoff and approach zones.

Rocky Mountain Metropolitan Airport's August 2021 Strategic Business Plan proposes to develop an additional 200 acres of land to develop new facilities and expand operations.

4.5.9 Risk Summary

- Overall significance is **Medium**.
- Changes since 2016: aircraft accidents were ranked as high significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that medium is a more accurate assessment of the risk.
- Broomfield averages 2.5 aircraft accidents per year, but almost all of them are confined to airport property and result in few or no injuries. An accident causing death or serious injuries happens roughly every 3.3 years.
- While a major off airport crash is unlikely, the impacts of a plane crash in a populated area could be severe.
- Related Hazards: Hazardous Materials Incidents, Critical Infrastructure Outage.



4.6 Critical Infrastructure Outage

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Critical Infrastructure Outage	Significant	Occasional	Critical	Medium

4.6.1 Description

Nearly 85 percent of critical infrastructure in the U.S. is privately owned and/or operated. Private ownership spans most industry sectors, including power/utilities, oil and gas, chemical/pharmaceutical, critical manufacturing, financial services, telecommunications, transportation, and aviation. Under Presidential Executive Order 13636, critical infrastructure is defined as the “systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety or any combination of those matters” (EO 13636 2013).

The federal government has identified the following 17 critical infrastructure sectors to facilitate federal-level response planning:

- Agriculture and Food
- Banking and Finance
- Chemical
- Commercial Facilities
- Commercial Nuclear Reactors, Materials & Waste
- Dams
- Defense Industrial Base
- Drinking Water & Water Treatment Systems
- Emergency Services
- Energy
- Government Facilities
- Information Technology
- National Monuments and Icons
- Postal and Shipping
- Public Health and Healthcare
- Telecommunications
- Transportation Systems

According to FEMA’s Strategic Foresight Initiative, “Aging infrastructure may become less reliable and impede response and recovery operations. For example, degrading transportation infrastructure would hinder the movement of materiel and personnel to disasters, degrading water infrastructure would make firefighting more difficult, and degraded health care infrastructure would make it more difficult to treat disaster survivors. Failing infrastructure could also become a hazard in its own right. Like the I-35 bridge collapse in Minnesota in 2007, people could be hurt or killed when a deficient structure collapse. An even more troubling hazard would be the collapse of structurally deficient dams” (FEMA 2011). Similar incidents were seen in Texas in 2021 after a winter storm event and many days of extreme cold that followed.

While dams are listed as critical infrastructure, the risk of dam failure is profiled separately in Section 4.8.

4.6.2 Past Events

There are no records of significant infrastructure failures in Broomfield, beyond relatively minor power outages. All communities are subject to periodic disruptions, outages or other impacts to critical infrastructure. Natural hazards, including blizzards, high winds, tornadoes and drought, can potentially



cause disruptions, in addition to human-caused hazards such as hazardous materials incidents and cyber terrorism.

One recent study found that power failures increased by more than 60% between 2015 and 2020. The study concluded that power outages during a heat wave could expose between 68% and 100% of the urban population to an elevated risk of heat exhaustion and/or heat stroke.

The Texas power outage of February 2021 is an example of the potential impacts of a major, prolonged outage during the winter. More than 4.5 million homes and businesses were left without power, for several days. Water service was also disrupted for 12 million people. At least 210 people were killed directly or indirectly, with some estimates as high as 702 killed.

4.6.3 Location

Subsection 4.3.3 above describes critical infrastructure facilities and key assets in the City and County of Broomfield. The location rating is **Significant**.

4.6.4 Magnitude and Severity

The potential severity and magnitude of critical infrastructure outages is **Critical**.

The loss of major critical facilities and infrastructure systems could have potentially devastating impacts throughout the County, including significant disruption to essential life, and economic and financial impacts, as well as the possibility of causing damage to additional infrastructure. Loss of local roads or small commercial facility may have immediate to limited impacts.

According to the 2018 Colorado State Hazard Mitigation Plan (SHMP), the interconnected nature of critical infrastructure means that a failure in one jurisdiction can often create impacts in neighboring jurisdictions. For example, interruption of emergency services in one area may lead to a need for response resources from other jurisdictions. The 2018 SHMP lists additional examples of interdependencies and cascading effects:

- **Commercial Facilities:** Disruption in commercial operations can have major economic impacts, and affect the ability of other critical infrastructure sectors to purchase needed supplies, parts, etc. A supply chain disruption could severely limit the state's ability to recover from any disaster or emergency.
- **Communications:** Most critical infrastructure rely heavily on communication systems to control and monitor operations. For some businesses losing communication is as serious as losing power. Emergency Services rely heavily on communications system both internally and to coordinate their operations.
- **Emergency Services:** As its operations provide the first line of defense for nearly all critical infrastructure sectors, a failure or disruption in emergency services can result in significant harm or loss of life, major public health issues, long-term economic loss, and cascading disruptions to other critical infrastructure. Reduced emergency services could put the state at increased risk of several human-made hazards, as well as limiting the state's ability to respond to and recover from natural and technological hazards.
- **Financial Services:** The unique, complex, broad-based, globally distributed, and highly integrated nature of the financial services sector makes it more interdependent and prone to cascading impacts that could have major effects on the commercial and manufacturing sectors, as well as government and healthcare sectors.
- **Food and Agriculture:** Interruption in any stage of the farm-to-table chain can lead to severe disruptions throughout the sector. Widespread disruptions to the food supply could have severe impacts on all critical infrastructure sectors, the economy, and the general public; severe food shortages could also degrade the public's ability to withstand other hazards such as prolonged winter storms.
- **Government Facilities:** Loss of facilities can disrupt the ability of state and local governments to provide essential services to the public, to include emergency services, the maintenance and repair of transportation systems, and other public sector services. While loss of government facilities may not increase the likelihood of natural or technological disasters, a lack of government coordination and response could greatly magnify the impacts of most hazards.

- **Healthcare and Public Health (HPH):** For many Americans, even a brief disruption in healthcare services could be catastrophic. At any one time, almost 50 percent of Americans require one or more prescription medications to mitigate health issues. Nearly 468,000 Americans require regular dialysis services. Long-term or widespread interruptions could put the public at increased risk of a pandemic or other biological hazards.
- **Transportation Systems:** Interruptions to commerce can affect the commercial, manufacturing, and agriculture sectors, to include potential critical supply chain disruptions. Interrupting the movement of the public affects all sectors if employees are not able to reach their worksites. Disruption of transportation systems can limit the ability of emergency services to reach affected areas. Utility work crews may be delayed in restoring services. Conversely, transportation interruptions can put some members of the public at severe risk if they are unable to reach needed medical services, such as dialysis patients.
- **Water and Wastewater Systems:** A drinking water contamination incident or the denial of drinking water services could severely impact manufacturing facilities, food and agricultural operations, healthcare services, and the operation of government and emergency services. A major, prolonged loss of clean water could have far-reaching public health, economic, environmental, and psychological impacts. Disruption of wastewater treatment facilities or services can cause loss of life, economic impacts, and severe public health and environmental impacts. If wastewater infrastructure were to be severely damaged or destroyed, the lack of redundancy in the sector might cause a loss of service potentially affecting the habitability of homes and workspaces in all sectors.

4.6.5 Probability of Future Occurrence

The probability of future occurrences is **occasional**.

Predicting the timing and location of major infrastructure disruptions and outages is as difficult as predicting the frequency and consequences of severe weather events or human-caused accidents. The Planning Team has rated the probability of future occurrences as occasional.

The following were identified in the 2018 SHMP as events that could increase the probability of future failures or outages:

- **Extreme Weather:** More severe storms, extreme and prolonged drought conditions, and severe flooding all combine to increase the risk of major infrastructure failure. Refer to sections 4.9 Drought, 4.12 Extreme Temperatures, 4.15 Hail, 4.18 Lightning, 4.20 Severe Wind, 4.21 Tornado, and 4.22 Winter Storm.
- **Aging Infrastructure:** While America's infrastructure continues to age and deteriorate, public investment in maintaining our infrastructure as a portion of gross domestic product has declined substantially for the past 50 years. The American Society of Civil Engineers (ASCE) has estimated that \$2.2 trillion would be needed to bring the nation's infrastructure up to a condition that meets the needs of the current population. The potential for accidents and failures from infrastructure operating beyond its intended lifespan or with insufficient maintenance thus continues to increase.
- **Growing Interdependencies:** Infrastructure systems are becoming more interconnected, both within and between sectors. While this has many operational and financial advantages, the extent of sector interdependencies greatly increases the likelihood of one failure leading to cascading failures through other systems. In an increasingly interconnected world, where critical infrastructure crosses national borders and global supply chains, the potential impacts increase with these interdependencies and the ability of a diverse set of threats to exploit them.
- **Cyber Vulnerabilities:** Cyber attacks against critical infrastructure systems have increased significantly and have the potential to cause major disruptions. Refer to Section 4.7 Cyber Attack Hazard Profile for further discussion.

4.6.6 Climate Change Considerations

Climate change projections show an increase in the frequency and severity of many of the hazards that impact the energy sector, thus potentially leading to an increase in the frequency of power failures. Higher average temperatures can be expected to put increased demand on the energy sector during summer months, while colder-than-normal temperatures can increase load during winter months. Higher average temperatures could also place increased load on Colorado's water supply. Additional large-scale wildfires can lead to overheating transmission lines which can also cause power outages in affected and surrounding areas.

Additionally, America's plans to reach net-zero carbon emissions by 2050 is likely to result in increased peak electricity demand as more people switch to electric cars, heating, and appliances, increasing the strain on transmission lines and may increase the frequency of power failures.

4.6.7 Vulnerability

People

The impacts on people from critical infrastructure outages can vary from minor to significant. Communication disruptions can lead to missed or delayed emergency service calls and responses. One recent study concluded that power outages during a heat wave could expose between 68% and 100% of the urban population to an elevated risk of heat exhaustion and/or heat stroke.

Electric power disruption could be an inconvenience for many but those individuals who are dependent on electricity to live independently in their homes it could be deadly. According to data from the U.S. Health and Human Services emPOWER map web viewer, 9% of Medicare Beneficiaries (1,121 of 12,033) in Broomfield rely on electricity-dependent medical and assistive equipment in order to live independently in their homes. Prolonged power outages could be life threatening to these individuals.

Property

Residences and businesses can be impacted by power outages and other infrastructure disruptions. Those outages rarely cause property damage to the structures themselves but can have significant economic costs as well as the impacts to people described above.

Critical Facilities and Infrastructure

Considerable investment and effort have been expended to ensure critical public infrastructure is resilient and that critical and emergency services can be rapidly restored after disruptions occur. The consequences of critical infrastructure impacts are addressed in the Broomfield EOP, the Broomfield COOP, Broomfield Departmental Plans/Procedures, and the response protocols of public and private partners. Restoring broadband and cellular service after utility disruptions may be as important as restoring electricity and water to emergency managers and citizens that utilize technology to communicate with one another.

Broomfield completed a system wide all-hazards evaluation of critical assets in 2020 as part of America's Water Infrastructure Act 2018 requirements (AWIA).

Xcel Energy has announced plans to transition towards renewable and resilient energy sources by 2050, which could reduce their vulnerability. The future of United Power's clean energy plans is to be determined.

Government Services

Public infrastructure concerns include electrical power, public safety, dam safety, water infrastructure, water treatment, road/bridge safety, and other traditionally government- owned infrastructure sectors. Restoring broadband and cellular service after utility disruptions may be as important as restoring electricity and water to emergency managers and citizens that utilize technology to communicate with one another.

Economy

Economic impacts can be significant due to critical infrastructure outages. The following is from the 2018 Colorado State Hazard Mitigation Plan.



“The costs associated with energy sector disruptions are known to be significant. According to a 2005 study, losses due to power interruption across all business sectors are estimated at between \$104-164 billion annually, and costs associated with power quality problems are estimated at \$15-24 billion annually. Industrial, tech, and digital business firms lose an estimated \$5.7 billion annually due to power interruption, and among high-tech business firms, the costs of downtime due to power interruption can exceed \$1 million per minute. In 2009, the U.S. Department of Energy estimated that power outages cost an average of \$150 billion annually, or about \$500 for every U.S. citizen per year. Based on an interim Department of Energy report on the 2003 Northeast Blackout, a statewide power disruption in Colorado could cost between \$18-49 million per hour.”

Historic, Cultural, and Natural Resources

Historic, cultural and natural resources are not likely to be impacted by critical infrastructure outages.

4.6.8 Development Trends

Additional development has the potential to increase the demand on aging infrastructure, which could increase the frequency of outages without investment to increase capacity.

4.6.9 Risk Summary

- Overall significance is **Medium**.
- Changes since 2016: none.
- All communities are subject to periodic disruptions, outages or other impacts to critical infrastructure.
- Critical infrastructure outages are both a hazard and a consequence of other hazard events.
- Communication failures can disrupt emergency communications.
- Power outages can be life threatening to individuals that are dependent on electricity. Roughly 1,121 Broomfield residents are electricity dependent.
- Related Hazards: Aircraft Accident, Cyber Attacks, Dam Inundation, Drought, Earthquake, Expansive Soils, Extreme Temperatures, Fire, Flood, Hail, Hazardous Materials Incidents, Land Subsidence, Lightning, Severe Wind, Tornado, and Winter Storm.



4.7 Cyber Attack

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Cyber Attack	Significant	Occasional	Critical	High

4.7.1 Description

The 2018 Colorado State Hazard Mitigation Plan defines cyber attacks as “deliberate exploitation of computer systems, technology-dependent enterprises, and networks.” Cyber attacks use malicious code to alter computer operations or data. The vulnerability of computer systems to attacks is a growing concern as people and institutions become more dependent upon networked technologies. The Federal Bureau of Investigation (FBI) reports that, “cyber intrusions are becoming more commonplace, more dangerous, and more sophisticated,” with implications for private- and public sector networks. Cyber threats can take many forms, including:

- **Phishing attacks:** Phishing attacks are fraudulent communications that appear to come from legitimate sources. Phishing attacks typically come through email but may come through text messages as well. Phishing may also be considered a type of social engineering meant to exploit employees into paying fake invoices, providing passwords, or sending sensitive information.
- **Malware attacks:** Malware is malicious code that may infect a computer system. Malware typically gains a foothold when a user visits an unsafe site, downloads untrusted software, or may be downloaded in conjunction with a phishing attack. Malware can remain undetected for years and spread across an entire network.
- **Ransomware:** Ransomware typically blocks access to a jurisdiction’s/agency’s/ business’ data by encrypting it. Perpetrators will ask for a ransom to provide the security key and decrypt the data, although many ransomware victims never get their data back even after paying the ransom.
- **Distributed Denial of Service (DDoS) attack:** Perhaps the most common type of cyber attack, a DDoS attack seeks to overwhelm a network and causes it to either be inaccessible or shut down. A DDoS typically uses other infected systems and internet connected devices to “request” information from a specific network or server that is not configured or powerful enough to handle the traffic.
- **Data breach:** Hackers gaining access to large amounts of personal, sensitive, or confidential information has become increasingly common in recent years. In addition to networked systems, data breaches can occur due to the mishandling of external drives.
- **Critical Infrastructure/SCADA System attack:** There have been recent critical infrastructure Supervisory Control and Data Acquisition (SCADA) system attacks aimed at taking down lifelines such as power plants and wastewater facilities. These attacks typically combine a form of phishing, malware, or other social engineering mechanisms to gain access to the system.

The 2018 Colorado State Hazard Mitigation Plan concludes: “This is a newly developing threat, so as more resources are devoted to countering the hazard, the risk of a disruption would hopefully decrease. Mitigation opportunities for this hazard include continued diligence of the state’s Office of Information Technology (OIT), as well as for other government and private sector entities to continue to monitor, block, and report cyber attacks, and continually assess the vulnerability of systems.”

The Broomfield Information Technology Department’s IT Security (ITSec) team is constantly working to maintain and improve the County’s defenses against cyber attacks.

4.7.2 Past Events

According to the FBI’s 2020 Internet Crime Report, the FBI received 791,790 cyber crime complaints in 2020, a 165% increase since 2016. Nationwide losses in 2020 alone exceeded \$4.2 Billion. Colorado ranked 10th among states in losses. Ransomware attacks accounted for 2,474 complaints and over \$29M in reported losses in 2020. Since many attacks go unreported, the actual numbers are likely higher. The cybersecurity firm Symantec reported in 2016 that one in every 131 emails contained malware, and the



company’s software blocked an average of 229,000 web attacks every day. And according to a 2016 study by Kaspersky Lab, roughly one in five ransomware victims who pay their attackers never recover their data.

In 2018, the Colorado Department of Transportation (CDOT) was impacted by a SamSam ransomware attack resulting in approximately a million dollars in loss. In 2020 both the town of Erie and the town of Lafayette Colorado fell victim to different types of cyber attacks. The town of Erie lost more than a million dollars during a business email account (BEA) scam. Lafayette lost approximately \$45,000 resulting from a ransomware attack.

The Privacy Rights Clearinghouse, a non-profit organization based in San Diego, maintains a timeline of 9,741 data breaches resulting from computer hacking incidents in the United States from 2005-2019. The database lists 47 data breaches against systems located in Colorado, totaling over 400,000 impacted records; it is difficult to know how many of those affected Broomfield residents. Attacks happening outside of the state can also impact local businesses, personal identifiable information, and credit card information. Table 4-8 shows several of the more significant cyber attacks in Colorado in recent years.

Table 4-8 Major Cyber Attacks Impacting Colorado, 2005-2020

Date Reported	Target	Total Records	Description
July 21, 2005	University of Colorado, Boulder	49,000	Data exposure/ personal identifiable information
August 2, 2005	University of Colorado, Denver	36,000	Data exposure/ personal identifiable information
July 17, 2007	Western Union, Greenwood Village	20,000	Credit card breach
April 22, 2014	Centura Health, Englewood	12,286	Health information breach
July 3, 2017	PVHS-ICM Employee Health and Wellness, Fort Collins	10,143	Data exposure/health information
February, 2018	CDOT	N/A	Data encryption/ ransomware
August, 2019	Regis University	N/A	DDoS
December, 2019	Southeast Metro Storm Water Authority (SEMSWA)	N/A	Ransomware
June, 2020	Colorado Information Analysis Center (CIAC)	Unknown	Data Breach
July 2021	City of Lafayette	Unknown	Ransomware

Source: Privacy Rights Clearinghouse

A 2017 study found ransomware payments over a two-year period totaled more than \$16 million. Even if a victim is perfectly prepared with full offline data backups, recovery from a sophisticated ransomware attack typically costs far more than the demanded ransom.

Recent years have seen an increase in ransomware attacks, particularly against local government systems. The City of Atlanta was hit by a major ransomware attack in 2018, recovery from which wound up costing a reported \$2.6 million, significantly more than the \$52,000 ransom demand. A similar attack against the City of Baltimore in 2019 affected the city government’s email, voicemail, property tax portal, water bill, and parking ticket payment systems, and delayed more than 1,000 pending home sales. In March 2019, Orange County, North Carolina was attacked with a ransomware virus, causing slowdowns and service problems at key public offices such as the Register of Deeds, the Sheriff’s Office, and county libraries. The attack impacted a variety of county services, including disrupting the county’s capability to process real estate closings, issue marriage licenses, process fees or permits, process housing vouchers, and verify tax bills.



A large, sophisticated malware attack, known as Olympic Destroyer, was launched against the 2018 Winter Olympics in PyeongChang, South Korea. The attack initially took down servers, email, Wi-Fi, and ticketing systems, which could have severely disrupted the games. Fortunately, the organizing committee had a robust cybersecurity group that was able to quickly restore most functions.

4.7.3 Location

The geographic extent is **significant**.

Cyber attacks can and have occurred in every location regardless of geography, demographics, and security posture. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the state can still impact people, businesses, and institutions within the County. All servers in the City and County of Broomfield are potentially vulnerable to cyber attacks. Businesses, industry, and even individuals are also susceptible to cyber attacks.

4.7.4 Magnitude and Severity

The potential magnitude and severity of cyber attack is **critical**.

There is no universally accepted scale to explain the severity of cyber attacks. The strength of a DDoS attack is often explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, the October 21, 2016 Dyn attack, peaked at 1.2 terabytes per second and impacted some of the internet's most popular sites to include Amazon, Netflix, PayPal, Twitter, and several news organizations.

Data breaches are often described in terms of the number of records or identities exposed. The largest data breach ever reported occurred in August 2013, when hackers gained access to all three billion Yahoo accounts. The hacking incidents associated with Colorado in the Privacy Rights Clearinghouse database are of a smaller scale, ranging from just 32 records to approximately 60,000, along with several cases in which an indeterminate number of records may have been stolen.

Ransomware attacks are typically described in terms of the amount of ransom requested, or by the amount of time and money spent to recover from the attack. One report from cybersecurity firm Emsisoft estimates the average successful ransomware attack costs \$81 million and can take 287 days to recover from.

4.7.5 Probability of Future Occurrence

The probably of future cyber attack is **occasional**.

Small-scale cyber attacks such as DDoS attacks occur daily, but most have negligible impacts at the local or regional level. Data breaches are also extremely common, but again most have only minor impacts on government services.

Perhaps of greatest concern to Broomfield are ransomware attacks, which are becoming increasingly common. It is difficult to calculate the odds of Broomfield or one of its municipal governments being hit with a successful ransomware attack in any given year, but it is safe to say it is likely to be attacked in the coming years.

The possibility of a larger disruption affecting systems within the County is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Major attacks specifically targeting systems or infrastructure in the County cannot be ruled out.

4.7.6 Climate Change Considerations

There are no known effects of climate induced impacts on human-caused hazards such as cyber attacks.

4.7.7 Vulnerability

People

Injuries or fatalities from cyber attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure. More likely impacts to the public are financial losses and an



inability to access systems such as public websites and permitting sites. Indirect impacts could include interruptions to traffic control systems or other infrastructure.

Data breaches and subsequent identity thefts can have huge impacts on the public. The Internet Crime Complaint Center (IC3) estimates that identity theft alone resulted in \$2.7 billion in losses to businesses and \$149 million in losses to individuals.

Property

The vast majority of cyber attacks affect only data and computer systems and have minimal impact on general property.

Critical Facilities and Infrastructure

The vast majority of cyber attacks affect only data and computer systems. However, sophisticated attacks have occurred against the SCADA systems of critical infrastructure, which could potentially result in system failures on a scale equal with natural disasters. Facilities and infrastructure such as the electrical grid could become unusable. A cyber attack took down the power grid in Ukraine in 2015, leaving over 230,000 people without power. A ransomware attack on the Colonia Pipeline in 2021 caused temporary gas shortages for the East Coast. The 2003 Northeast Blackout, while not the result of a cyber attack, caused 11 deaths and an estimated \$6 billion in economic loss.

Government Services

The delivery of services can be impacted since governments rely to a great extent upon electronic delivery of services. Most agencies rely on server backups, electronic backups, and remote options for Continuity of Operations/Continuity of Government. Many departments in the City and County of Broomfield have the option to move to a paper method including permitting, DMV services, payments to and from the County, and payroll. However, access to documents on the network, OneDrive access, and other operations that require collaboration across the County will be significantly impacted.

Cyber attacks can interfere with emergency response communications, access to mobile data terminals, and access to critical pre-plans and response documents. According to the Cyber & Infrastructure Security Agency, cyber risks to 9-1-1 systems can have “severe impacts, including loss of life or property; job disruption for affected network users; and financial costs for the misuse of data and subsequent resolution.” CISA also compiled a recent list of attacks on 9-1-1 systems including a DDoS in Arizona, unauthorized access with stolen credentials in Canada, a network outage in New York, and a ransomware attack in Baltimore.

Public confidence in the government will likely suffer if systems such as permitting, DMV, voting, or public websites are down for a prolonged amount of time. An attack could raise questions regarding the security of using electronic systems for government services.

Economy

Economic impacts from a cyber attack can be debilitating. The cyber attack in 2018 that took down the City of Atlanta cost at least \$2.5 million in contractor costs and an estimated \$9.5 million additional funds to bring everything back online. The attack in Atlanta took more than a third of the 424 software programs offline and recovery lasted more than 6 months. The 2018 cyber attack on the CDOT cost an estimated \$1.5 million. None of these statistics take into account the economic losses to businesses and ongoing IT configuration to mitigate from a future cyber attack.

Historic, Cultural, and Natural Resources

The vast majority of cyber incidents have little to no impact on historic, cultural, or natural resources. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic control devices.

4.7.8 Development Trends

Changes in development have no impact to the threat, vulnerability, and consequences of a cyber attack. Cyber attacks can and have targeted small and large jurisdictions, multi-billion-dollar companies, small mom-and-pop shops, and individual citizens. The decentralized nature of the internet



and data centers means that the cyber threat is shared by all, regardless of new construction and changes in development.

As more systems become more reliant on technology, this will likely increase the community's vulnerability. For example, a cyber attack on self-driving vehicles could be a mass casualty event.

4.7.9 Risk Summary

- Overall significance is **high**.
- Changes since 2016: cyber attacks were not profiled in the 2016 Plan.
- Ransomware attacks on government servers have been increasing sharply in recent years.
- There have been 69 significant data breaches reported in Colorado between 2005 and 2019.
- Cyberattacks can have debilitating economic impacts and decrease in public confidence.
- Related Hazards: Critical Facilities Outages.



4.8 Dam Inundation

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Dam Inundation	Limited	Unlikely	Critical	Medium

4.8.1 Description

Dams are water storage, control, or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of, or breach in, the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream.

Dam failures are most likely to happen for one of five reasons:

- Overtopping caused by water spilling over the top of a dam. Overtopping of a dam is often a precursor of dam failure. National statistics show that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures.
- Foundation defects, including settlement and slope instability, cause about 30% of all dam failures.
- Cracking caused by movements like the natural settling of a dam.
- Inadequate maintenance and upkeep.
- Piping when seepage through a dam is not properly filtered and soil particles continue to progress, and form sinkholes in the dam. Seepage often occurs around hydraulic structures, such as pipes and spillways; through animal burrows; around roots of woody vegetation; and through cracks in dams, dam appurtenances, and dam foundations.

The primary drivers of failure can also include various types of human errors, such as slips (actions committed inadvertently), lapses (inadvertent inactions), and mistakes (intended actions with unintended outcomes, due to errors in thinking). In the context of dam safety, mistakes are the most common type of human error which contributes to failures. Violations are also sometimes classified as a category of human errors and involve situations in which there is deliberate non-compliance with rules and procedures, usually because the rules or procedures are viewed as unworkable in practice.

In practice, dam failure rarely results in fatalities because there is typically enough advance warning to allow people to evacuate the area. However, intense storms may produce a flood in a few hours or even minutes for upstream locations. Flash floods occur within six hours of the beginning of heavy rainfall and dam failure may occur within hours of the first signs of breaching. Other failures and breaches can take much longer to occur, from days to weeks, as a result of debris jams or the accumulation of melting snow.

Dam inundation can also occur from non-failure events, such as when outlet releases increase during periods of heavy rains or high inflows. Controlled releases to allow water to escape when a reservoir is overfilling can help prevent future overtopping or failure. When outlet releases are not enough, spillways are designed to allow excess water to exit the reservoir and prevent overtopping. This can protect the dam but result in flooding downstream.

The U.S. Army Corps of Engineers and the Colorado State Engineer classify dams into four categories based on analysis of potential consequences from a sunny day failure of the dam, as shown in Table 4-9. The Colorado State Engineer periodically reviews the hazard classification of existing dams by evaluating the consequences of failure. If the State Engineer's review indicates the consequences of failure have changed, the State Engineer will assign an appropriate new hazard classification. The Colorado Division of Water Resources, Dam Safety Division performs regular dam safety inspections at a frequency appropriate to the hazard classification of the dam.



It is important to keep in mind that the hazard classification of a dam is a measure of the consequences if the dam were to fail, not a measure of how likely the dam is to fail or a representation of structural condition.

Table 4-9 Dam Hazard Classification Definitions

Hazard Class	Definition
High	A dam for which life loss is expected to result from failure of the dam.
Significant	A dam for which significant damage, but no life loss is expected to result from failure of the dam. Significant damage is defined as damage to structures where people generally live, work, or recreate, including public and private facilities. Significant damage is determined to be damage sufficient to render structures or facilities uninhabitable or inoperable.
Low	A dam for which neither life loss nor significant damage as defined for a Significant Hazard dam are expected to result from failure of the dam.
No Public Hazard (NPH)	A dam for which neither life loss nor significant damage as defined for a Significant Hazard dam are expected to result from failure of the dam.

Source: Colorado Division of Water Resources, Dam Safety Division, <https://dwr.colorado.gov/services/dam-safety>

Privately owned High and Significant hazard potential dams are required by Colorado regulations to have Emergency Action Plans (EAPs) in place, which provide for the emergency response procedures in the event of a dam emergency event. Federally owned High hazard dams are also required to have EAPs by Federal Regulations (USACE) and are required to have inundation maps as well. According to the 2018 State Hazard Mitigation Plan, all high hazard dams in Colorado have EAPs in place.

4.8.2 Past Events

In Broomfield’s history as a municipality and consolidated city-county, there have been no dam failure incidents or structures lost as a result of flooding from a dam incident.

4.8.3 Location

A **limited** portion of the County is at risk of dam inundation. **Figure 4-13** shows the high and significant hazard dams of concern to the City and County of Broomfield. The property study described in the Consequence Analysis section below identifies 3,318 buildings in identified inundation areas, representing 5% of the total buildings in the County; 1,276 of those are residential.

Dams Within the Planning Area

For this plan update, the 2018 National Inventory of Dams was consulted. There are four high hazard dams within the boundaries of City and County of Broomfield. Table 4-10 provides the names, locations, and other pertinent information for all high and significant hazard dams in the planning area. One of these dams is considered Conditionally Satisfactory by the Colorado Dam Safety Program, which means the safety inspection indicated evidence of structural distress (i.e., seepage, evidence of minor displacements, etc.) and if conditions worsen it could lead to failure of the dam. Nissen #2 is managed by Eagle Trace Golf Course; the other three are managed by City and County of Broomfield.

Table 4-10 High and Significant Hazard Dams in City and County of Broomfield

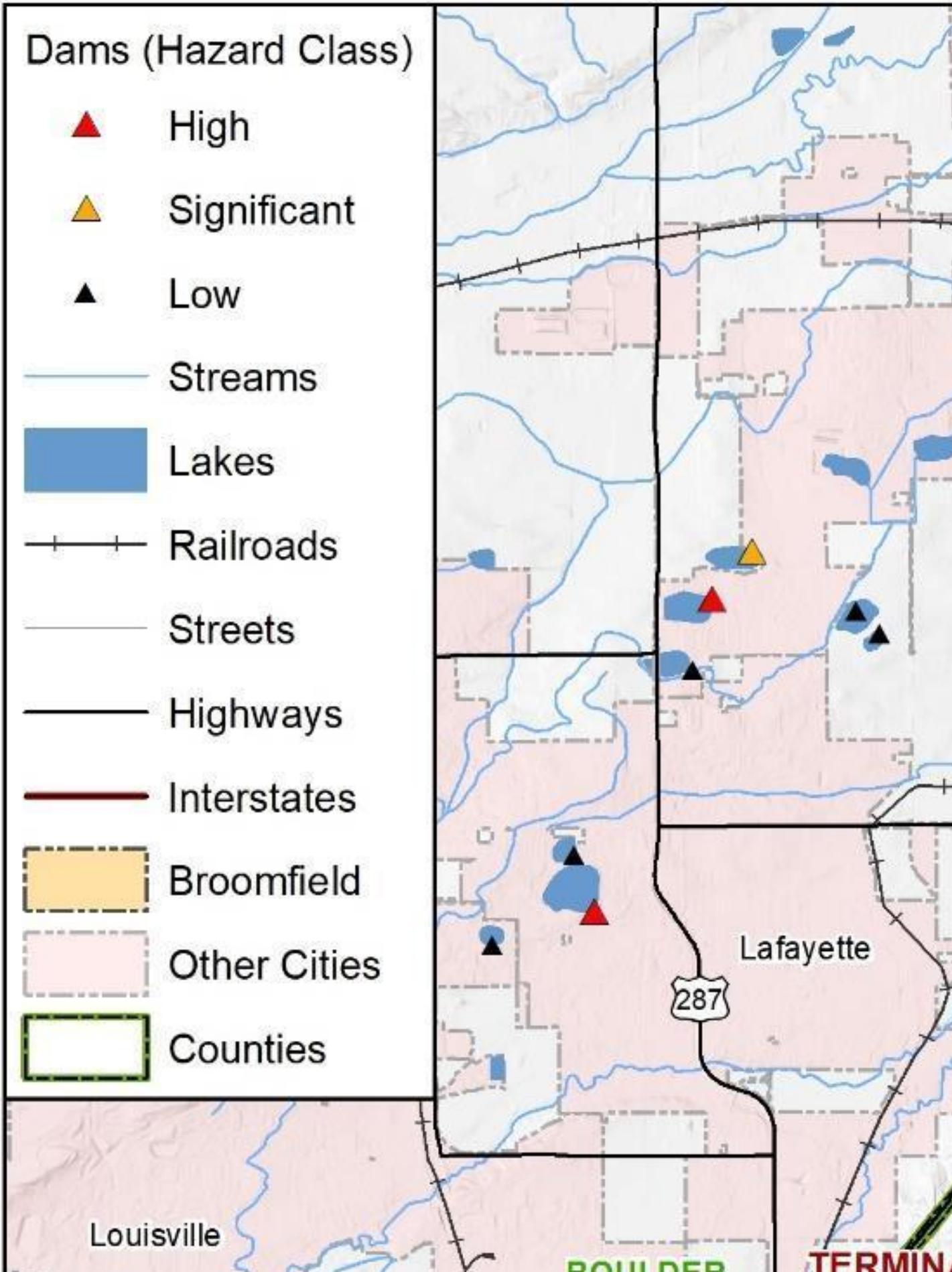
Dam Name	NID #	Hazard Class	EAP	Dam Ht. (ft)	Storage (acre-ft)	Overall Conditions	River/Stream	Nearest Downstream City/Distance (miles)
Great Western	CO00091	High	Yes	70	2,200	Conditionally Satisfactory	Walnut Creek	Westminster/1
Nissen #2	CO02128	High	Yes	6.2	154	Satisfactory	Big Dry Creek	Broomfield/0.1
Terminal Storage Reservoir	CO02778	High	Yes	31	386	Satisfactory	Big Dry Creek	Westminster/2.5
Siena	CO02859	High	Yes	40	450	Satisfactory	Coal Creek	Lafayette/2



Source: 2020 National Inventory of Dams; <https://nid.sec.usace.army.mil>



Figure 4-13 High and Significance Dams of Concern to Broomfield





Dams Upstream of the Planning Area

There are also 12 dams located outside of Broomfield that could affect the County if they were to fail; six of those are High Hazard dams and six are Significant Hazard dams. Table 4-11 provides the names, locations, and other pertinent information for these dams.

Table 4-11 High and Significant Hazard Dams Upstream of the City and County of Broomfield

Dam Name	NID #	Hazard Class	EAP	Dam Ht. (ft)	Storage (acre-ft)	Overall Conditions	River/Stream	Nearest Downstream City/Distance (miles)
Woman Creek	CO02787	High	Yes	49.8	836	Satisfactory	Woman Creek	Westminster/0.1
Standley Lake	CO00101	High	Yes	113	43,344	Satisfactory	Big Dry Creek	Westminster/0.1
Ketner	CO00093	High	Yes	30	166	Satisfactory	Walnut Creek	Westminster/0
Mckay Lake - East	CO00240	High	Yes	20	375	Satisfactory	Big Dry Creek	Westminster/1
Mckay Lake - South	CO02835	High	Yes	13	375	Satisfactory	Big Dry Creek	Westminster/0.2
Superior	CO02777	High	Yes	59	400	Satisfactory	Coal Creek	Superior/0.1

Source: 2020 National Inventory of Dams; <https://nid.sec.usace.army.mil>

Non-Failure Dam Incidents

The Colorado Department of Natural Resources (DNR) has a statewide database that identifies the potential for non-failure dam inundation to show potential areas of flooding where outlet capacity exceeds the downstream channel capacity. The dams at the highest risk of non-failure inundation are shown in Table 4-12. The ranking shown in the table represents the likelihood of hazardous conditions existing below the dams during a worst case, maximum outlet release scenario. Dams are ranked as high, moderate, or low likelihood for outlet releases to cause conditions that could require an emergency response to reduce potential downstream consequences. The ranking is based on a statewide database of high hazard dams that includes 441 high hazard dams that have been analyzed by the Colorado DNR for this aspect of dam incident flooding. The high, moderate, or low designations were assigned by DNR by dividing the total number of ranked dams across the state into thirds. Should there be a need to relieve pressure on the dam (e.g., if there was excess inflow from high rains or snowmelt) releases from the dams ranked as high or moderate may result in downstream flooding.

Table 4-12 Dams with Risk of Non-Failure Inundation

Dam ID	Dam Name	Outlet Description	Max Outlet Release Capacity (cfs)	Ranking	Outlet Release Hazard Rating
020212	Great Western	24" Steel	40	196	Moderate
020411	Nissen #2	18" Steel	22	265	Moderate
060324	Mckay Lake - South	2.5 Steel Pipe Located at East Dam (060202)	0	367	Low
060326	Siena	54" Steel Pipe Encased in Concrete - Controlled By 24" Sq. Slide Gate	45	305	Low
060315	Terminal Storage Reservoir	48" Steel Pipe W/ 18" By-Pass	11	311	Low

Source: State of Colorado Department of Natural Resources, Dam Safety

4.8.4 Magnitude and Severity

The potential magnitude and severity of a dam inundation events is **critical**.

Potential severity of a dam failure is typically measured by the hazard classification described above. Failure of a high hazard dam could potentially lead to multiple deaths; property destroyed and severely damaged; and/or interruption of essential facilities and services for more than 72 hours.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property located in the inundation area (downstream). The largest three dams in terms of maximum storage in and upstream the City and County of Broomfield are: the Standley Lake in Westminster along Big Dry Creek (with a capacity of 43,344 acre-feet); the Great Western in Broomfield along the Walnut Creek (with a capacity of 2,200 acre-feet); and Woman Creek Dam in Westminster along Woman Creek (with a capacity of 836 acre-feet).

A dam failure event's speed of onset can range from sudden, with little warning time prior to the release of dangerous flood flows, to an event that gradually unfolds. A spring or summer storm involving heavy rain can lead to a flash flood within six hours of the beginning of the event. Dam failure because of heavy rain can occur within hours of the first signs of failure. A dam failure event caused by a debris jam for example can take from days to weeks (FEMA 2019). Flooding from a non-dam failure flood event could last for several days depending on the amount of water needing to be released to relieve pressure on the dam.

4.8.5 Probability of Future Occurrence

The probability of future occurrences of a dam inundation event is **unlikely**.

The City and County of Broomfield has no recorded events of significant dam failures. The probability of a future event is unlikely, but it will always remain possible. High and significant hazard dams are closely monitored, as described above. Uncontrolled or controlled release flooding as well as spillway flooding below dams due to excessive rain or runoff are more likely to occur than failures.

4.8.6 Climate Change Considerations

The potential for climate change to affect the likelihood of dam failure has been incorporated into the 2020 Rules and Regulations for Dam Safety and Dam Construction, based on a state-of-the-practice regional extreme precipitation study completed in 2018 (DWR, 2018). This study determined a very high likelihood of temperature increases, resulting in increased moisture availability to extreme storms. As such, an atmospheric moisture factor of 7% is required to be added to estimates of extreme rainfall for spillway design.

4.8.7 Vulnerability

People

Table 4-13 shows the number of residents estimated to live in dam inundation areas, based on the number of residential properties located in inundation zones. Citywide there are 3,318 people in the City and County of Broomfield (5% of the total population) potentially at risk of dam inundation.

In practice, dam failure rarely results in fatalities because there is typically enough advance warning to allow people to evacuate the area. However, impacts to residential properties can be severe, to include not only direct flood damage but also contamination due to flooding of hazardous waste results in public health issues, as well as damage to sanitation services. Depending on the severity of the event, large numbers of people may be displaced or left homeless.

Property

Inundation mapping was provided by the City and County of Broomfield and the CWCBC. Combined with the parcel data in a GIS format with assessed values, this allowed comparative analysis of these layers to determine parcels and improvement values by type that fall within the boundaries of the dam inundation areas. Content value is assumed to be 50% the improvement value for residential structures and 100% the improvement value for non-residential structures.

GIS was used to create a centroid or point representing the center of the parcel polygon. The dam inundation areas were then overlaid in the parcel centroids. For the purposes of this analysis, if the



dam inundation area intersected a parcel centroid, inundation was assigned for the entire parcel. The model assumes that every parcel with a building or dwelling value greater than zero is improved in some way. Specifically, an improved parcel assumes there is a building on it. It is important to note that there could be more than one structure or building on an improved parcel (i.e., condo complex occupies one parcel but might have several structures). In these cases, the analysis counts this as one structure. Only improved parcels and the value of their improvements were analyzed. The end result is an inventory of the number and types of parcels and buildings subject to dam inundation.

Table 4-13 shows the number of residential and non-residential parcels located in mapped dam inundation areas, broken down by jurisdiction. The table also shows estimated value of the structures and their contents. In all, 1,276 residential buildings and 32 commercial buildings are at risk of dam inundation.

Table 4-13 Properties Exposed to Dam Inundation

Property Type	Improved Parcel Count	Building Count	Population
Agricultural	1	1	
Commercial	20	32	
Exempt	8	34	
Residential	829	1,276	3,318
Total	858	1,343	3,318

Source: Wood Analysis of City and County of Broomfield data

Critical Facilities and Infrastructure

Critical facilities that could be impacted by dam failure are shown in Table 4-14. In all 19 critical facilities have been identified as being at risk of dam inundation. This constitutes 3% of the critical facilities in the County.

Table 4-14 Critical Facilities Exposed to Dam Inundation, by Dam Name

Dam Name	FEMA Lifeline	Facility Type	Count
Fortune & Standley Lake	Communications	Land Mobile Private	1
		Microwave Service	1
	Transportation	Good Condition Bridge	1
Great Western	Hazardous Material	Tier II	1
Siena	Safety and Security	Police Station	1
	Transportation	Airport	1
Standley Lake	Communications	Microwave Service	1
	Food, Water, Shelter	WWTP	1
	Safety and Security	City Facility	1
Superior	Safety and Security	Historical Place	1
	Transportation	Good Condition Bridge	2
Terminal Storage Reservoir	Communications	Land Mobile Private	1
	Energy	Oil Gas Facility	1
		Oil Gas Well	2
	Safety and Security	City Facility	1
Total			19

Source: Wood Analysis of City and County of Broomfield and HIFLD data

Government Services

A dam inundation event may cause short-term accessibility issues for first responders performing routine duties or personnel reporting to work locations. Damages to facilities/personnel in an incident area may require temporary relocation of some operations. Regulatory waivers may be needed locally. Responders in flooded areas at the time of incident or assisting in evacuations could be at risk. Impacts to transportation corridors and communications lines could affect first responders' ability to effectively respond.

The ability to respond and recover may be questioned and challenged by the public if planning, response, and recovery are not timely and effective, regardless of the dam owner.

Economy

Local economy and finances could be adversely affected, possibly for an extended period depending on damage. Loss of facilities or infrastructure for the provision of government services is expected to be non-existent or negligible.

Historic, Cultural, and Natural Resources

Wetland impacts due to dam or levee failure flooding can affect water quality and wildlife habitat. Dam failure flooding may alter stream flow patterns, increase erosion, and lead to release of hazardous materials, sediment, or waste into streams, rivers, drinking water supply, ground water, and air. Historic and cultural resources could be affected just as housing or critical infrastructures would, were a dam to fail and cause downstream inundation that could further erode surfaces or cause scouring of structural foundations.

4.8.8 Development Trends

Future developments in Broomfield will continue to be vulnerable to possible dam failure. The increasing population and expanding areas of development within the County will continue to have risk for communities located downstream of significant or high hazard dams. The HMPC noted that in the past five years residential development has increased downstream of the Great Western Dam. Additionally, any further development downstream of existing dams will elevate the possible consequences if a dam should fail. Development downstream of dams does not only increase exposure to dams in general through growth, but also the exposure to high hazard dams by increasing the hazard itself.

The following mitigation actions completed since 2016 have reduced Broomfield's vulnerability to dam inundation:

- Annual Dam Safety Inspections with the Colorado Division of Dam Safety.
- Annual Dam Monitoring Reports completed by Broomfield's Reservoir Monitoring consultants, Deere & Ault.
- EAPs updated annually for each dam.
- Monthly measurements taken at each dam's monitoring wells.
- Deere & Ault completed a Toe Drain Analysis for Great Western Reservoir in 2020.
- Deere & Ault investigated Great Western's phreatic surface changes over time and developed safety thresholds to track any changes in the water surface levels. The safety thresholds were incorporated into Broomfield's monitoring wells tracking system.
- Deere & Ault led a 2-day Semi-Quantitative Risk Assessment (SQRA) workshop to identify and assign likelihoods and consequences of potential failure modes at Great Western Reservoir.

4.8.9 Risk Summary

- Overall Significance is **medium**.
- Changes since 2016: None. Dam failure was discussed in the flood profile of the 2016 Plan but was not ranked separately.
- 1,343 buildings are exposed within dam inundation areas. Of which 1,276 are residential and 32 are commercial buildings.
- Approximately 3,318 people are exposed within the dam inundation areas in the County.



- 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).
- Related Hazards: Critical Infrastructure Outages, Cyber Attack, Earthquake, Flood.



4.9 Drought

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Drought	Extensive	Likely	Moderate	High

4.9.1 Description

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. 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, but in general terms 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 area’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 stream flow, 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.

With its semi-arid conditions, drought is a natural part of the Colorado climate cycle. Due to natural variations in climate and precipitation sources, it is rare for all of Colorado to be deficient in moisture at the same time. However, single season droughts over some portion of the state are quite common. Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users that have a different water supply. Individual water suppliers may use criteria, such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler, to define their water supply conditions. Drought is further compounded by the complexity of water rights throughout the Western U.S.

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in Colorado are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flash flooding and erosion. A drought may also increase the speed at which dead and fallen trees dry out and become particularly dangerous as fuel sources in wildfires. Drought may also weaken trees in areas already affected by mountain pine beetle infestations, causing more extensive damage to trees and increasing wildfire risks. An ongoing drought which severely inhibits natural plant growth cycles may increase the susceptibility of the area to wildfire for a period of time. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

4.9.2 Past Events

Colorado has experienced multiple severe droughts over the years. The most significant of the instrumented period (which began in the late 1800s) are listed in Table 4-15. Although drought conditions can vary across the state, it is likely that the City and County of Broomfield was affected by most of these dry periods.

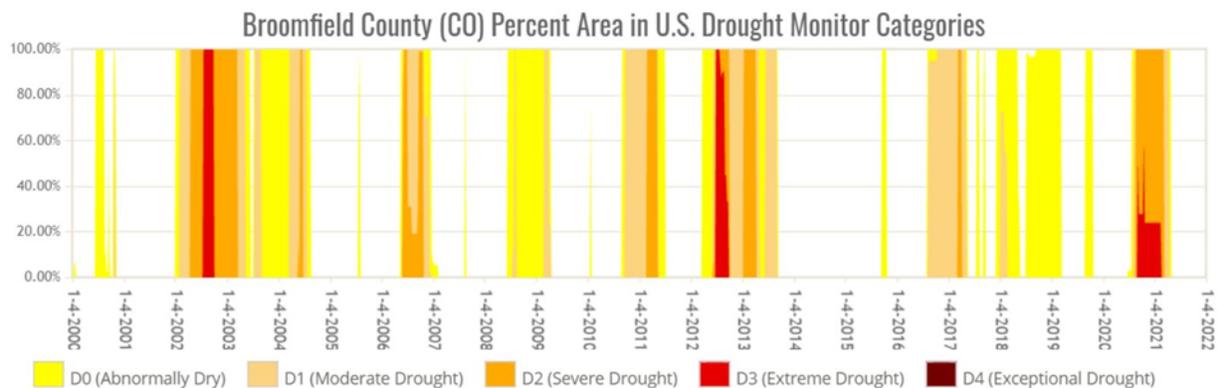
Table 4-15 Historical Dry and Wet Periods in Colorado, 1893-2020

Date	Dry	Wet	Duration (years)
1893-1905	X		12
1905-1931		X	26
1931-1941	X		10
1941-1951		X	10
1951-1957	X		6
1957-1959		X	2
1963-1965	X		2
1965-1975		X	10
1975-1978	X		3
1979-1999*		X	20
2000-2006*	X		6
2007-2010		X	3
2011-2013	X		2
2018	X		1

Source: McKee, et al. *Modified for the Colorado State Drought Plan in 2018 and City and County of Broomfield Mitigation Plan 2021 based on input from the Colorado Climate Center and U.S. Drought Monitor.

Drought is a regular and widespread occurrence in the State of Colorado. According to the U.S. Drought Monitor records for the City and County of Broomfield, in the 1,122-week period from 2000 through June 29, 2021, the county spent 524 weeks (46% of the time) in some level of drought, defined as Abnormally Dry (D0) or worse conditions. Approximately 28% of the time, or 309 weeks, was spent in Moderate Drought (D1) or worse conditions. Weeks in drought are shown in time series in Figure 4-14.

Figure 4-14 City and County of Broomfield Drought Intensity, 2000-Jan. 4, 2021



Source: U.S. Drought Monitor

Since 2012 there have been nine drought declarations issued by the USDA’s Secretary of Agriculture in the City and County of Broomfield, six of which 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 or more.

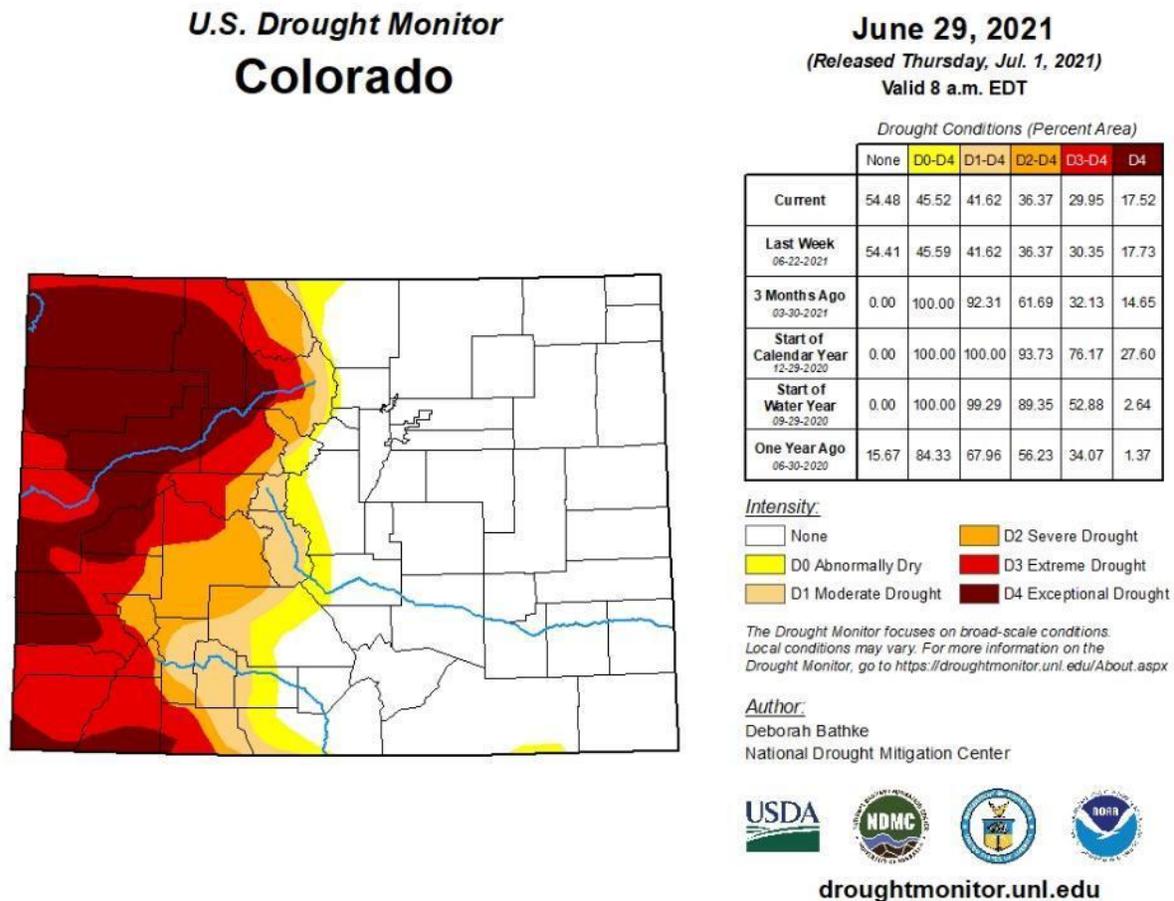
4.9.3 Location

Droughts are regional events, sometimes impacting multiple states simultaneously. Therefore, as the extent of the planning area is relatively compact and its climate is fairly continuous, it is reasonable to

assume that a drought will impact the entire planning region simultaneously. Based on this information, the location rating for drought is **extensive**.

Figure 4-15 shows U.S. Drought Monitor for Colorado as of June 29, 2021, illustrating the regional nature of drought. It is worth noting that much of Broomfield’s water supply comes from the Western Slope, so droughts there can have significant impacts even if Broomfield itself is not in drought conditions.

Figure 4-15 U.S. Drought Monitor as of June 29, 2021



4.9.4 Magnitude and Severity

The impacts drought can have on modern society are often underrated. Droughts cause obvious and severe impacts on agricultural areas by destroying existing crops and prolonging unsuitable growing conditions which hinders efforts to recover agricultural losses. This causes secondary financial impacts first on the farmers, who have no crops to sell, and then on the consumers, who must pay higher prices for scarce produce. Increased demand for a decreased water supply raises water costs, which also drives up the overall costs to both farm producers and consumers.

Urban areas are also impacted by rising water costs, which may impact personal property and personal water usage bills. Recreational uses which are water-dependent may increase significantly in price or decrease in availability, particularly those which are based in reservoirs or lakes, as the water levels may be too low to sustain safe recreation. Finally, the increased risk of wildfires impacts the planning region. While the hazard of fire itself is profiled separately, drought conditions increase the likelihood that wildfires will occur, either naturally or due to human causes.

To calculate a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area, information from the event of record is used. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it reflects common occurrence. The event of record for Broomfield occurred between July and November of 2002, during the middle of a larger drought event from 1999 to 2003 which was impacting the entire state. The event impacted the entire planning area, with 100% of the County within the D3 Extreme Drought range for more than two consecutive months according to the U.S. Drought Monitor. Any damages inflicted on critical facilities and services (critical infrastructure) resulted in no loss or disruption of services. There were no directly attributable documented illnesses or injuries, and the medical response capability of the County was not impacted. However, the drought seriously impacted water supply levels and water quality, and several severe wildfires, augmented by drought conditions, occurred nearby the planning area during this time.

The U.S. Drought Monitor classifies droughts into different categories, from D0 (Abnormally Dry) to D4 (Exceptional Drought), as shown in Figure 4-16. Periods of dryness are classified in one of these categories as the drought’s life cycle is tracked. The following table explains each of these categories.

Figure 4-16 U.S. Drought Monitor Drought Severity Classifications

Category	Description	Possible Impacts	Ranges				
			Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	<ul style="list-style-type: none"> Going into drought: <ul style="list-style-type: none"> short-term dryness slowing planting, growth of crops or pastures Coming out of drought: <ul style="list-style-type: none"> some lingering water deficits pastures or crops not fully recovered 	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	<ul style="list-style-type: none"> Some damage to crops, pastures Streams, reservoirs, or wells low, some water shortages developing or imminent Voluntary water-use restrictions requested 	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	<ul style="list-style-type: none"> Crop or pasture losses likely Water shortages common Water restrictions imposed 	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	<ul style="list-style-type: none"> Major crop/pasture losses Widespread water shortages or restrictions 	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	<ul style="list-style-type: none"> Exceptional and widespread crop/pasture losses Shortages of water in reservoirs, streams, and wells creating water emergencies 	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

Source: U.S. Drought Monitor

Drought impacts in the planning area can be wide-reaching: economic, environmental, and societal. The most significant impacts associated with drought are those related to water intensive activities such as wildfire protection, commerce, tourism/recreation, municipal usage, and wildlife preservation. Although the agricultural industry in the County is limited, it is expected to experience crop losses and livestock feeding expenses and deaths. The City and County of Broomfield may see an increase in dry fuels and associated wildfires, and some loss of tourism/recreation revenue. Water supply issues for municipal, industrial, and domestic needs will be a concern for the entire County. Lawn and tree impacts in suburban areas could result from water restrictions. Vulnerability increases with consecutive winters of below average snowpack. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. It also increases the wildfire hazard and even landslide hazard.

Based on these factors, the magnitude and severity ratings for droughts are considered **moderate**.

4.9.5 Probability of Future Occurrence

Drought is a frequent occurrence along the semi-arid Front Range, where a prolonged drought develops approximately every 15-20 years. According to information from the Colorado Drought Mitigation and



Response Plan (2018), including recent drought conditions Colorado was in drought for 50 of the past 126 years between 1893 and 2018. Looking at the weekly U.S. Drought Monitor data cited above, Broomfield spent approximately 28% of the time, or 309 weeks, in Moderate Drought (D1) or worse conditions from 2000 to January 2021. Given the regular recurrence of drought in Colorado and along the Front Range, the probability of future occurrence is rated **likely**.

4.9.6 Climate Change Considerations

The Intergovernmental Panel on Climate has projected dramatic changes in regional climate characteristics between present-day and the coming decades if global temperatures rise between 1.5 degrees Celsius and 2 degrees Celsius. Climate change can have impacts both in terms of inter-annual droughts and intra-annual runoff patterns (State of Colorado Drought Mitigation and Response Plan Update, 2018). Temperatures increased and resulting changes in evaporation and soil moistures will also add to the trend of decreasing runoff in a majority of Colorado Basins. The following table shows the challenges water managers may face with the projected changes in climate.

Table 4-16 Future Drought Vulnerability Due to Climate Change and Challenges Faced by Colorado Water Managers

Challenge	Observed and/or Projected Change
Water demands for agriculture and outdoor watering	Increasing temperatures raise evapotranspiration by plants, lower soil moisture, alter growing seasons, and thus increase water demand.
Water supply infrastructure	Changes in snowpack, streamflow timing, and hydrograph evolution may affect reservoir operations including flood control and storage. Changes in the timing and magnitude of runoff may affect functioning of diversion, storage, and conveyance structures.
Legal water systems	Earlier runoff may complicate prior appropriation systems and interstate water compacts, affecting which rights holders receive water and operations plans for reservoirs.
Water quality	Although other factors have a large impact, “water quality is sensitive both to increased water temperatures and changes in patterns of precipitation” (CCSP SAP 4.3, p. 149). For example, changes in the timing and hydrograph may affect sediment load and pollution, impacting human health.
Energy demand and operating costs	Warmer air temperatures may place higher demands on hydropower reservoirs for peaking power. Warmer lake and stream temperatures may affect water use by cooling power plants and other industries.
Mountain habitats	Increasing temperature and soil moisture changes may shift mountain habitats toward higher elevation.
Interplay among forests, hydrology, wildfires, and pests	Changes in air, water, and soil temperatures may affect the relationships between forests, surface and groundwater, wildfire, and insect pests. Water-stressed trees, for example, may be more vulnerable to pests.
Riparian habitats and fisheries	Stream temperatures are expected to increase as the climate warms, which could have direct and indirect effects on aquatic ecosystems (CCSP SAP 4.3.), including the spread of instream non-native species and diseases to higher elevation and the potential for non-native plant species to invade riparian areas. Changes in streamflow intensity and timing may also affect riparian ecosystems.
Water - and snow - based recreation	Changes in reservoir storage affect lake and river recreation activities; changes in streamflow intensity and timing will continue to affect rafting directly and trout fishing indirectly. Changes in the character and timing of snowpack and the ratio of snowfall to rainfall will continue to influence winter recreational activities and tourism.
Groundwater resources	Changes in long-term precipitation and soil moisture can affect groundwater recharge rates; coupled with demand issues, this may mean greater pressure on groundwater resources.

Source: State of Colorado Drought Mitigation and Response Plan 2018, Reproduced from CWCB



4.9.7 Vulnerability

Based on the County’s recent multi-year droughts and Colorado’s drought history, it is evident that all of the planning area is vulnerable to drought. The agricultural industry of the County, though very limited, could experience hardships, including agricultural losses, and livestock feeding expenses and deaths.

The Colorado State Drought Mitigation Plan includes vulnerability to state owned buildings and critical infrastructure, state land board lands, state operated recreational activity, aquatic habitat and species, agriculture activities, protected environments, recreation, socioeconomics, and the municipal and industrial (M&I) sectors. Broomfield generally ranked moderate in vulnerability across the sectors. The sector vulnerability scores for Broomfield are shown in Table 4-17. A score of 3.0 or above means that sector is highly vulnerable to drought; Broomfield doesn’t reach the 3.0 score for any of the sectors.

Table 4-17 City and County of Broomfield Drought Vulnerability Score by Sector

Sector	Score
Socioeconomic	2.40
Agriculture	2.06
Recreation	1.94
Environment	1.67
Average Overall Vulnerability	1.57
State Assets	1.35
Energy	0.00

Source: 2018 State of Colorado Drought Mitigation and Response Plan

The National Drought Mitigation Center (NDMC), located at the University of Nebraska in Lincoln, provides a clearinghouse for information on the effects of drought based on reports from media, observers, impact records, and other sources.

According to the NDMC’s Drought Impact Reporter, during the 20-year period from 2000 through 2020, 924 drought impacts were recorded for the State of Colorado, of which 13 were reported to affect the City and County of Broomfield. Table 4-18 summarizes the number of impacts reported by category. Note that the Drought Impact Reporter assigns multiple categories to each impact, so there is some duplication between categories.

Table 4-18 NDMC Drought Impact Reporter, 2000-2020

Impact Category	# of Impacts
Agriculture	4
Business & Industry	2
Fire	2
Plants & Wildlife	5
Relief, Response & Restrictions	5
Society & Public Health	2
Tourism & Recreation	4
Water Supply & Quality	2

Source: NDMC Drought Impact Reporter (<https://droughtreporter.unl.edu/map/>)

People

The historical and potential impacts of drought on populations include agricultural and recreation/tourism sector job loss, secondary economic losses to local businesses and public



recreational resources, increased cost to local and state governments for large-scale water acquisition and delivery, and water rationing and water wells running dry for individuals and families. 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.

Property

Drought does not typically have a direct impact on buildings, although an increase in expanding or collapsing soils could affect building foundations. Developed areas may experience damages to landscaping if water use restrictions are put in place, however these losses are not considered significant.

Critical Facilities and Infrastructure

Water supply issues for municipal, industrial, and domestic needs will be a concern for the entire County during droughts. Water restrictions could lead to lawn and tree impacts in suburban areas. Much of the City and County of Broomfield's water supply comes from sources in the Western Slope region of Colorado. Because of this, even in times when Broomfield may not be in active drought, droughts impacting other areas of the state can still lead to disruptions to the County's water supply. Vulnerability increases with consecutive winters of below average snowpack.

Government Services

Periods of prolonged and/or severe drought can diminish the County's water supply and force the County to initiate water usage restrictions. The County may need to balance competing demands from water users, which may affect public confidence in local governance.

Economy

Drought impacts on the County's natural environment and the cascading impacts to the recreation sector could lead to less people visiting and spending money in County which could have a negative impact on the entire local economy.

The CWCB maintains a Future Avoided Cost Explorer (FACE) tool, which estimates annual damages from drought. According to FACE analysis, the City and County of Broomfield could potentially experience an average annual loss of \$70,000 due to drought conditions under current population and climate scenarios. (See Table 4-19 below.)

Historic, Cultural, and Natural Resources

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

Drought can also increase risk of wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. A drought may also increase the speed at which dead and fallen trees dry out and become more potent fuel sources for wildfires. Drought may also weaken trees in areas already affected by mountain pine beetle infestations, causing more extensive damage to trees and increasing wildfire risk, at least temporarily (CWCB 2018).

Drought conditions can also cause soil to compact, decreasing its ability to absorb water, making an area more susceptible to flash flooding and erosion (CWCB 2018).

Another potential impact of drought is on shade trees on both public and private property throughout the County. A loss of tree canopy could in turn increase Broomfield’s vulnerability to extreme heat, as described in Section 4.12.

4.9.8 Development Trends

Drought vulnerability will increase with future development as there will be increased demands for limited water resources. Increased development also lends itself to the increased potential for impervious surface development, which reduces the amount of water absorbed into the ground from precipitation.

The FACE developed by the CWCB provides an in-depth look at the potential economic impacts and expected annual damages from future flood, drought, and wildfire events. The tool looks at three different climate scenarios (current climate conditions, 2050 future - moderately warmer climate and 2050 - severely warmer climate) as well as compares current population to low, medium, and high growth population scenarios. The following table compares the estimated annual damages for the City and County of Broomfield due to drought events for each of the climate and population scenarios.

Table 4-19 Potential Future Economic Losses from Drought in the City and County of Broomfield

Climate Scenarios	Population Scenarios		
	Low Growth (~89,900)	Medium Growth (~95,600)	High Growth (~102,000)
Current Conditions	Total damages: \$70,000	Total damages: \$70,000	Total damages: \$70,000
	Total damages per person: >\$10	Total damages per person: >\$10	Total damages per person: >\$10
Moderately Warmer Climate by 2050	Total damages: \$60,000	Total damages: \$60,000	Total damages: \$60,000
	Total damages per person: >\$10	Total damages per person: >\$10	Total damages per person: >\$10
Severely Warmer Climate by 2050	Total damages: \$70,000	Total damages: \$70,000	Total damages: \$70,000
	Total damages per person: >\$10	Total damages per person: >\$10	Total damages per person: >\$10

Source: CWCB Future Avoided Cost Explorer: Hazards <https://cwcb.colorado.gov/FACE>

The following mitigation activities taken since 2016 have helped to reduce the County’s drought vulnerability:

- Broomfield staff members participate in Water Availability Task Force (WATF) meetings facilitated by the CWCB. Participation in WATF helps staff stay informed on regional drought concerns and communicate with other communities on potential impacts and actions.
- Broomfield staff members also participate in the newly developed Front Range Drought Coordination Group. This group shares drought condition information, promotes regional drought mitigation actions, and develops communication materials.
- Installation of a satellite reservoir level monitoring sensor at Great Western Reservoir to provide real-time reservoir level readings for accounting accuracy and decision making purposes.

4.9.9 Risk Summary

- The overall significance of drought is **high**.
- Changes since 2016: drought was ranked as medium significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that high is a more accurate assessment of the risk.



- Drought vulnerability may increase over time as demand for water from different sectors increases and as the County plans for economic development around the use of water resources.
- Climate change may result in an increase in the frequency and severity of drought which could lead to impacts to the recreation and tourism industry in the County.
- The effects of recent droughts have exposed the vulnerability of the planning area's economy to drought events.
- Related hazards: Extreme Temperatures, Fire, Flooding.



4.10 Earthquake

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Earthquake	Extensive	Unlikely	Critical	Low

4.10.1 Description

An earthquake is caused by a sudden slip on a fault. Stresses in the earth’s outer layer push the sides of the fault together. Stress builds up and the rocks slip suddenly, releasing energy in waves that travel through the earth’s crust and cause the shaking that is felt during an earthquake. The amount of energy released during an earthquake is usually expressed as a Richter magnitude and is measured directly from the earthquake as recorded on seismographs. Another measure of earthquake severity is intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface as felt by humans or resulting damage to structures and defined in the Modified Mercalli scale, shown in Table 4-20. Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Table 4-20 Modified Mercalli Intensity (MMI) Scale

Magnitude	Mercalli Intensity	Effects	Frequency
Less than 2.0	I	Micro-earthquakes, not felt or rarely felt; recorded by seismographs.	Continual
2.0-2.9	I to II	Felt slightly by some people; damages to buildings.	Over 1M per year
3.0-3.9	II to IV	Often felt by people; rarely causes damage; shaking of indoor objects noticeable.	Over 100,000 per year
4.0-4.9	IV to VI	Noticeable shaking of indoor objects and rattling noises; felt by most people in the affected area; slightly felt outside; generally, no to minimal damage.	10K to 15K per year
5.0-5.9	VI to VIII	Can cause damage of varying severity to poorly constructed buildings; at most, none to slight damage to all other buildings. Felt by everyone.	1K to 1,500 per year
6.0-6.9	VII to X	Damage to a moderate number of well-built structures in populated areas; earthquake-resistant structures survive with slight to moderate damage; poorly designed structures receive moderate to severe damage; felt in wider areas; up to hundreds of miles/kilometers from the epicenter; strong to violent shaking in epicentral area.	100 to 150 per year
7.0-7.9	VIII<	Causes damage to most buildings, some to partially or completely collapse or receive severe damage; well-designed structures are likely to receive damage; felt across great distances with major damage mostly limited to 250 km from epicenter.	10 to 20 per year
8.0-8.9	VIII<	Major damage to buildings, structures likely to be destroyed; will cause moderate to heavy damage to sturdy or earthquake-resistant buildings; damaging in large areas; felt in extremely large regions.	One per year
9.0 and Greater	VIII<	At or near total destruction - severe damage or collapse to all buildings; heavy damage and shaking extends to distant locations; permanent changes in ground topography.	One per 10-50 years

Source: USGS. <http://earthquake.usgs.gov/learn/topics/mercalli.php>

Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, communication, and transportation lines. Other damaging effects of earthquakes include surface rupture, fissuring, ground settlement, and permanent horizontal and vertical shifting of the ground. Secondary impacts can include landslides, seiches, liquefaction, fires, and dam failure. The combination of widespread primary and secondary effects from large earthquakes makes this hazard potentially devastating.

Colorado's earthquake hazard is similar to other states in the intermountain west region. It is less than in states like California, Nevada, Washington, or Oregon, but greater than many states in the central and eastern United States. There are many unknowns about the earthquake hazard in Colorado, but the potential for damaging earthquakes does exist.

4.10.2 Past Events

According to the U.S. Geological Survey (USGS), eastern Colorado is nearly aseismic, with just a few epicenters in the Arkansas and Platte River valleys. Most shocks in the history of Colorado have been centered west of the Rocky Mountain Front Range. The first seismographs in Colorado of sufficient quality to monitor earthquake activity were installed in 1962. Newspaper accounts are the primary source of published data for earthquake events before that time.

More than 400 earthquake tremors of magnitude 2.5 or higher have been recorded in Colorado since 1867. Some of these known or estimated epicenters are shown in Figure 4-18 below. More earthquakes of magnitude 2.5 to 3 probably occurred during that time but were not recorded because of the sparse distribution of population and limited instrumental coverage in much of the state. For comparison, more than 20,500 similar-sized events have been recorded in California during the same period. Although many of Colorado's earthquakes occurred in mountainous regions of the state, some have been located east of the mountains. According to the USGS, there have been no recorded epicenters in the City and County of Broomfield, however many of the events listed below impacted the wider Denver Metro area and presumably future events of this scale could impact Broomfield.

Several notable events include:

- **November 7, 1882** - The first ever to cause damage in Denver, probably centered in the northern Front Range near Rocky Mountain National Park and is the largest historical earthquake in the state. The magnitude is estimated to be about 6.6 on the Richter scale. The quake was felt as far away as Salina, Kansas and Salt Lake City, Utah.
- **September 29, 1965** - A magnitude 4.7 earthquake epicentered near Arvada shook the northern metro area and cracked plaster and windows.
- **November 14, 1966** - A strong shock rumbled through the Denver area, causing some damage at Commerce City and Eastlake. The magnitude of this event was between 4.1 and 4.4.
- **April 10, 1967** - This was one of the largest in a series of earthquakes that began in 1962; 118 windowpanes were broken in buildings at the Rocky Mountain Arsenal, a crack in an asphalt parking lot was noted in the Derby area, and schools were dismissed in Boulder, where walls sustained cracks. Legislators quickly moved from beneath chandeliers in the Denver Capitol Building, fearing they might fall. The Colorado School of Mines rated this shock a magnitude 5.0.
- **August 9, 1967** - The strongest and most widely felt shock in Denver's history struck at 6:25 in the morning. The magnitude 5.3 tremor caused the most serious damage at Northglenn, where a church's concrete pillar roof supports were weakened, and 20 windows were broken. An acoustical ceiling and light fixtures fell at one school. Many homeowners reported wall, ceiling, floor, patio, sidewalk, and foundation cracks. Several reported basement floors separated from walls. Extremely loud, explosive-like earth noises were heard. Damage on a lesser scale occurred throughout the area.
- **November 26, 1967** - The magnitude 5.2 event caused widespread minor damage in the suburban areas of northeast Denver. Many residents reported it was the strongest earthquake they had ever experienced. It was felt at Laramie, Wyoming, to the northwest, east to Goodland, Kansas, and south to Pueblo, Colorado. At Commerce City merchandise fell in

several supermarkets and walls cracked in larger buildings. Several persons scurried into the streets when buildings started shaking back and forth.

- **March, April, and November 1981** - On April 2nd a sharp earthquake, magnitude 4.1, occurred that was centered approximately 12 miles north of downtown Denver in the Thornton area. Some slight damage (MM VI) was observed at Commerce City and Thornton. The quake was felt in other parts of Adams County and in parts of Arapahoe, Boulder, Clear Creek, Denver, Douglas, Jefferson, Gilpin, and Weld Counties. This earthquake was preceded by a small tremor located in the same area on March 24 at 6:04 a.m. MST with magnitude 2.8. It was felt in the Commerce City and Northglenn-Thornton area. The north central part of Colorado experienced a small earthquake on September 16, 1981 at 1:59 p.m. MDT. The magnitude 2.1 tremor was located in the Commerce City-Thornton area and was felt by a few people in that area.
- **November 8, 1989** - A minor earthquake with a magnitude of 2.5 was felt in the northern Denver Metropolitan Area at 7:24 am. The shock was felt at different intensities in several location, MM IV at Thornton and MM III at Eastlake, Montbello, Northglenn and in parts of Denver. A small aftershock, ML 1.8, occurred about 90 seconds later.

4.10.3 Location

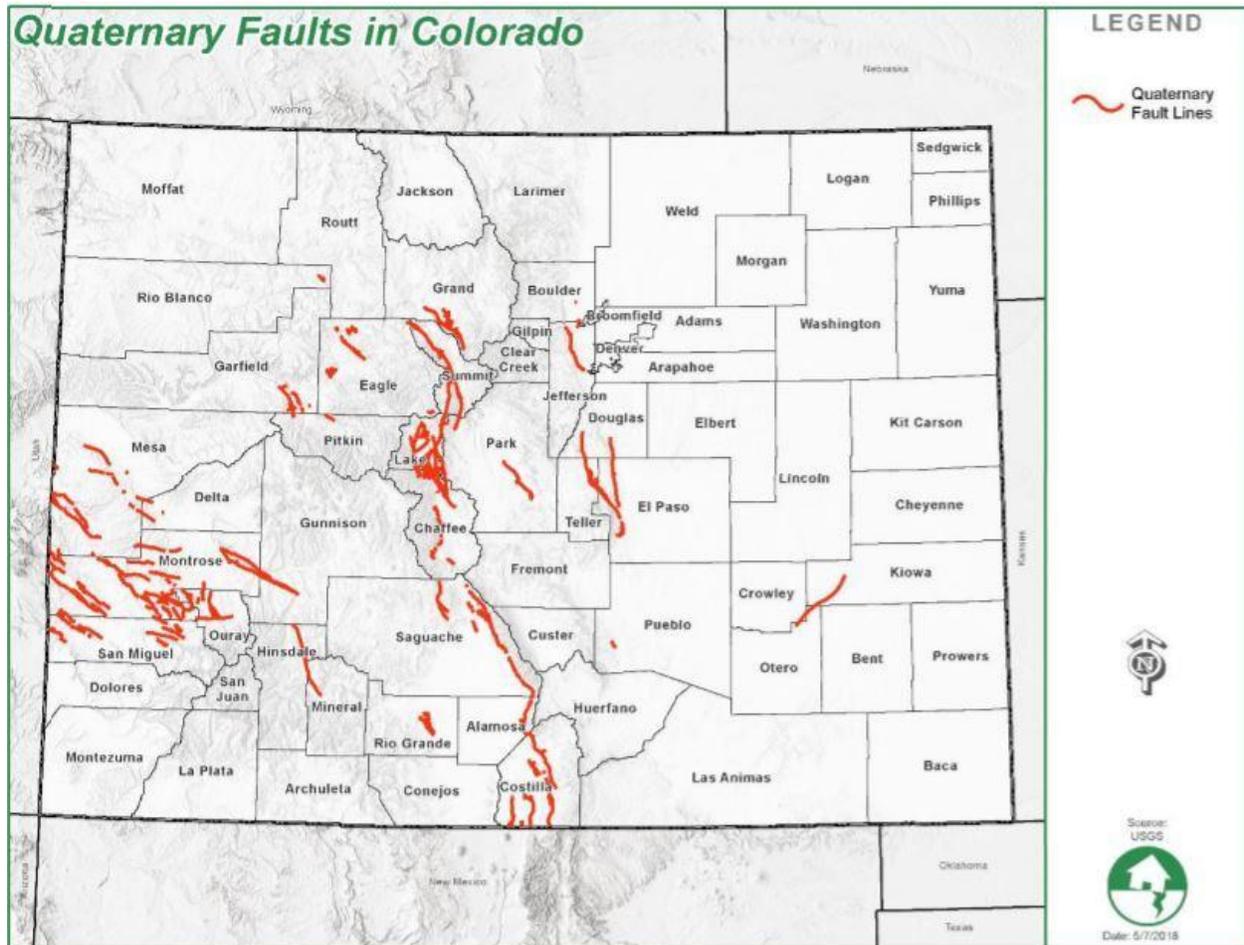
Geological research indicates there are about 100 potentially active faults in Colorado with documented movement within the last 2.6 million years (Quaternary). Figure 4-17 indicates that potentially active faults exist in the vicinity of the City and County of Broomfield that are capable of producing damaging earthquakes. There could be other faults in the state that may have potential for producing future earthquakes that are not known to be hazardous or do not rupture the ground surface.

Faults have been classified based on the geologic time frame of their latest suspected movement (in order of activity occurrence, most recent is listed first):

- H—Holocene (within past 15,000 years)
- LQ—Late Quaternary (15,000-130,000 years)
- MLQ—Middle to Late Quaternary (130,000 - 750,000 years)
- Q—Quaternary (approximately past 2.6 million years)

Faults with evidence of movement in the past 130,000 years (Late Quaternary) are considered active faults. Faults that last moved between 130,000 and 1.8 million years ago may be considered potentially active. These active and potentially active faults are thought to be the most likely source for future earthquakes (Source: 2018 Colorado State Hazard Mitigation Plan). The only known potentially active fault in close proximity to the City and County of Broomfield is the Golden Fault, which is a Quaternary fault located in adjacent Jefferson County. This fault runs along the base of the foothills west of Golden, roughly paralleling Highway 93 from Highway 72 to the north down to Highway 285 near Morrison, and is shown on the map in Figure 4-17, which is taken from a statewide map of Colorado earthquake hazards developed by the CGS. The fault runs through sparsely developed sections of western Arvada, Golden, western Lakewood, and just east of Morrison. According to the Colorado Earthquake Evaluation Report associated with the Colorado Hazard Mitigation Plan the fault is thought to be capable of producing a M6.5 earthquake. The Colorado Late Cenozoic Fault, Fold, and Earthquake Database considers this a “suspect feature” that has not shown evidence of movement in the past 500,000 years, and that definitive evidence of Quaternary movement is lacking. Many of these faults and historic epicenters are also shown in Figure 4-18 below.

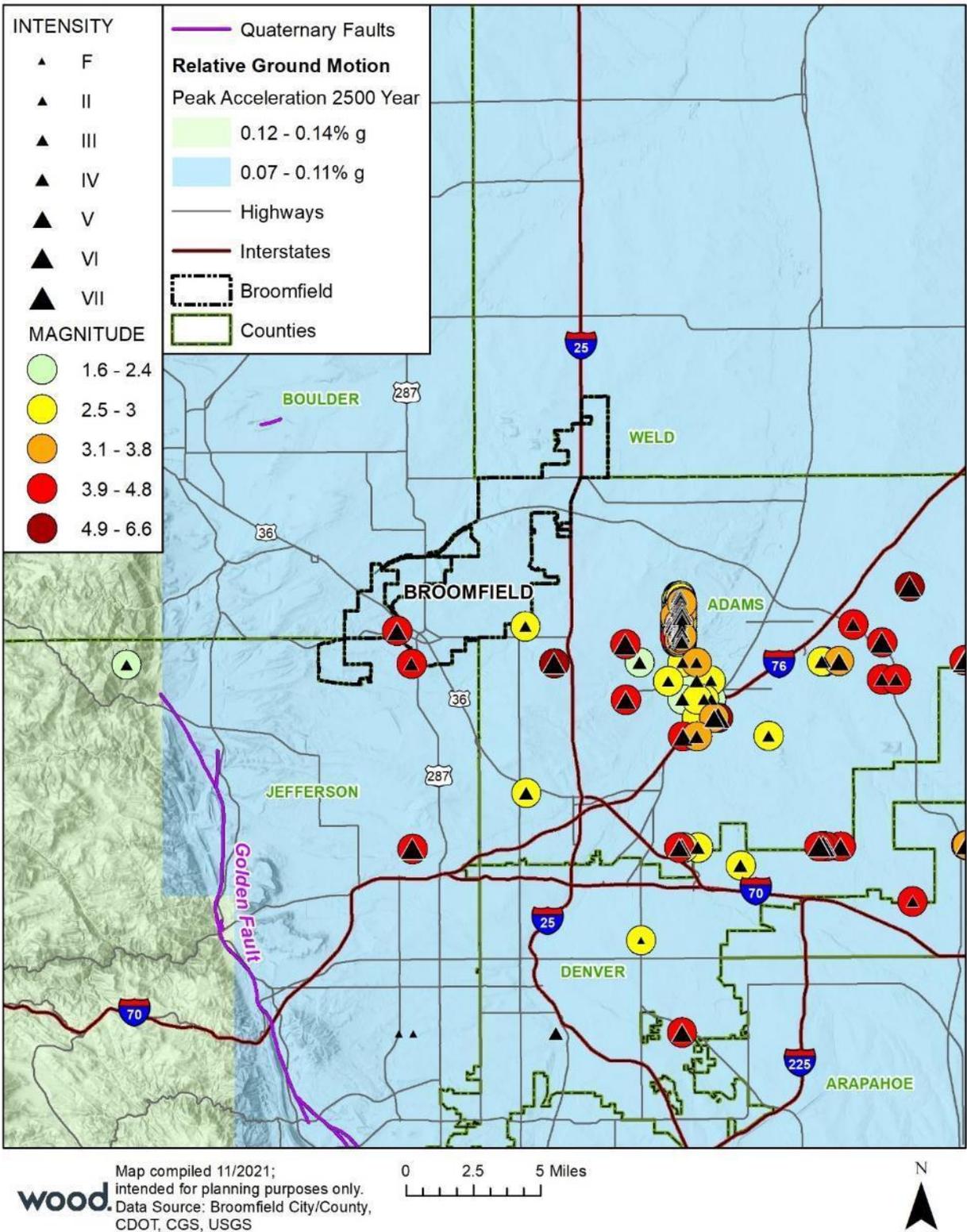
Figure 4-17 Colorado Quaternary Fault Map



Source: State of Colorado Natural Hazard Mitigation Plan, 2018

In addition to the Golden Fault there are potentially active faults to the north (Walnut Creek (Q) and Vailmont (MLQ), Rock Creek (Q) in Boulder County), east (Rocky Mountain Arsenal Fault (H) in Adams County), and further south (Ute Pass (MLQ)) in Douglas County. The Golden, Ute Pass, and Walnut Creek faults, all of which could affect Broomfield, are three of the state's five potentially most damaging faults, according to the Earthquake Evaluation Report. The Walnut Creek Fault is in unincorporated Jefferson and Boulder Counties near Rocky Flats. In addition to these faults there is a fault suspected to be located beneath the Rocky Mountain Arsenal, which has been the source of damaging earthquakes in the Denver Metro area and is considered by the CGS to have the potential of producing a magnitude 6.25 earthquake. This fault is not shown on the map because it is not evident on the earth's surface.

Figure 4-18 Earthquake History in Broomfield and Vicinity



Based on this information, the location rating for earthquake is extensive.



4.10.4 Magnitude and Severity

Earthquakes in or near Broomfield are low probability but potentially high consequence events. The primary earthquake hazard in the City and County of Broomfield includes strong ground shaking, which could affect the entire planning area. It is prudent to expect future earthquakes as large as magnitude 6.6, the largest historical event in Colorado. Studies indicate earthquakes as large as 7.25 could occur within the state, but scientists are unable to accurately predict when and where an event of that magnitude could occur (Source: Colorado Earthquake Hazards - Colorado Earthquake Mitigation Council 2008.) While structural damage could result to buildings, damage to non-structural building elements and contents will account for the majority of damages. A 6.5 earthquake has the potential to cause fatalities and multiple injuries. The general perception is that earthquakes do not happen in Colorado, thus the populace is ill-prepared for what to do when one occurs. There is also potential for rupture of the ground surface, which could happen along a fault trace. Though a remote possibility, the potential for fault rupture would be most likely along the Golden Fault, in the vicinity of Golden along the base of the foothills southwest of the City and County of Broomfield.

During the development of this mitigation plan, HAZUS-MH was used to model the consequences of a large earthquake in the City and County of Broomfield. The results of this analysis are presented in the Vulnerability Assessment subsection below. Considering a worst-case scenario, the potential magnitude/severity rating of earthquakes is **critical**, with significant property damage and/or multiple injuries/fatalities.

4.10.5 Probability of Future Occurrence

According to the CGS, it is not possible to accurately estimate the timing or location of future dangerous earthquakes in Colorado because the occurrence of earthquakes is relatively infrequent in the state, and the historical earthquake record is relatively short (only about 145 years). It is prudent to expect future earthquakes as large as magnitude 6.6, the largest historical event in Colorado. Studies indicate earthquakes as large as 7.25 could occur within the state, but scientists are unable to accurately predict when and where it will occur (Source: Colorado Earthquake Hazards - Colorado Earthquake Mitigation Council 2008.)

National seismic hazard zone maps indicate the probability of earthquakes in the United States, based on analyses of faults, soils, topography, and past events. Figure 4-18 above represents the 2,500-year probability ground motion, which is more of a worst-case scenario, and depicts the shaking level that has a 2 percent chance of being exceeded over a period of 50 years. In this scenario, Broomfield lies in the range of 0.07 and 0.11 percent peak acceleration. Ground motions become structurally damaging when average peak accelerations reach 10 to 15 percent of gravity, average peak velocities reach 8 to 12 centimeters per second, and when the MMI Scale is about VII (18-34 percent peak ground acceleration), which is considered to be very strong (general alarm; walls crack; plaster falls).

Thus, probability for an earthquake producing minor shaking is considered occasional, and an earthquake causing significant damage is **unlikely**, with less than a 1 percent chance of occurrence over the next 100-year period.

4.10.6 Climate Change Considerations

According to the Colorado State Hazard Mitigation Plan, the best available data does not indicate that climate change is expected to influence future earthquake events in the planning area.

4.10.7 Vulnerability

As noted above, earthquakes strike with little to no warning and can have multiple impacts on an area. After-effects from an earthquake can include impacted roadways, downed power and communication lines, fires, and damages to structures (especially poorly built, or those already in disrepair).

Earthquake vulnerability data was generated during the 2021 update using a Level 1 HAZUS-MH analysis. HAZUS-MH estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.



People

The entire population of Broomfield is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. Whether impacted directly or indirectly, the entire population will have to deal with the consequences of earthquakes to some degree if a significant event occurs in the front range. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

Three population groups are particularly vulnerable to earthquake hazards:

- **Linguistically Isolated Populations**—Approximately 3.1% of the planning area population over 5 years old speaks English “less than very well.” Problems arise when there is an urgent need to inform non-English speaking residents of an earthquake event. They are vulnerable because of difficulties in understanding hazard-related information from predominantly English-speaking media and government agencies.
- **Population below Poverty Level**—Families with incomes below the poverty level in 2019 made up 2.8% of the total county population. These families may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Poorer residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population over 65 Years Old**—Approximately 13.3% of the residents in Broomfield are over 65 years old. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

Impacts on persons and households in the planning area were estimated for the 2,500-Year Probabilistic Earthquake. Table 4-21 summarizes the results. Further impacts to the population as estimated by HAZUS are detailed in Table 4-25. It is estimated in a 2 p.m. time of occurrence scenario, which is likely to be a worst-case scenario, that there would be 31 injuries across the county, four of which would require hospitalization, and one fatality.

Table 4-21 Estimated Earthquake Impact on Persons and Households

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
2,500-Year Earthquake	60	30

Source: HAZUS-MH Global Summary Report, Wood analysis

Property

The HAZUS analysis estimates that there are 19,562 buildings in the planning area, with a total replacement value of \$7.17 billion. Because all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the countywide property exposure to seismic events. Most of the buildings (92%) and most of the associated building value (83%) are residential. According to the model about 1,110 buildings will be at least moderately damaged. A summary of these damage estimates is included in Table 4-22 below.

Table 4-23 breaks down the expected damage to buildings by the type of construction. Note that unreinforced masonry buildings make up 55% of the buildings completely destroyed, despite only being 3% of the County’s overall building count.

Table 4-22 Estimated Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	30.13	0.19	5.30	0.23	3.62	0.39	0.90	0.54	0.06	0.65
Commercial	742.03	4.58	159.38	7.03	106.87	11.43	25.08	15.15	1.64	18.72
Education	26.47	0.16	4.69	0.21	3.14	0.34	0.66	0.40	0.04	0.49
Government	6.49	0.04	1.35	0.06	0.95	0.10	0.19	0.12	0.01	0.15
Industrial	231.32	1.43	51.10	2.25	39.16	4.19	9.85	5.95	0.57	6.50
Other Residential	758.92	4.69	208.30	9.19	165.74	17.73	24.62	14.88	1.42	16.22
Religion	46.85	0.29	8.47	0.37	5.50	0.59	1.11	0.67	0.08	0.86
Single Family	14343.66	88.62	1828.35	80.65	609.95	65.24	103.10	62.29	4.94	56.40
Total	16,186		2,267		935		166		9	

Source: HAZUS-MH Global Summary Report, Wood analysis

Table 4-23 Expected Building Damage by Building Type

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	11668.79	72.09	1494.79	65.94	280.55	30.01	18.38	11.11	0.32	3.64
Steel	201.89	1.25	47.12	2.08	43.33	4.63	9.78	5.91	0.88	10.10
Concrete	187.03	1.16	43.09	1.90	28.36	3.03	4.80	2.90	0.22	2.48
Precast	202.18	1.25	39.44	1.74	41.95	4.49	14.44	8.72	0.47	5.36
RM	3084.53	19.06	360.27	15.89	308.56	33.00	72.22	43.64	0.82	9.33
URM	404.64	2.50	119.67	5.28	82.49	8.82	24.47	14.79	4.81	54.95
MH	437.00	2.70	162.56	7.17	149.71	16.01	21.41	12.94	1.24	14.14
Total	16,186		2,267		935		166		9	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Source: HAZUS-MH Global Summary Report, Wood analysis

Property losses were estimated through the Level 1 HAZUS-MH analysis for a 2,500-year probabilistic earthquake. The figure below is an excerpt from the HAZUS global summary report and shows the results for two types of building loss:

- Direct building losses, representing damage to building structures.
- Business interruption losses.

For the 2,500-year probabilistic earthquake scenario the estimated damage potential is \$152.6 million.

Table 4-24 HAZUS Building Related Economic Loss Estimates for 2,500 Year Scenario

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.2104	3.4063	0.2372	0.1062	3.9601
	Capital-Related	0.0000	0.0893	3.1493	0.1417	0.0337	3.4140
	Rental	1.6892	0.8441	2.6332	0.1183	0.0545	5.3393
	Relocation	5.9925	0.8553	3.8404	0.6209	0.4972	11.8063
	Subtotal	7.6817	1.9991	13.0292	1.1181	0.6916	24.5197
Capital Stock Losses							
	Structural	11.0221	1.7958	5.4605	1.4525	0.6935	20.4244
	Non_Structural	44.4142	10.0614	12.5156	4.8027	1.5708	73.3647
	Content	18.4620	2.9565	7.5643	3.4125	1.0014	33.3967
	Inventory	0.0000	0.0000	0.2956	0.5703	0.0320	0.8979
	Subtotal	73.8983	14.8137	25.8360	10.2380	3.2977	128.0837
	Total	81.58	16.81	38.87	11.36	3.99	152.60

Source: HAZUS-MH Global Summary Report, Wood analysis; values shown are in millions of dollars.

The HAZUS analysis also estimated the amount of earthquake-caused debris in the planning area for the 2,500-Year probabilistic earthquake scenario event at 37,000 tons.

Critical Facilities and Infrastructure

All critical facilities and infrastructure in the planning area are exposed to the earthquake hazard. Hazardous material (HAZMAT) releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding HAZMAT are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

HAZUS-MH classifies the vulnerability of critical facilities to earthquake damage in two categories: at least moderate damage or complete damage. The analysis did not indicate any damages in these categories to specific facilities. The model also estimates lifeline damages to linear networks such as transportation and utilities. Economic losses to the transportation system are estimated at \$20,000 and utility lifelines at \$14.9 million.

Government Services

Damage impacts to transportation corridors and communications lines could affect first responders' ability to effectively respond in the aftermath of an earthquake. Damage to government facilities/personnel in the incident area may require temporary relocation of some operations. Regulatory waivers may be needed locally. The public may question local government's ability to respond and recover if planning, response, and recovery are not timely and effective. A significant earthquake may require disaster declarations and aid programs. These needs may impact funding or administrative resources for other regular operations or may necessitate changes to existing operating procedures.

Economy

HAZUS-MH models total economic losses including building and lifeline related losses previously described. Total earthquake scenario loss estimates are summarized in Table 4-25 below.



Table 4-25 HAZUS_MH Earthquake Loss Estimation 2,500-Year Scenario Results

Type of Impact	Impacts to County
Total Buildings Damaged	Slight: 2,267 Moderate: 935 Extensive: 166 Complete: 9
Building and Income Related Losses	\$152.6 million 64% of damage related to residential structures 16% of loss due to business interruption
Total Economic Losses (includes building, income, and lifeline losses)	\$167.5 Million Building: \$128.1 Million Income: \$24.5 Million Transportation/Utility: \$14.9 Million
Casualties (based on 2 a.m. time of occurrence)	Without requiring hospitalization: 16 Requiring hospitalization: 2 Life threatening: 0 Fatalities: 0
Casualties (based on 2 p.m. time of occurrence)	Without requiring hospitalization: 27 Requiring hospitalization: 4 Life threatening: 0 Fatalities: 1
Casualties (based on 5 p.m. time of occurrence)	Without requiring hospitalization: 20 Requiring hospitalization: 3 Life threatening: 0 Fatalities: 0
Fire Following Earthquake	0 Ignitions
Debris Generation	37,000 tons of debris generated 1,480 truckloads
Displaced Households	60
Shelter Requirements	30

Source: HAZUS-MH 4.2

Historic, Cultural, and Natural Resources

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. Streams can be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology. Historic building stock is commonly made of unreinforced masonry which is vulnerable to damage from earthquakes. The HAZUS-MH model projects that more than half of buildings experiencing complete damage in the 2,500-year scenario would be unreinforced masonry construction. Table 4-26 below summarizes building damage by building construction type.



Table 4-26 Expected Building Damage by Building Type

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	11668.79	72.09	1494.79	65.94	280.55	30.01	18.38	11.11	0.32	3.64
Steel	201.69	1.25	47.12	2.08	43.33	4.63	9.78	5.91	0.88	10.10
Concrete	187.03	1.16	43.09	1.90	28.36	3.03	4.80	2.90	0.22	2.48
Precast	202.18	1.25	39.44	1.74	41.95	4.49	14.44	8.72	0.47	5.36
RM	3084.53	19.06	360.27	15.89	308.56	33.00	72.22	43.64	0.82	9.33
URM	404.64	2.50	119.67	5.28	82.49	8.82	24.47	14.79	4.81	54.95
MH	437.00	2.70	162.56	7.17	149.71	16.01	21.41	12.94	1.24	14.14
Total	16,186		2,267		935		166		9	

*Note:

- RM Reinforced Masonry
- URM Unreinforced Masonry
- MH Manufactured Housing

Source: HAZUS-MH Global Summary Report, Wood analysis

4.10.8 Development Trends

Land use in the planning area will be directed by the comprehensive plans adopted by the county and its planning partners as well as local permitting departments and zoning maps. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced with modern code adoption and enforcement.

4.10.9 Risk Summary

- Earthquakes represent a potentially high consequence but low probability hazard for the planning area; due to the low probability the overall significance is considered **low**.
- Changes since 2016: none.
- Colorado has much lower seismic activity compared to other Western states.
- Resulting damages to building stock and utility lifelines, and income related losses could equate to millions of dollars based on HAZUS-MH modeling.
- Light casualties are anticipated.
- The cost of retrofitting buildings to meet earthquake seismicity standards may be cost-prohibitive, but low-cost non-structural measures can reduce property loss and prevent injury.
- Earthquakes could produce damaging and disruptive rockfalls that could damage roads and block access/egress.
- Related hazards: Infrastructure Outage.



4.11 Expansive Soils

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Expansive Soils	Extensive	Likely	Moderate	Medium

4.11.1 Description

Expansive or swelling soils are made up of layers of clay that when exposed to water can expand up to 20% by volume and exert up to 30,000 pounds of force per square foot, more than enough to break up any structure they encounter. Expansive soils are some of the most widely distributed and costly geologic hazards. Expansive soil and rock are characterized by clayey material that shrinks as it dries or swells as it becomes wet. In addition, trees and shrubs placed closely to a structure can lead to soil drying and subsequent shrinkage. The parent (source) rock most associated with expansive soils is shale. Where the claystone layers turn up on end near the foothills, the effects of swelling are intensified and the phenomenon is called heaving bedrock, which causes heave ridges.

In Colorado, swelling soils expand and contract naturally during seasonal wetting (winter and spring) and drying (summer and fall) conditions and in their natural, undeveloped state they cause little damage. However, exposure to additional water sources, such as lawn and garden irrigation or precipitation drainage from houses, and reduced evaporation properties caused by the development of roads, sidewalks, buildings and parking lots, may cause the swelling soils to expand more than they would if they remained undeveloped. In addition, the re-grading of development areas may expose more swelling soil to moisture than the natural state, causing a more widespread swelling event.

4.11.2 Past Events

Expansive soil incidents are not tracked systematically in Colorado, so data on past events is limited. Expansive soils have caused damages and presented engineering challenges from the very first development along the Front Range urban corridor. Most problems are repairable and insured, but for the few with major structural problems, resolution is sometimes reached through litigation.

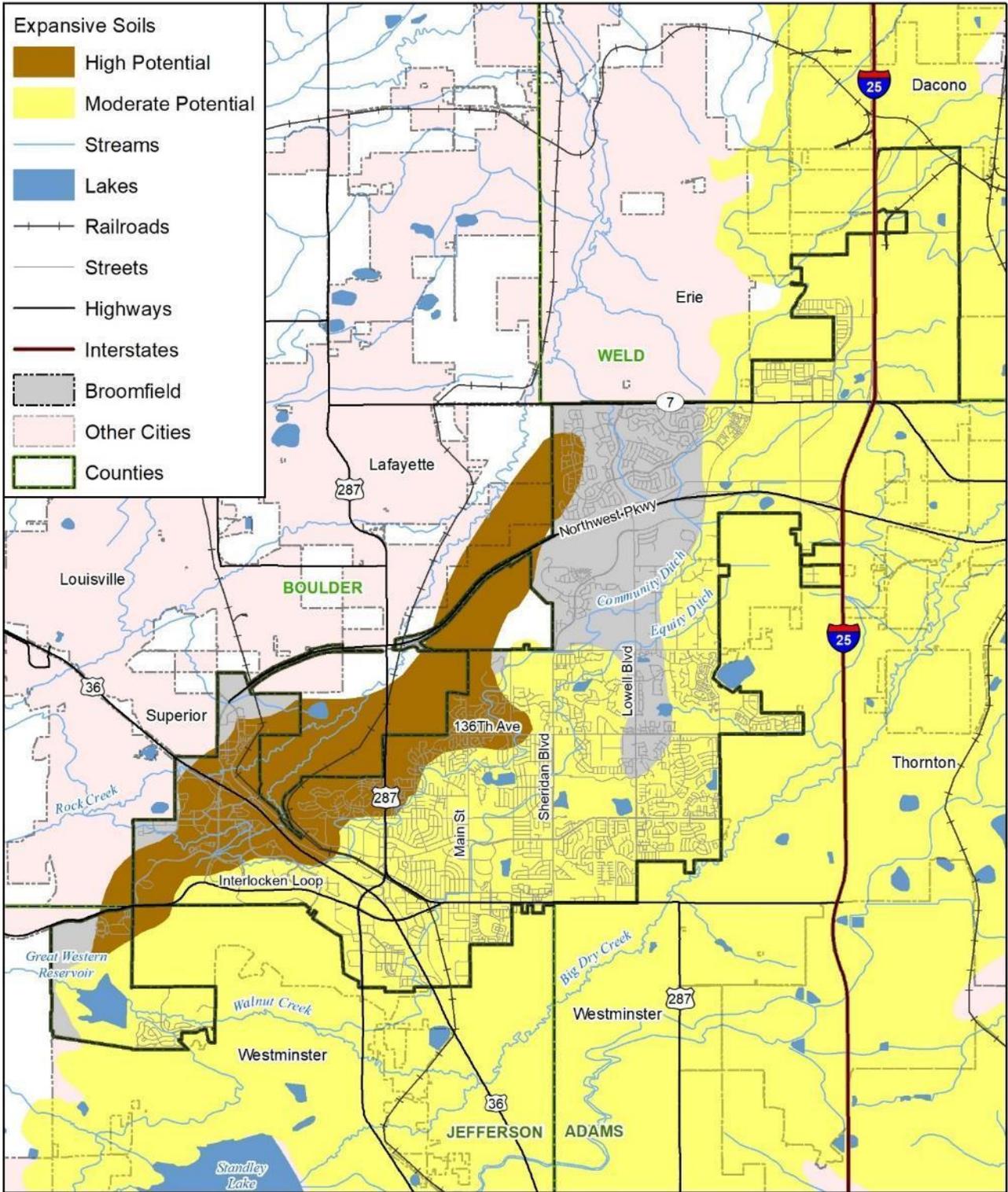
One notable incident occurred in 2006, when three businesses were forced to close or relocate due to swelling soils underneath the Village at Flatiron Crossing shopping center in Broomfield. The damages included cracked drywall, buckling concrete, and shifting beams. The shopping center had previously experienced problems with damages to foundations, walkways, and parking lots due to expansive soils.

4.11.3 Location

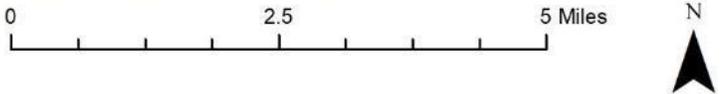
Like much of the central U.S. west to the Continental Divide, Broomfield is underlain by a sedimentary bedrock formation known as the Pierre Shale. Where the Pierre Shale is at or near the surface, problems with swelling soils can occur. The presence of expansive soils 10 feet or more below structural foundations does not tend to cause damage. Only a site-specific soils study can determine risk and recommended mitigation measures for a specific location. Broomfield does require geotechnical studies when submitting plans for new development.

As shown in Figure 4-19, the majority of the County has moderate potential of expansive soils, with some areas along the northwest edge of the County at high potential. Based on this information, the geographic extent rating for expansive soils is **extensive**.

Figure 4-19 City and County of Broomfield Expansive Soils



Map compiled 6/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, Colorado Geological Survey



4.11.4 Magnitude and Severity

Swelling soils are one of the nation's most prevalent causes of damage to buildings. According to the 2018 State Hazard Mitigation Plan, annual losses nationwide are estimated in the range of \$2 billion. In Colorado, the cost is estimated at \$16 million annually. Potential damages include severe structural damage; cracked driveways, sidewalks, and basement floors; heaving of roads and highway structures; condemnation of buildings; and disruption of pipelines and other utilities. Destructive forces may be upward, horizontal, or both. Injuries, illnesses and deaths associated with the hazard are rare and unlikely, and probably incurred as secondary hazards resulting from damages to infrastructure. Overall, though the fiscal damage may be extensive, the overall severity and impacts of the hazard are readily mitigated, reducing the overall impacts.

Buildings designed with lightly loaded foundations and floor systems often incur the greatest damage and costly repairs from expansive soils. Building in and on swelling soils can be done successfully, although more expensively, as long as appropriate construction design and mitigation measures are followed. In some cases, avoidance may be the best mitigation policy.

Based on these factors, the magnitude and severity rating for swelling soils is considered **moderate**.

4.11.5 Probability of Future Occurrence

Since records of specific occurrences are not available, it is difficult to estimate the probability of future occurrences. The hazards occur seasonally and annually, which should theoretically equate to a highly likely rating. However, mitigation efforts implemented with more recent construction should reduce the likelihood of the hazard having damaging impacts. Due to the extensiveness of swelling soils across the County, the probability rating for this hazard is considered as **likely**.

4.11.6 Climate Change Considerations

Changing climate conditions are expected to affect soil resources in many ways. During hot, dry years annual grasses that stabilize and protect topsoil often fail to germinate or do not grow well. This leaves soil surfaces highly vulnerable to erosion from wind and precipitation runoff. Without the availability of nutrient- rich topsoil, crops struggle to survive and flourish. As discussed previously, higher rates of erosion can have a profound effect on agricultural production and on the economies of rural areas of the county.

Many soils and rocks have the potential to swell or expand based on a combination of its mineralogy and water content. The actual swelling of expansive soils will be caused by a change in the environment (e.g. water content, stress, chemistry, or temperature) in which the material exists. Since the 1950s, snow precipitation and duration of snowpack have both decreased while rising temperatures have increased the rate of water evaporating into the air and earlier runoff, creating drier soil conditions in Colorado (EPA 2016). More extremes in climate conditions (e.g. wet-dry conditions), could potentially exacerbate the swelling of expansive soil issues in the future.

4.11.7 Vulnerability

People

An estimated 8,089 people live in areas with high potential of expansive soils, with another 41,311 in areas with moderate potential. However, there are no reported injuries or deaths to these soil hazards in Broomfield, and direct impacts on people are likely to be very minimal.

Property

The majority of the hazard's significance is drawn from the exposure of existing development to this hazard. Older construction may not be resistant to the swelling soil conditions and, therefore, may experience expensive and potentially extensive damages. This includes heaving sidewalks, structural damage to walls and basements, the need to replace windows and doors, or dangers and damages caused by ruptured pipelines. Newer construction may have included mitigation techniques to avoid most damage from the hazard, but the dangers continue if mitigation actions are not supported by homeowners. For example, the maintenance of grading away from foundations and the use of appropriate landscaping near structures must be continued to prevent an overabundance of water in vulnerable soils near structures. While continued public education efforts may help increase compliance for landscaping and interior finishing mitigation actions, physical reconstruction of

foundations is probably not feasible in all but the most heavily impacted of existing development. Therefore, damages may be expected into the future for existing structures.

GIS was used to create a risk assessment for geological hazards in Broomfield overlaid on parcel and assessor’s data. For the purposes of the analysis, if the hazard zone intersects an improved parcel center, its improved value is included and the parcel is counted in Table 4-27 and Table 4-28. This analysis does not take into account site-specific mitigation measures that may be in place, thus estimating losses for expansive soils is difficult.

Table 4-27 Properties at High Risk from Expansive Soils

Property Type	Improved Parcels	Buildings	Population
Agricultural	4	14	
Commercial	82	116	
Exempt	10	15	
Industrial	10	18	
Mixed Use	2	8	21
Residential	2,961	3,103	8,068
Total	3,069	3,274	8,089

Source: Wood Analysis of City and County of Broomfield data

Table 4-28 Properties at Moderate Risk from Expansive Soils

Property Type	Improved Parcels	Buildings	Population
Agricultural	5	6	
Commercial	341	462	
Exempt	99	198	
Industrial	210	245	
Mixed Use	15	33	86
Residential	14,162	15,856	41,226
Total	14,832	16,800	41,311

Source: Wood Analysis of City and County of Broomfield data

Critical Facilities and Infrastructure

While critical infrastructure services are not uniquely vulnerable to the hazard, structures experience the same risks identified for private and commercial properties: if they are built on swelling soil without adequate or appropriate building mitigation, they are vulnerable to damage. In worst-case scenarios, this could include loss of communication lines or severe damages to structures rendering them uninhabitable. If this occurred to a hospital or jail, for instance, it could have significant social repercussions, in addition to the incurred costs. Schools built in the area may pose a danger to occupants if the buildings are severely damaged in an event. If building integrity is compromised, it may also reduce the sheltering capacity or public health distribution capacity of the County, as schools are often used for these functions.



Table 4-29 lists critical facilities potentially exposed to expansive soils.

Table 4-29 Critical Facilities at Risk from Expansive Soils

FEMA Lifeline	Facility Type	High	Moderate	Total
Communications	Land Mobile Private	15	26	41
	Microwave Service	6	12	18
Energy	Oil Gas Facility	2	24	26
	Oil Gas Well	1	209	210
Food, Water, Shelter	City Facility		3	3
	Event Center		2	2
	WWTP		2	2
Hazardous Material	Tier II	7	25	32
Health and Medical	Adult Day Care Facility		1	1
	Assisted Living Residence/Nursing Home		1	1
	Cemetery		3	3
	City Facility		2	2
	Disability Care		1	1
	Elderly Care Facility		4	4
	Home and Community Based Services	1	6	7
	Home Health		7	7
	Hospice		2	2
	Medical Facility		5	5
Safety and Security	Rehabilitation or Recovery		1	1
	City Facility	1	8	9
	Elementary School		7	7
	EOC		1	1
	Fire Station		6	6
	High School	1	4	5
	Historical Place	3	40	43
	K-12		1	1
	K-8 School		3	3
	Middle School		2	2
	Police Station	1	2	3
	Post Office		2	2
	Pre-K-6		2	2
	Pre-K-8		1	1
	School		1	1
Special Needs		2	2	
Transportation	Airport		1	1
	Good Condition Bridge	6	19	25
	Fair Condition Bridge	7	8	15
	Poor Condition Bridge		1	1
	Park-n-Ride	1	1	2



FEMA Lifeline	Facility Type	High	Moderate	Total
Total		52	448	500

Source: Wood Analysis of data from City & County of Broomfield, National Inventory of Dams, HIFLD, DWR, EAP

Government Services

Government facilities are as susceptible to damage from expansive soils as any other buildings.

Economy

The economic cost of this hazard is typically minor in the short term, although over time they can add up to significant impacts.

Historic, Cultural, and Natural Resources

Collapsible and expansive soils are a natural environmental process. Nonetheless they have the potential to alter the landscape and can cause damages to historic and cultural resources.

4.11.8 Development Trends

Because such a large portion of the County is exposed to expansive soils, limiting development in at-risk areas is not practical. The best mitigation measure is by encouraging or requiring building techniques that make structures more resilient to the hazard.

4.11.9 Risk Summary

- The overall risk from expansive soils is medium.
- Changes since 2016: expansive soils were ranked as high significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that low is a more accurate assessment of the risk.
- While a significant portion of Broomfield is potentially exposed to expansive soils, the potential impacts are relatively minimal.
- Better building techniques can reduce the risk from expansive soils.
- Related hazards: Drought.



4.12 Extreme Temperatures

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Extreme Temperatures	Extensive	Likely	Moderate	High

4.12.1 Description

Extreme Heat

The Colorado State Hazard Mitigation Plan defines extreme heat as “temperatures over 90 degrees for an extended period of time, or that hover 10 degrees or more above the average high temperature for the region and last for multiple consecutive days.” In a normal year, about 175 Americans succumb to the demands of summer heat. According to the National Weather Service (NWS), among natural hazards, only the cold of winter—not lightning, hurricanes, tornadoes, floods, or earthquakes—takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died.

Heat disorders generally have to do with a reduction or collapse of the body’s ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body’s inner core begins to rise, and heat-related illness may develop. Elderly persons, small children, those with chronic illnesses, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails.

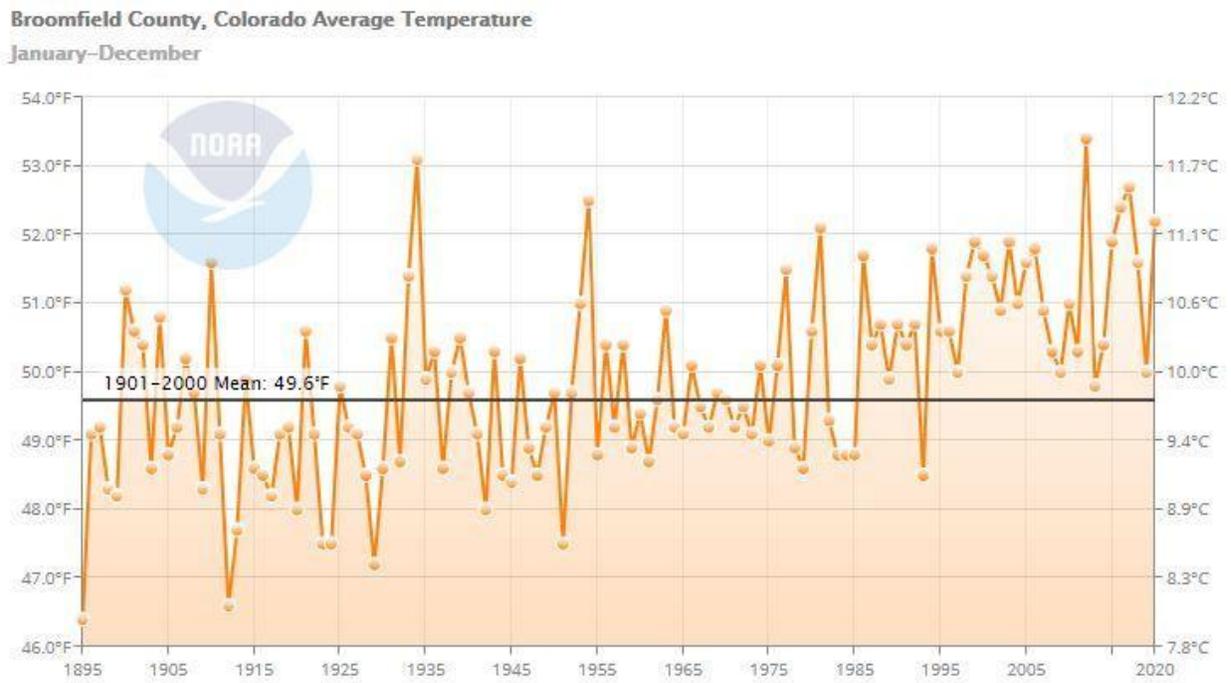
Extreme Cold

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities.

4.12.2 Past Events

According to the NWS Forecast Office for Denver/Boulder, there have been 82 streaks with temperatures of 90 degrees or greater since 1895, which accounts for more than 150 days of extremely hot temperatures in the metro area (NWS). During 2008, Denver’s 87-year-old record for the number of consecutive days above 90 degrees Fahrenheit was broken. The new record of 24 consecutive days surpassed the previous record by almost a week. On August 1st, it reached 104 degrees, breaking a record set in 1938 and on August 2nd, it reached 103 degrees, breaking a record set in 1878. In addition, as of August 2008, the area documented 68 days with temperatures above 100°F and 29 days with temperatures below -20°F between February 2008 and 1872 (NWS), as shown in Figure 4-20.

Figure 4-20 City and County of Broomfield Average Annual Temperature, 1895-2020



Source: NOAA

By contrast, the Denver Metro area averages 156 days a year with a minimum temperature of 32°F or less. The highest recorded temperature for the City and County of Broomfield 110°F, and the lowest is -30°F. The Southwest Climate and Environmental Information Collaborative (SCENIC) reports data summaries from a station in the City of Boulder. Table 4-30 contains temperature summaries related to extreme heat for the station.

Table 4-30 Temperature Data from Boulder Station

Station	Average Annual Maximum Temperature	Average Annual Minimum Temperature	Extreme Maximum Temperature	Extreme Minimum Temperature	Avg Annual Days Max. >90	Avg Annual Days Max. <32	Avg Annual Days Min. <32	Avg Annual Days Min. <0
Boulder (050848)	65	38	102 6/23/2012	-24 12/22/1990	30.1	14.3	132.9	4.8

Source: SCENIC Period of Record: 1960-2020

Since temperature variations are a regional hazard, many of the previous occurrences are documented at a regional level as well. For example, between 2000 and 2020 the NCEI database reflects one incident of extreme temperatures for the City and County of Broomfield (extreme cold/wind chill in 2011), but documents eight incidents in nearby Denver County. Therefore, the incidents below impact more than just the planning region.

1983 - A cold spell impacted the entire Metro area with readings dipping to -21°F, marking the coldest recorded temperature in 20 years.

1989 - Periods of extreme cold and high winds combined with snow created a severe storm scenario. Stapleton Airport was closed, and a 46-car pileup occurred on Interstate 25.



April 11, 1995 - Extreme cold was reported across the region with temperatures recorded at 13° F. Damages to wheat crops in Arapahoe County were estimated at \$1 million (\$1.4 million in 2008 dollars).

December 16-18, 1996 - Extreme wind chills impacted the entire Front Range and plains regions. Lows in the Denver area were reported at -9° F. A homeless man found in his car, with a body temperature of only 85° F at the time, died a few hours later.

October 24-25, 1997 - A blizzard left snow up to 4' deep in the foothills and wind gusts were documented at 70 mph. With wind chill, temperatures dropped to between -25° F and -40° F. A State of Emergency was declared, with five recorded deaths and 15 injuries.

December 18-24, 1998 - An arctic air mass settled in over northeastern Colorado dropping overnight temperatures well below zero for six consecutive days. Overnight temperatures bottomed out at -19° F on the morning of the 22nd. At least 15 people, mostly homeless, were treated for hypothermia at area hospitals. The bitter cold weather was responsible, either directly or indirectly, for at least five fatalities. Three of the victims died directly from exposure. The cold weather also caused intermittent power outages. Following the cold snap, thawing water pipes cracked and burst in several homes and businesses causing extensive damage. Damage estimates were unavailable.

June and July 2000 - June 29th marked the beginning of a near record hot streak for the Denver area. The maximum high temperature at Denver International Airport equaled or exceeded the 90° F mark for 17 consecutive days, from June 29th-July 15th: one day short of tying the all-time record. The record of 18 consecutive days was set in two different years, July 1st-18th, 1874 and July 6th-23rd, 1901.

February 1-4, 2011 - A frigid Arctic air mass settled into the Front Range Urban Corridor to start out the month. At Denver International Airport, overnight low temperatures on the 1st through the 3rd were 13 and 17 below zero and zero respectively. The icy temperatures caused pipes to crack and burst following the freeze. At the Jefferson County Courts administration building, a steady stream of water from a crack on the 5th floor went unnoticed and flooded all floors of the administration wing overnight, damaging much of the office equipment, furniture, and carpet. The icy temperatures also forced the closure of several school districts.

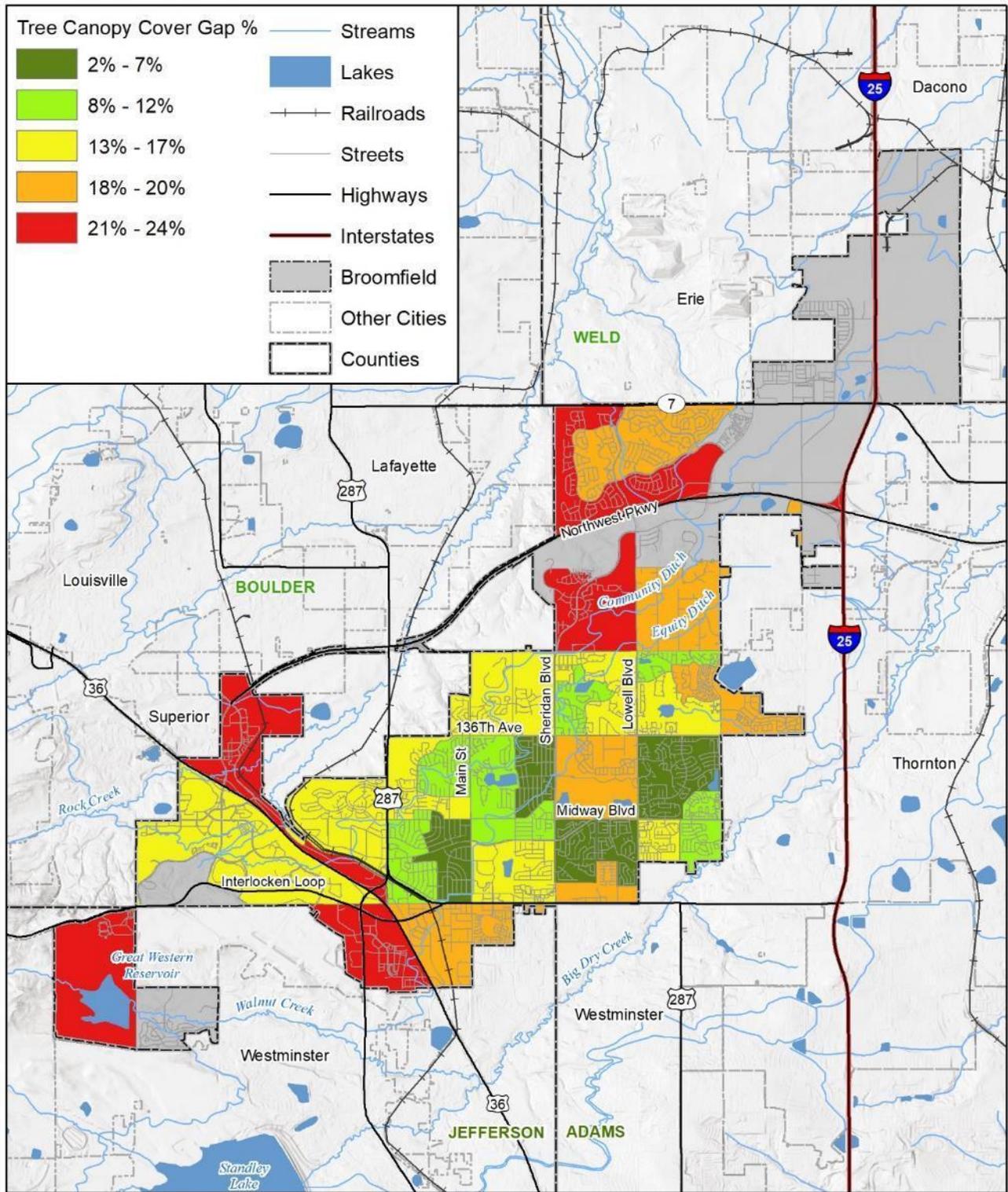
4.12.3 Location

The inherent nature of temperature hazards makes them a regional threat, impacting most or all of the planning area simultaneously due to the relatively limited geographical extent of the County, although the impacts may vary by location. This is reflected in the record of past events, which consistently discusses the Denver Metro Area, rather than singling out particular counties or communities.

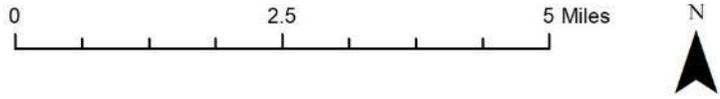
Urbanized portions of the Denver Metro Area can experience pockets of heightened temperatures where surfaces such as pavement and roofs become hotter than the air temperatures, a phenomenon known as the urban heat island effect. These hot surfaces also retain heat, causing high temperatures to persist even when air temperature drops. Per the EPA, “the annual mean air temperature of a city with 1 million people or more can be 1.8-5.4° F (1-3° C) warmer than its surroundings. On a clear, calm night, however, the temperature difference can be as much as 22° F” (U.S. EPA). Colorado’s climate tends to experience large day and night temperature differentials. This nighttime cooling will help alleviate heat conditions and is thought to benefit and reduce risk of extreme heat.

According to the EPA, the urban heat island effect is caused when cities “replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat”. This phenomenon exacerbates the impacts of extreme heat in cities and is correlated to the extent of tree canopy and green spaces in cities. The non-profit organization American Forests has created a map of tree cover in metropolitan areas across the U.S. along with the percentage of tree canopy recommended for a particular area based on natural biomes and population density. American Forests recommends coverage of 24% for Broomfield based on its location and demography. The difference between actual tree coverage and the recommended coverage is measured as a Tree Canopy Coverage Gap is shown in Figure 4-21. (Grey areas represent a lack of data.) This tool can help anticipate which parts of Broomfield can anticipate more severe impacts during extreme heat events.

Figure 4-21 City and County of Broomfield Tree Canopy Coverage Gap



Map compiled 9/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, American Forests



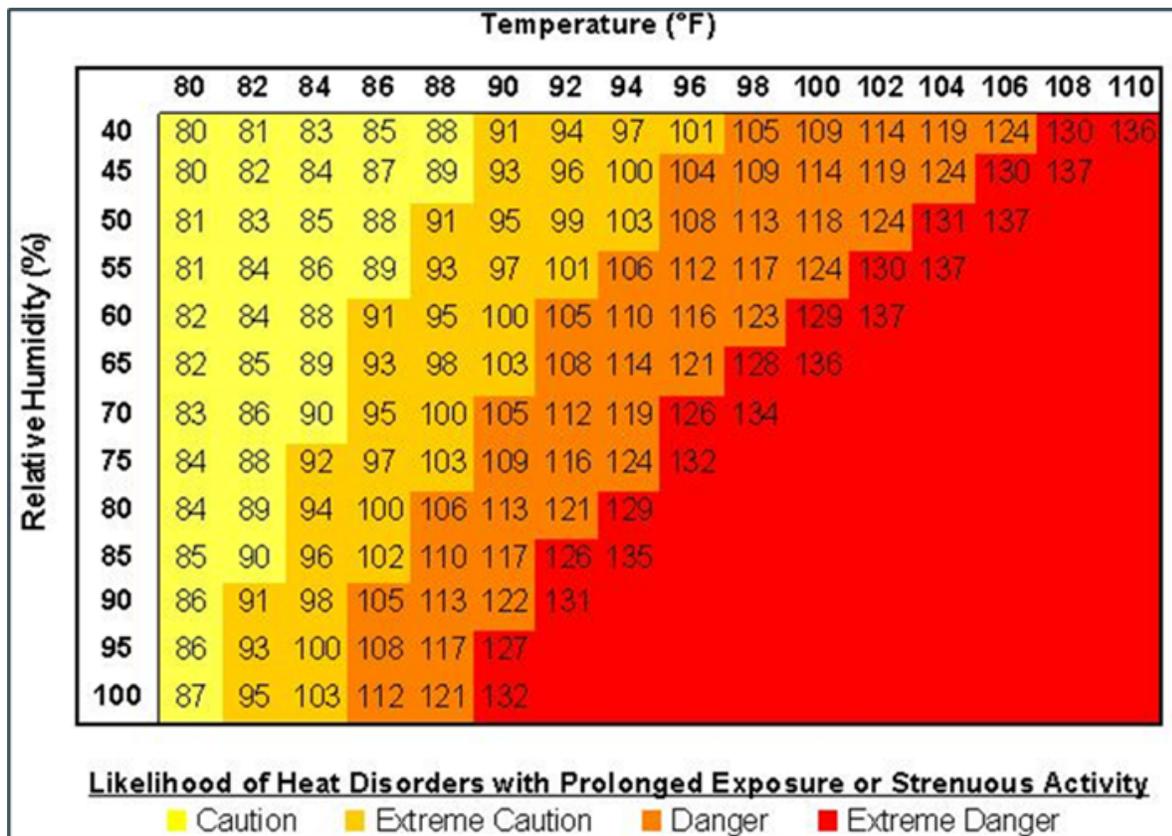
Based on this information, the location rating for extreme temperatures is **extensive**.

4.12.4 Magnitude and Severity

Information from the event of record is used to calculate a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it is a reflection of common occurrence. Since temperature extremes refer to both extreme heat and extreme cold, there is not a single event of record. The event of record for extreme heat in the Denver Metro Area occurred in the summer of 2000, prior to the formation of the City and County of Broomfield. While specific property damages are not available, the event coincided with a severe drought period, which caused extensive damages to crops and personal property, impacted overall water supplies, and caused economic damages throughout the region due to both conditions.

The NWS Heat Index Program provides a measure of the extent of typical health impacts of exposure to heat, as shown in Figure 4-22 and Table 4-31. During these conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration, and health risks rise. The chart below illustrates the relationship of temperature and humidity to heat disorders.

Figure 4-22 Heat Index Chart



Source: NWS

Note that Heat Index (HI) values were devised for shady, light wind conditions. Exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Table 4-31 Typical Health Impacts of Extreme Heat by Heat Index

Heat Index	Disorder
80-90° F	Fatigue possible with prolonged exposure and/or physical activity

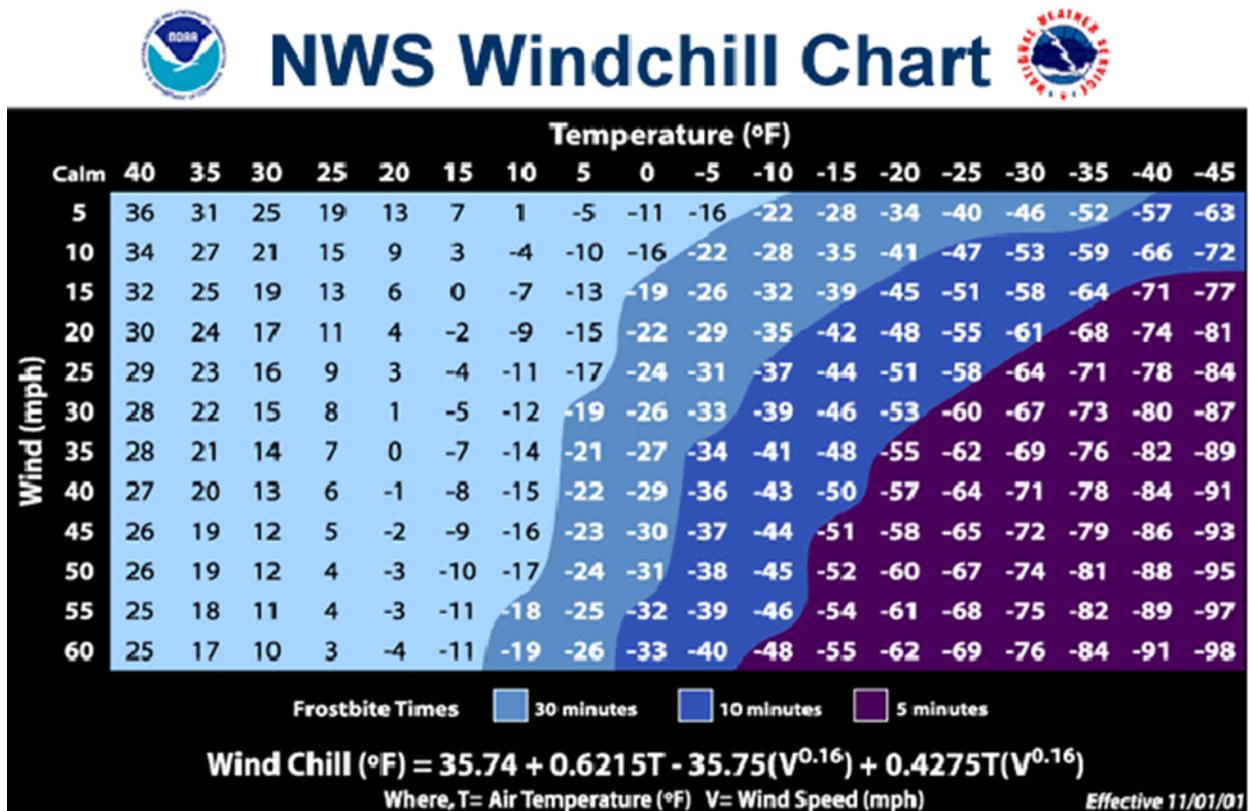
Heat Index	Disorder
90-105° F	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F	Heatstroke/sunstroke highly likely with continued exposure

Source: NWS HI Program, www.weather.gov/os/heat/index.shtml

The NWS has in place a system to initiate alert procedures (advisories or warnings) when the HI is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime high is expected to equal or exceed 105° F and a nighttime minimum high of 80° F or above is expected for two or more consecutive days.

In 2001, the NWS implemented an updated Wind Chill Temperature index (see Figure 4-23). This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 4-23 National Weather Service Wind Chill Chart



Source: NWS

The NWS Denver/Boulder Forecast Office issues warnings and advisories for cold temperatures. The following is a breakdown on the various NWS defined watches, warnings and advisories that could be issued:

- Wind Chill Watch is issued when wind chill warning criteria are possible in the next 12 to 35 hours.

- Wind Chill Warning is issued for wind chills of at least -25°F on the plains and -35°F in the mountains and foothills.
- Wind Chill advisory is issued on the plains when wind and temperature combine to produce wind chill values of -18°F to -25°F and -25°F for the mountains and foothills.
- Freeze Watch is issued when freeze conditions are possible in the next 12 to 36 hours.
- Freeze Warning is issued during the growing season when widespread temperatures are expected to drop to below 32°F.
- A frost advisory is issued during the growing season when temperatures are expected to drop to between 32°F and 35°F on clear calm nights.

The event of record for extended periods of severe cold in the City and County of Broomfield occurred during February 1-4 in 2011. Damages caused by ruptured water pipes were considered extensive in both the private and public sectors. Nationwide, extreme temperatures remain the leading cause of weather-related deaths.

Based on these factors, the magnitude and severity rating for temperature extremes is considered **moderate**.

4.12.5 Probability of Future Occurrence

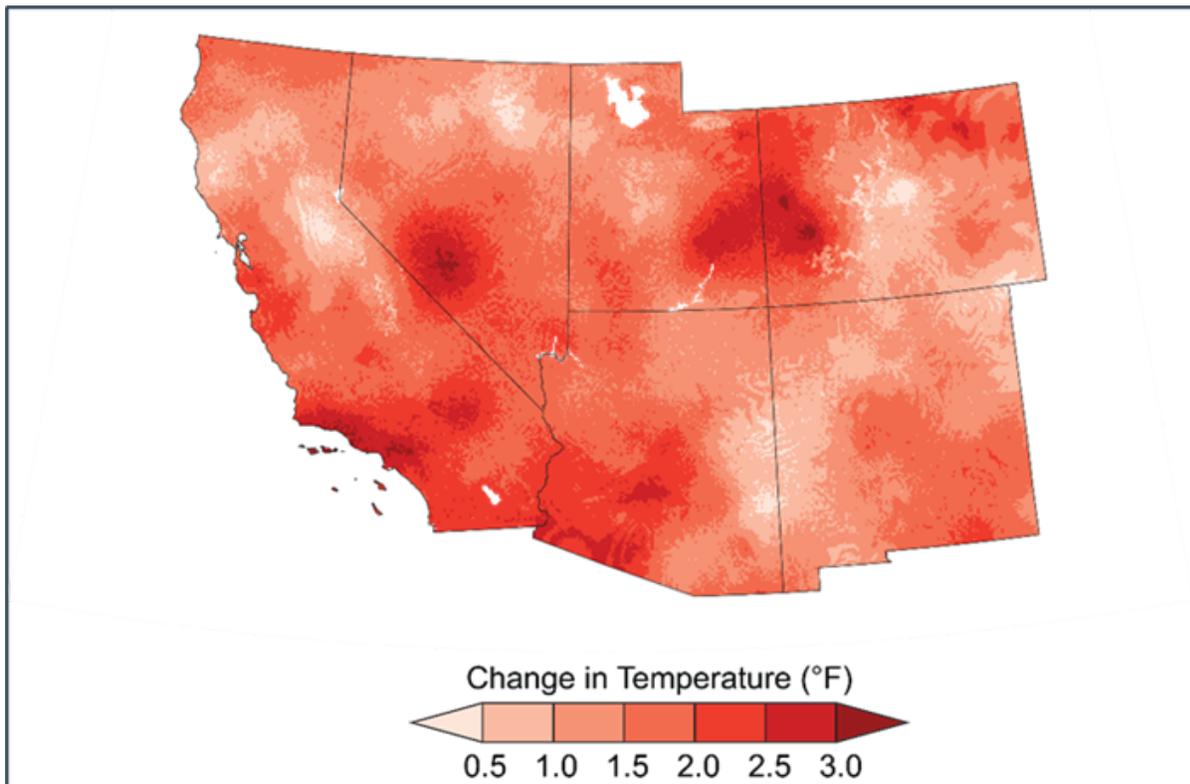
Temperature extremes occur on a regular basis, with an annual average of 30 days a year exceeding 90°F and an annual average of 14 days where high temperatures do not exceed freezing (32°F). Severe incidents or prolonged exposures to a temperature extreme are a higher threat to the community than isolated, seasonal occurrences.

As mentioned above in the past events section, there have been 82 streaks with temperatures of 90 degrees or greater since 1895. By contrast, the Denver Metro area averages 156 days a year with a minimum temperature below 32°F, and approximately 14 days per year where the maximum temperature does not rise above freezing. This results in an approximately 66% probability of an extreme heat event and an approximately 4% probability of extreme cold occurring in any given year. This corresponds to a probability of future occurrences rating of **likely**.

4.12.6 Climate Change Considerations

Climate change is projected to increase the uncertainty of weather patterns and produce more frequent and more extreme weather events. Scientists have suggested that warming in the Arctic has been linked to changes in the jet stream which may lead to increased polar vortex events in Colorado. The polar vortex is well documented and is described as large areas of low pressure and cold air surrounding the North and South poles. Increased temperatures in the polar regions have weakened and destabilized the jet stream leading to polar air to dip into lower latitudes, bringing it farther south than typical (UC Davis).

Figure 4-24 Change in Average Temperature Across the Southwest, from the Period 1901-1960 to the Period 1986-2016

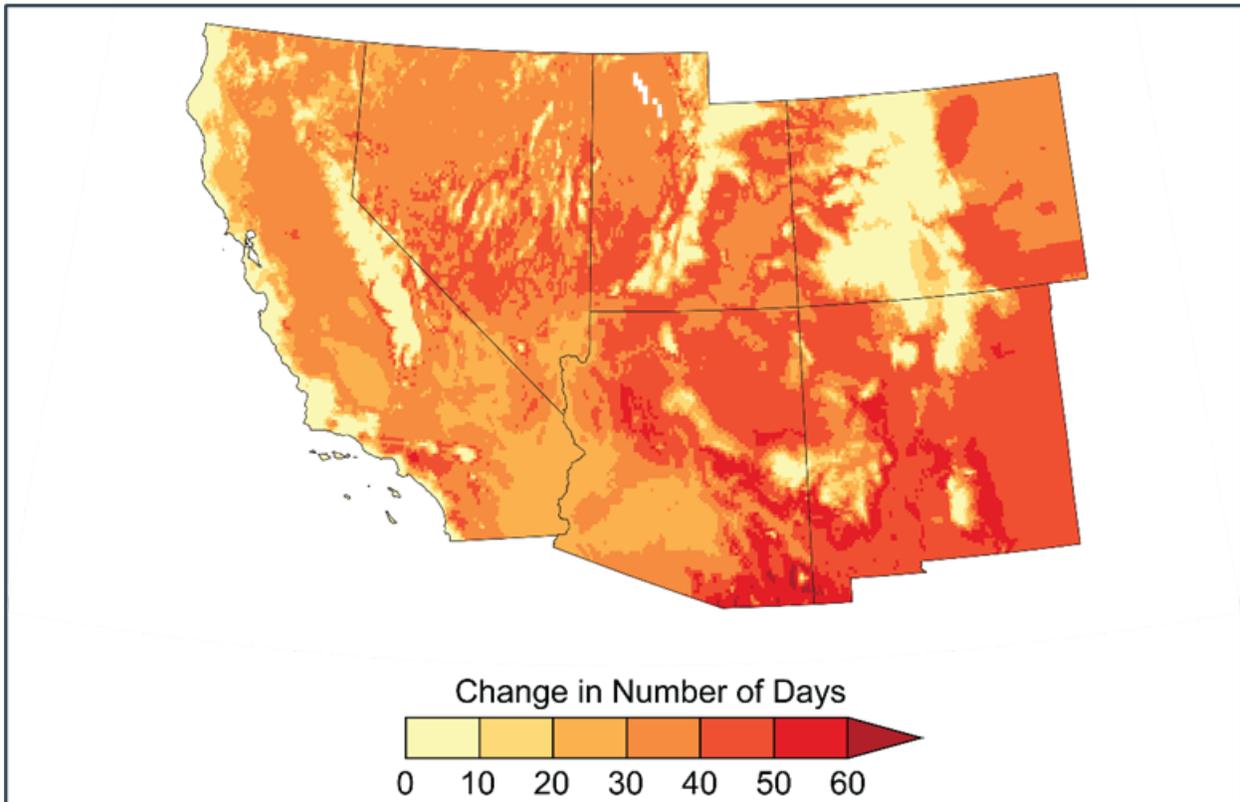


Source: Fourth National Climate Assessment

Research cited in the Fourth National Climate Assessment indicates that average temperatures have already increased across the Southwest and will likely continue to rise. Figure 4-24 shows the difference between the 1986-2016 average temperature and the 1901-1960 average temperature. This trend toward higher temperatures is expected to continue and would cause more frequent and severe droughts in the Southwest as well as drier future conditions and an increased risk of megadroughts—dry periods lasting 10 years or more). Additionally, current models project decreases in snowpack, less snow and more rain, shorter snowfall seasons, and earlier runoff, all of which may increase the probability of future water shortages (Gonzalez et al., 2018).

Extreme heat is also expected to increase in frequency. Figure 4-25 shows projected increases in extreme heat as an increase in the number of days per year when the temperature exceeds 90°F by the period 2036-2065 compared to the period 1976-2005. Under the higher emissions scenario (RCP8.5), the number of days of extreme heat would increase in the City and County of Broomfield by 30 to 50 days based on the figure below.

Figure 4-25 Projected Increases in Extreme Heat



Source: Fourth National Climate Assessment *Based on higher emission scenario RCP8.5

4.12.7 Vulnerability

All people, property, and environments in the planning area would be exposed to some degree to the impacts of extreme temperatures. Extreme heat and cold can exacerbate the effects of other hazards as well, such as drought, fire, flooding, and winter storms.

People

Traditionally, the very young and very old are considered at higher risk to the effects of extreme temperatures, but any populations outdoors in the weather are exposed, including otherwise young and healthy adults and homeless populations. Arguably, the young-and-otherwise-healthy demographic may be more exposed and experience a higher vulnerability because of the increased likelihood that they will be out in the extreme temperature deviation, whether due to commuting for work or school, conducting property maintenance such as snow removal or lawn care, or for recreational reasons. Individuals and families with low budgets as well as inner city dwellers can also be susceptible due to poor access to air-conditioned housing. Generally, more than 75% of people and property in the City and County of Broomfield are affected in instances of extreme temperatures.

According to the U.S. EPA, individuals with the following combinations or characteristics are typically at greater risk to the adverse effects of excessive heat events: individuals with physical or mobility constraints, cognitive impairments, economic constraints, and social isolation. People who live or work in buildings without cooling systems are also more vulnerable. Populations living in densely populated urban areas are likely to be more exposed to extreme heat events.

Property

Recent research indicates that the impact of extreme temperatures has been historically under-represented. The risks of extreme temperatures are often profiled as part of larger hazards,

such as severe winter storms or drought. However, as temperature variances may occur outside of larger hazards or outside of the expected seasons but still incur large costs, it is important to examine them as stand-alone hazards.

Extreme cold impacts structures when pipes or water mains freeze and burst, causing damage. Cold can also, in the most extreme of circumstances, make materials more fragile and breakable, although the Front Range rarely gets this cold. Extreme cold may also lead to higher electricity and natural gas demands to maintain appropriate indoor heating levels combined with damages caused to the delivery infrastructure such as frozen lines and pipes. Cold may impact transportation as well. Exposed populations may be at risk while waiting for public transportation, particularly when combined with wind chill, and some vehicles may not start which impacts the commute of the workforce and, in worst-case scenarios, the movement of emergency services personnel.

Critical Facilities and Infrastructure

Prolonged heat exposure can have significant impacts on infrastructure. Prolonged high heat exposure increases the potential of pavement deterioration, as well as railroad warping or buckling. High heat also puts a strain on energy systems and consumption, as air conditioners are run at a higher rate and for longer. Extreme heat can also reduce transmission capacity over electric systems.

Secondary impacts of extreme cold can affect the supporting mechanisms or systems of a community's infrastructure. For example, when extreme cold is coupled with high winds or ice storms, power lines may be downed, resulting in an interruption in the transmission of that power shutting down electric furnaces, which may lead to frozen pipes in homes and businesses.

The impact of severe temperature deviation on power delivery is a significant factor when assessing current development exposure. Xcel Energy, the utility provider for the City and County of Broomfield, estimates that service outages due to extreme temperatures cost the utility an average of \$50,000 to fix for every 20,000 people affected. This includes repair and replacements costs, equipment usage, and crew overtime.

Government Services

Instances of extreme temperatures may put stress on the local government's ability to provide essential services and to conduct regular operating procedures. The provision of emergency shelters for warming or cooling may become necessary, which will fall on the City and County to coordinate messaging and provide locations for local residents.

Water utilities are likely to face the greatest challenges to continuity of operations and delivery of services, especially when extreme heat occurs during long-term widespread droughts, where opportunities for resource-sharing are limited. Water suppliers may need to change water rates, set usage restrictions, adjust to changes in demand, address water line damage or repairs due to drought stress, account for changes in water quality, and seek alternative water supplies. Should a public water system be severely affected, the cost of shipping in outside water could total into the millions of dollars.

Economy

Extreme temperatures can lead to potential loss of facilities or infrastructure function or accessibility and uninsured damages. Impacts to the transportation sector and movement of goods can impact the economy locally and regionally. Historic events in Colorado have impacted community business districts where a majority of businesses are lost (CO SHMP 2018).

Historic, Cultural, and Natural Resources

Extreme temperatures can have significant impacts to these natural ecosystems. Increasing temperatures may cause species to shift habitats in elevation and latitude and extended periods of extreme heat can stress both flora and fauna species. Extreme heat may also be a secondary effect of droughts or may cause temporary drought-like conditions. For example, several weeks of extreme heat increases evapotranspiration and reduces moisture content in vegetation, leading to higher wildfire vulnerability for that time period even if the rest of the season is relatively moist. According to Colorado Parks and Wildlife, warmer temperatures can also lead to earlier snowmelt affecting insect

and wildlife life cycles as well as seed production and germination. Extreme cold spells can also kill crops and cause physical damage to the natural vegetation.

4.12.8 Development Trends

Since structures are not usually directly impacted by severe temperature fluctuations, continued development is less impacted by this hazard than others in the plan. However, new development can add stress to the electric grid, potentially increasing the possibility of brownouts or blackouts.

Pre-emptive cautions such as construction of green buildings that require less energy to heat and cool, use of good insulation on pipes and electric wirings, and smart construction of walkways, parking structures, and pedestrian zones that minimize exposures to severe temperatures may help increase the overall durability of the buildings and the community to the variations. Continued development also implies continued population growth, which raises the number of individuals potentially exposed to variations. Public education efforts should continue to help the population understand the risks and vulnerabilities of outdoor activities, property maintenance, and regular exposures during periods of extreme heat and cold.

In 2020, the Broomfield City Council adopted Resolution No. 2020-169, the Greenhouse Gas (GHG) Emissions Reduction Resolution, which set GHG reduction targets of 100% by 2050 community-wide and by 2045 for municipal operations. The upcoming greenhouse gas reduction roadmap will include recommendations for more efficient and greener buildings, which may help lower the County's vulnerability to extreme temperature events.

4.12.9 Risk Summary

- The overall significance of this hazard to the County is **high**.
- Changes since 2016: none.
- Urban areas are more exposed to extreme heat events due to the Urban Heat Island Effect.
- The greatest risk for both extreme heat and extreme cold often is to those who are outdoors and exposed to these temperatures.
- On average, the County experiences 30 days per year where temperatures exceed 90°F, and an average of 5 days below 0°F.
- The effects of climate change may result in an increase in frequency of extreme heat events.
- Related hazards: Fire, Flood, Drought, Winter Storm.

4.13 Fire (Structural and Wildland)

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Fire	Significant	Likely	Moderate	Medium

4.13.1 Description

Wildfire

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as wildland urban interface (WUI) areas, where development is adjacent to densely vegetated areas.

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 needles, leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Structures such as homes and associated combustibles are also potential fuel sources. The type of prevalent fuel directly influences the behavior of wildfire. Light fuels such as grasses burn quickly and serve as a catalyst for fire spread. “Ladder fuels” are fuels low to the ground that can spread a surface fire upward through brush and into treetops. These fires, known as crown fires, burn in the upper canopy of forests and are nearly impossible to control. The volume of available fuel is described in terms of fuel loading. Many parts of the planning area are extremely vulnerable to wildfires, as a result of dense vegetation combined with urban interface living. Non-native species have become invasive in the area, specifically, Tamarisk and Russian Olive. These species burn readily and pose a threat to homes and other structures in the lower reaches of the county and into municipalities.
- **Topography** - An area’s terrain and land slopes affect its susceptibility to wildfire spread. Both the fire intensity and the 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. In addition, topography impacts the ability of firefighters to combat the blaze by hampering access for equipment, supplies, materials and personnel.
- **Weather** - Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfires. High temperatures and low relative humidity dry out the fuels that feed the wildfire, increasing the odds that fuel will more readily ignite and burn more intensely. Wind is the most treacherous weather factor. The greater the wind, the faster a fire will spread, and the more intense it will be. In addition to wind speed, wind shifts can occur suddenly due to temperature changes or the interaction of wind with topographical features such as slopes or steep hillsides. Lightning also ignites wildfires, which are often in terrain that is difficult for firefighters to reach. Drought conditions contribute to wildfire vulnerability and susceptibility. During periods of drought, low fuel moisture and lack of precipitation increase the threat of wildfire. There are no known effective measures for human mitigation of weather conditions. Careful monitoring of weather conditions that drive the activation and enforcement of fire safety measures and programs, such as bans on open fires, are ongoing weather-related mitigation activities.

Wildfires are of significant concern throughout Colorado. According to the Colorado State Forest Service, vegetation fires occur on an annual basis; most are controlled and contained early with limited damage. For those ignitions that are not readily contained and become wildfires, damage can be extensive. According to the 2018 State of Colorado Hazard Mitigation Plan, a century of aggressive fire suppression combined with cycles of drought and changing land management practices has left many of Colorado’s forests unnaturally dense and ready to burn. Further, the threat of wildfire and potential losses is constantly increasing as human development and population increases and the WUI expands.

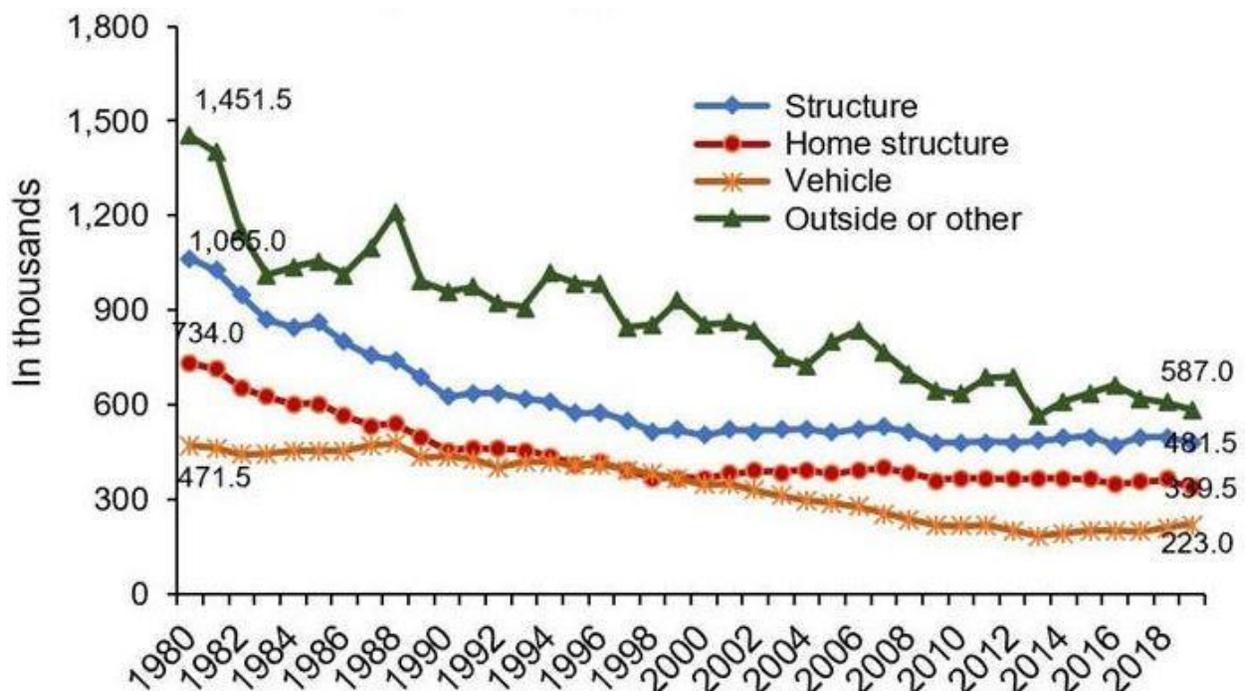
Structural Fire

Of greater risk for the City and County of Broomfield is the potential for structural fires. According to the National Fire Protection Association (NFPA), every 24 seconds a fire department responds to a fire somewhere in the U.S. Due to the urbanized nature of Broomfield and the relatively limited extent of the WUI within the county compared to other Colorado counties, the risk presented by structural fires is more present. The leading cause of home structure fires and non-fatal home fire injuries is cooking equipment, while smoking and the use of smoking materials is the leading cause of home fire deaths. Three out of five home fire deaths resulted from fires in which no smoke alarms were present or in which smoke alarms were present but did not operate. Compared to other age groups, older adults were more likely to be killed in a home fire.

An **urban conflagration** is a term given to describe a large and destructive fire in an urban area that spreads beyond natural or artificial barriers to threaten lives and property. The 2021 Marshall Fire is a singular example of how destructive these types of fires can be.

Overall, non-wildland fires have been trending downwards in their frequency since 1980 as shown in Figure 4-26 below. North Metro Fire and Rescue (NFMR) is the fire district which provides fire protection, emergency medical services, hazardous materials response, and rescue services for Broomfield. The district was formed in 1946 and covers 63 square miles with a population of approximately 110,000 residents, including the City and County of Broomfield, City of Northglenn, and unincorporated areas of Boulder, Adams, Weld, and Jefferson Counties.

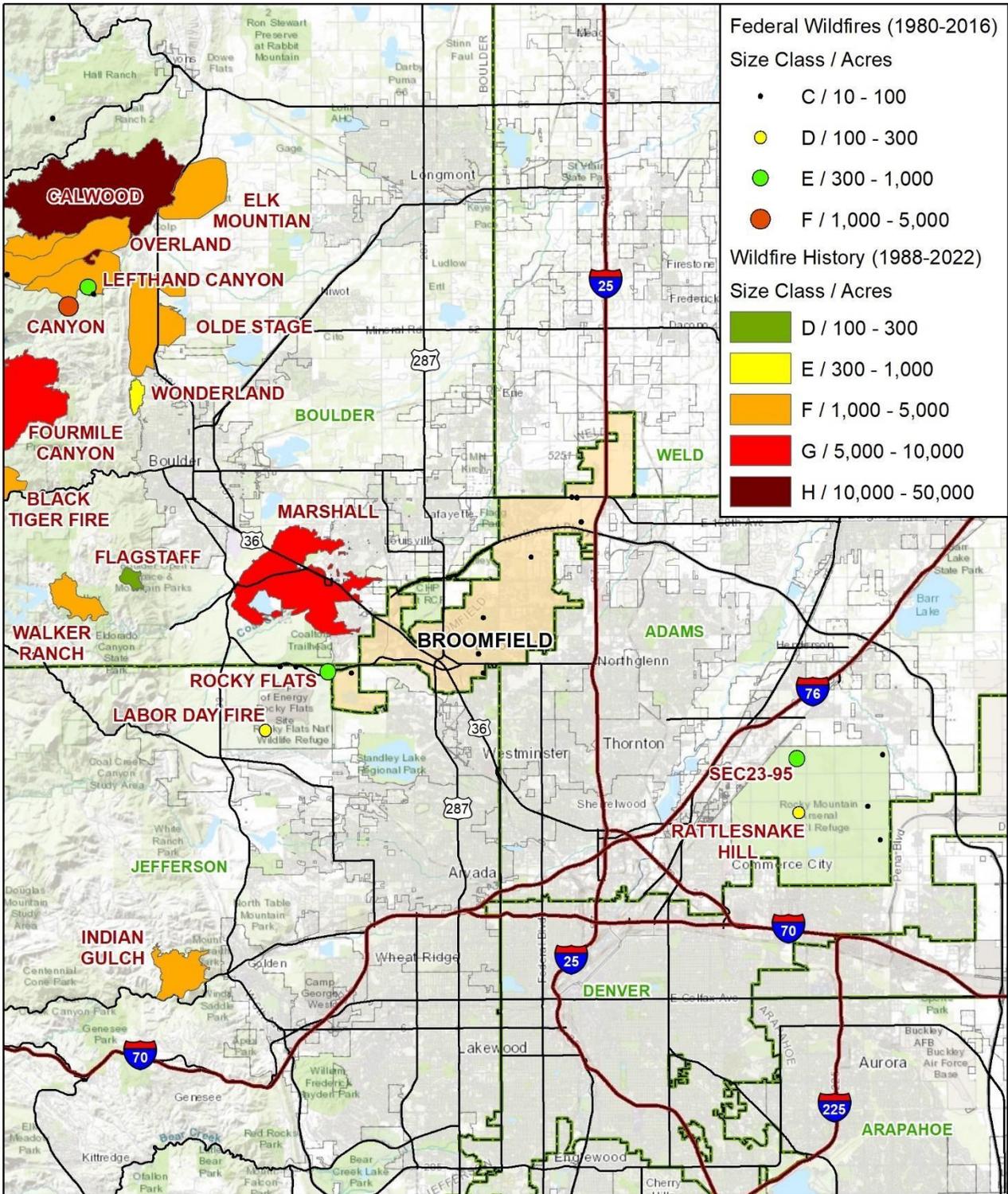
Figure 4-26 Fires by Incident Type in the U.S.: 1980-2019



Source: NFPA



Figure 4-27 Wildfire History Near the City and County of Broomfield



Federal Wildfires (1980-2016)

Size Class / Acres

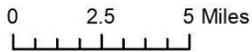
- C / 10 - 100
- D / 100 - 300
- E / 300 - 1,000
- F / 1,000 - 5,000

Wildfire History (1988-2022)

Size Class / Acres

- D / 100 - 300
- E / 300 - 1,000
- F / 1,000 - 5,000
- G / 5,000 - 10,000
- H / 10,000 - 50,000

Map compiled 4/2022;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, Colorado State Forest Service CO-WRAP,
USGS, US Fish and Wildlife Service, Boulder County





4.13.2 Past Events

Wildfire

Grassland and forest fires occur throughout the state, including in the Front Range foothills, and every county has some area determined to be at least a moderate risk. The traditional wildfire season runs from March through August; however, wildfires can occur any time of the year. Although many of Broomfield's neighboring counties have suffered repeated devastating wildfires, relative elevation, development patterns, vegetative cover, and relatively limited extent of the WUI within the planning area have resulted in limited previous occurrences of wildfire within the City and County of Broomfield. Figure 4-27 shows the locations and sizes of several previous wildfires in the vicinity of the planning area.

Structural Fire

According to NFPA, local fire departments responded to 1,291,500 fires in 2019 nationwide. Together, these fires caused approximately 3,700 deaths, 16,600 injuries, and close to \$15 billion in property damage.

In March 2000, the Maryel Manor apartment fire in Broomfield displaced more than 50 senior residents and injured one firefighter. None of the residents were injured but the entire building was destroyed. NFMR personnel and staff members spent the days and weeks following this incident helping the displaced residents move their salvaged items from the apartments. According to North Metro Fire Rescue, the fire remains one of the most notable calls on record.

In December 2021, the Marshall Fire demonstrated how destructive grass fires can be when they spread to an urban area. A brush fire broke out in nearby Boulder County following months of unusually warm and dry conditions. Driven by high winds with gusts up to 115 mph, the fire quickly spread to the Town of Superior and the City of Louisville. Thousands of people were forced to evacuate. The fire destroyed 1,084 homes and seven businesses and damaged another 149 homes and 30 businesses; total estimated damages were \$513M as of January 7, 2022. At least one person was killed, and six others were injured.

4.13.3 Location

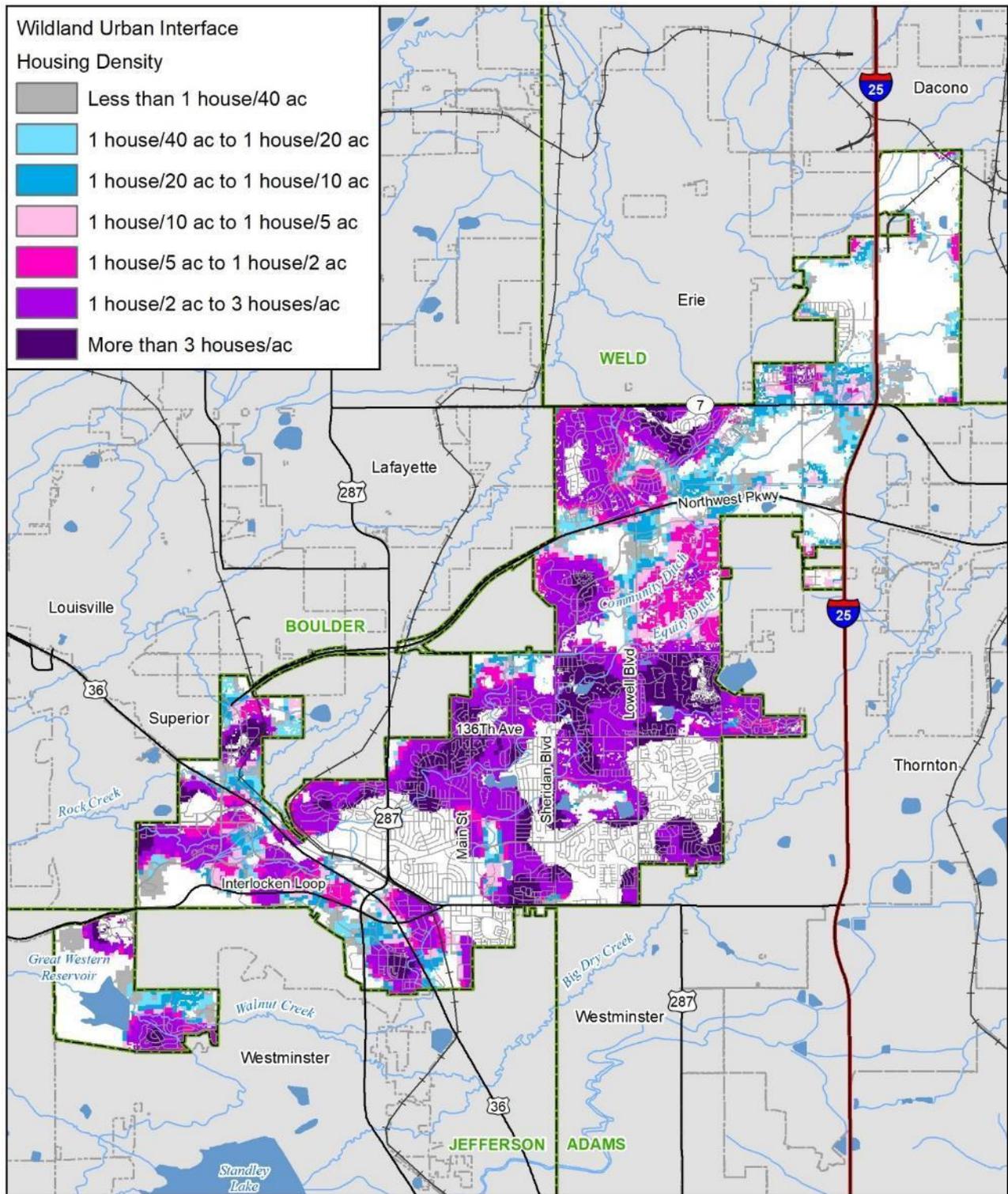
A significant portion of the County is at risk from wildfires and structural fires.

Wildfire

The areas of greatest concern for wildfire risk in the WUI, where development is interspersed or adjacent to landscapes that support wildland fire. While traditionally associated with forested mountain areas, WUI areas are also present in grasslands, prairies, valleys, or in any area where a sustained wildfire may occur and impact developed areas. Fires in the WUI may result in major losses of property and structures, threaten greater numbers of human lives, and incur larger financial costs. In addition, WUI fires may be more dangerous than wildfires that do not threaten developed areas, as firefighters may continue to work in more dangerous conditions in order to protect structures such as businesses and homes. As the development of WUI areas increases, the likelihood of a severe wildfire may also increase. Figure 4-28 shows WUI areas within the planning area as determined by the Colorado Forest Atlas. The Colorado Wildfire Risk Assessment Portal (COWRAP) defines the WUI using housing density data to delineate where people and structures meet and intermix with wildland fuels.

As an urban area, the wildland urban interface in Broomfield consists mostly of open space and grassland rather than the heavily forested areas traditionally associated with the WUI. While this does reduce the intensity of WUI fires in Broomfield, they remain a significant threat.

Figure 4-28 City and County of Broomfield Housing Density in the Wildland Urban Interface



Map compiled 6/2021; intended for planning purposes only. Data Source: Broomfield City/County, CDOT, Colorado Forest Atlas - Colorado State Forest Service

0 2.5 5 Miles

N



Structural Fire

Structural fires regularly occur in all developed areas of the City and County of Broomfield. Future development and population growth will necessitate a corresponding increase in fire suppression resources and capabilities to maintain current fire safety standards.

4.13.4 Magnitude and Severity

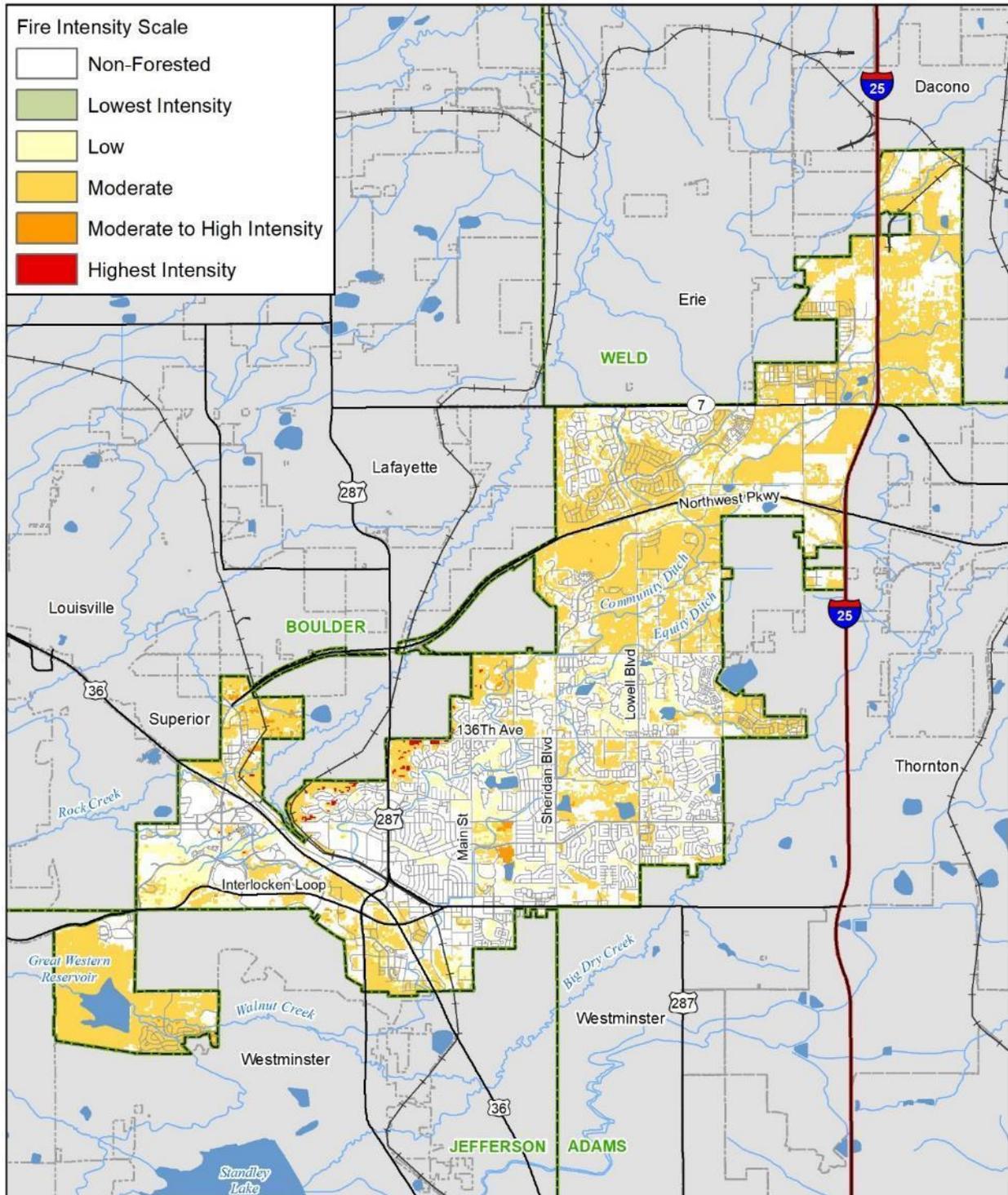
The overall severity of fires in Broomfield is **moderate**.

Wildfire behavior is dictated in part by the quantity and quality of available fuels. Fuel quantity is the mass of material per unit area. Fuel quality is determined by several factors, including fuel density, chemistry, and arrangement. Arrangement influences the availability of oxygen surrounding the fuel source. Another important aspect of fuel quality is the total surface area of the material that is exposed to heat and air. Fuels with large area-to-volume ratios, such as grasses, leaves, bark, and twigs are easily ignited when dry. In developed areas, landscaping can also contribute to wildfire fuels. Climatic and meteorological conditions that influence wildfires include solar insolation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire.

The Colorado Forest Atlas also conducts a Fire Intensity Scale analysis, which uses fuels, topography, and weather as inputs to determine the relative intensity (from Class 1, lowest to Class 5, highest) of a potential wildfire. This data provides a summary of how intense potential fires could burn in each area when considering these factors. According to data from the Fire Intensity Scale analysis, large portions of the planning area are within the moderate intensity rating, see Figure 4-29. Figure 4-30 and Figure 4-31 show the wildfire risk areas of the planning area as well as the relative WUI risk according to the Colorado Forest Atlas. These maps are a summary of the relative potential likelihood for a wildfire in a given area.

Note that even in developed areas, landscaping can also contribute to wildland fire fuels. Climatic and meteorological conditions that influence wildland fires include solar insolation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire, as seen in the 2021 Marshall Fire. While the severity of past wildland fires on Broomfield have been limited, the Marshall Fire demonstrated how potentially destructive grass fires can be when they spread to an urban area.

Figure 4-29 City and County of Broomfield Fire Intensity Scale



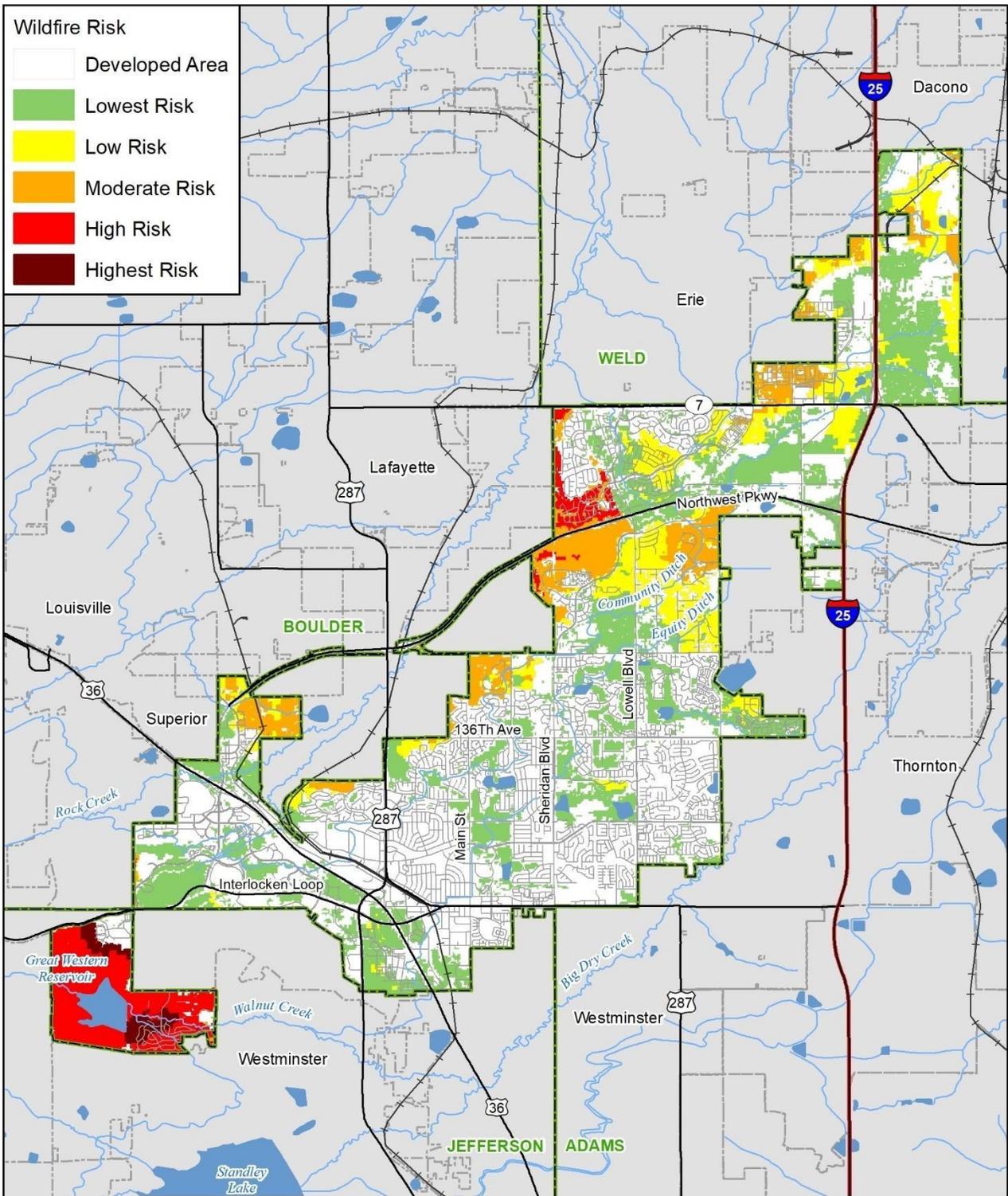
Map compiled 6/2021; intended for planning purposes only.
Data Source: Broomfield City/County, CDOT, Colorado Forest Atlas - Colorado State Forest Service

0 2.5 5 Miles

N



Figure 4-30 City and County of Broomfield Wildfire Risk



Map compiled 4/2022;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, Colorado Forest Atlas - Colorado State Forest Service

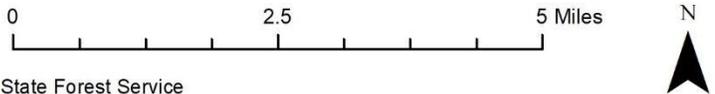
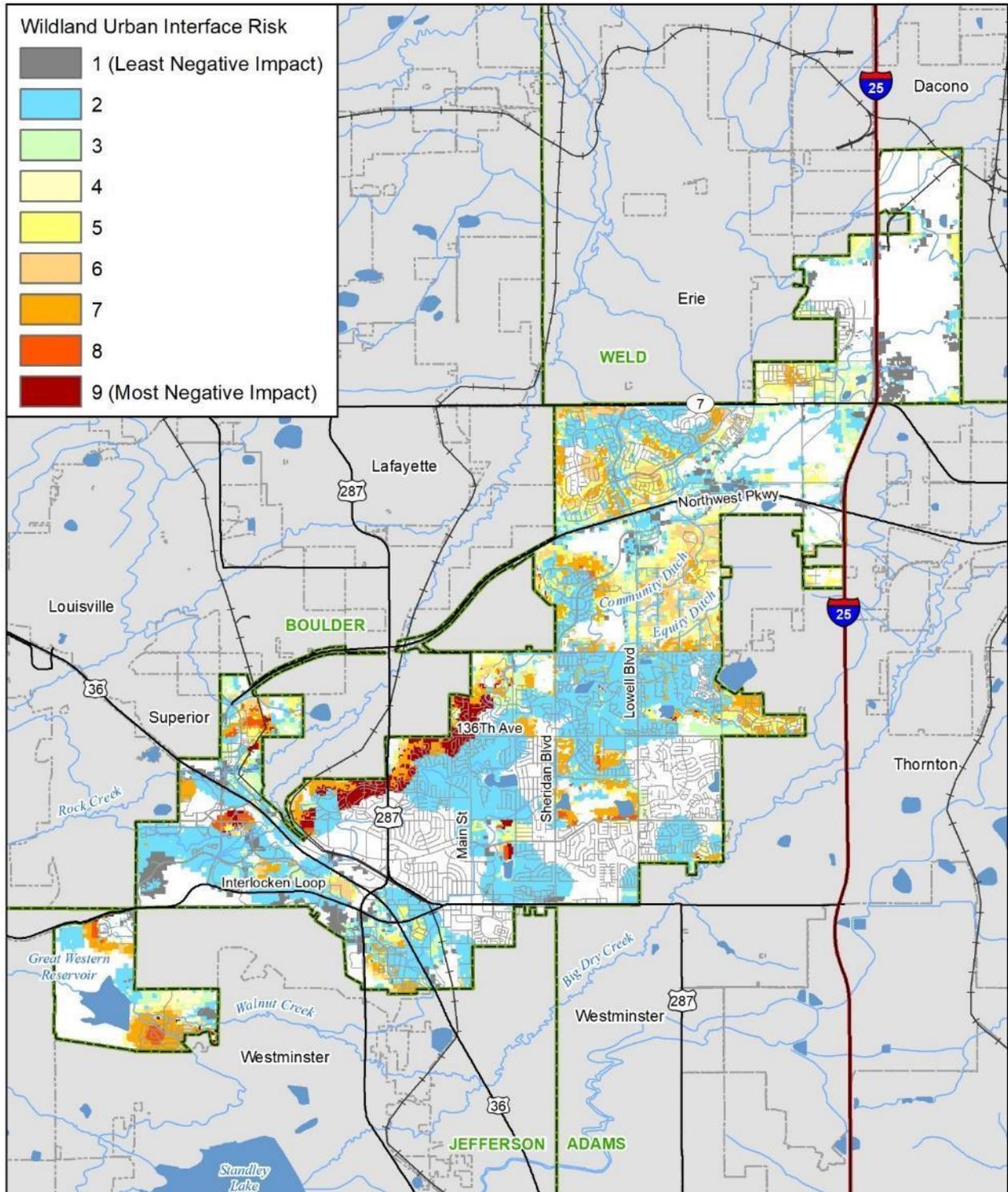


Figure 4-31 City and County of Broomfield WUI Communities and WUI Risk



Map compiled 6/2021; intended for planning purposes only.
Data Source: Broomfield City/County, CDOT, Colorado Forest Atlas - Colorado State Forest Service

0 2.5 5 Miles

N

4.13.5 Probability of Future Occurrence

Since 1980 there have been eight wildland or grass fire incidents within the City and County of Broomfield, none of which have burned 100 or more acres. Thus, the probability of a fire less than 100 acres occurring in any given year is approximately 20%, while the chances of a major wildfire occurring in any given year is close to 0%. In contrast, the odds of a structural fire occurring in any given year are all but certain. This corresponds to a probability of future occurrences rating of **likely**.

4.13.6 Climate Change Considerations

Climate is a major determinant of wildfire through its control of weather, as well as through its interaction with fuel availability, fuel distribution and flammability at the global, regional, and local levels. With hotter temperatures, drier soil and worsening drought conditions in the entire Western U.S., wildfires have the potential to become more extreme. Currently humans are the main cause of fire ignition globally, although lightning has been predominantly responsible for large fires nearby in the Front Range. Colorado and the Western United States have seen significant increases in forest area burned in recent years, and the risk of wildfires in the future are expected to increase due to a lengthening fire season and drier conditions. According to a report from the International Panel on Climate Change:

Fire season has already lengthened by 18.7% globally between 1979 and 2013, with statistically significant increases across 25.3% but decreases only across 10.7% of Earth's land surface covered with vegetation; with even sharper changes being observed during the second half of this period. Correspondingly, the global area experiencing long fire weather season has increased by 3.1% per annum or 108.1% during 1979-2013. Fire frequencies under 2050 conditions are projected to increase by approximately 27% globally, relative to the 2000 levels, with changes in future fire meteorology playing the most important role in enhancing global wildfires, followed by land cover changes, lightning activities and land use, while changes in population density exhibit the opposite effects.

Land use, vegetation, available fuels, and weather conditions (including wind, low humidity, and lack of precipitation) are chief factors in determining the number and size of fires in Colorado each year. Generally, fires are more likely when vegetation is dry from a winter with little snow and/or a spring and summer with sparse rainfall. As a result, climate induced hazards in Colorado (specifically, a pattern of extended drought conditions) have contributed to increased concern about wildfire in Broomfield.

The frequency, intensity, and duration of wildfires have increased across the Western United States since the 1980s. The U.S. Department of Agriculture's "Effects of Climate Variability and Change on Forest Ecosystems" General Technical Report, published in December 2012, found that the Colorado region, among others, will face an even greater fire risk over time. The report expects Colorado to experience up to a five-fold increase in acres burned by 2050. The report's findings are consistent with previous studies on the relationship between climate change and fire risk. Colorado landscapes, including those that characterize the City and County of Broomfield, are expected to become hotter and drier as the planet warms, which in turn is expected to increase regional wildfire risk.

It is unclear whether climate change will have a significant impact on the frequency or severity of structural fires. However, the 2021 Marshall Fire demonstrated how hotter, drier conditions combined with high winds could increase the likelihood of wildland fires spreading into urban areas.

4.13.7 Vulnerability

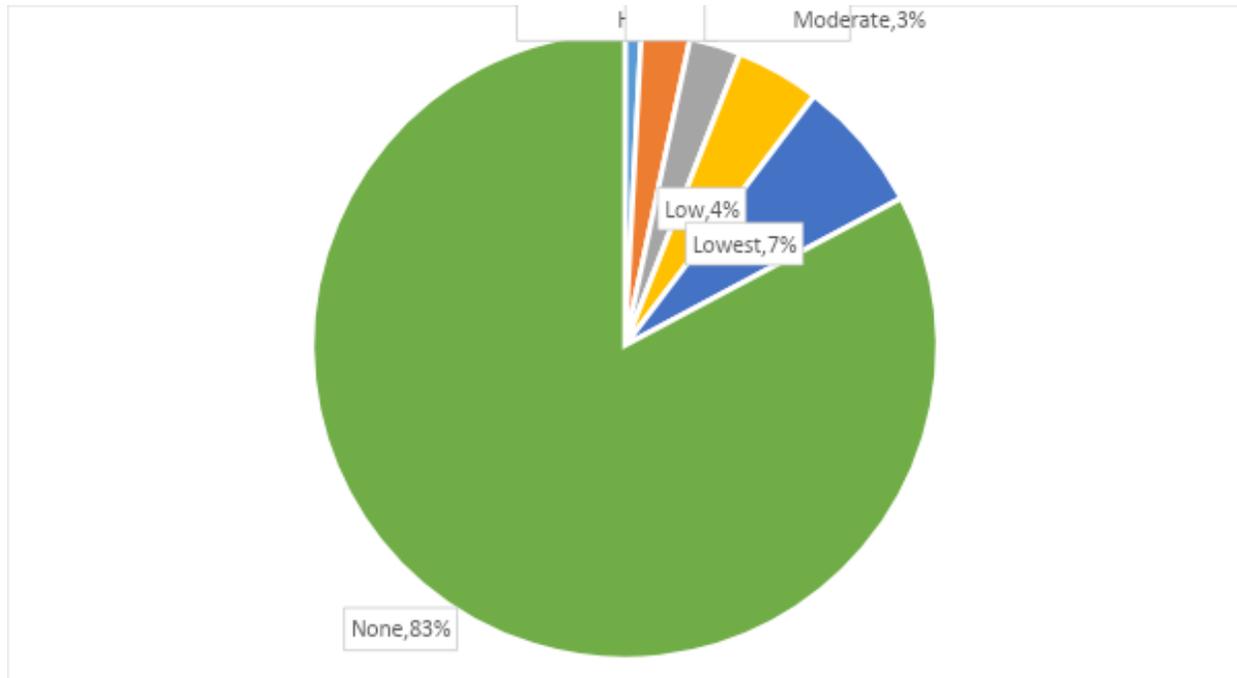
Information for the exposure analyses provided in the sections below was downloaded from the Colorado Forest Atlas in 2021. The distribution of risk areas in the planning area are shown in Figure 4-30 and Figure 4-31.

People

Population could not be examined by WUI area because census block group areas do not coincide with the fire risk areas. Instead, the population vulnerable to wildfire was estimated using the residential structure count of buildings in the various fire risk areas and applying the census value of 2.6 persons per household for the City and County of Broomfield. Utilizing this method, the analysis estimates that 5.4% of the County's population (3,666) live in areas exposed to at least a moderate wildfire risk.

Figure 4-32 shows the estimated percentage of Broomfield residents living in the Wildland Urban Interface based on the WUI Risk categories. Approximately 17% of residents live in WUI areas, although the majority of those are in Low or Lowest risk.

Figure 4-32 Percentage of Broomfield Residents Living in WUI Risk Areas



Source: City and County of Broomfield, COWRAP, Wood GIS Analysis

Smoke and air pollution from wildfires, even those burning many hundreds of miles away, can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. A study from the University of California San Diego found that wildfire smoke is more harmful to respiratory health in humans than pollution from cars (NPR 2021). Studies have also shown an increase in ambulance calls, hospital visits and an increase of people experiencing respiratory or cardiac emergencies (NPR 2020).

Wildfire can also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Property

Property damage from wildfires can be severe and can significantly alter entire communities; however, historically impacts in the planning area have been much more limited than in adjacent counties. Table 4-32 displays the number of structures at Highest, High, and Moderate wildfire risk within the planning area (as seen in Figure 4-30) and their values, based off 2021 county tax assessor data. 1,443 buildings with a total value of more than \$1.6 billion are potentially exposed to wildfire risk.



Table 4-32 City and County of Broomfield Exposure and Value of Structures in Moderate, High, and Highest Wildfire Risk Areas

Property Type	Improved Parcel Count	Building Count Highest	Building Count High	Building Count Moderate	Total Building Count	Improved Value	Estimated Content Value	Total Value
Agricultural	3	0	1	9	10	\$1,632,550	\$1,632,550	\$3,265,100
Commercial	4	0	0	4	4	\$13,794,320	\$13,794,320	\$27,588,640
Exempt	5	0	13	6	19	\$65,021,240	\$65,021,240	\$130,042,480
Mixed Use	1	0	0	2	2	\$369,070	\$369,070	\$738,140
Residential	1,339	197	589	622	1,408	\$977,105,220	\$488,552,610	\$1,465,657,830
Total	1,352	197	603	643	1,443	\$1,057,922,400	\$569,369,790	\$1,627,292,190

Source: City and County of Broomfield, COWRAP, Wood GIS Analysis

Critical Facilities and Infrastructure

Wildfires frequently damage community infrastructure, including roadways, communication networks and facilities, power lines, and water distribution systems. Efforts to restore roadways include the costs of maintenance and damage assessment teams, field data collection, and replacement or repair costs. Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground distribution lines, and soil erosion or debris deposits into waterways after the fire. Utilities and communications repairs are also necessary for equipment damaged by a fire. This includes power lines, transformers, cell phone towers, and phone lines.

Government Services

Historically, wildfires in Broomfield have had minimal impact on delivery of government services. Large fires can affect the availability of resources over an extended response. Power interruption may occur if facilities are not adequately equipped with backup generation.

Economy

Economic impacts of wildfires in Broomfield have historically been limited. In addition to the losses described above, large fires can also force business closures, and impact recreation and tourism areas. The economic cost of fighting wildfires is also significant.

The cost of direct losses to structural fires, in terms of physical damages, the cost of repairs, and business interruption, can be significant.

Historic, Cultural, and Natural Resources

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts, such as damage to fisheries, soil erosion, and spread of invasive plant species.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

4.13.8 Development Trends

Characteristic of the Colorado Front Range, the City and County of Broomfield has experienced rapid growth for the past ten years as people move to the Denver Metropolitan Area. Much of this growth has occurred in the WUI, where developing lands are adjacent to undeveloped land. While the risk of wildfire on undeveloped land is generally understood, much of the adjacent developing land is equally



at risk. As development in WUI areas continues to increase, the risk to lives, property, and resources correspondingly increases.

4.13.9 Risk Summary

- The overall significance of this hazard to the County is **low**.
- Changes since 2016: fire was ranked as high significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that low is a more accurate assessment of the risk.
- The planning area can expect a 20% chance of a wildfire less than 100 acres in a given year, but the vast majority of those are minor incidents with minimal impacts.
- 3,666 people live in areas potentially exposed to wildfire risk, however most of those are in relatively low risk areas.
- Future growth into interface areas in and around open space could increase wildfire risk.
- Climate change could increase both the likelihood and severity of wildfires.

4.14 Flood

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Flood	Limited	Occasional	Moderate	Medium

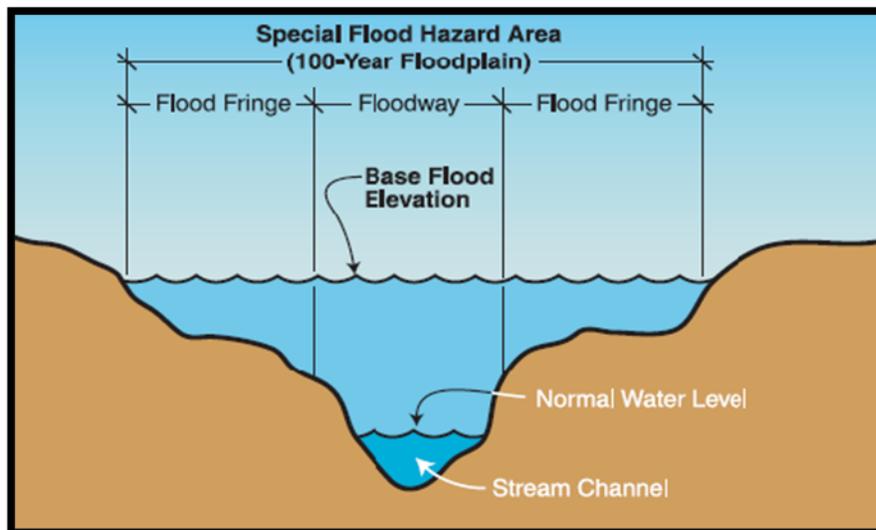
4.14.1 Description

Floods involve inundation of normally dry land or other areas. Common types of flooding applicable to the City and County of Broomfield include riverine flooding, localized or flash flooding (including storm generated flash floods), stormwater drainage flooding, and dam inundation (see Section 4.8 Dam Inundation).

Floods can cause substantial damage to structures, landscapes, and utilities, as well as cause life safety issues. Certain related health hazards are also common to flood events. Standing water and wet materials in structures can become breeding grounds for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When flood waters contain sewage or decaying animal carcasses, infectious disease becomes a concern. Direct impacts to populations such as drowning can be limited with adequate warning and public education about what to do during floods. Where flooding occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts.

Riverine flooding is defined as when a watercourse exceeds its “bank-full” capacity and is usually the most common type of flood event in Colorado. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils already saturated from previous rain events. It also occurs as a result from snowmelt, in which case the extent of flooding depends on the depth of winter snowpack and spring weather patterns. Floodplains are lowlands, adjacent to rivers, streams, and creeks that are subject to recurring floods. Figure 4-33 illustrates common floodplain terminology.

Figure 4-33 Floodplain Terminology



Source: FEMA

Flooding events are typically measured in terms of magnitude and the statistical probability that they will occur. The 1% annual chance flood event is the standard national measurement for flood mitigation and insurance. A 1% annual chance flood, also known as the ‘100-year flood’, has a 1 in 100 chance of being equaled or exceeded in any 1 year and has an average recurrence interval of 100 years. It is important to note that this recurrence interval is an average; it does not necessarily mean that a flood of such a magnitude will happen exactly every 100 years. Sometimes, only a few years may pass



between one 1% annual chance flood and another, while two other 1% annual chance floods may be separated by 150 years. The 0.2% annual chance flood event, or the '500-year flood', is another measurement which represents a 0.2% chance (or 1 in 500 chance) of occurring in a given year.

A change in environmental conditions or land uses can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels (e.g., leading to flash flooding). These changes are most often created by human activity in developed areas but can also be created by other natural events (such as wildland fires) which cause compound effects. For example, wildfires create hydrophobic soils, a hardening or "glazing" of the earth's surface that prevents rainfall from being absorbed into the ground, thereby increasing runoff, erosion, and downstream sedimentation of channels.

Flash flooding events can occur from sudden intense storms, a dam or levee failure, or from a rapid release of water held by an ice jam or snowmelt. Most flash flooding is caused by slow moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. Flash flooding in Broomfield occurs most often around urbanized areas where much of the ground is covered by impervious surfaces. Flash floodwaters move at very high speeds due to the sudden rush of water, leading to "walls" of water which can reach heights of 10 to 20 feet. Flash floodwaters and the accompanying debris can uproot trees, roll boulders, and damage or destroy buildings, bridges, and roads.

Urban flooding is the result of development and the ground's decreased ability to absorb excess water without adequate drainage systems in place. Typically, this type of flooding occurs when land uses change from fields or woodlands to roads and parking lots. Urbanization can increase runoff two to six times more than natural terrain. Stormwater refers to water that collects on the ground surface or is carried in the stormwater system when it rains. In runoff events where the amount of stormwater is too great for the system, or if the channel system is disrupted by vegetation or other debris that blocks inlets or pipes, excess water remains on the surface. This water may pond in low-lying areas, often in street intersections. This is known as **stormwater flooding** or ponding, and can carry debris, dirt, chemicals, and pollutants from impervious surfaces, leading to health issues.

Stream bank erosion is measured as the rate of the change in the position or horizontal displacement of a stream bank over a period of time. It is generally associated with riverine flooding and discharge and may be exacerbated by human activities such as bank hardening and dredging.

Dam inundation can occur because of structural failure, overtopping, seismic activity, or other reasons that cause a dam or levee to release its contents (often water), leading to flooding. Dam inundation is described in more detail under Section 4.8 Dam Inundation.

4.14.2 Past Events

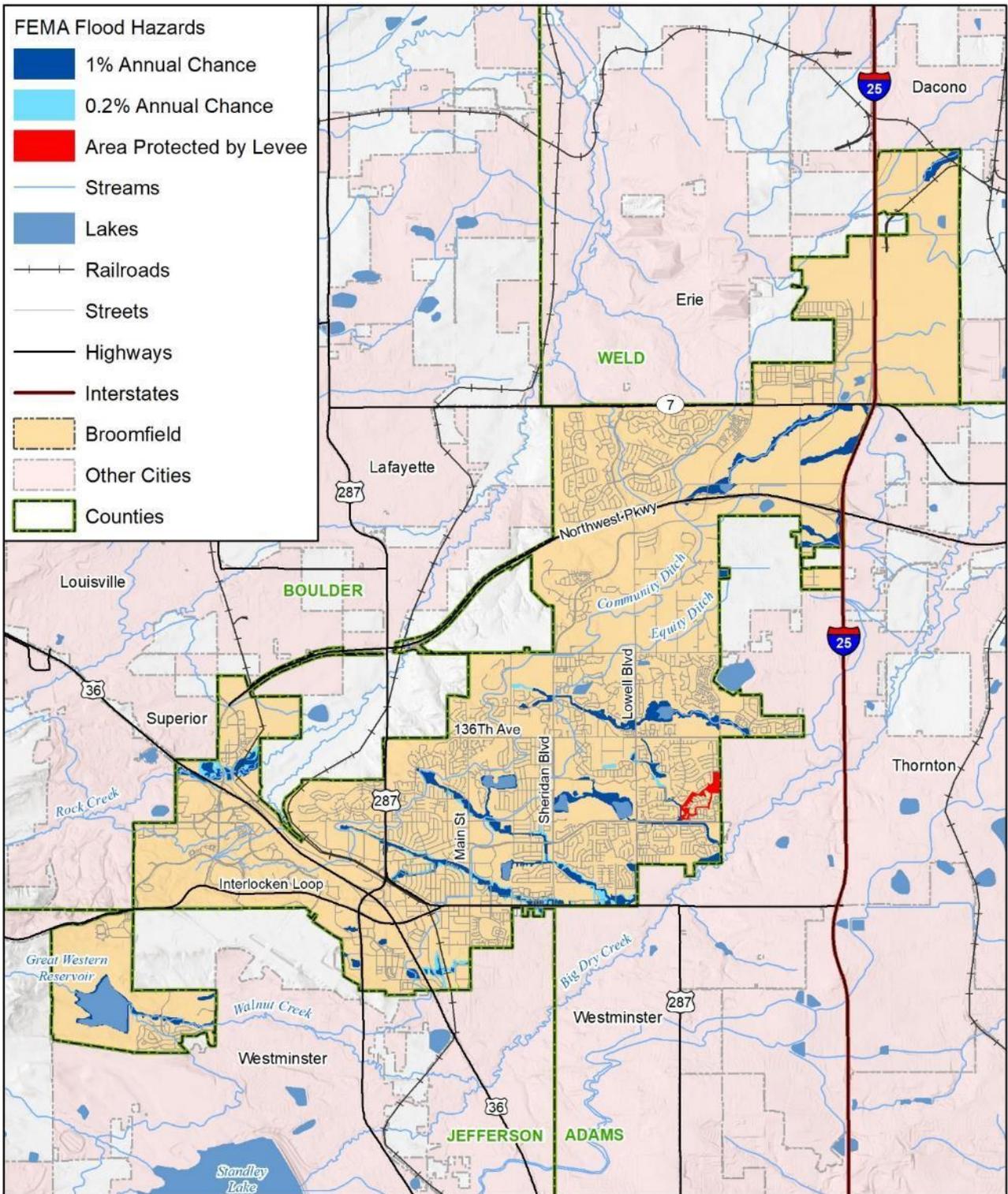
According to the latest City and County of Broomfield FIS, dated August 15, 2019, flooding has generally been caused by heavy local rainstorms.

In September 2013, heavy rain and catastrophic flooding occurred along Colorado's Front Range. Broomfield sustained damage to the headgate for the Upper Church Ditch and the diversion structures (water control facilities) for both Upper Church Ditch and McKay Ditch, which are located in Jefferson County. Although Broomfield was not one of the 18 Colorado counties designated for FEMA public assistance after the 2013 floods, these structures were eligible for disaster relief funding since Jefferson County was one of the 18 designated counties. Water Broomfield diverts through the McKay Ditch and the Upper Church Ditch is delivered into Great Western Reservoir just east of Indiana Street.

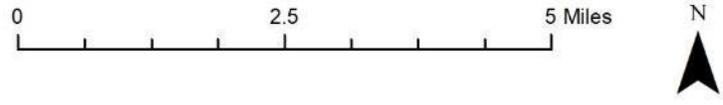
4.14.3 Location

The geographical extent is limited.

Figure 4-34 City and County of Broomfield Special Flood Hazard Areas



Map compiled 5/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, FEMA NFHL 9/24/2020



As shown in Figure 4-34, most floodplain areas are located in central portions of the County. The County's FIS identifies the following as the principal flood problems:

- City Park Channel. Located in the southwestern portion. Well defined and narrow until it crosses West 120th Avenue.
- Nissen Channel. Flows southeasterly through central Broomfield. Narrow and shallow. For approximately 1,400 feet, the stream flows down East 7th Avenue between Ash and Birch Streets. Runoff from the West Lake and Gay Reservoir basins, located in northeastern Broomfield, flows through shallow, poorly defined channels.

Additionally, there is an area protected by levee (shown in red in Figure 4-34) in the southeast portion of the County.

4.14.4 Magnitude and Severity

The potential magnitude and severity of a flood event is **moderate**.

The severity of a flooding event is determined by the following key aspects: 1) a combination of stream and river basin topography and physiography; 2) precipitation and weather patterns; 3) recent soil moisture conditions; 4) the degree of vegetative clearing, and 5) effects on life, property, the environment, and the economy in terms of injuries and deaths, and damages or losses to structures, crops, resources, and critical facilities.

As previously discussed, major floods can result in death and injuries, induce property damages that threaten structural integrity, and impact critical services, facilities, and infrastructure. Flooding impacts a community only to the degree that it affects the lives or property of its citizens and the community's overall ability to function. Therefore, the most vulnerable areas of a community will be those most affected by floodwaters in terms of potential losses, damages, and disruption of community services and utilities. For example, an area with large developments on the floodplain is significantly more vulnerable to the impacts of flooding than a rural or undeveloped zone where potential floodwaters would have little impact on the community due to lack of the built environment and human presence.

Several factors contribute to the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood vulnerability range from specific characteristics of the floodplain to characteristics of the structures located within the floodplain. The following is a brief discussion of some of these flood factors which pose risk.

- **Elevation:** The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage, due to the higher likelihood that it will come into contact with water for a prolonged amount of time.
- **Flood depth:** The greater the depth of flooding, the higher the potential for significant damages due to larger availability of flooding waters.
- **Flood duration:** The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage.
- **Velocity:** Flowing water exerts forces on the structural members of a building, increasing the likelihood of significant damage (e.g., such as scouring).
- **Construction type:** Certain types of construction and materials are more resistant to the effects of floodwaters than others. Typically, masonry buildings, constructed of brick or concrete blocks, are the most resistant to damages simply because masonry materials can be in contact with limited depths of flooding without sustaining significant damage. Wood frame structures are more susceptible to damage because the construction materials used are easily damaged when inundated with water.

4.14.5 Probability of Future Occurrence

The probability of future occurrence is **occasional**.



Periodic flooding of lands adjacent to rivers and streams is a natural occurrence in the County and can be expected to take place based upon established flood recurrence intervals.

A 100-year flood, which has a 1% chance (1 in 100) of occurring in a given year, is a regulatory standard used by federal agencies, states, and NFIP- participating communities to administer and enforce floodplain management programs, as well as set insurance requirements nationwide.

The 500-year flood event, which has a 0.2% chance (1 in 500) chance of occurring in a given year, is another commonly mapped and studied event by FEMA flood related programs and efforts.

For context, the main flood recurrence intervals used in planning, floodplain studies, and other regulatory contexts are summarized in Table 4-33, and more detailed descriptions of FEMA special flood hazard zones applicable to Broomfield are contained in Table 4-34. The most recent FEMA special flood hazard areas mapped, which contain the 100- and 500-year events and hence where riverine flooding is expected to primarily occur in the future, are shown on Figure 4-34 under the Hazard Location subsection of this chapter.

Table 4-33 Annual Probability of Flooding Based on Recurrence Intervals

Flood Recurrence Interval	Annual Chance of Occurrence
10-year	10%
50-year	2%
100-year	1%
500-year	0.2%

Table 4-34 FEMA Special Flood Hazard Zones

Flood Zone	Definitions
FEMA Special Flood Hazard Areas (SFHAs) Subject to Inundation by the 1% or 0.2%-Year Floods	
Zone A	100-year floodplain, or areas with a 1% annual chance of flooding. Because detailed analyses are not performed these areas, no depths or base flood elevations are shown in Zone A areas.
Zone AE	Detailed studies for the 100-year floodplain. The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 zones.
Zone AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. Average flood depths derived from detailed analyses.
Other Flood Areas	
Floodway	A regulatory floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.
Zone X (shaded)	Areas with a 0.2% annual chance flooding (1 in 500 chance), between the limits of the 100-year and 500-year floodplains. This zone is also used to designate base floodplains of lesser hazards, such as areas protected by levees from the 100-year flood, shallow flooding areas with average depths of less than one foot, or drainage areas less than one square mile.
Zone X (unshaded)	500-year floodplain (0.2% annual chance). Area of minimal flood hazard.

4.14.6 Climate Change Considerations

According to the NOAA, there is generally more rain and snow falling in the Northern Hemisphere and precipitation has increased by about 5% over the last century. An increase in precipitation alone is not immediately alarming, but “factors such as precipitation intensity, soil moisture and snow conditions,

and basin topography are also important in determining the occurrence and severity of flooding.” As with temperature, it is the extremes that matter most with regard to rainfall. According to Robert Hanson, author of *The Thinking Person’s Guide to Climate Change*, “Data shows a clear ramp up in precipitation intensity for the United States, Europe, and several other areas over the last century, especially since the 1970s. When it rains or snows in these places, it now tends to rain or snow harder, over periods ranging from a few hours to several days.” Additionally, with wildfires already being a problem in many parts of Colorado, increasing periods of drought and lack of precipitation are expected to exacerbate conditions for fires to occur, and in turn worsen the potential for runoff and flooding associated with burned areas.

These events can lead to increased infrastructure damage, injury, illness, and death. Additionally, warmer temperatures in the winters may cause increased precipitation to fall as rain instead of snow in mountain regions of Colorado. This may lead to elevated stream flows and increased flood risk across the state. As climate science and data evolves it will be important for communities in and around the City and County of Broomfield to address how our changing climate will affect how water moves through local streams and regional landscapes.

4.14.7 Vulnerability

People

Based on the GIS analysis performed, where the FEMA SFHAs were overlaid with the Broomfield parcel layer to obtain the number of vulnerable residential properties (i.e., those intersecting the hazard layer), the total at-risk population to this hazard was estimated. The total population exposed to flooding hazards was calculated by multiplying the average persons per household value for each participating jurisdiction by the total properties of residential nature found to intersect with the flood hazard layers. This assessment estimates that 42 people (0.1% of total population) reside within the 1% flood hazard area, while an additional 83 people live in the 0.1% flood hazard area. For more details, refer to Table 4-35 and Table 4-36

The impacts of flooding on vulnerable populations can be more severe. Families may have fewer financial resources to prepare for or recover from a flood, and they may be more likely to be uninsured or underinsured. Individuals with disabilities may need more time to evacuate, so evacuation notices will need to be issued as soon as feasible, and communicated by multiple, inclusive methods.

Property

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Seepage into basements is common during flood events. Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Homes in flooded areas can also suffer damage to septic systems and drain fields. In many cases, flood damage to homes renders them uninhabitable.

Vulnerability to flooding was determined by summing potential losses to Broomfield’s parcels in GIS, by using the latest FEMA NFHL data along with the County parcel layer the provided by the Assessor’s Office. FEMA’s NFHL data depicts the 1% annual chance and the 0.2% annual chance flood events. Flood zones A, AE, and AO are variations of the 1% annual chance event and were included in the analysis due to being present in the City and County of Broomfield. The “Shaded Zone X” along with the subtype 0.2% annual chance hazard zone were used to represent the 500-year flood event.

GIS was used to create a centroid, or point, representing the center of each parcel polygon. Only parcels with improvement values greater than zero were used in the analysis; this assumes that improved parcels have a structure of some type. The FEMA flood zones were overlaid in GIS on the parcel centroid data to identify structures that would likely be inundated during a 1% annual chance or 0.2% annual chance flood event. Property improvement values for the points were based on the assessor’s parcel data and summed by parcel type and jurisdiction across the County, along with content values and total values.



Results of the overlay analysis are summarized in Table 4-35 and Table 4-36. Based on these results, there are 43 buildings in the 1% annual chance flood zone: 16 are residential buildings and 27 are non-residential properties. The total parcel exposure value vulnerable to the 1% annual chance flood is over \$64 million.

There are 41 buildings vulnerable to the 0.2% annual chance of flooding: 32 are residential properties and nine are commercial buildings.

Table 4-35 Properties Exposed to 1% Annual Chance Flooding

Property Type	Improved Parcel Count	Building Count	Improved Value	Estimated Content Value	Total Value	Estimated Loss	Population
Commercial	7	10	\$3,710,390	\$3,710,390	\$7,420,780	\$1,855,195	
Exempt	6	8	\$12,234,030	\$12,234,030	\$24,468,060	\$6,117,015	
Industrial	7	9	\$3,196,110	\$4,794,165	\$7,990,275	\$1,997,569	
Residential	10	16	\$16,668,230	\$8,334,115	\$25,002,345	\$6,250,586	42
Total	30	43	\$35,808,760	\$29,072,700	\$64,881,460	\$16,220,365	42

Source: Wood Analysis of City and County of Broomfield & NFHL data

Table 4-36 Properties Exposed to 0.2% Annual Chance Flooding

Property Type	Improved Parcel Count	Building Count	Improved Value	Estimated Content Value	Total Value	Estimated Loss	Population
Commercial	6	9	\$7,791,440	\$7,791,440	\$15,582,880	\$3,895,720	
Residential	30	32	\$84,678,370	\$42,339,185	\$127,017,555	\$31,754,389	83
Total	36	41	\$92,469,810	\$50,130,625	\$142,600,435	\$35,650,109	83

Source: Wood Analysis of City and County of Broomfield & NFHL data

There are additional 40 mobile homes (of the 590 structures within the park) and 104 people that are within the levee protected area.

Critical Facilities and Infrastructure

The impacts of floodwater on critical facilities such as police and fire stations, health facilities, and water or wastewater treatment facilities among others can greatly increase the overall effect of a flood event on a community (e.g., if critical potable facilities are impacted). In general, most of these facilities are located in areas with lower risk to flooding due to recent requirements for developers to consider hazard risks in their plans. However, the GIS analysis performed indicates several critical facilities were found to be vulnerable to 1% and 0.2% annual flood hazard areas, as listed in Table 4-37.

A total of 21 facilities are located in 1% annual chance flood area, representing 4% of the County’s total critical facilities. Three (3) critical facilities, representing 1% of city’s total critical facilities are located in the 0.2% annual flood hazard area. As shown in Table 4-37, the greatest number of facilities in both the 1% and 0.2% annual chance flood area across the County are transportation critical facilities such as bridges.

Table 4-37 Critical Facilities Within FEMA Flood Hazards, by FEMA Lifelines

Flood Zone	FEMA Lifeline	Facility Type	Count
1% Annual Chance	Communications	Land Mobile Private	4



Flood Zone	FEMA Lifeline	Facility Type	Count
	Hazardous Material	Tier II	2
	Safety and Security	Historical Place	1
	Transportation	Good Condition Bridge	7
Total			21
0.2% Annual Chance	Transportation	Good Condition Bridge	2
		Fair Condition Bridge	1
	Total		
Grand Total			24

Source: Wood Analysis of City and County of Broomfield NFHL and HFLID data,

Government Services

Publicly owned facilities are a key component of daily life for all citizens of the County. Public buildings are of particular importance during flood events because they house critical assets for government response and recovery activities. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Loss of power and communications can be expected. Drinking water and wastewater treatment facilities may be temporarily out of operation.

Flooding can have various impacts to responders in terms of response time and the personal safety of first responders. Flooded roadways are a common occurrence in Broomfield and can block emergency vehicles from crossing certain areas, delaying response times.

Public confidence may be hindered if warnings and alerts prior to the flood event are not communicated effectively. The government’s ability to respond and recover may be questioned and challenged by the public if planning, response, and recovery is not timely and effective, particularly in areas that have repeated flooding.

Economy

Flooding can have a major economic impact on the economy, including indirect losses such as business interruption, lost wages, reduced tourism and visitation, and other downtime costs. Flood events can cut off customer access to a business as well as close a business for repairs or permanently. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

Historic, Cultural, and Natural Resources

There are significant historic, cultural, and natural resources and assets located throughout the County (e.g., trails and natural spaces, lakes). According to the GIS analysis on critical facilities described above, 1 historical place is located in the 1% annual flood area. 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 that are no longer wetlands may suffer from oversaturation of water, as will areas that are particularly impacted by drought. Areas which may have recently suffered from wildfire damage may erode because of flooding, which can permanently alter an ecological system.

National Flood Insurance Program (NFIP) Policies and Repetitive Flood Properties

FEMA insures properties against flooding losses through the NFIP. Table 4-38 provides detailed information on NFIP policies the County. NFIP insurance data there were 90 flood insurance policies in force in the City and County of Broomfield with \$31,303,200 of coverage. However, only 11 of those



policies were for properties located in the 1% annual floodplain; the rest were Preferred Risk Policies that offer low-cost coverage for properties in areas of low-to-moderate flood risk.

Table 4-38 National Flood Insurance Program Policies

Building Type	Policies in Force	Insurance in Force	# of Closed Paid Losses	Amount of Closed Paid Losses
Single Family	73	\$22,889,000	14	\$4,335.25
2-4 Family	0	\$0	0	\$0
All Other Residential	2	\$745,000	0	\$0
Non-Residential	15	\$7,669,200	1	\$17,266.41
Total	90	\$31,303,200	15	\$21,601.66

Source: FEMA Community Information Systems (CIS)

The City and County of Broomfield does not currently participate in the NFIP’s CRS.

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 Severe Repetitive Loss property (SRL) is defined as a residential property that is covered under an NFIP flood insurance policy and: a) has at least four NFIP claim payments (including building and contents) over \$5,000 each, and the cumulative amount of such claims payments exceeds \$20,000; or, b) a property for which at least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both a) and b) above, at least two of the referenced claims must have occurred within any ten-year period and must be greater than ten days apart.

There are no Repetitive Loss or SRL properties in the City and County of Broomfield as of July 2021.

4.14.8 Development Trends

As population continues to increase in the City and County of Broomfield, it will be important to enforce regulations limiting development in flood-prone areas. Zoning and land use plans should take into account not only the dollar amount of damage that buildings near waterways could incur, but also the added risk of floodplain development activities that alter the natural floodplain of the area (for example, narrowing the floodplains by building new structures close to rivers and streams).

4.14.9 Risk Summary

- The overall significance rating for flood in the County is **medium**.
- Changes since 2016: flood was ranked as high significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that medium is a more accurate assessment of the risk.
- Citywide an estimated 43 buildings worth \$64,881,460 is exposed to a 1% annual chance flood hazard. 41 buildings worth \$142,600,435 are estimated to be at risk to a 0.2% annual flood chance hazard.
- There are 24 critical facilities, 4% of total facilities in the County, are located in the 1% and 0.2% annual flood chance areas.
- Flooding in Broomfield has generally been caused by heavy local rainstorms.
- Continued compliance with the NFIP and the promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Related Hazards: Critical Infrastructure Outages, Drought, Dam Inundation, Hail.



4.15 Hail

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Hail	Extensive	Likely	Critical	Medium

4.15.1 Description

Hail forms when updrafts carry raindrops into extremely cold areas of the atmosphere where the drops 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. The process of falling, thawing, moving up into the updraft and refreezing before falling again may repeat many times, increasing the size of the hailstone. Hailstones are usually less than two inches in diameter, but have been reported much larger and may fall at speeds of up to 120 mph. Hailstorms occur throughout the spring, summer, and fall in the region, but are more frequent in late spring and early summer. These events are often associated with thunderstorms that may also cause high winds and tornadoes. 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 NWS uses to classify thunderstorms as severe: if a thunderstorm produces hail more than 3/4 of an inch, it qualifies as severe.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a supercooled drop, the water does not freeze onto the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Because the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are “frozen” in place, leaving cloudy ice.

The NWS classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Table 4-39 below indicates the hailstone measurements utilized by the NWS.

Table 4-39 Hailstone Measurements

Severity	Size Description	Hail Diameter Size (inches)
Non-Severe Hail Does not typically cause damage and does not warrant severe thunderstorm warning from the NWS.	Pea	1/4”
	Mothball	1/2”
	Penny	3/4”
	Nickel	7/8”
Severe Hail Research has shown that damage occurs after hail reaches around 1 inch in diameter and larger. Hail of this size will trigger a severe thunderstorm warning from the NWS.	Quarter	1” (severe)
	Half Dollar	1 1/4”
	Walnut/Ping Pong Ball	1 1/2”
	Golf Ball	1 3/4”
	Hen Egg/Lime	2”
	Tennis Ball	2 1/2”
	Baseball	2 3/4”
	Teacup/Large Apple	3”
	Grapefruit	4”
	Softball	4 1/2”
Computer CD-DVD	4 3/4 - 5”	

Source: NWS, Severe Weather 101 Hail Basics

In Colorado, hail is one of the most damaging hazards. In fact, the 1996 July hailstorm set a record for most damaging hailstorm on a national level at that time. The 2017 hailstorm, which largely impacted nearby Jefferson County, was the costliest insured disaster in Colorado history and the second costliest nationwide. According to the 2018 State Hazard Mitigation Plan, the damaging hail season in Colorado ranges from mid-April to mid-August. Colorado's Front Range, including the entire planning area, is located in the heart of Hail Alley, which receives the highest frequency of large hail in North America and most of the world. According to an April 2020 report from the National Insurance Crime Bureau (NICB), Colorado had the second highest number of insurance claims involving hail from 2017-2019. The Rocky Mountain Insurance Information Association (RMIIA) also reports that hailstorms have caused upwards of \$5 billion over the last 10 years.

4.15.2 Past Events

Since hailstorms are so prevalent in Colorado, the most useful previous occurrences to examine are those which caused a particularly high amount of damage or incurred some other unique cost or impact. The NCEI database does not have any records of storm events in Broomfield prior to it becoming a County in 2001, as this database only records information at the County level. The NCEI records 29 hail events in the planning area between January 1, 2001 and December 31, 2020. Some of these individual storm records included in the database reflect the different size hailstones for the same storm event; the true number of recorded events is 17. Several selected incidents, including some not captured in the NCEI database and some which may have impacted nearby jurisdictions, are profiled below. These selections illustrate the severity of the hail hazard for the jurisdiction and are representative of the range and risk but are not comprehensive.

June 8, 2004 - A series of hailstorms stretching along the Front Range from Colorado Springs to Larimer County and out to the eastern border of the state dropped hailstones ranging from dime to golf ball sized. The hail in nearby Jefferson County fell mostly between 7:00 and 8:00 pm across Evergreen and Golden. Statewide, insurance damages were reported at \$146.5 million (\$166.4 million in 2009 dollars). This storm was classified as the eighth most costly hailstorm event in Colorado history as of July 2009.

August 10, 2004 - Hailstones that fell in Broomfield during this event tie for the largest on record in the planning area, at 1.5" in diameter. No injuries or damages are recorded in the NCEI database.

May 8, 2017 - A severe afternoon thunderstorm produced what would become the most expensive insured catastrophe in Colorado state history, and the second costliest hailstorm in U.S. history. Hailstones recorded in the event ranged in size from 0.75 inches to 2.75 inches in diameter depending on the location and impacted a large highly populated area of Jefferson County including the cities of Lakewood, Arvada, and Wheat Ridge. According to NCEI, an estimated 150,000 auto insurance claims and 50,000 homeowner insurance claims were filed. The event severely damaged and forced a six-month closure of the Colorado Mills Mall in Lakewood, resulting in an estimated monthly loss of \$350,000 in lost sales tax revenue in addition to lost business revenue. The total damage cost of the event totaled around \$2.3 billion.

June 18, 2018 - A series of severe storms impacting the front range communities and stretching east out to Washington County were recorded. This event dropped 1.5" hailstones in Broomfield, tying the August 2004 event for the largest hailstones recorded in the county.

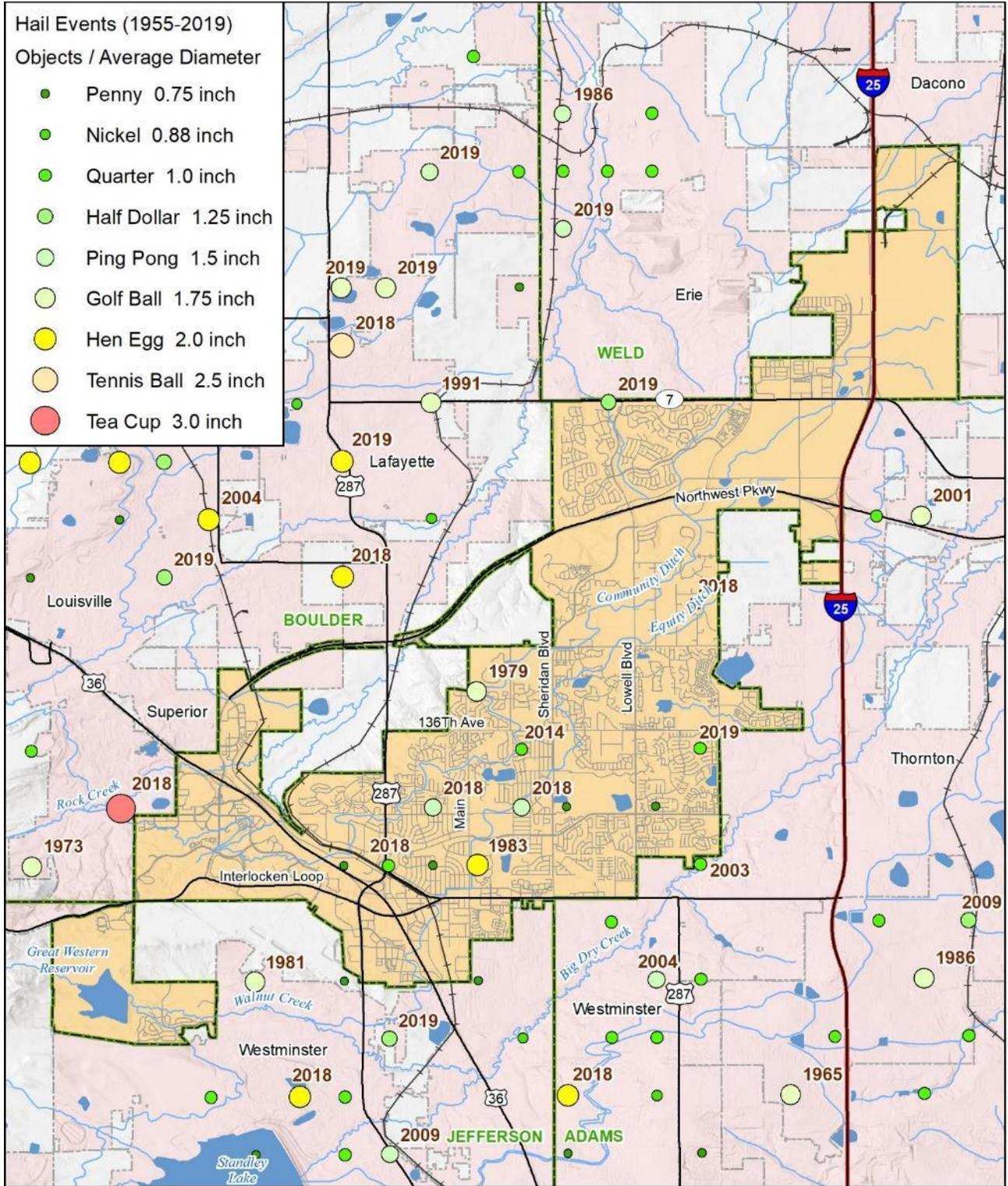
July 25, 2018 - Severe thunderstorms moved across Boulder, Broomfield, Douglas, Elbert, and Weld counties. The storms produced winds gusts to around 80 mph, quarter size hail and very heavy rain; they downed trees and damaged homes and vehicles. A farm off York Street in Broomfield lost 200 acres of corn, resulting in \$200,000 of recorded crop damages. The storm also caused scattered power outages that took several hours to restore.

4.15.3 Location

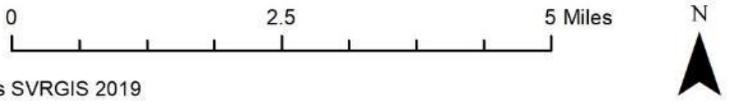
Figure 4-35 below illustrates the location and magnitude of hail events within and adjacent to the planning area from 1955-2019.



Figure 4-35 City and County of Broomfield Hail Events, 1955-2019



Map compiled 6/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, NOAA, National Westher Services SVRGIS 2019





Hailstorms occur during severe storms, which are regional in nature. However, just as the amount of precipitation in the form of snow or rain may vary significantly within a single storm, so may the amount, size, and duration of hail within a severe storm. In general, hail can fall anywhere in Colorado. The areas where hail is most frequently reported with damaging effects are in the eastern plains, where hail damages crops and livestock, and in the Denver Metro area, where hailstorms damage buildings, cars and trees, and may cause driving conditions to deteriorate. The extent of impact ranges from limited, where a single area within the planning area is affected, to significant, where more than 50% of the County is impacted. There are no known incidents where a single hailstorm impacted more than 75% of the County; however, while hail is *possible* anywhere in the planning area, it is not likely to affect the entire area simultaneously.

Based on this information, the geographic extent rating for hailstorms is **extensive**.

4.15.4 Magnitude and Severity

Information from the event of record is used to calculate a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it is a reflection of common occurrence. Due to the lack of recorded instances of widespread damage in the planning area, the event of record can be considered as the May 8, 2017, Jefferson County event. According to the Rocky Mountain Insurance Information Association (RMIAA), the event caused \$2.3 billion in damages to property in the jurisdiction. This storm was the costliest in Colorado history and the second costliest storm in U.S. history. This event occurred approximately 10 miles south of the planning area, and due to the similar geography, topography, climate, and urban development of both Broomfield and Jefferson County it can be assumed that an event of this scale could occur in Broomfield as well.

Also of note are the July 20, 2009 and July 11, 1990 hail events. The former of these events resulted in \$767.6 million in insured damages according to the RMIAA. The latter resulted in 60 direct injuries in the duration of the event, and damages inflicted on critical facilities and services (critical infrastructure) resulted in a loss or disruption of services for a minimal amount of time. Documented injuries were considered critical, though the medical response of the jurisdiction was considered minimally impacted.

According to the RMIAA, eight of the top ten hazard events in Colorado by the amount of insured loss were either entirely hail-related or involved hail as a hazard. RMIAA also ranks Colorado 2nd in the U.S. for hail insurance claims.

Based on these factors, the magnitude severity rating for hailstorms is considered **critical**

4.15.5 Probability of Future Occurrence

The record of previous occurrences, as discussed earlier, is likely incomplete, but provides a useful reference for hailstorms which produced significant size stones and/or caused damage. There have been 29 recorded hail incidents across 17 individual events in the County since 2001. The methodology for calculating the probability of future occurrences is described in Section 4.1.4. This results in a probability of occurrence of a hailstorm in Broomfield of 89% in any given year.

This corresponds to a probability of future occurrences rating of **likely**.

4.15.6 Climate Change Considerations

According to the 2018 Colorado State Hazard Mitigation Plan, the future impacts of climate change are expected to influence future hail events. Ongoing efforts to reduce Colorado's greenhouse gas emissions and adapt to a changing climate, such as the Colorado Climate Plan and Broomfield's Greenhouse Gas Reduction Plan (to be published in 2022), will help to reduce the impacts of climate induced hazards such as hail.

4.15.7 Vulnerability

All assets located in Broomfield can be considered at risk from severe hail events. This includes 100% of the County's population, and all buildings and infrastructure within the County.

People

Exposure is the greatest for people caught outside in the open without shelter. Large hail can cause significant bruising, concussions, the potential for broken bones, and even death. The impacts of hail on vulnerable populations can be more severe. Low-income families are more likely to live in poorly constructed homes that are more likely to be damaged, and are more likely to be uninsured or underinsured, making it more difficult for them to recover from hail events. Individuals with disabilities may need more assistance after a major event, especially if transportation or utility services are disrupted. Severe weather warnings must use methods that reach vision or hearing-impaired people and those with limited English proficiency.

Property

Research into the damages inflicted by this hazard indicates the hazard has a high impact on the entire planning area, and perhaps the greatest potential damage impacts to property. Hail impacts anything exposed to the event, including structures, infrastructure, landscaping, personal property and vehicles, people, agriculture, and livestock. Hail is also the costliest insured-losses natural disaster to impact the state of Colorado, with nine separate incidents falling within the top ten disasters list for the state. Existing development remains exposed to hail with minimal mitigation opportunities. Individuals can mitigate exposure by remaining indoors and away from windows during hailstorm events. Vehicles can be parked under shelters to help minimize damage costs incurred in that arena. However, in many cases it is impossible to move existing development away from the impact areas. For example, hail heavily impacts the economic contributors who house merchandise outdoors, such as car retailers, home improvement stores and gardening stores. Damage to landscape and agriculture is also almost impossible to prevent, as the plants cannot be transported indoors for the storm.

Critical Facilities and Infrastructure

Hail can lead to the temporary incapacitation of roads when small hail stones build up so deep, they block roads. Hail has also been observed to block storm drains and prevent proper runoff, potentially resulting in localized flooding as a secondary hazard. Most structures, including the County's critical facilities, should be able to provide adequate protection from hail to individuals but the structures themselves could suffer broken windows and dented exteriors. Those facilities with backup generators are better equipped to handle a severe weather situation should the power go out.

Government Services

Hail may pose a significant risk to the provision of government services. Government buildings and facilities are vulnerable to damage from hail events, similar to all property. Significant damage to an essential government facility could force the temporary closure of that facility, disrupting the ability of local governments to provide the usual level of service to residents.

Economy

The economic impact from hail can be severe and potentially long lasting. As mentioned throughout this section, hail is the costliest insured hazard in Colorado. Direct damages have totaled \$5 billion over the last 10 years statewide, but severe indirect economic impacts can also be felt through businesses forced to close for repairs. For example, the 2017 event of record led to the City of Lakewood losing an estimated \$350,000 in monthly sales tax revenue due to a several month closure of the Colorado Mills mall. A similar scale event impacting one of the major commercial areas of Broomfield, such as Flatirons Crossing, could result in similar extended losses and indirect economic impacts in addition to the direct damage costs.

Historic, Cultural, and Natural Resources

While hail is a natural environmental process, it can cause significant environmental damage. As discussed throughout this section, hail poses a significant threat to crops. Additionally, hail can cause tree limbs to break, damage to trees and other plants in bloom, and shred foliage. Some cultural and historic properties may also potentially be at risk of damage from hail.

4.15.8 Development Trends

Consideration for future development's ability to avoid excessive hail damages may include the use of hail resistant roofing/shingles, resilient landscaping, construction of covered parking, or semi-sheltered



structures to minimize extensive losses. The availability of shelters in the many open spaces and parks throughout Aurora may afford some protection to recreation populations. The enforcement of existing land use and zoning ordinances requiring durability of building materials may improve the resilience of future buildings. In some cases, the costs of future mitigation efforts, even in new future development, may outweigh the potential insurance losses.

The increase in solar panel usage throughout Broomfield could increase the County's vulnerability to hail of 1" or greater.

4.15.9 Risk Summary

- The overall significance of this hazard to the planning area is **medium**.
- Changes since 2016: hail was ranked as low significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that medium is a more accurate assessment of the risk.
- Hail is not as high profile as hazards such as tornadoes, blizzards, or floods, because losses are typically covered by insurance, but hail events consistently inflict one of the highest rates of damage on the planning area.
- Severe hail events can cause significant damage to buildings, vehicles, and above ground utility lines, as well as catastrophic damage to vegetation and crops.
- On average, the Front Range area has 6 to 13 days per year with hail exceeding 1 inch in diameter.
- For people caught outdoors in the open, large hail has the potential to cause significant bruising, concussions, broken bones, and even death.
- Older structures and those made of less durable materials could be highly vulnerable to severe hail events.



4.16 Hazardous Materials Incident

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Hazardous Materials Incident	Significant	Likely	Negligible	Low

4.16.1 Description

Hazardous Materials are any material or group of materials of a specific quantity that individually or when combined, cause harm to people, property, or the environment. The City and County of Broomfield recognizes the Environmental Protection Agency's (EPA) list of hazardous materials as required by the Emergency Planning and Community Right-to-Know Act (EPCRA) as the authoritative list of regulated substances. Hazardous Materials may be stored in fixed locations or transported on road or railways.

The U.S. Department of Transportation (DOT), U.S. EPA and the Occupational Safety and Health Administration (OSHA) all have responsibilities relating to the transportation, storage, and use of hazardous materials and waste. The Right-to-Know Network maintained by the U.S. Coast Guard's National Response Center (NRC) is a primary national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States and its territories. In Colorado, the manufacture, use, storage, and transportation of hazardous materials is regulated by the CDPHE. Hazardous materials carriers are subject to Colorado Public Utility Commission (PUC) registration and insurance requirements. Colorado statutes require that any person transporting hazardous materials that require placarding to obtain a Hazardous Materials Permit from the Public Utilities Commission. Safety oversight is the jurisdiction of the Colorado State Patrol.

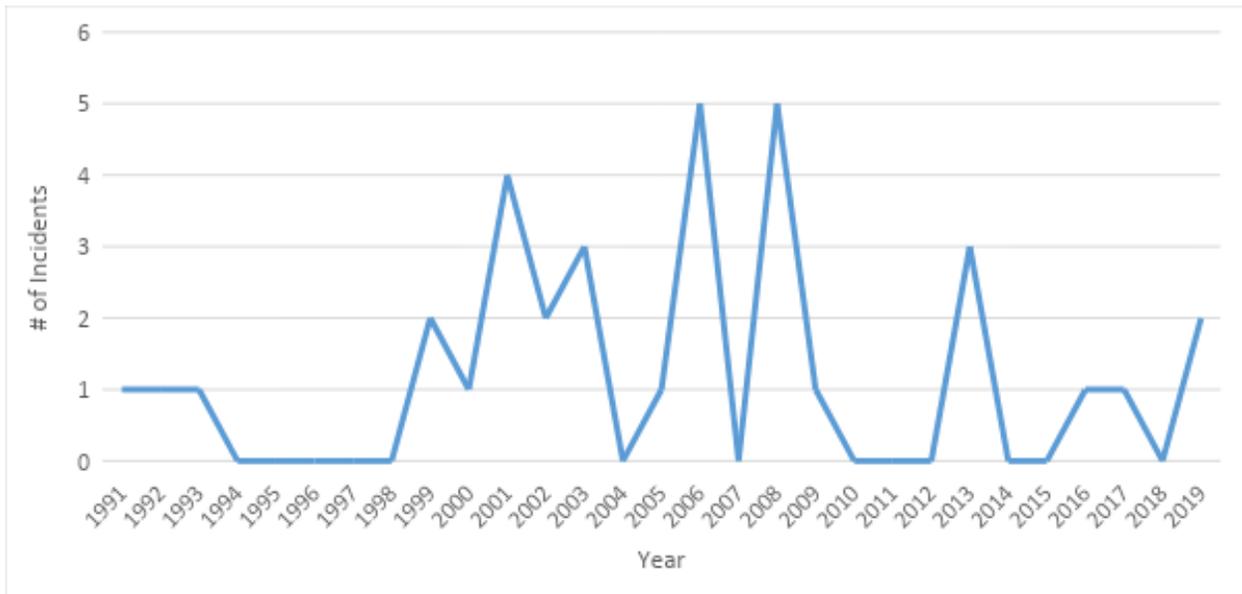
The U.S. Department of Transportation divides hazardous materials into the following classes:

- Explosives
- Compressed gases: flammable, non-flammable compressed, poisonous
- Flammable & combustible liquids
- Flammable solids: spontaneously combustible, dangerous when wet
- Oxidizers and organic peroxides
- Toxic materials: poisonous material, infectious agents
- Radioactive material
- Corrosive material: destruction of human skin, corrodes steel

4.16.2 Past Events

Hazardous materials incidents occur regularly in the City and County of Broomfield. Statistics from the NRC indicate that between 1991 and the end of 2019, 34 hazardous materials incidents were reported in the City and County of Broomfield or an average of one incident per year. This number almost certainly excludes a number of very small spills that were not reported to the NRC. Of the events reported three were damaging resulting in a total \$250,000 in damages. None of the events resulted in casualties. As shown in Figure 4-36, the trend has been fairly consistent over the last 30 years, with an average of one incident per year during the 1990s and 2010s, and two per year during the 2000s.

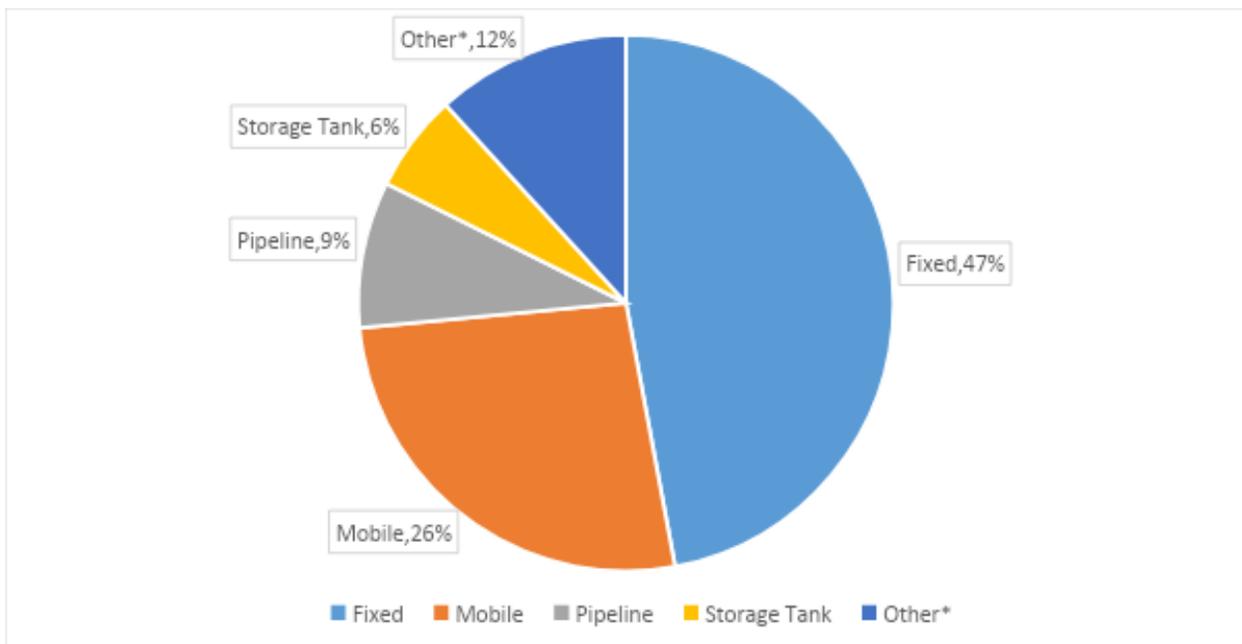
Figure 4-36 Hazardous Materials Incidents Reported in Broomfield, 1991-2019



Source: NRC

As shown in Figure 4-37, hazardous material incidents in Broomfield are most common at fixed sites; only 26% of incidents occur during transportation.

Figure 4-37 Hazardous Materials Incidents in Broomfield by Type, 1991-2019



*Other includes Aircraft, Continuous, Railroad, and Unknown Sheen
Source: NRC

From 1952 to 1994, the Rocky Flats Plant produced plutonium pits, commonly referred to as the triggers for nuclear weapons. The Rocky Flats Plant also processed plutonium for reuse and manufactured defense-related components from depleted uranium. Production of the triggers and other classified work resulted in radiological and hazardous material contamination within the main



industrial area which covered approximately 384-acres. Fires in the production buildings in 1957 and 1969 released radioactive materials into the off-site lands west and south of the site, and tritium was found in Broomfield's drinking water supply in 1973.

In 1989, the FBI agents and the U.S. EPA raided the Rocky Flats site to investigate alleged environmental crimes. As soon as news of the raid surfaced, Broomfield began construction of a diversion ditch around Great Western Reservoir. The purpose of the ditch was to prevent contaminated runoff, originating from the Rocky Flats site, from entering Broomfield's drinking water supply. After the 1989 raid, production of the triggers ceased, and cleanup of the site began in 1995.

Cleanup activities, which were regulated by both the EPA and the CDPHE, took 10 years and cost \$7 billion to complete. Although the site was officially closed on September 29, 2006, residual contamination and hazardous waste still remains within the former industrial production area. The residual contamination is in the form of buried building foundations, process lines, and waste piles; contaminated groundwater plumes; contaminated soils below 6 feet; and two on-site landfills. Due to the nature and extent of residual contamination remaining, ongoing remedial activities are required for the foreseeable future. The remedial activities (which include institutional and physical controls to prevent soil disturbance, groundwater treatment systems, and water quality monitoring stations) are necessary to ensure that the actions taken for closure remains protective of human health and the environment.

Due to the previously noted building fires that occurred on the Rocky flats site in 1957 and 1969, some of the soils in the vicinity of Great Western Reservoir in western Broomfield have plutonium concentrations which are higher than background. However, after extensive soil sampling during closure, the EPA determined these levels were not high enough to trigger any additional remedial action and that the higher than background areas within Broomfield were released for unrestricted use.

Part of the cleanup included \$75 million for the acquisition of new water rights and construction of a new water treatment plant to replace Broomfield's Great Western Reservoir as a source of drinking supply. The replacement drinking water system came online in 1997 and Great Western Reservoir was subsequently re-purposed as a non-potable supply (i.e. not for drinking water) to irrigate large parks, open spaces, and commercial areas in Broomfield.

Although Great Western Reservoir is no longer used as a source of supply for Broomfield's drinking water, the diversion ditch around Great Western Reservoir is still in use as a precautionary measure due to the residual contamination that remains on the Rocky Flats site.

Broomfield remains actively involved with the post closure treatment and monitoring activities to make sure that the remaining radiological and hazardous materials at Rock Flats don't migrate off-site.

4.16.3 Location

The location of possible hazard material incidents is rated as **significant**.

Hazmat incidents can occur at fixed facilities or during transportation, as discussed below. Overall, the geographic coverage of this hazard in the City and County of Broomfield is limited—less than 10% of the planning area affected based on historical experience - but depending on the type and quantity of spills and the medium affected, the geographic coverage could become large, particularly if a material was released into a stream or waterway.

Generally, with a fixed facility, the hazards are pre-identified. The U.S. EPCRA requires industries to report on the storage, use, and releases of hazardous substances to federal, state, and local governments. Facilities in Colorado must submit an emergency and hazardous chemical inventory form (Tier II form) to the CDPHE and, if required by local reporting regulations, the LEPC and local fire departments annually. Tier II forms provide state and local officials and the public with information on the general hazard types and locations of hazardous chemicals present at facilities during the previous calendar year. The inventory forms require basic facility identification information, employee contact information for both emergencies and non-emergencies, and information about chemicals stored or used at the facility.

There are 37 Tier II facilities in the City and County of Broomfield. GIS analysis was used to overlay the location of Tier II facility sites with flood, dam inundation, geologic and wildfire layers. Note some of these Tier II facilities may be located in more than one hazard area. Refer to each hazard subsection for more information on facilities in those hazard areas.

Table 4-40 Tier II Facilities Located in Hazard Areas

Hazard Type	Number of Tier II Facilities
1% Annual Flood Chance	2
Dam Inundation	1
Expansive Soils High	7
Expansive Soils Moderate	25
Landslide	1
Land Subsidence	3
Wildfire - High Risk	1
Wildfire - Moderate Risk	4
Wildfire - Low Risk	3
Wildfire - Lowest Risk	4

Source: Wood Analysis of City and County of Broomfield and HIFLD data

Figure 4-3 in the Asset Summary Section show critical facilities in the City and County of Broomfield, including identified hazardous materials sites. As shown in those maps, these sites are located throughout the County.

The EPA also requires facilities containing certain extremely hazardous substances to generate Risk Management Plans (RMPs) and resubmit these plans every five years. As of August 2, 2021, there are no RMP facilities located in the City and County of Broomfield.

There are two routes, I-25 and U.S. 36, in the City and County of Broomfield that have been designated by the Colorado State Patrol for the transportation of hazardous and radiological materials.

The Rocky Flats Plant was established in 1951 as part of the United States' nationwide nuclear weapons production program. The northerly portion of the industrial site was located in the Walnut Creek watershed which was upstream of Broomfield's drinking water supply - Great Western Reservoir.

4.16.4 Magnitude and Severity

The magnitude and severity are rated as **negligible**.

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. Impacts from hazardous materials releases can include:

- Fatalities
- Injury
- Evacuations
- Property damage
- Animal fatalities (livestock, fish & wildlife)
- Air pollution
- Surface or ground water pollution/contamination
- Interruption of commerce and transportation

Numerous factors influence the impacts of a hazardous materials release, including the type and quantity of material, location of release, method of release, weather conditions, and time of day. This makes it difficult to predict precise impacts. The impact to life and property from any given release depends primarily on:

- The type and quantity of material released.
- The human act(s) or unintended event(s) necessary to cause the hazard to occur.
- The length of time the hazard is present in the area.
- The tendency of a hazard, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space.
- Characteristics of the location and its physical environment that can either magnify or reduce the effects of a hazard.

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

The impacts of major hazardous materials incidents are potentially catastrophic, causing multiple deaths, property damage, and/or interruption of essential facilities and service for more than 72 hours. Pipeline accidents and gas explosions account for the majority of deaths and injuries caused directly by hazardous materials nationally. However, historically the impact of hazardous materials incidents in Broomfield have been limited, with no deaths or injuries reported.

4.16.5 Probability of Future Occurrence

It is **likely** that the City and County of Broomfield will experience a hazardous material incident in any given year. Since 2000, the County has averaged one hazardous materials incident per year.

4.16.6 Climate Change Considerations

There are no known effects of climate induced impacts on human-caused hazards such as hazardous materials incidents.

4.16.7 Vulnerability

People

Hazardous materials incidents impact on people is highly dependent on the location of the incident, but can cause injuries, hospitalizations, and even fatalities to people nearby. The most likely routes are inhalation, absorption, and ingestion. 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.

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. Vulnerable populations can be more severely impacted by hazardous materials incidents. People with existing health risks or compromised immune systems could be severely affected by releases of even relatively low-impact materials. Low-income families may be more likely to live in industrial areas or near hazardous materials routes. Individuals with disabilities may need more time to evacuate, so evacuation notices will need to be issued as soon as feasible, and communicated by multiple, inclusive methods.

Property

The impact of most fixed facility incidents is typically localized to the property where the incident occurs. The impact of small spills during transportation may also be limited to the extent of the spill and remediated if needed. Cleanup from major spills can be lengthy and expensive.

Critical Facilities and Infrastructure

Impacts on critical facilities are similarly 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.



Government Services

The vast majority of hazardous materials incidents have minimal impacts on continuity of operations beyond short-term road closures. However, a large spill or a particularly hazardous substance could take weeks or even months to clean up.

Nationally, recent large hazardous materials incidents such as the 2013 fertilizer plant explosion in West, Texas, and several railway fuel oil explosions in 2013-2015 affected confidence in government's ability to prevent or protect people from those types of disasters. Typically, the impact to public confidence is minimal so long as the government acts appropriately by sharing timely and accurate information, follows mitigation procedures focused on, in this order, life safety, incident stabilization, property protection, and environmental protection. Additionally, the government is responsible for ensuring proper resolution by reviewing remediation reports in the event of spill involving mitigation actions. Issues such as long-term closures of major interstates may cause frustration from the public. These impacts can be mitigated by following proper messaging and cleanup procedures.

Hazardous Materials incidents can have a more significant impact to responders, particularly those responders conducting initial size-up operations and those conducting scene entry, mitigation, and cleanup operations. This qualitative assessment is based on the likelihood of lower levels of personal protective equipment donned by initial responders, the handling and proximity of mitigation responders and cleanup technicians.

Economy

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. The economic impacts of major road closures alone can range from \$2,000 to \$250,000. Large and publicized hazardous material-related events can deter tourists and recreationists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant not only for Broomfield but also for the entire Denver Metro region.

Even small incidents have cleanup and disposal costs, and for a larger scale incident, these could be extensive and protracted. Evacuations can disrupt home and business activities. Large-scale incidents can easily reach \$1 million or more in direct damages, with clean-ups that can last for years.

Historic, Cultural, and Natural Resources

In many instances of hazardous materials releases, the environment is the most significantly affected component of the system consisting of people, property, and the environment. Environmental impact often includes water quality, air quality, and soil contamination. Again, the impact to the environment is scale dependent and ranges from minimal and temporary such as a small chemical spill on a roadway to catastrophic and permanent as seen at the nearby Rocky Flats. Widespread effects can occur when materials contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

4.16.8 Development Trends

As the City and County of Broomfield continues to experience population growth and development over time, it is anticipated that there will be increased exposure to potential life loss, injuries, and environmental damage resulting from a hazardous materials incident. Serious considerations must be made concerning land use and regulations as increasing development pressures push residential and commercial investment closer to railways and identified hazardous and nuclear materials routes.

Mitigation efforts since 2016 include adding a full-time employee to North Metro's Fire Prevention Bureau to perform focused fire code inspections, including those identified facilities with hazardous materials. Tier II information has been added to the building pre-plans that can be accessed and reviewed while enroute to an incident. The fire district added additional capabilities in air monitoring and a specialized foam trailer for large-scale oil and gas incidents.

4.16.9 Risk Summary

- The overall significance is **Low**.



- Changes since 2016: hazardous materials incidents were ranked as medium significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that low is a more accurate assessment of the risk.
- There were 34 hazardous materials incidents reported between 1991-2019, an average of one incident per year. Nearly half (47%) these incidents took place at fixed facility sites and half took place during transport.
- None of the past incidents resulted in reported injuries, fatalities, evacuations or damages.
- There are 37 Tier II facilities and no Risk Management Plan facilities.
- Related Hazards: Aircraft Accident, Critical Infrastructure Outage, Cyber Attack, Dam Inundation, Earthquake, Fire, Expansive Soils, Flood, Lightning, Tornado, Winter Storm.



4.17 Land Subsidence

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Land Subsidence	Limited	Occasional	Negligible	Low

4.17.1 Description

Land subsidence is the sinking of the land over manmade or natural underground voids and the settlement of native low-density soils. Subsidence can occur gradually over time or virtually instantaneously. Subsidence occurs naturally and also through human-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.

Human-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. In Broomfield and the surrounding area, past coal and clay mining activities have created surface subsidence in some areas and created the potential for subsidence in other areas. Any area where past subsurface mining was documented has some risk of subsidence; while maps of past mine workings and extents are often inaccurate or incomplete, rough estimates are available.

4.17.2 Past Events

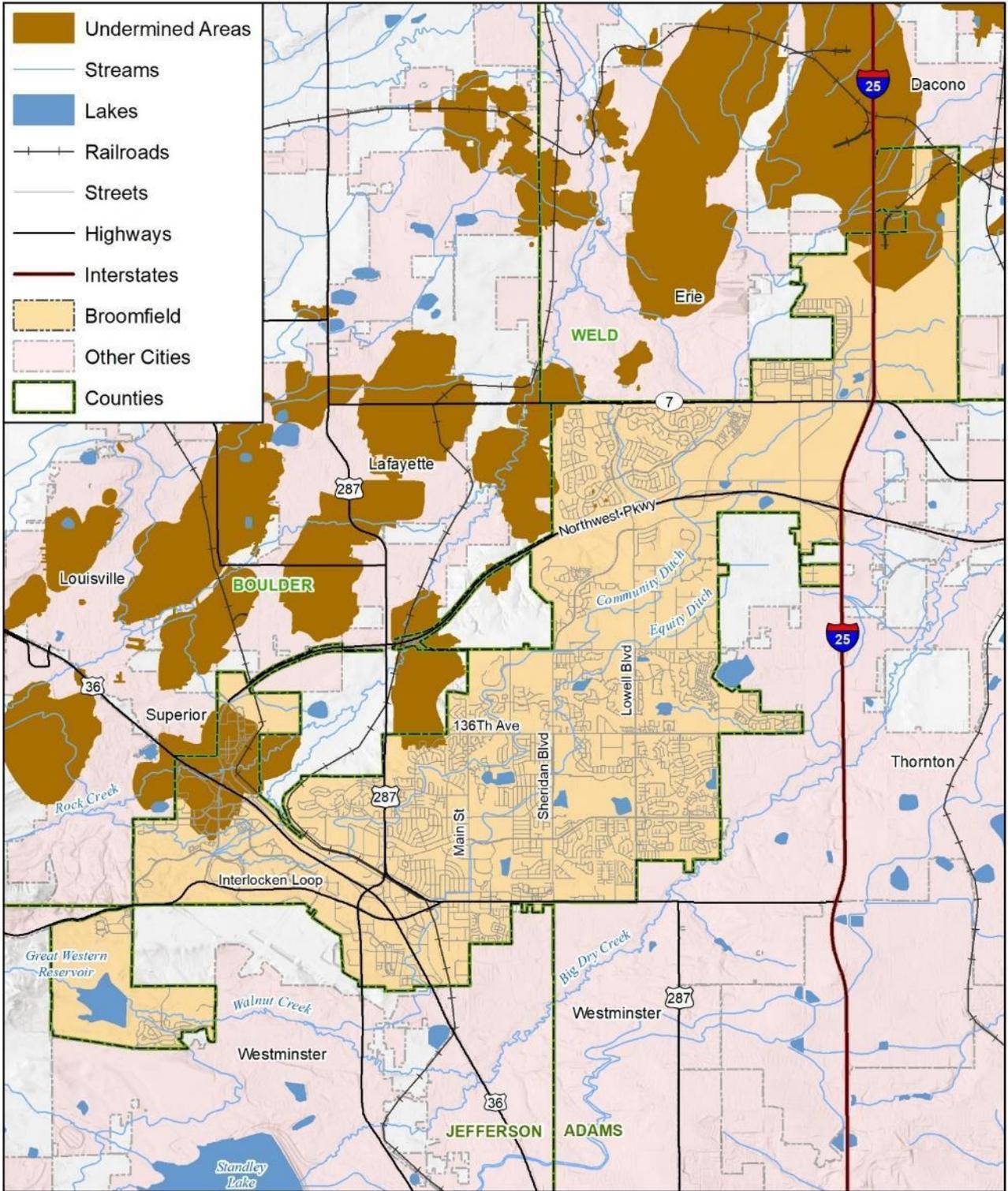
Land subsidence incidents are not tracked systematically in Colorado, so data on past events is limited. Anecdotally there have been a number of sinkholes or related incidents of varying severity in Broomfield. Two of the more significant incidents are described below.

- April 7, 2010: A sinkhole appeared during morning rush hour on Lowell Boulevard north of Sheridan Parkway near the Anthem neighborhood. The road remained closed in both directions until the following afternoon. Repairs were estimated to cost \$15,000 to \$20,000.
- July 12, 2019: A section of US 36 just west of Church Ranch Boulevard collapsed when a crack in the highway turned into a sinkhole, collapsing the road embankment. The collapse was believed to be caused by water intrusion creating a void underneath the road 10 feet wide and over 150 feet long. Repairs cost over \$20 million.

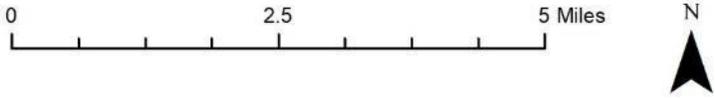
4.17.3 Location

Subsidence can potentially occur anywhere the soil conditions are right, but the highest risk is associated with undermined areas. As shown in Figure 4-38, there are significant areas of undermining east and north of Broomfield, which extend into the northwestern part of the County near US36 and Northwest Parkway, as well as the northeastern tip of the County north of 168th Avenue. The geographic extent of the hazard is **limited**.

Figure 4-38 City and County of Broomfield Undermined Areas



Map compiled 6/2021;
intended for planning purposes only.
Data Source: Broomfield City/County,
CDOT, Colorado Geological Survey





4.17.4 Magnitude and Severity

Subsidence can happen suddenly and without warning or can occur gradually over time, and can result in serious structural damage to buildings, roads, irrigation ditches, underground utilities, and pipelines. It can disrupt and alter the flow of surface or underground water. Weight, including surface developments such as roads, reservoirs, and buildings and manmade vibrations from such activities as blasting or heavy truck or train traffic can accelerate natural processes of subsidence, or incur subsidence over manmade voids. Fluctuations in the level of underground water caused by pumping or by injecting fluids into the earth can initiate sinking to fill the empty space previously occupied by water or soluble minerals. The consequences of improper use of land subject to ground subsidence can be excessive economic losses, including the high costs of repair and maintenance for buildings, irrigation works, highways, utilities, and other structures. This results in direct economic losses to citizens as well as indirect economic losses through increased taxes and decreased property values. As noted previously, the cost of sinkhole repairs can range from several thousand dollars to several million dollars.

The 2018 Colorado State Hazard Mitigation Plan notes that most homeowner’s insurance policies specifically exclude subsidence events. Over 1,000 participants are currently enrolled in the Mine Subsidence Protection Program in Colorado, which was established to pay for damage to homes that results from coal mine subsidence.

There are minimal risks to injury and death from unexpected subsidence or accidental exposure to it, but the risk is possible. No injuries or deaths related to subsidence have been reported in the planning area, but the State Hazard Mitigation plan documented two injuries related to subsidence in the state. Overall, the potential magnitude of the hazard is **negligible**.

4.17.5 Probability of Future Occurrence

Due to a lack of data, it is difficult to estimate the probability of future occurrences. Subsidence over abandoned coal mines is a potential hazard for thousands of buildings along the Front Range urban corridor, and these numbers will continue to grow as more people move into the state. The probability of significant subsidence events is rated as **occasional**.

4.17.6 Climate Change Considerations

Changing climate conditions are not anticipated to affect subsidence.

Vulnerability

People

As shown in Table 4-41, 1,209 Broomfield residents live in undermined areas at risk of subsidence. While injuries resulting from subsidence are extremely rare, the potential financial costs to these individuals should not be ignored, given that most homeowners policies exclude subsidence damage.

Property

Property exposed to subsidence and erosion can sustain minor damages or can result in complete destruction. According to CGS, merely an inch of differential subsidence beneath a residential structure can cause several thousand dollars of damage. Structures may be condemned as a result of this damage resulting in large losses. FEMA estimates that there are over \$125 million in losses in the U.S. annually as a result of subsidence. Structures exposed to erosion hazard areas may be undermined, resulting in damages.

As shown in Table 4-41, 465 buildings have been identified in in undermined areas at risk of subsidence.

Table 4-41 Properties at Risk of Subsidence due to Undermining

Property Type	Improved Parcels	Buildings	Population
Agricultural	1	1	
Commercial	34	48	
Exempt	4	4	



Property Type	Improved Parcels	Buildings	Population
Mixed Use	1	4	10
Residential	437	461	1,199
Total	438	465	1,209

Source: Wood Analysis of City and County of Broomfield data

Critical Facilities and Infrastructure

Subsidence can result in serious structural damage to critical facilities and infrastructure such as, roads, irrigation ditches, underground utilities and pipelines. Large ground displacements caused by collapsing soils can damage roads and structures and alter surface drainage. Minor cracking and distress may result as the structures respond to small adjustments in the ground beneath them. Erosion can also impact structures such as bridges and roads by undermining their foundations. Structures and underground utilities found in areas prone to subsidence or soil erosion can suffer from distress. The shifting and settling of the structure can be seen in a number of ways:

- Settlement, cracking and tilting of concrete slabs and foundations,
- Displacement and cracking in door jams, window frames, and interior walls, or
- Offset cracking and separation in rigid walls such as brick, cinderblock, and mortared rock.

Table 4-42 summarizes 100 critical facilities in Broomfield that have been identified as being at risk of subsidence due to undermining. Two-thirds of these (68) are oil and gas well and facilities. There are also 20 bridges identified as exposed.

Table 4-42 Critical Facilities at Risk of Subsidence due to Undermining

FEMA Lifeline	Facility Type	Count
Communications	Land Mobile Private	6
Energy	Oil Gas Facility	6
	Oil Gas Well	62
Hazardous Material	Tier II	3
Safety and Security	High School	1
	Historical Place	1
Transportation	Good Condition Bridge	8
	Fair Condition Bridge	12
	Park-n-Ride	1
	Total	100

Source: Wood Analysis of data from City & County of Broomfield, National Inventory of Dams, HIFLD, DWR, EAP

Government Services

Government facilities are as susceptible to damage from expansive soils as any other buildings. Road closures can block or delay emergency response routes.

Economy

The economic cost of this hazard can vary widely based on the size and location of the incident. Sinkhole repairs can range from several thousand dollars to several million.

Historic, Cultural, and Natural Resources

Subsidence has the potential to alter the landscape and can cause damages to historic and cultural resources.



4.17.7 Development Trends

Any future development in undermined areas should take the potential risk of land subsidence into account.

4.17.8 Risk Summary

- The overall risk from land subsidence is **low**.
- Changes since 2016: none.
- While subsidence can potentially occur anywhere, the risk is greatest in undermined areas, including areas in the northwest and northeast portions of the County.
- The primary impacts are to buildings and infrastructure, particularly roads. Repair costs vary widely but can be substantial.
- Related hazards: flood, expansive soils.

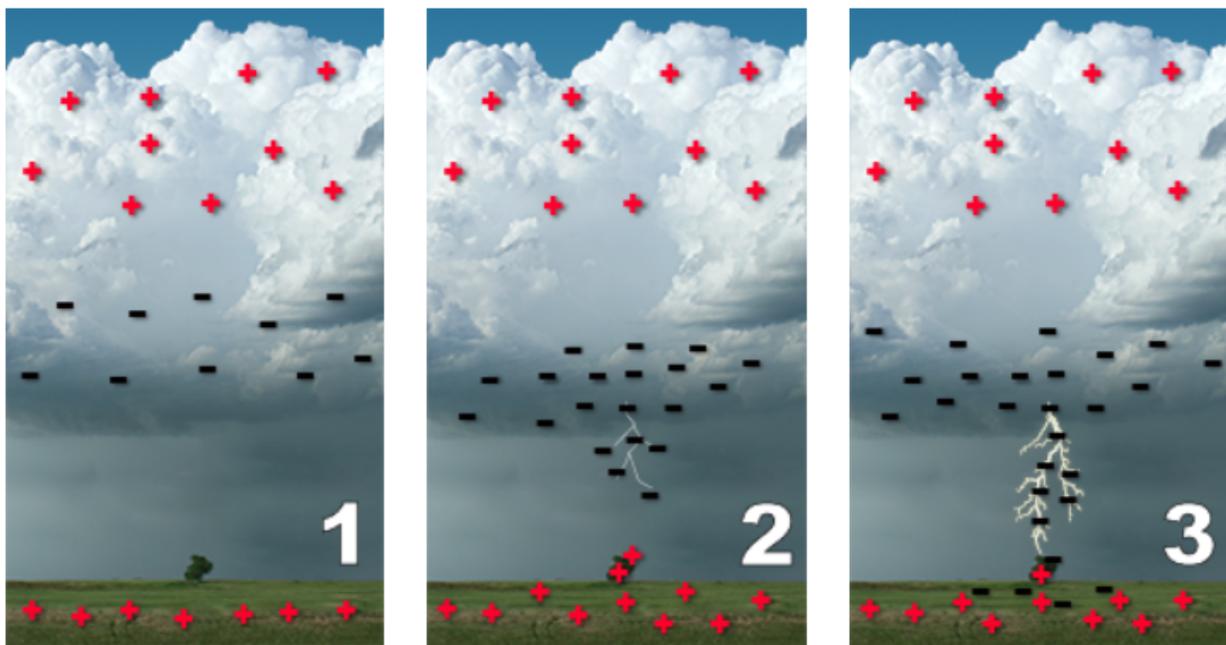
4.18 Lightning

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Lightning	Extensive	Likely	Negligible	Low

4.18.1 Description

Lightning results from the separation of electrical charges and the generation of an electrical field within a thunderstorm which forms when ice particles and water droplets collide within a cloud. Positively charged particles rise to the top of the cloud while negatively charged particles fall to the base of the cloud. Simultaneously, positive charged particles gather at the ground and travel with the storm. As the negative charges at the base of the cloud increase, they send a channel called a “stepped leader” toward the positively charged particles at the ground, which collect in the ground and in objects on the ground and reach toward the stepped leader in a “streamer.” Lightning is the electrical transfer that occurs when the stepped leader and the streamer connect.

Figure 4-39 Cloud-to-Ground Lightning Formation



Source: NWS

Lightning is one of the more dangerous weather hazards in Colorado. Each year, lightning is responsible for deaths, injuries, and property damage, including damage to buildings, communications systems, power lines, and electrical systems. According to the NWS, in an average year, about 500,000 cloud-to-ground lightning flashes occur in Colorado, and since 1980, lightning causes an average of two fatalities and 12 injuries annually across the State. Colorado ranks fourth in the nation in fatalities due to lightning strikes, with 149 deaths between 1959 and 2019.

4.18.2 Past Events

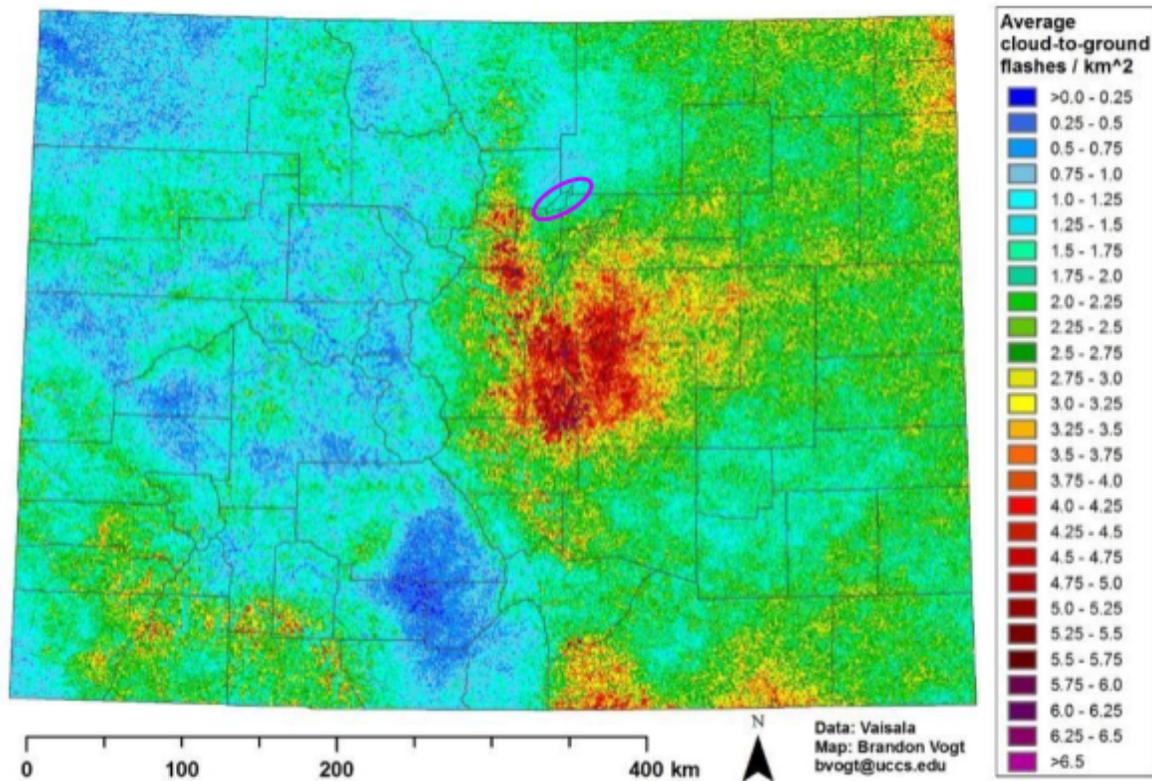
NOAA’s NCEI Storm Events Database only records lightning events that resulted in a fatality, injury, or reported property or crop damage. It only lists one damaging lightning event for Broomfield for the period of record from 1996 through 2020; on June 2, 2019, lightning struck a home in Broomfield causing \$1,000 in damage to the shingles but no fire. There were no fatalities, injuries, or crop damages.

The National Weather Service’s Colorado Lightning Resource page maintains records of lightning casualties by County in Colorado from 1980 through 2020; however, the NWS has no records of lightning related casualties in Broomfield during this period.

4.18.3 Location

Lightning can strike anywhere in the City and County of Broomfield. The figure below shows the lightning flash density for Colorado from 1996 to 2016. Broomfield experiences approximately 1-2.5 cloud-to-ground flashes per square kilometer per year. The geographic extent of the hazard is extensive.

Figure 4-40 Colorado Lightning Density, 1996-2016



Source: NWS

4.18.4 Magnitude and Severity

Lightning can occur anywhere there is a thunderstorm and can even strike miles away from the storm. Lightning is measured by the Lightning Activity Level (LAL) scale, shown in Table 4-43, which was created by the NWS to define lightning activity into a specific categorical scale. The LAL is a common parameter that is part of fire weather forecasts nationwide. Broomfield is at risk to experience lightning in any of these categories. Overall the potential severity of lightning is **negligible** based on the scarceness of documented damages to date.

Table 4-43 NWS Lightning Activity Level Scale

Level	Description
LAL 1	No thunderstorms.
LAL 2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud-to-ground strikes in a five-minute period.
LAL 3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud-to-ground strikes in a five-minute period.

Level	Description
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent, 11 to 15 cloud-to-ground strikes in a five-minute period.
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud-to-ground strikes in a five-minute period.
LAL 6	Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag warning.

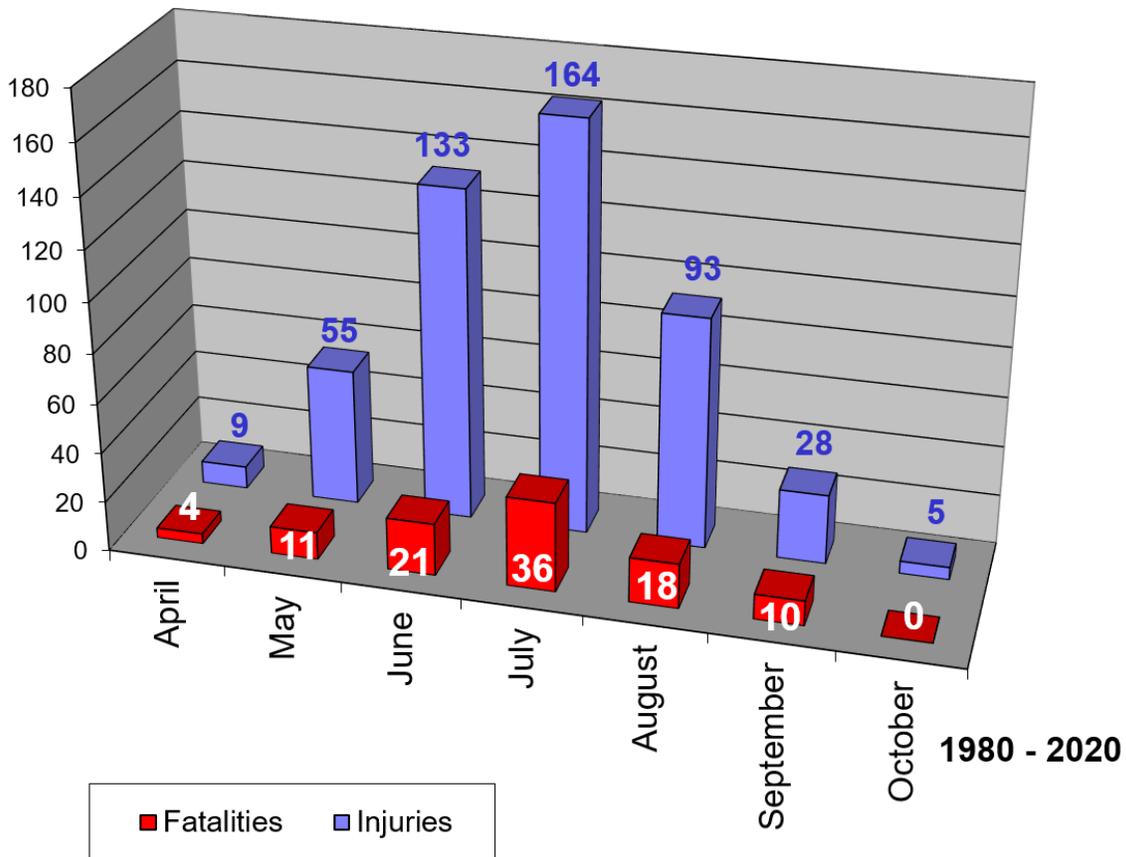
Source: NWS

4.18.5 Probability of Future Occurrence

Based on the NCEI historical record for the planning area from 1996 through 2020 of only one reported lightning strike that caused property damage and no records of lightning causing injury or death, Broomfield has a 4 percent annual probability of experiencing a damaging lightning strike.

However, it should be noted that although reports of past damaging impacts from lightning are limited, the number of total flashes is much higher, and the potential for damaging impacts persists. The figure below illustrates lightning-caused fatalities and injuries by month across the State of Colorado. Given this data, lightning strikes causing injury or fatality are more likely during summer months. The overall probability of significant lightning events is rated as likely.

Figure 4-41 Fatalities and Injuries Caused by Lightning by Month in Colorado, 1980-2020



Source: NWS

4.18.6 Climate Change Considerations

Per the 2018-2023 Colorado Enhanced State Hazard Mitigation Plan, the future impacts of climate change on lightning are unclear. A 2014 report in *Science* suggested that lightning strikes over the contiguous United States may increase by 12% for every degree rise in global average air temperature due to potential increases in convective available potential energy. However, more research is needed to better understand this potential connection.

4.18.7 Vulnerability

People

Cloud-to-ground lightning can kill or injure people by direct or indirect means. The lightning current can branch off to a person from a tree, fence, pole, or other tall object. In addition, lightning strikes may conduct their current through the ground to a person after the lightning strikes a nearby tree, antenna, or another tall object. The current also may travel through power or telephone lines, or plumbing pipes to a person who is in contact with an electric appliance, telephone, or plumbing fixture. People working or recreating outdoors are at the highest risk to death or injury from lightning strikes.

Lightning can also cause power outages, which can themselves be life threatening to those dependent on electricity for life support. Approximately 1,121 residents in the planning area rely on electricity-dependent medical equipment to be able to live independently in their homes.

Property

Lightning strikes can damage property. If struck by lightning, structural damage is possible, as well as the potential for a fire. There has been one recorded incident of roof damage caused by lightning in Broomfield.

Critical Facilities and Infrastructure

Similar to impacts on property, lightning strikes can damage critical facilities and infrastructure. Structural damage or fires may result from lightning strikes. Facilities lacking proper surge protection may suffer damages to electrical systems, and SCADA systems may be damaged or taken offline. Broomfield's water treatment plant and raw water pump station have both lost power due to past lightning strikes.

Government Services

Lightning is unlikely to disrupt government services. However, in the event that lightning strikes a government facility lacking appropriate surge protection or backup power, localized, temporary interruptions may result.

Economy

Lightning is unlikely to have significant local economic impacts; however, business interruption can occur if lightning causes power outages. Localized business losses could occur if a structure catches fire due to a lightning strike.

Historic, Cultural, and Natural Resources

Lightning strikes may cause wildfires, which can cause significant impacts on natural resources. See Section 4.18 for more detail.

4.18.8 Development Trends

New development and population increase in the planning area will result in increased exposure to lightning. However, development trends are not expected to affect the probability or severity of lightning strikes.

4.18.9 Risk Summary

- The overall significance of this hazard is **low**.
- Changes since 2016: lightning was ranked as medium significance in the 2016 Plan. Based on additional analysis and experience, the HMPC felt that low is a more accurate assessment of the risk.



- Despite limited records of past damages, lightning is common in the planning area, particularly during summer months.
- People working or recreating outdoors are at the highest risk to death or injury from lightning strikes.
- While direct life safety impacts from lightning are relatively rare in Broomfield, lightning can also start wildfires and cause power outages.
- Related Hazards: Severe Wind, Hail, Fire.



4.19 Public Health Hazard

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Public Health Hazards	Extensive	Likely	Critical	Medium

4.19.1 Description

Public health hazards, including epidemics and pandemics, have the potential to cause serious illness and death, especially among those who have compromised immune systems due to age or underlying medical conditions. There are several contagious and infectious diseases present in the State of Colorado that constitute a public health risk.

A pandemic can be defined as a public health emergency that attacks a large population across great geographic distances. Pandemics are larger than epidemics in terms of geographic area and number of people affected. Epidemics tend to occur seasonally and affect much smaller areas. Pandemics, on the other hand, are most often caused by new subtypes of viruses or bacteria for which humans have little or no natural resistance. Consequently, pandemics typically result in more deaths, social disruption, and economic loss than epidemics.

There are three conditions that must be met before a pandemic begins:

- A new virus subtype must emerge that has not previously circulated in humans (and therefore there is no pre-existing immunity),
- This new subtype must be able to cause disease in humans, and
- The virus must be easily transmissible from human to human.

As of March 2020, the City and County of Broomfield, the nation, and the world are dealing with the COVID-19 pandemic (caused by the SARS-CoV-2 virus), confirming that pandemic is a key public health hazard in the county. This hazard risk assessment includes an analysis of pandemic risk in the City and County of Broomfield and an analysis of the impacts of the hazards profiled in this plan on public health.

Unlike seasonal flu, an influenza pandemic has much greater potential for loss of life and significant social disruption due to higher rates of transmission and more severe health impacts. The COVID-19 virus has a much higher rate of transmission than the seasonal flu, primarily by airborne transmission of droplets/bodily fluid. Common symptoms include fever, cough, fatigue, shortness of breath or breathing difficulties, and loss of smell and taste. While most people have mild symptoms, some people develop acute respiratory distress syndrome with roughly one in five requiring hospitalization and a fatality rate of approximately 1%. A key challenge in containing the spread has been the fact that it can be transmitted by people who are asymptomatic.

In addition to influenza pandemics (human-to-human transmission), several zoonotic diseases (animal-to-human transmission) have been identified by CDPHE as a threat to public health and are briefly discussed below. Other outbreaks related to food/water-borne diseases and new variants of the SARS-CoV-2 virus may occur at any time.

4.19.2 Past Events

The CDPHE releases an annual reportable disease summary for each county. The diagnoses with the highest incidences the City and County of Broomfield for 2016 through 2018 are summarized in Table 4-44 below.

Table 4-44 Reportable Diseases in Broomfield, 2016-2018

Diagnosis	Incidents in 2016	Incidents in 2017	Incidents in 2018
Influenza - Hospitalized	16	41	42
Hepatitis C, Chronic	23	41	32



Diagnosis	Incidents in 2016	Incidents in 2017	Incidents in 2018
Animal Bites	72	70	35
Hepatitis B, Chronic	5	5	10
Carbapenem-Resistant Pseudomonas Aeruginosa (CRPA)	N/A	26	33
Campylobacteriosis	15	13	14
Salmonellosis	6	5	9
Group A Strep Invasive	N/A	1	0
Pertussis	21	11	4
Giardiasis	4	9	7

Source: <https://cdphe.colorado.gov/colorado-reportable-disease-data>

Since the early 1900s, five lethal pandemics have swept the globe:

1918-1919 Spanish Flu: The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. At one point, more than 10 percent of the American workforce was bedridden.

1957-1958 Asian Flu: The 1957 Asian Flu pandemic killed 1.1 million people worldwide, including about 70,000 people in the United States, mostly the elderly and chronically ill. Fortunately, the virus was quickly identified, and vaccine production began in May 1957.

1968-1969 H3N2 Hong Kong Flu: The 1968 Hong Kong Flu pandemic killed 1 million people worldwide and approximately 100,000 people in the United States. Again, the elderly were more severely affected. This pandemic peaked during school holidays in December, limiting student-related infections, which may have kept the number of infections down. Also, people infected by the Asian Flu ten years earlier may have gained some resistance to the new virus.

2009-2010 H1N1 Swine Flu: This influenza pandemic emerged from Mexico in early 2009 and was declared a public health emergency in the U.S. on April 26. By June, approximately 18,000 cases had been reported in the U.S. and the virus had spread to 74 countries. Most cases were fairly mild, with symptoms similar to the seasonal flu, but there were cases of severe disease requiring hospitalization and a number of deaths. The CDC estimates that 43-89 million people were infected worldwide, with an estimated 8,870 to 18,300 H1N1 related deaths, including 12,469 deaths in the United States.

2020-Ongoing COVID-19: The COVID-19 or novel coronavirus pandemic began in December 2019 and was declared a pandemic in March of 2020. As of March 22, 2021, 472 million cases have been reported around the world with over 6 million deaths, including approximately 80 million cases and 972,000 deaths in the U.S. The City and County of Broomfield has seen 13,000 cases so far resulting in 438 hospitalizations and 128 deaths as of March 22, 2021.

In addition to pandemics, zoonotic diseases (caused by viruses, bacteria, parasites, and fungi) spread via animals to humans are also a public health concern. According to CDPHE, the most common of these diseases documented in Colorado from 2015-2019 are summarized in the table below. All areas in the City and County of Broomfield are at risk of an occurrence of any of these diseases.

Table 4-45 Most Common Zoonotic Diseases in Broomfield, 2015-2019

Disease	Five-Year Average in CO
Rabies, Animal	172
West Nile Virus	107
Malaria	28
Tularemia	17



Source: <https://cdphe.colorado.gov/animal-related-diseases>

4.19.3 Location

The geographic extent of the hazard is **extensive**. Most, if not all, communities in the City and County of Broomfield would be affected, either directly or by secondary impacts. More highly populated areas may be affected sooner and may experience higher infection rates. Pandemics occur not only on a county or state level, but on a national and global scale.

The current COVID-19 pandemic has affected all 64 Colorado counties. The City and County of Broomfield has reported 5,032 cases so far resulting in 292 hospitalizations and 76 deaths as of July 12, 2021. During November and December 2020, a spike in COVID-19 cases led to a strain on medical system in Colorado's North Central Region (which includes Broomfield), where 90% of intensive care unit (ICU) beds were occupied (North Central Region Healthcare Coalition Emergency Management Resources, [NCR]).

4.19.4 Magnitude and Severity

The overall severity of public health hazards is **critical**. The magnitude of a public health emergency will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemic influenza is more easily transmitted from person-to-person but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time.

As seen with the ongoing COVID-19 pandemic in the City and County of Broomfield, the rapid spread of the virus combined with the need for increased hospital and coroner resources, testing centers, first responders, and vaccination administration sites caused significant strain on the medical system and public health departments. A short-term risk assessment prepared for City and County of Broomfield during September 2020 presented a risk matrix to capture a snapshot of the severity of COVID-19 at any point in time, using key metrics to help emergency management personnel understand what resources may be needed under low, medium, and high-risk scenarios. Additionally, other public health related triggers or comingled public health hazards (such as an outbreak of another pathogen) or even a more contagious strain of SARS-CoV-2 such as the recent Delta B.1.617.2 variant can quickly lead to even more outbreaks and tip the City and County of Broomfield into the high RC.

The Pandemic Intervals Framework (PIF) is a six-phased approach to defining the progression of an influenza pandemic. This framework is used to guide influenza pandemic planning and provides recommendations for risk assessment, decision making, and action. These intervals provide a common method to describe pandemic activity which can inform public health actions. The duration of each pandemic interval might vary depending on the characteristics of the virus and the public health response.

The six-phase approach was designed for the easy incorporation of recommendations into existing national and local preparedness and response plans. Phases 1 through 3 correlate with preparedness in the **pre-pandemic interval**, including capacity development and response planning activities, while Phases 4 through 6 signal the need for response and mitigation efforts during the **pandemic interval**.

Pre-Pandemic Interval

In nature, influenza viruses circulate continuously among animals (primarily birds). Even though such viruses might develop into pandemic viruses, in Phase 1 no viruses circulating among animals have been reported to cause infections in humans.

Phase 1 is the natural state in which influenza viruses circulate continuously among animals but do not affect humans.

In **Phase 2** an animal influenza virus circulating among domesticated or wild animals is known to have caused infection in humans and is thus considered a potential pandemic threat. Phase 2 involves cases of animal influenza that have circulated among domesticated or wild animals and have caused specific cases of infection among humans.

In **Phase 3** an animal or human-animal influenza virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, for examples, when there is close contact between an infected person and an unprotected caregiver. Limited transmission under these circumstances does not indicate that the virus has gained the level of transmissibility among humans necessary to cause a pandemic. Phase 3 represents the mutation of the animal influenza virus in humans so that it can be transmitted to other humans under certain circumstances (usually very close contact between individuals). At this point, small clusters of infection have occurred.

Pandemic Interval

Phase 4 is characterized by verified human-to-human transmission of the virus able to cause “community-level outbreaks.” The ability to cause sustained disease outbreaks in a community marks a significant upward shift in the risk for a pandemic. Phase 4 involves community-wide outbreaks as the virus continues to mutate and become more easily transmitted between people (for example, transmission through the air)

Phase 5 is characterized by verified human-to-human spread of the virus into at least two countries in one World Health Organization (WHO) region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short. Phase 5 represents human-to-human transmission of the virus in at least two countries.

Phase 6, the pandemic phase, is characterized by community-level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. Designation of this phase will indicate that a global pandemic is underway. Phase 6 is the pandemic phase, characterized by community-level influenza outbreaks.

4.19.5 Probability of Future Occurrence

The probability of major public health hazards in the future is considered **likely**. Public health hazards have affected Broomfield residents and visitors every year. However, most of those will have relatively minor impacts within the capabilities of the County’s public health system.

It is not possible to predict when the next pandemic will occur, or how severe it will be. Based on the five pandemics that have affected the United States in roughly the last 100 years, a pandemic occurs on average roughly every 20 years.

Today, a much larger percentage of the world’s population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster. Pandemics typically last for several months to 1-2 years. For the current COVID-19 pandemic, due to the virus’ ability to mutate and rapidly infect those who have not been vaccinated, the pandemic may extend for several years, and booster vaccines may be necessary to prevent future outbreaks.

4.19.6 Climate Change Considerations

According to the best available data, the changing climate is expected to exacerbate future pandemics. Climate change will influence vector-borne disease prevalence, although the direction of the effects (increased or decreased incidence) will be location- and disease specific. The intensity and extent of certain diseases is projected to increase. Climate change threatens to increase the spread of infectious diseases because changing heat, rain, and humidity levels allow disease carrying vectors and pathogens to come into closer contact with humans. As Colorado’s climate becomes warmer, mosquito populations could swell, making the region more favorable for disease transmission. Warmer weather

could also play a role in elevated seasonal deer mouse populations. Disadvantaged populations such as people with compromised health and those in lower socioeconomic status communities are expected to bear a greater burden as a result of their current reduced access to medical care and limited resources for adaptation strategies.

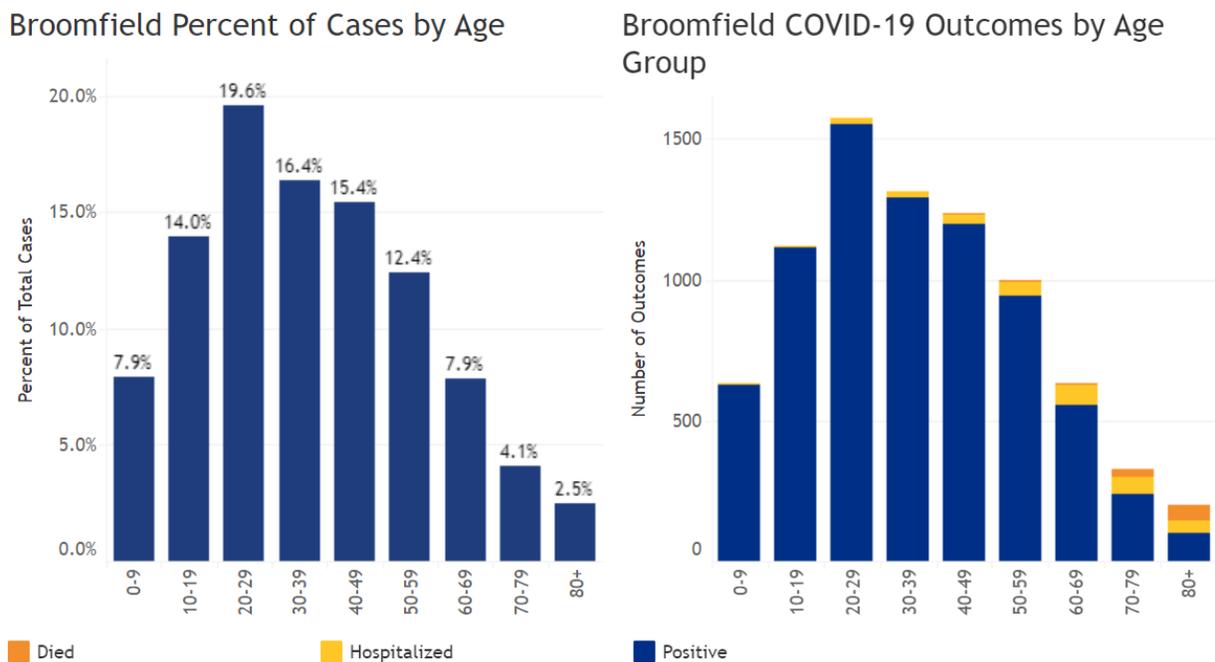
Additional research is needed to determine the effects of climate change on the frequency and duration of epidemics and pandemics.

4.19.7 Vulnerability

People

Pandemics have the ability to affect large segments of the population for long periods of time. According to the 2018 Colorado State Hazard Mitigation Plan, a pandemic flu outbreak could affect approximately 30% of the state’s overall population, with as much as 10% possibly needing hospitalization. The number of hospitalizations and deaths will depend on the virulence of the virus. Risk groups cannot be predicted with certainty; the elderly, people with underlying medical conditions, and young children are usually at higher risk, but as discussed above this is not always true for all influenza strains. People without health coverage or access to good medical care are also likely to be more adversely affected. As seen with the current COVID-19 pandemic in the City and County of Broomfield, although the most positive cases occurred in the 20-29 age group, hospitalizations and deaths disproportionately affected the elderly.

Figure 4-42 COVI-19 Cases in Broomfield as of December 2021



Source: City and County of Broomfield, <https://broomfield.org/3357/Demographics>

In the event of a pandemic, medical personnel would be incredibly overtaxed. For pandemics that particularly affect elderly communities such as COVID-19, long-term care facilities should implement measures to prevent transmission as much as possible to avoid local outbreaks and adverse outcomes. Help from the federal government and from other states would likely be limited, as other portions of the country are likely to also be affected. Communities may have to rely on their own resources for a much longer period of time as compared to other disasters. Medications may be limited to help prevent or treat the disease. It typically takes many years to develop, manufacture, and distribute a vaccine. According to the CDC, the 1967 mumps vaccine was previously the fastest vaccine ever developed, which still took four years. The COVID-19 vaccine was developed and began distribution in a phased



approach within one year. Health care supplies such as protective gear would also likely be in high demand, and supply chains, including at the manufacturing level, are also likely to be significantly disrupted. National stockpiles may not be enough to resupply local health care providers.

Other responders will be impacted similarly to the general public, although the nature of their jobs may make social distancing more difficult which could potentially lead to higher infection rates, thereby reducing available responders.

Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Additionally, traditional sheltering facilities including homeless shelters or facilities stood up to support displaced persons due to an evacuation or other reason due to a simultaneous disaster occurring cannot be done in a congregate setting. This requires additional planning considerations or use of facilities that allow for non-congregate shelter settings which may require an approval of a request to FEMA for non-congregate sheltering, and may have an increased cost (such as the use of individual hotel rooms) as opposed to traditional congregate sheltering facilities.

Critical Facilities and Infrastructure

Depending on the severity and stage of the pandemic, hospitals and morgues will be heavily affected and may be overwhelmed. In addition, a pandemic will likely also impact Tier 1 Mission Essential Functions as defined in the City and County of Broomfield COOP, as indicated in the table below. Other critical facilities and infrastructure are not directly affected by a pandemic but may have difficulty maintaining operations and maintenance activities due to a significantly decreased workforce. Schools may be forced to close until case counts or infection rates fall below specific thresholds and a sufficient portion of the population has been vaccinated.

Government Services

Government facilities may have difficulty continuing to provide services due to staffing shortages, as indicated by several of the Tier 1 Mission Essential Functions table above. The City and County of Broomfield COOP address how to continue to provide essential services during a staffing shortage.

Table 4-46 Potential Pandemic Impacts on Mission Essential Functions

Tier 1 Mission Essential Functions	Potential Pandemic Impacts at Low Risk Level	Potential Pandemic Impacts at Medium Risk Level	Potential Pandemic Impacts at High Risk Level
Command and Control of incident - EOP and Public Health Emergency Operations Plan (PHEOP) implementation	None.	Potential staffing concerns for key decision makers, IC and EOC.	Staffing concerns for key decision makers, IC and EOC.
Provide law enforcement for the protection, security, and safety of people within the City and County of Broomfield	Social distancing guidelines	Social distancing guidelines, possible staffing concerns	Social distancing guidelines, staffing concerns, possible increased social unrest
Ensure dependable and safe water supply for consumption and fire protection through distribution and storage of potable water and free flowing wastewater	None	Staffing concerns	Staffing concerns



Tier 1 Mission Essential Functions	Potential Pandemic Impacts at Low Risk Level	Potential Pandemic Impacts at Medium Risk Level	Potential Pandemic Impacts at High Risk Level
collections and treatment systems			
Ensure a safe and dependable transportation infrastructure for the safe and uninterrupted flow of essential transportation	None	Staffing concerns	Staffing concerns
Provide Child and Adult Protection Services (base service level)	Social distancing guidelines	Social distancing guidelines, possible staffing concerns	Social distancing guidelines, staffing concerns
Provide for care and welfare of inmates	Social distancing protocols	Social distancing protocols, possible staffing concerns	Social distancing protocols, staffing concerns
Provide a safe and dependable building operation for uninterrupted work for essential personnel	Workforce social distancing guidelines	Workforce social distancing guidelines, possible staffing concerns	Workforce social distancing guidelines, staffing concerns
Serving as the point of contact for information gathering and deploy strategic communication efforts, including the dissemination of internal and external information	See EOP Public Information Annex	See EOP Public Information Annex	See EOP Public Information Annex
Provide fuel along with repair and maintenance of vehicles/equipment	None	Supply Chain issues.	Supply Chain issues.
Respond to communicable disease	See Section 2 below	See Section 2 below	See Section 2 below
Provide cyber security	None	Staffing concerns	Staffing concerns

Source: City and County of Broomfield COOP

Economy

In a normal year, lost productivity due to illness costs U.S. employers an estimated \$530 billion. During a pandemic, that figure would likely be considerably high and could trigger a recession or even a depression. According to an October 2020 report by the Journal of the American Medical Association (JAMA) Network, the estimated cumulative financial costs of COVID-19 pandemic related to the COVID-19 economic recession and compromised health (premature death, mental health, long-term health impairment) in the U.S. population was almost \$16 trillion.

Historic, Cultural, and Natural Resources

Impacts to these resources are typically minimal. However, reduced tourism could lead to additional economic impacts.



4.19.8 Development Trends

Population growth and development contribute to pandemic exposure. Future development in and around the City and County of Broomfield has the potential to change how infectious diseases spread through the community and impact human health in both the short and long-term. New development may increase the number of people and facilities exposed to public health hazards and greater population concentrations (often found in special needs facilities and businesses) put more people at risk. During a disease outbreak those in the immediate isolation area would have little to no warning, whereas the population further away in the dispersion path may have some time to prepare and mitigate against disease depending on the hazard, its transmission, and public notification.

4.19.9 Risk Summary

Ongoing mitigation activities should focus on preventing infection during flu season. This includes, but is not limited to, pre-season community outreach campaigns to educate the public about risks and available support; establishing convenient vaccination centers; reaching out to vulnerable populations and care givers; and issuing advisories and warnings.

- Overall significance is **medium**.
- Changes since 2016: public health hazards were ranked as high significance in the 2016 Plan. Based on additional analysis and recent experience with the COVID-19 pandemic, to include increased capacity developed over the past year, the HMPC felt that medium is a more accurate assessment of the risk.
- Pandemics affecting the U.S. occur roughly once every 20 years but cannot be reliably predicted.
- Effects on people will vary, but as much as 30% of the population could become ill, and 10% may need to be hospitalized.
- Effects on property are typically minimal, although quarantines could result in short-term closures. Critical facilities may have difficulty maintaining operations due to staffing shortages.
- Lost productivity due to illness and potential business closures could potentially have severe economic impacts. Social distancing requirements and fear of public gatherings could significantly reduce in-person commerce.
- Related Hazards: Critical Infrastructure Outages, Hazardous Materials Incident.



4.20 Severe Wind

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Severe Wind	Extensive	Highly Likely	Moderate	Medium

4.20.1 Description

Severe wind typically develops with strong pressure gradients and gusty frontal passages. The closer and stronger two systems (one high pressure, one low pressure) are, the stronger the pressure gradient, and therefore, the stronger the winds are.

Downburst winds, which can cause more widespread damage than a tornado, occur when air is carried into a storm’s updraft, cools rapidly, and comes rushing to the ground. Cold air is denser than warm air, and therefore, wants to fall to the surface. On warm summer days, when the cold air can no longer be supported by the storm’s updraft, or when an exceptional downdraft develops, the air crashes to the ground in the form of strong winds. These winds are forced horizontally when they reach the ground and can cause significant damage. These types of strong winds can also be referred to as straight-line winds. Downbursts with a diameter of less than 2.5 miles are called microbursts and those with a diameter of 2.5 miles or greater are called macrobursts. A derecho is a series of downbursts associated with a line of thunderstorms. This type of phenomenon can extend for hundreds of miles and contain wind speeds in excess of 100 mph.

In late winter, Broomfield is also vulnerable to high downslope winds known as Chinook winds, which are strong, warming winds that race down the eastern slopes of the Continental Divide over the foothills and into the plains. High winds during these events can reach hurricane force and potentially cause more damage than a localized severe thunderstorm. During Chinook wind events, the highest winds occur closest to the intersection of the mountains and plains (a peak gust wind speed of 147 mph was recorded at the National Center for Atmospheric Research on Table Mesa in Boulder).

4.20.2 Past Events

Data from NOAA’s Storm Events Database was used to compile past wind events in the Broomfield planning area. The Storm Events Database includes wind events classified as follows:

- **High Winds:** Sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration.
- **Strong Winds:** Non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph), resulting in a fatality, injury, or damage.
- **Thunderstorm Winds:** Winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage.

The NCEI Storm Events Database reports 179 high wind events, four strong wind events, and six thunderstorm wind events affecting Broomfield from 1996 through 2020. These events, summarized in the table below, occurred across 148 separate days and caused 3 deaths, 20 injuries, \$8,968,000 in property damage, and \$11,000 in crop damage. Events are reported on a zone level and the statistics include impacts for the entire affected area of each event; therefore, these statistics likely include impacts outside the Broomfield planning area. Regardless the impacts are representative of real or potential impacts of wind in the planning area.

Table 4-47 Summary of Wind Events in Broomfield, 1996-2020

Event Type	Event Count	Deaths	Injuries	Property Damage	Crop Damage
High Wind	179	3	20	\$8,927,000	\$11,000
Strong Wind	4	0	0	\$41,000	\$0
Thunderstorm Wind	6	0	0	\$0	\$0

Source: NCEI Storm Events Database



The table below lists wind events that have occurred in the planning area in the last five years.

Table 4-48 NCEI Recorded Wind Events in Broomfield, 2016-2020

Date	Event Type	Deaths	Injuries	Property Damage	Crop Damage
12/25/2016	High Wind	0	0	\$0	\$0
1/9/2017	High Wind	0	0	\$0	\$0
2/10/2017	High Wind	0	0	\$100,000	\$0
3/6/2017	High Wind	0	0	\$0	\$0
3/7/2017	High Wind	0	0	\$0	\$0
1/30/2018	High Wind	0	0	\$0	\$1,000
3/5/2018	High Wind	0	0	\$0	\$0
3/5/2018	High Wind	0	0	\$0	\$0
3/23/2018	High Wind	0	0	\$0	\$0
4/13/2018	High Wind	0	0	\$0	\$0
4/17/2018	High Wind	1	0	\$0	\$0
4/17/2018	High Wind	0	0	\$0	\$0
11/2/2018	High Wind	0	0	\$0	\$0
11/24/2018	High Wind	0	0	\$0	\$0
11/30/2019	High Wind	0	0	\$0	\$0
1/4/2020	High Wind	0	0	\$0	\$0
1/6/2020	High Wind	0	0	\$0	\$0
1/17/2020	High Wind	0	0	\$0	\$0
1/17/2020	High Wind	0	0	\$0	\$0
6/6/2020	High Wind	0	0	\$0	\$0
6/6/2020	Thunderstorm Wind	0	0	\$0	\$0
6/6/2020	Thunderstorm Wind	0	0	\$0	\$0
6/6/2020	Thunderstorm Wind	0	0	\$0	\$0
6/8/2020	High Wind	0	0	\$0	\$0
10/11/2020	High Wind	0	0	\$0	\$0
10/11/2020	High Wind	0	0	\$0	\$0
11/8/2020	High Wind	0	0	\$0	\$0
11/14/2020	High Wind	0	0	\$0	\$0
11/14/2020	High Wind	0	0	\$0	\$0
12/22/2020	High Wind	0	0	\$0	\$0

Source: NCEI Storm Events Database

4.20.3 Location

The geographic extent of this hazard is **extensive**. All areas of Broomfield are susceptible to severe wind. The figure below shows the location of past wind event impacts in and around the planning area.



4.20.4 Magnitude and Severity

The overall severity of this hazard is **moderate**. The Storm Prediction Center has developed damage indicators to be used with the Enhanced Fujita tornado scale for different types of buildings. These indicators can also be used to classify any high wind event. Indicators for different building types are shown in the following tables.

Table 4-49 Damage to Institutional Buildings from High Wind

Damage Description	Wind Speed Range (Expected Speed)
Threshold of visible damage	59-88 MPH (72 MPH)
Loss of roof covering (<20%)	72-109 MPH (86 MPH)
Damage to penthouse roof & walls, loss of rooftop HVAC equipment	75-111 MPH (92 MPH)
Broken glass in windows or doors	78-115 MPH (95 MPH)
Uplift of lightweight roof deck & insulation, significant loss of roofing material (>20%)	95-136 MPH (114 MPH)
Façade components torn from structure	97-140 MPH (118 MPH)
Damage to curtain walls or other wall cladding	110-152 MPH (131 MPH)
Uplift of pre-cast concrete roof slabs	119-163 MPH (142 MPH)
Uplift of metal deck with concrete fill slab	118-170 MPH (146 MPH)
Collapse of some top building envelope	127-172 MPH (148 MPH)
Significant damage to building envelope	178-268 MPH (210 MPH)

Source: Storm Prediction Center, 2009

Table 4-50 Damage to Educational Institutions from High Wind

Damage Description	Wind Speed Range (Expected Speed)
Threshold of visible damage	55-83 MPH (68 MPH)
Loss of roof covering (<20%)	66-99 MPH (79 MPH)
Broken windows	71-106 MPH (87 MPH)
Exterior door failures	83-121 MPH (101 MPH)
Uplift of metal roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	85-119 MPH (101 MPH)
Damage to or loss of wall cladding	92-127 MPH (108 MPH)
Collapse of tall masonry walls at gym, cafeteria, or auditorium	94-136 MPH (114 MPH)
Uplift or collapse of light steel roof structure	108-148 MPH (125 MPH)
Collapse of exterior walls in top floor	121-153 MPH (139 MPH)
Most interior walls of top floor collapsed	133-186 MPH (158 MPH)
Total destruction of a large section of building envelope	163-224 MPH (192 MPH)

Source: Storm Prediction Center, 2009

Table 4-51 Damage to Metal Building Systems from High Wind

Damage Description	Wind Speed Range (Expected Speed)
Threshold of visible damage	54-83 MPH (67 MPH)



Damage Description	Wind Speed Range (Expected Speed)
Inward or outward collapsed of overhead doors	75-108 MPH (89 MPH)
Metal roof or wall panels pulled from the building	78-120 MPH (95 MPH)
Column anchorage failed	96-135 MPH (117 MPH)
Buckling of roof purlins	95-138 MPH (118 MPH)
Failure of X-braces in the lateral load resisting system	118-158 MPH (138 MPH)
Progressive collapse of rigid frames	120-168 MPH (143 MPH)
Total destruction of building	132-178 MPH (155 MPH)

Source: Storm Prediction Center, 2009

Table 4-52 Damage to Electric Transmission Lines from High Wind

Damage Description	Wind Speed Range (Expected Speed)
Threshold of visible damage	70-98 MPH (83 MPH)
Broken wood cross member	80-114 MPH (99 MPH)
Wood poles leaning	85-130 MPH (108 MPH)
Broken wood poles	98-142 MPH (118 MPH)

Source: Storm Prediction Center, 2009

4.20.5 Probability of Future Occurrence

The probability of high winds in the future is **highly likely**. As noted above, Broomfield City and County has experienced 148 days with severe wind events since 1996, averaging 5.8 days with wind events annually. However, only 25 days included reports of death, injury, or damages to property or crops, which equates to 1 day with damaging wind impacts annually.

Chinook winds are expected to continue as a common winter occurrence, while thunderstorm and downburst winds will be expected in late spring and early summer when the jet stream weakens and travels north, reducing wind shear.

4.20.6 Climate Change Considerations

More research is needed to determine what impacts climate change may have on severe wind events. The 2018-2023 Colorado State Hazard Mitigation Plan reports that the area at risk, extent, intensity, and frequency of severe wind events are not projected to change. However, it is unknown if the duration of severe wind events may be affected by climate change.

4.20.7 Vulnerability

People

Per NCEI records, over the last 25 years, there have been 3 deaths and 20 injuries reported in the Broomfield County zone as a result of severe winds. Deaths and injuries have resulted from downed trees, flying debris, strong winds overturning heavy objects onto individuals or overturning vehicles while individuals were inside, winds blowing out windshields and windows, and winds causing structure collapses. Individuals who cannot take shelter during severe wind events are at greater risk.

High winds can also cause power outages, which can be life threatening to those dependent on electricity for life support. Approximately 1,121 residents in the planning area rely on electricity-dependent medical equipment to be able to live independently in their homes.

Property

All buildings in Broomfield can be considered at risk from severe wind. Older buildings, which are often subject to less advanced building codes, suffer increased vulnerability to wind over time. For example, per FEMA's Guidelines for Wind Vulnerability Assessments of Existing Critical Facilities, roof structure

blow-off or collapse typically occurs to buildings constructed before 1990 due to building codes and standards. Roughly 33% of housing stock in Broomfield was built before 1990. Mobile homes, which are most often occupied by low income, socially vulnerable residents, are the most dangerous places during a windstorm or tornado. Studies indicate that 45% of all fatalities during tornadoes occur in mobile homes, compared to 26% in traditional site-built homes. Overall, mobile homes make up just over 2% of Broomfield's housing stock.

Critical Facilities and Infrastructure

Infrastructure damage from severe wind is dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to structures and shelters

Downed electrical lines following a storm can increase the potential for lethal electrical shock and can also lead to other hazard events such as wildfires.

Government Services

As noted above, severe wind may cause infrastructure damages that could result in utility and service interruptions. However, continuity of government operations is unlikely to be affected by severe wind.

Economy

Economic losses may result from business interruption or lost productivity due to damages to infrastructure or property or interruption of services. However, most financial losses due to wind are related to direct property damages as well as subsequent debris removal, response, and repair activities. Per NCEI records, over the last 25 years, severe wind events have caused \$8,968,000 in property damages in the Broomfield County zone. This equates to an annualized loss of \$358,720.

Historic, Cultural, and Natural Resources

Severe winds can cause erosion and damage trees and vegetation. Environmental impacts may also result from secondary effects of wind. Severe winds can trigger or spread wildfires under some conditions. Winds may also lead to hazardous materials releases; for example, a past event recorded by NCEI noted that winds toppled a semi-truck hauling hazardous material.

The Broomfield Historic Landmark Board has designated five historic properties in Broomfield, all built between 1908 and 1919. Given their age, these structures may be more vulnerable to the impacts of wind.

4.20.8 Development Trends

Population growth and development in the planning area will result in an increase in exposure to severe winds. However, development trends are not expected to affect the probability or severity of wind hazards provided buildings are constructed in adherence with local building codes.

4.20.9 Risk Summary

- Overall significance is **medium**.
- Changes since 2016: none.
- Severe wind events are highly likely to continue occurring in Broomfield.
- Severe winds have caused 3 deaths, 20 injuries, and over \$8.9 million in property damage in the Broomfield area over the last 25 years.
- Related Hazards: Lightning, Hail, Tornado, Winter Storm.

4.21 Tornado

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Tornado	Limited	Occasional	Moderate	Low

4.21.1 Description

A tornado is a narrow, violently rotating column of air that extends from the base of a cumulonimbus cloud to the ground. The visible sign of a tornado is the dust and debris that is caught in the rotating column made up of water droplets. Tornadoes are the most violent of all atmospheric storms. The following are common ingredients for tornado formation:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (i.e., from southeast at the surface to west aloft)
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornadoes can form from individual cells within severe thunderstorm squall lines. They also can form from an isolated supercell thunderstorm. Weak tornadoes can sometimes occur from air that is converging and spinning upward, with little more than a rain shower occurring in the vicinity.

The U.S. experiences more tornadoes than any other country. In a typical year, approximately 1,000 tornadoes affect the U.S. The peak of the tornado season is April through June, with the highest concentration of tornadoes in the central U.S. Figure 4-47 in the Probability of Future Occurrence section shows the annual average number of tornadoes between 1991 and 2015. Colorado experienced an average of 49.5 tornado events annually in that period. Colorado ranks 9th among the 50 states in frequency of tornadoes, but 38th for the number of deaths. Nationwide, Colorado ranks 31st for injuries and 30th for the cost of repairing the damages due to tornadoes. When these statistics are compared to other states by the frequency per square mile, Colorado ranks 28th for injuries per area and 37th for costs per area.

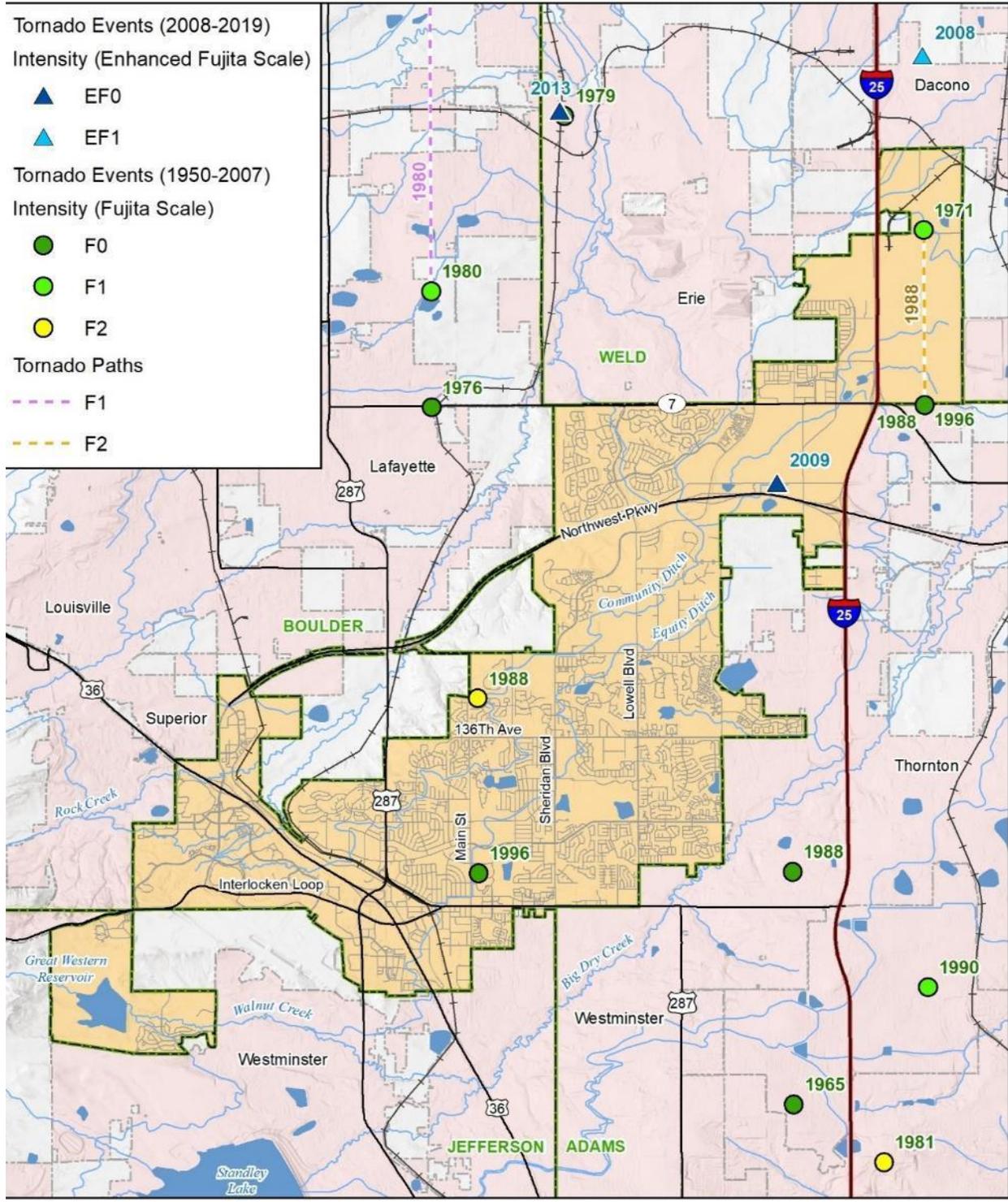
Tornadoes form when cool, dry air sits on top of warm, moist air. In Colorado, this most often happens in the spring and early summer (i.e., May, June, and July) when cool, dry mountain air rolls east over the warm, moist air of the plains during the late afternoon and early evening hours. However, tornadoes are possible anywhere in the state, at any time of year and at any point during the day.

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, most injuries and deaths 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

4.21.2 Past Events

According to data from the NWS, there have been six tornadoes which tracked through the boundaries of the City and County of Broomfield from 1950 through 2019. However, only one of these events has occurred since the formation of the county in 2001. The locations and magnitudes of these events are shown below in Figure 4-44.

Figure 4-44 City and County of Broomfield Tornado Events, 1950-2019



Map compiled 11/2021;
 intended for planning purposes only.
 Data Source: Broomfield City/County,
 CDOT, NOAA, National Weather Services SVRGIS 2019

0 2.5 5 Miles N

4.21.3 Location

Tornadoes are possible anywhere in Colorado, even in mountainous terrain. In 2007, a tornado damaged thousands of trees outside of Woodland Park in Pike National Forest in Teller County. Another tornado, which occurred in Clear Creek County in 2012, is one of the highest elevation tornadoes ever recorded, touching down at approximately 11,900 feet above sea level. The severe weather conditions that spawn tornadoes are regional events which may impact any extent of the planning at a given time, and in this regard, the possible geographic extent for tornadoes is extensive. However, tornadoes as a stand-alone event are single point (or limited point) occurrences similar to lightning. While knowing that the entire planning area is vulnerable to a tornado, the realistic assessment of tornado occurrences indicates that these single point events occur in a negligible density. An average of the two extremes may yield the most likely extent rating.

Based on this information, the geographic extent rating for tornadoes is **limited**.

4.21.4 Magnitude and Severity

Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 miles per hour and damage paths can be more than one mile wide and 50 miles long. Tornadoes have been known to lift and move objects weighing more than 300 tons a distance of 30 feet, toss homes more than 300 feet from their foundations, and siphon millions of tons of water from water bodies. Tornadoes also generate a tremendous amount of flying debris or “missiles,” which often become airborne shrapnel that causes additional damage. If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, roofs, and walls. However, the less spectacular damage is much more common.

In 2007, the NWS began rating tornadoes using the Enhanced Fujita Scale (EF-scale). The EF-scale is a set of wind estimates (not measurements) based on damage. Standard measurements are taken by weather stations in open exposures. Table 4-53 shows the wind speeds associated with the Enhanced Fujita Scale ratings and the associated damage indicators associated with each rating. Visual examples of the degree of damage which could be expected with each EF rating are shown in Figure 4-45 below.

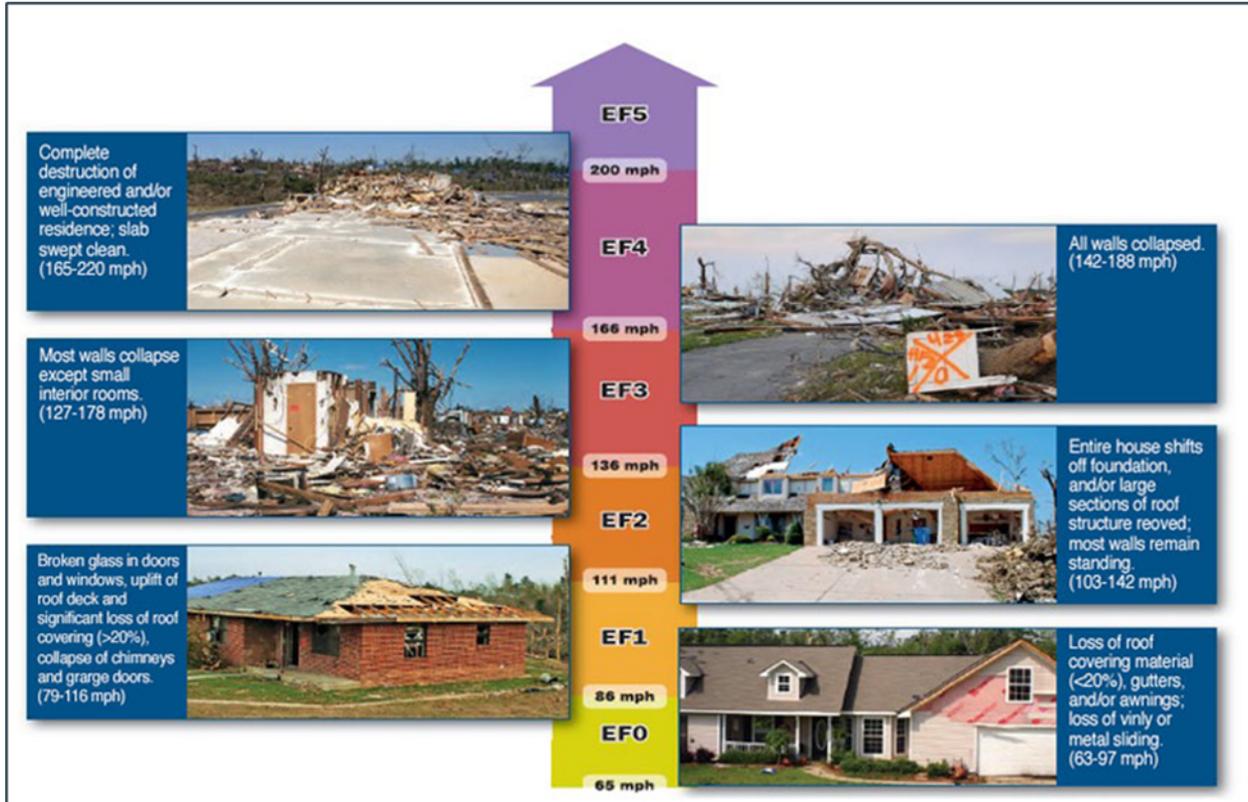
Table 4-53 Enhanced Fujita Scale with Damage Descriptions

Enhanced Fujita Scale			
Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely levelled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses levelled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise

Enhanced Fujita Scale			
			buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA

Figure 4-45 Potential Damage Impacts from a Tornado



Source: NOAA

Tornadoes are potentially the most dangerous of atmospheric storms. If a major tornado were to strike the urbanized areas of Broomfield, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. The potential for damage is significant, however based on the past record of occurrence it is unlikely for a high magnitude event to strike the planning area.

The magnitude and severity rating for this hazard is **moderate**.

4.21.5 Probability of Future Occurrence

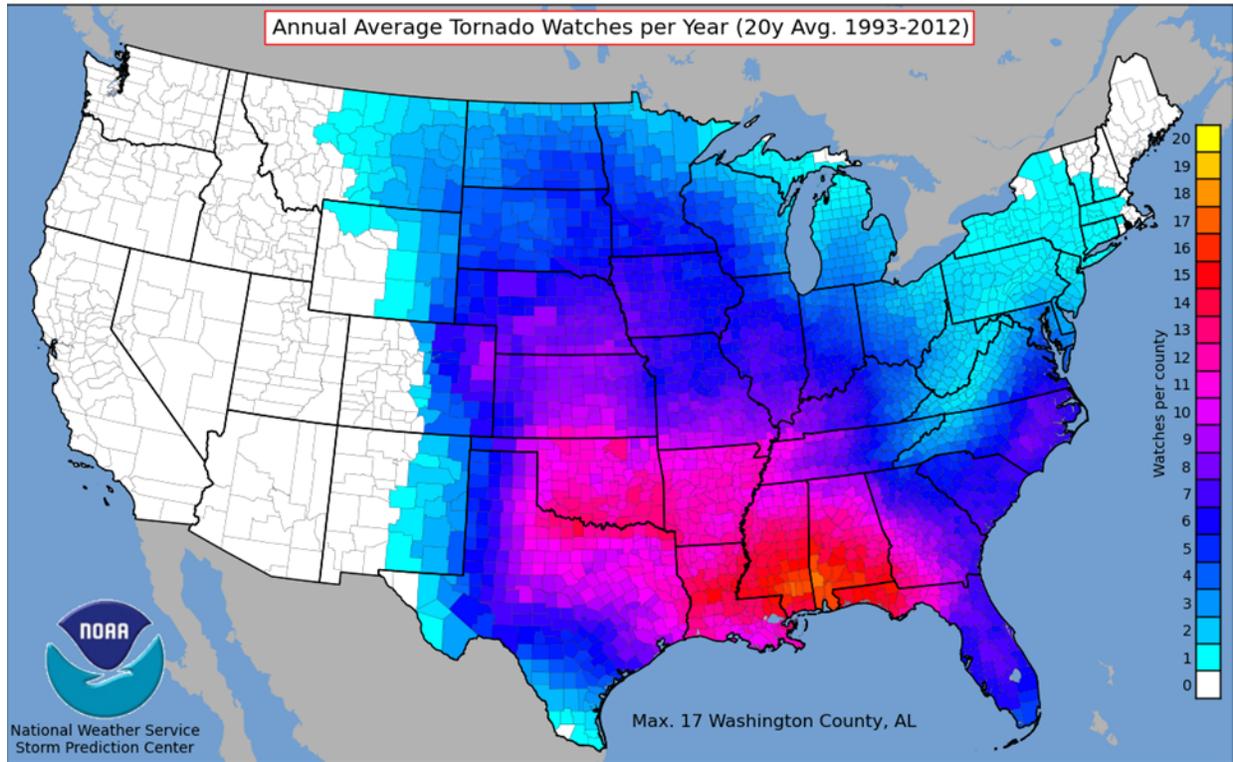
The NOAA’s storm prediction center issues tornado watches and warnings nationwide:

- **Tornado Watch**—Tornadoes are possible. Remain alert for approaching storms. Watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information.
- **Tornado Warning**—A tornado has been sighted or indicated by weather radar. Take shelter immediately.

A study from NOAA’s National Severe Storms Laboratory used historical data to estimate the daily probability of tornado occurrences across the U.S., regardless of tornado magnitude. Figure 4-46 shows the estimates. The density per 25 square miles in the map’s legend indicates the probable number of tornadoes for each 25 square mile cell within the contoured zone that can be expected over a similar

period of record. It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone on the map

Figure 4-46 Total Annual Tornado Watches in the U.S. (1993-2012)

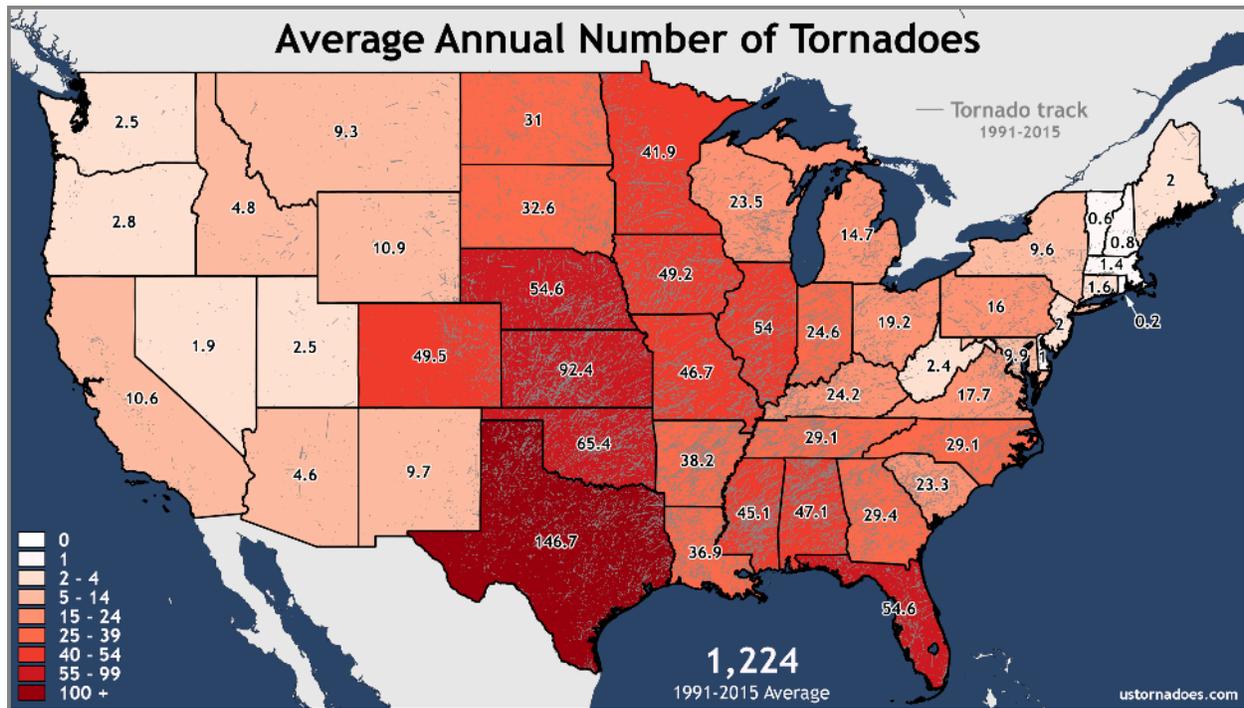


Source: NOAA

Figure 4-47 below shows the average number of recorded tornadoes per year in each state from 1991 to 2015. Tornadoes have been reported nine months of the year in Colorado, with peak occurrences between May and August. Statewide, June is by far the month with the most recorded tornadoes. There have been nine recorded tornadoes between 1950 and 2019, therefore, there is a 13% chance in any given year for a tornado in Broomfield.

According to data from the NWS, there have been six tornadoes which tracked through the boundaries of the City and County of Broomfield from 1950 through 2019. Based on this, the probability of future occurrence rating for tornadoes is **occasional**.

Figure 4-47 Annual Average Number of Tornadoes in the U.S. (1991-2015)



Source: U.S. Tornadoes

4.21.6 Climate Change Considerations

Climate change impacts on the frequency and severity of tornadoes are unclear. 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. The level of significance of this hazard should be revisited over time.

4.21.7 Vulnerability

People

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure after tornado events and could suffer more secondary effects of the hazard. Approximately 9% of Medicare Beneficiaries in the planning area rely on electricity-dependent medical equipment to be able to live independently in their homes.

Individuals caught in the path of a tornado who are unable to seek appropriate shelter are especially vulnerable. This may include individuals who are out in the open, in cars, or who do not have access to basements, cellars, or safe rooms

Property

All property is vulnerable during tornado events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Mobile homes are more vulnerable to the impacts of a tornado event compared to housing types due to methods of construction. Statewide, mobile homes represent about 4% of total housing, while in the City and County of Broomfield 2.1% of the total

housing stock is mobile homes. If an EF3 or higher tornado were to hit populated areas of the county substantial damage to property would be likely.

Secondary impacts of damage caused by tornado events often result from damage to infrastructure. Downed power and communications transmission lines, coupled with disruptions to transportation, create difficulties in reporting and responding to emergencies. These indirect impacts of a tornado put tremendous strain on a community. In the immediate aftermath, the focus is on emergency services.

Critical Facilities and Infrastructure

All critical facilities and infrastructure are likely exposed to tornadoes, though the likelihood of damage to any critical facilities or infrastructures from a tornado is extremely limited. The most common problems associated with this hazard are utility losses. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to downed trees or other debris.

Tornadoes can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly. Any facility that is in the path of a tornado is likely to sustain damage.

Additionally, fires may result from damages to natural gas infrastructure. Hazardous materials may be released if a structure is damaged that houses such materials or if such a material is in transport.

Government Services

Damage impacts to transportation corridors and communications lines could affect first responders' ability to effectively respond in the aftermath of a tornado. Damage to government facilities/personnel in incident area may require temporary relocation of some operations, and potentially disrupt government services. The public may question local government's ability to respond and recover if planning, response, and recovery are not timely and effective. A significant tornado may require disaster declarations and aid programs. These needs may impact funding or administrative resources for other regular operations or may necessitate changes to existing operating procedures.

Economy

Loss of power and minimal damage following a tornado could cause disruptions to the local economy through forced temporary closures of businesses and preventing people from traveling to work. More severe tornadoes could result in significant economic disruption and hinder recovery through the forced extended or permanent closure of businesses damaged in the event. Additionally, tornadoes which cause significant property damage could negatively impact the local economy.

Historic, Cultural, and Natural Resources

Environmental features are exposed to tornado risk, although damages are generally localized to the path of the tornado. However, if tornadoes impact facilities that store HAZMAT areas impacted by material releases may be especially vulnerable. Historic buildings built prior to modern building codes would be more prone to damage.

4.21.8 Development Trends

All future development will be potentially exposed to tornadoes. Development regulations that require safe rooms, basements, or other structures that reduce risk to people would decrease vulnerability but may not be cost-effective given the relative infrequency of damaging tornadoes in the City and County of Broomfield.

4.21.9 Risk Summary

- The overall rating of this hazard is **low**.
- Changes since 2016: none.
- Historically, tornadoes have not a particularly large or frequent impact on the planning area. There have been 9 recorded tornado events in the County since 1950. None resulted in recorded property damage or injuries.



- Elderly and individuals who depend on electricity for medical needs are vulnerable to power outages caused by a tornado. 9% of Medicare Beneficiaries in the County rely on electricity-dependent equipment.
- All property is potentially vulnerable during tornado events, but mobile homes are disproportionately at risk due to the design of the homes. 2.1% of total housing in the County are mobile homes.
- Related Hazards: Severe Wind.



4.22 Winter Storm

Hazard	Location	Potential of Future Occurrence	Potential Severity/Magnitude	Overall Significance
Winter Storm	Extensive	Highly Likely	Moderate	Medium

4.22.1 Description

Winter storms and severe winter weather events, including blizzards, heavy snow, and ice storms, are a common occurrence in Colorado and can affect Broomfield throughout the fall, winter, and spring seasons. The following definitions detail the types of winter weather events that can occur in Broomfield:

Blizzards, as defined by the NWS, are a combination of sustained winds or frequent gusts of 35 mph or greater, and visibilities of less than a quarter mile from falling or blowing snow for 3 hours or more. A blizzard does not necessarily indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel treacherous, even on foot. The strong winds may also cause dangerous wind chills. Ground blizzards can develop when strong winds lift snow off the ground and severely reduce visibilities.

Heavy snow may fall during winter storms in large quantities. Six inches or more in 12 hours, or eight inches or more in 24 hours, creates conditions that may significantly hamper travel or create hazardous conditions. The NWS issues warnings for such events. Smaller amounts can also make travel hazardous, but in most cases, only results in minor inconveniences. Heavy wet snow before the leaves drop from the trees in the fall, or after the trees have leafed out in the spring, may cause problems with broken tree branches and power outages.

Ice storms develop when a layer of warm (above freezing), moist air aloft coincides with a shallow cold (below freezing) pool of air at the surface. As snow falls into the warm layer of air, it melts to rain, and then freezes on contact when hitting the frozen ground or cold objects at the surface, creating a smooth layer of ice. This phenomenon is called freezing rain. Similarly, sleet occurs when the rain in the warm layer subsequently freezes into pellets while falling through a cold layer of air at or near the Earth's surface. Extended periods of freezing rain can lead to accumulation of ice on roadways, walkways, power lines, trees, and buildings. Almost any accumulation can make driving and walking hazardous. Thick accumulations can bring down trees and power lines.

The NWS also tracks data on:

Winter Storms, defined as winter weather events that have more than one significant hazard (including falling or blowing snow, ice, and/or sleet) and meet or exceed regional 12- and/or 24-hour warning criteria for at least one of the included elements; and

Winter Weather, defined as events that do not meet regional warning criteria but that cause death, injury, or a significant impact to commerce or transportation.

4.22.2 Past Events

Data from NOAA's NCEI Storm Events Database was used to compile past winter storm events in the Broomfield City and County planning area.

The NCEI Storm Events Database reports 8 days with blizzard events, 49 days with heavy snow events, 62 days with winter storm events, and 48 days with winter weather events affecting Broomfield from 1996 through 2020. These events, summarized in the table below by year, caused 2 injuries and \$34,100,000 in property damage. Events are reported on a zone level and the statistics include impacts for the entire affected area of each event and thus likely include impacts outside the Broomfield planning area.

Table 4-54 NCEI Recorded Days with Winter Storm Events, Broomfield County, 1996-2020

Year	Blizzard	Heavy Snow	Winter Storm	Winter Weather	Total Days
1996	0	6	1	0	7



Year	Blizzard	Heavy Snow	Winter Storm	Winter Weather	Total Days
1997	1	6	4	0	11
1998	0	3	3	0	6
1999	0	9	2	0	11
2000	0	5	0	0	5
2001	1	7	2	0	10
2002	0	2	1	0	3
2003	1	1	1	0	3
2004	0	0	4	0	4
2005	0	0	3	0	3
2006	1	1	2	0	4
2007	1	1	3	2	7
2008	0	1	0	2	3
2009	0	0	6	4	10
2010	0	0	2	2	4
2011	0	0	4	4	8
2012	0	0	1	2	3
2013	0	0	5	2	7
2014	0	0	3	4	7
2015	1	1	3	6	11
2016	1	2	4	0	7
2017	0	1	3	2	6
2018	0	0	1	3	4
2019	1	1	2	9	13
2020	0	2	2	6	10
Total	8	49	62	48	167

Source: NCEI Storm Events Database

The table below lists winter storm-related events that have occurred in the planning area in the last five years.

Table 4-55 NCEI Recorded Winter Storm Events, Broomfield County, 2016-2021

Date	Event Type	Deaths	Injuries	Property Damage	Crop Damage
2/1/2016	Winter Storm	0	0	0	0
3/17/2016	Winter Storm	0	0	0	0
3/23/2016	Blizzard	0	0	0	0
3/23/2016	Winter Storm	0	0	0	0
4/15/2016	Heavy Snow	0	0	0	0
4/16/2016	Heavy Snow	0	0	0	0
12/16/2016	Winter Storm	0	0	0	0
1/4/2017	Winter Storm	0	0	0	0
2/1/2017	Winter Weather	0	0	0	0
4/3/2017	Winter Weather	0	0	0	0
4/28/2017	Winter Storm	0	0	0	0



Date	Event Type	Deaths	Injuries	Property Damage	Crop Damage
5/17/2017	Heavy Snow	0	0	0	0
10/8/2017	Winter Storm	0	0	0	0
1/21/2018	Winter Storm	0	0	0	0
2/19/2018	Winter Weather	0	0	0	0
10/13/2018	Winter Weather	0	0	0	0
11/11/2018	Winter Weather	0	0	0	0
1/11/2019	Winter Weather	0	0	0	0
1/21/2019	Winter Weather	0	0	0	0
2/6/2019	Winter Weather	0	0	0	0
2/22/2019	Winter Weather	0	0	0	0
2/22/2019	Heavy Snow	0	0	0	0
3/2/2019	Winter Weather	0	0	0	0
3/13/2019	Blizzard	0	0	0	0
4/10/2019	Winter Weather	0	0	0	0
10/9/2019	Winter Weather	0	0	0	0
10/23/2019	Winter Weather	0	0	0	0
10/27/2019	Winter Weather	0	0	0	0
10/29/2019	Winter Storm	0	0	0	0
11/25/2019	Winter Storm	0	0	0	0
2/3/2020	Winter Weather	0	0	0	0
2/6/2020	Winter Weather	0	0	0	0
3/19/2020	Winter Storm	0	0	0	0
4/11/2020	Heavy Snow	0	0	0	0
4/15/2020	Winter Weather	0	0	0	0
4/15/2020	Winter Storm	0	0	0	0
9/7/2020	Winter Weather	0	0	0	0
10/23/2020	Winter Weather	0	0	0	0
10/23/2020	Heavy Snow	0	0	0	0
11/24/2020	Winter Weather	0	0	0	0
3/13/2021	Blizzard	0	0	0	0
Total		0	0	0	0

Source: NCEI Storm Events Database

The following event narratives from the NCEI Storm Events Database and the previous plan detail specific local impacts from past events:

April 10-11, 2001 - A blizzard including a combination of freezing rain, followed by heavy snow and damaging winds led to widespread electrical outages. Snowfall totals included 14 inches at Broomfield. Sustained winds from 35 to 58 mph with gusts to around 75 mph were recorded. Interstate 25 was closed just south of the Wyoming border. Denver International Airport was completely shut down due to power surges and outages. Power outages affected nearly all of northeast Colorado. Some areas only had scattered outages for a few hours, while more remote areas were blacked out for over a week. Most businesses were closed and school classes canceled. Overall, 220,000 Xcel Energy customers were affected, making it the worst outage in the company's history. Overall, at least 500 poles were downed or damaged during the storm. The company replaced 120 electrical poles, repaired 180 additional



poles, and repaired or replaced another 400 cross-arms. Approximately \$1.6 million was spent on repairs across northeastern Colorado.

March 17-19, 2003 - A blizzard and severe winter storm resulted in \$6.2 million in damages and snow removal costs in the City and County of Broomfield. The NWS recorded a total of 31 inches of snow in Broomfield over a three-day period. The majority of damages was the result of wet, heavy snow that collapsed roofs, porches, awnings, carports, and outbuildings (there was also significant damage from downed trees and limbs). According to the Rocky Mountain Insurance Information Association (RMIIA), the blizzard of March 2003 was the costliest winter storm from snow and ice damage in Colorado history (\$93.3 million in estimated losses from more than 28,000 claims filed).

December 21, 2006 - Strong winds and heavy snow brought blizzard conditions to the Interstate 25 Corridor, from the Wyoming state line south to Colorado Springs. Storm totals generally ranged from 2 to 4 feet in and near the Front Range Foothills and Palmer Divide. Denver measured 20.7 inches of snow officially, ranked as the 7th biggest snowstorm since 1946. The storm forced the closure of Denver International Airport, stranding nearly 5,000 travelers as 2,000 flights were canceled. DIA remained closed for a total of 45 hours, the longest closure in its 12-year history. Police and National Guardsmen rescued hundreds of commuters stuck in their cars and sent them to temporary shelters set up by the Red Cross. All highways and interstates, including I-25, I-70 and I-76 were shut down. Mail delivery was also suspended. The Regional Transportation District (RTD) suspended its bus service for the first time since the March 2003 blizzard.

March 26-27, 2009 - At Denver International Airport, hundreds of flights were canceled. In addition, schools throughout the region were shut down and many roads closed due to multiple accidents. Dozens of vehicles slid on Interstate 25 which involved up to 75 vehicles, between Fort Collins and Cheyenne. Fifteen people were treated for minor injuries. Portions of U.S. Highway 36, between Denver and Boulder, were also closed during the day. The Red Cross opened up six shelters for stranded motorists. Storm totals included 14 inches in Broomfield.

October 27-29, 2009 - An extended period of moderate to heavy snowfall led to heavy wet snowfall accumulation on trees and resulted in broken branches and scattered electrical outages. The Red Cross set up numerous emergency shelters for stranded travelers. The blowing snow at Denver International Airport forced the cancellation of hundreds of flights. Schools throughout the region were also closed. Storm totals included 20.5 inches at Broomfield.

February 2-4, 2012 - A slow moving and powerful storm system brought heavy snow to areas in and near the Front Range Foothills, with blizzard conditions over the northeastern plains of Colorado. Denver International Airport canceled more than six hundred flights. In addition, snow and blowing snow produced near zero visibilities, forcing officials to close the westbound lanes of Interstate 70, between the Kansas state line and Denver, as well as the eastbound lanes from Denver to Limon. Other road closures included: State Highway 86, between Kiowa and I-70, U.S. Highway 40, between Limon and Eads, and State Highway 71, from Last Chance to Limon to Ordway. Storm totals included 22 inches in Broomfield.

February 15-16, 2015 - A storm system brought heavy snow to areas in and near the Front Range Foothills. Multiple accidents occurred as the onset of the storm occurred during the evening commute. A multi-car pileup occurred on eastbound I-70 which forced the closure of a four-mile stretch of the interstate in both directions from C-470 to Lookout Mountain. The Colorado State Patrol said at least 50 cars were involved, but not all crashed. Numerous vehicles became stuck when the slush turned to ice. About 60 flights were canceled at Denver International Airport. Several cities from around Denver to Broomfield to Boulder were on accident alert.

March 23, 2016 - A powerful blizzard produced extremely heavy and intense snowfall with snowfall rates exceeding 3 inches per hour at times. Storm totals included 23 inches in Broomfield. Many roads became impassable due to the depth of fallen snow, drifting snow, and near zero visibilities during the day. CDOT estimated over 2,000 vehicles became trapped on I-25 near Monument Hill alone, with hundreds of stuck or abandoned cars elsewhere. Numerous power outages occurred as heavy wet snow accumulated on trees, despite the strong winds. At the peak, several hundred thousand residents along

the Front Range were without power. Denver International Airport was closed for 7 hours during and just after the peak of the blizzard, with around 1,300 canceled flights.

October 16, 2019 - A powerful winter storm brought very heavy snowfall to the Front Range Mountains, Foothills, I-25 corridor and northeast plains. Heavy snow developed in and near the Front Range Foothills of Larimer and Boulder counties, then spread south and east across the rest of the region. All schools were closed on the 25th and 26th across the entire area, including all the major universities and colleges across northeast and north central Colorado. Federal, state, city, and county offices were closed on the 25th. I-70 west of Denver was closed due to a rockslide. Storm totals included 14” in Broomfield.

March 13-14, 2021 - The fourth largest snowstorm in Denver’s history moved through the metro area, dropping 27.1” at DIA. Approximately 25,000 people lost power across Colorado and Wyoming. The number of stranded motorists needing rescue/recovery put a significant strain on responders.

4.22.3 Location

The geographic extent rating for winter storms is **extensive**. All of the City and County of Broomfield is subject to blizzard, heavy snowfall, ice storm, and other winter weather conditions. The size of events varies and may range from isolated (impacting only a portion of the Denver Metro area) to statewide. Most severe winter storms are widespread events, impacting multiple counties simultaneously and for extended time periods.

4.22.4 Magnitude and Severity

The NWS definitions listed in Section 4.22.1 above can be used as measures of the magnitude of winter weather events. Additionally, Figure 4-48 shows the Winter Storm Severity Index (WSSI), which provides NWS partners and the general public with an indication of the level of winter precipitation severity and its potential related societal impacts. The overall severity of this hazard is **moderate**.

Figure 4-48 Winter Storm Severity Index (WSSI) Scale

Potential Winter Storm Impacts	
	<p>No Impacts Impacts not expected.</p>
	<p>Limited Impacts Rarely a direct threat to life and property. Typically results in little inconveniences.</p>
	<p>Minor Impacts Rarely a direct threat to life and property. Typically results in an inconvenience to daily life.</p>
	<p>Moderate Impacts Often threatening to life and property, some damage unavoidable. Typically results in disruptions to daily life.</p>
	<p>Major Impacts Extensive property damage likely, life saving actions needed. Will likely result in major disruptions to daily life.</p>
	<p>Extreme Impacts Extensive and widespread severe property damage, life saving actions will be needed. Results in extreme disruptions to daily life.</p>

Source: https://www.weather.gov/ict/WSSI_Overview

4.22.5 Probability of Future Occurrence

According to the NCEI data of past events discussed above, Broomfield averages 6.7 winter storm-related events (blizzard, heavy snow, winter storm, and winter weather) each year. Based on this



historical record, winter storm events are highly likely to continue occurring in Broomfield each year. The probability of future winter storms is **highly likely**.

4.22.6 Climate Change Considerations

According to the 2018-2023 State Hazard Mitigation Plan, winter storm events are projected to become more severe, and winter precipitation events are expected to increase in frequency. However, the Fourth National Climate Assessment reports that portions of the Southwest are experiencing an increase in the proportion of rain to snow in precipitation patterns and projections indicate continuations of this trend as well as a shorter snowfall season.

4.22.7 Vulnerability

People

Severe winter storms can cause a significant public safety hazard, especially as a result of transportation impacts which can occasionally strand motorists and disrupt emergency and medical services. Response activities may require rescuing stranded travelers, getting them to heated facilities, and providing food, water, and medical care.

People are also vulnerable to prolonged power outages during severe winter storm events. During extended winter-time power outages, people often make the mistake of bringing portable generators inside or not venting them properly, leading to carbon monoxide poisoning.

Property

Damages primarily occur because of high winds, ice storms, and snow loading. The water content or weight of the snow often determines the level of damages to structures, trees and utility lines. Heavy snow loads on roofs, particularly large span roofs, can cause roofs to leak or even collapse depending on their construction.

Although winter weather in Broomfield is generally mild and dry, severe winter storms can bring down trees and power lines, freeze water pipes, and damage homes. All assets in Broomfield can be considered at risk to severe winter storm events. Per NCEI records, in the last 25 years winter storm events resulted in \$34,100,000 in property damages in the Broomfield County zone, which equates to an annualized loss of \$1,364,000.

Critical Facilities and Infrastructure

The greatest issue for critical facilities during significant winter storms is the inaccessibility of facilities due to poor roadways or utility outages. During periods of heavy snow, ice, or blizzards, roads can quickly become impassable, stranding motorists and isolating communities. Long-term road closures during an extended winter storm may diminish and threaten propane and fuel supplies. Possible impacts to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants

Debris may also block roadways making transportation and commerce difficult if not impossible. Those facilities with backup generators are better equipped to handle a prolonged severe winter storm should the power go out.

Government Services

Power outages and poor road conditions may interrupt continuity of operations and provision of services. In extreme cases, past events have resulted in airport shutdowns, which could affect supply chains in addition to impacting travelers.



Economy

Economic losses may result from business interruptions due to poor road conditions and/or power outages.

Historic, Cultural, and Natural Resources

Heavy snow and ice accumulations may cause damages to trees and landscaping.

4.22.8 Development Trends

Growth and new development will result in increases in population and building exposure in the planning area. Setting building code requirements for new development to ensure greater resistance to ice and snow loads will minimize vulnerability of new structures.

4.22.9 Risk Summary

- Overall significance is **medium**.
- Changes since 2016: none.
- Severe winter storms can produce strong winds and significant accumulations of snow and ice. These events are likely to continue occurring in the future.
- Power outages and poor road conditions are likely impacts of severe winter storms.
- Related hazards: Extreme Temperatures, Severe Wind.

5 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 shall include:

A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

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.

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 of the plan details the City and County of Broomfield's strategy for reducing losses and impacts from the hazards listed in Chapter 4. It covers the broad goals, implementation objectives, and specific actions the County will pursue. Section 5.1 below establishes the goals and objectives of this plan; Section 5.2 describes the progress participating jurisdictions have made since the 2016 Plan; Section 5.3 outlines the process by which new mitigation actions were identified and prioritized; and Section 5.4 lists the updated mitigation action plan.

5.1 Goals and Objectives

Goals are 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.

The following are the mitigation goals for the 2022 Plan:

- **Goal 1:** Reduce loss of life, property damages, and economic impacts caused by hazard events.
- **Goal 2:** Improve capabilities to reduce disaster losses.
- **Goal 3:** Increase public awareness and engagement of potential hazard impacts.

Objectives define mid-term implementation approaches to attain the goals and are more specific and measurable. The planning team identified a number of objectives to help prioritize projects in support of the plan goals. The objectives are as follows:

- Goal 1: Reduce loss of life, property damages, and economic impacts caused by hazard events.
- Objective 1.1: Prevent Losses from Drought
 - 1.1.1. Promote Water Conservation
 - 1.1.2. Improve Water Supply
- Objective 1.2: Prevent Losses from Flooding



- 1.2.1. Promote Flood Insurance
- 1.2.2. Sponsor Site-Specific, Cost-Effective Mitigation Projects
- Objective 1.3: Prevent Losses from Tornadoes and Severe Windstorms
 - 1.3.1. Improve Public Warning
 - 1.3.2. Improve Public Awareness of Tornado and Wind Hazards
- Objective 1.4: Prevent Losses from Winter Storms
 - 1.4.1. Identify and Equip Shelters
- Objective 1.5: Prevent Losses from Other Hazards Identified in this Plan
 - 1.5.1. Develop Projects Focused on Preventing Loss of Life, Injuries, and Property Damage from Hazards
- Objective 1.6: Protect Critical Infrastructure and Lifelines from Hazards
 - 1.6.1. Develop Projects Focused on Mitigating Impacts to Critical Infrastructure
 - Goal 2: Improve capabilities to reduce disaster losses.
- Objective 2.1: NWS Storm Ready Certification
 - 2.1.1. Coordinate with NWS
 - 2.1.2. Identify Other Program Requirements/Equipment Needs
 - 2.1.3. Determine Benefits and Costs of Program Participation
- Objective 2.2: Continue Local Flood Protection Programs
 - 2.2.1. Maintain NFIP participation
 - 2.2.2. Increase Public Awareness of Flood Hazard Areas and Potential Losses
 - 2.2.3. Promote Flood Insurance for Residents/Businesses in Flood Hazard areas
 - 2.2.4. Seek Improved Floodplain Mapping
- Objective 2.3: Strengthen Connections Between Hazard Mitigation Activities and Preparedness, Response, and Recovery Activities
 - 2.3.1. Disaster Plans
 - 2.3.1.1. Broomfield EOP
 - 2.3.1.2. Broomfield COOP
 - 2.3.2. Hazardous Materials and LEPC Plans
 - 2.3.2.1. Materials Transported through Broomfield
 - 2.3.2.2. Materials Stored in Broomfield



- 2.3.2.3. Materials Manufactured in Broomfield
- 2.3.3. Broomfield Comprehensive Plan
- Objective 2.4: Reduce Damage to and Maintain Functionality of Critical Facilities & Infrastructure
 - 2.4.1 Strengthen COOP and Capability to Deliver Essential Services
 - 2.4.2. Strengthen Local Recovery Planning
 - 2.4.3. Develop Projects and Protect Critical Assets in Natural Hazard Risk Areas
 - 2.4.4. Seek FMA, BRIC, and MAP Program Funds for Needed Plans and Projects
 - Goal 3: Increase public awareness and engagement of potential hazard impacts.
- Objective 3.1: Continue to Develop and Expand Public Awareness and Information Programs
 - 3.1.1. Utilize Range of Risk Communication Tools: Websites, Social Media, Newspapers, Newsletters, Utility Bills
 - 3.1.2. Support Established Programs and Provide Preparedness Resources (Tornado, Winter Storm, Lightning, Hail)
 - 3.1.3. Identify and Target Specific Areas at Risk to Natural and Human-Caused Hazards

5.1.1 Changes from 2016

To facilitate the goals update of this plan, during the second meeting, the HMPC members were provided a breakdown of the list of goals from the 2016 City and County of Broomfield Hazard Mitigation Plan. This review was conducted to ensure the plan’s mitigation strategy reflected current policies and priorities, updated risk assessment information, and was integrated with existing plans and policies. They were told that they could use, combine, or revise the statements provided or develop new ones, keeping the risk assessment in mind. The HMPC changed Goal 1 by removing the word “natural” to reflect the addition of technological hazards into this plan. The HMPC also recommended adding engagement to Goal 3 as the community could benefit from both awareness and engagement as it relates to hazards.

Finally, the HMPC decided to remove the 4th goal from the 2016 Plan, “Maintain FEMA eligibility for federal mitigation funding,” as this is less of a goal and more something that needs to be occurring not only with the HMP but with other Emergency Management plans and activities. Two new objectives were added (1.5 and 1.6), and a few other objectives were modified to better reflect current priorities.

5.2 Progress on Previous Mitigation Actions

The City and County of Broomfield has been successful in implementing actions identified in the 2016 Plan. The 2016 mitigation strategy contained eight mitigation actions; some of those actions covered multiple projects, which were broken out into separate actions to make them easier to track resulting in 14 actions in all. Of those 14 actions, seven have been completed and one action was deleted for no longer being a high priority for the County. These completed and deleted actions are shown in Table 5-1.

Table 5-1 2016 Mitigation Actions Completed or Deleted

#	Mitigation Action Title	Hazard	Notes
1a	Dredging Ellie’s Pond	Flood	Completed; Created additional open water area that had been compromised by years of cattail encroachment. Restoring the open water area provides more of the intended detention/flood control benefit and encourages waterfowl to visit the pond. Sedimentation in the pond will be monitored such that when open water becomes



#	Mitigation Action Title	Hazard	Notes
			significantly compromised additional dredging will be budgeted.
1b	City Park Channel Improvements (Lower Reach)	Flood	Completed; removed travel lanes on a major arterial/highway (US 287) from the 1% annual chance floodplain. While Broomfield and the traveling public on W 120 th benefit from this work, these improvements lie in Westminster's jurisdiction. Westminster has added the maintenance of this newly constructed channel segment to the MHFD work request for monitoring and any necessary future work.
2b	Water Treatment Plant Expansion	Flood	Completed; Expansion of Treatment Plant has been completed.
3	All-Hazards Preparedness Guide - Citizen Version	All Hazards	Completed; The Citizen Preparedness Guide was developed in 2018. Copies are available upon request and distributed at community events.
4	All-Hazards Preparedness Guide - Business Version	All Hazards	Completed; The Business Preparedness Guide was developed soon after the 2016 HMP and was completed. Since then, more revisions could be done to update the document. More printouts are needed as well for distribution.
5	Lightning Safety and Awareness	Lightning	Deleted; The item is not a high priority moving forward and no future action is planned. The City and County of Broomfield has one site with lightning detection and one mobile lightning detection unit. No more systems are needed at this time.
6	Research Benefits-Costs of Participation in NWS StormReady Program	All Hazards	Completed; Research was done and resulted in no action being taken. New Emergency Management staff may conduct more research in the future to reassess
7	Linking Mitigation to the Comprehensive Land Use Plan	All Hazards	Completed; The 2016 update to the Comprehensive Plan includes the reference to the HMP, but there is not a stand-alone Hazard Mitigation element. Can consider that stand-alone Hazard Mitigation Element in future amendment.

The remaining six actions have been carried over into the 2022 Plan; four of those were reported as being in progress and another two are being implemented on an annual basis. Details in these projects can be found in Table 5-2.

5.2.1 Continued Compliance with NFIP

Recognizing the importance of the NFIP in mitigating flood losses, an emphasis will be placed on continued compliance with the NFIP. As an NFIP participant, the County has 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.

5.3 Identification and Prioritization of Mitigation Actions

In order to identify and select mitigation measures to support the mitigation goals, each hazard identified in Section 4.1: Hazard Identification was evaluated in regard to the various options for mitigation. Hazards that pose the highest threat to the community were considered the highest priority in the development of hazard specific mitigation measures.

The HMPC considered the following categories of mitigation actions, as defined in FEMA's 2013 Local Mitigation Planning Handbook:

- **Plans and regulations:** These actions include government authorities, policies, or codes that influence the way land and buildings are developed and built.
- **Structure and infrastructure projects:** These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could

apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.

- **Natural systems protection:** These are actions that minimize damage and losses and also preserve or restore the functions of natural systems.
- **Education and awareness:** These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

The HMPC also considered the following categories as defined in the CRS:

- **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.

Additional information on projects considered under each of the above categories can be found in Appendix E.

At planning meeting #3, the HMPC was provided with handouts describing the categories and listing examples of potential mitigation actions for each category, as well as for the identified hazards. FEMA's 2013 document *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* was referenced and made available for reference, along with FEMA's 2020 *Mitigation Action Portfolio*. Attendees were then asked to submit mitigation action ideas via an online poll. Action submissions included details describing how the actions will be implemented and administered, to include cost estimates, potential funding sources, and estimated timeline for completion. Each action was required to be tied to one or more of the goals and objectives.

Actions were compared against identified hazards to ensure that the plan contains a comprehensive range of mitigation actions and projects for each of the highest risk hazards. An emphasis on new and existing buildings and infrastructure was stressed. While the HMPC focused primarily on those hazards identified as posing the highest risk to the jurisdiction, mitigation actions were also suggested for some low priority hazards.

While the primary focus was on developing mitigation actions in the categories described above, some actions were proposed that do not fall into one of the above categories and which may be better defined as planning or preparedness actions. Some of these actions were nonetheless included in the plan, as the jurisdiction felt they were important actions to reduce losses from future disasters even if they do not meet the strict definition of mitigation.

5.3.1 Prioritization Process

Once the new mitigation actions were identified, 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).

- **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 the action protect lives?
- Does the action address hazards or areas with the highest risk?
- Does the action protect critical facilities, infrastructure, or community assets?
- Does the action meet multiple objectives (Multiple Objective Management)?

The above criteria were used to prioritize actions in an iterative process over the course of the plan update process. At the start of the process, participants were asked to validate or update the priorities of their continuing actions from the 2016 Plan. When submitting new mitigation actions, HMPC members were asked to prioritize those as well.

5.3.2 Mitigation Funding Sources

The Colorado DHSEM Mitigation Team is the primary state entity responsible for coordinating and facilitating technical assistance for local hazard mitigation planning. The mission of the Mitigation Team is to promote community resiliency and sustainability for the people of Colorado by fostering partnerships and maximizing the availability of mitigation and recovery resources.

Federal Programs

Federal mitigation programs serve as critical funding sources to reduce the risk of natural hazards to Colorado's people, property, environment, and economy. Colorado and its mitigation partners attempt to maximize the application of federal funding from FEMA, USDA, USACE, HUD, SBA, and other agencies each year. Mitigation money from FEMA supports several mitigation projects each year. The state will continue to apply for mitigation grants through the HMA Program, specifically its FMA and BRIC grants as the availability of funds is announced. Additionally, applying for FEMA's Rehabilitation of HHPD Grant Program will be considered where possible.

Education projects, outreach programs, repeater sites, early detection and warning/notification systems, generators for backup power, and chippers for slash and mulch projects are very popular in Colorado. Local communities are constantly seeking sources of funding to maintain programs and install or upgrade systems. Unfortunately, funds for these types of projects are limited and the need strongly outweighs the availability. Even if communities get startup funds, continuation of programs creates new financial needs on already very tight budgets with competing demands. In spite of this, Colorado communities have made great strides and progress in prevention and preparedness activities and continue to do more each year by taking advantage of limited opportunities.

State Programs

The state has loan and grant programs for which mitigation activities are eligible. Funding sources traditionally used have been energy impact funds, gaming funds, general funds, and severance tax. Many state agencies have grant programs, including, but not limited to, DHSEM, DOLA, CSFS, CDNR and the State Conservation Service.

State agencies continually work to identify new strategies for implementing mitigation projects, including new funding sources. The Mitigation Team works with local communities to expand the number of FEMA HMA programs for which communities are eligible to qualify.

5.4 Mitigation Action Plan

This section outlines the development of the final 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.

The 2022 City and County of Broomfield mitigation action plan lists the actions developed and prioritized as described above. As noted above, 14 mitigation actions were included in the 2016 Plan. Of those, seven were reported as having been completed and one was determined to be no longer relevant and was deleted. (See Table 5-1.) The remaining six actions were carried over into the 2016 Plan, along with 13 new actions.

The action plan details how the County will reduce the vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. The action plan summarizes who is responsible for implementing each of the prioritized actions as well as when and how the actions will be implemented. All actions are tied to specific goals to ensure alignment with the Plan's overall mitigation strategy. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals.

Many of these mitigation actions are intended to reduce impacts to existing development. In addition, actions are identified to reduce impacts to future development. 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.

Projects were tied to specific infrastructure Lifeline categories where appropriate, to better align with the latest FEMA guidance and grant requirements. Actions that protect critical infrastructure note which lifeline category is protected using the following abbreviations:

- COM: Communications
- ENG: Energy
- FWS: Food, Water, Sheltering
- HAZ: Hazardous Waste
- H&M: Health & Medical
- S&S: Safety & Security
- TRN: Transportation
- NI: None Identified

The City and County of Broomfield's mitigation actions are listed in Table 5-2, which includes information on the mitigation actions, lead and supporting agencies, estimated cost, potential funding sources, and estimated timeline.

The parameters for the timeline are as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

The estimated cost ranges were as follows:

- Low = less than \$10,000
- Medium = more than \$10,000 and less than \$100,000
- High = more than \$100,000

The status of the actions are reported as follows:

- Not Started - Work has not begun
- In Progress - Work has begun but not completed
- Annual Implementation - Ongoing with no specific end date
- New in 2022 - New action developed for this plan update

Table 5-3 lists a crosswalk of mitigation actions against the hazards they address.

Table 5-2 City and County of Broomfield Mitigation Action Plan

#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
1	Continuing Participation in the NFIP. In coordination with the Mile High Flood District, continue to participate in the National Flood Insurance Program by implementing and improving upon effective floodplain and stormwater management practices. Participation in the NFIP enables Broomfield residents to purchase flood insurance policies at reduced rates. With population projected to grow at an annual average rate at 2.4% over the next 15 years, continued strict enforcement of floodplain and stormwater regulations will be necessary to offset potential impacts of/to new development.	Dam Inundation, Flood	1, 2, 3; NI	Community Development Department; Engineering Division	Within existing budget. Cost-sharing for future flood control construction projects potentially available from CIP, MHFD, FEMA (HMA), State of Colorado (CWCB)	Ongoing	High	Annual Implementation. All work in a floodplain or floodway requires a Floodplain Permit which is reviewed/approved by the Engineering Division. Where work is in the floodway a no-rise certification or Conditional Letter of Map Revision (CLOMR) is required. Broomfield adopts new FIRM maps through an ordinance update. Broomfield regulates work in the floodplains using the most current FIRM maps, recent CLOMRs and LOMRs and the National Flood Hazard Layer (NFHL).
2	Nissen Reservoir Channel Improvements. Broomfield has CIP funds budgeted for channel improvements along Nissen Channel from upstream of Perry Street to Lowell Blvd. Improvements will reduce flood impacts to existing businesses.	Flood	1; FWS	Community Development Department; Engineering Division	\$1.6M; 50% CIP budget, and 50% from MHFD	Ongoing	High	In Progress. Broomfield is contributing matching funds with the Mile High Flood District (MHFD) for improvements on Nissen Channel (including an improved crossing at Perry Street). Broomfield continues to work with MHFD for solutions and creek improvements on City Park Channel at Midway Park.
3	Promotion of Water Resource Development and Conservation Measures. Coordinate with local water providers to continually identify and promote water conservation measures	Drought, Extreme Temps	2, 3; FWS	Department of Public Works; Water Supplies Division	N/A Variable depending on conditions. Individual conservation efforts	Ongoing	Medium	Annual Implementation. Introduced Garden in a Box program to residents in partnership with Resource Central.



#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
	including, but not limited to, incentive programs, water-efficient appliances, xeriscaping and the use of recycled water where feasible. Monitor proceedings of the Colorado WATF to help anticipate water issues and, when necessary, support water providers in the implementation of conservation measures. As the population of Broomfield increases, a correspondingly higher vulnerability to drought and its impacts can be expected. Water supply planners must also be cognizant of the effects of climate change on the frequency and severity of future droughts.				distribute costs. CIP, Public-Private Partnerships			Broomfield's Graywater Ordinance was passed by City Council on September 14th, 2021. Broomfield was also selected as a partner community in a non-essential turf replacement pilot project led by Western Resource Advocates. The project will help identify the costs and benefits of a large-scale turf replacement program.
4	Windy Gap Firing Project. This project is a multi-agency cooperative effort and will result in the construction of a 90,000-acre-foot reservoir in Larimer County, Colorado. Engineering design will start in 2016 and construction will begin as early as 2021. Broomfield is planning to own approximately 29% of the storage volume and Broomfield's proportional share of the project is approximately \$177 million.	Drought, Extreme Temps	1, 2; FWS	Public Works	\$177 Million. CIP - Water Fund	2021-2025	High	In Progress. Construction plans have been approved and construction is scheduled to commence in 2021.
5	Siena Reservoir pump station and pipeline. This project will help meet peak summer demands. Engineering design is planned to start in 2021 and will be constructed in 2022.	Drought, Extreme Temps	1, 2; FWS	CIP, Public Works	\$8.5 million. CIP	2021-2025	Medium	In Progress. Preliminary Design Report is in progress.
6	Integrating Mitigation with Other Plans and Programs. Ideally, identified mitigation actions should be implemented through existing plans and policies, which already have support from the community and policy makers. The incorporation of elements of this plan into existing planning mechanisms	Active Threat, Aircraft Accident, Critical Infrastructure Outage, Cyber Attack, Dam Inundation, Drought,	2, 3; NI	Emergency Management; in cooperation with all departments, partners and stakeholders	No or low-cost. Staff time/costs are within existing budgets	Ongoing	High	In Progress. Emergency Management has been involved in plan development and revision processes to ensure mitigation principles are incorporated. The 2020



#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
	requires coordination between Emergency Management and the staff of each department responsible for implementing specific mitigation actions. Mitigation is most successful when it is incorporated within the day-to-day operations of public works, community development, public health and other mainstream functions of local government. Multi-objective projects that mutually benefit partners and stakeholders are usually more cost-effective and more-broadly supported. Many other local plans present opportunities to address hazard mitigation in a way that can support multiple community objectives. The Hazard Assessment provides data, analysis, and maps that can be integrated into other plans to inform policies and decision making.	Earthquake, Expansive Soils, Extreme Temps, Fire, Flood, Hail, Hazardous Materials, Land Subsidence, Lightning, Public Health, Severe Wind, Tornado, Winter Storm						Comprehensive Plan references the HMP.
7	Hazard Mapping Address Search Tool. Tool for residents to search business/home and see all hazards that could impact that address.	Aircraft Accident, Critical Infrastructure Outage, Dam Inundation, Earthquake, Expansive Soils, Fire, Flood, Hazardous Materials, Land Subsidence	3; NI	IT/GIS, Emergency Management	<\$5,000 in staff time; internal	Mid-2022	High	New in 2022
8	Improve At Risk Populations Awareness. Information Technology Security (ITSec) will work with law enforcement during October (Cybersecurity month) to improve "at risk" citizens awareness of cyber attacks. Itsec will create a presentation, present and answer questions, and provide support.	Cyber Attack	3; COM	Itsec/cyber security/ Investigation BPD	<\$5,000 in staff time; internal	October 2022	High	New in 2022



#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
9	Evacuation route signage for subdivisions impacted by oil & gas development. Install signage on streets in those subdivisions within 1, 2 miles of oil & gas development directing evacuation routes	Hazardous Materials	1, 3; S&S	Broomfield Streets, Adams County Street & Bridge	< \$10,000; CIP budget, HMA Grants, DOT Grants	2022	High	New in 2022
10	Public hazards workshop. Create a public hazards workshop for residents that highlight hazards that are relevant to the Broomfield area	Hail, Fire, Flood, Tornado, Severe Wind, Extreme Temps, Drought	3; NI	Emergency Management	< \$5,000; internal budget, EMPG	2023	Medium	New in 2022
11	Tree planting initiative. Incentives for residents, businesses to plant high yielding shade trees to be more equitable in our green infrastructure.	Extreme Temps	1, 2, 3; PWR	Parks, Recreation, and Senior Services	\$50,000; EPA	2022-2024	Medium	New in 2022
12	Restoration for resistance & resiliency in open space. A project looking at how ecological restoration on open space, both native vegetation/habitat and Ag, can create resilience from natural hazard impacts in the face of climate change. Native landscapes & Ag properties can sequester carbon and protect against urban heat island effect, and groundwater recharge (drought) and wildfire risk (frequent, low intensity). Eliminate fire prone invasives.	Drought, Extreme Temps, Fire, Winter Storm	1,2; NI	Open Space & Trails, Parks Services	Variable, using volunteer and staff efforts across Broomfield open space properties. Minimal cost for small project is \$5,000; internal budget	2022-2027	Medium	New in 2022
13	City Park channel flood reduction. Highest concentration of single family residence properties in the floodplain. 1 - reduce risk. 2 - reduce insurance cost. 3 - improve utilities/ infrastructure. (a. Construct storm sewer in 3rd Ave.)	Flood	1; H&M, S&S, TRN	Engineering; CIP, Public Works, Finance, MHFD	\$3+ Million; MHFD maintenance funds	2024	Medium	New in 2022



#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
14	Safe Room/Shelters. Identify areas within the community as shelters for weather hazards. Also identify safe areas in the community for active threats (human-caused) Could also be used as alternative care site (pandemic).	Active Threat, Aircraft Accident, Critical Infrastructure Outage, Dam Inundation, Earthquake, Fire, Flood, Hail, Hazardous Materials, Lightning, Public Health, Severe Wind, Tornado, Winter Storm	1; S&S	PD; NMFR, Emergency Management, Building Department	\$5,000 of staff time and signage for any existing sites; internal budget	2023	Medium	New in 2022
15	Annual FEMA preparedness month campaign. Engage residents in educational campaign during FEMA's preparedness month (September) to educate and incentivize preparedness as well as mitigation activities.	Active Threat, Aircraft Accident, Critical Infrastructure Outage, Cyber Attack, Dam Inundation, Drought, Earthquake, Expansive Soils, Extreme Temps, Fire, Flood, Hail, Hazardous Materials, Land Subsidence, Lightning, Public Health, Severe Wind, Tornado, Winter Storm	3; NI	Emergency Management	\$10,000 in print outs, staff hours, give away items; Internal budget	Annual starting in 2022	Low	New in 2022
16	Mapping of expansive soils and slide prone areas. Data showing areas of permits issued for high prone expansive soils areas. Need data showing slide prone areas and what type of soils are in these areas. Determine these areas, instigate better efforts for construction and determining potential soils for slide	Expansive Soils, Land Subsidence	1, 2; S&S, H&M	Building Division - Engineering Division	TBD; internal budget, HMA Grants	TBD	Low	New in 2022



#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
	control. Using data from building permits to see potential areas of expansive soils.							
17	Replacement of Great Western Reservoir Outlet Works. The outlet pipe, which extends from the upstream face of the dam, through the embankment, and downstream, was originally constructed in 1966. It is a 24-inch ID steel pipe installed in 40-foot segments. The outlet pipe has shifted and required various repairs over the last 30 years, including the installation of Weko seals to maintain pipe integrity at the joints. Several of these Weko seals have shifted and bulged in the last 15 years, indicating the pipe has continued to shift. Furthermore, it is no longer standard practice to extend the outlet works through the central portion of the dam embankment. It is the opinion of the City’s engineering consultants that the outlet pipe will require more significant repair or replacement within 10 to 20 years.	Dam Inundation	1, 2; FW, HAZ, S&S	Broomfield Public Works Department	\$8.5M; CIP budget	10-20 years	Medium	New in 2022
18	Replacement of Great Western Reservoir Toe Drain System. The toe drain system at Great Western Dam was constructed in 1966 and consists of 6-inch diameter corrugated metal pipes (CMP) that extend under the original toe of the dam embankment, for a length of about 1500 feet, encased in an angled blanket/chimney drain layer. When the toe berm was constructed at Great Western Dam in 2003, the existing toe drain system was left in place and connected into a new manhole and downstream outlet pipe. At the time of that construction, the CMP toe drainpipes were in	Dam Inundation	1 2; FW, HAZ, S&S	Broomfield Public Works Department	\$8.3M; CIP budget	2024-2026	High	New in 2022



#	Title and Description	Hazards	Goals & Lifelines	Lead Agency & Partners	Cost Estimate & Potential Funding	Timeline	Priority	Status & Implementation Notes
	questionable condition, but the decision was made to leave the pipes in place. The toe drainpipes are now over 50 years old and appear to be past the end of their design life. The blanket drain consists of large gravel, cobbles and boulders, and is not filter compatible with the dam embankment or the drainpipe system. Additionally, there is visible buildup in the downstream end of both drains where they enter the collection manhole which has restricted flow through the toe drainpipes, manhole, and outfall pipe. Due to the significant mineral buildup in the toe drainpipes, the significant age and deterioration of the toe drainpipes, the pipe collapse of the south toe drain, and the filter incompatibility of the blanket drain system to the earthen embankment and the toe drainpipes, the City's engineering consultant recommends that significant efforts be undertaken by Broomfield to address deficiencies in the toe drain system at Great Western Dam.							
19	Explore feasibility of burying power lines. Work with Excel to determine how practical it would be to bury power lines in and around the City to reduce the risk of downed power lines resulting in power outages and potentially starting wildfires.	Infrastructure Outage, Fire, Severe Wind, Tornado, Winter Storm	1 2; ENG	Broomfield Public Works Department	TBD; HMA grants, public-private partnership	2023-2025	Low	New in 2022



Table 5-3 Mitigation Actions by Hazard Addressed

Action #	Active Threat	Aircraft Incident	Critical Infrastructure Outage	Cyber Attack	Dam Inundation	Drought	Earthquake	Expansive Soils	Extreme Temperatures	Fire	Flood	Hail	Haz Mat Incident	Land Subsidence	Lightning	Public Health Hazard	Severe Wind	Tornado	Winter Storm
1					X						X								
2											X								
3						X			X										
4						X			X										
5						X			X										
6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8				X															
9													X						
10						X			X	X	X	X					X	X	
11									X										
12						X			X	X									X
13											X								
14	X	X	X		X		X			X	X	X	X		X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16								X						X					
17					X														
18					X														
19			X							X							X	X	X

6 Plan Implementation and Maintenance

DMA Requirement §201.6(c)(4)(ii):

[The plan shall include] a plan maintenance process that includes:

A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

A process by which local governments incorporate the requirements of the mitigation plan into other planning 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.

Discussion on how the community will continue public participation in the plan maintenance process.

6.1 Implementation

Once adopted, the plan faces the truest test of its worth: implementation. While this plan contains many worthwhile actions, the County 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 5-2 in Chapter 5 Mitigation Strategy, and through pervasive efforts to network and highlight the multi-objective, win-win benefits of each project to the community and its stakeholders. These efforts include the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable 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 through the routine actions of monitoring agendas, as well as attending meetings, and promoting a safe, sustainable community. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities.

Simultaneously to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the costlier 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; this will help ensure the County is in a position to capitalize on the opportunity when funding becomes available. 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.

6.1.1 Implementation and Maintenance of the 2016 Plan

As detailed in Section 5.2, the County has made considerable progress on the implementation of the plan, and on decreasing the County's vulnerability to hazards. While the HMPC did not meet formally during the past five years, there were a number of conversations and meetings with individual departments to gather status information on projects.

The status of mitigation actions and success stories are captured in Chapter 5.

6.1.2 Role of the HMPC in Implementation and Maintenance

With adoption of this plan, City staff will be tasked with plan implementation and maintenance. This will be accomplished by keeping the HMPC active throughout the lifecycle of the plan. The HMPC will:

- 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 City Council and other partners, and
- Inform and solicit input from the public.
- Coordinating 5-year cycle updates of this HMP.

Other duties include reviewing and promoting mitigation proposals, providing technical assistance in implementing mitigation codes and ordinances, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the County website, in the local newspaper, and on social media.

6.2 Plan Maintenance

The City and County of Broomfield Hazard Mitigation Plan is a living document that may be adjusted or updated as conditions change, actions progress, or new information becomes available. This section describes the method and schedule the County will follow for monitoring, evaluating, and updating the Plan over the next five years.

Plan maintenance involves an ongoing effort to monitor and evaluate the implementation of identified action items in the plan, and to update the plan as progress, opportunities, obstacles, or changing circumstances are encountered.

6.2.1 Monitoring

Monitoring refers to tracking the implementation of the plan over time. Broomfield Emergency Management will be responsible for reaching out to lead and supporting agencies identified in the mitigation actions table for status on those mitigation actions. Emergency Management will also coordinate with HMPC members annually every spring to identify and track any significant changes in their agencies' mitigation efforts.

Broomfield Emergency Management will use the following process to track progress, note changes in vulnerabilities, and consider changes in priorities as a result of project implementation:

- A representative from the responsible entity identified in each mitigation action will be responsible for tracking and reporting to the HMPC when project status changes. The representative will provide input on whether the project as implemented meets the defined goals and objectives and is likely to be successful in reducing vulnerabilities.
- If the project does not meet identified goals and objectives, the HMPC may select alternative projects for implementation.
- Projects that were not ranked high priority but were identified as potential mitigation strategies will be reviewed periodically to determine feasibility of future implementation.
- New mitigation projects identified will require an individual assigned to be responsible for defining the project scope, implementing the project, and monitoring the success of the project.
- Mitigation activities not identified as actions in this plan will also be tracked to ensure a comprehensive hazard mitigation program, and to assist with future updates.

A sample meeting agenda and progress report are included as Appendix H.

6.2.2 Evaluation

Evaluating refers to assessing the effectiveness of the plan at achieving its stated purpose and goals. Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan, such as:



- Decreased vulnerability because of implementing recommended actions,
- Increased vulnerability because of failed or ineffective mitigation actions, and/or
- Increased vulnerability because of new development (and/or annexation).

The HMP will meet annually to evaluate the implementation of the plan and consider any changes in priorities that may be warranted. Broomfield EM will coordinate with all participating agencies to facilitate an effective maintenance and implementation process. Completed projects will be evaluated to determine how they have reduced vulnerability. 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.

6.2.3 Updates

The Broomfield Hazard Mitigation Plan will be reviewed and revised at least once every five years in accordance with the DMA 2000 requirements and latest FEMA and Colorado DHSEM hazard mitigation planning guidance. Updates to this plan will consider:

- Has the nature or magnitude of hazards affecting the County changed?
- Are there new hazards that have the potential to impact the County?
- Have growth and development changed the County's vulnerabilities?
- Do the identified goals and actions still address current and expected conditions?
- Have mitigation actions been implemented or completed?
- Has the implementation of identified mitigation actions resulted in expected outcomes?
- Are current resources adequate to implement the plan?
- Should additional local resources be committed to address identified hazards?
- The updated plan will document success stories where mitigation efforts have proven effective, as well as areas where mitigation actions were not effective, and will include re-adoption by all participating entities following Colorado DHSEM/FEMA approval.

6.3 Incorporation into Other Planning Mechanisms

Another important implementation mechanism that is highly effective and low-cost is the incorporation of hazard data and mitigation plan principles and recommendations into other plans and mechanisms. Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. The mitigation plan can be considered as the hub of a wheel with spokes radiating out to other related planning mechanisms that will build from the information and recommendations contained herein. Properly implemented, the HMP should serve as one of the foundational documents of the County's emergency management program, since everything emergency management does should relate back in one way or another to the hazards the jurisdiction faces.

As stated in Section 6.1 above, implementation through existing plans and/or programs is recommended wherever possible. Based on this Plan's capability assessment and progress made on mitigation actions noted in Chapter 5, the County continues to implement policies and programs to reduce losses to life and property from natural and human-caused hazards. The HMPC will be responsible for integrating the data, goals and objectives, and other elements of this Plan into other plans, as appropriate.

The following sections provide some guidance on how the County may use the updated HMP to inform and improve other plans, procedures, and programs.

6.3.1 Comprehensive Plans

Integrating hazard mitigation into the jurisdiction's comprehensive or general plan is considered a best practice by both FEMA and the American Planning Association. The County's Comprehensive Plan was last updated in 2016 and includes mentions of flood and fire hazards as well as the HMP but does not address citywide hazards in a comprehensive manner. Broomfield EM will work with the County Planning Department to ensure that hazards data and mitigation goals and objectives inform the next Comprehensive Plan update.



6.3.2 Response Plans

The City and County of Broomfield EOP was last updated in 2013 and is currently under revision and being updated. While the EOP is an all hazards document, it also contains hazard specific information and concerns. The EOP should reference the HMP and the top natural hazards therein. Hazard information from this HMP update will be incorporated into the EOP as appropriate.

6.3.3 Continuity of Operations Plans (COOP)

The City and County of Broomfield maintains a COOP that details the County, and associated departments and agencies, critical functions and how they will protect those functions in order to continue to provide essential services during a disaster or interruption. By defining and describing the hazards facing the County, including frequency and severity, the HIRA informs the COOP plans by giving context to what types of disasters or interruptions are most likely to occur. Critical facilities and assets located in hazard areas in Section 4.2 should be prioritized for COOP planning.

6.3.4 Public Awareness and Education Programs

The County's ongoing public education and outreach efforts should reflect the hazards and vulnerabilities described in this Plan. In addition to preparing for disasters, public education should include ways in which the public can reduce their vulnerability to natural and human-caused hazards. Furthermore, mitigation activities and success stories should be communicated to the public to show the benefits of effective mitigation planning.

6.3.5 Capital Improvements Plan

Some of the mitigation actions listed in the Mitigation Strategy (Section 5.4) came from the County's Capital Improvements Plan, and thus have already been identified for funding. High-dollar actions listed or identified in the future can also be added to the Capital Improvements Plan to ensure that hazard mitigation projects continue to receive funding. The prioritization of actions listed in Table 5-2, while not binding on capital improvement planning, can be used to inform the prioritization of those actions. Even projects for which the County intends to seek grant funding may also need to be addressed in the Capital Improvements Plan, given that most mitigation grants require significant local matching funds.

6.4 Continued Public Involvement

Continued public involvement is also imperative to the overall success of the Plan's implementation. This updated HMP will be posted on the County's website for reference and can be used to help inform the County's ongoing public education and outreach program, such as the completion of mitigation actions that reduce the community's vulnerability, can be shared with the public through forums like public meetings, public preparedness, and resilience trainings, and through social media. Public comments on the plan can also be addressed to the Broomfield EM at any time at the contact information provided. This helps keep the concept of hazard mitigation alive and helps show the public that their government officials are working to keep them safe.

The update process provides an opportunity to publicize success stories from the Plan implementation and seek additional public comment. When the HMPC reconvenes for the five-year plan update, they will coordinate with all stakeholders participating in the planning process—including those that joined the committee since the planning process began—to update and revise the plan. The plan maintenance and update process will include continued public and stakeholder involvement and input through participation in designated committee meetings, surveys, web postings, and press releases to local media.

See Section 6.3.4 above for additional information on how mitigation will be incorporated into the County's public awareness and education programs.



Appendix A: Plan Adoption and Approval



BROOMFIELD CITY COUNCIL

To: Mayor and City Council
From: Jennifer Hoffman, City and County Manager
Prepared by: Clay Shuck, Director of Operations
Lenzi McGee, Emergency Preparedness and Response Coordinator

Meeting Date	December 13, 2022
Agenda Category	Consent Agenda
Agenda Item #	7(b)

Proposed Resolution No.2022-157 Adopting the City and County of Broomfield Hazardous Mitigation Plan Summary

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- Staff is requesting City Council approval of proposed Resolution No. 2022-157 adopting the final City and County of Broomfield [Hazardous Mitigation Plan \(HMP\)](#) approved by the Federal Emergency Management Agency (FEMA) and the Colorado Department of Public Safety, Office of Emergency Management.
- The purpose of the plan is to provide Broomfield officials and their public and private sector partners with a tool to guide policies and actions that can be implemented to reduce risk and future losses from natural and human-caused hazards.
- FEMA-approved mitigation plans are required for communities that wish to apply for both pre-disaster mitigation grants or, should there be a Presidential Disaster Declaration, post-disaster mitigation grants.
- The Federal Emergency Management Agency (FEMA) defines mitigation as "sustained action taken to reduce or eliminate long-term risk to people and their property from hazards." Local Hazard Mitigation Plans (HMP) form a foundation for communities who seek to reduce risks from hazards to people, property, and infrastructure.
- 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. HMPs assist communities in reducing risk from hazards by identifying resources, information, and strategies for risk reduction. This plan documents Broomfield's hazard mitigation planning process, identifies relevant hazards and risks, and outlines the strategies that will be used to decrease vulnerability and increase resilience and sustainability.
- The benefits of a local HMP include enhanced understanding of the risks that a community faces, an opportunity to align risk reduction efforts with other planning initiatives such as comprehensive plans, capital improvement plans, and Emergency Operations Plans (EOP).
- The 2022 update was guided by a planning team composed of a consultant for Woods and Associates along with members of the Broomfield Emergency Management Advisory Committee (BEMAC) who represent a wide variety of technical expertise and community interests, including public safety, public works, community development, emergency management, public health, floodplain management, and utilities services.
- This Broomfield-specific Hazard Mitigation Plan (HMP) has been approved by FEMA pending Council Adoption. The HMP meets the requirements of the Disaster Mitigation Act (DMA) of 2000, 44 CFR Part 201.6, and the most current FEMA "how-to" planning guide. In addition, the plan will be aligned with the 2018-2023 [State of Colorado HMP](#).
- This plan will be reviewed, approved, and adopted within a five-year cycle as per the Disaster Mitigation Act of 2000. The next version of this plan will need to be updated and re-approved by Colorado Division of Homeland Security and Emergency Management and FEMA Region VIII no later than December 2027.

Financial Considerations

Formal approval of this plan by FEMA assures that Broomfield will remain eligible for federal grant funding under FEMA's Hazard Mitigation Grant Program and Pre-Disaster Mitigation program.

Prior Council or Other Entity Actions

- Resolution No. 2004-118 Adopting the Denver Regional Hazard Mitigation Plan by Reference.
- [Resolution No. 2011-3](#) Adopting an Updated Regional Hazard Mitigation Plan.
- [Resolution No. 2016-59](#) Adopting the Broomfield Hazardous Mitigation Plan (HMP)
- Colorado Department of Public Safety, Office of Emergency Management Reviewed August 15, 2022 .
- Federal Emergency Management Agency (FEMA) Reviewed October 1, 2022

Boards & Commissions Prior Actions & Recommendations

- N/A



RESOLUTION NO. 2022-157

A RESOLUTION APPROVING A HAZARD MITIGATION PLAN FOR THE CITY
AND COUNTY OF BROOMFIELD

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY AND COUNTY OF
BROOMFIELD, COLORADO:

Section 1. That the Hazard Mitigation Plan attached hereto as Exhibit A and
made an integral part hereof is hereby approved.

Section 2. This resolution is effective upon its approval by the City Council

APPROVED on December 13, 2022.

THE CITY AND COUNTY OF BROOMFIELD,
COLORADO

Mayor

ATTEST:

Office of the City and County Clerk



APPROVED AS TO FORM:

NCR

City and County Attorney



U.S. Department of Homeland Security
Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267



FEMA

R8-MT

January 5, 2023

The Honorable Guyleen Castriotta
City and County of Broomfield
One DesCombes Drive
Broomfield, CO 80020

Dear Mayor Castriotta:

We are pleased to announce the approval of the City and County of Broomfield 2022 Hazard Mitigation Plan as meeting the requirements of the Stafford Act and Title 44 Code of Federal Regulations 201.6 for a local hazard mitigation plan.

The City and County of Broomfield is hereby eligible for FEMA Hazard Mitigation Assistance grant programs. All requests for funding will be evaluated individually according to the specific eligibility and other requirements of the particular programs under which the application is submitted. Approved mitigation plans may be eligible for points under the National Flood Insurance Program Community Rating System.

The plan is approved through January 4, 2028. A local jurisdiction must revise its plan and resubmit it for approval within five years to continue to be eligible for mitigation project grant funding. We have provided recommendations for the next plan update on the enclosed Plan Review Tool.

We wish to thank the jurisdictions for participating in the process and commend your continued commitment to mitigation planning. Please contact Mark Thompson, State Hazard Mitigation Officer, Colorado Division of Homeland Security and Emergency Management at markw.thompson@state.co.us or (720) 630-0770 with any questions on the plan approval or mitigation grant programs.

Sincerely,

**NICOLE M
AIMONE** Digitally signed by
NICOLE M AIMONE
Date: 2023.01.05
07:27:02 -0700

Nicole M. Aimone
Acting Mitigation Division Director

Enclosure

cc: Mark Thompson, State Hazard Mitigation Officer, Colorado Division of Homeland Security and Emergency Management

www.fema.gov



Appendix B: Hazard Mitigation Planning Committee



Appendix C: Planning Process Documentation



Appendix D: Public Input



Appendix E: Mitigation Alternatives



Appendix F: References



Appendix G: Acronyms and Definitions



Appendix H: Example Progress Meeting Agenda and Report