City of Lakewood

Climate Hazard and Social Vulnerability Study

April 2025

Extended Executive Summary

Image: Lakewood Civic Center. Source: City of Lakewood.

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Prepared for

City of Lakewood

Lakewood
Sustainability
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Introduction

The city of Lakewood, Colorado, is an incorporated home-rule municipality and a suburban community of 156,000 people. It is situated southwest of Denver and adjacent to the foothills of the Rocky Mountains. Lakewood is already experiencing significant impacts from climate change, including increasing drought, temperature extremes, flooding, wildfires and extreme weather events. Projections indicate these trends will intensify in the coming decades, with disproportionate effects on the city's populations experiencing the most social vulnerabilities. These shifts in climate will affect people's homes, health, and way of life, making it more important than ever to prepare for the challenges ahead. This Climate Hazard and Social Vulnerability Study builds upon the Jefferson County Hazard Mitigation Plan to further evaluate the risks climate hazards pose to people, infrastructure, and the economy, while identifying potential adaptation actions to enhance the city's resilience.

Image: Aerial view of the city of Lakewood, Colorado. Source: Adobe Stock under SSG's license.

A Changing Climate

Lakewood's climate is expected to become hotter, drier in summer, and more unpredictable over the coming decades. Rising temperatures will likely lead to more frequent and intense heat waves, making extreme heat a growing concern. Winters are projected to be milder overall, but occasional severe cold snaps may still occur due to shifting atmospheric patterns. Precipitation patterns are expected to change, with slightly more annual rainfall, particularly in the spring, but also more dry days throughout the year. These longer dry periods, combined with rising temperatures, could contribute to more frequent droughts and an increased risk of wildfires.

To better understand how these climate changes will affect the city, this study conducted a Climate Vulnerability and Risk Assessment, which evaluated risk based on three key factors: how likely a hazard is to occur, how vulnerable the community is to that hazard, and what the consequences would be if it happens. Ten hazards were evaluated in the process: hailstorms, extreme heat, extreme cold, flooding, wildfires, high winds and tornados, drought, biodiversity change, lightning and winter storms. Through the assessment process, five priority hazards were identified based on their levels of risk: hailstorms, extreme heat, extreme cold, flooding and wildfires. While hailstorms are expected to remain similar to historical trends and extreme cold events may become less frequent, climate change is projected to worsen the impacts of extreme heat, flooding, and wildfires. These findings highlight the need for targeted adaptation measures to protect the community from a changing climate.

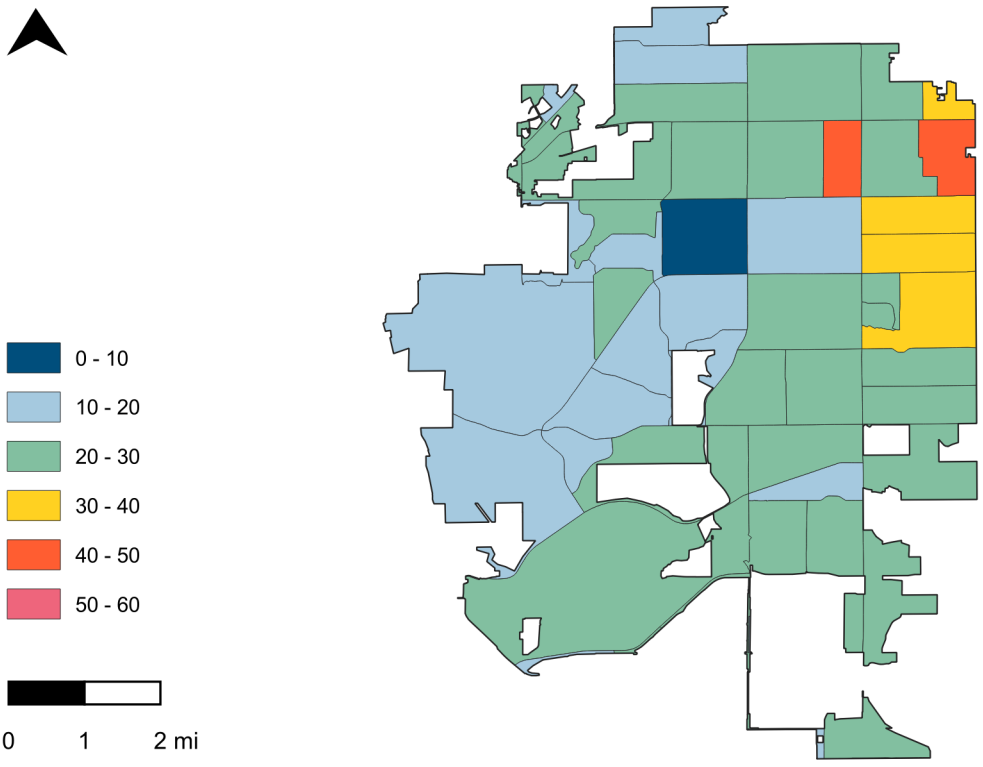
Image: Downed trees and traffic cuts due to heavy snowfall in Lakewood. Source: City of Lakewood.

Social Vulnerability

Social vulnerability was a key component of the study. The concept refers to the capacity of individuals or groups to anticipate, cope with and recover from hazards. Even though community members may experience the same physical hazards, those experiencing the most social vulnerabilities may be disproportionately impacted due to certain factors such as income, age, race, language and disability. The concept of social vulnerability emphasizes that certain groups — such as low-income households, aging adults, people with disabilities and marginalized racial groups — often face greater challenges in coping with and recovering from climate-related events.

To understand how climate change will impact residents experiencing higher levels of social vulnerability, the study incorporated an Equity Index developed by the Denver Regional Council of Governments (DRCOG). Based on 10 demographic indicators, the Index includes an equity score for each census tract in Lakewood, shown in **Figure 1**. In general, the eastern portion of the city has higher scores on the Equity Index, indicating higher levels of social vulnerability. This is due to economic and mobility challenges, as well the race and ethnicity of residents. Residents living on low incomes and facing cost burdens are particularly concentrated in the northeast corner of the city. This Equity Index was used throughout the study to inform the Climate Vulnerability and Risk Assessment.

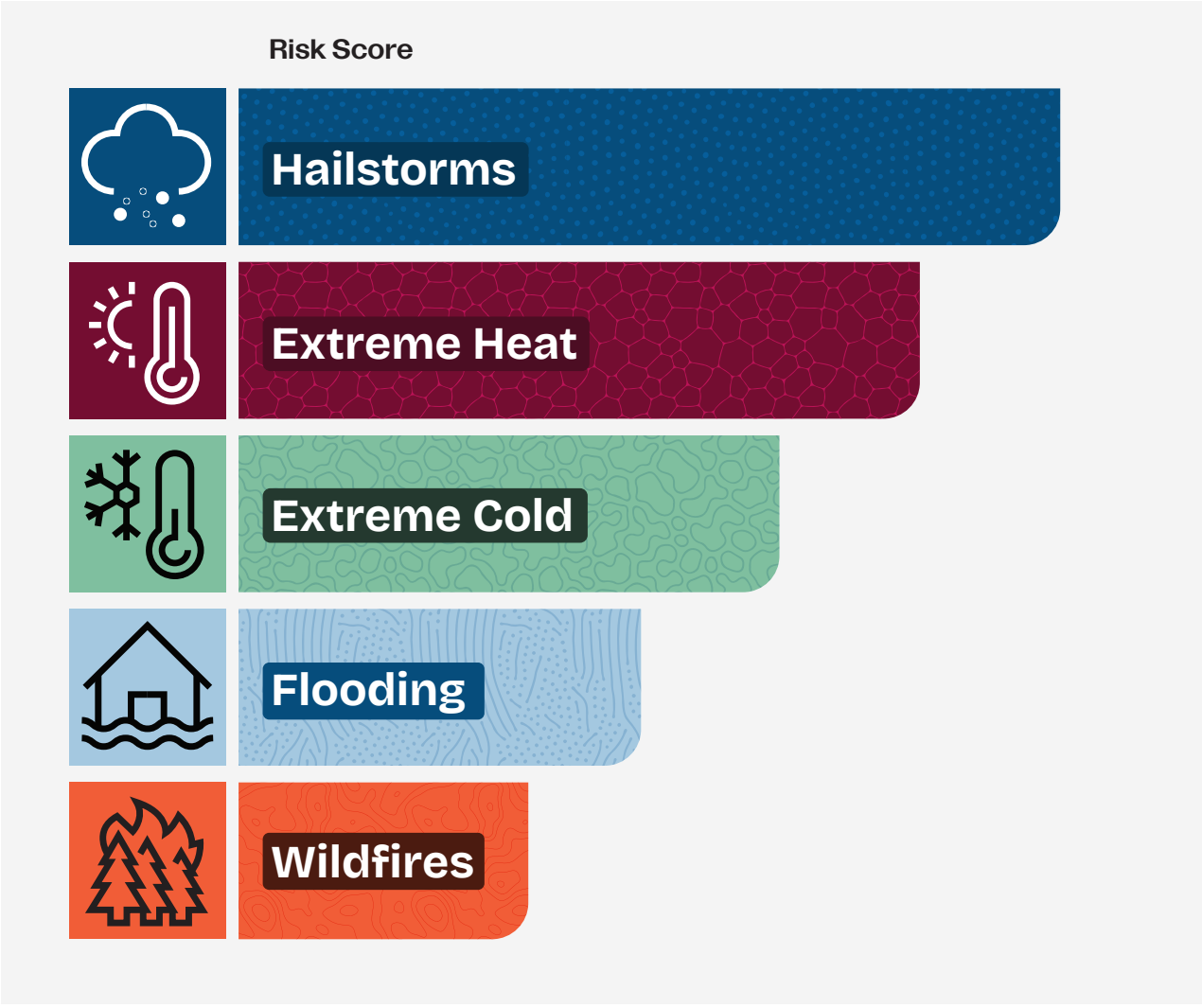
Figure 1. DRCOG Equity Index by census tract using ACS 2018-2022 data for the city of Lakewood.



Priority Hazards

Lakewood faces a range of climate-related hazards, but five have been identified as priority risks due to their likelihood, severity and potential impacts on people, infrastructure and the local environment. In order of their risk score, these top five hazards are hailstorms, extreme heat, extreme cold, flooding and wildfires. The following section highlights how each priority hazard is projected to change and who is most vulnerable, as well as the key adaptation actions.

Figure 2. Top five hazards for Lakewood based on risk score.



Climate-related hazard

Hailstorms

Hailstorms pose one of the most significant climate risks for Lakewood, and they have caused widespread property damage and rising insurance costs in recent years.

Some insurance providers have even reduced their presence in Colorado due to the increasing financial burden of severe hailstorms. However, projections for key climate indicators suggest that the frequency and severity of hailstorms are unlikely to increase significantly, though there is uncertainty in forecasting hailstorms, as complex interactions between several climate variables drive hail formation. While future storms may resemble historical events in intensity, the financial impact of hail damage could continue to rise due to expanding development and increasing repair costs.

Although hailstorms themselves may not worsen, many local systems remain highly vulnerable to their effects. Outdoor workers, residents without shelter, pedestrians, and cyclists face direct risks of injury, particularly during fast-moving storms. Homes without hail-resistant roofing, as well as farms, parks and recreational spaces, are also highly susceptible to damage. The aftermath of a severe hailstorm can disrupt local businesses, delay public services and strain emergency response resources. Given these risks, strengthening building resilience and increasing public awareness will be key strategies for reducing the impact of future hail events in Lakewood.

Potential adaptation actions related to hailstorms include:

- Provide building owners, homeowners and renters — especially in high-risk areas — with multilingual resources on how to strengthen their homes against extreme weather.
- Strengthen regional coordination on wildfire and extreme weather resilience and expand early warning systems for extreme weather events.
- Review and update municipal insurance policies to ensure city-owned assets and infrastructure are adequately covered for future climate risks.
- Establish an advisory service to help residents navigate insurance claims and understand financial recovery options.

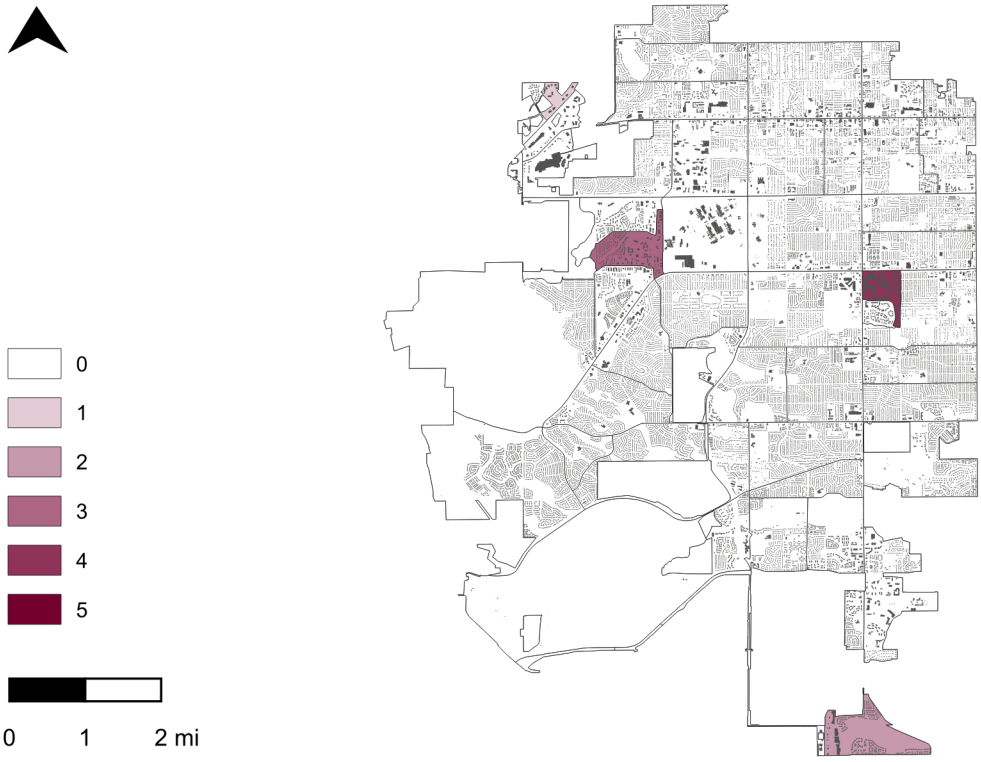
Climate-related hazard

Extreme Heat

Extreme heat is projected to become one of the most significant climate hazards for Lakewood, with longer, hotter summers and more frequent extreme heat days in the coming decades.

Rising nighttime temperatures will further intensify heat stress, particularly in areas most affected by the urban heat island effect, where paved surfaces and a lack of green space trap heat, making it harder for temperatures to cool down overnight. When nighttime cooling is limited, both people and infrastructure experience prolonged exposure to heat, increasing health risks and straining energy systems as air conditioning demand rises. **Figure 3** highlights heat risk priority areas based on a spatial analysis of the urban heat island effect and social vulnerability indicators.

Figure 3. Current heat risk priority areas.



Extreme heat events pose serious health risks, especially for older adults, young children, outdoor workers and individuals facing social isolation. Prolonged exposure to high temperatures can lead to heat exhaustion, heat stroke and other heat-related illnesses, which can become life threatening if not addressed quickly. People without access to air conditioning or stable housing face greater challenges, as they have limited ways to escape the heat. Extreme heat can also affect buildings and infrastructure, causing roofs and facades to crack, warp or curl, leading to costly damages to homes and businesses. With extreme heat becoming more frequent and intense, expanding cooling solutions, increasing urban tree cover and strengthening community support systems will be critical to protecting Lakewood's residents and infrastructure.

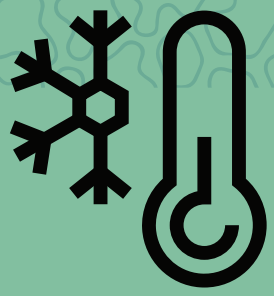
Potential adaptation actions related to extreme heat include:

- Develop a heat management plan for public spaces to ensure all city-hosted and permitted events provide adequate shade and cooling measures.
- Require a heat management plan for event organizers as part of the event application process.
- Set a minimum shading standard for public spaces by incorporating shade structures into city design guidelines.
- Expand emergency cooling zones by deploying temporary shade structures and promoting access to cooled indoor spaces.
- Build and expand splash pads in key locations using rainwater-fed and energy-efficient water features.
- Extend the season for water features by keeping splash pads and cooling facilities open longer.
- Expand community tree planting initiatives by adding shade trees along trails, sidewalks, creeks and outdoor sports fields.
- Set a tree canopy target to reduce the urban heat island effect.

Climate-related hazard

Extreme Cold

While extreme cold events are expected to become less frequent in Lakewood, they will still pose significant risks to vulnerable populations when they do occur.



Climate projections suggest a declining likelihood of extreme cold, along with lower wind speeds, which may reduce the impact of wind chill. However, the destabilization of the polar jet stream adds uncertainty to these trends. As the Arctic warms faster than other regions, the reduced temperature difference can weaken and disrupt the jet stream, leading to sudden, prolonged periods of extreme cold in mid-latitude areas like Lakewood.

Even as winters become milder overall, the potential for unexpected and intense cold snaps remains a concern. Certain groups, including outdoor workers, residents experiencing homelessness, children and older adults, are especially at risk when temperatures drop, particularly if they do not have access to adequate shelter. While most local buildings and infrastructure are designed to withstand cold conditions, severe cold events can still cause frozen and burst pipes, road hazards and increased demand on energy systems. Although Lakewood's winters are projected to warm over time, preparing for occasional extreme cold events remains essential to protecting public health, maintaining essential services and ensuring residents have access to safe and reliable heating when needed.

Potential adaptation actions related to extreme cold include:

- Adjust anti-idling policies during extreme weather to allow designated cooling or warming trucks for outdoor workers at job sites.
- Develop outdoor work recommendations for businesses to help reduce workers' exposure to extreme heat, cold and other hazardous conditions.
- Increase departmental funding for personal protective equipment (PPE) for extreme weather, including weather-resistant clothing, cooling vests and other protective gear.
- Create best practices for electric vehicle use during extreme weather by developing a user guide for city staff.
- Coordinate with non-profits to enhance snow removal services for older adults, individuals with disabilities and residents living on low incomes.

Climate-related hazard

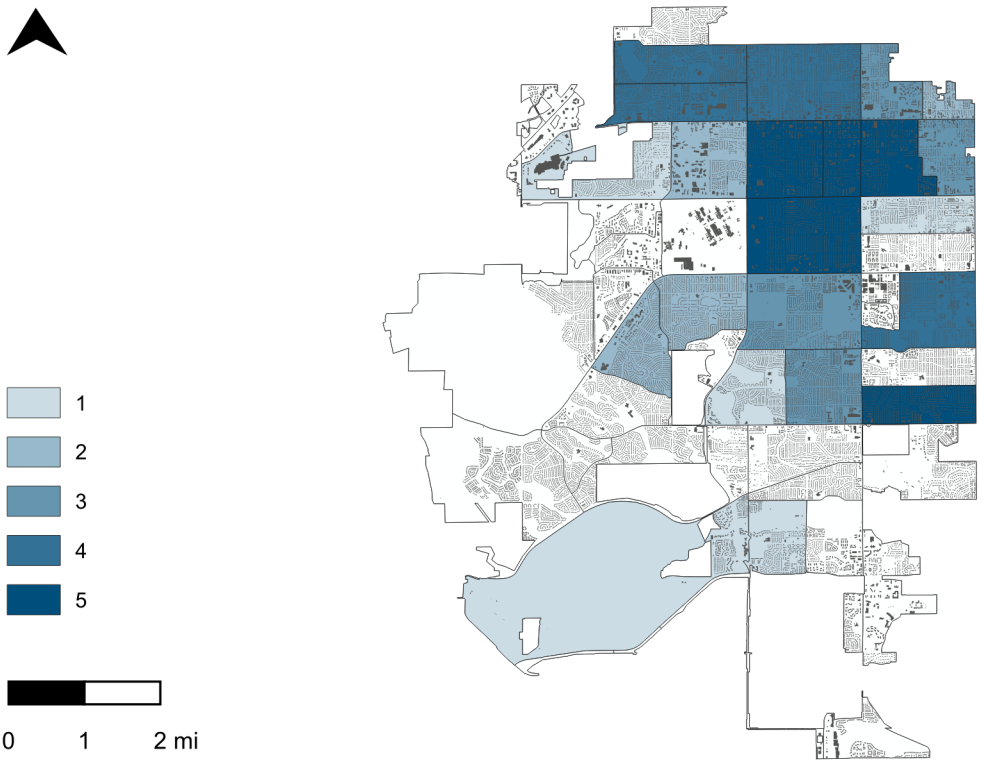
Flooding

Flooding is considered a moderate but growing risk for Lakewood, with climate change expected to bring slight increases in precipitation and runoff over the coming decades.

While overall annual precipitation is projected to rise slightly, spring rainfall is expected to increase more quickly than in other seasons. Additionally, the number of heavy rainfall days — when more than one inch of rain falls in a single day — is also projected to increase. This could lead to more frequent localized flooding, particularly in areas where stormwater drainage systems may struggle to keep up. Over time, annual runoff is expected to rise, which could place additional pressure on urban infrastructure, roads and waterways.

Certain populations are especially vulnerable to flooding, including residents with mobility challenges, individuals experiencing homelessness, outdoor workers, and residents experiencing social isolation, who may face greater challenges in evacuating or recovering from flood-related damage. Additionally, homes, businesses and critical infrastructure in flood-prone areas are at higher risk of water damage and disruption. Flood risks vary across Lakewood, with the northeastern part of the city facing higher potential risks from a rare flood event. **Figure 4** highlights flood risk priority areas based on a spatial analysis of potential flood impacts and social vulnerability indicators.

Figure 4. Current flood risk priority areas.



As flooding risks evolve, strengthening stormwater infrastructure, improving land-use planning and enhancing emergency preparedness efforts will be key to reducing future impacts on Lakewood's residents and infrastructure. The city is currently working on a project to reduce future flood risk called the North Dry Gulch improvement project. The purpose of the project is to update the city's storm sewer system in order to collect and convey a 100-year storm, effectively removing the floodplain from Dover Street to Newland Street. This project is expected to remove 19 residential and 67 commercial properties from the floodplain by 2070, saving approximately $20 million.

Potential adaptation actions related to flooding include:

- Offer rebate programs for flood- and fire-proofing upgrades to help homeowners make critical safety improvements in high-risk areas.
- Complete and implement a Culvert Replacement Study to identify and prioritize high-risk culvert replacements.
- Assess and improve high-risk roads prone to flooding.

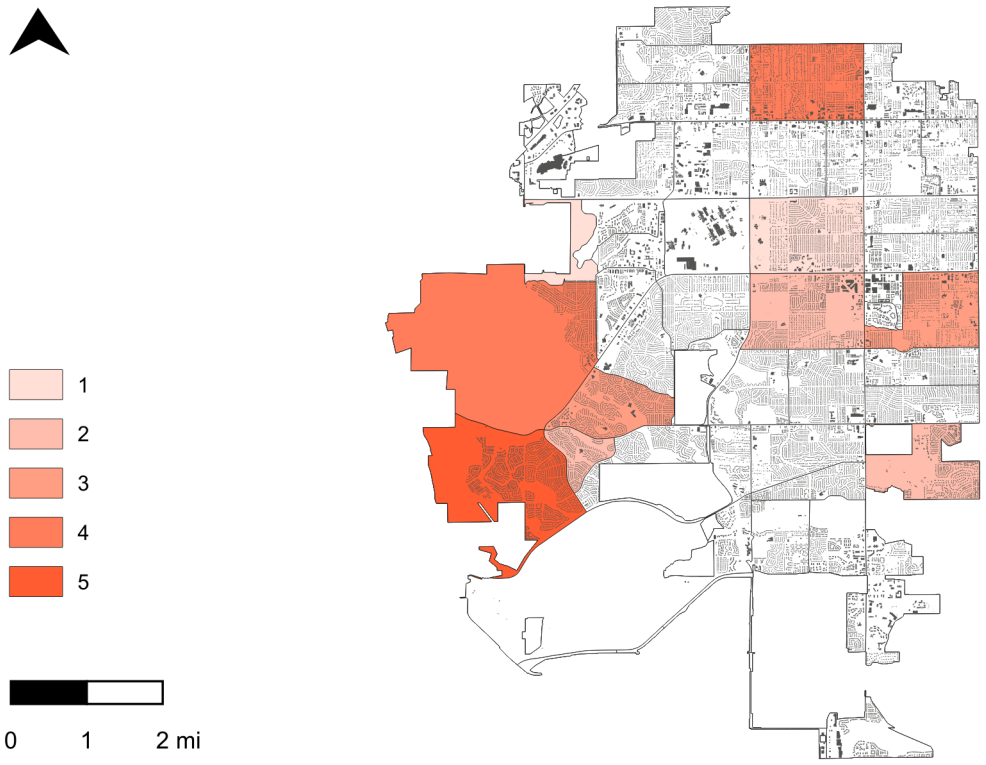
Climate-related hazard

Wildfires

Wildfires are considered a moderate but growing climate risk for Lakewood, as warmer and drier conditions are expected to increase the likelihood of fire activity in and around the city.

With more extremely hot days and a slight increase in the number of dry days each year, vegetation could become more prone to ignition, elevating wildfire risks. While fires have traditionally been more common in rural and forested areas, climate change is making urban and suburban communities more vulnerable, particularly those near parks, open spaces and the wildland-urban interface (WUI). **Figure 5** highlights current fire risk priority areas based on a spatial analysis of wildfire risks and social vulnerability indicators.

Figure 5. Current priority wildfire risk areas.



Certain areas and populations face greater wildfire risks than others. Residents living near Bear Creek, Green Mountain, Crown Hill Park and the Rooney Valley are especially vulnerable due to their proximity to fire-prone landscapes. Additionally, older adults, individuals with respiratory conditions and those sensitive to smoke exposure may experience health impacts from wildfire smoke, even if fires do not directly threaten their homes. Homes and businesses may also face power outages from utility shutdowns, a precaution sometimes taken during periods of extreme fire danger. Parks and natural areas are also at risk of damage from wildfires. As wildfire threats increase, improving emergency preparedness, strengthening fire prevention efforts and protecting vulnerable communities and infrastructure will be key to reducing risks and enhancing Lakewood's resilience to fire-related hazards.

Potential adaptation actions related to wildfires include:

- Review and update the Jefferson County Wildland Fire Evacuation Plan to ensure it meets the needs of residents.
- Strengthen regional coordination on wildfire and extreme weather resilience and expand early warning systems for extreme weather events.
- Offer rebate programs for flood- and fire-proofing upgrades to help homeowners make critical safety improvements in high-risk areas.
- Strengthen Sustainable Development Standards by requiring fire-proofing measures for new developments in wildfire-prone areas.

Community Engagement

The community engagement process ensured that the perspectives of Lakewood residents were reflected in the study recommendations. Engagement efforts included a mix of working groups and focus groups and a citywide survey targeting interested and affected parties, as well as the broader public. Activities included a Community Working Group with local leaders and organizations, as well as an Internal Working Group with city staff. Focus groups were held with representatives from business, development and utilities, as well as neighboring jurisdictions. The city also conducted a community survey, which received 228 responses, providing valuable data on residents' climate concerns, adaptation priorities and existing resilience initiatives. Through community discussions, surveys and workshops, six key themes emerged as top priorities, as highlighted in **Figure 6**. These key themes are summarized in the following section, along with potential actions to support each theme.

Figure 6. Emergent themes from community engagement.

Potential Actions

To help Lakewood prepare for a changing climate, this study identified **61 potential actions** to protect residents, strengthen infrastructure and make the city more resilient to extreme weather. These potential actions were developed based on climate risk assessments, community input and proven best practices in resilience planning. The potential actions are grouped into the six key themes that emerged during the community engagement process. The potential actions will inform the city's future policy analysis and planning efforts to ensure Lakewood remains a safe, sustainable and resilient community for years to come.

Image: Green Mountain fire in Lakewood. Source: City of Lakewood.

Key Theme

Public Engagement and Outreach

Community engagement emphasized the importance of greater public awareness of available programs, targeted outreach efforts for specific needs, and community-driven support systems and narratives to build trust.

Potential adaptation actions related to public engagement and outreach include:

1. Provide building owners, homeowners and renters — especially in high-risk areas — with multilingual resources on how to strengthen their homes against extreme weather.
2. Expand multilingual outreach in high-vulnerability neighborhoods and agricultural areas by increasing education on emergency preparedness, water conservation, energy efficiency and food security.
3. Establish a volunteer coordination platform that connects residents in need with available helpers during extreme weather events.
4. Create a voluntary registry for residents who may need assistance during extreme weather events.
5. Enhance communication about the Heat Repair Program and the Weatherization Assistance Program by developing and distributing multilingual outreach materials.
6. Assess and expand remote service options by reviewing which city services and programs can be offered remotely.
7. Integrate Indigenous knowledge into climate action efforts by partnering with Native American communities to incorporate traditional ecological knowledge, cultural practices and climate adaptation strategies into local resilience planning.
8. Establish a Climate Change Youth Committee to actively engage young people in climate policy discussions.
9. Work with the Diversity, Equity, and Inclusion (DEI) Advisory Committee to formally define people facing barriers and ensure that climate adaptation initiatives prioritize their needs.
10. Develop and apply an equity checklist for all climate adaptation and resilience projects.

Key Theme

Emergency Preparedness and Planning

Residents highlighted the need for enhanced emergency preparedness, including creating disaster plans for high-risk locations, improved hot and cold weather management strategies, and accessible emergency shelters with integrated support services.

Potential adaptation actions related to emergency preparedness and planning include:

11. Expand disaster outreach and recovery teams by working with police, fire departments and non-profits to provide support for residents.
12. Increase access to extreme weather shelters and resilience hubs by identifying indoor spaces for cooling, warming and clean air shelters.
13. Develop a policy for free transit during extreme weather to help residents safely reach cooling centers, shelters and essential services.
14. Enhance existing police initiatives to address trauma from extreme weather events by providing additional mental health support and crisis management for those affected by extreme weather and its aftermath.
15. Review and update the Jefferson County Wildland Fire Evacuation Plan to ensure it meets the needs of residents.
16. Strengthen emergency telecommunications systems by identifying gaps and investing in backup systems.
17. Create best practices for electric vehicle use during extreme weather by developing a user guide for city staff.
18. Develop a heat management plan for public spaces to ensure all city-hosted and permitted events provide adequate shade and cooling measures.
19. Require a heat management plan for event organizers as part of the event application process.
20. Set a minimum shading standard for public spaces by incorporating shade structures into city design guidelines.

Potential adaptation actions related to emergency preparedness and planning include:

21. Expand emergency cooling zones by deploying temporary shade structures and promoting access to cooled indoor spaces.
22. Build and expand splash pads in key locations using rainwater-fed and energy-efficient water features.
23. Extend the season for water features by keeping splash pads and cooling facilities open longer.
24. Support city departments in adapting to extreme weather by reviewing policies, identifying operational needs and ensuring staff are equipped with appropriate procedures and resources.
25. Adjust anti-idling policies during extreme weather to allow designated cooling or warming trucks for outdoor workers at job sites.
26. Develop outdoor work recommendations for businesses to help reduce workers' exposure to extreme heat, cold and other hazardous conditions.
27. Increase departmental funding for personal protective equipment for extreme weather, including weather-resistant clothing, cooling vests and other protective gear.

Key Theme

Climate-Resilient Infrastructure

Infrastructure resilience was a major theme in the engagement process. Residents emphasized the importance of improved stormwater and floodplain management, water conservation strategies, climate-adaptive building standards and support for homeowners to enhance property resilience.

Potential adaptation actions related to climate-resilient infrastructure include:

28. Develop and implement Community Climate Standards to improve the resilience of homes and farms.
29. Strengthen Sustainable Development Standards by requiring fire-proofing measures for new developments in wildfire-prone areas.
30. Expand the Sustainable Neighborhoods Program to include emergency planning and adaptation initiatives.
31. Offer rebate programs for flood- and fire-proofing upgrades to help homeowners make critical safety improvements in high-risk areas.
32. Complete and implement a Culvert Replacement Study to identify and prioritize high-risk culvert replacements.
33. Assess and improve high-risk roads prone to flooding.
34. Strengthen water and food security by expanding graywater systems, non-potable water use and rainwater harvesting, while also promoting drought-resilient agricultural techniques.

Key Theme

Energy Resilience

Participants emphasized the need for energy resilience through home weatherization education, community-scale renewable energy, expanded storage solutions and micro-grid development to ensure reliable power during extreme weather events.

Potential adaptation actions related to energy resilience include:

35. Develop an Energy Backup Supply Plan to ensure that multi-unit residential buildings have sufficient backup power.
36. Establish an Energy Emergency Supply Plan to require multi-unit residential buildings to maintain a minimum of 24 hours of emergency power.
37. Integrate energy storage in emergency heating and cooling centers.
38. Conduct a study on community-scale energy generation and storage to assess opportunities for renewable energy and battery storage solutions.
39. Conduct a study on micro-grid opportunities in existing developed areas.
40. Conduct a study on district energy systems for new developments.
41. Create a rebate program to support renewable energy and battery storage.
42. Expand utility cost assistance programs to provide financial relief for households who do not qualify for the Low-Income Energy Assistance Program (LEAP).

Key Theme

Natural Spaces and Green Infrastructure

Residents emphasized the importance of natural spaces in mitigating extreme heat, and advocated for an expanded tree canopy, shade structures and air quality protections. Residents also recognized the need to address threats to green infrastructure, such as invasive species.

Potential adaptation actions related to natural spaces and green infrastructure include:

43. Expand community tree planting initiatives by adding shade trees along trails, sidewalks, creeks and outdoor sports fields.
44. Set a tree canopy target to reduce the urban heat island effect.
45. Establish an Invasive Species Response Team by recruiting community volunteers.
46. Provide invasive species education for city staff through an internal training program.
47. Promote sustainable soil and land management by working with farmers and landowners to regenerative agriculture practices.
48. Update and expand the Natural Areas Plan to incorporate heat management strategies.
49. Create a voluntary wildlife and plant reporting platform by partnering with grassroots organizations and non-profits.

Key Theme

Governance and Collaboration

While not a major focus of public engagement, municipal governance and collaboration are key to addressing many of the actions that residents suggested. Governance and collaboration could include integrating climate adaptation into city policies and operations, enhancing staff training and strengthening regional collaboration to improve emergency preparedness, risk management and funding access.

Potential adaptation actions related to governance and collaboration include:

50. Integrate climate resilience into asset management practices.

51. Prioritize climate resilience in municipal budgeting to ensure funding aligns with long-term sustainability goals.

52. Strengthen procurement policies by requiring climate mitigation and adaptation considerations in all municipal purchasing and contracting decisions.

53. Require climate reporting in City Council decisions by including climate risk and adaptation strategies in staff and administrative reports.

54. Review and update municipal insurance policies to ensure city-owned assets and infrastructure are adequately covered for future climate risks.

55. Integrate climate adaptation into Diversity, Equity, and Inclusion (DEI) initiatives.

56. Support staff in incorporating climate resilience into project planning and decision-making.

57. Train city staff on climate adaptation strategies through regular workshops and capacity-building sessions.

58. Enhance cross-departmental coordination on climate risks.

59. Strengthen regional coordination on wildfire and extreme weather resilience and expand early warning systems for extreme weather events.

60. Establish an advisory service to help residents navigate insurance claims and understand financial recovery options.

61. Coordinate with non-profits to enhance snow removal services for older adults, individuals with disabilities and residents living on low-incomes.

Conclusion

This Climate Hazard and Social Vulnerability Study will inform future planning efforts across Lakewood and serve as a starting point for future policy and program ideas. The study builds upon the Jefferson County Hazard Mitigation Plan, assessing the risks that climate hazards pose to people, infrastructure and the economy. Potential adaptation actions have been identified through a climate vulnerability and risk assessment, spatial analysis and community engagement to improve the city's resilience to climate change. However, additional research, analysis and community input are necessary to evaluate the feasibility and benefits of these potential actions.

The rest of this report includes the complete Climate Hazard and Social Vulnerability Study for the city of Lakewood. The study consists of local contextual information, the detailed study approach, regional climate projections, the climate vulnerability and risk assessment results, an overview of key hazards and vulnerabilities and the community engagement results. It also includes a list of potential adaptation actions and a suggested implementation guide. This study serves as a foundation for ongoing climate resilience efforts in Lakewood, providing critical insights and possible strategies that will require continued collaboration, investment and community engagement to effectively address the challenges ahead.

Image: Bear Creek Lake Park at Lakewood, Colorado. Source: Adobe Stock under SSG's license.