Hazard Mitigation Plan

Green Lake County, Wisconsin

May 2025

Plan Provided by:
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Acronyms

ACE	Army Corps of Engineers
ADA	Americans with Disabilities Act
ALS	Advanced Life Support
ARC	American Red Cross
ARES	Amateur Radio Emergency Services
ASCS	Agriculture Stabilization and Conservation Service
ASL	Above Sea Level
ASPR	Assistant Secretary for Preparedness and Response
BIA	Bureau of Indian Affairs
CAD	Computer Aided Dispatch
CAR	Communities at Risk
CBRNE	Chemical, Biological, Radiological, Nuclear, or Explosive
CDBG	Community Development Block Grant
CEMP	Comprehensive Emergency Management Plan
CFR	Code of Federal Regulations
CI	City
CO	County
CO HWY	County Highway Department
CTH	County Highway
DFIRM	Digital Flood Insurance Rate Map
DHS	U.S. Department of Homeland Security
DNR	Wisconsin Department of Natural Resources
DOD	U.S. Department of Defense
DOT	Department of Transportation
DPW	Department of Public Works
DTM	Digital Terrain Maps
EAP	Emergency Assistance Program or Emergency Action Plan
EF	Enhanced Fujita Scale
EHS	Extremely Hazardous Substance
EM	Emergency Management
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EOC	Emergency Operations Center
EOP	Emergency Operating Procedure
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act

F	Fahrenheit or Fujita Scale
FCC	Federal Communications Commission
FCIC	Federal Crop Insurance Corporation
FD	Fire Department
FEMA	Federal Emergency Management Agency
FIRMS	Flood Rate Insurance Maps
FMA	Flood Mitigation Assistance
FmHA	Farmers Home Administration
FOIA	Freedom of Information Act
FOUO	For Official Use Only
FSA	Farm Service Agency
GIS	Geographic Information System
GPS	Global Positioning System
HazMat	Hazardous Materials
HazMit	Hazard Mitigation
HAZUS	Hazards United States
HAZUS-MH	Hazards United States Multi-hazard
HMGP	Hazard Mitigation Grant Program
HUD	U.S. Department of Housing and Urban Development
HVA	Hazard Vulnerability Analysis
HWY	Highway
ICS	Incident Command System
L	Liter
LE	Law Enforcement
LEPC	Local Emergency Planning Committee
LID	Land Information Department
LIDAR	Laser Imaging Detection and Ranging
LPDM	Lagrangian particle dispersion
LTPO	Long-Term Power Outage
LWC	Land and Water Conservation Department
MABAS	Mutual Aid Box Alarm System
MAP	FEMA's Risk Mapping, Assessment and Planning
ME	Medical Examiner
MHz	Megahertz
MMI	Modified Mercalli Intensity Scale
MOU	Memorandum of Understanding
MPH	Miles Per Hour
MSDS	Material Safety Data Sheet

NFIA	National Flood Insurance Act
NFIF	National Flood Insurance Fund
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NIDIS	National Integrated Drought Information System
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRP	National Response Plan
NWS	National Weather Service
PA	Public Address (System)
PDM	Pre-Disaster Mitigation
PGA	Peak Ground Acceleration
PH	Public Health
PSA	Public Service Announcement
POW	Plan of Work
P&Z	Planning and Zoning
RACES	Radio Amateur Civil Emergency Service
RES1	Single Family Dwelling
RES2	Manufactured Housing
RFC	Repetitive Flood Claims
SARA	Superfund Amendments and Reauthorization Act
SBA	Small Business Administration
SMART	Spatial Management, Analysis and Resource Tracking
SPI	Standardized Precipitation Index
SRL	Severe Repetitive Loss
STH	State Highway
TN	Township
USDA	U.S. Department of Agriculture
USFS	U.S. Forestry Service
USGS	U.S. Geological Survey
USH	U.S. Highway
UW	University of Wisconsin
UW Ext	University of Wisconsin – Extension Office
VHF	Very High Frequency
VI	Village
WEM	Wisconsin Emergency Management
WISP	Wisconsin Irrigation Scheduling Program

Introduction and Background

The Green Lake County Hazard Mitigation Plan is intended to provide strategies for reducing susceptibility to future damage to public and private infrastructure in the county. The Green Lake County Emergency Management Office applied for and was awarded a hazard mitigation planning grant in 2023. This grant program is sponsored by the U.S. Department of Homeland Security - Federal Emergency Management Agency (FEMA) and is administered by the Wisconsin Department of Military Affairs - Wisconsin Emergency Management (WEM). The procedures utilized in preparing this plan are based on guidance provided by FEMA and WEM and should therefore be considered consistent with the requirements and procedures in the Disaster Mitigation Act of 2000.

Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-228, as amended) is the impetus for involvement of state and local governments in evaluating and mitigating natural hazards as a condition of receiving federal disaster assistance. FEMA rules for implementing Section 409 are in 44 CFR Part 206 Subpart M.

Section 409 states that the county is obligated to try to reduce damage susceptibility to any hazard that has received relief funding in the past. Developing a hazard mitigation plan provides an opportunity for communities to meet this requirement by developing strategies for the reduction of potential losses from future natural disasters. Hazard mitigation planning is the process of developing a set of actions designed to reduce or eliminate long-term risk to people and property from hazards and their effects. Completion of this plan should put Green Lake County in an advantageous position when competing for pre- and post-disaster mitigation project dollars because projects have been pre-identified. The cooperation of government, private, and volunteer agencies is essential in mitigation efforts, and over the long term, it is hoped that implementation of this plan will save taxpayer dollars because less money is needed for post-disaster recovery activities. Furthermore, mitigation planning measures incorporated in economic or community development goals support a more comprehensive and effective government. This plan evaluates the risks that all natural hazards pose to the citizens and property of Green Lake County by presenting:

- A profile and analysis of past hazardous events

- An assessment of vulnerability of community assets
- Potential hazard mitigation strategies
- Methods for building community support and ensuring plan adoption

Plan Overview

The Green Lake County Hazard Mitigation Plan provides background information on Green Lake County and identifies those hazards that have occurred or could occur in the county. It includes a description of each hazard, its frequency of occurrence, appropriate actions in case of emergency, and possible steps to mitigate the hazard. These hazards are the basis for the development of all county emergency plans.

A well-prepared plan allows emergency management to act swiftly and efficiently in the event of a hazard, reducing the damage and the cost incurred from displacing residents and businesses. Hazard mitigation activities will be emphasized in the plan as a major component of overall emergency management. The plan is intended to provide strategies for reducing future damage to public and private infrastructure in the county, including flood damage.

Previous Planning Efforts and Legal Basis

The Green Lake County Emergency Management Office has completed and regularly updates a hazard vulnerability analysis (HVA) that identifies all likely natural and technological hazards that might or have occurred within the county and is based on the State of Wisconsin's HVA. The local HVA does not generally include detailed mitigation strategies for the identified hazards, but the county used the HVA as the basis for their original pre-disaster hazard mitigation plan and continues to reference it as the plan is updated.

There have also been plans and ordinances completed by individual Green Lake County departments or municipalities, which were used as reference materials for this plan, including:

Green Lake County Code of Ordinances[1]

Chapter 32	Emergency Management
Chapter 280	Comprehensive Plan
Chapter 284	Construction Site Erosion Control and Storm Water Management
Chapter 300	Floodplain Zoning
Chapter 315	Land Division and Subdivision
Chapter 323	Nonmetallic Mining Reclamation
Chapter 338	Shoreland Protection
Chapter 350	Zoning

City of Berlin Code of Ordinances[2]

Chapter 14	Buildings and Building Regulations
Chapter 62	Subdivisions
Chapter 82	Zoning

City of Green Lake Municipal Code[3]

Title 13	Zoning
Title 14	Subdivision Regulations
Title 15	Building Code

City of Markesan Building Regulations[4]

Part III, Chapter 366	Comprehensive Plan
Part III, Chapter 370	Floodplain Zoning
Part III, Chapter 377	Official Map
Part III, Chapter 385	Shoreland-Wetland Zoning
Part III, Chapter 390	Subdivision of Land
Part III, Chapter 400	Zoning

City of Princeton Code of Ordinances[5]

Part III, Chapter 395	Floodplain Zoning
Part III, Chapter 410	Shoreland-Wetland Zoning
Part III, Chapter 415	Subdivision of Land
Part III, Chapter 430	Zoning

Village of Marquette[6]

Ordinance 49	Building and Mechanical Code
Ordinance 54	Floodplain Zoning
Ordinance 55	Shoreland-Wetland Zoning

[1] https://www.ecode360.com/GR2053
[2] http://www.municode.com/resources/gateway.asp?pid=13496&sid=49
[3] http://cityofgreenlake.com/municipal-code/
[4] https://www.ecode360.com/MA3155
[5] https://ecode360.com/PR3158
[6] https://villageofmarquette.gov/ordinances-resolutions

Ordinance 59	Amendment to various sections of Floodplain Ordinance
Ordinance 66	Amendment to various sections of Building and Mechanical Code

The Village of Kingston[7] has no online ordinances.

Town of Brooklyn[8]

Chapter 98	Building Construction
Chapter 117	Comprehensive Plan
Chapter 148	Mobile Homes and Mobile Home Communities
Chapter 195	Subdivision of Land

The Towns of Green Lake[9], Mackford[10], Princeton[11], Seneca[12] have no relevant ordinances online.

The Towns of Berlin, Kingston, Manchester, Marquette, and St. Marie have no online ordinances.

According to the 2023 Wisconsin Comprehensive Plan and Local Land Regulations Inventory Report, 39 percent of local governments do not have an official website, do not post ordinances on their website, or have an incomplete listing of ordinances.[13]

As part of its Building Science program, FEMA studies how natural hazards affect structures. As part of this focus, it tracks building code adoption status for jurisdictions across the country through a searchable portal organized by hazard.[14]

The local HVA serves as the starting point for the hazard mitigation plan. Other data on historical events is gathered from the National Weather Service's storm report database, recent news reports, local resources (e.g., website; local community ordinances; local plans such as the comprehensive plan, stormwater management

[7] https://kingstonvillagewi.com

[8] https://ecode360.com/BR6581

[9] https://www.townofgreenlake.gov/ordinances

[10] https://www.townofmackfordwi.gov/government/ordinances

[11] https://tn.princeton.wi.gov

[12] https://townofsenecagreenlakeco.com

[13] https://doa.wi.gov/DIR/2023-Comp-Plan-and-Land-Regs-Inventory-Report.pdf

[14] https://stantec.maps.arcgis.com/apps/MapSeries/index.html?appid=a053ac48343c4217ab4184bc8759c350

plans), the FEMA Region V mitigation survey and from the memories of the local planning team members. Team members are presented with this educational background data and asked to rank their concern (likelihood of future occurrences and amount of disruption/damage should it occur) on a five-point scale (very high, high, medium, low, very low). From that, team members, members of the community, survey respondents, and other planning participants are asked to determine hazard mitigation strategies that might benefit their communities. Local existing plans are referenced again at this time, with the members and authors of these plans (e.g., comprehensive, stormwater management) serving as core members of the workgroup committee. The selected mitigation strategies are recorded and detailed in each chapter as well as in the table in Appendix E.

Mitigation strategies are reviewed over the five years of the plan's life by the leadership staff from the applicable departments (e.g., Emergency Management, Sheriff's Office/Communications, Highway, Land and Water Conservation, Zoning) with the elected leaders from the jurisdictions to triage projects and determine what can and should be done within the planning period. Agencies within the county that have the authority to regulate development include zoning administrations for Green Lake County, the Cities of Green Lake, Markesan, and Princeton, and the Villages of Kingston and Marquette. The City of Berlin, which is partially in Waushara County, also has that authority. These options are usually discussed in open meetings prior to implementation, as required by Wisconsin state law. The determining factor for most projects is obviously budget availability. The units of government have several options for funding implementation, including grants, special taxing authority (for the project and/or any matching funds), general purpose revenue from existing budgets, and regulatory authority, which can be used to require that an individual or business complete the project using their funds. The units of government use or improve, if necessary, the mechanisms described above to ensure the implementation of hazard mitigation ideas.

Plan Preparation, Adoption, and Maintenance

The Green Lake County Emergency Management Director contracted with Emergency Planning, Training and Exercise Consulting (EPTEC, Inc.) to draft this plan. A committee was organized to work with the county and the planning consultant to

perform activities required to update this plan. Attendance and participation were strongly encouraged to progress through the planning process. The committee understood that they would need to convey information to their jurisdictions; engage local leadership and staff to encourage a collective community voice; solicit input from their jurisdiction; and arrange for review and official adoption of the plan. The committee members include:

- Gary Podoll, Green Lake County Emergency Management
- Dave Cornelius, Green Lake County Emergency Management
- Mark Podoll, Green Lake County Sheriff's Office
- Bill Hutchison, Green Lake County Information Technology
- Mary Lou Neubauer, City of Princeton
- Jason Jerome, Green Lake County Department of Health and Human Service; and Village of Kingston
- Bill Wagner, Green Lake – Berlin Fire Department
- Sue Wendt, County Board - Zoning
- Todd Zamzow, City of Markesan
- Allison Krause, Health Department
- Tim Ludolph, City of Berlin
- Rachel Pulantz, Green Lake County Department of Health and Human Services – Health
- Matt Kirkman, Land Use, Planning, and Zoning
- Gerald Stannel, Geographic Information Systems (GIS)
- Sheila Pulice, Green Lake Rotary Club
- J ???, City of Green Lake Public Works Department
- Tammy Banding, Theda Care Berlin
- Art Cybul, Village of Marquette
- Lenora Borchardt, EPTEC, Inc. (Contractor)

An informational brochure was created, and copies were distributed throughout the community at local community gathering points such as municipal halls, libraries, etc. Meetings were held with the chief elected officials from the municipalities to explain and gather input regarding the program (e.g., previous occurrences and mitigation strategies.) The FEMA Region V survey was sent to every Kewaunee County city, village, and town clerk for distribution to the elected officials for discussion in public meetings, review, and completion. This survey requests information on their hazards, their future development, road projects, and mitigation strategies. Key county departments (i.e., Planning, LWCD, Highway, Sheriff's) also received the survey with a request for completion; the completed county and municipal surveys were compiled, and the results, along with the cover letter, can be found in Appendix G. Additional personal communications (i.e., via meetings and/or emails) with

each of the communities to elicit plan information were also conducted.

This project was begun in 2022. The workgroup met two times in 2024. There are some places where minor information was not available (e.g., dates of past projects, total dollar amounts spent), but it does not detract from the plan's readability or take away from highlighting the efforts that the county and its municipal partners have made in mitigating hazards. Green Lake County and its municipalities are proud to say that they came together to finish this plan to highlight strategies to make their communities more resilient over the next five years.

The committee met to evaluate and incorporate input from local officials and then to review and provide input on the progress of the plan. Invitations were extended via notices in newspapers and direct correspondence to members of the public, local officials, academia, business, non-profit, and industry leaders to participate in the process. A working draft of the plan was distributed to the County Emergency Management Directors from the contiguous counties (i.e., Columbia, Dodge, Fond du Lac, Marquette, Waushara, and Winnebago). No comments or edits were received. Unfortunately, although multiple attempts and invitations were made to members of the public, no public comments were received. OR: Comments received were reviewed and incorporated into the plan as appropriate. An additional effort was made to reach those whose primary language is not English, as well as underserved populations and those who may not have traditional access to the information being provided. A copy of the supporting materials, including community fliers, the mitigation brochure, a list of meeting dates and informational sessions to gather public and official input, etc., can be viewed in Appendix G.

The Green Lake County Hazard Mitigation Plan Workgroup reviewed the past events records (generally gathered from the National Weather Service), and a consensus was reached on the anticipated probability of future events. This probability was designated as "very high," "high," "medium," "low," or "very low" by the workgroup based on their evaluation and experience with the data.

The hazard mitigation strategies from the previous version of this plan were reviewed and progress is reported in Appendix D. The workgroup also, after reviewing the updated draft plan, selected the potential new mitigation projects, which are listed in Appendix E (Summary of Mitigation Strategies) and discussed in more detail in

each chapter's Hazard Mitigation Strategies section. The workgroup participants were given the *Mitigation Ideas: Possible Mitigation Measures by Hazard Type* (Mitigation Ideas, FEMA-R5, 9/02) booklet as an aid to generating ideas. All of the ideas generated during the workgroup meetings were incorporated into the plan and can be found in the Hazard Mitigation Strategies section of each chapter and are summarized in Appendix E. Based on the information collected, each of these projects was assigned a "very high," "high," "medium," "low" or "very low" priority based on the workgroup's internal consensus assessment during a discussion of the balances of risk, reward, cost effectiveness (cost benefit) and likelihood of local will and funding (local or grant) to complete the strategy.

The municipal leaders were briefed regarding the need to formally adopt this plan as a prerequisite for future mitigation funding eligibility. A draft was sent to Wisconsin Emergency Management (WEM) for review and approval. Based on WEM's comments, a final draft plan was completed, and a general meeting was held to review the plan with members of the public, local officials, academia, and business and industry leaders. Information and adoption paperwork were provided to the municipal leaders advising them of the need to formally adopt this plan as a prerequisite for future mitigation funding eligibility.

A resolution also has been passed by the Green Lake County board, the Cities of Berlin, Green Lake, Markesan, and Princeton; the Villages of Kingston and Marquette, and the Towns of Berlin, Brooklyn, Kingston, Manchester, Princeton, and Seneca. The Towns of Green Lake, Mackford, Marquette, and St. Marie have not individually adopted the plan but, as towns, are considered under the county's adoption. Scanned copies of the adoption resolutions can be found in Appendix C. The final plan has been submitted to WEM for review and certification and a final approval and notice of acceptance has been received of FEMA plan approval as of xxx.

The Disaster Mitigation Act of 2000 requires the monitoring, evaluation, and updating of the hazard mitigation plan every five years. This hazard mitigation plan is designed to be a "living" document and, therefore, will be reviewed and updated within five years from its approval date. The Green Lake County Hazard Mitigation Plan Workgroup will provide leadership and guidance throughout the plan's life cycle (i.e., monitoring, evaluating, and updating). Updates will allow municipal leaders and the public to

provide input into the process. The public will be notified of this opportunity via legal public notices.

The process for integrating hazard mitigation actions into other planning mechanisms will be led by the county Emergency Management Director. As he receives information between the five-year update periods (e.g., comprehensive or capital improvement plans) that might be included, it will be added to Appendix H: Inter-Revision Updates. Green Lake County Emergency Management maintains responsibility and is the point of contact for all issues (e.g., monitoring, updating, and evaluating the effectiveness) regarding this plan. Municipalities can contact the county Emergency Management Director to add updated local information to Appendix H at any time. Furthermore, the county Emergency Management Director may solicit updates from the plan's stakeholders (county offices, municipalities, the public, etc.). The solicitation would seek to determine if there are new elements for the mitigation plan, as well as any plans (new or updates) in which the mitigation plan can and/or will be used as a source plan. Comments will be received and discussed at the county's Emergency Management committee meeting. Note that after a disaster, the Emergency Management committee may also meet to discuss mitigation strategies that might be applicable. These same stakeholders will be invited to fully participate in the five-year plan update, which will be detailed in the updated plan documents and will fully conform to FEMA's requirements.

Green Lake County and the municipalities at all levels within the State of Wisconsin (i.e., city, village, town) are individually empowered to enact all of the hazard mitigation strategies in this plan. Realistic constraints to enacting include adequate budgeting, and, as unincorporated municipalities, towns are unable to independently receive federal grants. The county has a history of working collaboratively to support town initiatives. During the plan's lifecycle, the county and incorporated municipalities will consider the strategies listed in Appendix E as they annually prioritize "regular" maintenance projects, as they set their annual budgets, after a disaster period and as grants become available that might help off-set the costs of some of the strategies listed within the plan. These projects will be reported to the county Emergency Management Director. The Director will keep and compile the inter-revision data for inclusion in the five-year update, which will be coordinated through county Emergency Management, beginning at least 18 months prior to expiration, and at which time they will report on their progress towards meeting the hazard mitigation

goals. The update will bring together many of the same workgroup members as well as any new stakeholders (e.g., elected officials, businesses, academia, members of the public) who respond to the invitation to participate and have an interest in mitigation planning.

The plan participants also recognize this document as an important planning tool within the community and will use this plan as a reference as they complete and update community ordinances and other planning, such as zoning, shoreland, floodplain, wetland, park and recreation, sustainability, and farmland preservation. They will also refer to it as they are involved in the planning and other preparedness activities of the municipalities. The plan was adopted, but after discussions with the communities, it was unclear if it was incorporated into their plans. There is also no evidence that this plan was integrated with other planning efforts.

Many of these plans are on a regular updating cycle, and as emergency management is notified that they are up for renewal, they will provide any relevant planning materials (from the hazard mitigation plan and any additional information received since the plan's approval). Municipalities with planning departments are also encouraged to refer to the mitigation plan in their zoning updates, flood and shoreland planning, and in their comprehensive plans.

After this plan has passed its reviews from Wisconsin Emergency Management (WEM) and the Federal Emergency Management Agency (FEMA) and is approved, the county and its municipalities will have working copies. Green Lake County Emergency Management will also refer to this plan in their emergency preparedness activities.

Physical Characteristics of Green Lake County

General Community Introduction

Green Lake County has only existed since 1858, but its settlement started much earlier. Originally under the judicial jurisdiction of Brown County, the territory was established as Marquette County in 1836 and fully organized in 1848 with the county seat at Marquette. Green Lake County was separated from Marquette County by an Act of Legislation in 1858, with the county seat at Berlin. In 1862, the citizens voted to move the county seat to Dartford (now known as Green Lake). In 1863, the first courthouse was built in Dartford at the present site. In 1866, dissension between the factions moved the county seat to Princeton with an early morning raid on the records. In the same year, the Supreme Court ordered the county seat back to Dartford. Later attempts were made to detach the western towns from Fond du Lac County to Green Lake County and make Ripon the county seat. Those efforts failed.

Luther Gleason is credited with being the first to settle in the new territory near the village of Marquette on the Fox River, migrating from Vermont in 1831. He was an Indian trader and kept a store. James Powell settled in the Town of Green Lake in 1835 or before. Hiram McDonald was the third settler in the County. He was located in the Town of Mackford in 1836.

Anson Dart and his two sons located at the outlet of Twin Lakes in 1840 and put up the first frame house. In 1843, William Dakin and Satterlee Clark settled near the Center House. The first post office in the county was at Mr. Clark's. Mr. W.A. Millard was probably the first settler on the Village of Manchester site, arriving in 1846. In 1846, R. Day, J. Burt, Henry Pratt, and others came to Little Green. In 1847, the county comprised three electoral precincts, Puckaway, Lake Marie, and Big Green. In that same year, Mr. Atkins put up a log cabin in the Town of Berlin.

In May of 1847, Nathan Strong entered the land on which part of the City of Berlin now stands. Joel Day erected the first frame house here in 1848, and the settlement was originally called Strongsville.

Also, in 1847, Datus Lewis, J. Larkin, and others commenced the Seventh Day Baptist settlement in the town of Berlin on the east

side of the river and named the area Berlin after their former home in upstate New York. John Winchell built a log cabin in the Town of Princeton in 1848. In July of 1848, Royal Treat purchased 132 acres and plotted out the city in 1849. It was originally called Treat's Landing. The Town of Brooklyn, at first settlement, was called Lexington. On its organization in January of 1849, the name was changed to Arcade and again changed to Brooklyn in the winter of 1850.

The first settler in Seneca, Mr. Ayshford, arrived about 1850. The Village of Kingston was organized in 1858, and Green Lake County is officially recognized.[15]

Plan Area

Green Lake County, covering approximately 354 square miles in central Wisconsin, is one of the smallest counties in the state. It was formed in 1856 from Marquette County and contains Wisconsin's deepest lake, Green Lake. The county seat is the City of Green Lake. The largest city in Green Lake County is Berlin. Green Lake County is home to approximately 18,556 people.

Green Lake County lies within the Central Plain geographic province in the northwest portion of the county and within the Eastern Ridges and Lowlands geographical province in the southeast portion of the county. The Central Plain of Wisconsin is a crescent-shaped belt covering about 13,000 square miles. All of it is floored by the weak Cambrian sandstone, except in the northwest, where the removal of the sandstone has exposed the underlying Keweenawan lavas for a small area.

Topographic features in the Eastern Ridges and Lowlands are distinct, but they are low. Alternate weak and resistant rock layers are carved by streams and weather into a belted plain. This plain has parallel strips of upland and lowland corresponding to the more important resistant and weak strata. The uplands are called cuestas. A cuesta is a ridge that has a steep escarpment on one side and a long, gentle slope on the other. The topography of the Eastern Ridges and Lowlands is controlled by cuestas.[16]

[15] http://www.co.green-lake.wi.us/general.iml?mdl=history.mdl
[16] http://www.wisconline.com (now archived)

Green Lake County is bordered on the northeast by Winnebago County, the east by Fond du Lac County, the southeast by Dodge County, the southwest by Columbia County, the west by Marquette County, and the north by Waushara County.

In Wisconsin, there are three types of sub-county, full-service local government units: towns, which are unincorporated, and villages and cities, which are incorporated. Green Lake County contains the Cities of Berlin, Green Lake, Markesan, and Princeton; the Villages of Kingston and Marquette; and the Towns of Berlin, Brooklyn, Green Lake, Kingston, Mackford, Manchester, Marquette, Princeton, Seneca, and St. Marie. See Appendix A for a map of Green Lake County.

Green Lake County and the Cities of Berlin, Green Lake, Markesan, and Princeton; the Villages of Kingston and Marquette; and the Towns of Berlin, Brooklyn, Kingston, Manchester, Princeton, and Seneca have adopted the plan. Copies of the adoptions can be found in Appendix C.

The Towns of xxxx have not individually adopted the plan but, as towns, are considered under the county's adoption.

Geology

The high plain or plateau in the southeastern part of the county is underlain by dolomite and sandstone. Dolomite is the upper bedrock layer and is within a few feet of the surface in many places. Natural crevices and fissures are present in the dolomite, and sinkholes are scattered throughout the southeastern part of the county.

Sandstone underlies the dolomite. Although it is not exposed in many places, it has influenced many of the soils and landforms in the county. In most places where the protective dolomite cap has been removed by erosion, the sandstone has also been removed. Scattered throughout the county are a few exposures of sandstone, which are generally on the lower slopes below outcrops of dolomite. In many places where the dolomite outcrops, the underlying sandstone is not visible because it is mantled by soil material eroded from the higher slopes. In the areas underlain by dolomite, many deep valleys have been formed by geological erosion of the relatively soft sandstone.

Much of the loose sand that mantles the western parts of the county came from sandstone weathered by glaciers. The sand was moved by glacial meltwater and by wind and left thick deposits of valley fill.

There are four outcroppings of bedrock in Green Lake County, and they are located in Berlin, Mackford, Marquette, and Seneca Townships.[17] This bedrock is of the rhyolite variety.[18]

Topography

Wisconsin lies in the upper Midwest between Lake Superior, the upper peninsula of Michigan, Lake Michigan, and the Mississippi and Saint Croix Rivers. Its greatest length is 320 miles and greatest width 295 miles for a total area of 56,066 square miles. Glaciation has largely determined the topography and soils of the state, except for the 13,360 square miles of driftless area in southwestern Wisconsin. The various glaciations created rolling terrain with nearly 9,000 lakes and several areas of marshes and swamps. Elevations range from about 600 feet above sea level along the Lake Superior and Lake Michigan shores and in the Mississippi floodplain in southwestern Wisconsin to nearly 1,950 feet at Rib and Strawberry Hills.

The Northern Highlands, a plateau extending across northern Wisconsin, is an area of about 15,000 square miles with elevations from 1,000 to 1,800 feet. This area has many lakes and is the origin of most of the major streams in the state. The slope down to the narrow Lake Superior plain is quite steep. A comparatively flat, crescent-shaped lowland lies immediately south of the Northern Highlands and embodies nearly one-fourth of Wisconsin. The eastern ridges and lowlands to the southeast of the Central Plains are the most densely populated and have the highest concentration of industry and farms. The uplands of southwestern Wisconsin, west of the ridges and lowlands and south of the Central Plains, make up about one-fourth of the state. This is the roughest section of the state, rising 200 to 350 feet above the Central Plains and 100 to 200 feet above the Eastern Ridges and Lowlands. The Mississippi River bluffs rise 230 to 650 feet.[19]

[17] Soil Survey of Green Lake County, 1977
[18] Wisconsin Geological and Natural History Survey on the Building and Ornamental Stones of Wisconsin. Ernest Robertson Buckley, PhD. 1898.
[19] https://extension.wisc.edu/

Green Lake County is about 75 percent uplands, 18 percent wetlands, and 7 percent water. The plateau in the southeastern part of the county has an average elevation of about 1,000 feet above sea level (ASL). The northwestern part of the county has an average elevation ranging from 760 to 800 feet ASL. The rest of the county consists of knolls and valleys that have an average elevation of 800 to 900 feet ASL.[20]

Climate

The Wisconsin climate is typically continental with some modification by Lakes Michigan and Superior. Winters are generally cold and snowy, and summers are warm. About two-thirds of the annual precipitation falls during the growing season; this is normally adequate for vegetation, although there are occasional droughts. The climate favors dairy farming, and the primary crops are corn, small grains, hay, and vegetables. Storm tracks generally move from west to east and southwest to northeast.

The average annual temperature varies from 39°F in the north to about 50°F in the south, with statewide extreme records of 114°F (Wisconsin Dells, 7/13/1936) and minus 55°F (Couderay, 2/2/1996 & 2/4/1996). During more than half of the winters, temperatures fall to minus 40°F or lower, and almost every winter temperatures of minus 30°F or colder are reported from northern stations. Summer temperatures above 90°F average two to four days in northern counties and about 14 days in southern districts, including Green Lake County. During marked cool outbreaks in summer months, the central lowlands occasionally report freezing temperatures.

The freeze-free season ranges from around 80 days per year in the upper northeast and north-central lowlands to about 180 days in the Milwaukee area. The pronounced moderating effect of Lake Michigan is well-illustrated by the fact that the growing season of 140 to 150 days along the east-central coastal area is of the same duration as in the southwestern Wisconsin valleys. The short growing season in the central portion of the state is attributed to a number of factors, among them an inward cold air drainage and the low heat capacities of the peat and sandy soils. The average date of the last spring freeze ranges from early May along the Lake Michigan coastal area and southern counties to early June in the

[20] Soil Survey of Green Lake County, 1977

northernmost counties. The first autumn freezes occur in late August and early September in the northern and central lowlands and in mid-October along the Lake Michigan coastline. However, a July freeze is not entirely unusual in the north and central Wisconsin lowlands.

The long-term mean annual precipitation ranges from 30 to 34 inches over most of the Western Uplands and Northern Highlands, then diminishes to about 28 inches along most of the Wisconsin Central Plain and Lake Superior Coastal area. The higher average annual precipitation generally coincides with the highest elevations, particularly the windward slopes of the Western Uplands and Northern Highlands. Thunderstorms average about 30 per year in northern Wisconsin to about 40 per year in southern counties and occur mostly in the summer. Occasional hail, wind, and lightning damage are also reported.

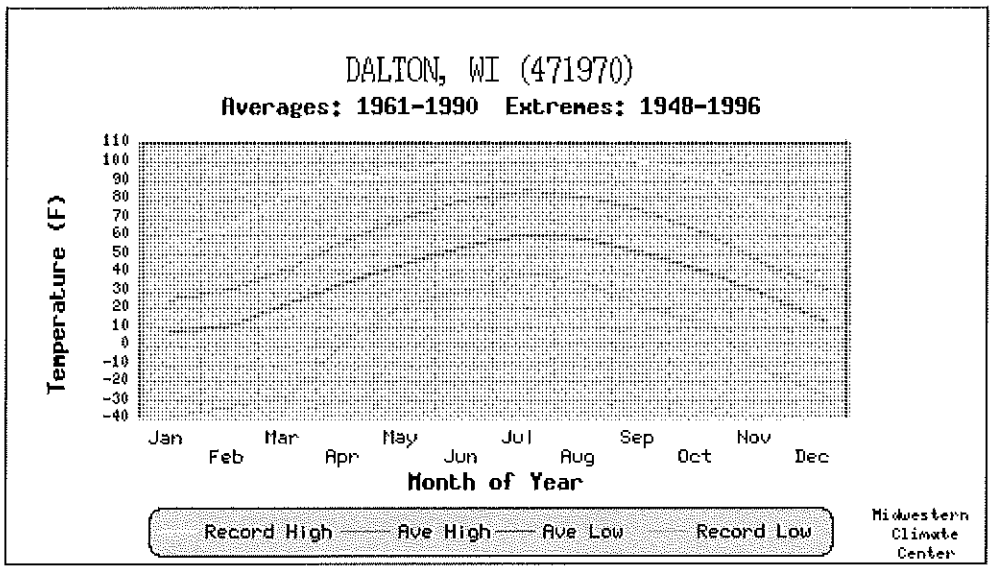
The average seasonal snowfall varies from about 30 inches at Beloit to well over 100 inches in northern Iron County along the steep western slope of the Gogebic Range. Greater average snowfall is recorded over the Western Uplands and Eastern Ridges than in the adjacent lowlands. The mean dates of first snowfall of consequence (an inch or more) vary from early November in northern localities to early December in southern Wisconsin counties. The average annual duration of snow cover ranges from 85 days in southernmost Wisconsin to more than 140 days along Lake Superior. The snow cover acts as protective insulation for grasses, autumn-seeded grains, alfalfa, and other vegetation.[21]

The average growing season is defined as the number of days following the last 32°F freeze in the spring through the beginning of fall. Green Lake County's growing season averages 137 days with a range of 119 to 154 days. Green Lake County's median date of last frost in the spring is May 12th, and the median date of the first frost in the fall is September 28th. [22]

[21] https://www.aos.wisc.edu/~sco/
[22] https://www.wisconsin.edu/

Climate Normals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Ave Daily High (F°)	25.5	30.2	42.7	57.6	69.8	79.7	83.7	81.0	73.2	61.6	45.8	30.9
Ave Daily Low (F°)	5.4	9.9	22.9	34.9	45.4	54.6	59.4	56.5	47.9	36.7	25.9	12.1
Growing Degree Days	0	2	32	143	333	510	645	578	376	185	34	3
Heating Degree Days	1519	1243	1014	567	259	56	8	26	146	474	876	1352
Cooling Degree Days	0	0	0	0	36	107	207	150	17	5	0	0
Ave Precipitation (")	1.08	1.04	2.14	2.79	3.31	3.76	3.29	3.61	4.11	2.38	2.14	1.54
Ave Snowfall (")	9.3	7.5	8.3	2.2	0.1	0.0	0.0	0.0	0.0	0.3	3.6	10.9

Climate Normals and Growing Season Summary



In 2012, the Wisconsin Department of Health Services (DHS), Bureau of Environmental and Occupational Health (BEOH) was awarded a grant to study and prepare for the anticipated climatic effects on the public's health. The Wisconsin Climate and Health Profile Report highlights evidence-based data related to extreme weather events, corresponding health outcomes, and the

development of projects and best practices to adapt to and prepare for future extreme weather events.

Over the past 60 years, Wisconsin has become warmer and wetter, especially during the winter months. Evidence and research drawn from the Wisconsin Initiative on Climate Change Impacts (WICCI) suggest that climate-sensitive human health impacts will likely be affected by precipitation changes, heat extremes, drought, winter weather changes, disease vectors, surface water, and groundwater. Those most vulnerable to these changes include the very young, elderly, persons with chronic disease (e.g., asthma), persons of low socio-economic status, persons with mental health issues, and those who are socially isolated.

Possible impacts during the four seasons include:

- Spring - More frequent and intense rain events may lead to more flooding with health impacts such as stress and mental health disorders, foodborne and waterborne illnesses, injuries, drowning, and death.
- Summer - Southern Wisconsin may experience approximately 28 more days exceeding 90 degrees Fahrenheit. Health impacts can include heat stress, respiratory disease, allergic reactions, and death.
- Fall - Extended periods of warming could cause more drought with health impacts including water and food insecurity, respiratory distress, allergic reactions, and death.
- Winter - Warmer winters might cause more ice, sleet, and rain. Health impacts may include traffic accidents, power outages, injuries, and death.[23]

Climate change is defined as *"Changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changes in the risk of certain types of severe weather events, and changes to other features of the climate system."*[24]

The Climate Change Explorer[25] looks at the top climate concerns for the country using the 2018 National Climate Assessment. It compares projections for the middle third of this century (2035 to

[23] *Wisconsin Climate and Health Profile Report*, 2014, WI Department of Health Services, Bureau of Environmental and Occupational Health http://www.dhs.wisconsin.gov/publications/P0/P00709.pdf
[24] U.S. Global Change Research Program, 4th National Climate Assessment
[25] https://crt-climate-explorer.nemac.org/

2064) with average conditions observed from 1961 to 1990. Some concerns for the county, which are more thoroughly addressed in relevant chapters of this plan, include:

- Extreme temperatures in Green Lake County have historically averaged 91°F. Extreme temperatures on the hottest days of the year are projected to increase by 7°F.
- Historically, the county has averaged 12 dry spells per year, which are defined as periods of consecutive days without precipitation. Projections show that the number is likely to increase by an average of one more dry spell.
- Intense rainstorms, those that drop two or more inches in one day, have averaged zero in the past, and that count is not projected to increase.
- Changing seasonal patterns may affect agricultural productivity.

The county can use the tool to explore further and to monitor changing conditions over the life of this plan. Future updates will include current data and address any significant changes to climate-related concerns. Population data showing potential Social Vulnerabilities is provided in the Demographics chapter of this plan.

Hydrology

The land in Wisconsin drains into Lake Superior, Lake Michigan, and the Mississippi River. The Mississippi and St. Croix Rivers form most of the western boundary. About one-half of the northwestern portion of the state is drained through the Chippewa River, while the remainder of this region drains directly into the Mississippi or St. Croix Rivers and into Lake Superior. The Wisconsin River has its source at a small lake nearly 1,600 feet above mean sea level on the Upper Michigan boundary and drains most of central Wisconsin. Most of its tributaries also spring from the many lakes in the north. Except for the Rock River, a Mississippi River tributary which flows through northern Illinois, eastern Wisconsin, including Green Lake County, drains into Lake Michigan.

Most of the streams and lakes in the state are ice-covered from late November to late March. Snow covers the ground in practically all the winter months except in extreme southern areas. Flooding is most frequent and most serious in April due to the melting of snow

and spring rains. During this period, flood conditions are often aggravated by ice jams, which back up the flood waters. Excessive rains of the thunderstorm type sometimes produce tributary flooding or flash flooding along the smaller streams and creeks.[26]

The Fox, Puchyan, White, and Grand Rivers flow through Green Lake County, all of which eventually flow into Lake Michigan to the east. Major lakes include Green Lake, Puckaway Lake, Little Green Lake, Grand Lake, Spring Lake, and Lake Maria. Green Lake is the deepest natural lake in the state, with depths up to 236 feet.[27]

Eleven watersheds are contained completely or partially within Green Lake County.[28] The watersheds in the Upper Fox Water Management Unit (WMU) drain into Lake Michigan and include:

- White River:[29] The White River Watershed is located primarily in Waushara County but extends south to Green Lake and Marquette counties. The watershed is 95,879 acres in size and contains 156 miles of streams and rivers, 1,017 acres of lakes, and 18,495 acres of wetlands. The watershed is dominated by forest (29%), grassland (27%), agriculture (21%), and wetlands (19%), and is ranked high for nonpoint source issues affecting groundwater.

- Mecan River:[30] The Mecan River Watershed is located in Waushara and Marquette counties, with a tiny area in Green Lake County. The watershed is 94,917 acres in size and contains 166 miles of streams and rivers, 1,837 acres of lakes, and 18,622 acres of wetlands. The watershed is dominated by forest (33%), agriculture (22%), grassland (22%), and wetlands (19%), and is ranked high for nonpoint sources affecting groundwater.

- Fox River:[31] The Fox River Watershed is located primarily in Winnebago County but extends west to Green Lake County and south to Fond du Lac County. The watershed is 76,643 acres in size and contains 236 miles of streams and rivers, 3102 acres of lakes, and 13,826 acres of wetlands. The watershed is dominated by agriculture (66%) and wetlands

[26] http://www.uwex.edu/sco/state.html
[27] Wisconsin Lakes, Wisconsin Department of Natural Resources, 2005
[28] https://apps.dnr.wi.gov/water/watershedSearch.aspx
[29] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924854
[30] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924925
[31] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924853

(18%) and is ranked high for nonpoint source issues affecting streams, lakes, and groundwater.

- Fox River – Berlin:[32] The Fox River-Berlin Watershed is located primarily in Green Lake County, but extends into parts of Waushara, Winnebago, and Marquette counties. The watershed is 133,595 acres in size and contains 328 miles of streams and rivers, 453 acres of lakes, and 41,067 acres of wetlands. The watershed is dominated by agriculture (41%), wetlands (30%), forest (12%), and grassland (11%), and is ranked high for nonpoint source issues affecting groundwater and medium for nonpoint source issues affecting streams.

- Buffalo and Puckaway Lakes:[33] The Buffalo and Puckaway Lakes Watershed is located in Marquette, Green Lake, and Columbia counties. The watershed is 144,072 acres in size and contains 305 miles of streams and rivers, 5,877 acres of lakes, and 35,513 acres of wetlands. The watershed is dominated by agriculture (27%), wetlands (24%), forest (23%), and grasslands (16%), and is ranked high for nonpoint source issues affecting groundwater.

- Lower Grand River:[34] The Lower Grand River Watershed is located primarily in Green Lake County, but also in Marquette, Columbia, and Dodge counties. It is 70,011 acres in size and includes 185 miles of streams and rivers, 1,264 acres of lakes, and 13,715 acres of wetlands. The watershed is dominated by agriculture (44%), wetlands (19%), forest (17%), and grassland (14%), and is ranked high for nonpoint source issues affecting groundwater.

- Big Green Lake:[35] The Big Green Lake Watershed is located primarily in Green Lake County, but extends east into Fond du Lac County and edges just a bit into the southwestern corner of Winnebago County. The watershed is 68,676 acres in size and contains 141 miles of streams and rivers, 655 acres of lakes, and 5,102 acres of wetlands.

  At the time of the 2010 Census, the Wisconsin Population Lab determined the Big Green Lake Watershed hosted

[32] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924749
[33] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924750
[34] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924855
[35] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924895

12,429 inhabitants. The majority of the land cover in the Big Green Lake Watershed is dominated by Agriculture (65%), followed by Open Land and Water (15.53%). Forest also covers a sizeable portion of the watershed (8.76%), followed by Wetlands, which constitute approximately five and three-quarters of the watershed. The last reasonably sized land cover is Suburban (3.22%). The remainder of land cover constitutes slightly over one and a half percent of the total land cover; these include Urban (0.87%), Grassland (0.81%), and Barren (.07%).

- Upper Grand River:[36] The Upper Grand River Watershed is located in Fond du Lac and Green Lake counties. It is 39,651 acres in size and contains 85 miles of rivers and streams, 41 acres of lake, and 2,973 acres of wetlands. The watershed is dominated by agriculture (76%) and grasslands (8%) and is ranked high for nonpoint source issues affecting groundwater and medium for nonpoint source issues affecting streams

- Swan Lake:[37] The Swan Lake Watershed is located in Green Lake and Columbia counties. It is 51,592 acres in size and contains 113 miles of rivers and streams, 943 acres of lakes, and 6,862 acres of wetlands. The watershed is dominated by agriculture (48%), forest (19%), grasslands (16%), and wetlands (13%), and is ranked high for nonpoint source issues affecting groundwater and medium for nonpoint source issues affecting streams.

The watersheds in the Upper Rock WMU drain into the Mississippi River and include:

- Beaver Dam River:[38] The Beaver Dam River Watershed is located primarily in Dodge County, with small segments lying in Columbia, Green Lake, and Fond du Lac Counties. As in the basin's other watersheds, land use is primarily agricultural (64%), with dairy farming and cash grain cropping predominant. Water quality monitoring indicates that polluted runoff effects are severe on most streams and lakes. Because of this, WDNR selected the watershed as a priority watershed project in 1990, and it began in 1991. Communities with municipal wastewater discharges in the

[36] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924751
[37] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924753
[38] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924754

watershed are Beaver Dam, Fox Lake, Randolph, Lowell, and Reeseville. The Fox Lake Correctional Institution and four industrial facilities also discharge into the watershed.

The Beaver Dam River Watershed drains 292 square miles of land in Dodge, Columbia, Green Lake, and Fond du Lac counties in South Central Wisconsin. The watershed is part of the Upper Rock River Basin. The Beaver Dam River drains to the Crawfish River. The Beaver Dam River Watershed was divided into 17 smaller drainage areas, called subwatersheds, for this planning effort. Land use in the watershed is mainly agricultural, and is currently dominated by dairy and cash grain farming. The watershed population is stable at approximately 35,000 people. About half the population of the watershed lives in rural areas, while half live in the cities of Beaver Dam, Fox Lake, and Juneau.

- Upper Rock River:[39] The Upper Rock River Watershed is divided roughly in half by a county boundary, with the northern portion of the watershed in Fond du Lac County and the southern portion in Dodge County. This watershed encompasses approximately 258 square miles and includes 335 total stream miles, 1,629 total lake acres, and 40,443 total wetland acres. Wetlands and lakes make up 25% of the water resources in the watershed. The dominant water resources in this watershed are both the West and South branches of the Rock River, as well as all of Horicon Marsh. The primary land use is agricultural (59%), but urbanization continues to grow. There are three municipal wastewater facilities discharging into the watershed: Brandon, Burnett, and Waupun. The Kekoskee Sanitary District and one industrial facility also discharge into the watershed.

  The watershed encompasses approximately 259 square miles and includes 335 total stream miles, 1,629 total lake acres, and 34,062 total wetland acres. Agriculture activities and wetlands dominate the landscape in the watershed, with open water/open space and suburban development occurring as minor features.

  There are three municipal wastewater facilities discharging into the watershed: Brandon, Burnett, and Waupun. The

[39] https://apps.dnr.wi.gov/water/watershedDetail.aspx?key=924760

Kekoskee Sanitary District and one industrial facility also discharge into the watershed.

Groundwater reservoirs are recharged by direct precipitation. Spring is a prime time for recharge because evapotranspiration is low, and melting snow and rainfall infiltrate and percolate the water table on unfrozen ground. Fall is another prime time for high recharge. During the summer, groundwater levels drop because precipitation is lower, causing losses to evaporation and transpiration to exceed precipitation. In addition, groundwater is lost to surface waters by discharge in the form of springs.[40] The winter period normally lacks infiltration because of frozen ground.

Groundwater resources constitute an extremely valuable element of the natural resource base of Green Lake County. The groundwater reservoir not only sustains lake levels and provides the base flow of streams in the county, but also comprises a major source of water for domestic, municipal, and industrial water users. Like surface water, groundwater is susceptible to depletion in quantity and to deterioration in quality.

WDNR's Outstanding and Exceptional Resource Waters Program provides a designation for Wisconsin's cleanest waters. An outstanding resource water is defined as a lake or stream that has excellent water quality, high recreational and aesthetic value, high-quality fishing, and is free from point source or non-point source pollution. An exceptional resource water is defined as a stream that exhibits the same high-quality resource values as an outstanding resource water but that may be impacted by point source pollution or that may have the potential for future discharge from a small sewer community. Exceptional resource waters in Green Lake County are:[41]

- Assemble Creek - All
- Snake Creek - To town road bisecting S15 T16N R12
- White Creek – All

Wisconsin is a state with a large quantity of groundwater and is a critical resource both statewide and within the county. It is the main source of drinking water for 70% of Wisconsin residents and 95% of Wisconsin communities. From 1979 to 2005, total water use in Green Lake County increased from 3.8 million gallons per day to 8.3 million gallons per day. The increase in total water use is due

[40] DeVaul, 1967

[41] https://dnr.wisconsin.gov/topic/SurfaceWater/orwerw.html

primarily to an increase in aquaculture and irrigation. The proportion of county water use supplied by groundwater has fluctuated between 94% and 99% during the period 1979 to 2005.

The state has nearly 11,500 public water systems, which meet the daily water needs of about 4 million people. Public water systems that are owned by a community are called municipal water systems, and Green Lake County has five: [42]

- Berlin Waterworks
- Dalton Waterworks
- Green Lake Waterworks
- Markesan Waterworks
- Princeton Waterworks

In addition to the public water systems, about 850,000 private wells provide drinking water to Wisconsin's population. Unlike public water systems, the protection and maintenance of a private well is largely the responsibility of homeowners.

Land use decisions can have impacts on groundwater, as anything that is spilled or spread on the ground can impact the quality. As a result, pollution is a very real threat to the county's water supplies. Ways to protect groundwater include:

- Wellhead Protection Plans and Ordinances: Wellhead protection plans are developed to achieve groundwater pollution prevention measures within public water supply wellhead areas. A wellhead protection plan uses public involvement to delineate the wellhead protection area, inventory potential groundwater contamination sources, and manage the wellhead protection area. All new municipal wells are required to have a wellhead protection plan. A wellhead protection ordinance is a zoning ordinance that implements the wellhead protection plan by controlling land uses in the wellhead protection area. Of the five municipal water systems, only Berlin and Markesan have wellhead protection plans, with Berlin also having a wellhead protection ordinance.

- Animal Waste Management Ordinances: Most Wisconsin counties, including Green Lake County, have adopted an animal waste management ordinance that applies to all unincorporated areas of the county (areas outside of city and

[42] https://wi.water.usgs.gov/gwcomp/find/greenlake/watersystems.html

village boundaries). While the purposes of such ordinances vary among counties, a key purpose is often to protect the groundwater and surface water resources. This is accomplished by regulations such as:

- Permitting of animal waste storage facilities;
- Permitting of new and expanding feedlots;
- Nutrient management;
- Prohibiting:
  - Overflow of manure storage structures;
  - Unconfined manure stacking or piling within areas adjacent to stream banks, lakeshores, and in drainage channels;
  - Direct runoff from feedlots or stored manure to waters of the state;
  - Unlimited livestock access to waters of the state where high concentrations of animals prevent adequate sod cover maintenance.

- Nitrate - The county's aquifers are close to the land surface, and their limited natural protection makes them vulnerable to pollution. From 1990-2006, 81% of 208 private well samples collected in Green Lake County met the health-based drinking water limit for nitrate-nitrogen (NO_3-N), with 78 (38%) containing 2-10 mg/L of NO3-N, and served as indicators that land use has likely affected groundwater quality. Another 39 (19%) of samples exceeded the 10 mg/L limit levels. See the map in Appendix A for locations where limits were exceeded.

  In 2006, the Wisconsin DNR and DATCP reported that NO_3-N is the most widespread groundwater contaminant in Wisconsin and that the nitrate problem is increasing both in extent and severity, with 80% of nitrate inputs originating from manure spreading, agricultural fertilizers, and legume cropping systems. Septic systems can also be a significant nitrate source in densely populated areas, areas where fractured bedrock is near the surface, or areas with coarse-textured soils. Additionally, concentrations of NO_3-N in private wells frequently exceed the drinking water limit. For example, in 2005, 11.6% of 48,818 private wells exceeded the nitrate limit.

Land use affects nitrate concentrations in groundwater, with a study of over 35,000 private well samples being three times more likely to be unsafe to drink due to high nitrate in agricultural areas, especially those with sandy areas/highly permeable soils, than in forested areas. Groundwater with high nitrate levels from agricultural lands is also more likely to contain pesticides than groundwater with low nitrate levels.

- Pesticides - A pesticide is any substance used to kill, control, or repel pests or to prevent the damage that pests may cause. Included in the broad term "pesticide" are herbicides to control weeds, insecticides to control insects, and fungicides to control fungi and molds. Pesticides are used by businesses and homeowners as well as by farmers, but figures for the amounts and specific types of pesticides used are not generally available on a county-by-county basis. A 2005 report indicates that approximately 13 million pounds of pesticides are applied to major agricultural crops in Wisconsin each year, including over 8.5 million pounds of herbicides, 315,000 pounds of insecticides, one million pounds of fungicides, and 3 million pounds of other chemicals (this last category applied mainly to potatoes). The report also shows that herbicides are used on 100% of carrots for processing, 99% of potatoes, 98% of cucumbers for processing, 98% of soybeans, 97% of field corn, 89% of snap beans for processing, 87% of sweet corn, and 84% of green peas for processing. Insecticides are used on 97% of potatoes, 96% of carrots, and 88% of apples. Fungicides are used on 99% of potatoes, 88% of carrots, and 89% of apples.

  A 2002 study estimated that 36% of private drinking water wells in the region of Wisconsin that includes Green Lake County contained a detectable level of an herbicide or herbicide metabolite. Pesticides occur in groundwater more commonly in agricultural regions, but can occur anywhere pesticides are stored or applied. 14,380 acres of land in Green Lake County are in atrazine prohibition areas.

- Arsenic - Arsenic is an element that occurs naturally in some of Wisconsin's aquifers and may contaminate well water drawn from those aquifers. It is a particular

problem in parts of the Fox River valley of northeastern Wisconsin. However, arsenic has been detected in wells in every county in Wisconsin, and arsenic concentrations greater than the drinking water limit of 10 µg/L (micrograms per liter, or parts per billion) have been documented in 51 of Wisconsin's 72 counties. 100% of 10 private well samples collected in Green Lake County met the health standard for arsenic. Of the 16 water samples analyzed for arsenic in Green Lake County, six samples (38%) have detectable arsenic, and no samples are greater than the recently reduced drinking water limit of 10 µg/L (or parts per billion). Most private wells in the county have unknown arsenic levels.

- Contaminated Groundwater and/or Soil - Properties that were or are contaminated with hazardous substances can be found using the WDNR's Bureau for Remediation and Redevelopment Tracking System (BRRTS).[43] Green Lake County has six open leaking underground storage tank (LUST) sites, which have contaminated soil and/or groundwater with petroleum, which includes toxic and cancer-causing substances. However, given time, petroleum contamination naturally breaks down in the environment. There are eight environmental repair (ERP) sites, which are sites other than LUSTs that have contaminated soil and/or groundwater. Examples include industrial spills or dumping, buried containers of hazardous substances, and closed landfills that have caused contamination.

- Concentrated Animal Feeding Operations (CAFO) - There are four concentrated animal feeding operations (i.e., greater than 1,000 animal units) in Green Lake County. Three (i.e., Hilltop Dairy, LLC; MAM Farms, Pride View Dairy) have current operating permits, and one has an expired permit (i.e., Trillium Hill Farms).[44] CAFOs are required under their Wisconsin Pollutant

[43] https://dnr.wi.gov/topic/Brownfields/botw.html
[44] https://www.dnr.state.wi.us/topic/AgBusiness/data/CAFO/cafo_cty.asp?CountyChoice=Green+Lake&Submit=Submit

Discharge Elimination System (WPDES) permits to practice proper manure management and ensure that adverse impacts to water quality do not occur. Permit applicants must submit detailed information about the operation, a manure management plan, plans and specifications for all manure storage facilities, and a completed environmental analysis questionnaire. Once a WPDES CAFO permit is issued, operators must comply with the terms of the permit by following approved construction specifications and manure spreading plans, conducting a monitoring and inspection program, and providing annual reports. Other potential groundwater contaminants from agriculture include fertilizers and pesticides. Large amounts of nitrogen fertilizers are used when fields are planted continuously with corn, and they can leach into groundwater as nitrate.[45]

- Licensed Landfills and Superfund Sites – There is one licensed landfill (WMWI – Valley Trail in Berlin) and no Superfund sites in Green Lake County. In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the Superfund law. The Superfund law created a tax on the chemical and petroleum industries, which went into a trust fund to help pay for cleaning up abandoned or uncontrolled waste sites. The U.S. Environmental Protection Agency (EPA) administers the Superfund trust fund and works closely with state and local governments and tribal groups to remediate sites that may endanger public health or the environment. The contamination at many of these sites was created years ago when environmental regulations were virtually nonexistent and companies dumped or emitted hazardous materials freely into the environment. Years later, the threat to humans and the ecosystems remains so great that the sites need to be cleaned up.

  Since much of this contamination was caused many years ago, it can be hard to find the parties responsible, or the parties responsible may be unwilling or unable to pay for the cleanup. In these cases, the Superfund trust

[45] https://dnr.wi.gov/topic/AgBusiness/CAFO/

fund can be used to pay for most of the cleanup process. States must pay for a portion of such cleanups. CERCLA also provides the EPA with enforcement tools to compel those responsible for causing the contamination to pay for the cleanup, including the issuance of administrative orders. If the trust fund is used, then EPA and the state may go to court to recover their expenditures from those who are responsible.

- Cleanup -
  - Petroleum Environmental Cleanup Fund Award - Over $11 million has been spent in Green Lake County on petroleum cleanup from leaking underground storage tanks, which equates to $579 per county resident. The Petroleum Environmental Cleanup Fund Award (PECFA) program was created in response to the enactment of federal regulations requiring release prevention from underground storage tanks and cleanup of existing contamination from those tanks. PECFA is a reimbursement program returning a portion of incurred remedial cleanup costs to owners of eligible petroleum product systems, including home heating oil systems. As of May 31, 2007, $11,089,396 has been reimbursed by the PECFA fund to clean up 61 petroleum-contaminated sites in Green Lake County. This equates to $579 per county resident, which is more than double the statewide average of $264 per resident.
  - Nitrate Removal Systems – As of 2005, over 20 municipal water systems in Wisconsin have spent over $24 million reducing nitrate concentrations in municipal water systems. In Green Lake County, the Village of Dalton has spent $35,000 on a well reconstruction project to reduce nitrate concentrations in its municipal water system. This equates to $117 per person in its service district and incurs $940 in annual maintenance costs.

Soil Types

The soil of Green Lake County is similar to that found throughout Wisconsin, which varies from droughty and loamy sands to very poorly drained wet organic soils with a wide range of well-drained to moderately well-drained, sandy and silty loams between these extremes. In general, most of the soils of Green Lake County are suitable for agricultural pursuits (i.e., farming crops such as corn, soybeans, or vegetables and/or livestock production). A Green Lake County soil survey was prepared by the Natural Resources Conservation Service[46].

A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil. According to the "Soil Survey of Green Lake County, Wisconsin"[47] there are seven soil associations in Green Lake County:

- Plano-Mendota-St. Charles association is described as well-drained and moderately well-drained, nearly level to sloping soils that have a subsoil mainly of silt loam and silty clay loam underlain by calcareous, gravelly, or very gravelly sandy loam glacial till.

- Kidder-Rotamer-Grellton association is described as well-drained and moderately well-drained, nearly level to steep soils that have a subsoil mainly of loam, clay loam, and sandy clay loam underlain by calcareous, gravelly sandy loam glacial till.

- Lapeer-Mecan-Okee association is described as well-drained and somewhat excessively drained, gently sloping to steep soils that have a subsoil of sandy loam underlain by calcareous, gravelly sandy loam or gravelly loamy sand glacial till.

- Oakville-Brems-Granby association is described as well-drained, moderately well-drained, and poorly drained, nearly level to steep soils that have a subsoil of fine sand underlain by fine and medium sand.

[46] http://websoilsurvey.nrcs.usda.gov/app/
[47] Soil Survey of Green Lake County, 1977 - https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/wisconsin/green_lakeWI1977/greenlake.pdf

- Boyer-Oshtemo-Gotham association is described as well-drained and somewhat excessively drained, nearly level to steep soils that have a subsoil mainly of loamy fine sand, sandy loam, and loamy sand underlain by sand or stratified sand and gravel outwash.

- Willette-Poy-Poygan association is described as very poorly drained and poorly drained, nearly level organic soils and soils that have a subsoil of silty clay and clay underlain by sand or calcareous clay and silty clay.

- Adrian-Houghton association is described as very poorly drained, nearly level organic soils underlain by sandy, loamy, or clayey material or marl.

Wetlands

From the sedge meadows of southern Wisconsin to the spruce bogs in the north, wetlands cover a wide array of landscapes. They share in common the ability to support aquatic or "water-loving" plants and provide habitat for more species of plants and animals than any other type of landscape in Wisconsin. Habitat is not their only functional value. Wetlands can also store water to prevent flooding, purify water, protect lake and stream shores from eroding, and provide recreational opportunities for wildlife watchers, anglers, hunters, and boaters.[48]

Because wetlands provide many benefits to the environment, several municipal, state, and federal ordinances/regulations protect wetland areas. The basic concept associated with these laws is that wetland areas on any property cannot be disturbed without a permit. Wetlands store flood waters and filter water from precipitation before it enters lakes and streams. Some wetlands also recharge local groundwater aquifers. By slowing water movement, wetlands reduce the likelihood that heavy rainfall or spring snowmelt will cause erosion and flooding. Wetlands retain eroded soil and hold nutrients that would otherwise promote excessive weed growth and algae blooms in lakes and streams. These nutrients, when held in the wetlands, produce a heavy growth of vegetation that provides nesting sites, food, and cover for waterfowl, small mammals, and many other types of wildlife.

[48] https://dnr.wisconsin.gov/topic/Wetlands

Wetlands also provide recreational opportunities for humans (wildlife observation, hiking, hunting, etc.).

There are three basic factors in determining whether a property is a wetland:

- The presence of water at, near, or above the surface (hydrology).
- Water is present long enough to sustain aquatic plant life (hydrophytic vegetation).
- Soils are indicative of wet conditions (hydric soils).

Figuring out what is or is not a wetland can be extremely confusing if you only associate "wetlands" with the presence of water. It is possible that a property could have standing water for a portion of the year and still not be a wetland, and it is also possible that a true wetland with all three of the above characteristics may never have water present above the land surface.

Wetlands serve a variety of functions, including playing an important role in stormwater management and flood control, filtering pollutants, recharging groundwater, providing a habitat for many wildlife species and plants, and offering open space and passive recreational opportunities. Wetlands include all marshes, swamps, fens, bogs, and those areas excluded from cultivation or other uses because they are intermittently wet.

There are two main levels of jurisdiction (often overlapping) concerning wetlands in Green Lake County are the Wisconsin Department of Natural Resources and municipal zoning agencies. The Land Use Planning and Zoning Department has jurisdiction over wetlands in county zoning plans, while wetlands within city or village boundaries are also subject to the appropriate municipality's regulations. According to the Wisconsin Department of Natural Resources, Green Lake County has approximately 58,816 acres of wetlands (approximately 25.9% of its total area). This is 1.1% of the total statewide acreage of wetlands.[49]

Land Use

Green Lake County is primarily a rural community in the east-central portion of the state. The land in Green Lake County consists

[49] https://dnr.wisconsin.gov/topic/Wetlands

of farmland, shoreland, and forests as well as commercial, residential, and industrial land. The total land area is 354 square miles. The total water area is 26 square miles. The county has some natural areas that will not be developed and some rural farming areas, as well as light manufacturing and other primarily service businesses that have chosen to locate in the area.

Natural Areas

Green Lake County has many natural areas, including:

- **Berlin Fen State Natural Area**[50] contains two mound fens, the smaller on the south side near the abandoned railroad trail and the larger covering nearly the entire northern portion of the site. The mounds are dome-shaped piles of wet calcareous peat and have unique combinations of plants. The larger mound is dominated by shrubby cinquefoil and chairmaker's rush, while the smaller mound is dominated by prairie grasses.

- **Fountain Creek Wet Prairie State Natural Area**[51] is a large, wet, low prairie situated in the basin of the Grand River Marsh. The wet prairie, a rare community type in Wisconsin, is characterized by prairie cord grass, bottle gentian, blue-joint grass, Kalm's brome, mountain mint, prairie blazing-star, marsh fern, and Michigan lily.

- **Princeton Prairie State Natural Area**[52] is located in an extensive basin where the meandering White and Puchyan

[50] https://dnr.wisconsin.gov/topic/statenaturalareas/BerlinFen

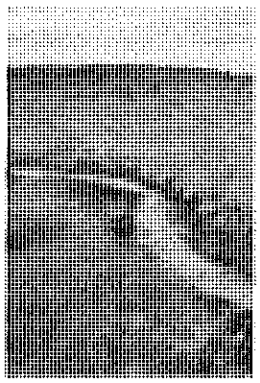
[51] https://dnr.wisconsin.gov/topic/statenaturalareas/FountainCreekWetPra

[52] https://dnr.wisconsin.gov/topic/statenaturalareas/PrincetonPrairie

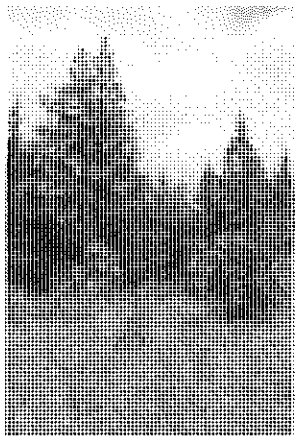
Rivers empty into the Fox River, Princeton Prairie features a high-quality wetland complex with numerous rare plants and animals. The site contains a diversity of wetland communities with southern sedge meadow, wet-mesic prairie, and open marsh.

- **Puchyan Prairie State Natural Area**[53] features a mosaic of wetland communities, including a large wet-mesic prairie, marsh, and sedge meadow in the floodplain of the Puchyan River.

- **Snake Creek Fen State Natural Area**[54] features a high-quality calcareous fen and associated springs located within a large wetland complex in the Snake Creek corridor. The fen is characterized by saturated soil and is dominated by prairie grasses and forbs, along with several indicator fen species.



- **White River Prairie-Tamaracks State Natural Area**[55] contains one of the largest tamarack bogs and one of the largest and least disturbed wet prairies remaining in Wisconsin. The tamarack bog contains a dense canopy of tamarack with an understory dominated by sphagnum moss, with a sparse willow and dogwood component. The low, wet prairie contains an excellent flora with some fen aspects and is dominated by a great diversity of native species.



[53] https://dnr.wisconsin.gov/topic/statenaturalareas/PuchyanPrairie
[54] https://dnr.wisconsin.gov/topic/statenaturalareas/SnakeCreekFen
[55] https://dnr.wisconsin.gov/topic/statenaturalareas/WhiteRiverPrairieTamaracks

- **White River Sedge Meadow State Natural Area**[56] features the largest southern sedge meadow in Wisconsin and contains a full variety of environmental gradients due to the extensive size of the natural area. The wetland complex contains a deep marsh with cattails and tussock sedge, and contains a good variety of emergent aquatic species to the south. Scattered shrub-carr islands are also present. Because of its size, White River Sedge Meadow has been identified as the best opportunity within Wisconsin to manage wet meadow birds.

Vegetation

The vegetation in Green Lake County consists mostly of oak savanna. In the north and west, large areas of soft maple are present. In the southeast areas of prairie bluestem and composites are present.[57]

[56] https://dnr.wisconsin.gov/topic/statenaturalareas/WhiteRiverSedgeMeadow

[57] http://www.wisconline.com/counties/greenlake/index.html (now archived)

Demographics

Human Settlement Patterns

The first evidence of human settlement in the Mississippi River Region was approximately 11,000 years ago, following closely the withdrawal of the Wisconsin glacier. These earliest known "Paleo-Indians" were hunter-gatherers who traveled in small nomadic family groups. This Ice Age era was known geologically as the Pleistocene period.

Between 1670 and 1680, the first Europeans to visit this land were the French traders who established trading and military posts in the name of France, and the Jesuits who brought Christianity to the native inhabitants. Because the French made no definite settlement of the territory, they yielded their rights to the English in 1761, who claimed possession until after the Revolutionary War. By the Treaty of 1835, the Indian tribes gave up their homeland and were moved to the country west of the Mississippi.

Green Lake County has only existed since 1858, but its settlement started much earlier. Originally under the judicial jurisdiction of Brown County, the territory was established as Marquette County in 1836 and fully organized in 1848 with the county seat at Marquette. Green Lake County was separated from Marquette County by an Act of Legislation in 1858, with the county seat at Berlin. In 1862, the citizens voted to move the county seat to Dartford (now known as Green Lake). In 1863, the first courthouse was built in Dartford at the present site. In 1866, dissension between the factions moved the county seat to Princeton with an early morning raid on the records. In the same year, the Supreme Court ordered the county seat back to Dartford. Later attempts were made to detach the western towns from Fond du Lac County to Green Lake County and make Ripon the county seat. Those efforts failed.

Luther Gleason is credited with being the first to settle in the new territory near the village of Marquette on the Fox River, migrating from Vermont in 1831. He was an Indian trader and kept a store. James Powell settled in the Town of Green Lake in 1835 or before. Hiram McDonald was the third settler in the County. He was located in the town of Mackford in 1836.

Anson Dart and his two sons located at the outlet of Twin Lakes in 1840 and put up the first frame house. In 1843, William Dakin and Satterlee Clark settled near the Center House. The first Post Office in the County was at Mr. Clark's. Mr. W.A. Millard was probably the first settler on the Village of Manchester site, arriving in 1846. In 1846, R. Day, J. Burt, Henry Pratt, and others came to Little Green. In 1847, the county comprised three electoral precincts, Puckaway, Lake Marie, and Big Green. In that same year, Mr. Atkins put up a log cabin in the Town of Berlin.

In May of 1847, Nathan Strong entered the land on which part of the City of Berlin now stands. Joel Day erected the first frame house here in 1848. The settlement was originally called Strongsville.

Also, in 1847, Datus Lewis, J. Larkin, and others commenced the Seventh Day Baptist settlement in the town of Berlin on the east side of the river and named the area Berlin after their former home in upstate New York. John Winchell built a log cabin in the town of Princeton in 1848. In July of 1848, Royal Treat purchased 132 acres and plotted out the city in 1849. It was originally called Treat's Landing. The Town of Brooklyn, at first settlement, was called Lexington. On its organization in January of 1849, the name was changed to Arcade and again changed to Brooklyn in the winter of 1850.

The first settler in Seneca, Mr. Ayshford, arrived about 1850. The Village of Kingston was organized in 1858, and Green Lake County is officially recognized.[58]

Population

In the 2020 U.S. Census, the county was home to 19,016 people, and according to the 1 July 2023 U.S. Census Bureau estimate,[59] there were 19,344 people residing in Green Lake County for an increase of approximately 1.7%.

According to the 2019-2023 U.S. census projection, there were 8,143 households in Green Lake County with an average of 2.31 people per household. The same projection indicates that the median household income was $66,917 and that the per capita

[58] https://www.greenlakecountywi.gov/general/green-lake-county-history/?s=history#
[59] https://www.census.gov/quickfacts/fact/dashboard/greenlakecountywisconsin,US/PST045221

income was $37,510. Approximately 10.4% of the people live below the poverty line. The 2023 census estimate also indicated that there were approximately 10,817 housing units within the county as of July 1.

According to the U.S. Census report, the majority of people in Green Lake County reported that they were white (96.1%), with 91.1% stating they were white alone. People of Hispanic or Latino origin were counted as a subcategory of those reporting that they were white. Those reporting as two or more races were 1.2%. American Indians account for 0.8% of the population of Green Lake County. Black alone was 0.9%, and Asian alone was 0.8%.

Other miscellaneous demographic information reported by the Census Bureau is detailed below. These figures identify potential needs for special consideration in a disaster response or in recovery operation planning and implementation.

- People under 5 years old: 5.3%
- People under 18 years old: 21.7%
- People over 65 years old: 24.1%
- Females: 49.7%
- Foreign born: 1.6%
- People with a disability, under 65 years old: 10.7%

The Climate Change Explorer[60] utilizes U.S. Census data to find disadvantaged communities that may suffer extreme adverse impacts due to climate change and/or natural hazards. Additional data can be found by clicking on the link to Explore Neighborhoods at Risk.

Green Lake County contains the Cities of Berlin, Green Lake, Markesan, and Princeton; the Villages of Kingston and Marquette; and the Towns of Berlin, Brooklyn, Green Lake, Kingston, Mackford, Manchester, Marquette, Princeton, Seneca, and St. Marie.

Transportation Network

Green Lake County has an adequate transportation network that connects the county's inhabitants and visitors to commercial,

[60] https://crt-climate-explorer.nemac.org/

recreational, and educational sites. These roadways support the majority of traffic movements within the county.

Although private vehicles are the primary mode of transportation in Green Lake County, there are biking and pedestrian opportunities available to the residents and visitors. The primary transportation system consists of a hierarchical network of state and county highways, as well as other local roads and streets that pass through or near the county. There are no interstate highways located within the county.

To help plan for current and future traffic conditions, it is useful to categorize roads based on their primary function. Functional classification is the process by which highways are grouped into classes according to the character of services they are intended to provide, ranging from a high degree of travel mobility to land access functions.[61] Green Lake County roads and their classifications include: [62]

Rural Principal arterials serve corridor movements having trip length and travel density characteristics of an interstate or interregional nature.

- State Highway 23

Rural Minor arterials, in conjunction with principal arterials, serve moderate to large-sized places (cities, villages, towns, and clusters of communities) and other traffic generators, providing intra-regional and inter-area traffic movements.

- State Highway 44
- State Highway 49
- State Highway 73
- State Highway 91

Rural Major Collectors, provide service to smaller-to-moderate places and other intra-area traffic generators, and link those generators to nearby larger population centers (cities, villages, and towns) or higher function routes.

- State Highway 44
- County Road A

[61] https://wisconsindot.gov/Pages/projects/data-plan/plan-res/function.aspx
[62] https://wisconsindot.gov/Documents/projects/data-plan/plan-res/functional/rural/greenlake.pdf

- County Road AW
- County Road B
- County Road C
- County Road D
- County Road E
- County Road F
- County Road GG
- County Road H
- County Road HH
- County Road J
- County Road K
- County Road M
- County Road P
- County Road S
- North and South Lawson Drive, Green Lake
- Mill Street, Green Lake
- South Street, Green Lake
- Thrasher Drive, Green Lake

Rural Minor Collectors, provide service to all remaining smaller places, link the locally important traffic generators with their rural hinterland, and are spaced consistently with population density so as to collect traffic from local roads and bring all developed areas within a reasonable distance of a collector road.

- County Road A
- County Road B
- County Road BB
- County Road EE
- County Road FF
- County Road H
- County Road JJ
- County Road KK
- County Road N
- County Road O
- County Road Q
- County Road S
- County Road T
- County Road X
- County Road XX
- Horner Road
- Puckaway Road

- Saint Marie Road
- Spring Grove Road
- North and South Capron Street, Berlin
- Center Street, Berlin
- Ceresco Street, Berlin
- West Cumberland Street, Berlin
- West Franklin Street, Berlin
- East Marquette Street, Berlin
- Memorial Drive, Berlin
- Mound Street, Berlin
- West Park Avenue, Berlin
- South Pearl Street, Berlin
- Quarry Street, Berlin
- South Washington Street, Berlin
- Water Street, Berlin
- South Wisconsin Street, Berlin
- Illinois Avenue, Green Lake
- Lake Street, Green Lake
- Mill Street, Green Lake
- North Street, Green Lake
- Northwest Road, Green Lake
- Water Street, Princeton

All other rural roads not classified as arterials or collectors are referred to as local function roads. A map in Appendix A shows the various roads in the county and their classifications.

The Green Lake County Highway Commission is responsible for the year-round maintenance of 229 miles of county trunk highways and 70 miles of state highways.[63] With continued maintenance, these roads will continue to serve the population effectively.

Non-passenger rail lines that pass through the county are the Union Pacific and the Wisconsin and Southern Railroad. There are no commercial ports located in Green Lake County. The nearest commercial port is located in Green Bay; passenger ferries are located in Manitowoc and Milwaukee, offering passage across Lake Michigan to Lower Michigan. There are no airports in Green Lake County. The nearest airports are located in Appleton, Madison, Green Bay, and Milwaukee. There is no bus service providing transportation within the county.

[63] https://www.greenlakecountywi.gov/departments/highway/

Land Use and Development Trends

Land use is an important determinant in the potential impact a particular hazard may have, and an action that may be taken to mitigate the hazard's impact. An understanding of the amount, type, and spatial distribution of urban and rural land uses within the county is an important consideration in the development of a sound hazard mitigation plan.

Green Lake County is primarily a rural community with some natural areas that will not be developed and some rural farming areas, as well as light manufacturing and other primarily service businesses that have chosen to locate in the area.

The county was experiencing slow growth on par with other demographically similar Wisconsin counties until the economic "Great Recession" that began in 2008, which has halted growth and actually constricted community activity in some areas. As of the time of this plan, it is expected that growth trends will mirror the recovery of the general national, state, and regional economy, which is difficult to predict at this time.

Current land use is variable and includes residential, commercial, industrial, agricultural, wetlands, woodlands, and unused rural/open lands. The Wisconsin Department of Revenue (WDOR) tax assessment data classifies the land use in Green Lake County as follows[64]:

- *Agricultural (Includes WDOR categories of Forest, Agricultural Forest, and Other) - Lands devoted primarily to agriculture, small-scale agricultural forestation,* and lands that are producing, or are capable of producing, commercial forest products (as defined by State of Wisconsin Statute 70.05) and other supporting activities. Also includes lands containing dwelling units and related improvements associated with agricultural use. This category does not include forests or woods that are in parks or that are not being forested under WDOR definitions.
- *Residential* - Lands containing dwelling units and related improvements not associated with agricultural use.

[64] https://www.revenue.wi.gov/slfreportscotvc/2017soaGReenLake.pdf

- *Commercial* - Lands, including improvements, devoted primarily to commercial operations, including, but not limited to, dining, lodging, and retail sales establishments.
- *Manufacturing* - Lands, including improvements, devoted primarily to manufacturing and industrial operations, including, but not limited to, assembling, processing, and fabricating.
- *Undeveloped* - Lands generally unfit for any of the aforementioned uses, including, but not limited to, parks, hunting grounds, wetlands, ponds, gravel pits, and road rights of way.

Land Use Changes Based on 2024 WDOR Green Lake County Tax Assessment Data [65]

Land Use Category	2023 Equalized Value	2024 Equalized Value	Percent Change
Agricultural	$26,510,600	$29,526,500	11%
Agricultural Forest	$31,439,100	$35,864,900	14%
Forest	$29,582,700	$33,549,000	13%
Residential	$2,927,333,900	$3,334,366,900	14%
Commercial	$278,171,200	$290,648,400	4%
Manufacturing	$32,027,800	$33,319,500	4%
Undeveloped	$54,157,700	$64,353,100	19%
Other	$145,269,700	$166,105,800	14%
Total	**$3,524,492,700**	**$3,987,734,100**	**13%**

The mission of the Green Lake County Land Use Planning and Zoning Department is: "*To provide land use services related to Planning, Code Enforcement, Surveying, Geographic Information Systems (GIS), and Land Records Modernization for the people of Green Lake County, that promotes the public health, safety, and general welfare through well-planned development and responsible stewardship of the land by equitable administration and enforcement of ordinances, regulations, and planning practices.*" To that end, the following projects were identified by the municipalities for potential future development and/or improvement within the county:

[65] https://www.revenue.wi.gov/SLFReportsassessor/2024socgreenlake.PDF

City of Green Lake

- Mill Street bridge – widen the bridge to allow for more flow and a better design. Scour Critical Bridge is being updated to a standard bridge that will accept larger storm events (provided by the County Highway Department). This is a $1.2M project slated for completion in 2025.

City of Berlin

- Replace and increase the storm sewer on East Marquette Street. There is flooding in rain events of 3+ inches per hour (provided by the City of Berlin Department of Public Works). This is a $2M project to be completed during the plan period of 2025-2030.

Village of Marquette, Town of Marquette, and Green Lake County

- County Road H is being rebuilt through the Village of Marquette to assist in drainage mitigation. Run-off causes flooding in low-lying areas, making the road very difficult to drive on due to potholes and narrowing of the road itself. This is a $1M project slated for completion in 2025.

Town of Mackford

- Several roads and intersections in the township are in need of snow fencing due to severe drifting. The county would provide the fence, and the town would provide labor. This project is slated to be completed during the plan period of 2025-2030.

Countywide

- Grading of shoulders to a 4 percent slope for proper run-off (provided by County Highway Department). This is a $15,000 project slated for completion in 2025.

Public Safety Support

The type and location of public emergency services are important considerations in hazard mitigation planning because of the potential direct involvement of such facilities in certain hazard situations. The location of these services is shown on maps in Appendix A.

To coordinate these services, Green Lake County has created an emergency operations plan (EOP). The plan provides a general overview for county and municipal emergency response personnel during response to a number of disasters. This document serves to coordinate the county and local units of government during times of response and recovery. It also provides a link between the county and municipal plans.

The departments listed below provide ongoing training to their staff and participate in periodically scheduled disaster exercises with area hospitals, other emergency medical services, law enforcement, fire services, and emergency management.

Medical and Ambulance Service

The Green Lake County Office of Emergency Management, city and county emergency services responders, hospital emergency staff, and various departments have developed medical and mass casualty plans. These plans will be used in the event of a disaster. Green Lake County communities are served by a complete range of health facilities and health professionals. These health care facilities will coordinate with responding agencies to ensure the best utilization of services and the least injury or loss of life from a disaster situation.

There is one hospital located within the county: [66]

- **ThedaCare Medical Services Center–Berlin Inc.**
  225 Memorial Drive, Berlin, WI 54923

Green Lake County relies on a mix of volunteer, paid-on-call, and paid staff to provide pre-hospital emergency medical services. Details for pre-hospital medical units and their licensing levels are listed below:

- **Berlin Emergency Medical Service**
  Berlin, WI 54923
  License Level: EMT-Paramedic
- **Green Lake Area TEMS Unit**
  Green Lake, WI 54941
  License Level: TEMS Team
- **Green Lake/Brooklyn First Responders**
  Green Lake, WI 54941

[66] https://www.dhs.wisconsin.gov/guide/hospitaldir.pdf

920-229-6135
License Level: First Responder

- **Princeton Ambulance Service**
  Princeton, WI 54968
  License Level: EMT-Basic
- **Southern Green Lake County Ambulance Service**
  Markesan, WI 53946
  License Level: EMT-Intermediate Technician

Each of these departments provides monthly training to their staff, and they participate in periodically scheduled disaster exercises with area hospitals, other emergency medical services, law enforcement, fire services, and emergency management.

Fire Service

Green Lake County is served by seven fire departments, which are staffed primarily by all-volunteer firefighters who attend regularly scheduled training activities. See the Green Lake County Fire Zones Map in Appendix A for district boundary details.

Some county fire departments also feature specialized skills such as water rescue/dive, hazardous materials, and confined space entry. The list of fire departments is below:

- Berlin Fire Department
- Dalton Volunteer Fire Department
- Green Lake-Brooklyn Fire Department
- Kingston Volunteer Fire Department
- Grand River Fire District Markesan Fire Department
- Marquette Volunteer Fire Department
- Princeton Fire and Rescue Department

Law Enforcement

Law enforcement agencies are responsible for responding to criminal incidents, traffic incidents, and other requests for law enforcement services; investigating criminal offenses and

apprehending the perpetrators; investigating law violations; maintaining a smooth, orderly, and safe flow of traffic; and public information activities.

The Green Lake County Sheriff's Department provides service to all the towns and villages for law enforcement and also provides dispatch services to the entire county. The following departments supplement the Sheriff's Department:

- Berlin Police Department
- Green Lake Police Department
- Markesan Police Department
- Princeton Police Department

The sheriff is the chief law enforcement officer in the county and is responsible for the protection of life and property within the boundaries of Green Lake County. The Sheriff's Office provides law enforcement service on a 24-hour basis to unincorporated areas of the county or to those jurisdictions that do not maintain full-time police service.

The Wisconsin State Patrol and Wisconsin Department of Natural Resources also provide law enforcement services within the county. The Wisconsin State Patrol provides limited coverage from its north-central region office in Wausau.[67]

Special Teams

Wisconsin Emergency Management (WEM) contracts and manages twenty-two Regional Hazardous Materials Response Teams. The teams are divided into Task Forces (i.e., Northeast Task Force, Northwest Task Force, Southeast Task Force, Southwest Task Force). These Task Forces are then divided into Type I, Type II, and Type III teams, all with complementary capabilities and training requirements. [80] Hazardous materials response in Green Lake County is performed by Type II and Type III Teams.

[67] http://wisconsindot.gov/Documents/about-wisdot/who-we-are/dsp/dsp-regions-map.pdf

The Wisconsin Hazardous Materials Response System may be activated for an incident involving a hazardous materials spill, leak, explosion, injury, or the potential of an immediate threat to life, the environment, or property. The Wisconsin Hazardous Materials Response system responds to the most serious spills and releases requiring the highest level of skin and respiratory protective gear. This includes all chemical, biological, or radiological emergencies.

In addition, there are regional bomb squad teams, dive teams, and special weapons and tactics (SWAT) teams available throughout the state.

Archaeological and Historical Resources

The National Register of Historic Places also includes a listing of locations in Green Lake County.[68] As mitigation projects are considered, the county is committed to ensuring that archaeological and historical sites are preserved.

Historic Sites		
Historic Site Name	**Address**	**Municipality or Township**
Vacant/Not in Use[69]		
Beckwith House Hotel	101 W. Huron St.	Berlin
Historic Districts[70]		
Huron Street Historic District	Roughly, Huron St. from Fox R. to 124 E. Huron, including adjacent side streets	Berlin
Princeton Downtown Historic District	Approximately .33 miles E from Jct. WI 23 and WI 73	Princeton
State Listing[71]		
Beckwith House Hotel	101 W. Huron St.	Berlin
Beckwith, Nelson F., House	179 E. Huron St.	Berlin
Berlin Post Office	122 South Pearl St.	Berlin
Berlin High School	289 E. Huron St.	Berlin

[68] https://nationalregisterofhistoricplaces.com/wi/green+lake/state.html
[69] https://nationalregisterofhistoricplaces.com/wi/green+lake/vacant.html
[70] https://nationalregisterofhistoricplaces.com/wi/green+lake/districts.html
[71] https://nationalregisterofhistoricplaces.com/wi/green+lake/state.html

Historic Sites		
Historic Site Name	**Address**	**Municipality or Township**
Green Lake County Courthouse	492 Hill St.	Green Lake
Green Lake Village Hall	534 Mill Street	Green Lake
Hamilton-Brooks Site	Address Restricted	Berlin
Huron Street Historic District	Roughly, Huron St. from Fox R. to 124 E. Huron, including adjacent side streets	Berlin
Ketchum, Daniel and Catherine, Cobblestone House	147 East Second Street	Marquette
Luther, J. P., Company Glove Factory	139 S. Pearl St.	Berlin
McClelland--Kasuboski House	W404 W. Hillside Rd.	Berlin
Nathan Strong Park Historic District	Roughly bounded by North Wisconsin, East Moore, North Swetting and East Huron streets	Berlin
Princeton Downtown Historic District	.33 miles between Jct. WI 23 and WI 73	Princeton
Thrasher Opera House	506 Mill St.	Green Lake
Wisconsin Power and Light – Berlin Power Plant	143 Water Street	Berlin

The Wisconsin Historical Society maintains a list of archaeological sites and cemeteries known as the Archaeological Site Inventory Database (ASI); this list is available to governmental agencies upon request. These sites cover an extended period of time and include campsites/villages/communities, cabins/homesteads, sugar maple sites, cemeteries/burial mounds, trading/fur posts, mills/sawmills, and kilns.

All of these sites have been reported to the State Historical Society of Wisconsin and are protected sites. If there is concern that a mitigation project will impact one of these or any other identified or suspected archeological site, the county will work with the proper authorities to ensure that all applicable laws and regulations are followed.

The National Park Service [72] offers technical assistance to disaster-impacted communities. Their Guidance for State and Tribal Historic Preservation Leaders [73] provides information on grants, agencies, and other resources that may be available to provide assistance following a disaster to help ensure proper stewardship of historic properties and the environment. Steps taken to strengthen or rebuild communities can have long-term environmental and cultural impacts.

The county and its municipalities could also contact the National Trust for Historic Preservation [74], which is a privately funded non-profit organization that has led the movement to save America's historic places for more than 70 years. One program they lead is Main Street America[75], which is committed to strengthening communities through preservation-based economic development in older and historic downtowns and neighborhood commercial districts.

[72] https://www.nps.gov/

[73] https://www.nps.gov/subjects/historicpreservationfund/upload/Before_and_After_Disasters_Guide-online-form.pdf

[74] https://savingplaces.org/

[75] https://mainstreet.org/

Hazard Analysis and Previous Mitigation Projects

The following sections identify those hazards that have occurred or could occur in Green Lake County. Each includes a description of a hazard and its frequency of occurrence. Also included is a section that describes the general vulnerabilities of the community and its infrastructure to each particular type of hazard. More detailed and specific analyses will be conducted as projects are identified for inclusion in grant applications. As part of the application process, the methodology of data collection and future development patterns will be addressed. Estimates of potential dollar losses and the methodology used to arrive at those estimates will also be described during this application process. It should be noted that there have been no changes in the county or participating jurisdictions since the last plan update.

Wisconsin Emergency Management (WEM) completed and regularly updates the State Hazard Mitigation Plan, which was last revised in November 2021.[76] This plan describes the hazards that have occurred or are most likely to occur within the state and includes the frequency of occurrence, potential impacts, and suggested actions to mitigate the hazard. This plan is the basis for the development of all emergency management plans and is distributed upon revision to county emergency government directors and other stakeholder agencies.

For this plan, the Green Lake County Hazard Mitigation Plan Workgroup reviewed the past event records, and an internal workgroup consensus was reached on the anticipated probability of future events. This probability was designated as "very high", "high "medium," (3), "low" (2), or "very low" (1) by the workgroup based on their evaluation and experience with the data.

The workgroup understands that historical weather data provided by the National Weather Service does not include events that may adversely affect their communities but fall below the reporting thresholds. However, each weather event was analyzed for historic frequency and averages over the last 25 years and is noted within each section. Additionally, a table with this information is included in Appendix B, Frequency of Occurrence.

[76] https://wem.wi.gov/state-planning/

Hazard	Likelihood of Occurrence*	Severity of Effects if It Does Happen*	Misc. Notes
Drought/Dust Storm	Low	Low	Dust storms shut roadways down (accidents)
Earthquake	Very Low	Very Low	
Flood – Flash & River Flooding	Medium/High	Medium/High	Medium in the wider areas. High where the rivers narrow with no area to spill into (Berlin, Princeton, Markesan).
Flood – Dam Break	Medium (see note)	High	The Green Lake dam would have a higher likelihood due to structures, roads, and houses. Also, the Brooklyn Dam downstream would not be able to handle all that water.
Fog	Low	Low	TN of Mackford & TN Green Lake
Forest Fire	Low	Very Low	
Wildfire	Medium	Medium	
Severe Temperature - Hot	Medium	Low	Have been able to provide community support
Severe Temperature - Cold	Medium	Low	
Hail	High	Medium	Cars, windshields, roofs, and crops
Lightning	High	Medium	Generate fire, take out equipment
Thunderstorm	High	Medium	
Tornado	High	Very High	
Derecho (High Wind)	High	High	
Winter Storm (Snow and Ice)	High	High	
Utility Failure	High	High	Electric, natural gas, and communications

For the purposes of this document, the "Frequency of Occurrence" section will use the following descriptors, as selected by the hazard mitigation planning workgroup when they evaluated the history and their experiences and expectations for the probability of future events. These descriptors are generally assigned the probabilities below, unless otherwise defined within the chapter's text.

Descriptor	Number	Definition
Very Low	1	0% - 20% chance of a damaging incident occurring annually
Low	2	20% - 40% chance of a damaging incident occurring annually
Medium	3	40% - 60% chance of a damaging incident occurring annually
High	4	60% - 80% chance of a damaging incident occurring annually
Very High	5	80% - 100% chance of a damaging incident occurring annually

The National Risk Index (NRI) [77] It is an online tool provided by the Federal Emergency Management Agency (FEMA) that uses the best available source data to help illustrate communities most at risk of natural hazards. It calculates a baseline relative risk measurement for 18 natural hazards based on expected annual loss, social vulnerability, and community resilience.

Although 18 natural hazards are part of this data, some have no value as they do not pose a risk to Green Lake County, or are otherwise not specifically addressed in this plan. [78] Information for the remaining NRI hazards is included in the relevant chapters.

It should be noted that the NRI information may not necessarily match the hazard ratings above and is only being included for reference. General county statistics are below.

Ratings Summary

Risk Index	Very Low
Expected Annual Loss	Very Low
Social Vulnerability	Relatively Moderate
Community Resilience	Very High

[77] https://hazards.fema.gov/nri/map

[78] Hazards from the NRI data that are not included in this plan: Avalanche, Coastal Flooding, Hurricane, Landslide, Tsunami and Volcanic Activity.

Risk Index Overview

Rating	Very Low
Score	41.81
National Percentile	41.81
State Percentile	44.40

Social Vulnerability

Rating	Relatively Moderate
Score	40.52
National Percentile	40.52
State Percentile	80.60

Community Resilience

Rating	Very High
Score	80.62
National Percentile	80.62
State Percentile	51.40

Expected Annual Loss

Rating	Very Low
Score	41.29
National Percentile	41.29
State Percentile	43.10
Total ($)	4,334,707.23
Building Value ($)	2,659,874.50
Population	0.13
Population Equivalence ($)	1,480,195.78
Agricultural Value ($)	194,636.94

The emphasis in the following sections is on mitigation activities for each hazard as a major component of overall emergency management. Mitigation or prevention activities reduce the degree of long-term risk to human life and property from natural and man-made hazards. The cooperation of government, academia, the private sector, and volunteer agencies is essential in mitigation efforts. Green Lake County Emergency Management is committed to working with municipalities and the private sector to ensure that county mitigation information is shared and it is incorporated into their planning as appropriate.

Each community will be given a copy of the plan to use as a reference during their own preparedness activities (i.e., planning, training, permitting, zoning). Communities that have their own comprehensive plan will reference this mitigation plan and its contents in the next scheduled plan update during public meetings, workgroup sessions, and as texts are written. Municipalities that do not have comprehensive plans either are under the purview of and request assistance from the Green Lake County Planning, Resources, and Land Management Department or have their own planning departments. Members of the County Land Use Planning and Zoning Department and municipal planning departments were included on the Hazard Mitigation Workgroup and are aware of the benefits and requirements of utilizing this plan as they go about their preparedness activities.

Green Lake County and its municipalities have a history of identifying, planning, and completing hazard mitigation projects, including these (listed below), which received supplemental funding. It was also noted by the workgroup that there are several opportunities for grant funding from various federal and state resources, including:

- **CDBG** – The U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant-Disaster Recovery Assistance provides flexible grants to help cities, counties, and states recover from Presidentially-declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. In response to disasters, Congress may appropriate additional funding for the CDBG program as disaster recovery grants to rebuild the affected areas and provide crucial seed money to start the recovery process. Since CDBG Disaster Recovery assistance may fund a broad range of recovery activities, HUD can help communities and neighborhoods that otherwise might not recover due to limited resources. Disaster Recovery grants often supplement

the disaster programs of FEMA, the SBA, and the U.S. Army Corps of Engineers (i.e., these funds can be used for the local matching requirement of other federal grants).[79] CDBG Emergency Assistance Program (EAP) Projects:

- EAP #05-03 Cities of Berlin and Green Lake ($356,314) - Rehabilitation of damaged housing units, replacement of wells/septic systems and water/sewer lines, construction of replacement housing units, demolition and clearance of hazardous structures, and acquisition/relocation
- EAP #05-04 Green Lake County ($275,000) - Rehabilitation of damaged housing units, replacement of wells/septic systems and water/sewer lines, construction of replacement housing units, demolition and clearance of hazardous structures, and acquisition/relocation
- EAP #08-08 Green Lake County ($275,000) - Rehabilitation of damaged housing units

CDBG Public Facilities Grants during the 2021 state mitigation planning cycle (2017-2021):

- 2017: City of Princeton - $1,000,000
- 2019: City of Princeton - $420,900
- 2020: City of Berlin - $250,000
- 2021: Village of Markesan - $1,000,000

It was noted by the workgroup that there are several opportunities for grant funding from various federal and state resources, including:

- **HMGP** - The Hazard Mitigation Grant Program (HMGP) is authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster. HMGP is available, when authorized under the Presidential major disaster declaration, in the areas of the state requested by the

[79] http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/drsi

governor.[80] Hazard Mitigation Grant Program (HMGP) Projects Funded in Green Lake County:

- 2008 DR-1768 Green Lake, City $36,360 New

- **PDM** - The Pre-Disaster Mitigation (PDM) program is authorized by Section 203 of the Stafford Act, 42 U.S.C. 5133. The PDM program is designed to assist States, Territories, Indian Tribal governments, and local communities to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding from future major disaster declarations.[81] Pre-Disaster Mitigation (PDM) Projects and/or Plans Funded in Green Lake County[82]

    - 2002 WEM All $15,520 Technical Assistance Personnel, travel, and supplies
    - 2003 WEM All $32,834 Technical assistance Personnel, travel, and supplies
    - 2003C WEM All $176,812 Technical assistance Personnel, travel, and supplies
    - 2005C State of Wisconsin All $182,010 Development of structure inventory database
    - 2005C WEM All $88,480 Technical assistance Personnel, travel, and supplies
    - 2006C WEM All $22,141 Technical assistance Personnel, travel, and supplies
    - 2007C WEM All $70,092 Technical assistance Personnel, travel, and supplies
    - 2007C WEM All $402,574 Update Agreement with UW for HAZUS flood risk assessment
    - 2008C WEM All $23,897 Technical assistance Personnel, travel, and supplies
    - 2008C WEM $18,906 Technical assistance LPDM; personnel, travel, and supplies
    - 2009C WEM All $25,579 Technical assistance Personnel, travel, and supplies
    - 2010C WEM All $47,859 Technical assistance Personnel, travel, and supplies
    - 2016C Green Lake County $27,427.40 Plan Update

[80] http://www.fema.gov/hazard-mitigation-grant-program
[81] http://www.fema.gov/pre-disaster-mitigation-grant-program
[82] Note that several grants to the State of Wisconsin/WEM are listed when searching for Green Lake County projects. These state projects are deemed as benefiting the state's counties but are not listed in this plan because they were not directly received by the county.

- **BRIC** – The Building Resilient Infrastructure and Communities (BRIC) was created as Section 1234 of the Disaster Recovery Reform Act of 2018, which will replace the PDM Grant Program. BRIC is built upon lessons learned from that program and is funded based on a formula of obligations from the previous year for all active disasters, not just one disaster.[83] In 2025, the federal government cancelled this program. At the time of this plan's completion, it was unclear if there would be another program to replace it.
- **FMA** - The Flood Mitigation Assistance (FMA) program is authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). The Repetitive Flood Claims (RFC) program has the goal of reducing flood damages to individual properties for which one or more claim payments for losses have been made under flood insurance coverage, and that will result in the greatest savings to the National Flood Insurance Fund (NFIF) in the shortest period of time.[84] There have been no Flood Mitigation Assistance (FMA) Projects Funded in Green Lake County.[85]
- **SRL** - The Severe Repetitive Loss (SRL) program is authorized by Section 1361A of the NFIA and has the goal of reducing flood damages to residential properties that have experienced severe repetitive losses under flood insurance coverage and that will result in the greatest amount of savings to the NFIF in the shortest period of time.[86]
- **RFC** - The Repetitive Flood Claims (RFC) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). Up to $10 million is available annually for the Federal Emergency Management Agency (FEMA) to provide RFC funds to assist states and communities in reducing flood damages to insured properties that have had one or more claims to the National Flood Insurance Program (NFIP). FEMA

[83] Building Resilient Infrastructure and Communities | FEMA.gov
[84] http://www.fema.gov/flood-mitigation-assistance-program
[85] Note that several grants to the State of Wisconsin/WEM are listed when searching for Green Lake County projects. These state projects are deemed as benefiting the state's counties but are not listed in this plan because they were not directly received by the county.
[86] http://www.fema.gov/severe-repetitive-loss-program

may contribute up to 100 percent of the total amount approved under the RFC grant award to implement approved activities if the applicant has demonstrated that the proposed activities cannot be funded under the FFMA program. [87]

- **406 Mitigation** – The Public Assistance Section 406 Mitigation Funding may be considered by FEMA in a federal disaster declaration to fund mitigation measures to a public facility damaged by the event that enhance the facility's ability to resist similar damage in future events. This funding is authorized under Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act and provides discretionary authority to fund mitigation measures in conjunction with the repair of the disaster-damaged facilities, which usually present themselves during the repair efforts. The mitigation measures must be related to eligible disaster-related damages and must directly reduce the potential for future, similar disaster damages to the eligible facility. This work is performed on the parts of the facility that were actually damaged by the disaster, and the mitigation provides protection from subsequent events. Mitigation measures must be determined to be cost-effective, technically feasible, and in compliance with statutory, regulatory, and executive order requirements. In addition, the measure cannot cause a negative impact on the facility's operation, surrounding areas, or susceptibility to damage from another hazard.[88]

- **Municipal Flood Control Grant Program** - This Wisconsin Department of Natural Resources (DNR) grant is available to all cities, villages, towns, tribes, and metropolitan sewerage districts. Assistance is provided with items such as the acquisition of property, vacant land, structure removal, flood proofing, administrative support, and others.[89] Municipal Flood Control Grant Program Projects Funded in Green Lake County:

    - 2014-15 MFC-24206-14 City of Berlin, Green Lake/Waushara Counties $92,975.40 Marquette Street Storm Sewer Relief

- **Dam Removal Grant Program** - This Wisconsin DNR grant is available to all cities, villages, towns, tribes, and metropolitan sewerage districts and provides 100% of eligible project costs

[87] http://www.fema.gov/repetitive-flood-claims-program
[88] http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit/hazard-mitigation-funding-under-section-406-0
[89] http://dnr.wi.gov/Aid/MunFloodControl.html

up to a maximum of $50,000 to remove a dam. Assistance is provided with items such as: the acquisition of property, vacant land, structure removal, flood-proofing, administrative support, and others.[90] Green Lake County has not received any dam removal grants.

[90] http://dnr.wi.gov/aid/damremoval.html

All Hazards

One of the bedrock principles of emergency management is to approach issues from an all-hazards perspective. This is generally very cost-effective because it accomplishes preparedness and/or mitigation goals for many types of disasters with one resource. Some of the all-hazards mitigation projects that Green Lake County would like to accomplish are detailed in the following sections.

The planning committee also used the all-hazards approach to identify mitigation goals for the county and all of its municipalities. The purpose of the hazard mitigation plan is to identify hazard areas, to assess the risks, to analyze the potential for mitigation, and to recommend mitigation strategies where appropriate. Potential mitigation projects will be reviewed using criteria that stress the intrinsic value of the increased safety for people and property in relation to the monetary costs to achieve this (i.e., a cost-benefit analysis). With that in mind, the overall planning goals for the entire plan, as listed by the mitigation planning committee, were:

- **Objective 1:** To preserve life and minimize the potential for injuries or death.
- **Objective 2: To** preserve and enhance the quality of life throughout Green Lake County by identifying potential property damage risks and recommending appropriate mitigation strategies to minimize potential property damage.
- **Objective 3: To** promote countywide planning that avoids transferring the risk from one community to an adjacent community, where appropriate.
- **Objective 4: To** identify potential funding sources for mitigation projects and form the basis for FEMA project grant applications.

Vulnerability

Perhaps the largest risk that falls under the all-hazards banner is the continuing challenge of securing funding to keep up with the rapid technological changes and advances in the public safety communications infrastructure. When departments cannot communicate with each other, they cannot be effectively coordinated in a disaster, which could cause potential delays in providing critical services to citizens in need.

Another vulnerability is the fact that not all agencies that work together in disaster response and recovery can communicate with one another (i.e., are interoperable). Local first response agencies are generally able to communicate with one another, but communications-related issues will remain ongoing challenges as technologies evolve and departments acquire equipment suitable for their response.

Also, it is a continuing challenge to ensure that emergency services can notify the public in a timely manner. Because of the nature of modern society, adequate notification requires multiple outlets, but managing the usage, cost, and updates of these systems is an ongoing project for all communities.

Hazard Mitigation Strategies

Green Lake County and its municipalities have sought grants and partnerships to reduce the significant costs of improving their core communication networks, but much of the technology upgrade has been funded by county and municipal budgetary expenditures.

In this plan, many of the non-core communications projects that are listed are either not capital improvement projects and therefore are not very expensive (e.g., upgrading Memoranda of Understanding (MOU), updating the website) or they are projects that require significant capital outlays and are, for the most part, grant dependent. Since the profile (e.g., economic, geographic) of an area may change between the identification of a project in this plan and the availability of grant funds, projects will be identified within the plan and be slated for detailed study and analysis at such time as grants become available. The detailed study will identify the types and numbers of existing and future structures, the potential dollar losses to vulnerable structures, and the lead agency or department that will manage the project. At that point, grant-eligible projects will be evaluated using the appropriate grant criteria for factors such as:

- Overall benefit to the community
- Economic feasibility (i.e., a cost-benefit analysis)
- Compliance with environmental, social justice, and other laws

Public Alert and Notification

Public alert and notification plans are vital in a time of crisis to reduce property damage and human casualties. An advance plan allows the appropriate authorities to perform their emergency duties in an efficient manner. Green Lake County will maintain the following:

- Facilities, systems, and procedures to activate warning and communication capabilities,
- Systems to support communications, including:
    - Sirens to warn the public
    - Telephone and radio to notify public personnel
    - Local television, radio, and newspaper to spread warning information
    - Local law enforcement, fire, and rescue communications
    - An emergency communications center,
- Green Lake County Sheriff's office to receive and distribute warning information to the public and emergency management agencies.
- The Green Lake Rotary Club is interested in sirens and flooding concerns.

During an emergency, the general public receives information by sirens, mass notification systems, National Oceanic and Atmospheric Administration (NOAA) weather radio, local broadcast, printed media, door-to-door notification by emergency services personnel, and/or a mobile public address system. It should be noted that the ability to use the NOAA weather radio system for an expanded list of emergency messages is a positive move that makes this alert and warning tool even more valuable. As a result, Green Lake County will continue to promote increased use of these radios among the public.

Methods for notification of those with functional and access needs include door-to-door warnings, foreign language media messages, and closed-caption television messages. Other notices and

procedures can be found in Green Lake County's Emergency Operations Plan, which is reviewed and updated on a regular schedule.

With the above-mentioned program projects, Green Lake County and its municipal partners should be capable of the following:

- Disseminate emergency warning and notification to the public through its county-wide warning systems,
- Support emergency management operations,
- Provide adequate warning and communication systems, and
- Plan for alternative means and resources in the event of a warning or communication system breakdown.

Green Lake County will prepare facilities, systems, and procedures to activate warning and communication. During an emergency, Green Lake County will deliver prompt and accurate warnings to businesses and residents.

Interoperable Communications

The county budget to maintain communications systems has thus far been sufficient and as technology improves and additional interoperability grant funding is made available, the County Emergency Management and Sheriff's Office will monitor and improve the system as able. Green Lake County has recognized the need to improve interoperable communications between municipalities and the county by:

- Bring the Markesan School District and school bus companies from the UHF band to the VHF band. This is for interoperability during school uses and during disasters, when resources may be used by communities.

Website

Geographic information system (GIS) mapping data is available from the Green Lake County website.[91] The county emergency management office has a general webpage and will continue to

[91] http://gis.co.green-lake.wi.us/gisweb/GIS_Viewer/

update it to include links for general preparedness topics from agencies such as the Department of Homeland Security/FEMA, the American Red Cross, and Wisconsin Emergency Management. The county would also like to create a website for people to access during times of disaster so that they can receive the most current information. The Cities of Green Lake and Markesan also have emergency management webpages that they will continue to update for preparedness links.

Planning

Green Lake County and its municipalities have committed to creating and maintaining the emergency plans required to guide the community through all phases of emergency management, including:

- The Cities of Berlin, Green Lake, and Princeton have completed a Comprehensive Plan, which will be continually reviewed and consulted as development continues over the 10-year life cycles of the plans.
- The City of Princeton created an Emergency Operations Manual, which will be reviewed and updated annually.

Equipment

Green Lake County and its municipalities have identified the following weather stations and siren projects:

- City of Markesan: Purchase and install three more weather data collection stations. The goal is to purchase web-enabled devices that could share information with the National Weather Service as well as provide current information to citizens on the city website.
- The Town of Kingston is looking to add a siren to cover the Amish community of Dalton, which is unincorporated.
- Upgrade area early warning sirens:
    - City of Markesan: Has four sirens and two need replacing.
    - City of Markesan/Town of Green Lake: Siren for the Soldiers & Sailors City Park.

- City of Green Lake: Continue maintaining the civil defense siren on the downtown courthouse or move to a new location if the courthouse is sold to a private developer.

The City of Princeton would like to explore the purchase of emergency lighting equipment since Princeton owns the Electric Utility and would be responsible for emergency lighting when outages take place.

Drought and Dust Storms

Two types of drought occur in Wisconsin: agricultural and hydrologic. Agricultural drought is a dry period that reduces crop yields. Hydrologic drought is a dry period of sufficient length and intensity to affect lake and stream levels and the height of the groundwater table. These two types of drought may, but do not necessarily, occur together.

Dust storms result from a combination of high winds and dry, loose soil conditions. While high winds and periods of drought have each occurred in Green Lake County, there has never been a recorded dust storm event. Since natural hazards that have occurred in the past are more likely to occur in the future, it is unlikely that a dust storm event will occur in Green Lake County. This assertion is further bolstered by the fact that, while there is some irrigation done within the county, the soils in Green Lake County are not prone to blowing. While there are concerns about topsoil erosion, and some mitigation activities may be planned that would reduce the effects of these types of events, they will not be a major focus of this plan.

Physical Characteristics

The understanding that a deficit of precipitation has different impacts on groundwater, reservoir storage, soil moisture, snowpack, and streamflow led to the development of the Standardized Precipitation Index (SPI) in 1993. The SPI quantifies the precipitation deficit for multiple time scales. These time scales reflect the impact of drought on the availability of the different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, streamflow, and reservoir storage reflect longer-term precipitation anomalies. For these reasons, the SPI is calculated for 3, 6, 12, 24, and 48-month time scales.

The SPI calculation for any location is based on the long-term precipitation record for a desired period. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and

desired period is zero. Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation. Because the SPI is normalized, wetter and drier climates can be represented in the same way, and wet periods can also be monitored using the SPI.

The classification system shown in the SPI values table (below) defines drought intensities resulting from the SPI. The criteria for a drought event are also defined for any of the time scales. A drought event occurs any time the SPI is continuously negative and reaches an intensity of -1.0 or less. The event ends when the SPI becomes positive. Each drought event, therefore, has a duration defined by its beginning and end and an intensity value for each month that the event continues. The positive sum of the SPI for all the months within a drought event can be termed the drought's "magnitude." Current SPI maps for the United States are available online. [92]

SPI Values[93]	
2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to 1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2.0 and less	Extremely dry

The Palmer Index is an older scale and is used more often by governmental organizations. It is effective in determining long-term drought (i.e., over several months) and is not as good with short-term forecasts (i.e., weeks). It uses a zero as normal; drought is shown in terms of negative numbers, and excess moisture is reflected by positive figures. The future incidence of drought is highly unpredictable and may also be localized, making it difficult to determine probability with any accuracy.

Drought conditions may vary from below-normal precipitation for a few weeks to a severe lack of normal precipitation for several months. Drought primarily affects agricultural areas because the amount and timing of rainfall have a significant impact on crop production. The severity of a drought cannot, therefore, be

[92] https://www.drought.gov/data-maps-tools/us-gridded-standardized-precipitation-index-spi-nclimgrid-daily
[93] https://drought.unl.edu/ranchplan/DroughtBasics/WeatherandDrought/MeasuringDrought.aspx

completely measured in terms of precipitation alone but must include crop yields.

Frequency of Occurrence

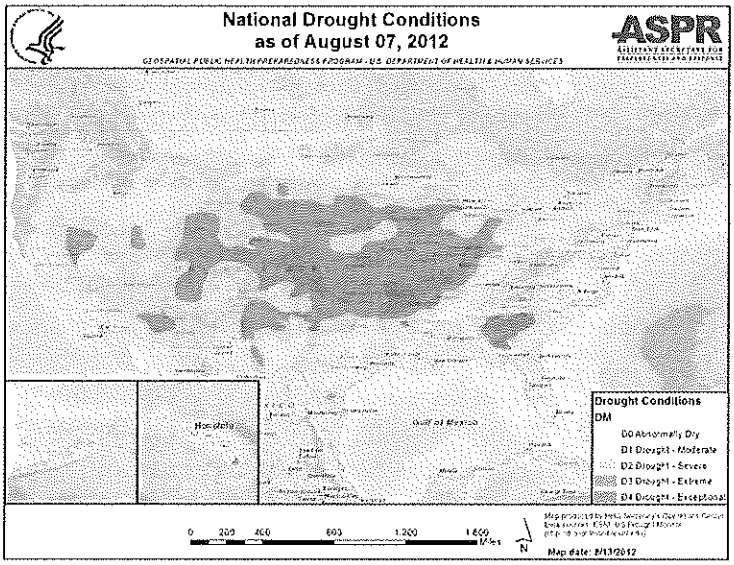
Drought is a relatively common phenomenon in Wisconsin and has occurred statewide in 1895, 1910, 1939, 1948, 1958, 1976, 1988, 1992, 2003, 2005, and 2012. The 1976 drought received a Presidential Emergency Declaration with damage to 64 Wisconsin counties, including Green Lake.[94] Estimated losses of $624 million primarily affected the agricultural sector. Reports show that Green Lake County was as affected as the rest of the state in this drought, receiving money for emergency feed programs for livestock and for increased fire protection of its wilderness areas. It should be noted that only 19% ($119,434,924) of this loss was compensated by any federal program.

The 2012 heat wave resulted in significant droughts across more than half the country, as well as increases in heat-related illnesses and deaths. July 2012 was the hottest month in US history, eclipsing the record set during the heart of the Dust Bowl in 1936. The worst of the heat was in the Midwest, the Plains, and along the Eastern Seaboard. Most of the contiguous U.S. had record and near-record warmth for the seven-month period, except the Pacific Northwest, which was near average. The August 7, 2012, Drought Monitor map shows 52.27% of the United States and Puerto Rico in moderate drought or worse, with Green Lake County in the D2 – Severe Drought category.[95] As of February 11, 2025, Green Lake County is partially in the D0- Abnormally Dry category.[96]

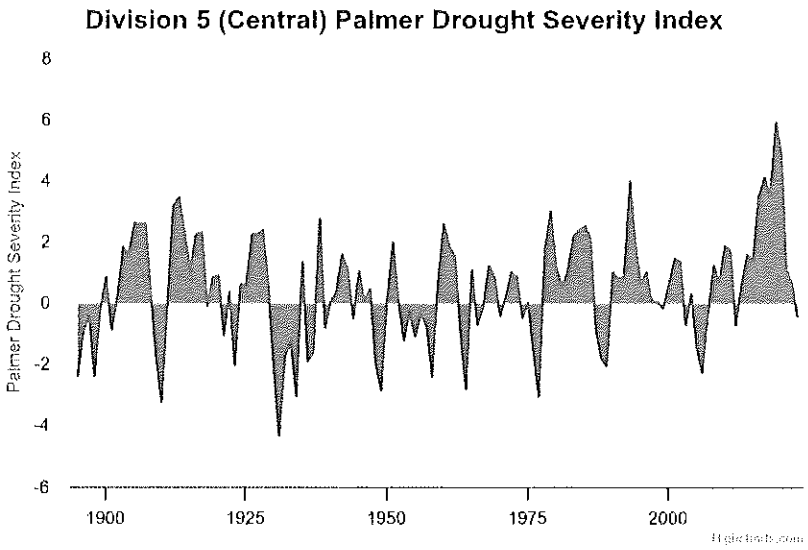
[94] http://www.fema.gov/disaster/3014/designated-areas

[95] 2012 Heat & Drought Federal Report, HHS ESF 8, UPDATE #2, U.S. Department of Health and Human Services, Assistant Secretary for Preparedness and Response

[96] https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?WI



The Palmer Index chart for the years between 1895 and the present day in Central Wisconsin, which includes Green Lake County, follows: [97]



[97] https://climatology.nelson.wisc.edu/wisconsin-climate-divisions/divisional-palmer-drought-severity-index/

The U.S. Drought Monitor (USDM) provides information that is updated weekly about drought conditions and information for the county. Current conditions, recent precipitation and temperature conditions, agriculture information, streamflow information, public health information, future conditions, and historical conditions are also available.[98] The same information is also available for the entire State of Wisconsin.[99]

As can be seen from the frequency table above, Green Lake County regularly experiences drought at least a moderate level two to three times every ten years. While drought is a regular occurrence, it is generally very difficult to predict with any accuracy, but according to the Wisconsin Hazard Mitigation Plan, "the NWS and National Integrated Drought Information System (NIDIS) are improving methodology to accurately forecast drought conditions. Both organizations use a combination of current and historical precipitation, streamflow, ground water, and crop data to perform short-term and long-term forecasts."[100]

On July 15, 2005, the Governor declared a drought emergency for the entire State of Wisconsin. This declaration, the first since August 2003, allowed farmers access to additional water for crop irrigation. The summer of 2012 was also extremely hot and dry across much of the United States, including Wisconsin. A table showing the drought events recorded by the National Weather Service for Green Lake County can be found in Appendix B.

Considering past occurrences, it can be surmised that Green Lake County has a low probability of drought or dust storm occurrence in the future, and the likelihood of damage due to drought or dust storm is considered low for agricultural and other types of losses. Over the past 25 years, there have been 17 occurrences of drought, for an average of less than one time per year.

It should also be noted that Green Lake County, like the rest of the world, is experiencing a changing climate. The University of Wisconsin-Madison, Nelson Institute for Environmental Studies, has partnered with the Wisconsin Department of Natural Resources to publish information in the Wisconsin Initiative on Climate Change Impacts.[101] This study shows a scientific consensus that, "Wisconsin is likely to become a much warmer state over the next

[98] https://www.drought.gov/states/wisconsin/county/green%20lake

[99] https://www.drought.gov/states/wisconsin

[100] State of Wisconsin Hazard Mitigation Plan

[101] Trends and Projections | Wisconsin Initiative on Climate Change Impacts (WICCI)

few decades, with average temperatures more like those currently experienced in states hundreds of miles to our south." Additionally, "our state is also likely to become somewhat wetter, with a modest increase in total precipitation and in the number of intense rainfall events. The amount of climate change varies by season, with winter experiencing the greatest warming and most likely increase in precipitation." The site's information shows that Green Lake County is likely to experience warmer weather and an increase in precipitation for all four seasons of the year, with the greatest increases in winter and summer. This will likely reduce the impact of drought in the future.

As noted earlier in this plan, the National Risk Index (NRI) tool [102] has been made available by the Federal Emergency Management Agency (FEMA). It calculates a baseline relative risk measurement for 18 natural hazards based on expected annual loss, social vulnerability, and community resilience. Below is data relevant to the hazard discussed in this chapter (drought). It should be noted that the NRI information may not necessarily match the hazard ratings reached by the county and is only being included for reference.

Number of Events	14
Annualized Frequency	0.30
Expo. - Agricultural Value ($)	13,418,405
Expo. - Total ($)	13,418,405
HLR - Overall Rating	Very Low
EAL - Agricultural Value ($)	108
EAL - Total ($)	108
Risk Score	18.5
Risk Rating	Very Low

"Expo." = Exposure / "HLR" = Historic Loss Ratio / "EAL" = Expected Annual Loss

Vulnerability

Drought generally impacts farm output by reducing crop yields and the health and productivity (e.g., milk) of livestock. As a result, a drought will seriously impact the economy of the entire county. Dust

[102] https://hazards.fema.gov/nri/map

storms impact farms in the long term by blowing away the top levels of soil, which are the richest. This could economically impact the county by reducing its long-term viability for farming.

The concern for agricultural losses due to drought is difficult to estimate because each incident will impact the county differently based on the length of the drought, when it occurs in the planting season and which crops were planted in various locations in that particular season but one can see, by looking at the agricultural statistics listed below [103] that this sector is an important part of the Green Lake County economy and that the losses could be considerable:

- Average size of farms: 221 acres
- Average value of agricultural products sold per farm: $68,294
- Average value of crops sold per acre for harvested cropland: $203.53
- The value of livestock, poultry, and their products as a percentage of the total market value of agricultural products sold: 56.55%
- Harvested cropland as a percentage of land in farms: 66.05%
- Average number of cattle and calves per 100 acres of all land in farms: 16.93
- Corn for grain: 45,183 harvested acres
- All wheat for grain: 3,350 harvested acres
- Soybeans for beans: 16,638 harvested acres
- Vegetables: 10,016 harvested acres
- Land in orchards: 25 acres

Drought is also a major risk factor for wildfire and can reduce the amount of surface water available for recreational activities (e.g., boating, fishing, water skiing) and for wildlife. This is important because, for example, low water levels can lead to an outbreak of disease (e.g., botulism) in migratory bird pools.

Prolonged drought can also impact the groundwater reserves. This can reduce the ability of the municipal water services and rural individuals with wells to draw adequate fresh water. This may especially impact rural homeowners who tend to have wells that are not drilled as deeply as municipal wells. In Green Lake County, the population that lives outside of the cities and villages is generally on

[103] http://www.city-data.com/county/Green_Lake_County-WI.html

well water. There could also be a safety risk during dust storms if they are severe enough to reduce the visibility of the roadways for drivers.

Hazard Mitigation Strategies

The goal of drought and dust storm mitigation activities is to reduce, in a cost-effective manner, the loss of lives and property due to these events.

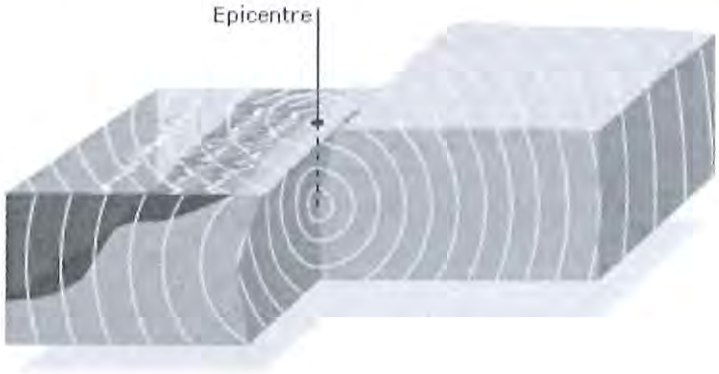
Some Green Lake County communities have adopted water usage regulations during drought conditions, but in general, mitigation strategies for periods of drought include preparing informational releases and plans for farmers and homeowners that can be used if needed.

Green Lake County farmers can contact the Green Lake County U.W. Extension Office and applicable programs sponsored by the U.S. Department of Agriculture (e.g., Farm Service Agency (FSA), Natural Resources Conservation Service (NRCS)) for information and guidance related to drought mitigation and/or the purchase of crop insurance. Various federal and state publications are available regarding groundwater movement, the hydrologic cycle, and irrigation methods. These agencies are also the lead agencies for obtaining emergency food and water supplies for agricultural use and for providing information regarding crop insurance. The Wisconsin Department of Natural Resources (DNR) can also provide assistance and permits for stream pumping for farms.

The hazard mitigation strategies listed above primarily involve providing information on water conservation measures to farmers and the public. Water conservation will ensure that the resource is available for critical residential, business, and agricultural uses (e.g., drinking, food irrigation, manufacturing, firefighting), and good farming practices may help prevent erosion of the rich topsoil found in Green Lake County. Since drought and dust storms are not hazards that affect buildings or traditional infrastructure (e.g., bridges, culverts), these strategies did not need to be designed to reduce damage to existing or future buildings and infrastructure.

Earthquakes

An earthquake is a shaking or sometimes violent trembling of the earth that results from the sudden shifting of rock beneath the earth's crust. This sudden shifting releases energy in the form of seismic waves (wave-like movement of the earth's surface). [104]



Physical Characteristics

Earthquakes can strike without warning and may range in intensity from slight tremors to great shocks. They can last from a few seconds to over five minutes, and they may also occur as a series of tremors over a period of several days. The actual movement of the ground during an earthquake is seldom the direct cause of injury or death. Casualties usually result from falling objects and debris because the shocks have shaken, damaged, or demolished buildings and other structures. Movement may trigger fires, dam failures, landslides, or releases of hazardous materials that compound an earthquake's disastrous effects.

Earthquakes are measured by two principal methods: seismographs and human judgment. The seismograph measures the magnitude of an earthquake and interprets the amount of energy released on the Richter Scale, a logarithmic scale with no upper limit. For example, an earthquake measuring 6.0 on the Richter Scale is ten times more powerful than a 5.0 and 100 times more powerful than a 4.0. This is a measure of the absolute size or

[104] http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/earthquake_guide.pdf

strength of an earthquake and does not consider the effect at any specific location. The Modified Mercalli Intensity (MMI) Scale measures the strength of a shock at a particular location (i.e., intensity).

A third, less often used way of measuring an earthquake's severity involves comparing its acceleration to the normal acceleration caused by the force of gravity. The acceleration due to gravity, often noted as "g," is equal to 9.8 meters per second. Peak Ground Acceleration (PGA) measures the rate of change of motion relative to the rate of acceleration due to gravity and is expressed as a percentage. These three scales can be roughly correlated, as expressed in the table that follows:[105]

Earthquake PGA, Magnitude, and Intensity Comparison Table			
PGA [%g]	**Magnitude [Richter]**	**Intensity [MMI]**	**Description [MMI]**
<0.17	1.0 - 3.0	I	I. Not felt except by a very few under especially favorable conditions.
0.17 - 1.4	3.0 - 3.9	II - III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
1.4 - 9.2	4.0 - 4.9	IV - V	IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing cars rock noticeably. V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
9.2 - 34	5.0 - 5.9	VI - VII	VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
34 - 124	6.0 - 6.9	VII - IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
>124	7.0 and higher	VIII or higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any [masonry] structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

[105] Wald, Quitoriano, Heaton and Kanamori, 1999

Most of Wisconsin's occurrences have not been severe, with only one registering 5.1 on the Richter Scale.

Frequency of Occurrence

Earthquakes that have affected Wisconsin from 1899 to 1987 are listed in the table that follows. The most severe earthquake in Wisconsin was the record earthquake of 1811, centered along the New Madrid Fault. Most earthquakes that do occur in Wisconsin are very low in intensity and can hardly be felt. These very minor earthquakes are fairly common, occurring every few years. Events of moderate magnitude have occurred in locations in Illinois and Michigan. Those and other stronger earthquakes centered in other parts of the country have been felt primarily in Southern Wisconsin.

Date	Location	Latitude North	Longitude West	Maximum Intensity	Magnitude
10/12/1899	Kenosha	42° 34'	87° 50'	II	3.0
3/13/1905	Marinette	45° 08'	87° 40'	V	3.8
4/22/1906	Shorewood	43° 03'	87° 55'	II	3.0
4/24/1906	Milwaukee	43° 03'	87° 55'	III	--
1/10/1907	Marinette	45° 08'	87° 40'	III	--
5/26/1909	Beloit	42° 30'	89° 00'	VII	5.1 (max)
10/7/1914	Madison	43° 05'	89° 23'	IV	3.8
5/31/1916	Madison	43° 05'	89° 21'	II	3.0
7/7/1922	Fond du Lac	43° 47'	88° 29'	V	3.6
10/18/1931	Madison	43° 05'	89° 23'	III	3.4
12/6/1933	Stoughton	42° 54'	89° 15'	IV	3.5
11/7/1938	Dubuque	42° 30'	90° 43'	II	3.0
11/7/1938	Dubuque	42° 30'	90° 43'	II	3.0
11/7/1938	Dubuque	42° 30'	90° 43'	II	3.0
2/9/1943	Thunder Mountain	45° 11'	88° 10'	III	3.2
5/6/1947	Milwaukee	43° 00'	87° 55'	V	4.0
1/15/1948	Lake Mendota	43° 09'	89° 41'	IV	3.8
7/18/1956	Oostburg	43° 37'	87°45'	IV	3.8
7/18/1956	Oostburg	43° 37'	87°45'	IV	3.8
10/13/1956	South Milwaukee	42° 55'	87°52'	IV	3.8
1/8/1957	Beaver Dam	42° 32'	98°48'	IV	3.6
2/28/1979	Bill Cross Rapids	45° 13'	89°46'	--	<1.0 MoLg
1/9/1981	Madison	43° 05'	87°55'	II	--
3/13/1981	Madison	43° 37'	87°45'	II	--
6/12/1981	Oxford	43° 52'	89°39'	IV-V	--
2/12/1987	Milwaukee	42° 95'	87°84'	IV-V	--
2/12/1987	Milwaukee	43° 19'	87°28'	IV-V	--
6/28/2004	Troy Grove, IL	41° 46'	88°91'	IV	4.2

Also, in Wisconsin, a 2012 article published in the Milwaukee Journal-Sentinel discussed an incident in Waupaca County that was not an earthquake as traditionally discussed and understood. This episode is highlighted in this plan because it was widely reported in the state and could be a concern for Green Lake County citizens:[106]

> *A 1.5-magnitude earthquake was recorded at 12:15 a.m. March 20 beneath Clintonville, according to the National Earthquake Information Center. The center is operated by the U.S. Geological Survey.*
>
> *The U.S. Geological Survey said several days of booms and vibrations that rattled windows and nerves last week likely were caused by a swarm of small earthquakes.*
>
> *Scientists at the Wisconsin Geological and Natural History Survey in Madison said the low-intensity seismic activity could have been produced by a phenomenon known as postglacial rebound.*
>
> *Granite bedrock beneath eastern Waupaca County is slowly adjusting to a great weight being lifted off it when the last glacier melted more than 10,000 years ago. As the granite stretches, rising only a few millimeters a year, it can crack to relieve pressure, according to David Hart, a geophysicist at the Wisconsin Geological and Natural History Survey.*
>
> *As it cracks, one piece slides or shifts places, releasing enough energy to create a seismic wave that rises to the surface.*
>
> *There is no known geologic fault beneath central Wisconsin, so the postglacial rebound is the only thing stretching the bedrock crust in the state, Hart said.*

This phenomenon was widely reported in local, state, and national news and drew interest from the public.

The nearest major active fault is the New Madrid Fault, stretching along the central Mississippi River Valley in Missouri. In recent years, considerable attention has focused on seismic activity in the New Madrid seismic zone that lies within the central Mississippi Valley, extending from northeast Arkansas through southeast Missouri, western Tennessee, and western Kentucky to southern Illinois. Scientists at the Center for Earthquake Information have computed a set of probabilities that estimate the potential for

[106] http://www.jsonline.com/news/wisconsin/rumbling-booming-resumes-in-clintonville-6e4p9o8-144653925.html

different magnitude earthquakes to occur at the New Madrid Fault. Even an 8.3 magnitude earthquake at the New Madrid Fault, however, would cause only minor damage in the southeastern corner of Wisconsin. At this time, it is not possible to predict the exact date, duration, or magnitude of an earthquake.

The earthquake threat to most of Green Lake County is considered very low (the 50-year acceleration probability is 2%). Minor damage (e.g., cracked plaster, broken windows) from earthquakes has occurred in Wisconsin, but most often the results have been only rattling windows and shaking ground. There is little risk except to structures that are badly constructed. Most of the felt earthquakes reported have been centered in other nearby states. The causes of these local quakes are poorly understood and are thought to have resulted from the still-occurring rebound of the Earth's crust after the retreat of the last glacial ice. The likelihood of damage from an earthquake is also very low.

As noted earlier in this plan, the National Risk Index (NRI) tool [107] has been made available by the Federal Emergency Management Agency (FEMA). It calculates a baseline relative risk measurement for 18 natural hazards based on expected annual loss, social vulnerability, and community resilience. Below is data relevant to the hazard discussed in this chapter. It should be noted that the NRI information may not necessarily match the hazard ratings reached by the county and is only being included for reference.

Number of Events	N/A
Annualized Frequency	0
Expo. - Building Value ($)	7,556,595,000
Expo. - Population	19,018
Expo. - Population Equiv. ($)	220,608,800,000
Expo. - Total ($)	228,165,395,000
HLR - Overall Rating	Relatively Low
EAL - Building Value ($)	11,588
EAL - Population	0
EAL - Population Equiv. ($)	2,589
EAL - Total ($)	14,177
Risk Score	21.4
Risk Rating	Very Low

"Expo." = Exposure / "HLR" = Historic Loss Ratio / "EAL" = Expected Annual Loss

Vulnerability

Any impact on the community from the earthquake would likely be due to a few broken windows and personal effects that were damaged in the earthquake. The damage to critical infrastructure and buildings would be negligible. Although there could be indirect effects from any unlikely losses to the electrical grid, transportation routes/goods shipments, and pipelines.

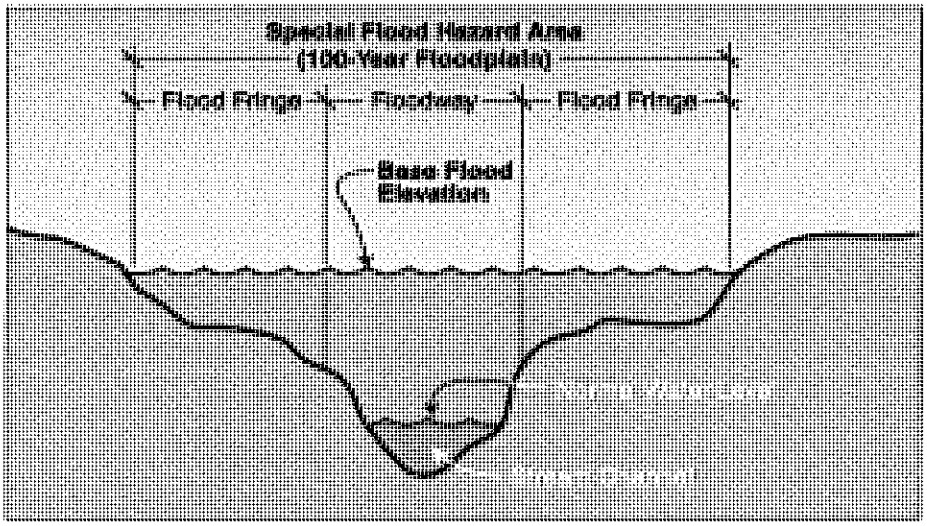
[107] https://hazards.fema.gov/nri/map

Hazard Mitigation Strategies

Since Green Lake County is not likely to suffer directly from a severe earthquake, the community impacts are not considered significant, and mitigation planning for this hazard is not necessary. If there is ever a need, obviously emergency resources will be mobilized, but the goal for this section of the plan is therefore to educate on the low risks of earthquake damage in Green Lake County.

Flooding and Dam Failure

Flooding is defined as a general condition of partial or complete inundation of normally dry land (i.e., the floodplains) caused by the overflow of inland waters or the unusual and rapid accumulation or runoff of surface waters from any source. Floodplains are the lowlands next to a body of water that are susceptible to recurring floods.[108]



Floods are common in the United States, including Wisconsin, and are considered natural events that are hazardous only when they adversely affect people and property.

Physical Characteristics

Major floods in Wisconsin have usually been confined either to specific streams or to locations that receive intense rainfall in a short period of time.

Flooding that occurs in the spring due to snow melt or during a period of heavy rain is characterized by a slow buildup of flow and velocity in rivers and streams over a period of days. This buildup continues until the river or stream overflows its banks, for as long as a week or two, then slowly recedes. Generally, the timing and

[108] FEMA, August 2001

location of this type of flooding are fairly predictable and allow ample time for the evacuation of people and property.

For prediction and warning purposes, floods are classified by the National Weather Service into two types: those that develop and crest over a period of approximately six hours or more and those that crest more quickly. The former are referred to as "floods" and the latter as "flash floods". Flash flooding occurs solely from surface run-off that results from intense rainfall. Flash flooding occurs less frequently in Wisconsin than flooding associated with spring snow melt, but it is unpredictable.

Generally, the amount of damage from flooding is a direct consequence of land use. If the ground is already saturated, stripped of vegetation, or paved, the amount of run-off increases, adding to the flooding. There is also a concern regarding the loss of topsoil and erosion due to flooding.

Terms commonly used when referring to flooding are "100-year flood" and "floodplain." A "100-year flood" is defined as a flood having a one percent chance of being equaled or exceeded in magnitude in any given year.

Flood Probability Terms Table[109]

Flood Recurrence Intervals	Percent Chance of Occurrence Annually
10 year	10.0%
50 year	2.0%
100 year	1.0%
500 year	0.2%

The Wisconsin Department of Natural Resources (DNR), working with local zoning offices, has designated floodplain areas as those places where there is the greatest potential for flooding. Flooding may also occur due to a dam breach or overflow. Dams are barriers built across a waterway to store, control, or divert water; a dam failure is a failure of the dam that causes downstream flooding. Failures may be caused by technological events (e.g., materials

[109] State of Wisconsin Hazard Mitigation Plan

failure) or by natural events (e.g., landslide, earthquake), with flooding being the most common result.

According to the Wisconsin Department of Natural Resources (WDNR) Dam Safety Program, there are approximately 3,800 dams in existence in the State of Wisconsin. Since the late 19th century, more than 700 dams have been built, then washed out or removed. Since 1967, approximately 100 dams have been removed. Almost 60% of the dams in Wisconsin are owned by a former company or private individual, 9% by the State of Wisconsin, 17% by a municipality such as a township or county government, and 14% by other ownership types.

The federal government has jurisdiction over most large dams in Wisconsin that produce hydroelectricity, approximately 5% or nearly 200 dams. The Wisconsin Department of Natural Resources regulates the rest of the dams. A dam with a structural height of over 6 feet and impounding 50 acre-feet or more, or having a structural height of 25 feet or more and impounding more than 15 acre-feet, is classified as a large dam. There are approximately 1,160 large dams in the State of Wisconsin.

The Wisconsin DNR database lists the following dams included in Green Lake County: [110]

Dam Official Name (Popular Name) *	Size	Latitude	Longitude	Owner Type	Waterway Name (Downstream City)
Kingston	Large	43.6964544	-89.1260222	Village of Kingston	Grand
Manchester	Large	43.68769	-89.04771	Green Lake County	Grand
Upper Green Lake	Large	43.8465856	-88.9602689	City of Green Lake	Puchyan
Stellmacher, H	Small	43.864054	-88.9337107		TR Silver River
Berlin	Small	43.9519978	-88.9593403	WI DNR	Fox
Lower Green Lake	Small	43.8569416	-88.9466139	Town of Brooklyn	Puchyan
Princeton	Large	43.82566	-89.16223	WI DNR	Fox
White River	Small	43.90291	-89.08429	WI DNR	Fox
Little Green Lake Outlet	Large	43.7344727	-88.9728235	Little Green Lake Protection and Rehab Dist.	Little Green Lake Outlet
Twin Lakes	Small	43.7983348	-88.9685096	Town of Green Lake	Little Hills Creek
Dobrinski, Pat	Small	43.8676696	-88.9593999		TR- Puchyan River
Hunter, Gerald	Small	43.6911809	-89.236798		TR- Belle Fountain Creek
Seward, L.J.	Small	43.941943	-88.9594508		TR-Fox River
Spaulding, T.	Small	43.8286847	-89.0073628		No waterway

[110] https://dnr.wisconsin.gov/topic/dams/damSearch.html

Dam Official Name (Popular Name) *	Size	Latitude	Longitude	Owner Type	Waterway Name (Downstream City)
White River Wildlife	Small	43.9417971	-89.1455996	WI DNR	TR-White River
Schram, Victor	Small	43.9295945	-88.9032194		No waterway
Sobieski,Thomas	Small	43.9305395	-88.9459724		TR-Fox River
Sondalle, James	Small	43.8445734	-89.1768872		Millrace Creek
Markesan	Small	43.7071396	-88.9839963		Grand River
Princeton	Small	43.8499404	-89.1352038	WI Power & Light Co.	Mecan River
Zeratsky	Small	43.8505634	-88.8941437		Unnamed TR to Silver Creek
Squirrel Woods	Small	43.9296289	-89.1303765	WI DNR	TR-White River
Junk Woods	Small	43.9529509	-89.0328971	WI DNR	
Rick Stel	Small	43.7541124	-89.08181		
Berm A	Small	43.7314168	-88.9051587	WI DNR	Drainage Ditch
Berm B	Small	43.7314183	-88.9051212	WI DNR	Drainage Ditch
Renner, James	Small	43.6590468	-89.0759362		Tributary to Fox River
Little Green Lake Prot & Reha	Small	43.738982	-88.9760381	Little Green Lake Protection and Rehab Dist.	
Wilke, David & Teresa	Small	43.6817218	-88.9075778		TR to Grand River
Paul Olson #2	Small	43.9635745	-89.1027079	NRCS	
Paul Olson #1	Small	43.9687349	-89.1023441	NRCS	
Green Lake Holding Company	Small	43.7933052	-89.0006923	Green Lake Holding Co.	Unnamed TR to Big Green Lake
Bernhagen	Small	43.6865	-89.03735		Unnamed TR to Grand River
Stel	Small	43.75788	-89.09445		TR to Lake Puckaway
Nowatzski	Small	43.6925511	-89.0221409		
MCGUIRE	Small	43.6819772	-89.0018697		TR to Grand River
Burdick	Small	43.7970138	-88.9392024		Unnamed TR to Hill Creek
Justmann	Small	43.70325	-88.94932		
Witthun	Small	43.6589215	-89.0717821		TR to Lower Grand River
Mike Norton	Small	43.8885788	-89.1008875		TR to Fox River
Wabiszewski #2	Small	43.7930854	-88.9878189	Green Lake Holding Co.	
Schattschneider	Small	43.7797719	-89.0116107		Unnamed

Most of these dams are small, mill-type dams under the jurisdiction of the DNR, municipalities, and are also privately owned. None of these dams could handle the volume of water generated by a 100- or 500-year flood without overtopping. These dams are inspected by the Wisconsin Department of Natural Resources (DNR), and the largest are required to have an Emergency Action Plan (EAP) and failure analysis on them.

The Wisconsin Department of Natural Resources assigns hazard ratings to large dams within the state. When assigning hazard

ratings, two factors are considered: existing land use and land use controls (zoning) downstream of the dam. Dams are classified into three categories that identify potential hazards to life and property downstream should the dam fail. A high hazard indicates that a failure would most probably result in the loss of life. A significant hazard indicates that a failure could result in appreciable property damage. A low hazard exists where failure would result in only minimal property damage, and loss of life is unlikely.

For Green Lake County, the Kingston, Upper Green Lake, and L. Green Lake P&R D. Sed. (5954) dams have a high hazard rating. The Little Green Lake Prot & Rehab District (5202) dam has a significant hazard rating. The other dams in Green Lake County are considered low hazard.

There are no dams in other counties that pose a significant flooding risk to the citizens of Green Lake County.

One potential effect of flooding is erosion. Erosion is defined as the removal of soil by the force of waves, currents, and/or ice at a lakeshore or streambank or by the power of wind or water on open land. Erosion is a natural process that can be accelerated by natural disasters (e.g., flooding, heavy rains, strong winds, drought) or by human activity (e.g., removal of plants/trees, tilling). Because of the many waterways in Green Lake County and the high use of recreational watercraft, there is concern about ensuring the stabilization of the shorelines.

Watersheds

Watersheds located in the county are described more fully in the Hydrology section of this plan.

Floodplain Regulations

Floodplain regulations have been in place in the cities, villages, and towns of Green Lake County for many years. The Department of Natural Resources requires that each municipality approve regulations that meet DNR guidelines. These regulations and guidelines result from the value of Wisconsin lakes and waterways and a desire to preserve them and to protect the people who reside near them. Unregulated development can lead to loss of lives and property during floods.

Chapter 614, Laws of Wisconsin 1965, requires counties to adopt regulations giving all lands within 300 feet of navigable rivers or streams protection from haphazard development. Under this legislation, Green Lake County has adopted a zoning ordinance that gives a measure of protection to watersheds. The law protecting floodplains was created to meet the following objectives:

- Reduce the hazards to life and property from flooding.
- Protect floodplain occupants from a flood that is or may be caused by their own land use, which is or may be undertaken without full realization of the danger.
- Protect the public from the burden of extraordinary financial expenditures for flood control and relief.

Encroachment on floodplains, including structures or fill, reduces the flood-carrying capacity.

To regulate and permit development in Special Flood Hazard Areas (SFHAs), Green Lake County requires that a land use permit be obtained before any new developments are started within the floodplain. Inspections are conducted to ensure compliance with the permits.

Frequency of Occurrence

Wisconsin has experienced several major floods during the last two decades. The 1973 and 1986 floods revealed that no floodplains or urban areas in Wisconsin can be considered safe from damage. Mill-dams have developed leaks on occasion but have not caused any flooding problems.

Green Lake County does have a history of flooding problems and has been included in four Presidential Disaster Declarations requests for flooding, most of which are detailed below:[111]

- FEMA-376-DR-WI: The President declared a major disaster as a result of flooding.
- FEMA-994-DR-WI: On July 23, 1993, the President declared a major disaster as a result of flooding that happened between June 7 and August 25.

[111] http://www.fema.gov/disasters

- FEMA 1526-DR-WI: On June 18, 2004, the President declared a major disaster as a result of severe storms and flooding that began on May 19th. Green Lake County was eligible for both Public and Individual Assistance as well as Hazard Mitigation.
- FEMA 1768-DR-WI: On June 14, 2008, the President declared a major disaster as a result of severe storms, tornadoes, and flooding. The county was eligible for assistance from the Public and Individual Assistance Programs as well as the Hazard Mitigation Program.
- FEMA 4402-DR-WI: On October 28, 2018, the President declared a major disaster as a result of severe storms, tornadoes, straight-line winds, flooding, and landslides. The county was eligible for assistance from the Public Assistance Program.

The following table summarizes repetitive loss damages attributed to flooding in Green Lake County by the National Flood Insurance Program through 30 September 2024.

Location	No. of Losses	Type of Losses	Total Paid	Average Paid
City of Berlin	6	Non-Residential	$53,662.80	$8,943.80
City of Berlin	3	Other Residential	$35,128.48	$11,709.49
City of Berlin	2	Single Family	$16,783.93	$8,391.97
City of Berlin	2	Non-Residential	$82,238.84	$41,119.42
City of Berlin	2	Other Residential	$48,779.21	$24,389.61
City of Berlin	2	Single Family	$5,512.78	$2,756.39
City of Princeton	2	Other Non-Residential	$4,215.63	$2,107.82

There are no severe repetitive loss properties in Green Lake County.

Tables showing the flood and flash flood events recorded by the National Weather Service can be found in Appendix B. A careful review of the geography and history of flooding in Green Lake County leads to the conclusion that there is a medium to high

probability of flooding in the future and a medium to high probability of damage and losses due to flooding. This flooding could occur due to urban stream flooding, flash flooding, or, less likely, due to a dam failure. It was also determined that there was a medium probability of a dam break in the county and a high probability of damage and losses due to a dam break.

The University of Wisconsin-Madison, Nelson Institute for Environmental Studies/ Wisconsin DNR's Wisconsin Initiative on Climate Change Impacts shows a scientific consensus that, "Wisconsin is likely to become a much warmer state over the next few decades...and...our state is also likely to become somewhat wetter, with a modest increase in total precipitation and in the number of intense rainfall events. The amount of climate change varies by season, with winter experiencing the greatest warming and most likely increase in precipitation." The site's information shows that Green Lake County is likely to experience warmer weather and an increase in precipitation for all four seasons of the year, with the greatest increases in winter and summer. Additionally, the increased number of intense rainfall events is likely to increase the number and intensity of flooding incidents.

As noted earlier in this plan, the National Risk Index (NRI) tool [112] has been made available by the Federal Emergency Management Agency (FEMA). It calculates a baseline relative risk measurement for 18 natural hazards based on expected annual loss, social vulnerability, and community resilience. Below is data relevant to the hazard discussed in this chapter (riverine flooding). It should be noted that the NRI information may not necessarily match the hazard ratings reached by the county and is only being included for reference.

Number of Events	13
Annualized Frequency	0.5
Expo. - Building Value ($)	233,108,944
Expo. - Population	413.6
Expo. - Population Equiv. ($)	4,797,763,865
Expo. - Agricultural Value ($)	1,515,107
Expo. - Total ($)	5,032,387,917
HLR - Overall Rating	Very Low

[112] https://hazards.fema.gov/nri/map

EAL - Building Value ($)	37,916
EAL - Population	0
EAL - Population Equiv. ($)	23,753
EAL - Agricultural Value ($)	16,994
EAL - Total ($)	78,663
Risk Score	22.9
Risk Rating	Very Low

"Expo." = Exposure / "HLR" = Historic Loss Ratio / "EAL" = Expected Annual Loss

Vulnerability

After flooding, whether caused by a storm or a dam failure, there is often damage. Potential vulnerabilities due to flooding events can include flooded public facilities and schools, many of which are the community's shelters needed when individual housing is uninhabitable. Utilities are also vulnerable in floods, which can bring down electric lines/poles/transformers, telephone lines, and disrupt radio communications. The loss of communications can impact the effectiveness of first response agencies, which need to communicate via two-way radio to mount emergency response and recovery activities. The public media communications utilized by emergency managers to provide timely and adequate emergency public information can also be impacted.

Residential structures may suffer from flooded basements, damaged septic systems, and damaged functionals (e.g., HVAC systems, clothes washers, and dryers). Homes may also be impacted by sewer back-up, and if the home is not properly cleaned after a flood, bacterial growth and mold may impact the home's air quality and cause illness among the occupants.

Businesses can suffer building and equipment damage similar to homes. Businesses may lose expensive products stored in basements or other low areas, as well as the ability to operate from their facility. If the facility must close, its owners and employees will most likely suffer economic hardships beyond what their personal losses may have entailed. Agricultural business losses involve the loss of standing crops and harvests that are damaged by flooded storage facilities in the immediate time period. On a longer time scale, the erosion of rich topsoil by floodwaters can degrade the land and impact future crop yields.

Perhaps one of the most expensive types of flood damage is that to roadways, which are washed out, inundated, and/or covered by debris, blocking access to emergency and public traffic.

Appendix F contains excerpts from the Green Lake County HAZUS report. HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. FEMA HAZUS-MH data were used to estimate the number of structures located within the one-percent chance, or 100-year floodplain, based upon Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA), the results of which are outlined in the report.

Hazard Mitigation Strategies

Green Lake County is committed to remaining compliant with the requirements of the National Flood Insurance Program (NFIP) and all other state and federal laws. According to the NFIP, the following communities participate in the program. [113]

- County of Green Lake
- City of Berlin
- City of Green Lake
- City of Markesan
- City of Princeton
- Village of Kingston
- Village of Marquette

[113] https://www.fema.gov/cis/WI.pdf

Additional Information Regarding Municipal NFIP Implementation [114]	
City of Berlin	
Date joined NFIP	Unavailable
Initial Flood Hazard Boundary Map (FHBM) Identified	1/16/1974
Initial Flood Insurance Rate Map (FIRM) Identified	9/30/1977
Current Effective Map Date	6/18/2013
Regular Program Entry Date	9/30/1977
How implemented	Continued reviewing and updating the projects identified in our All-Hazards Mitigation Plan.
City of Green Lake	
Date joined NFIP	Unavailable
Initial Flood Hazard Boundary Map (FHBM) Identified	10/22/1976
Initial Flood Insurance Rate Map (FIRM) Identified	9/27/1985
Current Effective Map Date	2/3/2010
Regular Program Entry Date	9/27/1985
How implemented	Continued reviewing and updating the projects identified in our All-Hazards Mitigation Plan.
City of Markesan	
Date joined NFIP	Unavailable
Initial Flood Hazard Boundary Map (FHBM) Identified	5/10/1974
Initial Flood Insurance Rate Map (FIRM) Identified	7/2/2003
Current Effective Map Date	2/3/2010
Regular Program Entry Date	7/2/2003
How implemented	Continued reviewing and updating the projects identified in our All-Hazards Mitigation Plan.
City of Princeton	
Date joined NFIP	Unavailable
Initial Flood Hazard Boundary Map (FHBM) Identified	12/28/1973
Initial Flood Insurance Rate Map (FIRM) Identified	6/15/1988
Current Effective Map Date	2/3/2010
Regular Program Entry Date	6/15/1988
How implemented	Continued reviewing and updating the projects identified in our All-Hazards Mitigation Plan.
Village of Kingston	
Date joined NFIP	Unavailable
Initial Flood Hazard Boundary Map	12/17/1973

[114] https://www.fema.gov/cis/WI.html

(FHBM) Identified	
Initial Flood Insurance Rate Map (FIRM) Identified	9/1/1986
Current Effective Map Date	2/3/2010
Regular Program Entry Date	9/1/1986
How implemented	Continued reviewing and updating the projects identified in our All-Hazards Mitigation Plan.
Village of Marquette	
Date joined NFIP	Unavailable
Initial Flood Hazard Boundary Map (FHBM) Identified	12/28/1973
Initial Flood Insurance Rate Map (FIRM) Identified	2/3/2010
Current Effective Map Date	2/3/2010
Regular Program Entry Date	2/3/2010
How implemented	Continued reviewing and updating the projects identified in our All-Hazards Mitigation Plan.

There are no areas in Green Lake County that have had special flood areas identified by FEMA but are not in the NFIP program. [115]

The plan is intended to identify areas that are particularly susceptible to flooding, assess the risks, analyze the potential for mitigation, and recommend mitigation strategies where appropriate. The goals of this plan are:

- Goal 1: To reduce, in a cost-effective manner using a cost-benefit analysis, the loss of lives and property due to these events. Another part of this goal is to promote safety and health in areas that have been or are prone to be flooded.
- Goal 2: To preserve and enhance the quality of life throughout Green Lake County by identifying potential property damage risks and recommending appropriate mitigation strategies to minimize potential property damage during/due to flooding.
- Goal 3: To promote countywide planning that avoids transferring the risk from one community to an adjacent community.
- Goal 4: To continue encouraging all Green Lake County communities' participation in the NFIP so that all county residents have access to affordable flood insurance coverage.

[115] https://www.fema.gov/cis/WI.html#comm_not_part_id

- Goal 5: To identify potential funding sources for mitigation projects and form the basis for project grant applications through FEMA's Pre-Disaster Mitigation (PDM) and/or Flood Mitigation Assistance (FMA) programs.

One hazard mitigation strategy selected is to inform the public about the availability of flood insurance; this task will be carried out by the County Emergency Management Office.

Short-term actions that can lessen the effects of flooding include:

- Issuance of early warnings through flood advisory bulletins,
- Dissemination of instructions to the public through the media,
- Preparation of congregate care facilities,
- Evacuation of people and property.

Temporary protective measures such as sandbagging, protection of buildings and other structures, and cut-off of gas and electricity may also be implemented. Other potential projects include:

- Update Mapping to include:
    - Update GIS data collection and incorporate it on schedule with the "Green Lake Land Information Plan" (v. 2025-2027),[116] which describes the data available and the updating schedule. There will be another new plan for 2028-2030, which will occur in the new plan period. This is done on 3-year cycles.
    - Apply to FEMA for a Letter of Map Amendment (LOMA) to incorporate FEMA-compliant, 1-foot Light Detection and Ranging (LIDAR) information. The county currently has 2-foot LIDA mapping and plans to upgrade to 1' in the next flight, scheduled for 2027, for an estimated $150,000 cost. This requires new panels to be printed.
    - Contract with aerial photography company for "fly-overs" during 1% chance flood events (oblique)

[116] https://www.greenlakecountywi.gov/wp-content/uploads/2024/12/Green_Lake_County_Land_Info_Plan_2024_FINAL.pdf

because this data provides a useful tool in determining the level of damage and mitigating areas of concern.

- Conduct a floodplain study at the confluence of the Fox River, White River, Puchyan River and Sucker Creek. Approximate floodplain area on FEMA maps. With the study, the safe development of the area could be accomplished.

- Continue floodplain ordinance outreach within the community and ensure that homeowners and builders follow floodplain regulations. As new residents come into the community/county, outreach is necessary. With the new floodplain maps effective, consult the parcel boundaries on all projects. Ongoing changes are being made as small-scale studies are being done. No large-scale changes are being proposed over the next five years.

- Advise the public of available governmental programs and information, including the NFIP, as it relates to flood issues

Green Lake County has a history of expensive damage to buildings and infrastructure due to floods. In addition to the strategies listed above that deal with public information and planning, the community can make current and future buildings and infrastructure more disaster-resistant by:

- Looking for acceptable (environmentally, socially, cost-benefit, politically, etc.), permanent solutions for removing water from flood-prone areas. Seek out funding sources (grants) to execute solutions. Some of the potential solutions may include acquisitions, demolitions, floodproofing, or moving water to surface streams.

- Pre-identifying infrastructure (roads, bridges, culverts, shoulders) prone to flooding and directing current and future budgetary dollars towards making the infrastructure disaster resistant, as it is scheduled for routine maintenance. Also performing preventative maintenance in areas of concern. Areas of concern include:

    - City of Berlin

        - Riverbank Improvements – Downtown area from the Franklin St. Bridge north to the Pedestrian

Bridge. Implement the Waterfront Improvement project as adopted by the Council in 2009.

- Stormwater Retention Ponds – North Business Park. Do a stormwater regional detention basin survey for North Business Park and implement the development of it.

- Southwest Drainage District. Create an area-wide drainage system to prevent flooding of private property. An initial study was made to determine the effect storm water/run-off has on this area and a means to correct the problem. A potential solution is to create waterways and ditches to channel water to prevent sheeting across many properties.

- Shorewall improvements – Riverside Park

- Berlin Foundry Shorewall – riverbank improvements. Privately owned, this foundry is set right on the banks of the river and has flooding through its buildings during times of high water. Measures to limit run-off into the river are important.

- Explore the feasibility of purchasing properties along Dock Street. The structures are storage facilities which may receive some damage in times of flooding, however, could be acquired and removed.

- Northeast Drainage District. Create an area-wide drainage system to prevent flooding of private property. An ongoing project for 10 years, some steps have been taken for implementation; however, full completion of the project has not taken place yet. A potential solution is to create waterways and ditches to channel water to prevent sheeting across many properties.

- Address flooding and roadway repairs associated with West & East Marquette St. The preliminary solution is to increase the storm

sewer size. Rain events greater than a 10-year storm event result in street flooding.

- Explore the flooding problem on Water Street between Cumberland Street and E Noyes Street to stop flooding into homes. The goal would be to prevent loss of personal property and business loss from flooding. The street was reconstructed in 2022 to protect the sanitary system, but it has not yet stopped home flooding. Some funding has been applied, but additional measures are needed to completely mitigate the problem.

- Install a screen before the Cumberland lift station to prevent rags from clogging pumps in high-flow events. The goal would be to prevent rags from getting into the wet well and clogging up pumps during floods or wet weather events, thus allowing employees to do other essential work.

- City of Green Lake

  - Continue to monitor lake level readings at Green Lake Upper Dam. Currently, readings are taken daily, Monday through Friday, when ice is not present.

- City of Markesan

  - Water retention area for properties on Manchester St. west of Margaret St. to prevent personal property loss.

  - Buyouts/Elevations:
    - Business located at 450 N Margaret/ Relocation
    - Residence/garage at 95 S. Bridge

  - With the assistance of the Village of Kingston & Towns of Kingston and Manchester - Work with County and State DOT to upgrade the culvert at State Hwy 44 and E. Vista and re-ditch Hwy 44 west of Margaret St.

- With the assistance of the Village of Kingston & Towns of Kingston & Manchester - Work with County and State DOT to clean trees and debris out of the Grand River west side of the village.

- City of Princeton
  - Explore options for erosion mitigation projects.
  - Riverbank Stabilization – Water Street to eliminate flooding and property damage.

- Village of Kingston
  - Continue working on shoreline restoration and lake clearing projects. Rip-rap has been placed along the shoreline.

- Village of Marquette
  - Explore hazard mitigation opportunities (i.e., buyout or elevation) in the Village of Marquette. Several homes were completely surrounded by flood waters in June of 2008. The ordinance was strengthened and approved. New construction has to follow the ordinance and building regulations, so it would be protected. Cannot mitigate the lake. The Village will seek funding when flooding does occur.

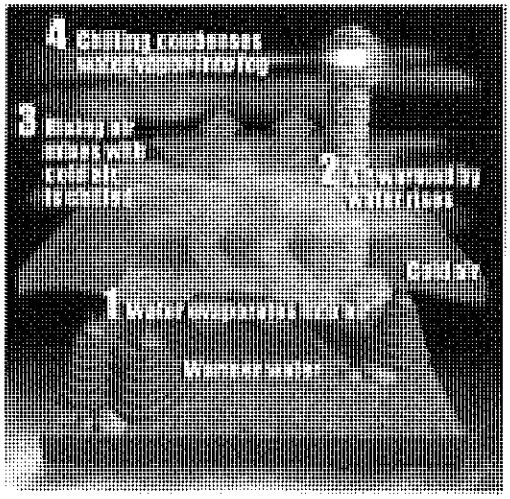
- Town of Marquette
  - Work with the Town of Marquette and Drager Rd. property owners to elevate Drager Rd. above RFE. With contiguous dry land access, the property owners can elevate their homes and remove them from the floodplain.
  - Work with the Town of Marquette and Marine Dr. property owners to elevate Marine Dr. above RFE. With contiguous dry land access, the property owners can elevate their homes and remove them from floodplain.

- Town of Princeton

- Explore hazard mitigation opportunities (i.e., buyout or elevation) on Fox River Lane as well as Birch Lane. Several homes were completely surrounded by flood waters in June of 2008.

Fog

Green Lake County has a long history dealing with fog, which, at its most basic definition, is a cloud based on the ground rather than in the atmosphere.



Physical Characteristics

Fog occurs when the air near the ground is saturated with moisture and condenses on tiny particles suspended in the air. These particles are called cloud condensation nuclei and actually attract water vapor molecules to their surfaces. Once condensation occurs on these tiny surfaces, the resulting liquid drops can remain suspended in the air because their weight causes them to descend slowly to the ground or be carried around by wind. The dew-point temperature, or saturation vapor pressure, can be reached by either adding more water vapor to the air or cooling the air down to the dew-point temperature. Fog is classified by the dominant formation process and exists as long as processes continue to maintain saturated conditions. There are several basic types of fog:[117]

- Radiation Fog is caused by cooling close to the Earth's surface. The Earth gives off long-wave radiation, which on

[117] http://www.usatoday.com/weather/tg/wrainfog/wrainfog.htm, http://www.usatoday.com/weather/wfog.htm https://www.farmersalmanac.com/six-different-names-for-fog-20887

a clear night travels out into space. If the temperature drops to the dew point close to the ground, radiation fog can form. Radiation fog is also known as ground fog. The fog normally disappears soon after sunrise as the sun's warmth evaporates it.

  - Valley Fog is one type of Radiation Fog that forms in mountain valleys during winter and can be more than 1,500 feet thick. Often, the winter sun is not strong enough to evaporate the fog during the day. When the air cools again the following night, the fog often becomes thicker, which makes it even harder for the sun to burn it off the following day. These fogs can last for several days until strong winds blow the moist air out of the valley. The tendency for cool, dense air to pool at the bottom of valleys also enhances valley fog.

- Advection Fog results from the movement (advection) of warm, moist air from the south over a colder land mass. During the winter, this is common when snow covers much of the Midwest. The snow cools the bottom portion of the moist airmass, often resulting in condensation. The thickest advection fog usually forms during nights with light winds because humid air near the ground is not mixed with the drier air above. With light winds, the fog near the ground can become thick and reduce visibility to zero; usually, the fog burns off during the day, but it can last many days if it is thick enough to block out the sun's light. This type of fog can occur almost anywhere in the United States, especially during winter warm-ups and early spring thaws. It can be widespread and very dangerous to commuters and aircraft travel.
- Evaporation Fog around Wisconsin is caused by cold air crossing over warmer bodies of water. The water evaporates its moisture into the colder air, which immediately condenses it into clouds and fog. This is what looks like steam over Lake Michigan, inland lakes, and rivers on a cold autumn or winter day. This rising fog can be found above thermal pools in Yellowstone National Park and is what you see when cool rain hits hot pavement. This may also be called "steam fog" or "sea smoke" when it forms over oceans. Sometimes this fog is lifted quickly and forms rotating whirls of fog known as *steam devils*.